Seamless Geology of NSW

A paradigm shift in geological mapping

James Ballard

SMEDG November 2018

Department of Planning and Environment

Contents

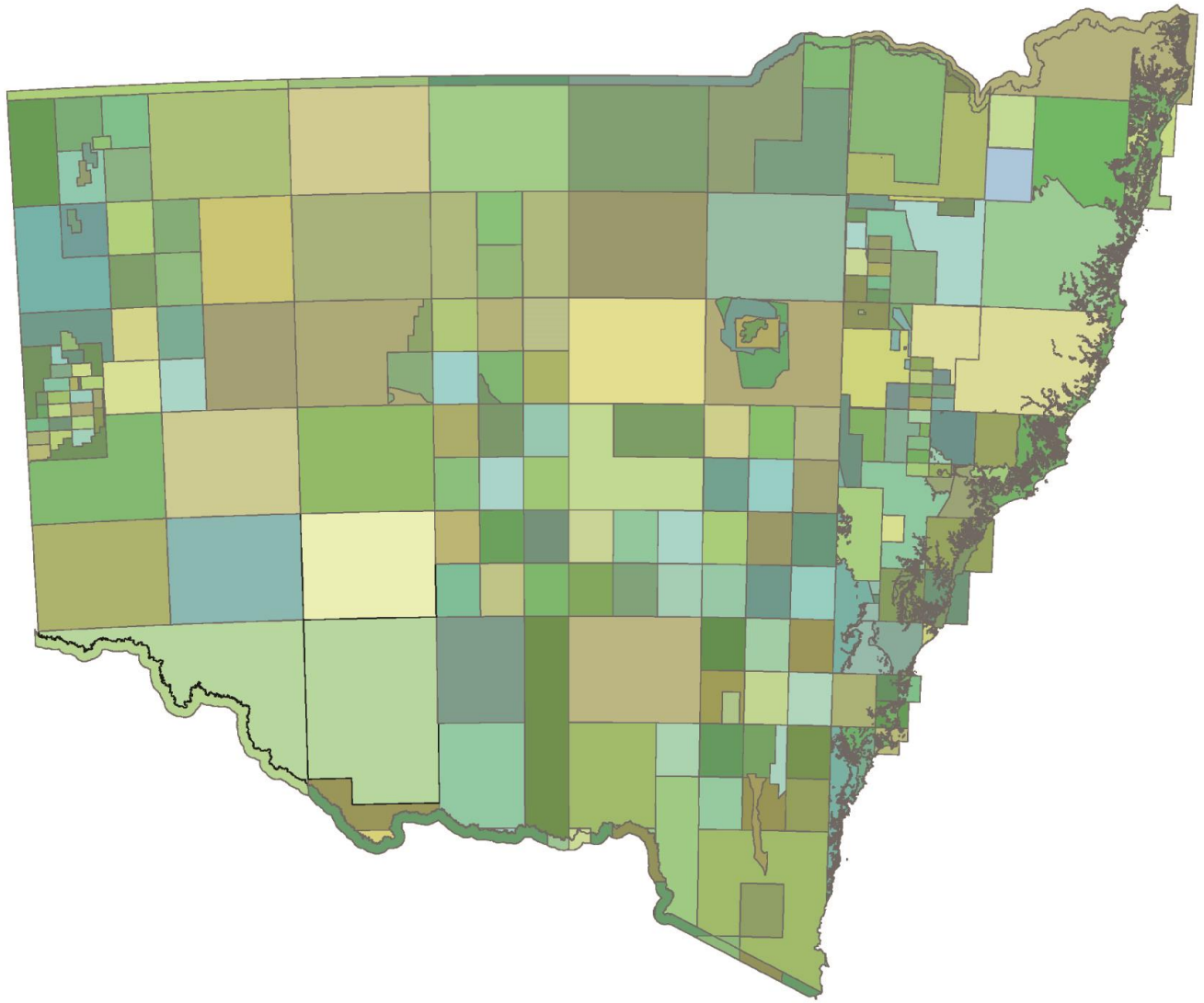
1

What is it?

NSW GOVERNMENT

NSW Seamless Geology Project

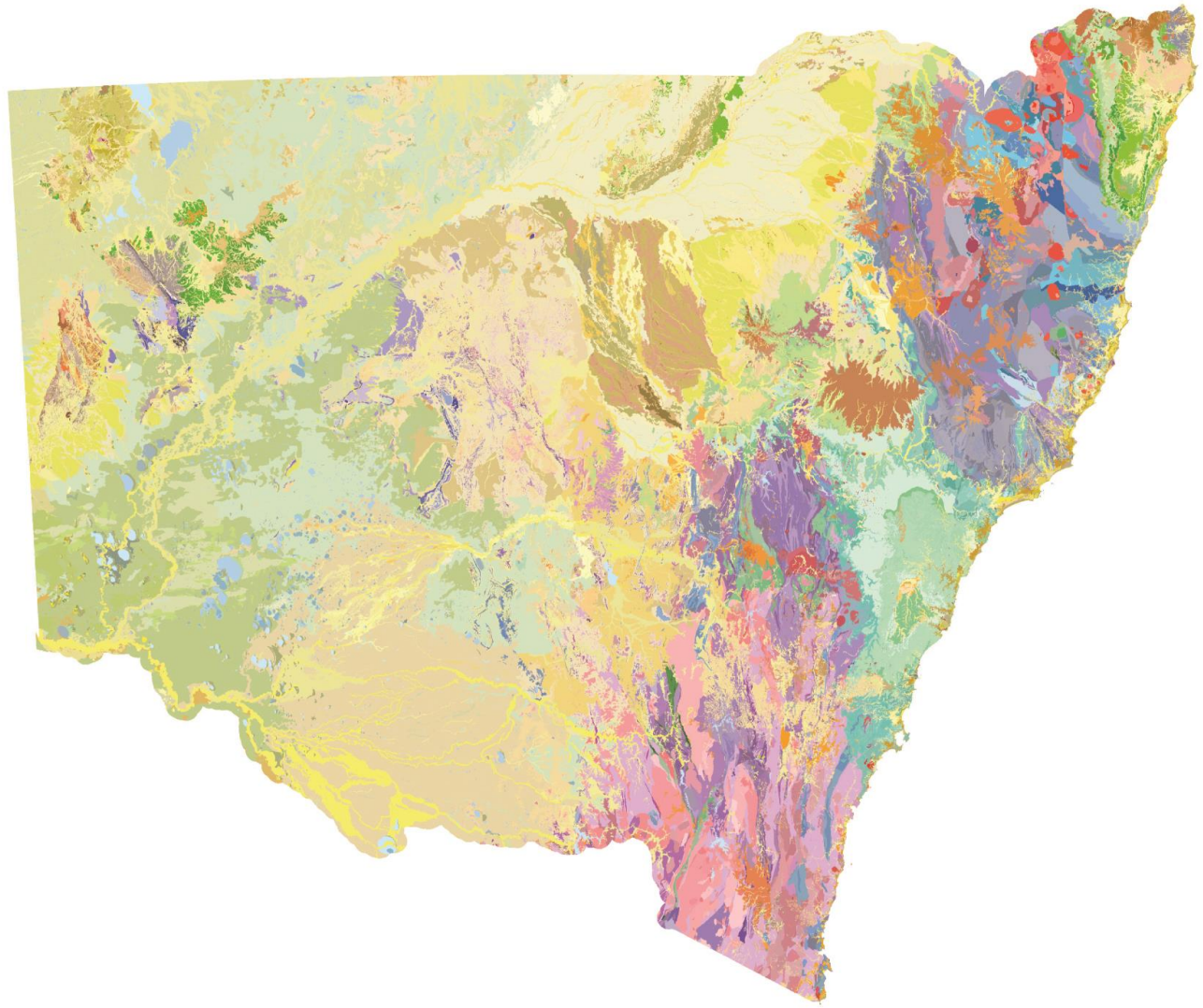
- Five year project (2013–2018).
- Joining the best available mapping across the state.
- Approximately 500 data sources at different scales and ages.
- Now in a consistent geodatabase format with a standard set of attributes.



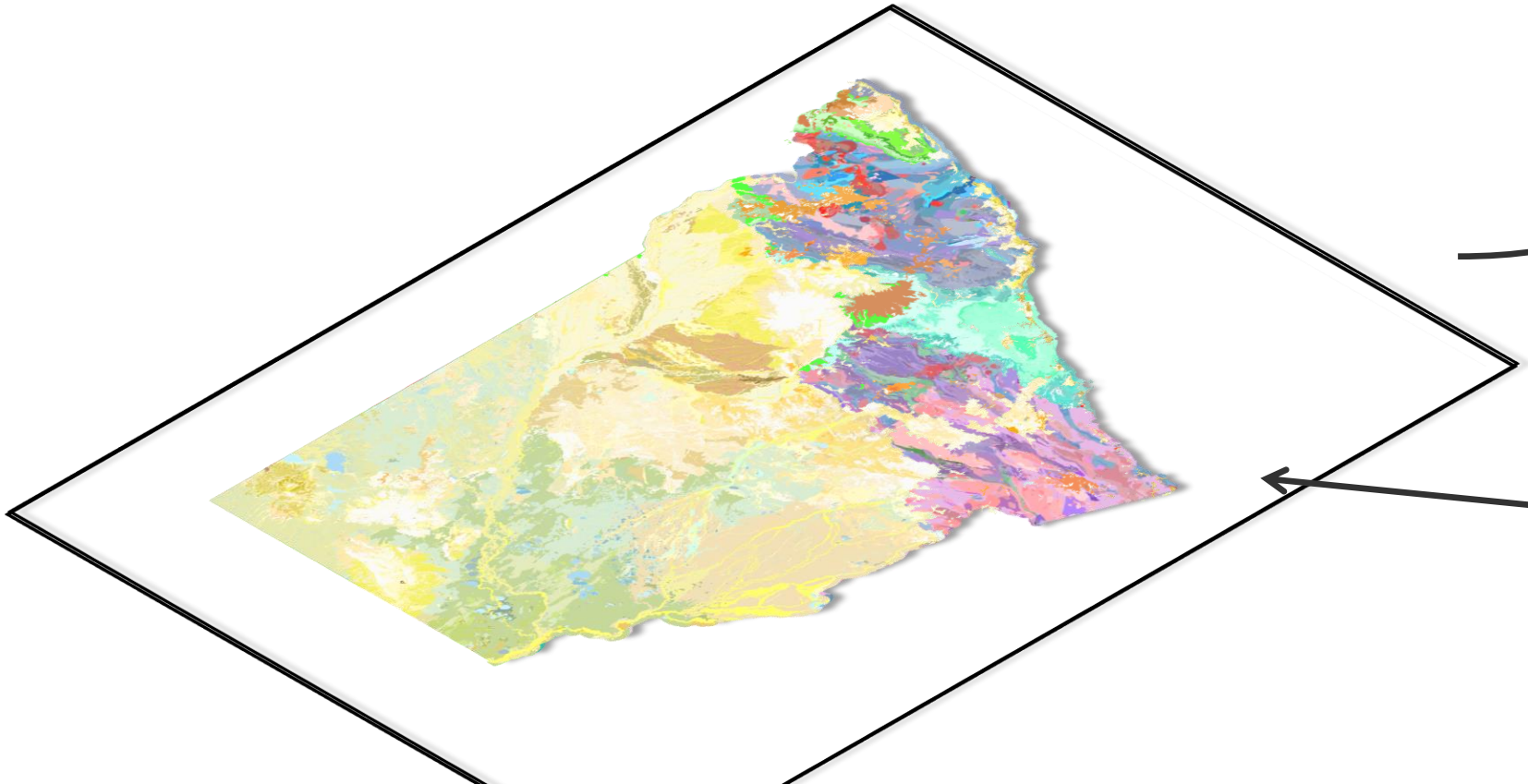
NSW GOVERNMENT

NSW Seamless Geology Project

- Connect line mismatches across boundaries, scale and units.
- Harmonise stratigraphic units.
- Create a series of eleven lithotectonic layers/provinces.



