DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2010/137

A photogeological study of the system of faults and dykes in an area in western Disko

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MINISTRY OF CLIMATE AND ENERGY

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Introduction

Understanding the geology in the coastal areas of western Disko, West Greenland, is important to exploration companies operating in the offshore areas west of Disko, because this provides a link between offshore and onshore geology. Western Disko has previously been studied by Pedersen (1977) who presented a detailed map of the area in scale 1:50.000, and the area is also shown on the 1:100.000 map sheet Mellemfjord (Pedersen & Ulff-Møller 1997). This report summarizes new results from a minor study of the intrusive and structural geology in a part of the area mapped by Pedersen (1977). The location of the study area is indicated in Figure 1. The results of this work will later be integrated with the results of a larger project that investigates the intrusive pattern on both Disko and Nuussuaq and forms part of the author's PhD thesis.

Method

The area is characterized by steep alpine terrain and is therefore well suited for studies by multi-model photogrammetry (Dueholm 1992). This work is based on photogrammetric interpretations of a set of 39 new coloured digital aerial photographs acquired in the summer of 2009 by Fugro Aerial Mapping, in combination with a set of oblique photographs acquired during several seasons of field work by Asger K. Pedersen. Both aerial and oblique photographs were set up in GEUS's photogeological laboratory's SOCET SET digital photogrammetric workstation. Apart from being able to map 3D geological features, SOCET SET is also used by GEUS to add data to our extensive topographical map databases. For this particular project the geological features were mapped in three dimensions and later analysed for structural trends in self-developed software written by Keld S. Dueholm. Typical errors on dyke and fracture orientations are estimated to around 1-2 degrees, while the error on fault orientation is influenced by the often broader, ill defined fault-zones and is typically around 5-10 degrees.

Results

The results of the new mapping are presented in an overview map (Figure 2) and in two detailed maps (Figures 3 and 4). From inspection of these it is evident that mapped dykes, fractures and faults are oriented in specific prominent directions. This is illustrated in Figure 5 which shows the data in rosette diagrams. From this it is seen that the mapped dykes have a preferred orientation around 175°. The mapped faults have the same preferred orientation and there is an additional group of faults clustering around 85-90°, approximately perpendicular to the main part of the data. Fractures, however, are generally oriented around 10° and 160° and form a conjugate set with the dykes and main fault set oriented perpendicular to the minimum stress direction (extension). The relatively small angle of 30°

between the conjugate fractures is consistent with the fracturing taking place at relatively low confining pressure.
The results are generally in good agreement with the 1:50.000 map of Pedersen (1977) and only a few new dykes have been identified during this work. The main differences are that some features mapped as dykes by Pedersen (1977) are now mapped as fractures or in a few cases not identified. The differences are however negligible and the results confirm the work of Pedersen (1977).
The volcanic succession dips 2-4°W with a strike of c. 170°, i.e. parallel to the dykes and faults. The sucession comprises the upper part of the Maligât Formation, namely the upper Rinks Dal Member, Nordfjord Member, Niaqussat Member, and Sapernuvik Member. The Sapernuvik Member forms the youngest Paleocene lavas known from Disko and Nuussuaq; only three lava flows are preserved but the member would presumably have been thicker before uplift and erosion (Bonow et al. 2006). The whole exposed succession in the study area is measured as 900 m thick, but extrapolating from the lower levels (middle and lower Rinks Dal Member) exposed up to 20 km to the east, the Maligât Formation 'going to sea' in the study area is at least 1500 m thick. This can also be seen from the vertical geological section in scale 1: 20 000 that covers the area (Pedersen et al. 2003).

Conclusions

1. The dykes and the main part of the faults in the study area generally strike 175°, while the fractures form a conjugate set with an acute angle of 30° between directions.
2. Dykes, faults and fractures were formed in the same stress field at relatively low confining pressures.
3. The volcanic succession in the area is at least 1500 m thick.

