2011

THE PHYSIOGRAPHIC REGIONS OF AUSTRALIA

Explanatory notes

Colin Pain, Linda Gregory, Peter Wilson and Neil McKenzie
Australian Collaborative Land Evaluation Program and
National Committee on Soil and Terrain

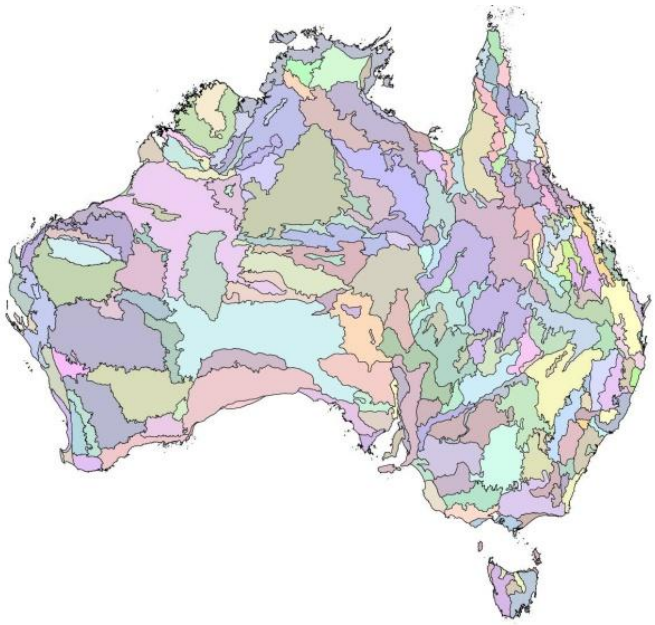
aclep
Australian Collaborative Land Evaluation Program

THE PHYSIOGRAPHIC REGIONS OF AUSTRALIA

EXPLANATORY NOTES

2011

Colin Pain[1], Linda Gregory[2], Peter Wilson[2] and Neil McKenzie[2]



Australian Collaborative Land Evaluation Program and

National Committee on Soil and Terrain

Australian Collaborative
Land Evaluation Program

[1] Geoscience Australia (Current address: MED_Soil (RNM-364), Departamento de Cristalografía, Mineralogía y Química Agrícola, Facultad de Química, Universidad de Sevilla, Spain.)

[2] CSIRO Land and Water, GPO Box 1666, Canberra, ACT 2601, Australia

TABLE OF CONTENTS

FIGURES

TABLES

1 INTRODUCTION

This report presents the methods and rationale behind the development and compilation of a revised map of the Physiographic Regions of Australia. The report gives an overview of physiographic mapping in Australia, describes current methods for mapping and provides a brief description of Australia's landscapes and the regions that have been defined. A discussion around the continual development of the resulting dataset is also included. The audience will range from those who are looking for a brief description of the physiography of Australia to those who will use the data for integrated studies of the environment.

2 BACKGROUND

2.1 Physiographic regions

"A physiographic region is a morphological unit with an internal coherence in its landform characteristics appropriate to the level of subdivision. It should be a discrete entity, although this requirement may be satisfied by a group of islands with intervening sea as well as by a continuous land area. Low-order regions should be entirely contained within the limits of regions of higher order. Uniformity of relief type may be a feasible criterion only for smaller units; units at higher levels will be more complex and will normally comprise a variety of forms, although these should be associated in a characteristic way which sets the region apart from its neighbours" (Jennings and Mabbutt, 1977).

From this it is clear that physiographic regions are defined and mapped in terms of landform characteristics. They are also discrete entities, with no inliers or outliers. At a continental scale of 1:2.5M they do not have uniform relief types. However, each physiographic region has an internal unity that derives from an association of landform characteristics. It is also, by implication, considered to be an area of similar landform evolutionary history. Each region also reflects the underlying geology, and has similar groups of regolith materials that are related to the landform types, their evolution, and the underlying bedrock. This means that the mapping criteria relate to landform attributes and the resultant mapped units are then described in terms of landform, underlying geology, regolith and soils. It does not imply conversely that physiographic region maps can be used as surrogates for directly mapping soils or their other descriptive attributes.

2.2 Previous mapping of physiographic regions

Physiographic regions are a means of dividing landforms into distinct regions, and are based upon Nevin Fenneman's classic American three-tiered approach of divisions, provinces and sections (Fenneman 1914, 1916) (see also Hammond 1954, 1964 and Lobeck 1957). Although they date from the mid-1910s, these concepts are still valid, and are the basis for similar classifications of other continents, including Australia.

In 1951, two maps of the physiography of Australia were published (Gentilli and Fairbridge 1951a, b), one by an American (Lobeck 1951) and the other by an Australian (Gentilli). These were followed by Jennings and Mabbutt in 1977, who utilised fresh information such as better topographic maps in conjunction with these previous maps, to produce an improved map of physiographic regions.

2.3 Why map physiography?

"Apart from its descriptive role, a map of physiographic regions provides a regional system of reference for geomorphological and related physical geographical accounts. Through the groupings of physiographic regional characteristics at different levels, the action of underlying controls, for instance geologic or climatic, may be made apparent. Further, the map can provide a

regional basis for an understanding of land characteristics that are dependent upon landforms, for example the distribution of soils or natural vegetation" (Jennings and Mabbutt 1986).

In his work in the United States, Fenneman (1914) stated "In a broad way the division of the United States into provinces serves two purposes; first, for the discussion and explanation of the physical features of the country; second, as a basis for the plotting and discussion of social, industrial, historical and other data of distinctly human concern". The same reasons hold true, more or less, for the map presented here. A map of physiographic regions provides many benefits to the management of natural resources. It forms a context for more detailed studies of other aspects of the physical environment of Australia, especially the distribution of soils.

The initial goal of the new map of physiographic regions was to provide upper levels of mapping (0, 1 and 2 – see Table 1) within the Australian Soil Resource Information System (ASRIS) (McKenzie et al. 2005, see also Johnston et al. 2003). The Jennings and Mabbutt map was recognized as being suitable for this purpose, but it was also recognized that new data, especially the Shuttle Radar Terrain Mission (SRTM) digital elevation model, would allow a more precise map to be compiled. In addition, state soil and land surveys contained a lot more important information that could be used to describe the regions. As higher mapping levels in ASRIS the physiographic regions provide a framework within which to place these more detailed studies.

Table 1. The spatial hierarchy of ASRIS land units (after Speight 1990).

Note that the database design for ASRIS allows intermediate Levels to be characterized (e.g. a System with a characteristic dimension significantly less that 300 m would be designated as Level 5.1 or 5.2 in the hierarchy).

ASRIS Level	Order of land unit tract	Speight's dimension	ASRIS dimension	Descriptive or defining attributes	Appropriate map scale
0	Division	300km	30 km	Broad physiography (slope and relief) and geology	1:10 million
1.0	Province	100 km	10 km	Physiography, water balance, dominant soil order and substrate	1: 2.5 million
2.0	Region		3 km	Physiography, regolith materials, age of land surface, water balance dominant soil suborder	1:1 million
				ASRIS Mapping Hiatus Levels above are based on subdivisions of the continent Levels below are aggregated from surveys.	
3.0	Zone	30 km	3 km	Regional groupings of geomorphic related systems	1:1 million
4.0	District	5 km	1 km	Groupings of geomorphic related systems	1:250 000
5.0	System	600 m	300 m	Local climate, relief, modal slope, single lithology or single complex of lithologies, similar drainage net throughout, related soil profile classes (soil-landscape*)	1:100 000
5.1			100 m	As for Level 5.0	1:25 000
6.0	Facet	40 m	30 m	Slope, aspect, soil profile class	1:10000
6.1			10 m		1:2500
6.2			3 m		1:1000
7.0	Site	20 m	10 m	Soil properties, surface condition, micro-relief	rarely mapped in conventional survey

McKenzie et al. (2005) note that the upper levels of ASRIS can be used for monitoring (a spatial framework for selecting representative sites, a system for spatial extrapolation of monitoring results, and broad assessment of resource condition) and modeling (providing data for modeling, a spatial association of input variables, and landform information for integrated regional studies). Speight (2008) notes that the kind of mapping unit that will best carry a message is broad, and its boundaries are smooth; this applies to the upper levels of ASRIS. They will also increase our understanding of landscape processes over large areas.

In other applications, the upper levels of the ASRIS hierarchy provide a background to regolith and landform evolution studies that have become an important part of mineral exploration (Taylor and Eggleton 2001). They will inform the delineation of units of management, such as the Interim Biogeographic Regionalisation of Australia (IBRA) and other biophysical regionalisations where landform is one of many land attributes that control landscape dynamics.

2.4 Australia's physiography

The Australian continent is dominated by plains and low rises. Exceptions are found in the central parts of the continent, such as the Flinders Ranges, and along the margins, particularly the Eastern Highlands, of which Tasmania is an off-shore continuation. The margins, except in the south, are generally higher than the inland areas, giving the continent a saucer shape. This is a fundamental attribute that Australia shares with other Gondwanaland continents such as Africa, all of which have the characteristic great escarpment. The Eastern Highlands of Australia are a well-studied, very fine example. There is a similar feature in northern Australia, where the plateau edge lies inland of the northern coastal lowlands. The inland edge of the Nullarbor Plain could also be considered the same kind of feature. These surface features appear to reflect deep crustal processes such as the gravity of the lithosphere. Another feature of Australian landforms is that they tend to be more complex in the east than in the west. This is, at least in part, a consequence of the more complex geological background in the east and is reflected in the smaller size of physiographic regions in the east compared with the west.