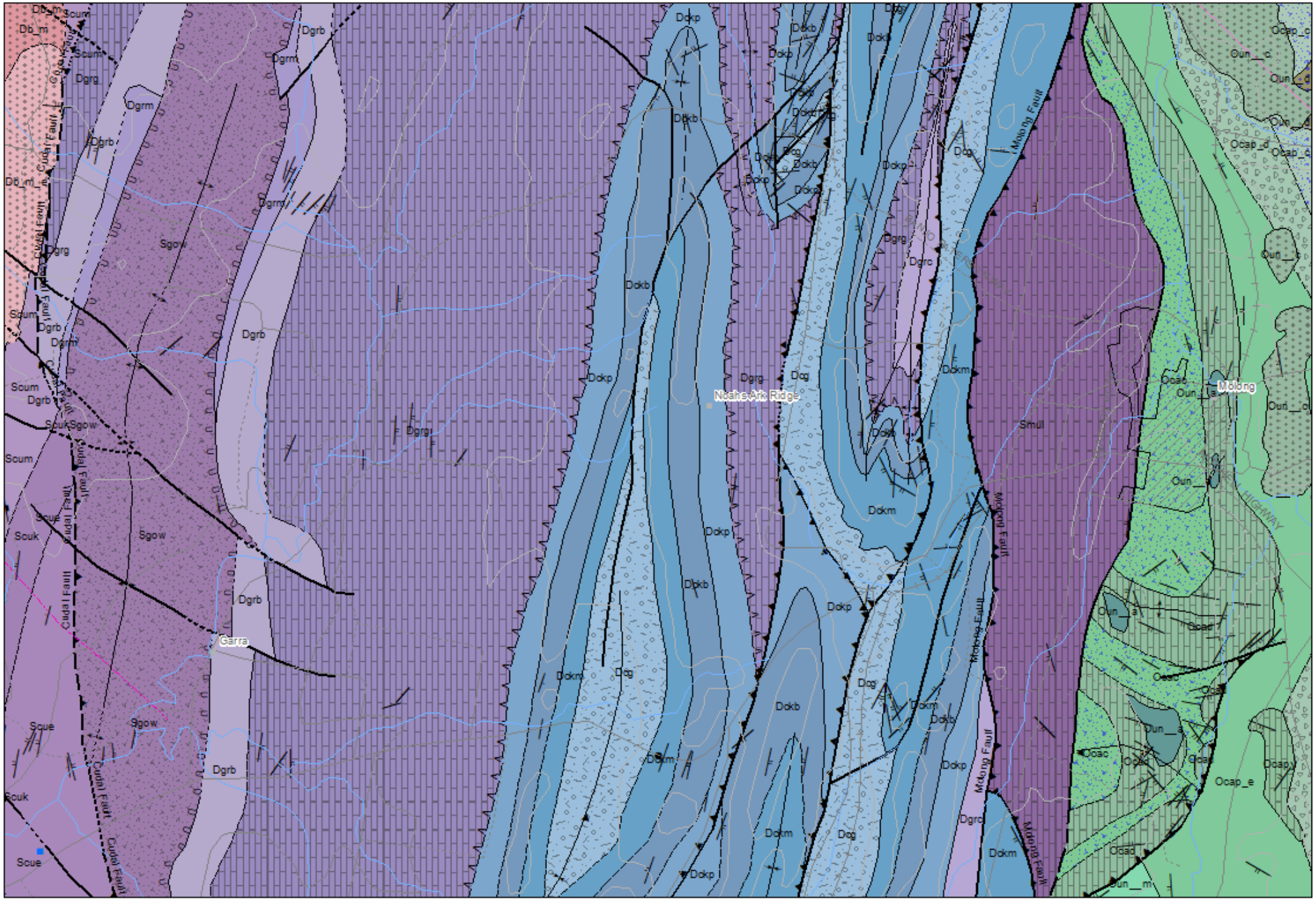
NSW GOVERNMENT



Unconsolidated cover (e.g. Cenozoic)

Consolidated cover (e.g. Devonian to Cretaceous basins)

Solid basement

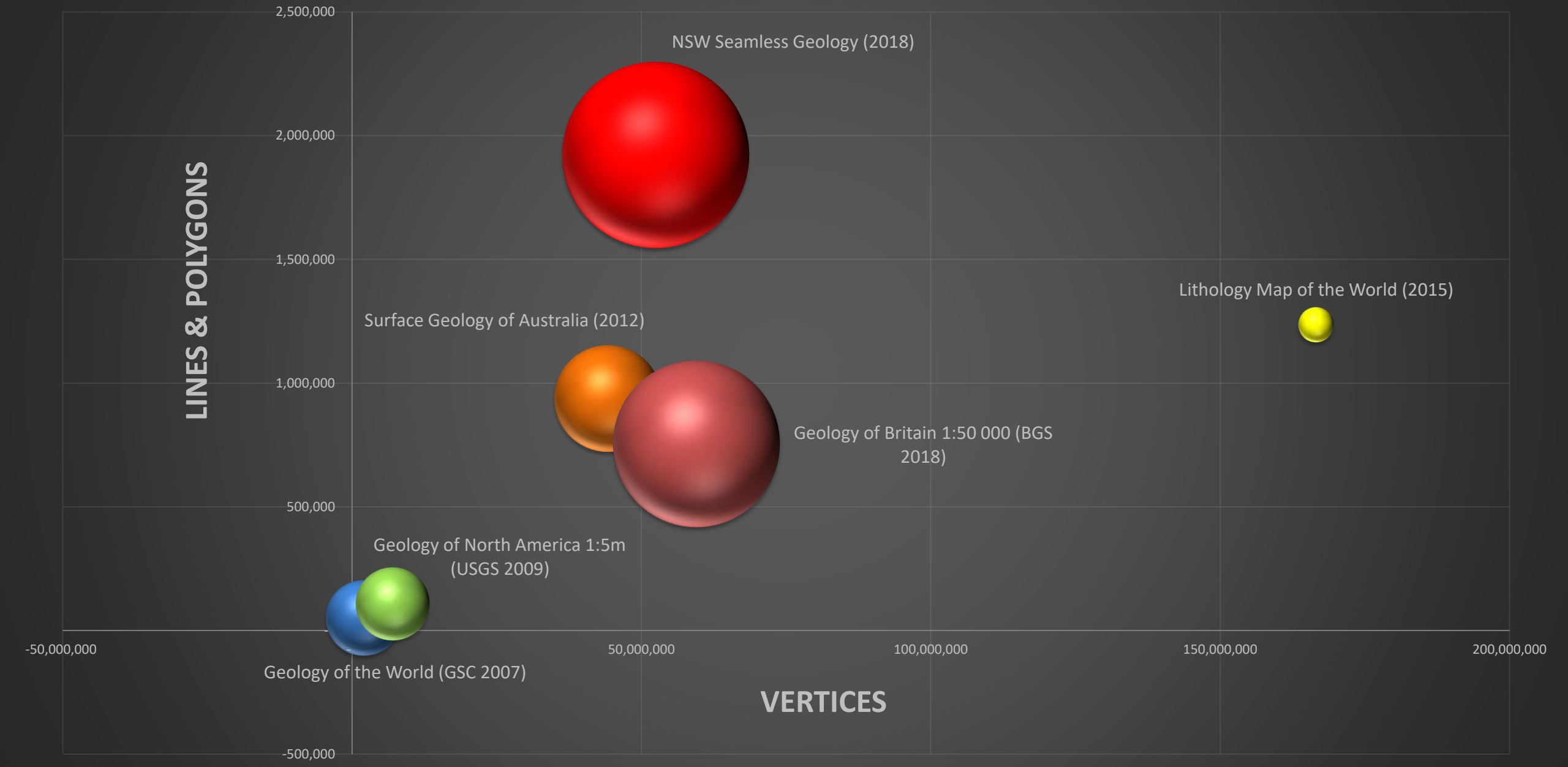

Noahs Ark Ridge
Garra
Mdong
Cudal Fault
Mdong Fault
Db_m
Scum
Dgrb
Dgrm
Dgrg
Sgow
Scuk
Scue
Dokp
Dokb
Dog
Dokm
Dgrc
Smul
Ocap_c
Oun__c
Ocap_d
Ocap_e
Oun__a
Oun__o
Oun__m
Ocad
Ocac
HIGHWAY

