Mineral Systems Atlas — a dynamic approach to the delivery of mineral exploration data

by

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The premise

An important remit of the Geological Survey of Western Australia (GSWA) is to support mineral exploration in Western Australia by providing pre-competitive geoscience data that reduce the risks related to discovery. Such data are stored in a variety of databases that have varying levels of interconnectedness and ease of querying. Currently, the onus is on the user to locate and download the relevant database(s), then extract appropriate subsets of data for use in prospectivity evaluations and target generation (e.g. Fig. 1a). This approach requires considerable understanding of the structure and content of GSWA data holdings, and for mineral explorers can be a time-consuming, inefficient use of scarce resources that could be better employed testing prospective targets sooner. GSWA recognizes that there is an opportunity to streamline the equitable delivery of pre-competitive geoscience data, by systematically interrogating its own databases to provide tailored derivatives that are of more immediate use to all mineral explorers (e.g. Fig. 1b).

Introducing the Mineral Systems Atlas

The Mineral Systems Atlas is a new online product that collates and delivers map-based geoscience data filtered to be specifically relevant to understanding and exploring for mineral deposits in Western Australia. We adopt a systematic approach to creating content by applying the mineral systems concept advocated by Wyborn et al. (1994) and McCuaig et al. (2010). The premise of this concept is that mineral deposits will only form and remain preserved where there has been a spatial and temporal coincidence of critical earth processes (i.e. geodynamic setting; lithosphere architecture; fluid, ligand and ore component reservoir(s); fluid flow drivers and pathways; depositional mechanisms; and post-depositional processes), and that the occurrence of these critical processes might be recognized from mappable geological features expected to result from them. It is these geological features ('targeting elements' in the parlance of McCuaig et al., 2010) that can potentially be extracted as digital map layers from geoscience datasets, and that may subsequently be used in Geographic information system (GIS)-based prospectivity studies.

We analyse particular mineral systems (as defined by Fraser et al., 2007) to define mappable geological proxies for critical mineralizing processes, drawing on in-house expertise, existing literature and collaborations with subject-matter experts. We then rank these proxies in terms of their robustness as targeting elements, how readily they may be generated from available GSWA databases, and how useful they are at different scales of mineral exploration (i.e. regional, camp, deposit). Structured queries are then created to extract relevant data from one or more statewide GSWA geoscience databases, for those proxies that can be practicably produced (e.g. Fig. 2). These queries operate directly on, and are dynamically linked to, primary GSWA geoscience data sources. No new data are acquired or created, although some information may be reformatted to meet the internal requirements of particular map layers. Furthermore, queries are scheduled to automatically update the derived proxy map layers whenever new data are added to the primary databases. Users may, therefore, be confident that the data layers portrayed in the Mineral Systems Atlas are always current.

Mappable proxies are delivered via an interactive online platform. The online Atlas categorizes map layers by mineral system (based on Fraser et al., 2007), or alternatively by commodity group (as defined in the MINEDEX database), and allows users to view, select and download only those datasets they require. An integral component of the Mineral Systems Atlas is an online guide that documents all aspects of the creation of the constituent map layers, and the relationships between primary and derived data (e.g. Fig. 3). The guide provides descriptions of current metallogenic models for each mineral system, the outcome of the mineral systems analyses to define the potentially mappable geological proxies and the procedures used to generate these layers. Included are query syntax and data dictionaries listing the terms used in specific queries to identify particular geological features in GSWA databases, so that users may adapt and apply the data extraction methodology to their own working environment and proprietary data.

