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NICKEL HYDROGEOCHEMISTRY OF THE NE YILGARN CRATON, WESTERN AUSTRALIA

David J Gray and Ryan RP Noble

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ABSTRACT

The hydrogeochemistry of the NE Yilgarn Craton of Western Australia has been examined to assess the utility of groundwater for regional exploration for Ni sulphide (NiS) mineralisation. The principal objective of this study is to develop reliable regional and smaller-scale hydrogeochemical vectors to NiS mineralisation in the NE Yilgarn Craton. To achieve this it is critical to understand groundwater expressions of NiS mineralisation, evaluate larger scale variation in element concentrations, test different collection, sample treatment and analytical protocols, and understand groundwater-induced dispersion processes in this environment.

Approximately 300 samples were collected from exploration drill holes, wells, farm bores and groundwater monitoring bores using a bailer system. An additional 210 samples were added to the assessment from previous work at the Harmony site and from regional background samples. Field measurements included pH, Eh, EC and temperature. Separate, field preserved sub-samples were collected for cation, anion, alkalinity and (using carbon sorption) Au/ PGE analysis. Additional methodology experimentation conducted on selected samples involved a comparison of 0.1µm and 0.45µm filtration and the use of anion and cation exchange resins to adsorb low concentrations of metals.

The hydrogeochemistry of the region is dominantly fresh and neutral, with increases in groundwater salinity in the base of palaeochannels and close to salt lakes. In contrast to other regions of the Yilgarn Craton, the waters in the NE are fairly homogeneous. They also have relatively low dissolved concentrations of metals compared with groundwaters from the central and southern Yilgarn. The results reported for this study indicate that hydrogeochemical sampling searching for NiS in the NE Yilgarn has significant potential for medium (100's m spacing) scale exploration. These findings may also be beneficial for smaller scale investigation to assess "near-miss" drilling in brownfields regions, as well as investigations in hydrogeochemically-similar greenfields regions. The geochemical halo around Ni deposits is sporadic, giving several false negatives; however, there are few false positives. Most high concentrations of metals associated with the Ni hydrogeochemical signature are indicative of sulphides and mineralisation. Chromium is the best indicator element for ultramafic rocks (particularly when S-poor), whereas Ni, Co, Pt and W are the best individual pathfinders for NiS mineralisation.

Hydrogeochemical differentiation and targeting for NiS is improved by using the Box-Cox transformation and deriving critical indices from the multielement data. The indices, consistent with the model for groundwater evolution around weathering sulphides, delineate the sulphide signature independent of the type of water *i.e.*, whether the major parameters of Eh and pH are different. The better performing indices for mineralisation targeting are Miner-S and Miner-FeS that use the mineralised signature (Ni+Co+W+Pt) and take away the groundwater signatures of weathering acid producing sulphides (Mo+Ba+Li+Al) and Fe-rich sulphides (pH-Eh+Fe+Mn). Massive NiS certainly gave stronger groundwater signatures

than disseminated mineralisation, which commonly were only clearly delineated using these combined indices.

Mineral saturation indices were not generally beneficial to exploration, as nearly all samples were under saturated with respect to most ore minerals. A few exceptions included those minerals associated with U mineralisation. Although U exploration is not part of this study, preliminary results would indicate that hydrogeochemistry would be an effective tool for U exploration in the NE Yilgarn.

Method developments implemented in this study indicate the use of either 0.1 μm or 0.45 μm filter size may well be acceptable for groundwater exploration in the NE Yilgarn, but further study of Fe and Al is required. At this stage the concentrations of "dissolved" Fe and Al should be interpreted carefully in such neutral/fresh groundwaters, but seem to have little influence on the dilution or concentration of metals of interest in solution. Carbon sachets have been routinely used for Au analysis, and can be used to achieve lower detection for Ag, Pd, Pt, U, W and other metals. This is important because PGE concentrations in NE Yilgarn groundwaters are too low (< 10 ppt) for direct solution analysis. The use of carbon extracted W, Pt and Pd has been a useful vector to Ni mineralisation. Results show that concentrations of Pt and, to a lesser degree, Pd are increased close to mineralisation. Improving the detection of PGEs in groundwater may enhance exploration success using hydrogeochemistry, particularly in the NE Yilgarn. Two exchange resins, in addition to the activated carbon, were tested in the Honeymoon Well region, but generally did not enhance analysis, with the exception of W on the Dowex MAC-3 anion resin. A major advantage of the carbon compared to the other exchange resins is the sorption of both negative and positive charged ions. The carbon technique uses unfiltered waters, is easy to use, and may be more practical to the mining and exploration industry hydrogeochemical sampling.