2

Significance of the dataset

NSW GOVERNMENT

Large geological GIS datasets



Data attribution example: polygons

Name and description

Unit hierarchy

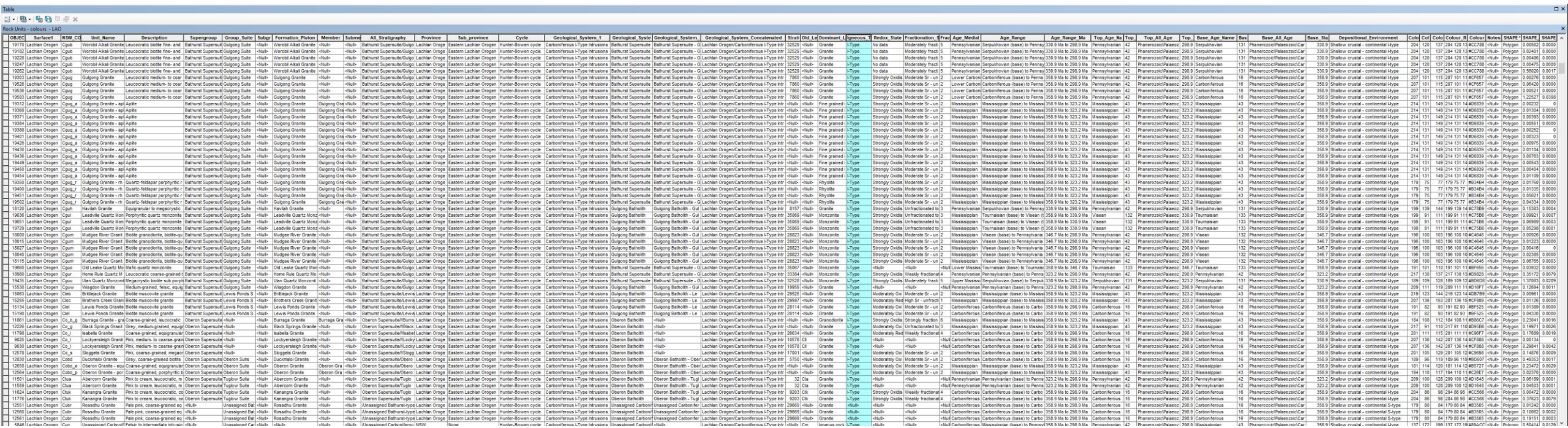
Province, cycle, system

Lithology, chemistry

Age range

Depositional environment

Colour, shape



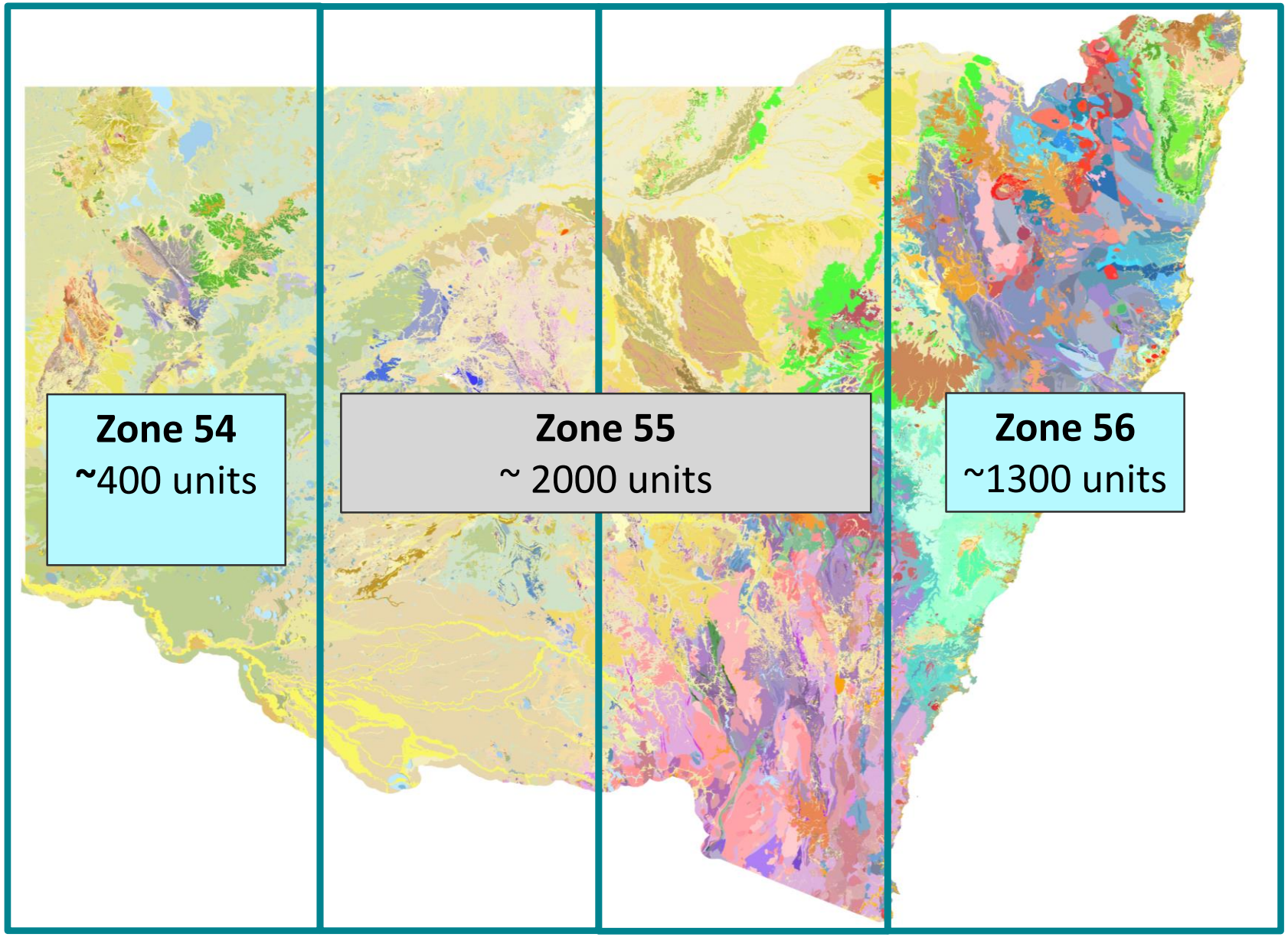
Stratigraphic unit tables

- Best available compilation of literature and current field work.
- Replace explanatory notes.
- e.g. Illawarra Coal Measures