3 MAPPING METHODS

The physiographic regions presented here are a modification of those compiled by Jennings and Mabbutt (1977). Boundaries for these regions were firstly refined with new information provided by the Shuttle Radar Topographic Mission (SRTM) elevation model. Later, state and territory representatives provided amendments to regions that reflected a more detailed understanding of relevant landscapes. While region descriptors are broadly defined, the methods used here are descriptive and qualitative.

3.1 The mapping criteria

Jennings and Mabbutt (1977) used landforms as the basis for subdivision at the region level. At the Division and Province level they used subdivisions that existed previously. Their regions used landform, geology, and terrain attributes as descriptors. They discuss location mainly in the context of providing names for each region, noting that in Australia there is a dearth of geographic names when compared with the United States.

The principles of Jennings and Mabbutt (1977, 1986) have been maintained in the compilation of regions in this new map. In particular:

- Land units at these levels are discrete entities and outliers are permitted only in exceptional cases (e.g. offshore islands, major plateau adjacent to extensive tablelands, parts of a unit separated by estuaries)
- Tracts are hierarchical and have a single parent-tract

3.2 Delineation of boundaries

3.2.1 Pattern recognition

Traditionally, mapping of landforms depended on the visual recognition of patterns in the landscape from topographic maps and aerial photographs, and more recently raw and enhanced images derived from remote sensing and digital elevation models. An example of this is provided by Multi-Resolution Valley Bottom Flatness (MrVBF), an enhancement of Digital Elevation Models (DEM) that highlights areas that are flat and low in landscapes (Gallant and Dowling 2003).

For details of landform mapping see Smith and Pain (2009) and Smith et al. (in press) for up-to-date summaries. Speight (2008) describes in detail the concept of landform patterns as they relate to landform mapping. However, the recognition of landform patterns relies implicitly on a number of attributes, even if these attributes are not explicitly part of the description of physiographic regions.

Many of the following attributes reflect the underlying geology that, together with landforms, gives most if not all regions their fundamental character.

- *Depth of dissection:* a measure of the depth to which rivers have cut down below some general level. It is assumed that the rivers began cutting down from the same general level.
- *Degree of dissection:* an indication of the amount of the original surface that is left. A slightly dissected surface has only a few valleys cut into it, while a highly dissected surface may have only a small part of the original surface left.
- In areas where there is nothing left of the original surface, it is unrealistic to use the term *degree of dissection*. These areas are completely dissected, and should be described in terms of their relative relief and drainage density.
- *Relative relief:* a measure of the average difference in elevation between the highest and lowest parts of the area under study. It is a relative measure, and is not related to absolute altitude, which is height above sea level.
- *Drainage density:* a measure of the density of drainage lines in an area, usually calculated as length of drainage channel per unit area (km/km^2). All channels that carry water, whether permanent or intermittent, are counted.
- *Channel spacing:* another way of measuring the density of drainage. This is obtained by drawing a straight line of a given length across a mapping unit, and counting the number of channels the line crosses. Speight (1990, 2008) discusses this measure, and gives a formula for converting channel spacing to drainage density.
- *Drainage patterns:* the plan shapes made by the drainage lines. Examples of drainage patterns are "dendritic" and "rectangular" (see Pain et al. 2007, Pain 2008).
- *Channel patterns:* the plan shapes of individual channels. Examples of channel patterns are "meandering" and "braided" (see Pain et al. 2007, Pain 2008).

3.2.3 Boundary refinement

The SRTM Digital Elevation Model, hill-shaded from the NW for consistency, for each 1:1M map sheet (38 in total) covering continental Australia was plotted along with the original Jennings and Mabbutt (1977) lines. Using the SRTM data as a guide and some or all of the attributes described above, the original lines were altered to more closely align with the landforms as portrayed on the shaded SRTM DEM. Regions were neither subdivided nor combined in the initial compilation of this map of physiographic regions.

Following this compilation, line work was sent on hard copy plots to state and territory agencies for comment and editing. The process of editing continued at an ACLEP workshop held in February 2007. Following the workshop, state and territory agencies checked line work and polygons against existing state and territory maps. For examples, WA line work is aligned with WA state soil landscape survey data.

State and territory edits were returned to CSIRO, where the final map was compiled, checked for consistency, and completed in November 2010.

3.3 Descriptors

The primary descriptors for regions are geographic name, a simple text description including major geologic and geomorphic features, and a list of regolith materials with their estimated proportions.

Table 2. Primary Region descriptors.

Descriptor	Example	Comment
division_id	1	1 digit code
division_name	Eastern Uplands Division	Division name used by Jennings and Mabbutt
division_desc	The eastern uplands of Australia. Landform patterns reflect structural contrasts. Meridional folding and faulting is reflected in a general North-South grain of relief. It includes both the Great Divide and the Great Escarpment.	Text description of the Division
province_id	108	3 digit code, including the division code as the first digit
province_name	Tasmanian Uplands Province	Province name used by Jennings and Mabbutt
province_desc	Hilly and mountainous, high relief.	Text description of the Province
province_regolith_material	Soil on bedrock (> 50%), saprolite (20 - 50%)	Based on various maps and reports from Geoscience Australia, CRC LEME, and state and territory geological surveys
region_id	10805	5 digit aggregate code
region_name	West Tasmanian Ridges	Modified from Jennings and Mabbutt
region_desc	Ridges of folded quartzite and conglomerate, glaciated in places, parallel valleys on weaker rocks.	Text description of the major geologic, and geomorphic features
region_regolith_materials	Moderately weathered bedrock (> 50%), unweathered bedrock (< 20%), terrestrial sediments (< 20%)	Based on various maps and reports from Geoscience Australia, CRC LEME, and state and territory geological surveys

3.3.1 Geographic names and landform descriptions

The majority of unit names have come directly from Jennings and Mabbutt, with a few accepted changes proposed by the various state and territory agencies (e.g. Werriwa Tablelands for the northern section of the Southern Tablelands in New South Wales) (Appendix A). Region names are composed of a geographical name combined with a generic topographic term. For some regions, more than one geographic name is used to indicate extent (e.g. Albany Esperance Sandplain). The topographic descriptor has been used in the plural to indicate complexity or recurrence of forms within the region, and singular to indicate more homogenous landscapes. Compound regions use two topographic descriptors (Jennings and Mabbutt 1977) (e.g. Stansmore Dunefield and Ranges).

3.3.2 Regolith materials

Regolith materials are described using the appropriate level of classification from Table 3 (Pain 2008). The relative area of up to three regolith classes are recorded using the descriptors dominant (>50%), subdominant (20–50%) and minor (<20%).

Table 3. Regolith types (Pain 2008).

Code	Name	Code	Name
SDT00	terrestrial sediments	SDM01	Biogenic marine carbonates
SDT01	lag on transported regolith	SDM02	spiculite
SDA00	alluvial sediments	SDB00	microbial sediments
SDA10	channel deposits	SDP00	swamp (paludal) sediments
SDA20	overbank deposits	SDP01	peat
SDC00	colluvial sediments	SDS00	coastal sediments
SDC01	scree	SDS01	beach sediments
SDC02	landslide deposit	SDS02	estuarine sediments
SDC03	mudflow deposit	EVA00	evaporite
SDC04	creep deposit	EVA01	halite
SDC05	sheet flow deposit	EVA02	gypsum
SDC06	colluvial fanglomerate	EVA03	acid sulphates
SDD00	spring deposits	VOL00	volcanic materials
SDD01	spring travertine	VOL01	lava flow
SDD02	spring tufa	VOL02	tephra
SDD03	spring clastics	IE00	impact ejecta
SDD04	spring evaporites	BU00	unweathered bedrock
SDE00	aeolian sediments	WIR00	in situ weathered bedrock
SDE01	aeolian sand	WIR10	saprolith
SDE02	loess	WIR11	saprock
SDE03	parna	WIR12	moderately weathered bedrock
SDF00	fill	WIR13	highly weathered bedrock
SDG00	glacial sediments	WIR14	very highly weathered bedrock
SDG01	moraine	WIR15	completely weathered bedrock
SDG02	ground moraine	WIR16	saprolite
SDG03	terminal moraine	WIR20	residual material, or pedolith
SDG04	lateral moraine	WIR21	lag on *in situ* regolith
SDG05	glacial outwash	WIR22	residual sand
SDL00	lacustrine sediments	WIR23	residual clay
SDL01	clastic lacustrine sediments	WIR24	soil on bedrock
SDL02	calcareous lacustrine sediments	UOC00	clay (unknown origin)
SDL03	organic lacustrine sediments (gyttja)	UOL00	soil (unknown origin)
SDL04	diatomite	UOM00	weathered material (unknown origin)
SDM00	marine sediments	UOS00	sand (unknown origin)

3.3.3 Supplementary descriptors

Future releases provided through ASRIS will contain summaries of relief, modal slope, an estimate of water-balance and climatic summaries such as mean annual temperature and mean annual precipitation. Main soil types from the Atlas of Australian Soils have yet to be added.

3.4 The Physiographic Regions dataset

The Physiographic Regions dataset consists of a planar vector GIS layer, and a relational database containing the hierarchy of attributes.

The vector layer is labelled with the region id, which allows both the connection to the attributes in the relational database and the aggregation through to provinces and divisions. Each region is represented by a closed "polygon", with the primary attributes already joined.

The relational database (Access) contains a table for each level (regions, provinces and divisions) and separate tables for regolith and soil (not yet attributed) and another table for proportions. A query flattens this structure and concatenates the regolith material into one field, so that it can be joined to the spatial data. A report tool is also included, which allows new listings to be created easily, post update (Appendix A).

ANZLIC 2.0 metadata are included with the data (Appendix B).

