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# EASTERN GOLDFIELDS GREENSTONE GEOCHEMICAL BARCODING PROJECT – NOTES TO ACCOMPANY 2023 DATA RELEASE

JR Lowrey and RH Smithies





Government of **Western Australia**  
Department of **Mines, Industry Regulation  
and Safety**

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**Geological Survey of  
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**Michele Spencer**

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**Cover image:** Episodic tides discharge sediments along a rocky shoreline at Cable Beach, Broome. Photo by Robin Bower

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## Appendix

*Available with the PDF online as an accompanying digital resource*

Eastern Goldfields greenstone geochemical barcoding dataset

# Eastern Goldfields greenstone geochemical barcoding project — notes to accompany 2023 data release

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## Abstract

The Eastern Goldfields greenstone geochemical barcoding project, an initiative under the State Government Exploration Incentive Scheme (EIS), aims to provide a high-quality whole-rock geochemical dataset that significantly aids in investigating stratigraphic links within and between greenstone belts, particularly where primary geological context (mainly outcrop) is limited. The project seeks to substantially increase the amount of publicly available, high-quality, multi-element geochemical data from igneous lithologies forming greenstone stratigraphy, targeting diamond drillcores that sample the most geologically well-constrained parts of various greenstone belts. Through detailed geochemical sampling of diamond drillcore, we aim to establish a geochemical 'barcode' of the stratigraphy (including local variations) in these better-known sections of greenstone belts. This information, in turn, can help inform stratigraphic interpretations of less well-understood regions, based on the degree of confidence to which geochemical correlations can be made. It is also expected that this significant increase in the amount of publicly available high-quality data will lead to a significant increase in the understanding of the evolution of Archean greenstone belts, of Archean crust in general, and of related mineral systems. Much of the sampling to date has been undertaken in the Kalgoorlie–Kambalda region but has extended to other parts of the Eastern Goldfields Superterrane where opportunities have presented, including where EIS co-funded diamond drillholes are located (Fig. 1).

This Record accompanies the third annual release of the geochemical data collected as part of the barcoding project and includes all newly acquired geochemical data this year ( $n = 1405$ ), as well as the data released in the previous 2022 data release (Lowrey & Smithies, 2022). The dataset (Appendix) is fully attributed with the sample details required for a range of uses, potentially beyond the scope of the project. This Record and accompanying dataset will be updated and re-released annually. Separate Records will continue to present interpretations of these data in line with the aims of the Eastern Goldfields greenstone geochemical barcoding project. Published Records relating to this project include:

- Record 2017/7 Towards a geochemical barcode for Eastern Goldfields Superterrane greenstone stratigraphy – preliminary data from the Kambalda–Kalgoorlie area
- Record 2018/15 A new look at lamprophyres and sanukitoids, and their relationship to the Black Flag Group and gold prospectivity
- Record 2020/6 Eastern Goldfields geochemical barcoding project: notes to accompany 2020 data release
- Record 2021/5 Eastern Goldfields geochemical barcoding project: notes to accompany 2021 data release
- Record 2022/8 Eastern Goldfields geochemical barcoding project: notes to accompany 2022 data release
- Report 226 Geochemical characterization of the magmatic stratigraphy of the Kalgoorlie and Black Flag Groups – Ora Banda to Kambalda region.
- Record 2022/3 Extreme rare earth element enrichment in altered basaltic rocks of the Eastern Goldfields

