Mapping Basement Structures in the Peace River Arch of Alberta Using Monogenic Signal Decomposition of Magnetic Data

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Abstract

Magnetic method is well-known as one of the most powerful tools used to map concealed geological structures especially those associated with magnetic crystalline basements. Crystalline Basements play an important roll in oil and gas exploration in sedimentary basins because they influence the geology of the overlying sedimentary rocks and subsequently on the formation of their oil and gas plays. Magnetic data are in general characterized by their low contrast and poor signal-to-noise ratio and therefore it is always challenging to extract subtle geological features from these data. Therefore, image enhancement is vital for extracting optimum geological and structural information from magnetic data. In this abstract, a new magnetic image enhancement approach is proposed. This approach is based on a recently developed digital processing technique known as monogenic signal decomposition. This new technique is able to decompose 2D magnetic signals into three primary attributes (amplitude, phase and orientation) and two secondary attributes (directional Hilbert and Riesz transform). Although many magnetic attributes have been utilized to map subtle geologic features, these five attributes appear to add more valuable information to magnetic data interpretation. The aim of this study is therefore to explore the monogenic signal decomposition approach as an alternative technique to extract geological and structural information from magnetic data.

This abstract therefore describes the rotation-invariant monogenic signal decomposition and demonstrate their use in enhancing magnetic data. The monogenic signal decomposition technique was first tested on the total magnetic intensity (TMI) grid of a synthetic magnetic data and after obtaining satisfactory results the technique was applied to real magnetic data. The synthetic magnetic data was derived from Bishop 3D magnetic model whereas the real data was derived from an aeromagnetic survey flown over the Peace River Arch structure of Western Canada Sedimentary Basin (WCSB). The results obtained from the synthetic and read data indicate that the proposed approach has excellent performance in extracting structural features especially geological boundaries, faults and fractures from the data.