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Accelerating minerals exploration with in-field characterisation, sample tracking and active machine learning

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Surface geochemistry is often used when looking for new mineral deposits, especially through thick cover sequences. Three key activities are commonly carried out: (a) field-based uniform surface sampling over a broad area, (b) lab-based sample analysis to establish geochemical background and variation maps, and (c) identification of areas of interest for further investigation. Going from sample collection to geochemical maps commonly takes months, meaning companies have to wait for next year's field season to investigate interesting anomalies. By chaining together a suite of novel hardware, portable characterisation and machine learning workflows we have reduced this timeframe to just 24 hours.

Our toolchain was designed to handle remote field areas (with no network access) and rugged conditions. It included:
(a) digital metadata capture using tablets and a mobile server running a custom FAIMS sampling app (http://www.fedarch.org/faims-mobile/),
(b) International geological sample numbers (IGSN, http://igsn.org) for searchable sample tracking and management,
(c) field-portable sample preparation coupled with optimised pXRF and ASD analysis, and
(d) a live machine learning system in the field to generate updated maps on the fly, predict new measurements before they were taken, and suggest optimal placement of new sample locations.

We demonstrate these efficiencies at the remote Nullarbor Plain in South Australia. Using these tools and helicopter-based sampling we were able to collect & analyse samples and conduct targeted infill sampling to generate regional geochemical and proxy-mineralogical maps of soil and rock over an area of nearly 4000 km2, within 7 days. We achieved a reduction in field sampling times from 20 minutes to 5-6 minutes per site for 5 sampling media, with analytical preparation and processing time of 4 minutes per sample in a 3 person team, carried out the next day at camp. A probabilistic machine learning model used the relationship between geospatial data (160 features) and new pXRF data collected on-the-fly. The results demonstrate a better understanding of the regional geochemistry, quantitative assessment of variation and directed the infill sampling. These workflows will enable industry to sample more efficiently and cheaply while reducing the risk of missing the next major discovery.