4 THE PHYSIOGRAPHIC HIERARCHY OF AUSTRALIA

4.1 Regions

Regions are basic geomorphological subdivisions of Australia. Each region is internally consistent in terms of its landform morphology and inferred origin as seen on the SRTM DEM. The goal was to create units that minimize within-unit variation and maximize between-unit variation in descriptive attributes. This may translate into regions with similar relief, underlying geology, and geomorphic origin. There are 220 mapped regions (see Figure 1 and Appendix A).

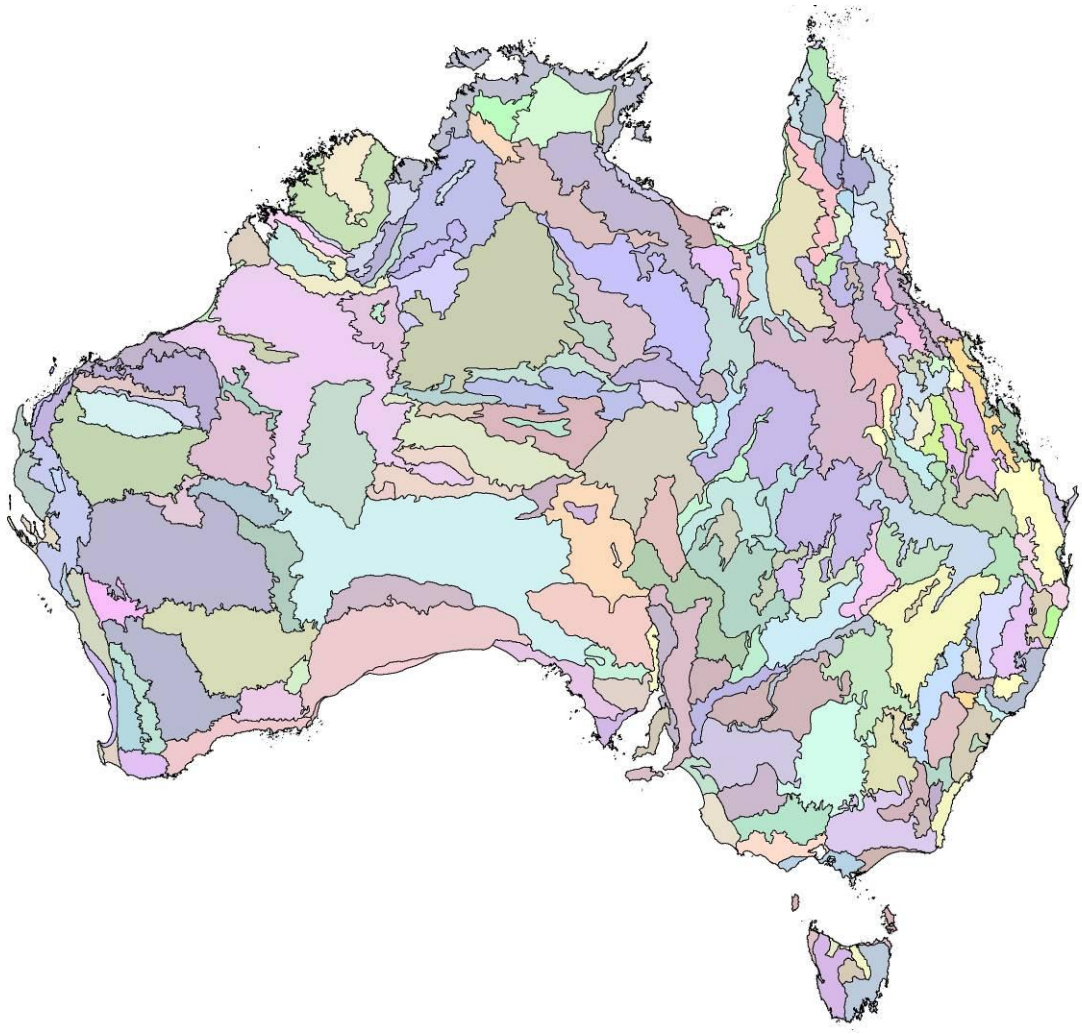


Figure 1. Physiographic Regions.

Some region boundaries coincide with major geomorphic boundaries. For example the Great Escarpment of eastern Australia, especially in New South Wales, forms a major geomorphic boundary between the tablelands and the coastal hills and lowlands (Figure 2). Other region boundaries, and especially those in the more central parts of the continent, tend to be more diffuse (Figure 3).

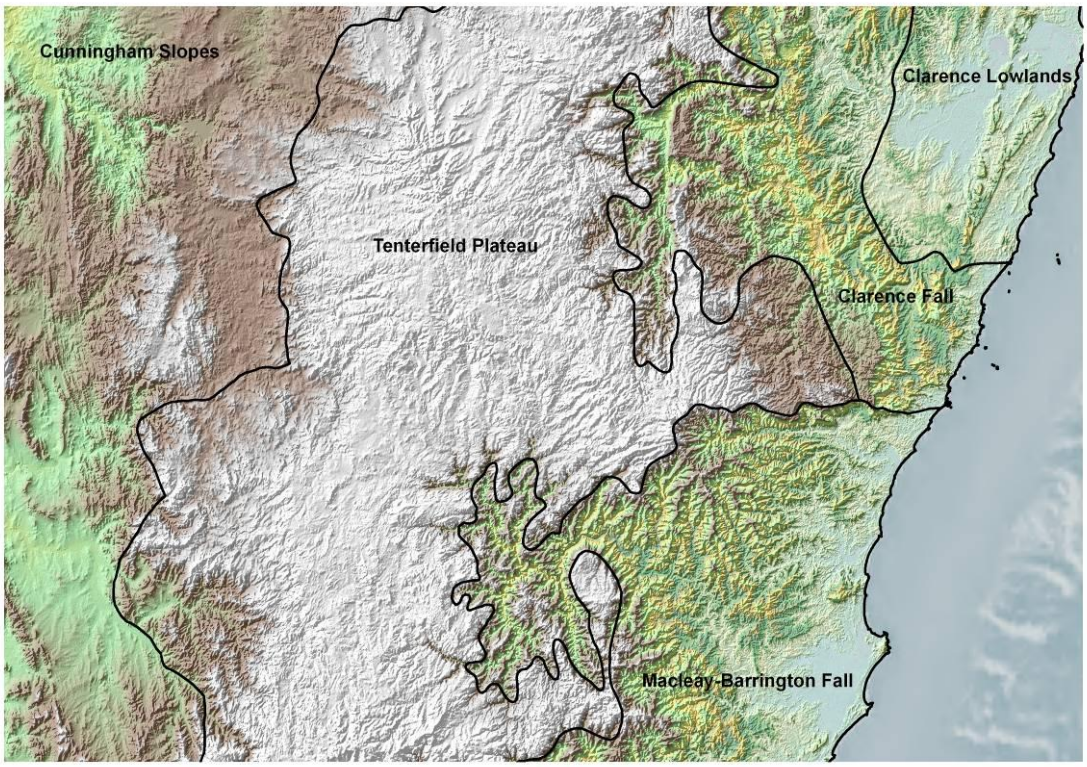


Figure 2. Extract from New South Wales showing some major geomorphic boundaries.

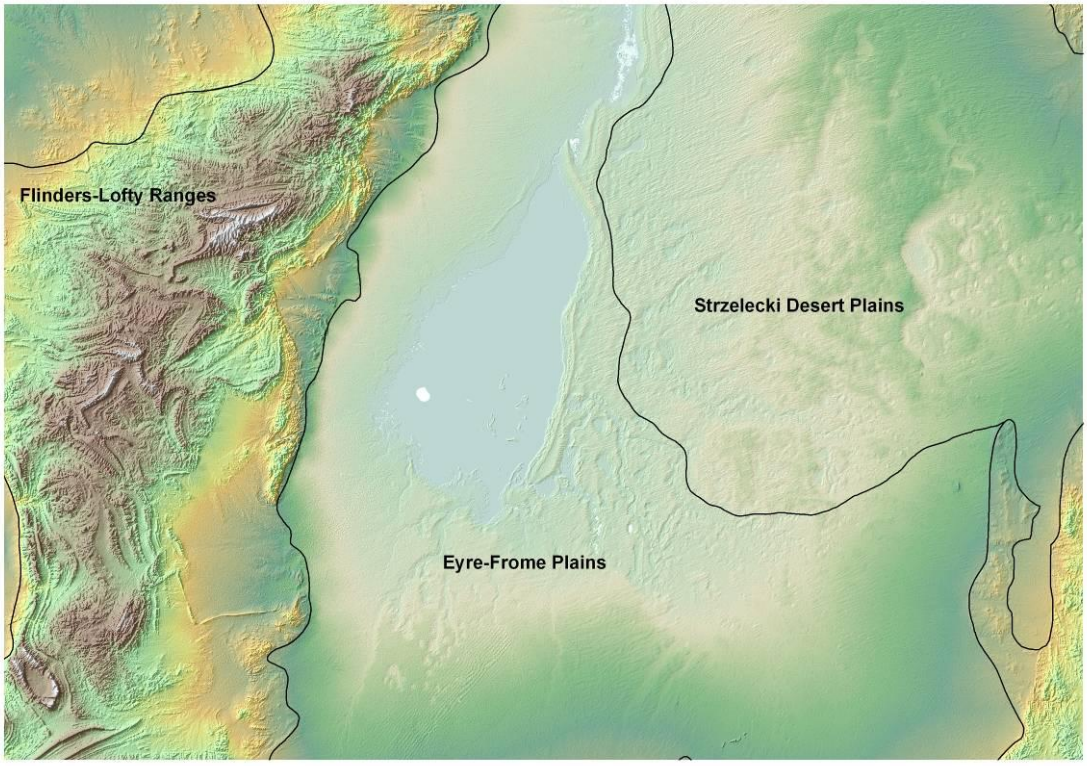


Figure 3. Extract from South Australia showing examples of sharp and diffuse boundaries.