**KEYWORDS:** Archean, greenstone, whole-rock geochemistry, Yilgarn Craton

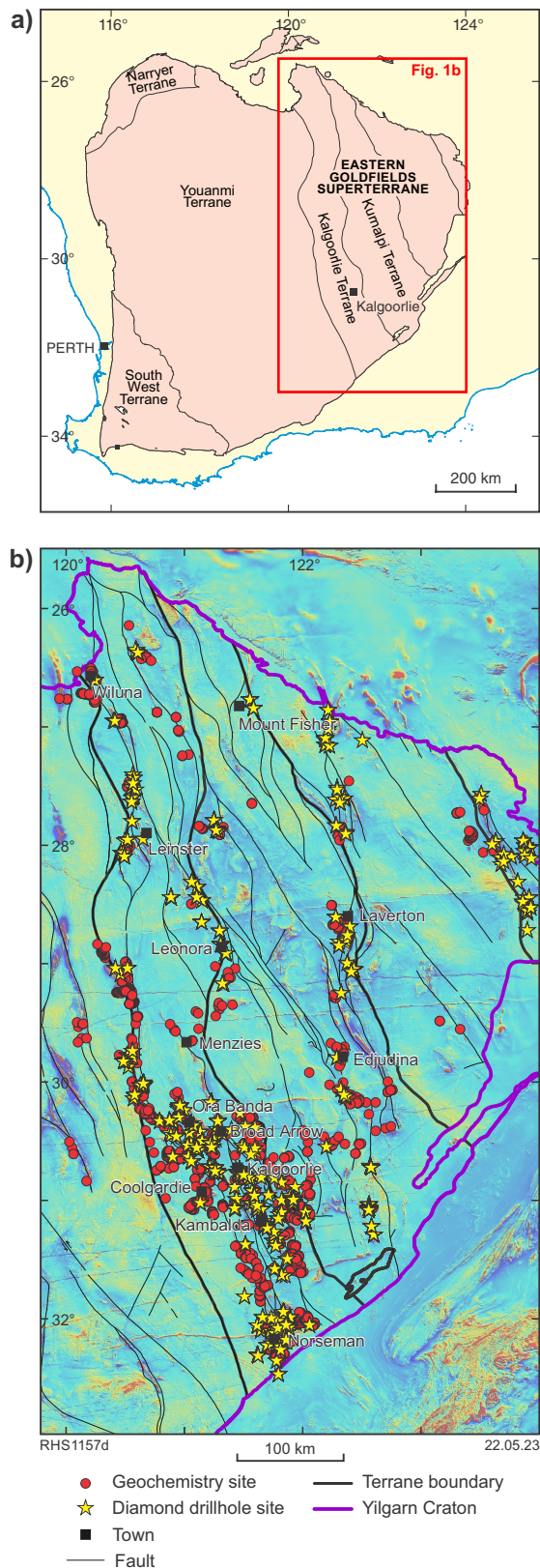


Figure 1. Eastern Goldfields greenstone geochemical barcoding project area overview and sample localities: a) location map of the study area; b) aeromagnetic image of the Eastern Goldfields Superterrane showing the locations of samples used for this study. Note that many sites represent the location of a diamond drillhole, cores from which commonly produced several samples. Hence, a single point (or symbol) may represent several samples

## Sample selection and analytical techniques

### Dataset content

The dataset in the Appendix contains only those samples collected or re-analysed specifically for the barcoding project. Other data produced by the Geological Survey of Western Australia (GSWA) and various universities and research organizations are available in published literature or in publicly available online datasets but are not reproduced in this dataset. The dataset includes whole-rock major and trace element data primarily covering supracrustal igneous (or meta-igneous) lithologies, including high-level (subvolcanic) intrusive rocks and volcanoclastic rocks. Most samples were collected from diamond drillcores, including co-funded EIS cores, donated company cores and cores to which various mining or exploration companies have provided access. A list of cores that were sampled is provided in the Appendix (under the spreadsheet labelled 'DDH details'). This list includes details relating to the location, length and average or initial orientation of the drillholes. Where orientation details are unavailable, the drillhole is assumed to be vertical. The sampling interval (length/depth in the relevant core) is noted for all drillcore samples.

In circumstances where access to diamond core is limited, and where outcrop sampling provides suitably fresh sample material, outcrop samples have been taken and are denoted as such in the dataset.

Each sample is accompanied by a geological description ('Sample description and details'). These are largely uncorrected or unedited notes made at the time of sampling.

For all samples, analyses for iron did not involve determination of ferric and ferrous proportions and all iron (total) is reported in the ferric state, denoted as  $\text{Fe}_2\text{O}_3\text{T}$ . All major element concentrations and totals are calculated and reported both considering and ignoring analytical loss on ignition (LOI), the prefix 'a' (e.g.  $\text{aSiO}_2$ ) denoting a concentration recalculated volatile free. No other derived values (e.g. ratios) are provided except for Mg# (molecular  $\text{Mg}/[\text{Mg}/\text{Fe}]$ ; with Fe calculated as  $\text{Fe}^{2+}$ ) and the Aluminum Saturation Index (ASI; molecular  $\text{Al}/[\text{Ca}+\text{Na}+\text{K}]$ ).