Name and attribution	**Illawarra Coal Measures** (Pil) Clark (1866)
Source of name	The Illawarra region of the south coast of New SouthWales, where the unit is well developed.
Synonymy	Clarke (1866) used the terms 'Illawarra Coal measures' and 'Illawarra beds' t refer to the coal-bearing sequence in the Illawarra district which he included i the more generic 'Upper Coal measures'. Other terms were later used (e.g. the 'Bulli Coal Measures' of David 1890 and David and Stonier 1891) but the ter 'Upper Coal Measures' was widely in use in the geological literature of the ea twentieth century (e.g. Carne 1908; Harper 1915). The term Illawarra Coal Measures was formally reinstated by Joplin, Hanlon and Noakes (1952). The term Illawarra Coal Measures (Clarke 1866) was introduced into the Western Coalfield by Bryan et al. (1966) who traced the continuity of this unit from th southern to the western Sydney Basin (Pogson & Walkins 1998).
Constituent units	Pib Cullen Bullen Subgroup Pic Cumberland Subgroup Pih Charbon Subgroup Pin Nile Subgroup Pis Sydney Subgroup Piw Wallerawang Subgroup The Cullen Bullen, Wallerawang, Charbon and Nile Subgroup are part of the Illawarra Coal Measures in the western part of the Sydney Basin. The Sydney and Cumberland Subgroup are restricted to south of the basin, instead.
Parent unit	None
Stratigraphic correlation	The Illawarra Coal Measures is correlative with the Tomago Coal Measures a the Singleton Supergroup of the Newcastle and Hunter coalfields, respectively (Barnes et al. 2002). It is also correlated with the Black Jackson Group of the Gunnedah Basin (Barnes et al. 2002). Although some of the constituent units the coal measures can be directly correlated, lateral relationships are complex (Herbert 1980).
Distinguishing or identifying features	None
Type section/locality/ area	There is no single type section for the Illawarra Coal Measures. Type sections the constituent units of the Illawarra Coal Measures were recorded by the Standing Committee on Coalfield Geology of N.S.W. (1986) and are located mainly in the Lithgow region of the Sydney 1: 250 000 map sheet area.
Thickness	The Illawarra Coal Measures is thin in the western half of Western Coalfield where it maintains a relatively uniform thickness of 100 m – 200 m. In the eastern half of the Coalfield, the Coal Measures thicken rapidly from 200 m to 900 m eastwards towards the trough areas of the Sydney and Gunnedah Basin (Yoo et al. 2001). In the Southern Coalfields Illawarra Coal Measures has an average thickness of 210 m, thickening to the north (> 500 m), and thinning to less than 50 m in the south west (Stephenson & Burch 2004.
Distribution	The Illawarra Coal Measures forms the western and southern segments of the Sydney Basin. Along the western side of the Sydney Basin, the Illawarra Coal Measures crops out nearly continuously (Bryan, McElroy & Rose 1966; Moff 2000) from the Goulburn River Valley area (ie, Gulgong-Ulan-Wollar) (Cameron, Meakin & Yoo 1999a) to the Canyonleigh area (Moffitt 2000) in
	southern part of the basin. The area along the Kangaroo Valley marks the southern extent of the unit, and from here it turns northward to the escarpment o the Illawarra Coastal Range.
Relationships and boundary criteria	The Illawarra Coal Measures conformably overlies the Shoalhaven Group and is unconformably overlain by the Narrabeen Group and Coal Cliff Sandstone.
Geomorphic and/or regolith expression	The Illawarra Coal Measures in the Moss Vale area is typically recessive, although in the far northwest of Moss Vale and northward onto Burragorang100 the unit is cliff forming (Trigg & Campbell 2016).
Lithology	In general, the Illawarra Coal Measures consist of sandstone, siltstone, shale and coal seams, with minor conglomeratic and tuffaceous beds. Contemporaneous volcanic activity is evidenced by tuffaceous sections within the seams (Stephenson & Burch 2004).
Primary structures/textures	The Illawarra Coal Measures has been affected by wide amplitude, very open folding and also faulting, at least some of which was active during sedimentatio (see Mullard, Cozens & Armstrong 1996 and references therein; Moffitt 2000). Bos (1988) reported minor faulting with displacements typically less than 5 m. Two major joint sets, both vertical, were reported (Bos 1988): the dominant set trending 110° and the other trending 020°.
Geochemistry	Unknown
Structure (tectonic)	None identified
Metamorphism	Overall the Illawarra Coal Measures displays no effects of metamorphism excep for local contact metamorphic effects produced by younger intrusions (Trigg & Campbell 2016).
Fossils	The Illawarra Coal Measures is largely non-marine and rich in macro- and micr fossil floras. Marine shelly fossils have been reported from the unit (Byrnes, Scheibnerova & Stuchbury 1981).
Age and evidence	Late Permian based on palynology and also U–Pb dating of some tuff horizons. Young and Laurie (1996, Chart 6) showed the age of the unit ranging from Kanzanian (part of the Guadalupian) to just below the top of the Permian. Bowman et al. (1986) noted that the top of the Permian is considered to be just above the top of the Illawarra Coal Measures on palynological grounds, althoug this is yet to be firmly established (Balme & Foster 1996; Retallack 1996). U–P SHRIMP dating indicates that the Illawarra Coal Measures was deposited in a relatively short time interval of less than ~12 million years (Carr, Fanning & Jones 2003).
Unconformities or hiatuses	None recognised
Environment of deposition or emplacement	Unknown
Economic geology	A feature of the Illawarra Coal Measures is the concentration of coal seams of commercial importance. In the southern coalfields these are: Bulli seam, Balgownie seam, Wongawilli seam and Tongarra seam (Wilson 1975, Moffit 2000) and in the western coalfields: Lithgow Coal, Lidsdale Coal, Ulan Coal, Irondale Coal, Bungaba Coal Member, Moolarben Coal Member, Turill Coal Member, Katoomba Coal, Middle River Coal Member (Yoo et al. 2001)
Geological	None known
and/or environmental hazards	
Geophysical characteristics	Unknown
Remarks	None
References	Balme B.E. & Foster C.B. 1996. Triassic (Chart 7). In: Young G.C. & Laurie J.R. eds. An Australian Phanerozoic Timescale, pp. 136–147. Oxford Univers Press, Melbourne. Barnes R., Dawson M., Spiller F. 2002 Geology - Integration and upgrade: N Western Regional Assessments: Brigalow Belt South Bioregion (Stage 2). A project undertaken for the Resource and Conservation Assessment Council; NSW Western regional assessments Geological Survey of New South Wales WRA/19, 157pp. Bos F. 1988. Geology and coal resources of Sutton Forest. The Shell Compar of Australia, Report C.R. 1521. New South Wales Geological Survey, Report 2006/007. Bowman H.N., Stroud W.J., Sherwin L. & Ray H.N. 1986. Sydney Basin stratigraphy. In: Sherwin L. & Holmes G.G. eds., Geology of the Wollongon and Port Hacking 1:100 000 sheets, 9029, 9129. Geological Survey of New South Wales, Sydney. Bryan J. H., McElroy C. T. & Rose G. (compilers). 1966. Sydney 1:250,000 Geological Series – Explanatory Notes, Sheet SI/56-5. 3rd edition. Geologica Survey of New South Wales, Sydney. Byrnes J.G., Scheibnerova V. & Stuchbury R. 1981. Evidence for marine influence during deposition of some coal measure sediments (Wongawilli coa seam) In: Abstracts of the Fifteenth Newcastle Symposium on 'Advances in t study of the Sydney Basin', p. 12. The University of Newcastle, Newcastle, N South Wales. Cameron R.G., Meakin N.S. & Yoo E.K. 1999b. Narrabeen Group In: Meaki N.S & Morgan E.J. (compilers) Dubbo 1:250 000 Geological Sheet SI/55-4, Explanatory Notes. 2nd edition. Geological Survey of New South Wales, Sydney. Carne J.E. 1908. The copper mining industry and the distribution of copper o in New South Wales. Mineral Resources 6. Geological Survey of New South Wales. Carr P., Fanning M. & Jones B.G. 2003. Geochronology of coal measures in t Sydney Basin from U-Pb SHRIMP dating of air-fall tuffs. In: Proceedings of 35th Symposium on 'Advances in the Study of the Sydney Basin', pp. 303–3 The University of Wollongong, Wollongong, New South Wales. Clarke W.B. 1866. On the occurrence and geological position of oil-bearing deposits in New South Wales. Quarterly Journal of the Geological Society of London 22, 439–448. David T.W.E. 1890. The Coal Measures of New South Wales and their associated eruptive rocks. Journal of the Royal Society of New South Wales 257–271. David T.W.E. & Stonier G.A. 1891. Report on coalmeasures of Shoalhaven District, and on a bore, near Nowra. Appendix No. 2J. Annual Report of the Department of Mines of N.S.W. for 1890, pp. 244–255. Harper L. F. 1915. Geology and Mineral Resources of the Southern Coal-fiel
	South Wales. Mullard B.W., Cozens S.J. & Armstrong M. 1996. Tectonic control on sedimentation and coal formation in the Southern Coalfield. In: Proceedings of the Thirtieth Newcastle Symposium on 'Advances in the study of the Sydney Basin', pp. 9–15. The University of Newcastle, Newcastle, New South Wales. Pogson D.J. & Watkins J.J. 1998 Bathurst 1:250 000 geological Sheet. SI/55-8: Explanatory Notes. Australian Geological Survey Organisation and Geological Survey of New South Wales SI/55-8 Retallack G.J. 1996. Early Triassic therapsid footprints from the Sydney Basin, Australia. Alcheringa 20, 301–314. Trigg S.J. & Campbell L.M. 2016. Moss Vale 1:100 000 geological sheet 8928. Explanatory Notes. Geological Survey of New South Wales, Maitland, NSW. Wilson R.G. 1975. Southern Coalfield. In: Traves D.M. and King D. (Eds) - Economic geology of Australia and Papua New Guinea - 2.Coal. AusIMM. Monograph Series 6, 206-218. Yoo E.K., Tadros N.Z. & Bayly K.W. 2001. A compilation of the geology of the Western Coalfield. Geological Survey of New South Wales report GS2001/204. Young G.C. & Laurie J.R. (eds) 1996. An Australian Phanerozoic timescale. Oxford University Press, Melbourne.
Figure caption	None
Photo caption	 Photograph Pil1: Exposures of the Illawarra Coal Measures and the disconforably overlying Hawkesbury Sandstone at Meryla Pass (GR 260150 6158550). Photographer S.J. Trigg.
Compiler	Marta Vega after S.J. Trigg & L.M. Campbell (2016)

Stratigraphic unit tables

- Zone 54
  - All compiled
  - In QA and waiting editing
- Zone 55
  - Being compiled
  - Zone 55 east due 31/12/18
  - Zone 55 west due 21/12/19
- Zone 56
  - All compiled
  - In QA and waiting editing



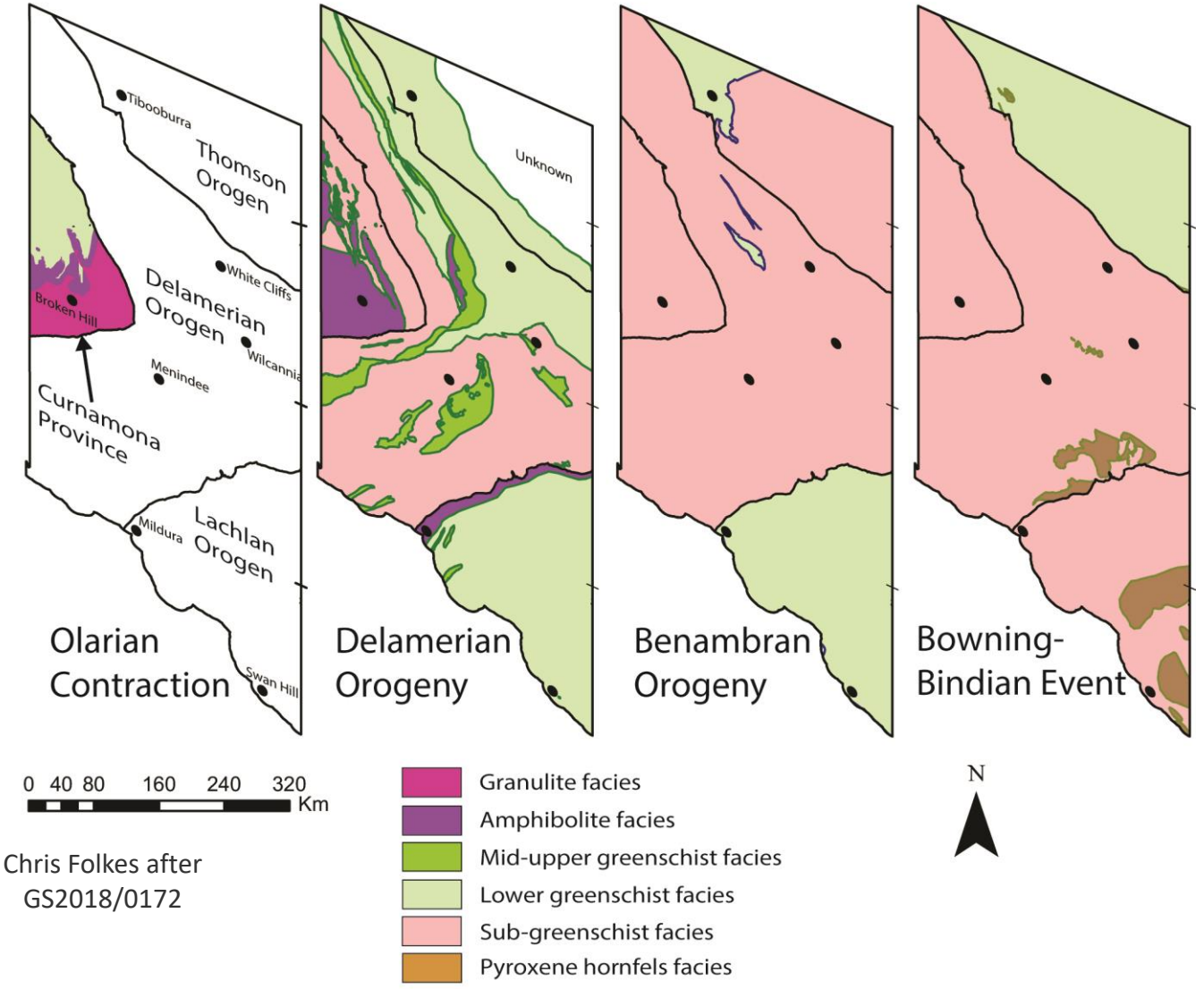
NSW GOVERNMENT

3

Value adding

Metamorphic maps

- Metamorphic facies and isograds mapped by geodynamic event.