4.2 Provinces

Provinces distinguish major physiographic changes across the country. They are compiled by grouping regions with similar landform and geological characteristics at a scale of ~1:2.5M for presentation at 1:10M. Provinces can be compiled using landform (mountains, hills, tablelands, plains) and/or processes (erosion, deposition). The potential energy of landscapes is also important (e.g. high-energy areas have steep slopes and high relief so they will have correspondingly high rates of sediment movement). Descriptors include geology, structure, and broad regolith types. Provinces can be used to make interpretations about landscape processes at the broadest scale. There are 23 Provinces delineated for Australia as shown in Figure 4..

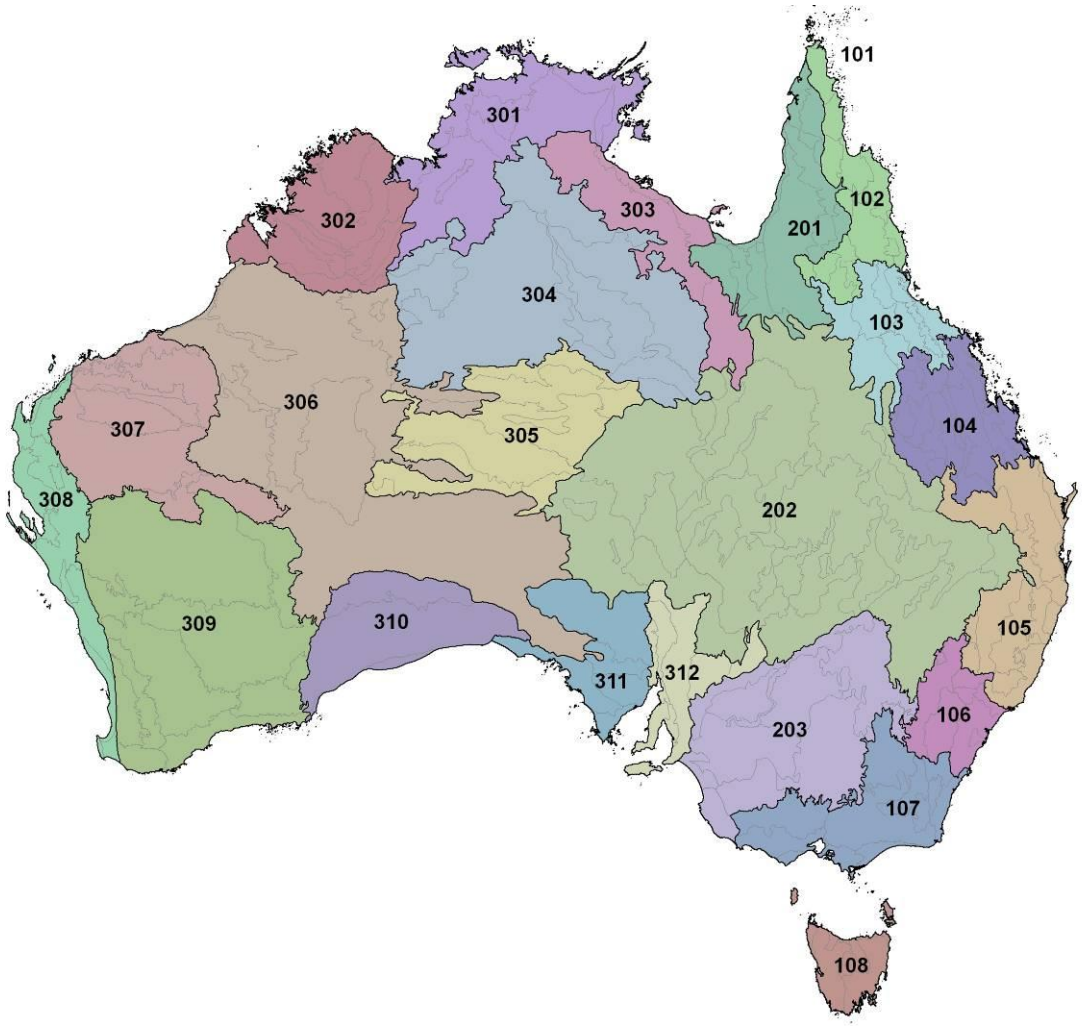


Figure 4. Physiographic Provinces.

4.3 Divisions

Mabbutt (1973) defined 3 very broad divisions of the Australian continent, the Western Plateau, the Interior Lowlands and the Eastern Uplands (as per Figure 5). These are broadly coincident with a geological subdivision into the western shields, the central basins and the eastern fold belts. The geological subdivision goes back to at least 1951 (Gentilli and Fairbridge 1951a and b). Dury (1968) used the same divisions, and further subdivided them into 15 morphological subdivisions. Mabbutt (1973) also provided further subdivisions. The divisions shown in Figure 3 are those from Jennings and Mabbutt (1977, 1986).

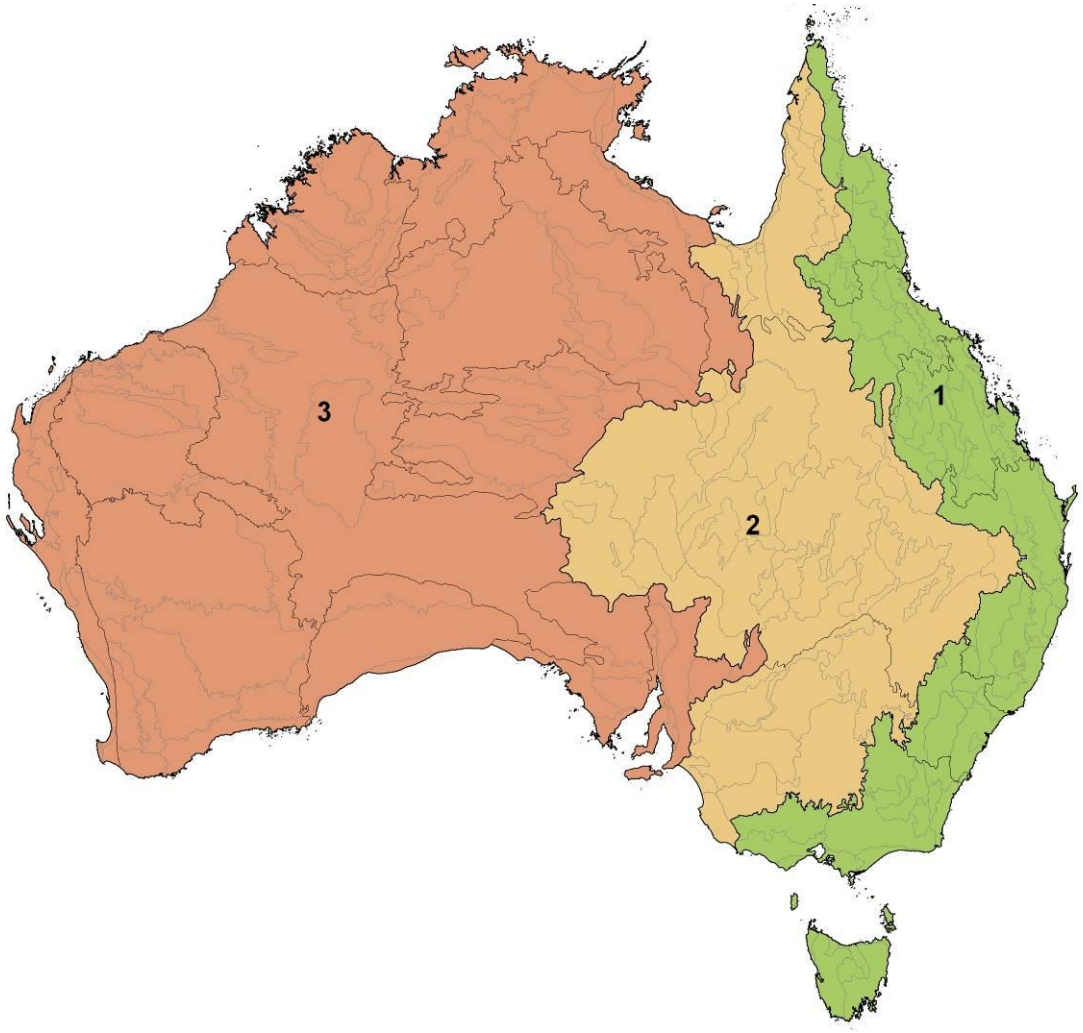


Figure 5. Physiographic Divisions.

5 FURTHER REVISION

Jennings and Mabbutt presented their map of the Physiographic Outlines and Regions in 1977, with the intention that it set in motion "a train of progressive improvement through consultation and realization of errors". This is the first attempt, to bring their ideas into a format that can be used for modelling, taking into account the availability of new source data and the resources of state and territory expertise. Further progression will include defining 15 sub-divisions between division and provinces, calculating summary descriptors for regions and using quantitative approaches to define the regions. Additional data sources provided by terrain analysis, such as the Multi-Resolution Valley Bottom Flatness index, provide opportunities for further refining the boundaries of regions.

5.1 Delineation of morphological sub-divisions

ASRIS requires a level of generalization between Division and Province, to help distinguish major physiographic divisions across the country. One suggestion is to use the subdivision suggested by Mabbutt in 1973. This needs to be assessed further, with a classification based on land forming processes. Table 4 presents one such possibility.

Table 4. Preliminary attempt at subdivision of ASRIS Level 0.

