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Resolving Whole-Lithospheric Architecture for Mineral Prospectivity and Beyond: A Probabilistic Inversion Approach

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The architecture of the lithosphere is shaped by diverse geodynamic processes, including the presence of metasomatized mantle volumes, lithospheric thickness transitions, crustal- and mantle-scale fluid migration pathways, and the influence of plumes and subducting slabs. These features are preserved in the physical and chemical structures of the lithospheric mantle and sub-lithospheric upper mantle, providing critical insights into mineral systems and resource prospectivity.

To address these complexities within the Canadian lithosphere and mantle, we apply a probabilistic inversion framework, **LitMod**, which integrates geological constraints with multiple geophysical techniques and incorporates a priori geochemical information. This unified approach enables the resolution of key lithospheric features, distinguishing between compositional (e.g., metasomatism) and thermal anomalies.

We present results from the first application of LitMod to Canada, highlighting its capability to map essential geophysical structures and surfaces. Validation of the model's predictions using independent geochemical datasets underscores the robustness and reliability of our results. Beyond advancing mineral prospectivity, this work contributes to broader geoscientific applications, including refining Glacial Isostatic Adjustment (GIA) models, improving Carbon Capture, Utilization, and Storage (CCUS) strategies, and enhancing seismic hazard assessments.