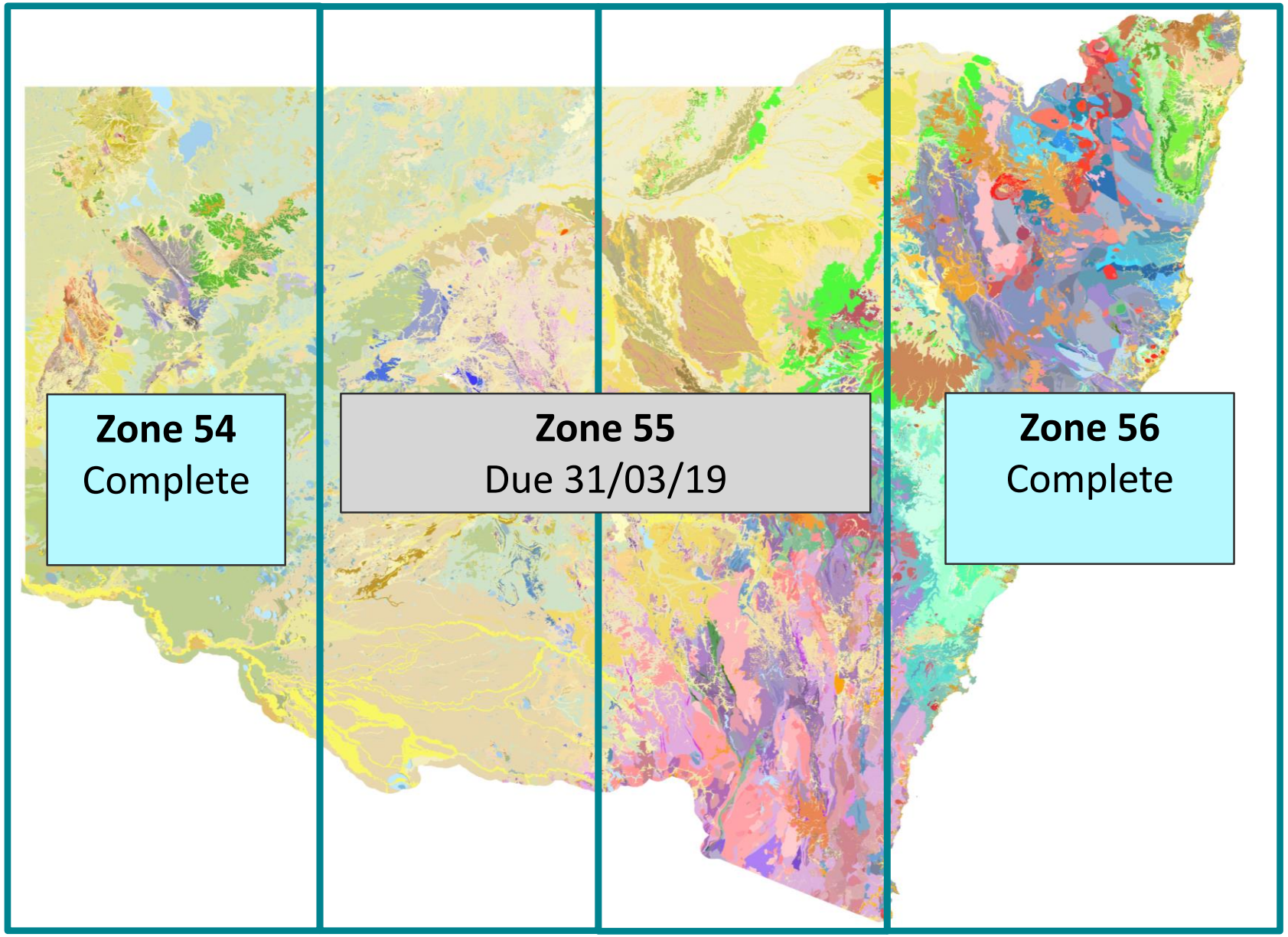


Chris Folkes after GS2018/0172

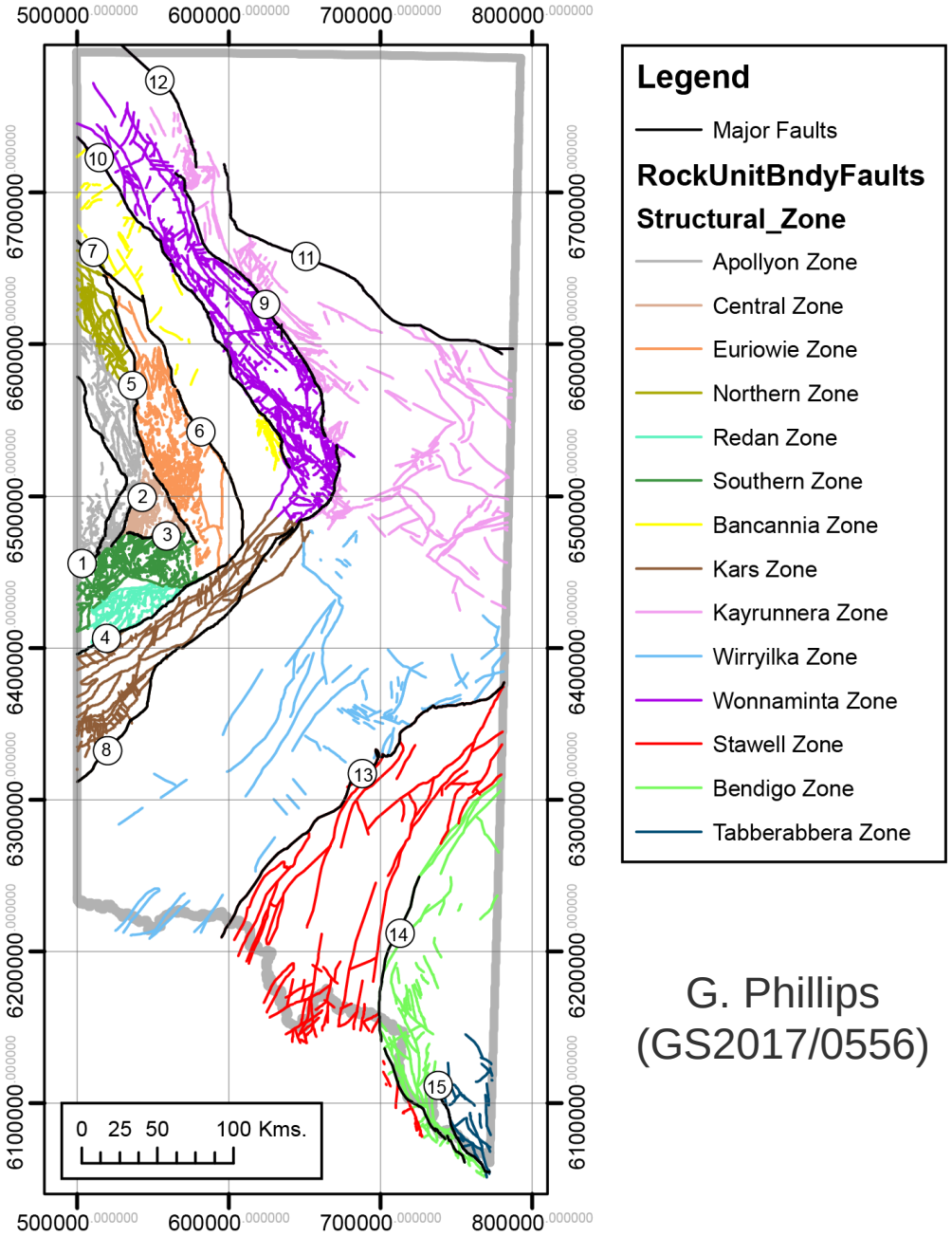
Metamorphic maps

- Zones 54 & 56 complete.

- Zone 55 currently underway.
  - Due early 2019.



NSW GOVERNMENT



G. Phillips (GS2017/0556)

Fault attribution

- Every fault attributed with:
  - geometry
  - order
  - parent
  - kinematics by geodynamic event.

Sub System	Province	Structural features	Relevance for mineral prospectivity
Olary Detachment	Curnamona	Faults located at the contact between the Broken Hill and Sundown groups.	Extensional detachment between the Broken Hill and Sundown Group is also a major redox boundary and potential site for Pb-Zn-Ag mineralisation (Gibson & Nutman, 2004).
Cobham Kink Zone	Curnamona & Delamerian	NE-SW striking faults located in the Cobham Kink Zone.	NE-SW striking zone of crustal weakness that may have favoured repeated igneous intrusions (Gilmore et al., 2007).
Arrowsmith	Delamerian	Dominantly NW-SE striking faults spatially associated with the Mt. Arrowsmith Volcanics.	Faults that are spatially related to the Neoproterozic (c. 585 Ma) mafic igneous Mount Arrowsmith Volcanics. These igneous rocks and associated faults may host magmatic nickel-sulfide and remobilised copper (Gilmore et al., 2007).
Larapintine	Delamerian	Basin bounding faults associated with the formation of post Delamerian basins.	Post-Delamerian basins including the Nuntherungie and Kayrunnera basins may contain orogenic gold.
Grasmere Knee Zone	Delamerian	Faults located in the Grasmere Knee Zone.	Zone of higher-strain that may host structurally modified and remobilised VMS/Besshi Cu, Pb, Au and Ag deposits.

Fault attribution data

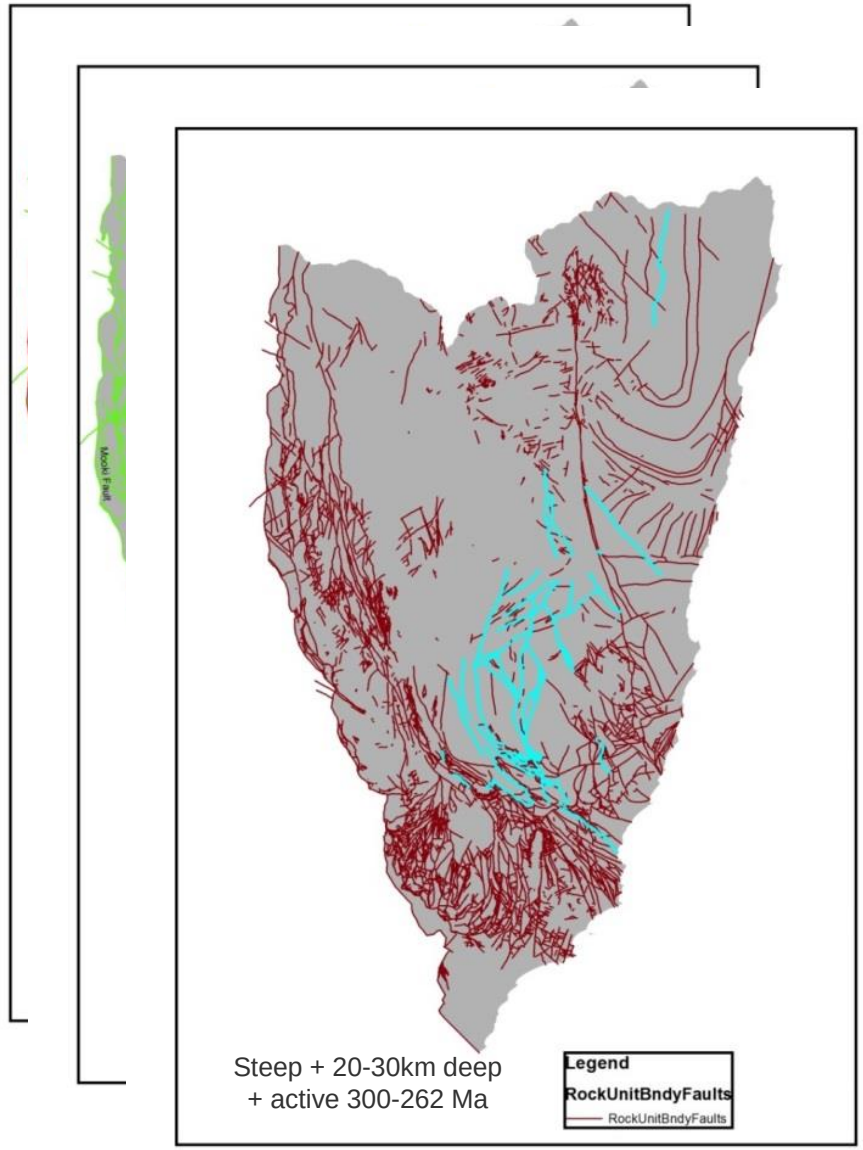
Last Edited By	G Phillips
DMRCode	Fault, position accurate
DMRCODE_Descriptic	Fault, position accurate
StructuralElementNan	Nowendoc Fault
Parent	Wongwibinda Tia Fault System
Sub_system	Manning Fault System
FaultOrder	2nd order fault
FaultConfidence	Accurate
Strike	136
FaultDipDirection	Northwest
FaultDipAngle	Steep (61-85 degrees)
FaultCrustalDepth	Lower (Approximate 20 to 30 km depending on terrane)
Length	5586
GravityVisibility	low visibility
MagneticVisibility	not visible
Event1	Hunter Bowen Cycle (300-262 Ma)
EventKinematics1	Normal dextral
Event2	Hunter Bowen contraction (262-252 Ma)
EventKinematics2	Reverse sinistral
Event3	<Null>
EventKinematics3	<Null>
Eventlast	Hunter Bowen contraction
Eventkinlast	Reverse sinistral
Source_Data	Dirks et al., 1992; Landenberger et al., 1995; Farell, 1992;
Comments	<Null>

