REGIONAL LATERITE GEOCHEMISTRY OF THE CENTRAL YILGARN

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Many areas of lateritic residuum in greenstone belts have been tested for Au, and many for base metals, over the past 20-30 years; is laterite geochemistry now passé? We think not!

The use of laterite geochemistry for mineral exploration in Western Australia was first investigated by Mazzucchelli and James (1966). Smith et al. (1984) built on this with multi-element geochemical studies of dispersion in gossanous material from the Gossan Hill Deposit at Golden Grove, and the nearby Scuddles Prospect (Smith and Perdrix, 1983). Subsequent studies of the Greenbushes rare metal pegmatite district showed a massive multi-element anomaly of approximately 20 x 12 km (Smith et al., 1987). Between 1980 and 1993, a regional geochemical database (CSIRO-AGE) of several thousand laterite samples was generated (Grunsky et al., 1988; Grunsky et al., 1989; Grunsky, 1991; Smith et al., 1992; Anand et al., 1993; Geological Survey of Western Australia, 1998), covering substantial parts of the Yilgarn Craton, mainly greenstone-dominated areas. Between 1997 and 2000, a collaborative research project between CRC LEME and Astro Mining NL, generated a further 3900 laterite samples over approximately 100,000 km^2 of the central Yilgarn Craton, mainly in granite-gneiss terrain (Cornelius et al., in prep.). In addition to these regional surveys, exploration companies have been exploring tenements all around the Yilgarn Craton, mainly for Au and Ni, using laterite geochemistry.

With this amount of work both from exploration and research organizations, a large find such as the Boddington Au deposit would now appear rather unlikely in terrain with a lateritic mantle preserved at surface. However, that does not negate the possibility of a Boddington-size deposit or a VHMS base metal deposit under transported cover.

Lateritic duricrust and gravel, apart from being well documented widely tested sample media in the Yilgarn Craton, reflect the geochemical composition of mineralisation and its host rocks. They have a relatively uniform matrix and can contain precious, base and rare metals, as well as many pathfinder elements. Geochemical dispersion halos in lateritic residuum due to a combination of mechanical transport and hydromorphic processes can be many times larger than the target. Lateritic materials mainly occur at surface as duricrust or sandplain.

Could laterite geochemistry play a role in exploring areas of transported cover? Lateritic gravel derived from the erosion of nodular and/or pisolitic lateritic duricrust forms beds at the base of alluvium or colluvium, together with sand, clay and lithic materials (newly formed nodules and pisoliths within sediments (ferricrete) are not discussed here). The lateritic gravel appears to retain geochemical characteristics of the bedrock it formed on despite removal of cutans and fracturing into smaller pieces. However, the sedimentary process mixes the geochemical signatures both from mineralization and from country rock, thereby diluting the target signature. Mixing may also be beneficial, particularly during a first pass regional geochemical survey, as the sample will represent a far greater area than lateritic residuum. Conventional exploration commonly disregards transported materials and, where transported sequences have been falsely characterized as residual and yield anomalous results, follow-up drilling commonly fails to detect the source of the anomaly as the material may have been transported for some distance. Such anomalies are considered 'false' anomalies. However, selective multi-element analysis of lateritic gravels within colluvium and alluvium combined with the use of microprobe analysis and microscopy could expand the application of laterite geochemistry from residual terrain to areas of transported cover.

What does an anomaly or geochemical trend in transported gravel mean and can anomalies be converted into targets which can be ranked and prioritized? Several case studies in the Yilgarn Craton have shown multi-element signatures of mineralization in nearby transported ferruginous gravels and particularly at the residual regolith – colluvium interface (e.g., Harmony (Robertson, 2004), and Calista and Bronzewing (Anand, 2001)). Current studies at the Jaguar and Teutonic Bore base metal deposits found multi-element geochemical signatures in transported gravels that appear to show the Teutonic Bore mineralization displaced at least 4 km downstream from the deposit. Critical for the interpretation are knowledge of:

- regional geochemical patterns in lateritic residuum (background signature)
- geochemical signature of the targeted mineralization in lateritic residuum (target signature)
- palaeotopography and dispersion direction

Exploratory statistical techniques such as score indices, and multivariate discriminant analysis can then be applied to identify targets in transported materials (and residuum) and to vector towards these targets by, for example, contouring score indices or statistical parameters.

CSIRO/CRC LEME and GSWA have commenced laterite geochemical mapping of the western Yilgarn Craton, to establish geochemical background over the entire Yilgarn Craton, and to identify and delineate broad geochemical trends. Sampling is on a 9 km triangular grid, sufficient to show regional geochemical trends (Cornelius et al., 2001). For the western Yilgarn, the total number of samples will be 5000 of which 1900 are available from existing collections. This leaves approximately 3100 locations but it is estimated that, due to difficult access and other problems, only about 2350 will be sampled. To date, approximately 900 samples have been collected and the SW quadrant of the Yilgarn Craton will be completed by July 2005.

Representative geochemical signatures of various deposit types are currently being compiled. Most data are already available as part of previous LEME or AMIRA projects and require compilation. Some samples will have to be re-analyzed to be compatible with the regional data sets. Where geochemical signatures in residual and locally transported ferruginous nodules suggest proximity to a target, preserved micro fabrics within the nodules may give further clues as to their origin. At Golden Grove, Gossan Hill, textural information from lateritic nodules and clasts can be diagnostic (Smith, 2004).

Understanding the palaeotopography and therefore probable dispersion directions is essential for interpretation of the laterite geochemical data and vectoring towards mineralization. Company drill information (depth of transported cover) and the landform will, in many cases, be sufficient to interpret geochemical trends. Where there is insufficient information, some stratigraphic drilling or geophysical surveys may be required to fill gaps.

In summary, the significant benefits that lateritic residuum has had for surface exploration in the past and the enormous knowledge base that exists suggest that it and its transported components have been underutilized in exploration under cover and that these media may be used to explore areas of colluvium and alluvium more effectively.

Fifteen years ago, Canada had no economic primary diamond deposit. It was the efforts of some determined companies, geologists and prospectors who unraveled the indicator mineral trails in glacial tills. Glaciofluvial sediments have now led to the discovery of diamond pipes and the start of what is now one of Canada’s most important mineral industries. The transported cover of the Yilgarn Craton could be similarly utilized rather than seen as an impediment to exploration.

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