The geological map of Western Australia — past, present and future

by

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Geological maps of Western Australia at scales approximating 1:2 500 000 have been a flagship product of the Geological Survey of Western Australia (GSWA) for over 120 years. The 2015 map is the 14th edition, and the first to have been compiled entirely digitally from larger scale data. Earlier editions provide snapshots of the evolution in geological understanding of the State, as well as changes in mapping techniques and reliability of the base data used to compile them. The changes reflected in these 14 editions of the State map also document two major revolutions in mapping style. The first was the transition from traditional surveying techniques to the use of aerial photography, and the second was the digital revolution involving the ubiquitous use of global positioning systems (GPS), geological information systems (GIS), and a vast array of high-resolution airborne and satellite imagery. The future of the State geological map revolves around effectively interpreting and integrating these digital datasets and presenting them in a way that they can be efficiently interrogated and used by an ever-widening range of users. The data-rich nature of these new Statewide datasets will likely change the way they are delivered and queried in the future.

Historic maps

The first official regional geological maps of Western Australia were produced by Ferdinand von Sommer in about 1848, and were little more than geological field sketches. Various regional maps of specific parts of the State were produced prior to the first Statewide coverage by CG Nicolay (c. 1886), although the first official State map was not produced until 1894 by HP Woodward. These early State maps were based primarily on limited surveying and exploration expeditions that relied on triangulation, chain-and-compass, and a large proportion of guesswork, and they did not always take all previous work into account. Consequently, they are not always accurate. The 1957 State map of Low and Connelly is the last of the ‘Geological Sketch Map’ era and was the first to benefit from the initiation of systematic 1:250 000 mapping of the State in the early 1950s. The first revolution in the production of the State map came with the widespread availability of aerial photography and geophysical data, as well as radiometric dating. This revolution is reflected in the 1966 State map, compiled by RC Horwitz, which was a complete re-interpretation of the geology of the State, and provided the first complete coverage in reliable detail. This was also the first State map to use the metric 1: 2 500 000 scale. The 1973 State map marks the introduction of the now-familiar GSWA style that persists, with minor additions and modifications, in the current edition. The 1998 State map, compiled by JS Myers and RC Hocking was the first to fully benefit from complete 1:250 000-scale coverage of the State, as well as more detailed aeromagnetic images, satellite imagery, and widespread 1:100 000-scale mapping. This map was also the last to be compiled by hand using 1:1 000 000-scale reductions of larger scale maps.

The 2015 edition

The 14th edition of the State geological map (2015) is a product of the second revolution in mapping at GSWA, involving the advent of GPS and GIS technology for data capture and map compilation, the Statewide coverage of very high-resolution satellite and airborne raster datasets, and abundant high-precision geochronological data. The 2015 map (Fig. 1) has been 17 years in the making, with the first 1:500 000 Statewide digital data coverage having been generated in 2001, and a fully re-interpreted dataset released in 2014. The 1:2 500 000 map was compiled by rolling up the 1:500 000-scale digital data released in 2014, using unit definitions held in the recently released Explanatory Notes System (ENS). This roll-up was conducted in two stages: the first to produce a slightly higher resolution digital dataset, and the second to generate a simplified version suitable for reproduction by offset printing. The digital data and a PDF of the map are available for download from the Data and Software Centre (www.dmp.wa.gov.au/datacentre) and the Department of Mines and Petroleum (DMP) eBookshop (www.dmp.wa.gov.au/ebookshop) respectively.