Western Plateau	Shield Landforms
	Cratonic Basin landforms
	Marginal Basin Landforms
Interior Lowlands	Carpentaria Lowlands
	Eromanga and Surat Basins
	Murray Basin
	Darling Basin
Eastern Uplands	Eastern Uplands

5.2 Additional summary descriptors

Statistical summaries of slope, relief, climate (excess water, mean annual temperature and total annual precipitation) and dominant soil order will be calculated for each of the regions, in a future release. Divisions and Provinces will include slope and relief (Table 5).

Table 5. Future list of descriptors

Descriptor	Example	Comment
region_name	West Tasmanian Ridges	Modified from Jennings and Mabbutt
region_desc	Ridges on folded quartzite and conglomerate, glaciated in places, parallel valleys on weaker rocks.	Text description of the major geologic, and geomorphic features
region_slope	11% (3–18%)	Modal slope with the 5^{th} and 95^{th} percentile.
region_relief	190 m (50–395 m)	Modal relief with the 5^{th} and 95^{th} percentile.
region_xswater	350 mm (90–850mm)	Median value for excess water (runoff + deep drainage) with the 5^{th} and 95^{th} percentile.
Mean Annual Temperature		Median value for mean annual temperature with the 5^{th} and 95^{th} percentile.
Mean Annual Precipitation		Median value for mean annual precipitation with the 5^{th} and 95^{th} percentile.
Regolith materials	Dominant: moderately weathered bedrock Minor: unweathered bedrock Minor: terrestrial sediments	Based on various maps and reports from Geoscience Australia, CRC LEME, and state and territory geological surveys.
Soil Order	Dominant: Rudosols Subdominant: Organosols Minor: Podosols	Based on interpretation of the Atlas of Australian Soils.

5.3 Quantitative delineation of regions

Traditionally, mapping of terrain depended on the qualitative recognition of patterns in the landscape from topographic maps and aerial photographs, and more recently raw and enhanced images derived from remote sensing and digital elevation models.

While taking advantage of new technologies and sources of data, mapping of landforms has remained a qualitative and descriptive process in this dataset, based on the expertise of many years of mapping and understanding landforms and their processes. MacMillan and Shary (2009) point out that "Human-devised conceptual classifications of repeating landform types tend to be far richer, subtler and more complex than any equivalent automated classifications that have been achieved to date." This map of physiographic regions demonstrates and captures that conceptual understanding of landform patterns and may provide guidance to future developments of methods that are quantitative, explicit, consistent and repeatable (Austin and McKenzie 1988).

6 CONCLUSION

The physiographic regions form a consistent framework for mapping soils and terrain at national and regional scales. They are compiled at a continental scale, and are subdivisions of Australia rather than aggregations of units from more detailed surveys.

Updates to the physiographic regions are foreseen, with the prospect of more explicit, consistent and repeatable methods currently being investigated.

7 ACKNOWLEDGEMENTS

Development of the new Physiographic Regions of Australia map was originally funded by the Australian Collaborative Land Evaluation Program, Department of Agriculture, Fisheries and Forestry, Geoscience Australia, CSIRO and the CRC LEME. It was a long process, with many people involved at all levels. The compilation of the spatial data was assisted by many, including David Jacquier (CSIRO Land & Water), Luisa Ruperta (Geoscience Australia), Linda Merrin (CSIRO Land & Water) and helpful state and territory land resource and technical specialists, particularly -.

WA Peter Tille, Ted Griffin

NT Jason Hill, Brian Lynch

SA David Maschmedt, John McDonald

QLD Tessa Chamberlain, Dan Brough

NSW Casey Murphy, Mark Young

Vic Nathan Robinson, David Rees

Tas Bill Cotching, Darren Kidd

8 REFERENCES

Austin, M., and McKenzie, N. (1988). Data analysis. In: Gunn, R H, Beattie, J A, Reid, R E and van de Graaff, R H.M. (eds.). Australian Soil and Land Survey Handbook: Guidelines for Conducting Surveys, Melbourne, Vic: Inkata Press: (Ch.15): 210-231

Dury, G.H. 1968. An introduction to the geomorphology of Australia. In Dury, G.H. and Logan, M.I. (Eds). Studies in Australian Geography Heinemann, Melbourne, 1-36.

Fenneman, N.M. 1914. Physiographic boundaries within the United States. Annals of the Association of American Geographers 4, 84-134.

Fenneman, N.M. 1916. Physiographic divisions of the United States. Annals of the Association of American Geographers 6, 19-98.

Gallant, J.C. and Dowling, T.I. 2003. A multi-resolution index of valley bottom flatness for mapping depositional areas. Water Resources Research 39, 1347-1360, doi:10.1029/2002WR001426.

Gentilli, J. and Fairbridge, R.W. 1951a. Physiographic Diagram of Australia, Notes to accompany a map prepared by A.K. Lobeck, The Geographical Press, Columbia University, New York.

Gentilli, J. and Fairbridge, R.W. 1951b. The Physiographic Regions of Australia. Notes to accompany a Geomorphological Map of Australia by J. Gentilli, University of Western Australia, Nedlands, WA.

Hammond, E.H. 1954. Small-scale continental landform maps. Annals of the Association of American Geographers 44, 33-42.

Hammond, E.H. 1964. Analysis of properties in landform geography: an application to broad-scale land form mapping, plus Map Supplement No. 4: Classes of Land- Surface Form in the Forty Eight States, U. S. A. Annals of the Association of American Geographers 54, 11–19.

Jennings, J.N. and Mabbutt, J.A. 1977. Physiographic outlines and regions. Australia: a Geography Jeans, D.N. (Editor), Sydney University Press, 38-52.

Jennings, J.N. and Mabbutt, J.A. 1986. Physiographic outlines and regions. Australia: a Geography (Second Edition), Volume 1 The Natural Environment. Jeans, D.N. (Editor), Sydney University Press, 80-96.

Johnston, R.M., Barry, S.J., Bleys, E., Bui, E.N., Moran, C.J., Simon, D.A.P., Carlile, P., McKenzie, N.J., Henderson, B.L., Chapman, G., Imhoff, M., Maschmedt, D., Howe, D., Grose, C., Schoknecht, N. Powell, B. and Grundy, M. 2003. ASRIS: the database. Australian Journal of Soil Research 41, 1021-1036.

Lobeck, A.K. 1957. Physiographic Diagram of the United States. The Geographical Press, C.S. Hammond and Co., Maplewood, New Jersey.

Lobeck, A.K.1951 Physiographic diagram of Australia [cartographic material at 1:7 500 000] / drawn by A.K. Lobeck to accompany text description and geological sections which were prepared by Joseph Gentilli and R.W. Fairbridge of the University of Western Australia, New York: Geographical Press.

Mabbutt, J.A. 1973. Landforms. Atlas of Australian Resources, Second Series Geographic Section, Department of Minerals and Energy, Canberra 19pp.

MacMillan, R.A. and Shary, P.A. 2009. Landforms and landform elements In: Hengl, T. and Reuter, H.I. (Eds), Geomorphometry: Concepts, Software, Applications. *Developments in Soil Science*, vol. 33, Elsevier, 227-254.

McKenzie, N.J., Jacquier, D.W., Maschmedt, D.J., Griffin, E.A. and Brough, D.M. 2005. The Australian Soil Resource Information System Technical Specifications, Version 1.5 Australian Collaborative Land Evaluation Program, on behalf of the National Committee on Soil and Terrain Information, www.asris.csiro.au, 89pp.

Pain, C.F. 2008. Field Guide for Describing Regolith and Landforms CRC LEME, c/o CSIRO Exploration and Mining, PO Box 1130, Bentley WA 6102, Australia, 94pp.

Pain, C.F., Chan, R., Craig, M., Gibson, D., Kilgour, P. and Wilford, J. 2007. RTMAP Regolith Database Field Book and Users Guide (Second Edition). CRC LEME Open File Report 231 92pp.

Smith, M.J. and Pain, C.F. 2009. Applications of remote sensing in geomorphology. Progress in Physical Geography 33, 568-582, DOI: 10.1177/0309133309346648.

Smith, M.J., Paron, P. and Griffiths, J. (Editors) in press. Geomorphological Mapping: a Handbook of Techniques and Applications. Developments in Earth Surface Processes 15, Elsevier, London.

Speight, J.G. 1990. Landform. In McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (Eds), Australian Soil and Land Survey Field Handbook, 2nd Edition, Inkarta Press, Melbourne 9-57.

Speight, J.G. 2008. Landform. In NCST (Editors), *Australian Soil and Land Survey Field Handbook* 3rd Edition, The National Committee on Soil and Terrain, Australian Collaborative Land Evaluation Program, Canberra Australia.

Taylor, G. & Eggleton, R. A. 2001. *Regolith Geology and Geomorphology.* John Wiley & Sons Ltd. ISBN 0 471 97454 4.

APPENDIX A – LISTING OF DIVISIONS, PROVINCES AND REGIONS

Division 1 Eastern Uplands Division

Province 101 Great Barrier Reef Province

Region	Region Name	Region Description
10101	North Reefs	Patch reefs with semi-continuous outer barrier.
10102	South Reefs	Patch reefs with bedrock islands and discontinuous outer barrier.