### Analytical methodology

Nearly all of the 7574 analyses reported here were analysed at a single commercial laboratory (Bureau Veritas [BV] Minerals Pty Ltd) employing a single set of analytical procedures, outlined below. This approach minimizes the potential for any variation in the dataset potentially attributable to variations in analytical procedure.

The dataset reported here includes 398 analyses of archived GSWA powders or crushed rock, representing 5% of the total samples. Many of these samples were pulverized using a tungsten carbide mill and their determined concentrations of tungsten (W) and cobalt (Co) were spuriously high due to contamination, so we do not report either element for that subset of data. The other 7202 samples (the majority) were collected by GSWA geologists and project collaborators from

drillcore and outcrops for the purposes of the geochemical barcoding project. Samples were visibly inspected and any weathering or excessive vein material was removed. Each sample was crushed either in-house or by BV Minerals, in both cases using a plate jaw crusher and low-Cr steel mill to produce a pulp with a nominal particle size of 85% <75 µm. A representative pulp aliquot was analysed for 13 elements as major and minor components, mass loss on ignition (LOI) and 52 elements as trace elements. Major and minor elements were determined by X-ray fluorescence (XRF) spectrometry on a fused glass disk and reported as element oxides. A fragment of each disk was then ablated by laser and analysed by induced coupled plasma mass spectrometry (LA-ICP-MS) for 49 of the 52 minor elements. Gold, Pd and Pt were analysed on a separate pulp aliquot by Pb collection fire assay and ICP-MS.

Data quality was monitored by 'blind' insertion of sample duplicates (i.e. a second aliquot of pulp or finely crushed material) at a rate of 1 per 10 unknown samples, as well as GSWA internal reference materials and certified reference materials (OREAS 24b; <www.ore.com.au>), also inserted at a rate of 1 per 10 unknown samples. BV Minerals also conducted repeat analyses of samples, variably certified reference materials and blanks. An assessment of accuracy and precision was made using data for 180 analyses of OREAS 24b, determined during the analysis of samples for the geochemical barcoding project itself. For analytes where the concentration is at least 10 times the lower level of detection (all analytes except Ag, Cd, Cl, In, Re, Sb, Se, Te, W) a measure of accuracy is provided by the agreement between the average determined value and the certified value according to half absolute relative difference (HARD); that is,  $(\text{analysis1} - \text{analysis2}) / (\text{analysis1} + \text{analysis2})$  (Stanley and Lawie, 2007). The average of measured concentrations for major and minor elements agree to within 1% of their certified values. The average of measured concentrations for most trace elements agree to within 3% of their certified or 'indicative' values. In terms of precision, the relative standard deviation (RSD), or covariance, for analysis of OREAS 24b is  $\leq 3\%$  RSD for major and minor elements. For trace elements with certified values greater than 10 times the lower analytical detection limit, most have  $\text{RSD} \leq 5\%$  (Ba, Ce, Co, Cs, Dy, Er, Ga, Gd, Hf, Ho, La, Nb, Nd, Pr, Rb, Sm, Sr, Ta, Tb, Th, U, V, Y, Yb, Zr) except for Cr, Eu, Lu, Mo, Ni, Pb, Sc, Sn, Tm (RSD between 5 and  $\leq 10\%$ ) and As, Be, Bi, Cu, Ge, Zn (10 to 15% RSD respectively). Similar levels of agreement were found for parent–duplicate pairs. All blank values were less than three times the lower level of detection.

## References

- Lowrey, JR and Smithies, RH 2022, Eastern Goldfields greenstone geochemical barcoding project – notes to accompany 2022 data release: Geological Survey of Western Australia, Record 2022/8.
- Stanley, CR and Lawie, D 2007, Average relative error in geochemical determinations: Clarification, calculation, and a plea for consistency: *Exploration and Mining Geology*, v. 16, p. 267–275.

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