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The Mineral Systems Atlas — delivering greater value from precompetitive geoscience data

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SUMMARY

The Mineral Systems Atlas and Guide are recent online systems developed and curated by the Geological Survey of Western Australia (GSWA). The objective of the Atlas and Guide is to more effectively deliver relevant precompetitive geoscience information on mineral systems to explorers and researchers.

Key words: Mineral Systems Atlas, digital data, mineral exploration, precompetitive geoscience, value-adding

INTRODUCTION

The Geological Survey of Western Australia (GSWA) has collected a vast wealth of pre-competitive geoscience data during its 130-year history, and makes this readily available to stakeholders (Fig. 1). Mineral explorers, for instance, use the data to reduce the technical risks related to the discovery of mineral deposits, hence informing investment decisions. GSWA data are extensively used and generally highly valued, in part because of their state-wide coverage, but more particularly because of their quality, having been systematically captured into a suite of rigorously structured, thoroughly validated and internally consistent databases (Riganti et al., 2015).

Nevertheless, there are challenges to using GSWA databases effectively. They are essentially standalone, with only a limited degree of interconnectedness via GSWA's WAROX field observation database, and not all are fully digital and "relational". The responsibility is on the user to locate and download the database(s) that may be relevant for them, then extract appropriate subsets of data. This requires some considerable understanding of the structure and content of GSWA data holdings, and can be a time-consuming, inefficient use of resources.

It is therefore likely that GSWA data are significantly underutilised. The GSWA recognises the consequent opportunity this provides to add significant value to its pre-competitive geoscience data, by itself systematically interrogating its databases to provide tailored derivatives that are of more immediate use to its clients. We here describe how we are applying this rationale, using as an example the newly-created Mineral Systems Atlas, tailored for use by mineral explorers.

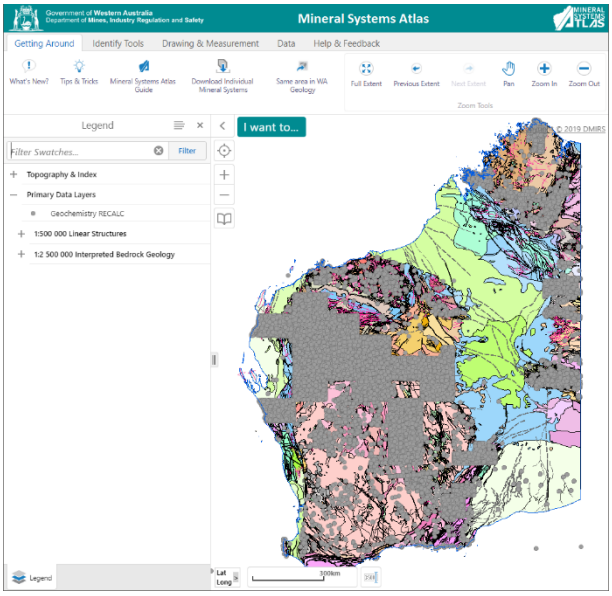

Figure 1. Example of unfiltered Western Australian Geology digital data, including the 1:2 500 000 interpreted bedrock geology polygon layer, the 1:500 000 Linear Structures layer, and all GSWA geochemistry samples.

EFFECTIVELY INTERROGATING PRIMARY GSWA DATABASES

The Mineral Systems Atlas is an evolving, interactive GIS-based platform that delivers tailored data layers relevant to Western Australian mineral deposits. Layer content is systematically defined 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 state-wide GSWA geoscience databases, for those proxies that can be practicably produced (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.

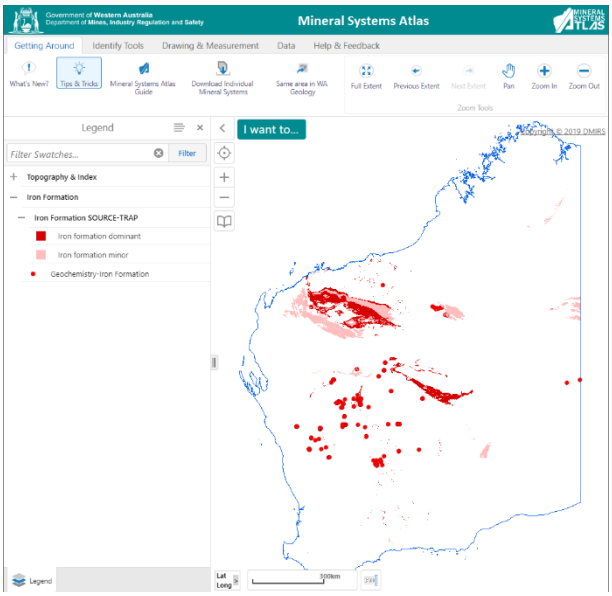

Figure 2. Layers are shown for the enriched Iron Formation mineral system featured in the GSWA Mineral Systems Atlas. The data were filtered from primary GSWA state-wide digital databases.

PROVIDING KNOWLEDGE WITH DATA

The Mineral Systems Atlas is an evolving, interactive GIS-based platform that delivers tailored data layers relevant to Western Australian mineral deposits (Fig. 2). The online portal is fundamentally a tool for viewing and accessing the tailored data. Map content is categorized by mineral system (based on the classification of Fraser et al., 2007), or alternatively by commodity group (as defined in the MINEDEX database).

An integral – and equally important – 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 (e.g. Fig. 3) 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.

Populating 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 readily permits 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.

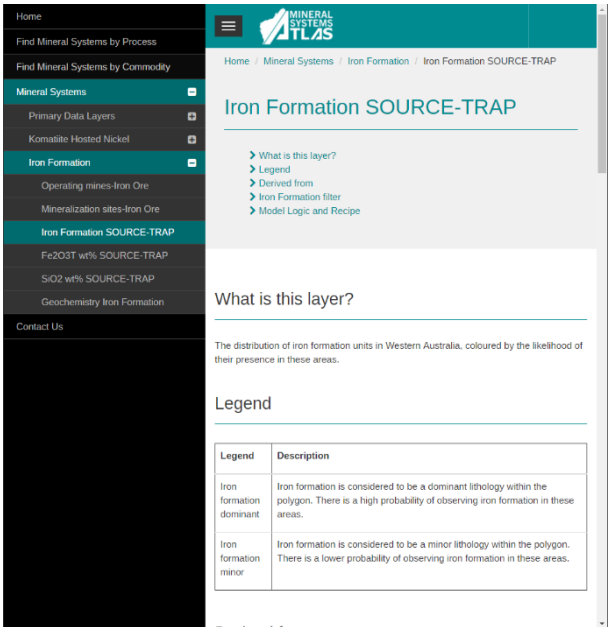

Figure 3. An excerpt from the Mineral Systems Atlas Guide demonstrates the type of content supporting the Atlas. Information is provided about the layers included in the Atlas, explaining the reasoning behind their inclusion and documenting the method for their creation.

MINERAL SYSTEMS ATLAS – GUIDING THE ACQUISITION OF NEW DATA

The short-term goal for GSWA is to develop additional proxy GIS layers 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 databases, 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.

CONCLUSIONS

The GSWA Mineral Systems Atlas marks a significant step towards streamlining the delivery of pre-competitive geoscience data. Knowledge about mineral systems drives the interrogation of existing geoscience data and the automated generation of new mappable proxies that describe the formative geological processes. The Mineral Systems Atlas clearly defines present gaps in data density and interconnectedness between existing GSWA databases. We envisage the Atlas instructing future GSWA activities in acquiring and releasing information about mineral systems and commodity groups in Western Australia.

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