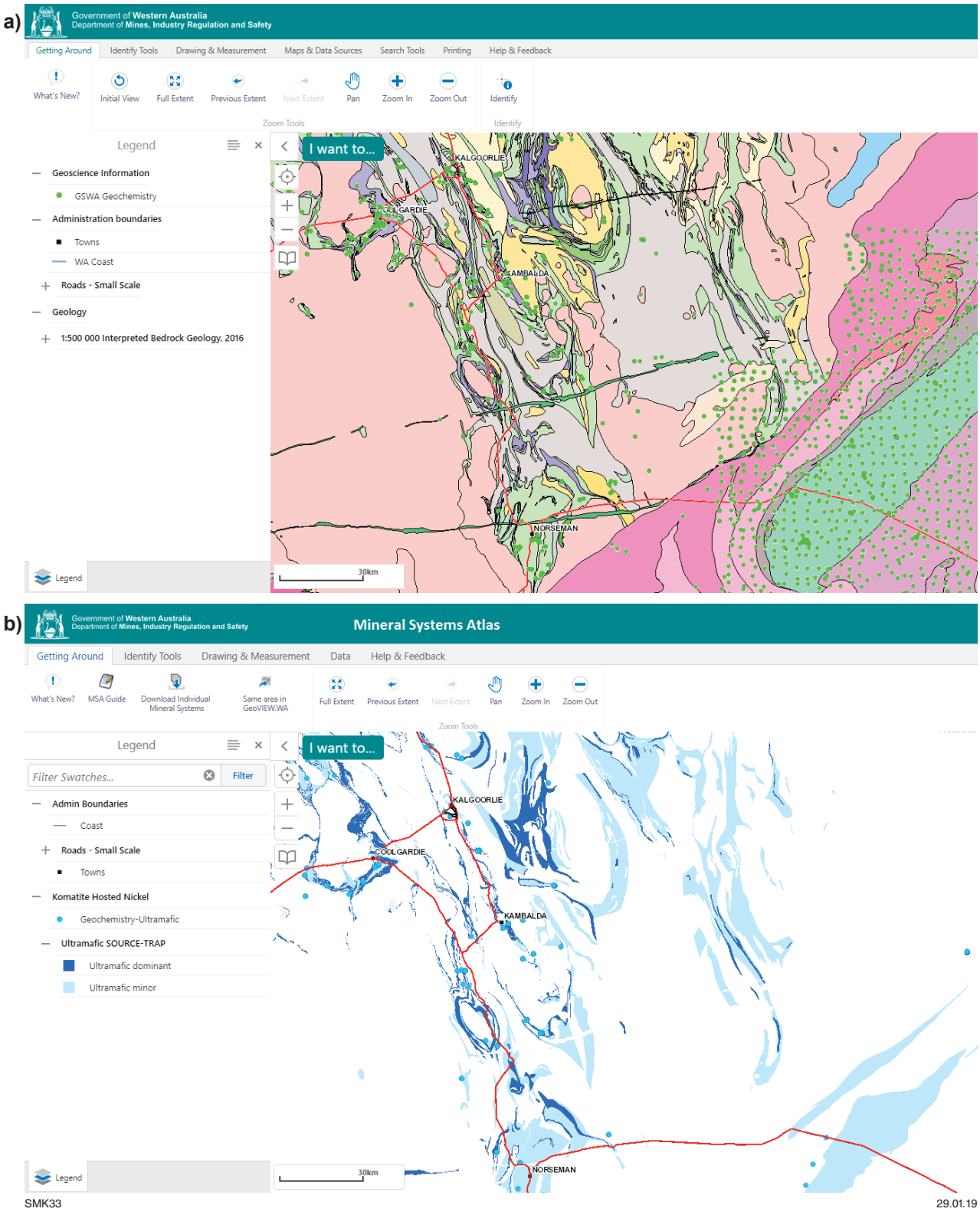

Figure 1. **Then and now — an illustration of the difference between the delivery of unfiltered data to stakeholders via GeoVIEW.WA, and providing queried data tailored to a specified mineral systems via the Mineral Systems Atlas: a) statewide 1:500 000 interpreted bedrock geology polygons are displayed for all rock types and GSWA geochemistry samples; b) a new, merged 1:500 000 and 1:100 000 interpreted bedrock geology map has been filtered to show only ultramafic rocks and GSWA geochemistry samples filtered for ultramafic rocks. Both maps are dynamically linked to the same data and are automatically updated as the source data change. Map b) is more relevant to nickel exploration and is better suited as an input for prospectivity analysis**