Province 102 Peninsular Uplands Province

Region	Region Name	Region Description
10201	Torres High Islands	Islands and low coastal tablelands of volcanic rocks and granite, with fringing reefs.
10202	Jardine Uplands	Locally dissected rolling sandstone upland with transgressive coastal dunes along eastern margin.
10203	Wenlock Uplands	Complex of tablelands and low plateaus with north-south lowlands, including the Great Escarpment, and coastal hills in the east.
10204	Coleman Plateau	Rolling sandy granitic plateau with low ridges of metamorphic rocks, includes Great Escarpment in the east.
10205	Laura Plain	Soft sedimentary rock lowlands, alluvial plains and coastal plain.
10206	Cooktown Ranges	Deeply dissected sandstone plateaus with mountain ranges of granite and metamorphic rocks to east, small bedrock islands.
10207	Palmerville Hills	Granitic hills and plateaus and sandstone mesas with intervening plains.
10208	Garnet Uplands	Hilly uplands with dissected greywacke and volcanics in north and undulating country on granite and metamorphic rocks in the south.
10209	Cairns Ranges	High ranges east of an interior lowland, consisting of coastal ranges, lowland corridors and bedrock islands.
10210	Atherton Tableland	Basaltic tableland.
10211	Newcastle Ranges	Rugged hills on acid volcanic, granite and metamorphic rocks.
10212	Gilbert Hills	Rolling country on granite, and ridges and valleys on metamorphic rocks.
10213	Gregory Range	Dissected sandstone plateau and hilly country on acid volcanic
10214	Einasleigh Plains	Undulating to irregular plains on granite and metamorphic rocks.

Province 103 Burdekin Uplands Province

Region	Region Name	Region Description
10301	Burdekin Plateaus	Young basaltic plateaus with primary volcanic forms; north-south axial belt of rugged ranges, chiefly on granite and metamorphic rocks.
10302	Burdekin Hills and Lowlands	In east, hills and foot-slopes on volcanic and mixed sedimentary rock with igneous intrusions; in west, dissected ferruginous-capped tablelands, mainly on sandstone.
10303	Hervey Tablelands	Granitic uplands, rugged ranges on volcanic rocks and minor dissected ferruginous-capped plateaus forming steep eastern upland margin.
10304	Townsville Lowlands	Alluvial and deltaic plains with scattered high hills.
10305	Gilberton Plateau	Partly dissected sandstone plateau.
10306	Cape River Plains	Plains with clay soils in the east, getting sandier to the west.
10307	Alice Tableland	Perched sandy plain with interior drainage and higher ferruginous-capped rim.
10308	Bulgonunna Tableland	Undulating tableland; higher centre and sloping margins on volcanic rocks with peripheral mantle of ferruginous clayey sand.

Province 104 Fitzroy Uplands Province

Region	Region Name	Region Description
10401	Connors Ranges	Rounded mountain ranges on the dissected eastern margin of the uplands.
10402	Carborough Ranges	Sandstone and basalt plateaus and lower rolling country on sedimentary and volcanic rocks.
10403	Belyando Plains	Clay plains and sandy plains with minor hills.
10404	Scartwater Hills	Hills, ridges and valleys on sandstone and minor metamorphic rocks.
10405	Townshend Ranges and Lowlands	Mosaic of mountains, hills, lowlands and peninsulas. Lowlands include alluvial plains, tidal flats and coastal dunes.
10406	Broadsound Plains	Plains, mainly alluvial, locally stony, with tidal flats.
10407	Mackenzie-Dawson Lowlands	Floodplains, clay plains and sandy bedrock lowlands.
10408	Cotherstone Plateau	Dissected sandstone plateau.
10409	Springsure-Clermont Plateaus	Moderately dissected low plateaus, mainly basalt with minor sandstone.
10410	Drummond Uplands	Ridges and valleys on sandstone and minor metamorphic rocks; rolling country on granite.

10411	Nagoa Scarplands	Sandstone strike ridges and clay valleys.
10412	Buckland Plateau	Dissected high plateau on basalt and sandstone.
10413	Expedition Scarplands	Rugged plateaus and ridges on sandstone.

Province 105 New England-Moreton Uplands Province

Region	Region Name	Region Description
10501	Taroom Hills	Sandstone ridges and shale lowlands.
10502	Maryborough Lowland	Lowland on weak sedimentary rocks, partly dune covered including Fraser Island.
10503	Moreton Lowland	Lowland on weak sedimentary rocks, with prominent volcanic plugs, includes dune islands.
10504	Toowoomba Plateau	Basaltic plateau terminating southeast in dissected volcanic pile (Mount Warning).
10505	Cunningham Slopes	Ridges and valleys in metamorphic rocks.
10506	Tenterfield Plateau	Undulating granitic plateau with higher residuals including basalt cappings.
10507	Clarence Fall	Dissected plateau margin on granite and metamorphic rocks.
10508	Clarence Lowlands	Coastal lowlands on weak sedimentary rocks, with littoral and alluvial plains.
10509	Nandewar Peaks	Dissected volcanic pile.
10510	Gunnedah Lowland	Alluvial plains, sandstone ridges and hills of basic intrusive rocks.
10511	Liverpool-Barrington Plateaus	Dissected basaltic plateaus.
10512	Macleay-Barrington Fall	Plateau flank dissected into narrow strike ridges and valleys.
10513	Bunya-Burnett Ranges	Mountain ranges, rugged and dissected on granitic and metamorphic rocks in east, broader uplands and upland basins, partly on sedimentary rocks, in west.

Province 106 Macquarie Uplands Province

Region	Region Name	Region Description
10601	Mitchell Slopes	Tablelands stepping down to west and breaking into detached hills.
10602	Warrumbungle Peaks	Dissected volcanic pile with plugs.
10603	Merriwa Plateau	Rolling basalt upland with sandstone cliffs.
10604	Hunter Valley	Undulating to low hilly country on weak rocks, with alluvial and sandy littoral plains.
10605	Goulburn Corridor	Broad valley floors on weaker rocks, overlooked by irregular dissected plateaus.

10606	Bathurst Tablelands	Granitic and basaltic tablelands and minor lowlands; includes the Canobolas dissected volcanic pile.
10607	Hawkesbury-Shoalhaven Plateaus	Deeply dissected sandstone plateaus.
10608	Cumberland Lowland	Undulating to low hilly country, mainly on shale.

Province 107 Kosciuszkan Uplands Province

Region	Region Name	Region Description
10701	Hume Slopes	Ridges and minor tablelands stepping down westwards and breaking into detached hills with intervening alluvial valley floors. Some strong structural control on landforms.
10702	Werriwa Tablelands	Upland plains with separating strike-aligned hills, closed lake basins.
10703	Australian Alps	Dissected high upland, glaciated locally with some periglacial features. Uplifted blocks surrounded by highly dissected high relief hill country.
10704	Tinderry-Gourock Ranges	High hill chains of granite, sandstone and greywacke, moderately dissected, some fault lines.
10705	Monaro Fall	Deeply dissected steeply sloping plateau margin in metamorphics and granite. Bounded in the west by the Great Escarpment.
10706	Monaro Tableland	Undulating upland plains with some tabular basalt relief and granite tors.
10707	East Victorian Uplands	Dissected high plateaus on various resistant rocks, with isolated high plains.
10708	West Victorian Uplands	Moderately high plateaus and strike ridges.
10709	West Victorian Plains	Plains mainly on basalt lavas with many volcanic forms and lakes, partly on weak sedimentary rocks.
10710	South Victorian Uplands	Low fault blocks, mainly of tilted and dissected sandstone; granite hills and islands, in two parts either side of Port Phillip Bay.
10711	Gippsland Plain	Terraced plains with sand and gravels.

Province 108 Tasmanian Uplands Province

Region	Region Name	Region Description
10801	Bass Islands	Islands with low plateaus, partly dune-covered with granite residual hills.
10802	Bass Coastal Platforms	Low coastal platforms, partly dune covered, with some mudstone and metamorphic hills.
10803	Midlands Plain	Fault-bounded lowland (graben) on weathered sediments, with some

		dolerite, sedimentary and metamorphic hills.
10804	Lakes Plateau	High dolerite plateau with many lakes, glaciated in west.
10805	West Tasmanian Ridges	Ridges of folded quartzite and conglomerate, glaciated in places, parallel valleys on weaker rocks.
10806	East Tasmanian Hills	Fault block hills and mountains on dolerite, sandstone, and mudstone, with granite residuals, ria coast.
10807	North West Ramp	Incised basalt ramp including coastal scarp, with some mudstone and weathered granite.

Division 2 Interior Lowlands Division

Province 201 Carpentaria Lowlands Province

Region	**Region Name**	**Region Description**
20101	Weipa Plateau	Bauxite-capped plateau on clayey sand and sandstone.
20102	Merluna Plain	Undulating clay plains with ferruginous rises.
20103	Holroyd Plains	Slightly dissected sandy plains, partly ferruginised.
20104	Karumba Plain	Littoral plain.
20105	Clara-Mitchell Plains	Sloping sandy alluvial plains with minor clay plains along distributary drainage.
20106	Bulimba Plateau	Dissected low sandstone plateau.
20107	Normanton Tableland	Stripped higher ferruginous surface on siltstone and sandstone.
20108	Armraynald Plain	Clay floodplain.
20109	Wondoola Plain	Clay floodplain.
20110	Donors Tableland	Stripped higher ferruginous surface on siltstone and sandstone.

Province 202 Central Lowlands Province

Region	**Region Name**	**Region Description**
20201	Winton-Blackall Downs	Undulating clay plains.
20202	Jericho Plain	Sandplain.
20203	Maranoa Lowland	Sandplain with low sandstone hills.
20204	Charleville Tableland	Low sandy tableland of weathered sandstone and shale.
20205	Condamine Lowlands	Undulating clay lowlands on siltstone and low sandstone hills; floodplains.
20206	Boulia Downs	Undulating clay plains with minor stony limestone plains.
20207	Whelen Lowlands	Undulating clay plains with silcrete-capped mesas in east.
20208	Eyre Creek Plain	Floodplain.

