AUTOMATIC DETECTION OF CIRCULAR OUTLINES FROM IMAGES OF GRAVITY AND AEROMAGNETIC FIELDS.
S. O. Krøgli[1], H. Dypvik[1] and B. Etzelmüller[1], [1]Department of Geosciences, University of Oslo, P.O.Box 1047, Blindern, N-0316 Oslo, Norway - sveinkro@geo.uio.no, henning.dypvik@geo.uio.no, bernd.etzelmüller@geo.uio.no.

Introduction: Compared to Sweden and Finland the number of Norwegian impact structures is low [1]. This fact initiated a systematic search for new impact structures in Norway by geographic information and image analysis. Different automatic techniques for detecting impact structures have been applied. This study is part of a cooperation program between the Universities of Oslo and Helsinki, the European Space Research and Technology Centre (ESA/ESTEC), and the geological surveys of Norway and Finland. The objectives are to develop workable automatic search algorithms and to discover new impact structures in Fennoscandia.

Geophysical data and impact structures: Fresh impact craters and associated breccias are characterized by their circumform shape [2]. The active Earth will eventually erase the surface expression and leave only deeper parts of the impact structures. In addition to topographic changes, physical properties of the target area may change after impact and lead to e.g. anomalies in the gravity and magnetic fields. An impact generated, generally circular, negative gravity anomaly is commonly found [3]. For complex craters a positive anomaly may be found at the central peak [3]. Magnetic anomalies display large variations across impact structures, but circular magnetic regions occur [3],[4]. Using simple circular shape characteristics enables the application of pattern recognition of spatial data by automatic detection methods. Possible impact craters may be detected, but additional field observations and laboratory analyses are needed to determine the impact origin.

Algorithm: Gravity and aeromagnetic data from Finnmark County [5] (Norway) are explored for circular features using a circular "rim-algorithm". A few different versions of this algorithm have been developed, all operating without a preceding edge detection requirement. In these algorithms it is the direction of the gradient that is important and the gradient value itself may be low. One method utilizes the aspect of the field surface. At a given radius, it calculates the ratio of circular outline pixels having a directional gradient towards a centre pixel compared to the total amount of circular outline pixels. The algorithm detected several circular features, e.g. on gravity data from Finnmark (Fig. 1), filtering of the results is needed. To refine and reduce the number of candidates, overlapping features should be removed and e.g. symmetry or results from other data should be inspected.

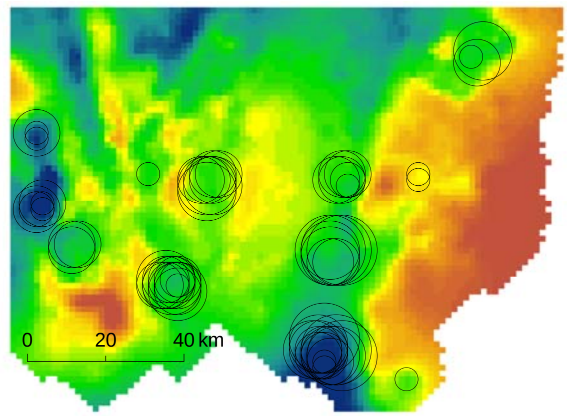

Fig. 1. Gravity field example, Finnmark, Norway. 1500 m spatial resolution, search interval from 6 km to 40 km. Two classes of circular features are displayed based on size and ratio. Ratio is the amount of outline pixels having a gradient in the direction of the centre compared to the total amount of outline pixels. The features with diameter less than 10 km have a ratio higher than 90 and those with diameters larger than 10 km have a ratio higher than 70.

Discussion: The spatial resolution of the regional data influence on the size of the detected features. Performing the analyses on e.g. a 100 m model may detect smaller features than the large-scale features resulting from analyses on the 1500 m model (Fig. 1). The algorithm has yet to be run on data including proven impact structures. With such data, parameters and thresholds may be calibrated for testing on data from other regions.

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