3D Aeromagnetic Mapping of the Williston Basin Basement

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Abstract

Regional magnetic anomalies are sensitive to the variations of the structure and composition of the crystalline basement. Most bodies within the basement have distinctive magnetic signatures which are characterized by their magnitudes, heterogeneity, and magnetic fabric. When calibrated with known geology, basement structures can often be mapped from aeromagnetic data under the cover of sedimentary rock.

The most important and accurate information provided by magnetic data is the structural fabric of the basement. Major basement structures can be interpreted from consistent discontinuities and/or pattern breaks in the magnetic fabric. Once the structures have been evaluated, correlated, and combined with those interpreted from the gravity data, a model for the evolution of the basement and overlying basins can be developed.

In this study, we focus on direct magnetic basement depth estimation from grid aeromagnetic data within the Saskatchewan and Manitoba parts of the Williston Basin. The objective is to produce a seamless and integrated interpretation of the basement and extend the previous interpretations by Miles et al. (1997), Kreis et al. (2000), and Pilkington and Thomas (2001). We analyse patterns observed in several attribute maps derived from aeromagnetic grids, invert for basement depth, and identify domain boundaries and structural patterns. The magnetic source inversion technique is employed and calibrated using well log data. The resulting depth maps are interpreted for structural fabric, revealing several groups of linear magnetic contrasts at different scale lengths.