20209	Eromanga Lowlands	Stony plains with silcrete-capped mesas, minor alluvial and sandy tracts.
20210	Diamantina Plain	Floodplain.
20211	Cooper Plain	Floodplain.
20212	Bulloo Plain	Floodplain and terminal floodout with pans and calcreted flats.
20213	Paroo Plain	Sandplain with alluvial flats and claypans.
20214	Warrego Plains	Main and distributary floodplains, sandplains with claypans.
20215	St George Plain	Sandplain - residual sand on old alluvium.
20216	Upper Darling Plains	Floodplains of centripetal anastomosing rivers.
20217	Lightning Ridge Lowland	Stony plains with minor silcrete-capped mesas.
20218	Simpson Desert Dunefield	South-north longitudinal dunes with sandstone ridges in the west and playas in the south.
20219	Sturt Desert Plains	Stony plains with minor sand ridges.
20220	Strzelecki Desert Plains	Longitudinal dunes and stony plains, minor clay pans and floodplains.
20221	Grey Range	Silcrete-capped tablelands.
20222	Warwick Lowland	Stony plains with silcrete-capped mesas.
20223	Oodnadatta Tablelands	Silcrete-capped low tablelands.
20224	Alberga Dunefield	Longitudinal dunes.
20225	Eyre-Frome Plains	Major salt lakes and adjacent alluvial plains; minor stony plains and longitudinal dunes.
20226	Denison Ranges	Beveled low ridges of folded metamorphic rocks.
20227	Nulty Springs Lowlands	Rolling downs and lowlands with hard red ridges and flats. Ferruginised regolith quite different from surrounding alluvial and sand plains.
20228	Innamincka Plains	Aeolian sandplain with W to NNW trending seif dunes, and numerous claypans and alluvial areas (floodout of Cooper Creek).
20229	Simpson Desert Plains	Aeolian dunefield (NNW trending seif dunes), with numerous claypans, aeolian sand, fine lacustrine and alluvial deposits.

Province 203 Murray Lowlands Province

Region	**Region Name**	**Region Description**
20301	Lower Darling Plain	Floodplain and lunette lakes.
20302	Cobar Plains	Plains with remnants of silcrete and low sandstone ridges, sand cover in west, with west-east longitudinal dunes.
20303	Condobolin Plains	Plains of gravel and sandy alluvium.
20304	Ivanhoe Plains	Plains with low west-east stabilised longitudinal dunes and

		sandplain, small pans with lunettes, minor sandstone ridges, floodplains.
20305	Riverine Plain	Alluvial plain.
20306	Mallee Dunefield	Fixed west-east calcareous longitudinal dunes.
20307	Wimmera Plain	Aeolian and alluvial sandplain, minor low sandstone ridges.
20308	Coorong Plain	Coastal barrier, lagoons and limestone dunes.
20309	Millicent Plain	Parallel dune limestone ridges with intervening swamps; closed karst depressions and young volcanoes in south east.
20310	West-Turkey Plains	Plains with variable dune cover, claypans, saline swamps, and intermittent lakes in low-lying areas.

Division 3 Western Plateau Division

Province 301 North Australian Plateaus Province

Region	**Region Name**	**Region Description**
30101	Top End Coastal Plains	Dissected ferruginous lowlands and minor islands; part alluvial, part estuarine coastal plains.
30102	Arnhem Ridges	Ranges of folded metamorphic rocks extending north-east as islands.
30103	Arnhem Plateau	Dissected sandstone plateau.
30104	Pine Creek Ridges	Rounded ridges of folded metamorphic rocks with granitic plains and minor quartzite plateaus.
30105	Daly Basin	Lowlands of limestone and weak sedimentary rocks, including alluvial plains; minor laterite-capped plateaus.
30106	Ord-Victoria Plateaus	Dissected plateaus, mainly basaltic but partly of sandstone with local ferruginous cappings.
30107	Whirlwind Plain	Alluvial plain, mainly clay.

Province 302 Kimberley Province

Region	**Region Name**	**Region Description**
30201	Kimberley Plateau	Sandstone plateaus (deeply dissected in places) with tabular high summits; some basaltic plateau; ria coast and islands to the north-west.
30202	Couchman Uplands	Undulating to hilly lower plateaus, on basalt, shale and sandstone.
30203	Leopold-Durack Ranges	Prominent ranges of dipping volcanic and granitic rocks and sandstones rimming the main Kimberley Plateau.
30204	Dampier Tablelands	Low sandstone tableland, partially laterized and with extensive sandplain cover.

30205	Fitzroy Ranges	Scattered tablelands and ranges of sedimentary rocks and extensive outcrop plains and sandplain and east-west longitudinal dunes.
30206	Richenda Foothills	Rounded hills and ridges and lowlands on a belt of granite and folded metamorphic and sedimentary rocks with minor basalt.
30207	Fitzroy Plains	Floodplains, sandplains and broad estuarine plains.
30208	Napier Limestone Ranges	Limestone tableland and intricately dissected bevelled ridges; separated by plains and rocky karst surfaces with box valleys.
30209	Springvale Foothills	Granitic, volcanic and sedimentary hills with minor undulating plains.
30210	Halls Creek Ridges	Ranges and rounded hills on sedimentary (and some volcanic) rocks.

Province 303 Carpentaria Fall Province

Region	Region Name	Region Description
30301	Manangoora Plains	Alluvial plains, minor ferruginised lowlands and islands, and littoral plains.
30302	Gulf Fall	Dissected coastal fall, tabular ridges giving place to sloping plains and low hills seawards.
30303	Isa Ridges	Rugged parallel ranges and narrow lowlands on folded metamorphic rocks and granites.
30304	Gulf Coastal Lowlands	Ferruginous lowlands with alluvial plains; littoral plains with dunefields and sandplains in coastal areas; sandstone rises associated with islands.

Province 304 Barkly-Tanami Plains Province

Region	Region Name	Region Description
30401	Sturt Plateau	Shallowly dissected plateau of ferruginised sandstone with alluviated valleys.
30402	Barkly Tablelands	Black clay plains, sandy rises of ferruginous sandstone, and minor stony limestone plains, interior drainage with calcrete in depressions.
30403	Tanami Sandplain	Sandplain with minor longitudinal dunes in south; floodplains and floodouts on margins; stony rises in north.
30404	Tanami Sandplain and Ranges	Sandplain with scattered low ranges and tablelands and occasional granitic and sedimentary hills.
30405	Davenport Ranges	Fold belt of bevelled sandstone ridges, with narrow lowlands on weaker rocks; central tract of lower hills and plains; extensive ferruginous mantles.
30406	Sandover Sandplain	Sandplain with minor low sandstone tablelands and floodouts; sandy ferruginous plains in south.

30407	Tobermory Plain	Slightly dissected limestone plain, part stony and part sandy.
30408	Toko Plateaus	Dissected sandstone plateaus.
30409	Birrundudu Plain	Low basaltic and sedimentary plain with clay soils and lateritic areas; indeterminate drainage with large claypans.

Province 305 Central Australian Ranges Province

Region	Region Name	Region Description
30501	Northern Alice Ranges	Ranges and rounded summits, partly granitic and partly of quartzite and sandstone.
30502	Northern Alice Plains	Granitic plains with ferruginous cappings; wash plains with sandplain, minor longitudinal dunes and calcrete-rimmed salt lakes in lowest parts.
30503	Central Ranges	Fold complex of prominent east-west ranges, mainly of quartzite; lowlands on limestone and shale with gravel terraces.
30504	Todd Plains	Stony lowland of calcareous conglomerate and other weak rocks, with extensive low dunes; anticlinal sandstone ridges.
30505	Amadeus Plains	Dunefields and sandplains with scattered sandstone ranges; salt lakes and calcrete plains along lowland axis.
30506	Western Desert Ranges	Dissected sandstone, granitic and volcanic ranges with prominent escarpments; separated by sandplains with dunes of hardpan wash plains.
30507	Kulgera Hills	Sandy granitic plains with prominent hills.
30508	Warburton Ranges	Ranges and hills of basic volcanic rocks and granite surrounded by hardpan wash plains and some sandplains.

Province 306 Sandland Province

Region	Region Name	Region Description
30601	Little Sandy Desert	East-west longitudinal dunes and minor salt lakes.
30602	Eighty Mile Plain	Coastal plains and dunes with some estuarine plains.
30603	Anketell Hills	Low mesas, buttes and stony rises of lateritized sandstone and shale among east-west longitudinal dunes and sandy plains.
30604	Great Sandy Desert Dunefield	East-west longitudinal dunes and minor salt lakes.
30605	Stansmore Dunefield and Ranges	East-west longitudinal dunes locally broken by narrow sandstone ranges.
30606	Gibson Desert Plains	Sandy or stony ferruginous plains.
30607	Redvers Dunefield	East-west longitudinal dunes.

30608	Macdonald Sandplain	Mainly sandplain with dune-fringed salt lakes.
30609	Rudall Tablelands	Dissected low sandstone tablelands with hills and ranges on gneiss and intervening areas of sandplains.
30610	Great Victoria Desert Dunes	West-east longitudinal dunes, broken by low tablelands and ridges in the northwest.
30611	Sturt Creek Floodout	Floodout with distributary channels and claypan.