Grouping

Architecture

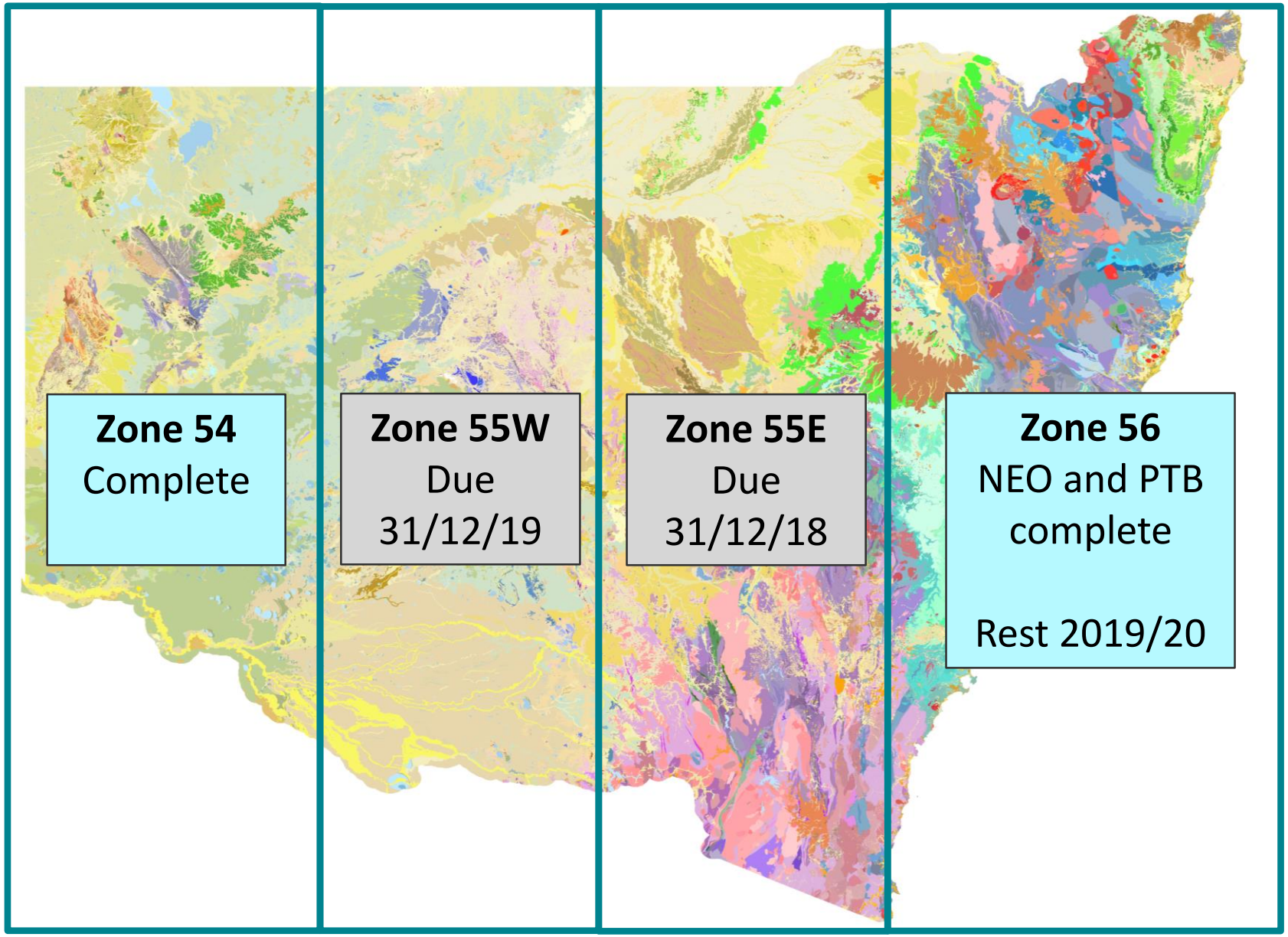
Geophysical character

Kinematics & event chronology



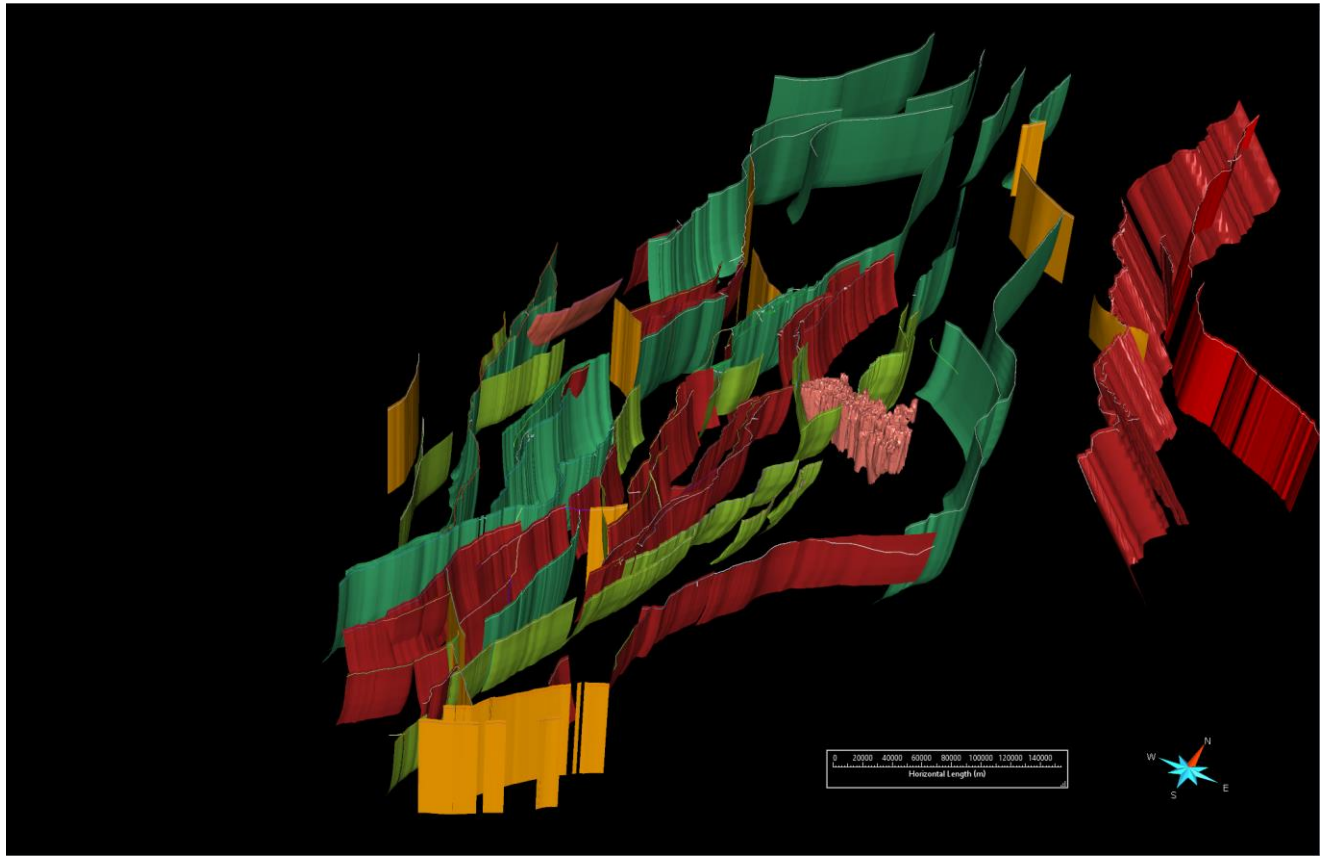
Fault attribution

- Zone 54 and NEO complete.
- Zone 55 due 2019.



