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An improved 3-D constrained stochastic gravity inversion method, adapted to the crustal-scale study of offshore rifted continental margins

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While seismic methods provide the best geophysical methods for characterizing crustal structure, regional potential field studies and, specifically, constrained 3-D potential field inversion studies, provide an efficient means of bridging between seismic lines and obtaining regional views of deep structure. Most existing potential field inversion codes have been developed for the mining industry with the goal of delineating dense bodies within less dense half-spaces. While these codes can be successfully applied to crustal-scale targets, they are not designed to generate models with the kind of depth-dependent layering expected within the crust and upper mantle and consequently, the results must be interpreted with such limitations in mind.

The development of improved inversion codes that will produce results that better conform to known density distributions within the crust and uppermost mantle will revolutionize the application of potential field methods for the study of rifted continental margins where only limited seismic constraints are available. Through insights gained from using existing inversion codes, we have developed a 3D inversion algorithm based on the constrained stochastic method and adapted it for use in regional crustal-scale studies. The new method honours existing sparse seismic constraints and generates models that can reproduce sharp boundaries at the base of the crust as well as more gradational density variations with depth for the crust to upper mantle transition. The improved regional crustal models provide crustal thickness estimates and crustal stretching factors that agree with the sparsely available seismic constraints, while also generating more realistic Earth models. Both synthetic and real examples from offshore eastern Canada, will be used to demonstrate the power of the new method.