References

Bonow, J.M., Japsen, P., Lidmar-Bergström, K., Chalmers, J.A. & Pedersen, A.K. 2006. Cenozoic uplift of Nuussuaq and Disko, West Greenland – elevated erosion surfaces as uplift markers of a passive margin. Geomorphology **80**, 325–337.

Dueholm, K.S. 1992: Geological photogrammetry using standard small-frame cameras. In: Dueholm, K.S. & Pedersen, A.K. (eds): Geological analysis and mapping using multi-model photogrammetry. Rapport Grønlands Geologiske Undersøgelse **156**, 7–17.

Pedersen, A. K. 1977: Tertiary volcanic geology of the Mellemfjord area, south-west Disko. Rapport Gronlands Geologiske Undersogelse **81**, 35–51.

Pedersen, A. K. & Ulff-Møller, F. 1984: Geological Map of Greenland, 1:100 000, Mellemfjord 69 V.1 Nord. Copenhagen: Geological Survey of Denmark and Greenland.

Pedersen, A.K., Larsen, L.M., Pedersen, G.K., Heinesen, M.V. & Dueholm, K.S. 2003: Geological section along the south and south-west coast of Disko, central West Greenland. 1:20 000 coloured geological sheet. Copenhagen: Geological Survey of Denmark and Greenland.