Province 307 Pilbara Province

Region	Region Name	Region Description
30701	De Grey Lowlands	Floodplains and deltaic plains with stony plains and sandplains; tidal flats and some metamorphic, volcanic and granitic hills and islands.
30702	Nullagine Hills	Dissected flat-topped hills of granitic, volcanic and metamorphic rocks; interspersed by stony plains on granite.
30703	Glengarry Hills	Hills, hardpan wash plains and stony plains on sedimentary, granitic and volcanic rocks.
30704	Hamersley Plateaus	Dissected bold plateaus and ranges of flat lying or moderately folded sandstone, quartzite and volcanic rocks.
30705	Chichester Range	Narrow range of hills and dissected plateaus on basalt and sedimentary rocks.
30706	Fortescue Valley	Mainly alluvial lowland with hardpan wash plains and sandplain, possibly a graben.
30707	Augustus Ranges	Parallel ranges and dissected plateaus with intervening hardpan wash plains and stony plains.
30708	Carnegie Hills	Sandstone tablelands, stony hardpan wash plains and salt lakes.

Province 308 Western Coastlands Province

Region	Region Name	Region Description
30801	Onslow Plain	Alluvial, deltaic and littoral plains; some sandplain and coastal dunes; minor islands.
30802	Yanrey-Cane Plains	Sandplain and south-north longitudinal dunes with intervening alluvial plains.
30803	North West Cape Ridges	Low ridges and peninsula formed by folded limestone and sedimentary rocks; sandy plains.
30804	Kennedy Range	Dissected sandstone plateau with partial ferruginous cappings, covered by longitudinal dunes.
30805	Carnarvon Plain	Alluvial plain and saline lake bed.
30806	Shark Bay Peninsulas	Peninsulas, islands and hinterland formed on indurated limestone

		dunes; sandplain, dunes and calcrete plains.
30807	Yaringa Sandplain	Sandplain with minor dunes; some stony plains.
30808	Greenough Hills	Dissected ferruginous plateaus and hills of sandstone and shale over granite, extensive sandplain on dissected plateau.
30809	Dandaragan Tablelands	Dissected ferruginous plateaus and hills on sedimentary rocks with areas of sandplain; extensive coastal dune system in west.
30810	Swan Plain	Dune ridges (on limestone along the coast) and inner alluvial plain.
30811	Donnybrook Lowland	Low moderately dissected ferruginous plateau on down faulted sedimentary rocks; swampy coastal plain in the south.
30812	Leeuwin Peninsula	Narrow granitic horst ridge with calcareous dune system on western margin and dissected ferruginous plateau in the east.

Province 309 Yilgarn Plateau Province

Region	Region Name	Region Description
30901	Murchison Plateau	Sandplains and hardpan wash plains with outgoing drainage and salt lakes, broken by ridges of metamorphic rocks and granite.
30902	Salmon Gums Plain	Flat to undulating plain with salt lakes and occasional granitic low hills.
30903	Southern Goldfields Plateau	Undulating plains with some sandplains, ferruginous breakaways; ridges of metamorphic rocks and granitic hills and rises; calcretes, large salt lakes and dunes along valleys.
30904	Woodramung Hills	Low rounded ridges of folded rnetamorphics with intervening sandy plains and hardpan wash plains..
30905	Northam Slopes	Flat floored valleys of moderately incised ocean-ward drainage; older ferruginous remnants with breakaways on divides in east; stripped granite on valley sides in west.
30906	Avon Plateau	Gently undulating surface of sandplains and ferruginous divides; stripped granitic slopes; and broad valley floors with salt lake chains.
30907	Coonana-Ragged Plateau	Undulating plains with low hills of granite and metamorphic rocks; calcretes and scattered small salt lakes along shallow valleys.
30908	Darling Range	High ferruginous plateau; steep western fall and deeply incised valleys of ocean-ward drainage exposing granitic basement.
30909	Warren-Denmark Slopes	Ferruginous plateau, increasingly dissected in the south, exposing on granite and gneiss; finally merging into narrow swampy plain and coastal dunes.
30910	Leemans Sandplain	Sandplain with some gravel plains, mesas and small salt lakes.
30911	Albany Esperance	Sandplains with weakly to moderately incised southerly valley and

	Sandplain	intervening hills and low ranges of granite and metamorphic rocks (extending as headlands and inlets).

Province 310 Nullarbor Plain Province

Region	Region Name	Region Description
31001	Carlisle Plain	Limestone plain with some salt lakes and sandplains.
31002	Bunda Plateau	Covered karst plain of flat lying limestone and calcrete with continuous cliff margin on south.
31003	Roe Plain	Coastal limestone plain with extensive dunes.
31004	Israelite Plain	Narrow coastal plain with extensive dunes.

Province 311 Eyre Peninsula Province

Region	Region Name	Region Description
31101	Gairdner Plain	Alluvial plains and salt lakes with some dunes.
31102	Gawler-Cleve Ranges	Rounded ranges of acid volcanic rocks and hills of metamorphic rocks.
31103	Eyre Dunefield	Stable north-west/south-east longitudinal dunes, locally broken by granite hills and ridges of metamorphic rocks.
31104	Ceduna Dunefield	Low limestone dune ridges; small granitic islands with dunes.
31105	Lincoln Hills	Low granite hills and plains extending as headlands and inlets.

Province 312 Gulfs Ranges Province

Region	Region Name	Region Description
31201	Flinders-Lofty Ranges	Complex fold belt of prominent ranges in north, chiefly quartzite with vales on weaker rocks; stepped fault blocks and islands in south, mainly of weathered metamorphic rocks with ferruginous cappings.
31202	Torrens-Gulf Plains	Salt lake and bahadas in north; alluvial and littoral plains in south; north-west/south-east longitudinal dunes, mainly stabilized.
31203	Andamooka Tableland	Dissected sandstone plateau with bold east escarpment.
31204	Barrier Ranges	Ranges and undulating lowlands of granite and metamorphics.
31205	Olary Spur	Low hill belt of folded crystalline and sedimentary rocks.
31206	Yorke Peninsula	Undulating lowland of folded crystalline and metamorphic rocks; cover of calcrete and stabilized north-west/south-east longitudinal dunes.

APPENDIX B – ANZLIC 2.0 METADATA

Citation

Title	Physiographic Regions of Australia
ANZLIC Identifier	Pending
Custodian	CSIRO Land & Water
Jurisdiction	Australia

Description

Abstract

The Physiographic Regions of Australia (Pain, Gregory, Wilson and McKenzie 2011) are a modification of those compiled by Jennings and Mabbutt (1977), and are based on a visual interpretation of landforms as expressed on the Shuttle Radar Terrain Mission (SRTM) digital elevation model (DEM). Apart from its descriptive role, a map of physiographic regions provides a regional system of reference for geomorphological and related physical geographical accounts. Through the groupings of physiographic regional characteristics at different levels, the action of underlying controls, for instance geologic or climatic, may be made apparent. Further, the map can provide a regional basis for an understanding of land characteristics that are dependent upon landforms, for example the distribution of soils or natural vegetation. Jennings J.N. and Mabbutt J.A. (1977) Physiographic outlines and regions. In 'Australia, a geography. Volume 1. The natural environment.' (Ed. DN Jeans) (Sydney University Press: Sydney).

Search word(s)

GEOSCIENCES Geomorphology

LAND Mapping

BOUNDARIES Mapping

Spatial Domain

Geographic Extent Name (GEN)

GEN category	Australia
GEN Custodial Jurisdiction	Australia
GEN Name	AUSTRALIA EXCLUDING EXTERNAL TERRITORIES

Geographic Bounding Box

North Bounding Latitude	-9
South Bounding Latitude	-44

East Bounding Longitude	154
West Bounding Longitude	112

Data currency

Beginning Date	2010
Ending Date	2015

Dataset Status

Progress	Complete
Maintenance and Update Frequency	Irregular

Access

Stored Data Format	DIGITAL – ESRI Geodatabase Feature class
	DIGITAL – Microsoft Access Database
Available Format	DIGITAL – ESRI Geodatabase Feature class
	DIGITAL – Microsoft Access Database
Access Constraints	None

Data Quality

Lineage

The Physiographic Regions were digitized or scanned from line work on 1:1 000 000 maps of elevation (SRTM 90m), shaded with an illumination in the NW. Lines were drawn onto the maps (with 4B pencils), by comparing the original lines of Jennings and Mabbutt and the landform patterns that could be seen in the SRTM hill shaded data. State and territory agencies provided corrections and updates to this initial line work, which were also digitized. Line work in Western Australia has been altered significantly, so that it approximates to an aggregation of the state soil landscape survey boundaries.

The 1:100 000 Geoscience Australia Coastline (2004) has been used, rather than state specific line work, to provide national consistency. Attributes within the accompanying database were attached to the polygons via the region_id.

Positional Accuracy

The nominal scale of this dataset is 1:2 500 000

Attribute Accuracy

Attribute accuracy is consistent across the dataset. Polygon ID's were used to join attribute data that was entered and managed in an Access database. ID's, names and descriptions have been checked for accuracy and consistency. Regolith materials are a concatenation of 3 materials listed in the database, including proportions.

Logical Consistency

The spatial dataset has been checked for overlaps and gaps, and correct labelling.

Completeness

The dataset coverage is complete for the whole of continental Australia.

Contact Information

Contact Organisation	CSIRO Land & Water
Contact Position	ASRIS data manager
Mail Address	GPO Box 1666
Locality	Canberra
State	ACT
Country	Australia
Postcode	2601
Email Address	asris@csiro.au
Telephone	+61 2 6246 5700
Facsimile	

Metadata Information

Metadata date	2010/12/07

Additional Metadata

Pain, C., Gregory, L., Wilson, P. and McKenzie, N. (2011) The physiographic regions of Australia – Explanatory notes 2011. Australian Collaborative Land Evaluation Program and National Committee on Soil and Terrain.

Jennings J.N. and Mabbutt J.A. (1986) Physiographic outlines and regions. In 'Australia, a geography. Volume 1. The natural environment.' (Ed. DN Jeans) (Sydney University Press: Sydney)