Although the 2015 State map is superficially similar to the previous edition, in detail there are many differences. The most notable distinctions are in the level of detail depicted on the map face, legend and tectonic units inset map. On the map face, this is due to the style of compilation, which has ensured that the 1:500 000-scale spatial accuracy has been preserved, mostly due to the large amount of detailed mapping carried out by GSWA since 1998. Areas that have been subject to significant re-interpretation include the East Kimberley, Rudall Province, East and West Pilbara, southwestern Hamersley Basin and the Ashburton Basin, Capricon Orogen, large parts of the Yilgarn Craton, the Albany–Fraser Orogen, Musgrave Province, west Arunta Orogen, and the west Granites–Tanami Orogen. The map incorporates a new dyke suites layer, based on mapping, geochronology and interpretation of high-resolution aeromagnetic data; this layer is considerably more detailed than the previous version that was based on outcrop mapping and lower resolution aeromagnetic data. Where warranted, some generalizations have been introduced: for example, specific lithologies within formal lithostratigraphic units are not differentiated, and the offshore faults and thickness contours of Phanerozoic and Neoproterozoic sedimentary rocks have been omitted, as have some of the more interpretive aspects of the structures (faults and folds). The tectonic units inset map is now produced at 1:10 000 000 scale and shows more detail as a consequence of improved understanding of the tectonic architecture of the State.

The most noticeable changes are to be found in the legend despite the same principles having been applied as the previous edition. First, the numerical timescale of 100 Ma age-bins, used primarily for the coding of some Precambrian units, has been revised with the major numerical subdivisions now roughly reflecting currently known periods of Western Australian crustal growth through orogenesis and magmatism. However, the internationally recognized boundaries at 2500 Ma (Archean–Proterozoic) and 541 Ma (Proterozoic–Phanerozoic) have been adhered to. The Precambrian and Phanerozoic parts of the legend have been combined into a single stratigraphic column with currently known age constraints indicated for every unit. Changes in scale at 600, 100 and 10 Ma allow the depiction of more detail in the Phanerozoic. In the Precambrian, there are some newly defined formal units, mainly in the Yilgarn Craton, Capricorn Orogen and Musgrave Province, and the informal units are more accurately defined based on their known ages. Coding of the Phanerozoic now includes lithology as well as age, which has allowed the depiction of lateral facies changes in the legend; uncertainties in ages are now also shown with blue range-bars. The most significant change to the legend has been the addition of major orogenies and tectonic events that are depicted in a separate column; the rough spatial distribution of events based on a generalized central meridian is also shown.

More detailed explanatory notes are presented in Record 2015/14 (Martin et al., 2016).

Future directions

The future of State geological datasets lies in maintaining the digital data via annual or semi-annual updates, and in the generation of new digital datasets to support activities such as the UNCOVER initiative and mineral systems studies. Regular maintenance of the digital data will ensure the turnaround from digital to printed product will be relatively short, should another printed State map be required. Regarding the development of new datasets, consensus needs to be reached as to what constitutes ‘cover’ and how best to present the data. Currently the State Cenozoic geology layer does not represent all Cenozoic materials, and so is only a partial ‘cover map’, and the map as a whole is not strictly a ‘bedrock’ map either. In order to support the UNCOVER initiative, it is proposed that the State geology datasets should ultimately be delivered in four time-layers, namely Precambrian, Paleozoic, Mesozoic and Cenozoic, but it will be some time before this can be effectively implemented. There is also the question of whether this data should be presented as separate 2D layers, or as 3D data, and how it should be attributed in order to assist explorers in the detection of mineral deposits under cover.

Similarly, the development of State datasets for mineral systems studies will require some thought and consultation regarding industry requirements and data presentation. The depiction of mineral systems data in 2D is likely to be ineffective, and it may be prudent to ensure that the attribution of State datasets is suitable for use in mineral systems studies. For example, this may include the distinction between major and minor structures, and the inclusion of additional geometric and kinematic attributes in the 2D data that will assist in mineral systems analysis.

In addition to new datasets to support the resources industry, the vast amount of data behind modern maps creates opportunities for alternative ways of presenting traditional data. This talk will present one such alternative in the form of an animation of the State map, but this and others should be explored further, particularly as a means to appeal to a broader GSWA customer base to include fields such as geotourism and education.

References

Martin, DMcB, Hocking, RM, Riganti, A and Tyler, IM 2016, Geological map of Western Australia, 14th edition – Explanatory Notes: Geological Survey of Western Australia, Record 2015/14.

