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# Working around microanalytical data gaps to make multiscale predictions-exploring the Bon Accord nickel mineral species

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The ~3.5 Ga South African Bon Accord nickel oxide deposit comprises a globally unique combination of Ni-rich minerals. The abundance of the Ni-$Fe^{3+}$-spinel trevorite has resulted in many complex formation theories, including either Fe-Ni meteorite impact or fragmentation and migration of a part of the Archean Earth's core. Reexamination of the materials using modern petrographic and geochemical techniques have recently associated the Bon Accord Deposit with metasomatism of oceanic lavas. This suggests the possibility that the outcrop represents an ancient hydrothermal vent. Strongly supporting this model is the only known natural occurrence of the boron-bearing Ni-oxide, bonaccordite. Normally observed to form as precipitates on fuel rods of nuclear reactors in an anthropogenic context. This synthetic occurrence demonstrates a clear link in bonaccordite mineralization with high temperature fluid flow, as would also be expected in a hydrothermal setting.

In this work, we present initial results of a program designed to constrain the abundance of bonaccordite in a natural sample leveraging a physics –informed machine learning model for multiscale – multimodal characterization. As the exact locations of bonaccordite in the sample are difficult to know *a priori, we* have developed a multiscale approach leveraging physics-based priors to predict the locations of bonaccordite grains from energy dispersive spectroscopy even though standard energy dispersive spectrometers are insensitive to boron. We then feed these predictions forward to an electron microprobe where we can test them. The framework presented here is applicable to multiscale correlative challenges where nanoscale features need to be isolated from complex background. The insights gained from this sample of the Bon Accord have the potential to open up new insight to Paleoarchean fluid- rock processes.