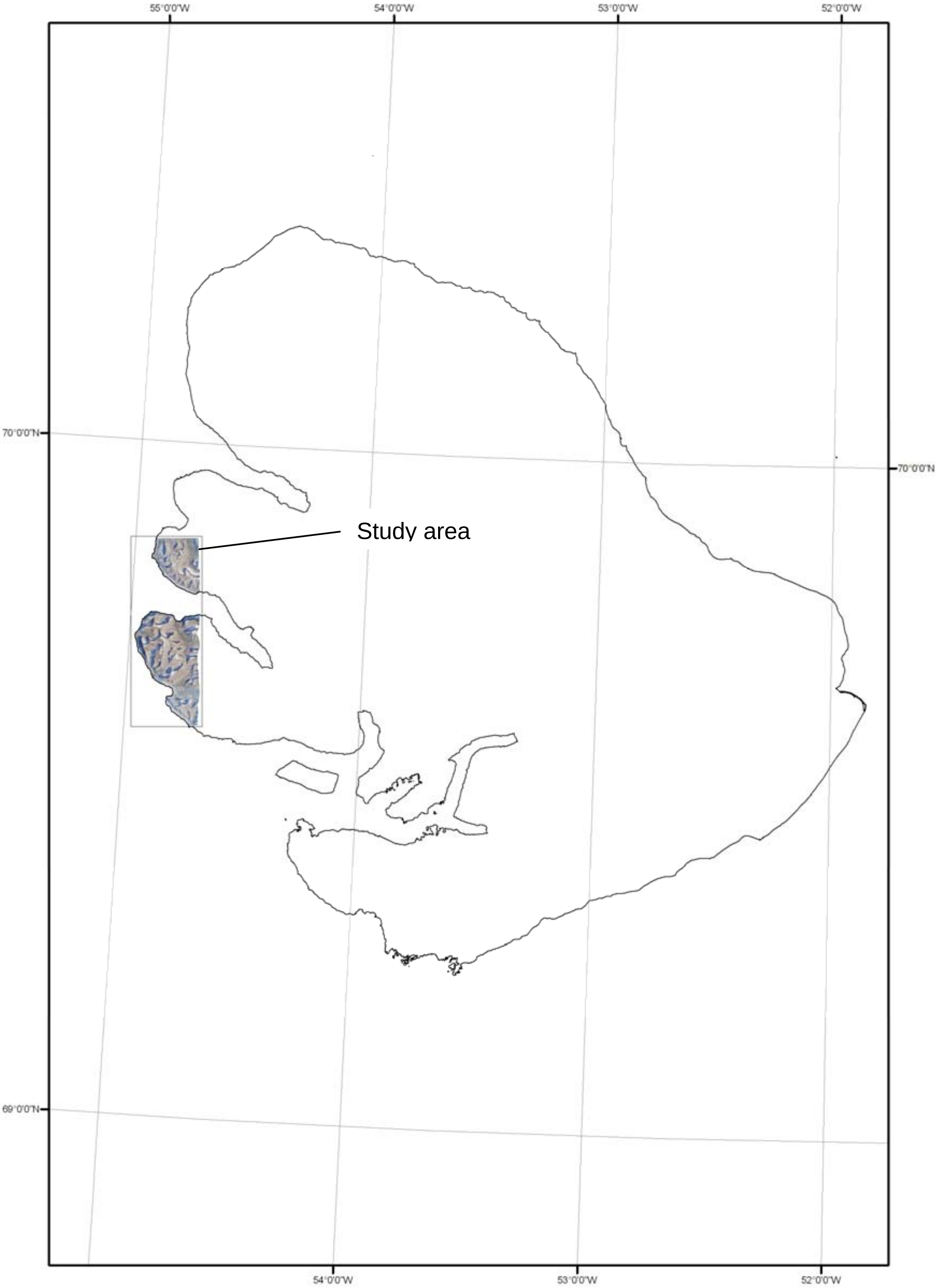


Figure 1. Overview map in scale 1:750.000. The location of the study area is indicated by the outline of the inset box.

