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Identification of Alteration Zones Associated with Hydrothermal Mineral Deposits within Aeromagnetic Data

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Aeromagnetic data can be effectively used for the prospectivity analysis of hydrothermal mineral deposits because the mineralising process commonly causes variation in the amount of magnetite in the rocks. In the case of structurally controlled mineral deposits, although magnetite may be created in the alteration zones associated with the hydrothermal fluids, it is much more common for the alteration to be magnetite destructive. This results in linear negative anomalies in the data coincident with major faults. In the case of porphyry-style mineralisation, the area of alteration is much larger and is roughly circular. There are approximately concentric alteration zones surrounding the central intrusion and in some parts magnetite is destroyed and in others it may be created. The result is annular magnetic responses which may be positive or negative with respect to the surrounding areas.

Automatic image analysis provides an objective and efficient means to identify geologically favourable environments for mineralisation within large magnetic datasets. Shape based feature detection techniques can be applied to identify either linear or circular alteration zones within the data. Here we describe the use of such methods for prospectivity analysis for Archaean lode-gold deposits and porphyry copper-gold deposits.

Linear features are found using a combination of texture analysis and line-like feature detection techniques. The texture analysis technique examines local magnetic variations and then laterally continuous regions that have high local magnetic variations are detected using a contrast and scale invariant line-like feature detection technique. In the feature detection process, bilateral symmetric characteristics of line-like features are effectively sought within the frequency domain. This technique is used to find lithological boundaries and shear zones for the prospectivity analysis of Archaean lode-gold deposits.

Concentric alteration zones are detected using the radial symmetry transform [1]. Given a set of radii of the features being searched, the radial symmetry transform finds circular features using local image gradients. Elevated or depressed circular features are identified based on a degree of convergence or divergence of image gradients respectively. This circular feature detection technique is used to find magnetic signatures of porphyry deposits.

[1] G. Loy and A. Zelinsky. Fast radial symmetry for detecting points of interest. IEEE Transactions on Pattern Analysis and Machine Intelligence, 25(8):959–973, Aug. 2003.