NSW GOVERNMENT

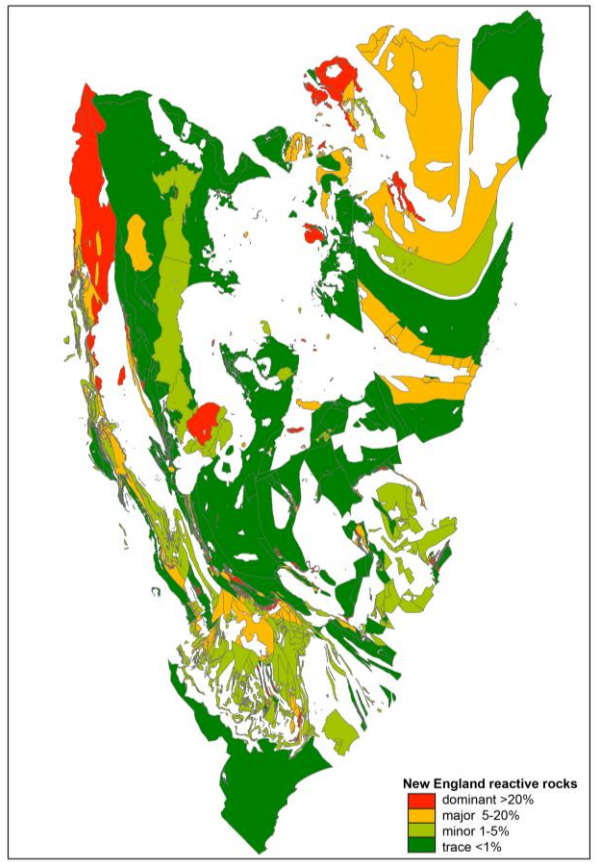
Integration of seamless and 3D geology

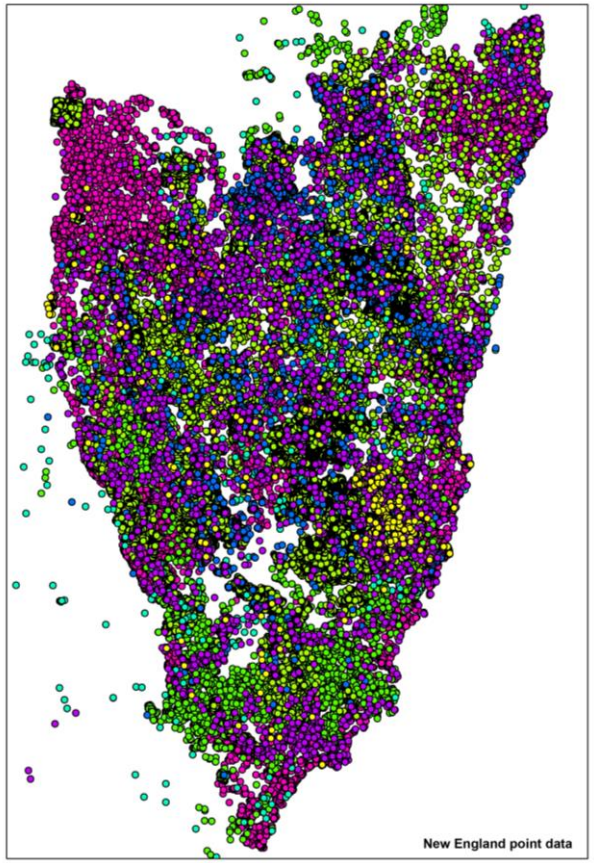


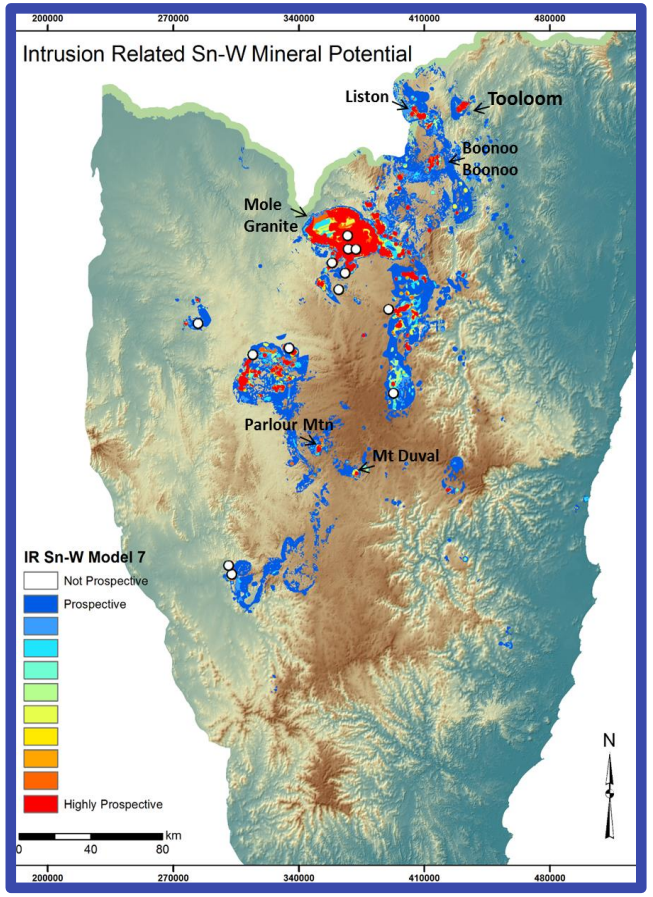
- Seamless outcrop & interpretation used to constrain 3D models.
- 3D models are then integrated with the seamless to improve it.
- This ensures a single geological model of NSW that is internally consistent in 2D and 3D.

NSW GOVERNMENT

Mineral potential mapping: New England Orogen





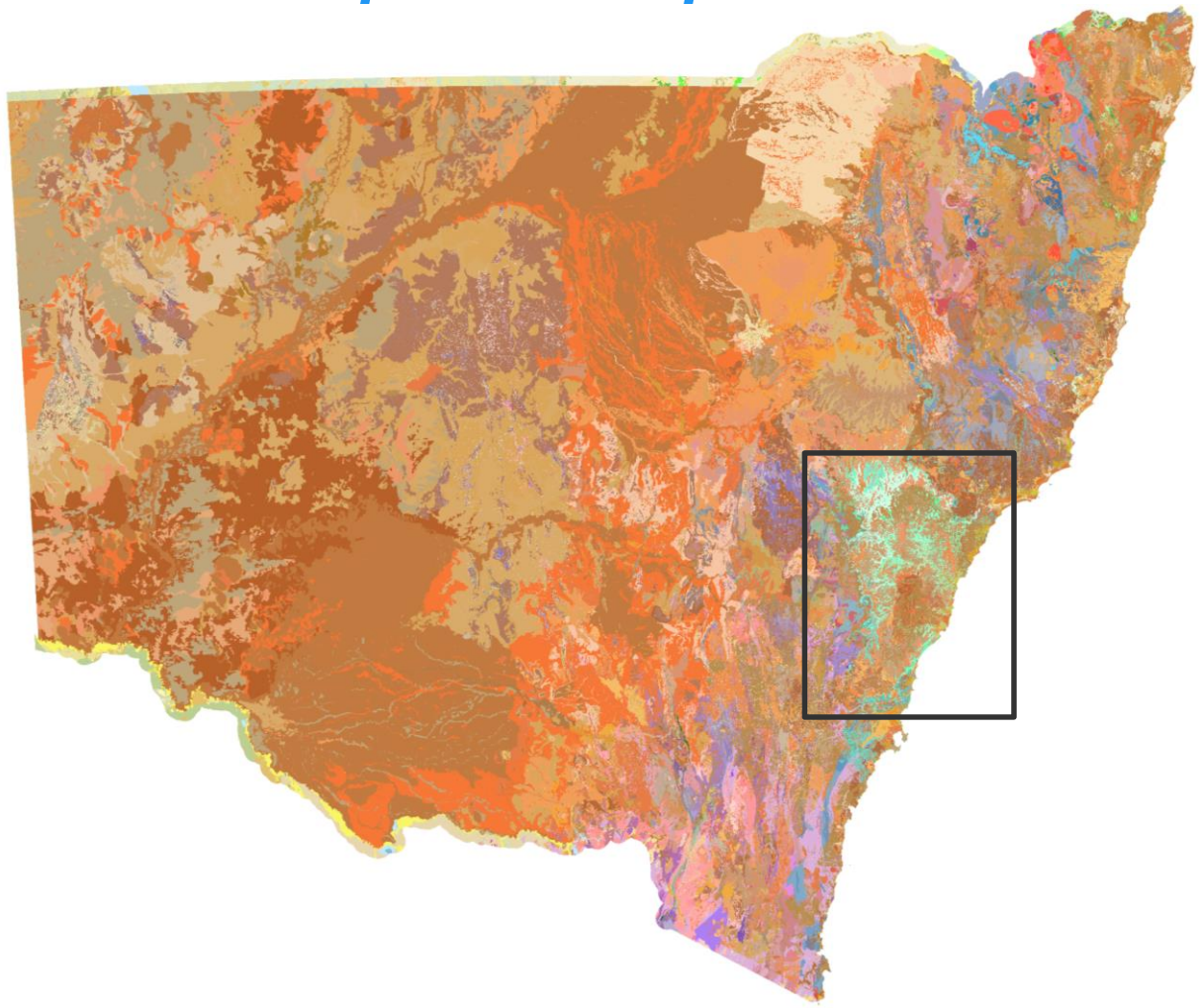


Seamless Geology

Reactive rocks
(Seamless Geology value-add)

