Executive Summary

The M462 Project was conceived to develop and test a new analytical workflow to separate the <2 µm soil and sediment fractions for multielement analysis along with other, commonly not utilised physico-chemical parameters that should aid exploration. The project delivered the method, workflow, and commercialised platform (UltraFine+ certified trademark pending); and demonstrated our success in experiments, orientation field surveys and new regional geochemical map products for Western Australia. This report condenses the two-year effort into two journal –style papers.

Part 1 - Method Optimisation Report *Refining fine fraction soil extraction and analysis for mineral exploration* by Noble, R.R.P., Lau, I.C., Anand, R.R. and Pinchand, G.T.

Part 2 – Site Studies and Regional Maps *Application of ultra fine fraction soil extraction and analysis for mineral exploration* by Noble, R.R.P., Morris, P.A., Anand, R.R., Lau, I.C. and Pinchand, G.T.

Additional data products and the public data release for the regional maps are linked in the Appendices for cloud data delivery to sponsors; and the data and report will also be hosted in GSWA publications repository and GeoView.

Greenfields exploration in Australia is in decline, and the technical challenge of exploring in deeply weathered and covered regions has not been fully addressed; yet exploration success in these areas is critical to the future economy. Commonly, soil sampling is paired with acid digestion and multi-element measurement. This established approach has not changed significantly over the past 30 years: that is, digest the <250 µm soil fraction and analyse the solution for elemental concentrations. In transported cover, the mobile element signature is contained in the smallest size fractions, so we tested the clay size fraction (<2 µm) as an improved sample medium for mineral exploration.

A series of experiments were conducted to demonstrate the value of using <2 µm fractions for exploration geochemistry. Twenty seven bulk reference soils were collected in the vicinity of known mineral deposits (including background areas) that reflect the common soil types of Western Australia. By analysing fine fractions (<2 µm) we produced reproducible, reliable results, with higher concentrations than from the <250 µm fraction (average increase of 100-250%). Key benefits were the reduction of nugget effects (in Au) and the challenges with detection limits in materials that are dominated by quartz sand. Testing sub-micron fractions showed that although <0.2 µm fraction was slightly different to the <2 µm and <0.75 µm fractions there was not significant additional value. The <2 µm fraction represent the most effective and cost efficient sample medium to use. The overall method development showed that ultrasonics were not required, a dispersant was critical for solid recovery and that Na-hexametaphosphate (technical or laboratory grade) was the most effective dispersant. The developed method proved the use of a small weight for analysis was effective (0.2 g) and microwave assisted aqua regia was the best analytical method for Au detection. Our research shows obvious benefits in using fine fractions for Au. Copper and Zn were consistently and abundantly extracted from the fine particle size fraction.

We applied the UltraFine+ workflow to a number of small orientation site studies in Western Australia, and reprocessed archived regional soil samples from the Geological Survey of Western Australia to test the method to improve exploration targeting. The orientation program involved ~200 samples from the Leonora and Sir Samuel 1:250k map sheets, an area that hosts known major Au and base metal deposits. We then applied this approach to the Kingston 250k map sheet area, analysing a further 300 samples in a region on the Yilgarn Craton margins that is essentially greenfields. There has been little exploration in the region, and the original geochemical survey data was heavily censored due to the dominance of transported regolith dominated by quartz-rich sand.

Of most relevance, the study revealed a marked decrease in censored results for Au (~67% to 10% below detection limit) using historic samples, and re-assaying them enabled us to produce a new geochemistry map of the Kingston 1:250,000 map sheet.