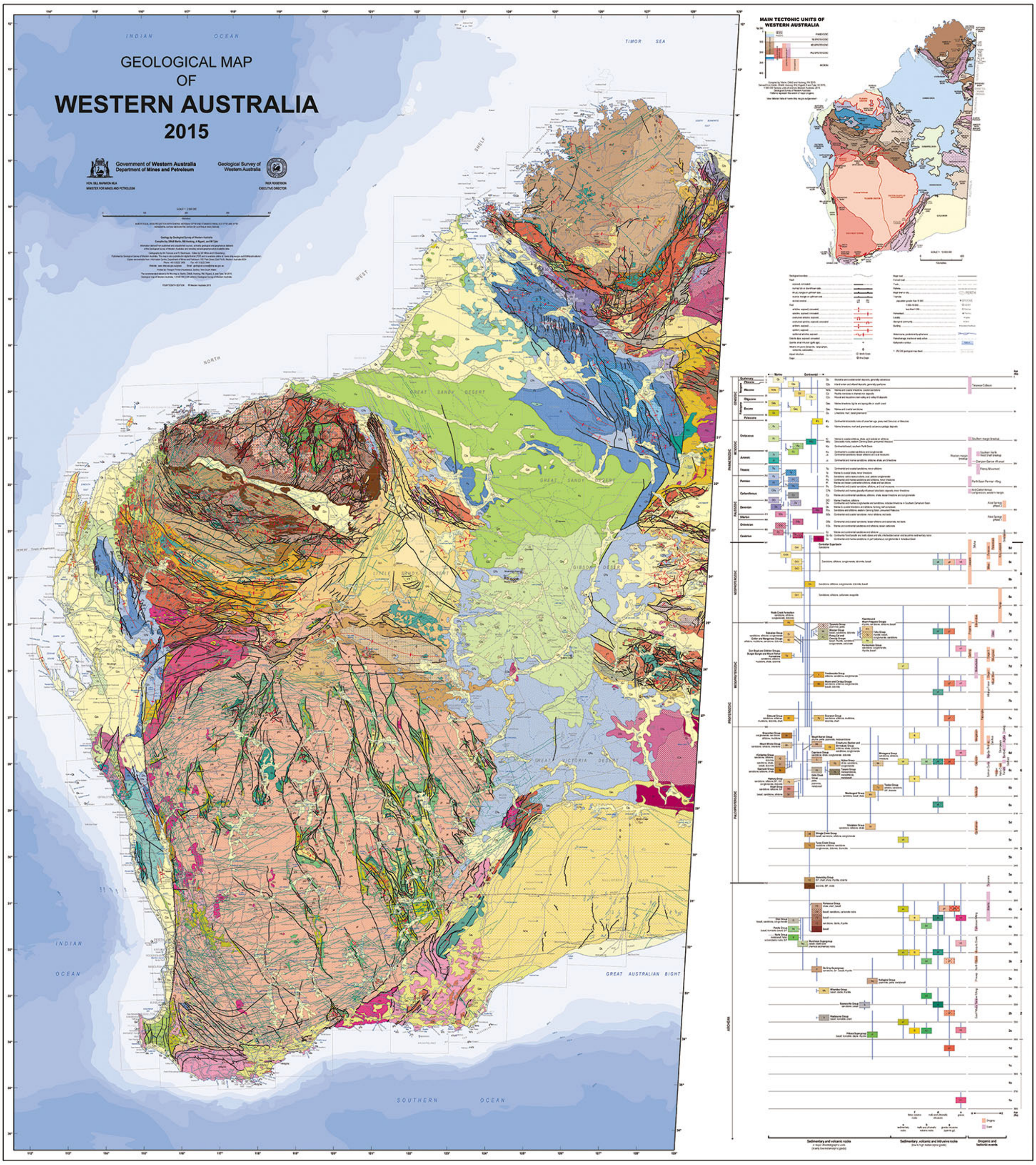

Figure 1. **1:2 500 000 geological map of Western Australia, 2015**