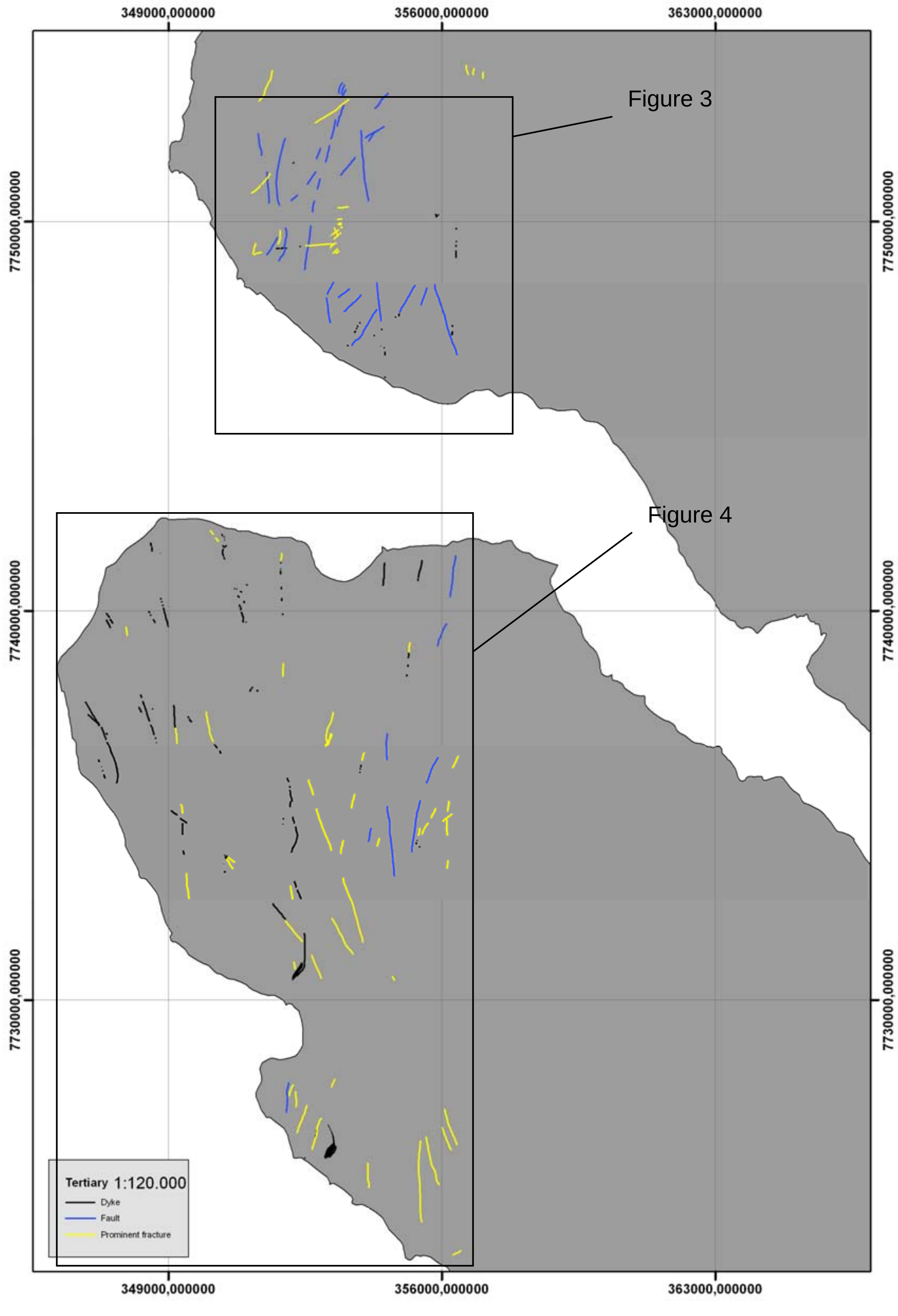


Figure 2. Map of the study area in scale 1:120.000, showing the location of the mapped dykes (black lines), faults (blue lines), and prominent fractures (yellow lines). Inset boxes indicate the outlines of Fig. 3 and Fig. 4.