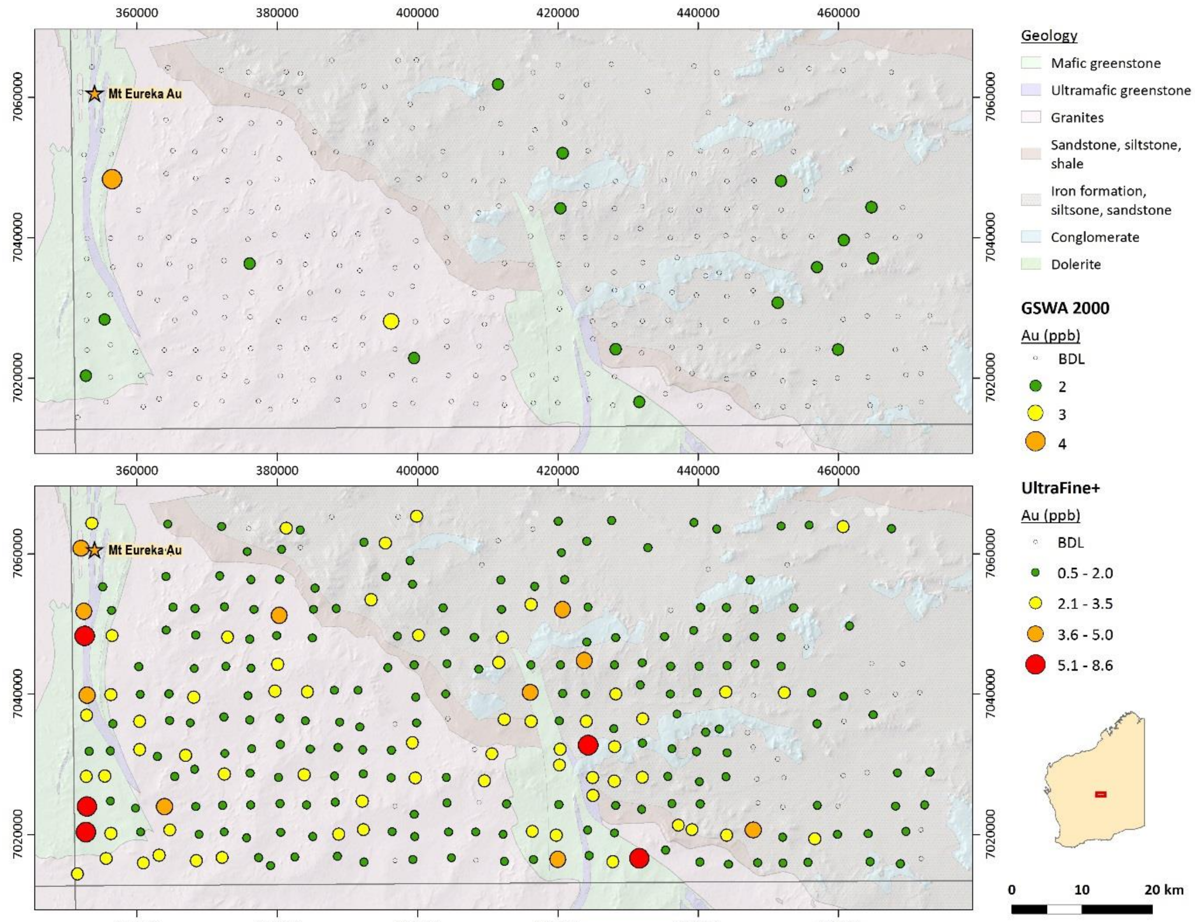

Figure: Gold (ppb) in soils in the Kingston 1:250 0000 map sheet. A) Original GSWA data with only a few detectable Au values, B) the new results of the Ultrafine+ method developed in this MRIWA project using the same samples, clearly showing the vast improvement in Au information. Mt Eureka is the only known small Au deposit in the region (mined in the 1930s). Geology is generalised and based on the data from GSWA (2014).

The new maps show geochemistry, some example indices for mineral exploration, and lithology indicators through cover, as well as map products of new interpretations using the additional spectral mineralogy proxies and particle size measurements. Adding spectral mineralogy, particle size and other physico-chemical parameters to this style of mapping is valuable, but is not commonly done, and is certainly not integrated, currently.

The application of the <2 µm particle size separation and the UltraFine+ workflow demonstrate the importance of the additional value from (re-)assaying regional soil and sediment samples to generate new targets and improve regional geochemical maps (see figure above). This is an exercise that can be applied to new greenfields surveys, and when exploration budgets are lean, applied to abundant, historically collected samples.

The developed workflow was transferred to the commercial laboratory partner (Lab West Pty Ltd) and is now being used by a number of sponsors of the project. UltraFine+ will now be available to all industry and commercial laboratories. The commercialisation of the UltraFine+ workflow (logo below) was nearly as important as the development and proof of the technique. The technique was designed to be robust for industry and streamlined enough to be economically viable.

The project has completed all its deliverables. Over the course of the project, we have determined that a number of additional developments will ensure this process is the world leader for providing better high-quality data in a useable format for future explorers. The next iteration of this workflow should improve the UltraFine+ method, particularly estimating organic C as well as building algorithms and machine learning to cloud-process the various data streams; and this should be part of the service from commercial laboratories in the future. We envisage a second project of similar size will realise the full potential of the workflow developed in this project over the next few years, and lead to a subsequent improvement to the WA greenfields exploration success rate.

UltraFine+