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Crustal geoneutrino signal expected at SNO+

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Thanks to an overburden of 6 km water equivalent and to a large mass of ultrapure liquid scintillator, the SNO+ detector is designed for performing low energy neutrino physics measurements and will address several fundamental physics goals, among which the study of geoneutrinos. The geoneutrino signal produced by U and Th distributed in the whole Earth's mantle is comparable to that originated by the 50 km × 50 km Close Upper Crust surrounding SNO+. Regional characterization of the continental crust is generally performed through either geologic mapping, geochemical sampling, or geophysical surveys. Rarely are these techniques fully integrated, due to limits of data coverage, quality, and/or incompatible datasets. We combine geologic observations, geochemical sampling, and geophysical surveys to create a coherent 3D geologic model of the Close Upper Crust surrounding SNO+, which includes the Grenville Front Tectonic Zone, the Southern Province, the Superior Province, and the Sudbury Igneous Complex. Nine aggregate geological units are geologically characterized, geophysically constrained and geochemically probed with 112 rocks samples representative of the different lithologies, whose U and Th contents have been assessed via HPGe and ICPMS measurements. According to this coherent numerical 3D model, the predicted heat production at SNO+ is 1.5+1.4-0.7 μW/m3 and the expected geoneutrino signal from the Close Upper Crust is 7.8+8.4-3.2 TNU (a Terrestrial Neutrino Unit is one geoneutrino event per 1032 target protons per year) to be compared with a total bulk crust signal of 31.2+8.6-4.7 TNU. The 1σ variability of the geoneutrino signal given by the Close Upper Crust strongly limits the SNO+ potentials for discriminating among different BSE compositional models of the mantle on the base of geoneutrinos experimental measurements. Future works aimed at constraining the crustal heat production and the geoneutrino signal at SNO+ will be inefficient without a geophysical characterization of the 3D structure of the heterogeneous Huronian Supergroup, which provides the largest uncertainty on the expected signal.

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