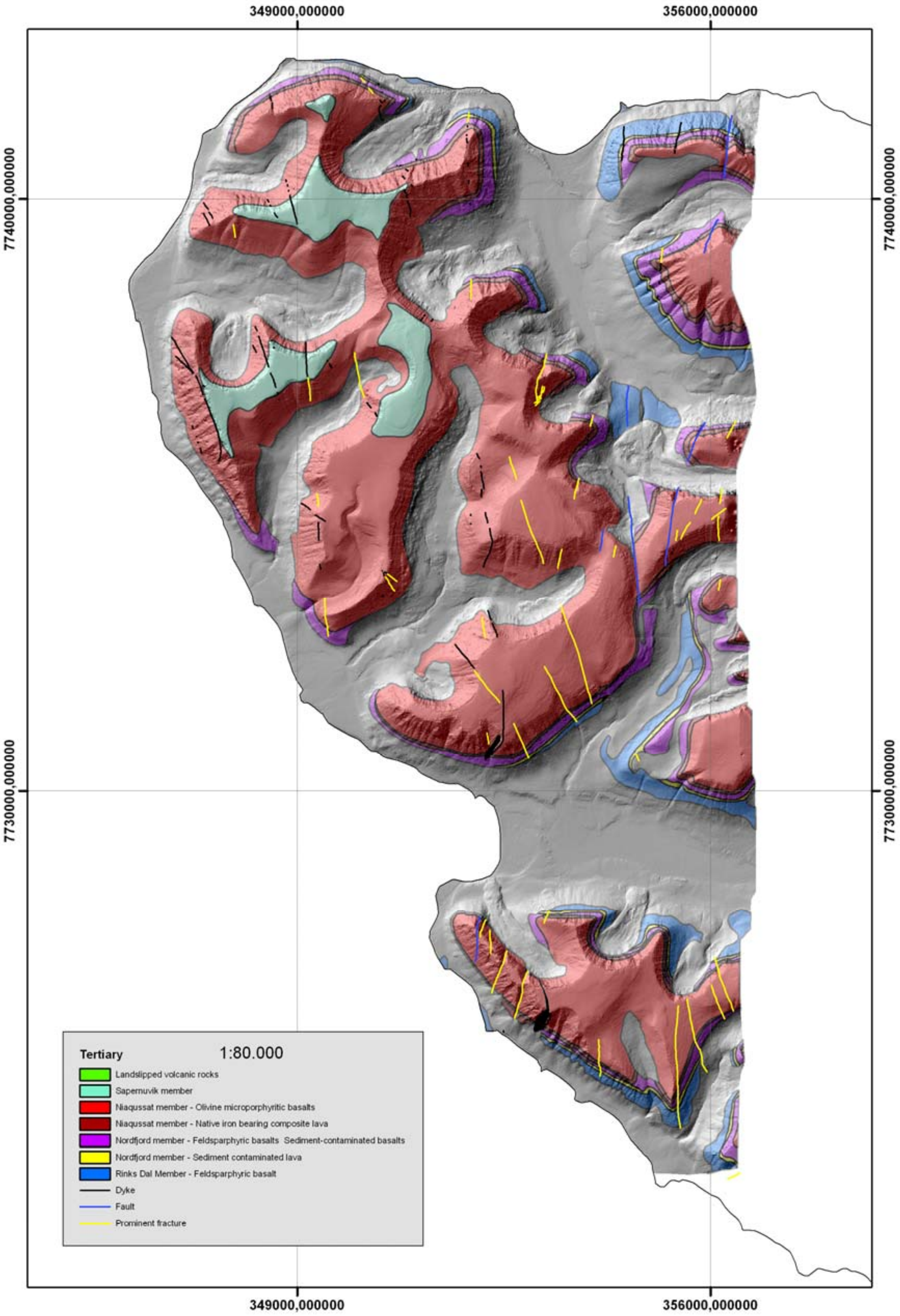


Figure 3. Close up map of the study area indicated in Fig. 2. The results are shown on a shaded relief of the Digital Elevation Model overlain by a digitized version of the Pedersen (1977) map. Legend in the figure. Only pre-Quaternary units are shown.

