

Delineation of Remanently Magnetized Intrusions Using Full Tensor Magnetic Gradiometry

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Magnetic surveys are extensively used to detect and delineate subsurface structures and ore-bearing systems. As near-surface, high-grade deposits become increasingly rare, new technologies are proving beneficial for delineating targets in more complex geological settings, including remanently magnetized environments. One such technology gaining attention is full tensor magnetic gradiometry (FTMG), which measures the spatial derivatives of the magnetic field that are not available from conventional total magnetic intensity (TMI) measurements, providing improved constraints on the magnetic source geometry and characterization. As deployed using a commercially available Superconducting Quantum Interference Devices (SQUID), FTMG provides enhanced imaging of subtle geological structures and magnetic lithological variations due to the FTMG system's improved resolution, lower noise, and magnetic directional sensitivity. To support the evaluation and broader application of this emerging technology, high-quality, open-access datasets are essential for de-risking its use within an exploration framework, enabling more confident adoption and providing baseline case studies.

To address this, the Geological Survey of Canada is acquiring and openly disseminating pre-competitive FTMG datasets. These datasets provide real world benchmarks for method development, inversion testing, and evaluation of emerging quantum sensors. This study presents SQUID-derived data and inversion results over a remanently magnetized magmatic sulfide deposit within the Midcontinent Rift of North America. Compared to TMI inversion, the SQUID-based inversions better delineate the intrusion, particularly when constrained by physical rock property measurements. These results highlight the value of FTMG in remanently magnetized environments and provide open access datasets that support ongoing methodological development across government, academia, and industry.