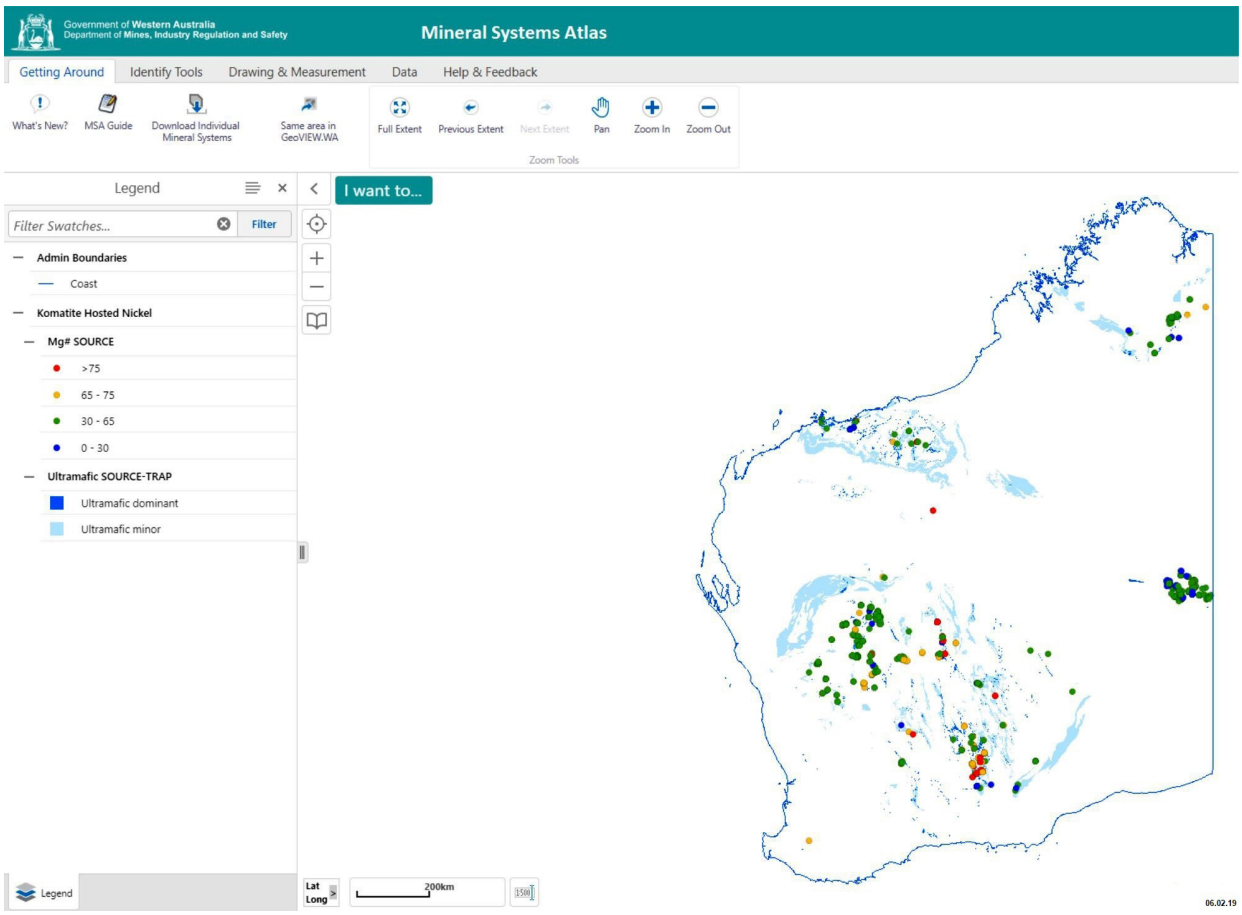

Figure 2. **Western Australian geochemistry data have been queried by selecting for ultramafic rocks and then calculating Mg numbers (100 * (MgO% / (MgO% + Fe_2O_3T%)) as defined by Rollinson (1993). Ultramafic rocks are shown in blue**