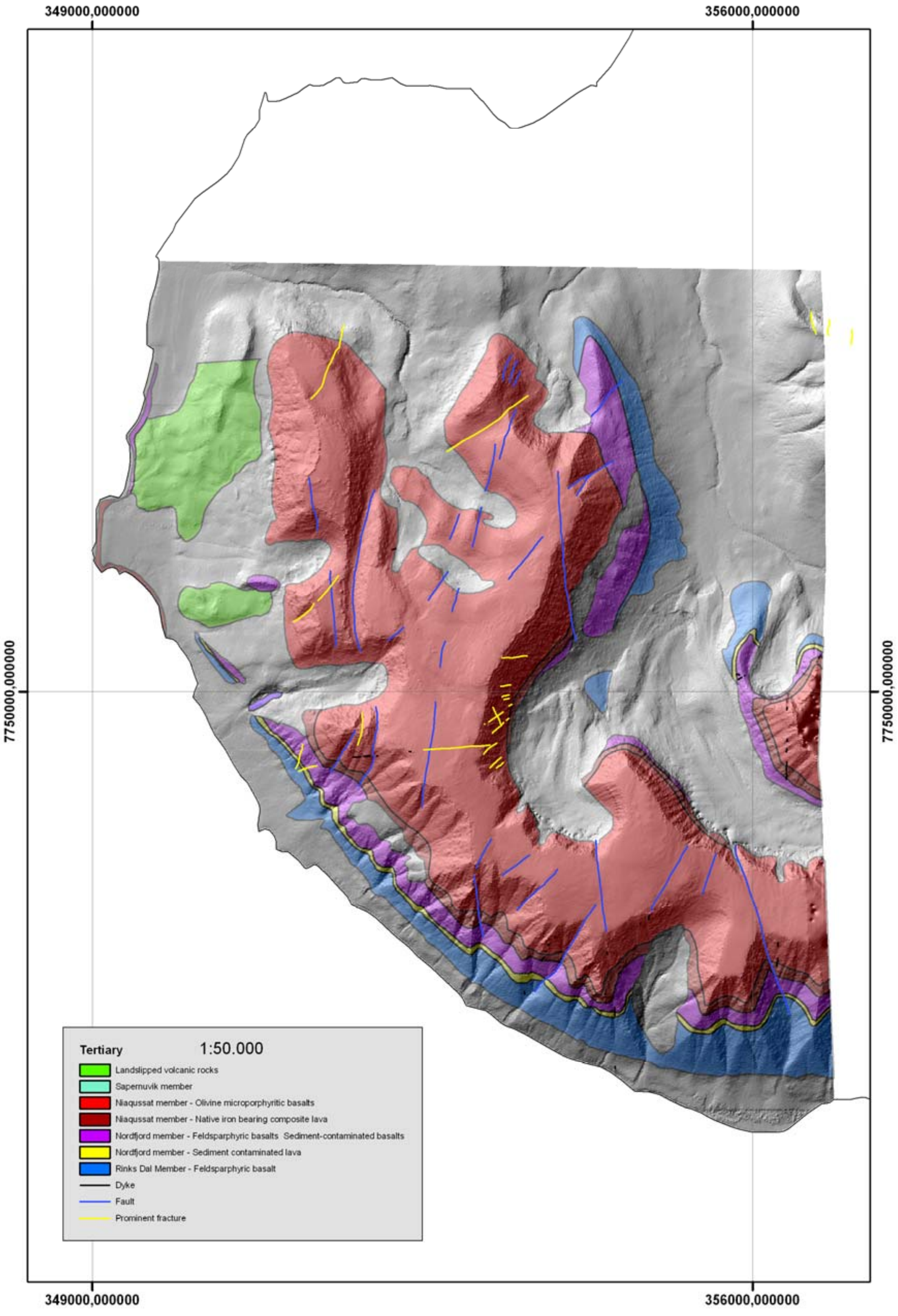
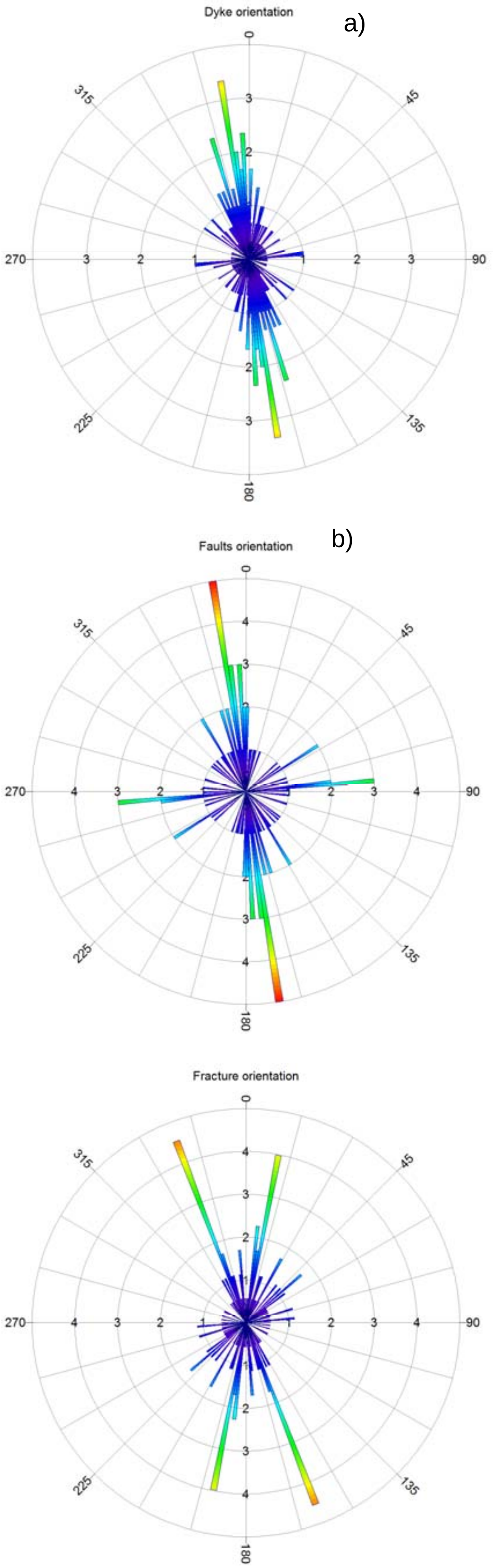


Figure 4. Close up map of the study area indicated in figure 2. Text as in figure 3.



n = 149

n = 50

n = 88

Figure 5. Rosette diagrams showing the preferred orientation of dykes (a), faults (b) and prominent fractures (c). The results are given as percentage of total, and the class interval is 2°.