Point-based data

Bedrock exposure map



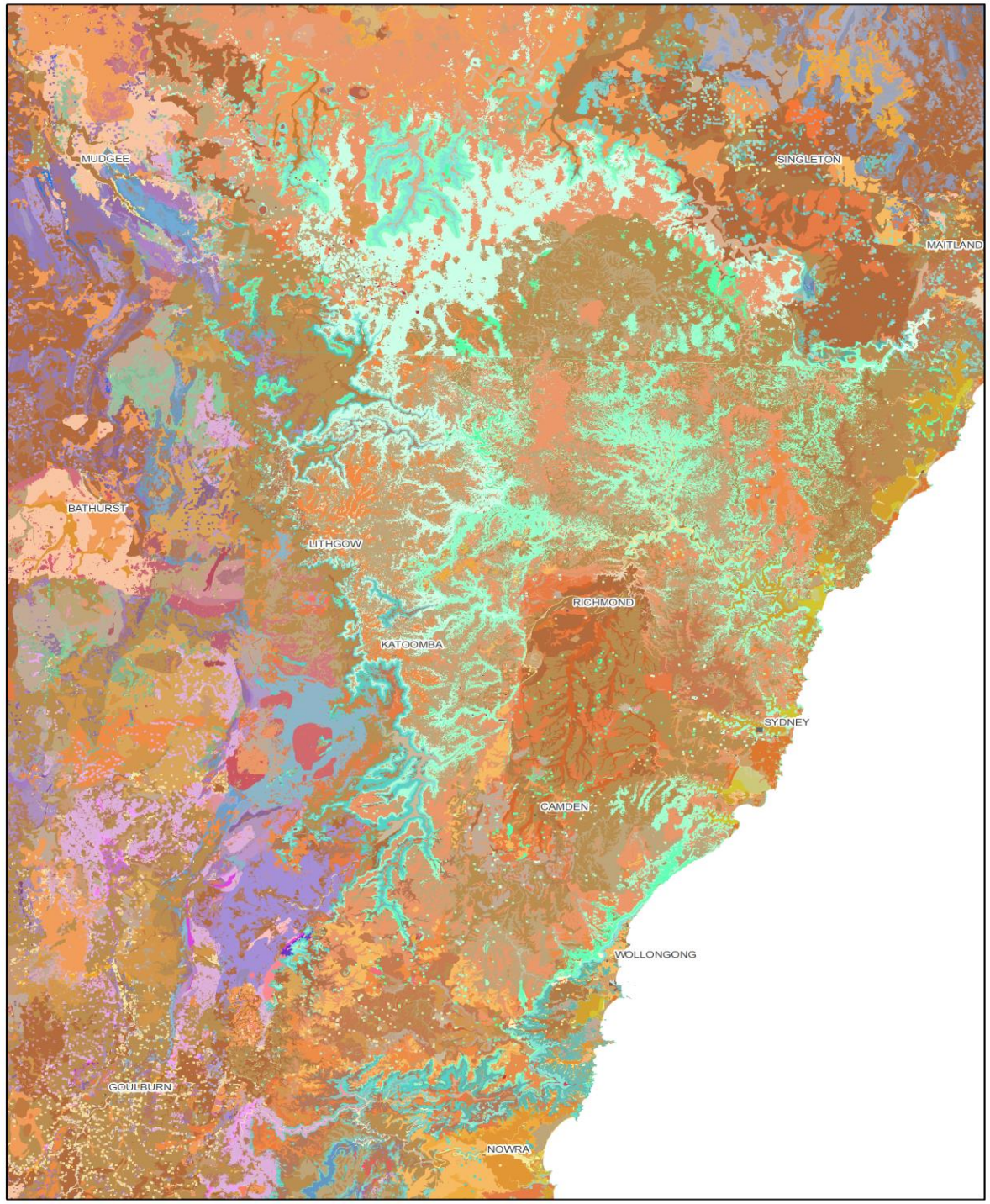
GSNSW
Field Obs

CSIRO
Soil Grid

NSW OEH
Soil Map

Bedrock exposure with soil map overlay

NSW GOVERNMENT



Bedrock exposure map example: Greater Sydney region

- Shows a much more reliable outcrop estimation.
- Will lead to better outcrop and soils mapping.

4

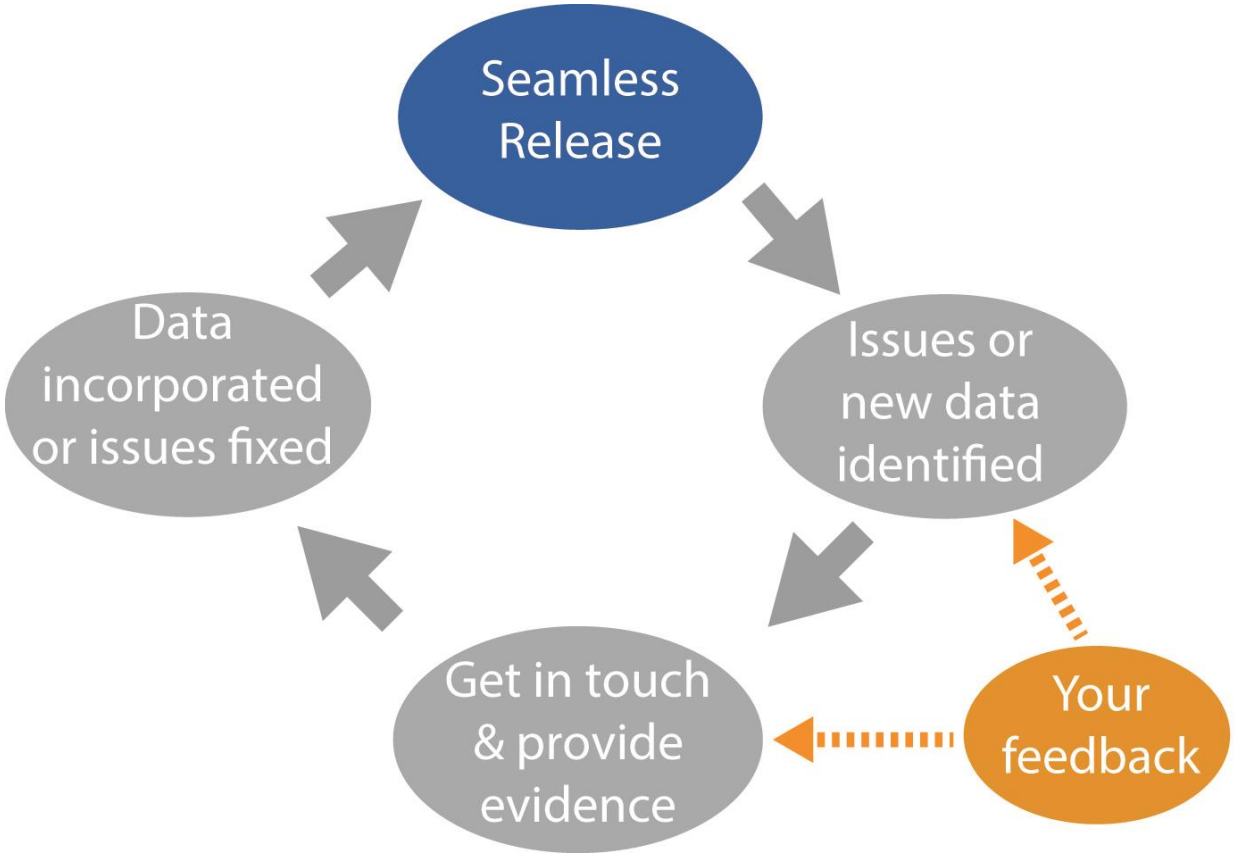
Summary: a new approach to mapping

NSW GOVERNMENT

What's next? It's just the beginning…

- One map to rule them all!
- Iterative process, with periodical updates/releases

Contributions welcome!



NSW GOVERNMENT

5

Where do you get it?

NSW GOVERNMENT

Accessing the data

Project webpage and GIS download:

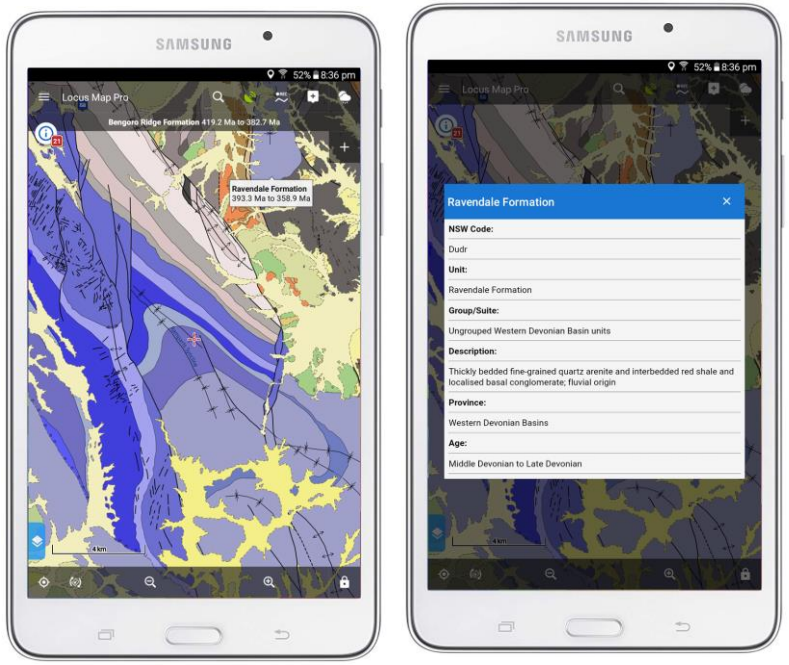
https://www.resourcesandgeoscience.nsw.gov.au/seamless-geology

MinView:

https://minview.geoscience.nsw.gov.au/

Mobile maps:

https://www.geoscience.nsw.gov.au/phonemaps/

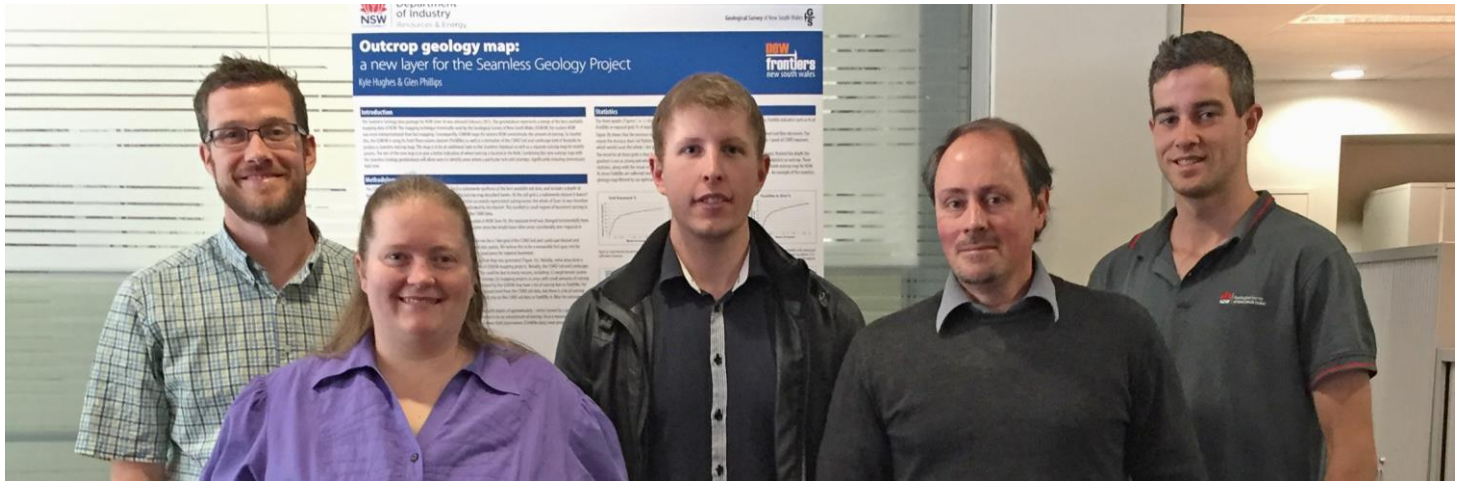


GIS Data

- **ArcGIS**
  - Good performing GIS software esp. with access to ArcGIS Pro.
- **Mapinfo**
  - Some of the larger layers including the CSP are difficult to render depending on your computer specs.
- **QGIS**
  - Free open source software
  - Has similar capabilities to ArcGIS and MapInfo

NSW GOVERNMENT

Seamless 'stitching' team



Glen Phillips (now external)

Liann Deyssing

James Ballard

Gary Colquhoun

Kyle Hughes

Chris Folkes

Joel Fitzherbert

Alexa Troedson (now external)

Phil Gilmore (Manager)

John Greenfield (Director)

NSW GOVERNMENT

James Ballard
james.ballard@planning.nsw.gov.au

NSW GOVERNMENT