

Trace elements in minerals that indicate nickel sulfide deposits

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Indicator minerals have long been used for the exploration of metal resources however, due to the common mineral suite and minimal alteration halo associated with intrusion-hosted magmatic sulfide deposits, there has not been a suitable suite of indicator minerals defined. In this study, we have determined a series of trace element signatures in chromite-magnetite, olivine, pyroxene, apatite, ilmenite, and plagioclase which are observed to indicate prospectivity of nickel sulfide deposits. We have created a large and robust database analysed from 1,160 samples collected from 12 case study areas in Western and South Australia and supplemented with samples from world-class ore deposits globally. These samples consist of both variably mineralised and barren examples of mafic-ultramafic intrusions. This trace element database contains more than 11,000 individual laser ablation (LA-ICP-MS) analyses of these minerals. This dataset was interpreted using machine learning models to predict the likelihood of an individual mineral analysis being associated with magmatic sulfide mineralisation. Spinel analyses were the most numerous in this study, with over 7,000 LA-ICP-MS analyses allowing for confident predictions of mineralised vs non-mineralised intrusions (77% accuracy). Based on model introspection, key elements to make these predictions included Co, Ga, V, Ni, and Cr. Further, trace element analysis of spinel shows the potential to indicate the sulfide volume as well as prospectivity. We verified that regolith formation and weathering have little effect on the trace elements in spinel, making it an ideal resistate indicator mineral for exploration. Minerals such as olivine, plagioclase, and pyroxene do not survive in the weathering profile, although these minerals still show potential for use as in-situ indicator minerals. These in-situ minerals can indicate if an intrusion is prospective for massive sulfides using minimal drilling. Trace elements within minerals have great potential to be used in active exploration for nickel resources globally.