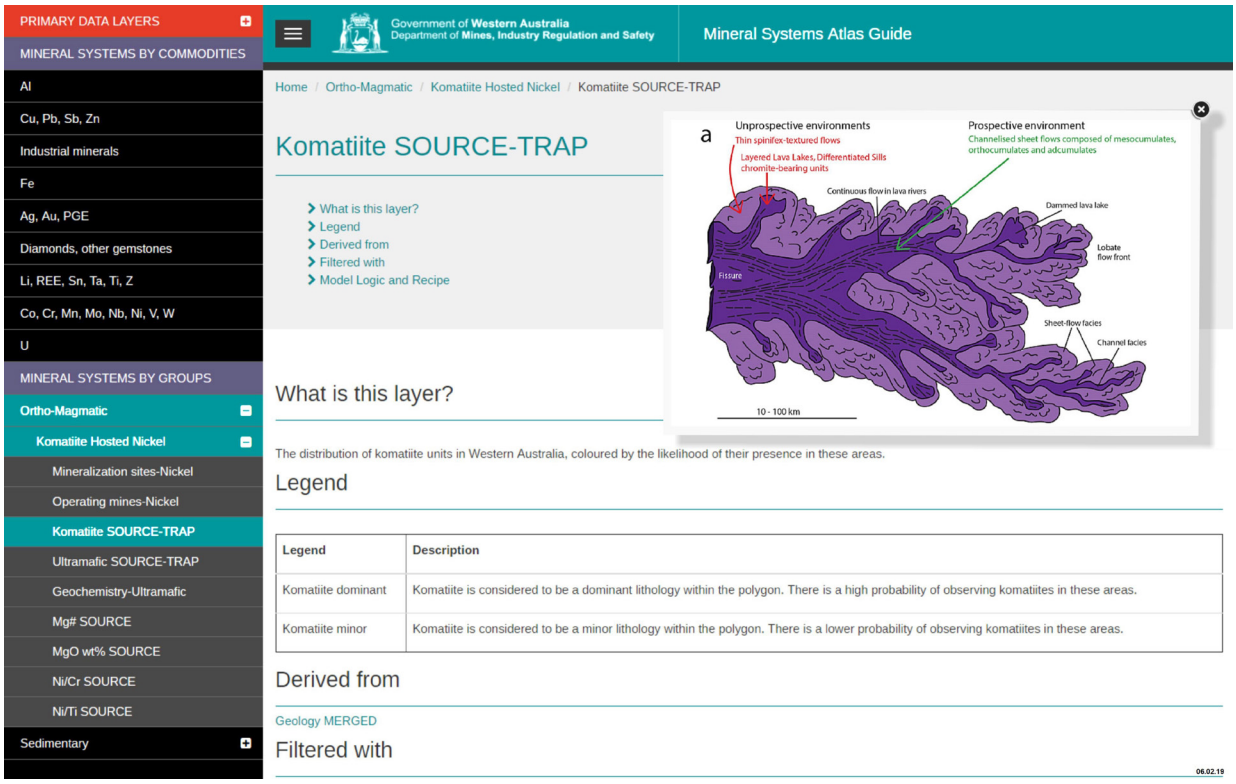

Figure 3. **Example description of the komatiite layer with an expanded model of a komatiitic lava flow. The online Mineral Systems Atlas Guide complements the GIS platform by describing the derived data layers, explaining the reasoning behind their inclusion in the specific mineral systems, and documenting their creation via an SQL query of GSWA source data**

Population of the Mineral Systems Atlas is at an early stage. Mineral systems analyses have been completed for the economically important komatiite-hosted Ni sulfide and BIF-hosted iron ore deposits, and a selection from the large list of potential geological proxy layers has been created — enough to demonstrate the utility and potential of the Atlas. The modular and hierarchical design of the online platform and user guide will readily permit the addition of new mineral systems and new geological proxy layers as these progressively become available, and there will be close engagement with end-user stakeholders throughout the future development of the Atlas.

An influential tool?

The Mineral Systems Atlas marks a significant step towards streamlining the delivery of pre-competitive geoscience data, and should assist mineral explorers to more efficiently generate and test potential prospects. It will also have a significant influence on GSWA activities. Ongoing effort will focus on expanding Atlas content to include all the major mineral systems and commodity groups in Western Australia, particularly those elements that represent critical and constituent metallogenic processes common to many systems (for instance, those mapping lithosphere architecture as potential channel ways for mineralizing fluid flow, or orogenic [high-energy] events that might have driven mineralizing processes).

The short-term focus will therefore be on generating proxy maps that are realistically obtainable using current datasets. However, not all possible target-element maps defined in mineral systems analyses can necessarily be produced from current data holdings. This requires GSWA to thoroughly examine these maps, with the consequence that any inadequacies will quickly become apparent. For example, required data may be incomplete or entirely absent from databases capable of storing these data. Furthermore, existing databases may not be capable of storing such data, or the appropriate data and their associated database(s) may not yet exist. Awareness of these gaps will inevitably compel GSWA to review and improve its strategies, systems and work programs dealing with data acquisition, management and accession — considerations that might include incorporation of appropriately high-quality third-party geoscience data relevant for Western Australian geology and mineralization.

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