Places of Geoheritage Significance in New South Wales Comprehensive Regional Assessment (CRA) Forest Regions

A project undertaken as part of the NSW Comprehensive Regional Assessments

June 1998

PLACES OF GEOHERITAGE SIGNIFICANCE IN NEW SOUTH WALES COMPREHENSIVE REGIONAL ASSESSMENT (CRA) FOREST REGIONS

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The project has been overseen and the methodology has been developed through the Environment and HeritageTechnical Committee which includes representatives from the New South Wales and Commonwealth Governments and stakeholder groups.

GIVEN THE SIZE OF THE STUDY AREA, THE TIME AND RESOURCES AVAILABLE, THE NATURE OF THE DATA AND THE LIMITATIONS OF THE DESKTOP SURVEY TECHNIQUE IT FOLLOWS THAT:-

1 The Results are Incomplete

The results of this survey represent only the first stage of a comprehensive **identification** of places of geoheritage significance in the study area.

If the methodology and resources used were to be applied for an extended period of time (say 6 more months) it is likely than some **thousands** more places with potential geoheritage significance would be identified.

At every stage of the project the consultants have become aware of further large and significant sources of data relevant to geoheritage which there has simply not been time or resources to access.

It is not possible for a study of this type or scale to produce a comprehensive assessment of places of geoheritage significance.

2 The Source Data is Incomplete

While many geological features reported in the literature or plotted on maps are able to be recognised as being potentially significant, many well-known landform features have received little formal study. While some can be identified from topographic maps or from a combination of geological and topographic maps, there is often little data available, despite the place being well-known.

3 The Size and Location Data has Limitations

At best the real location of places identified in this study will lie within an error circle of 1 km radius from the nominated position. Many places could not be located with this degree of precision.

This does not mean that poorly-located places lack significance or that with further work they could not be satisfactorily located in the future.

4 The Current Status of Values at the Place Can't be Determined

It is not practically possible to determine using data available in a desk survey, other than for large robust places, if the significant values are intact at the place. Recent field information is required.

5 The Data is Insufficient for Thresholding

Given that the state of knowledge of the geoheritage for the study area remains incomplete after this project the data produced are not suitable for application of a thresholding process.

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Places of Geoheritage Significance in New South Wales Comprehensive Regional Assessment (CRA) Forest Regions

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1 INTRODUCTION

The aim of this project is to identify and document places of geoheritage significance in the Upper North East, Lower North East, South and Eden Comprehensive Regional Assessment (CRA) Forest Regions in New South Wales.

Places of Geoheritage Significance are places containing **those components of natural geodiversity which are of significant value to humans for purposes which do not decrease their intrinsic or ecological value: such purposes may include scientific research, education, aesthetics and inspiration, cultural development and contribution to a sense of place experienced by human communities** (Dixon, 1996).

Geodiversity is defined by the Australian Natural Heritage Charter (Cairnes, 1996) as **the range of earth features including geological, geomorphological, palaeontological, soil, hydrological and atmospheric features, systems and earth processes**.

1.1 SCALE OF PROJECT

The Upper North East, Lower North East, South and Eden Regional Forest Assessment (CRA) Forest Regions cover most of the coast and eastern portion of the highlands of New South Wales amounting to some 160 000 square kilometres. The area is covered in whole or part by **ninety four** (94), 1: 100 000 Scale Topographic Maps.

The study area is very diverse as it encompasses parts of five major geological provinces (Clarence-Moreton Basin, Lorne Basin, Sydney Basin, New England Fold Belt and Lachlan Fold Belt) and parts of five major landform units (coast, coastal plain, great escarpment, highlands plateau and western slopes). The scale of the project is thus considerably out of proportion to the time and resources available.

1.2 PREVIOUS WORK

This is the first ever attempt at regional assessment of all types of places with geoheritage significance undertaken in New South Wales.

Previous studies of geoheritage in New South Wales have either documented a small number of places to AHC nomination standard over the state as a whole:-

Percival (1979)	167 identified 47 documented	principally geological
Stevenson (1981)	33 places	principally geological
Schon (1984)	42 places	principally geological
Goldbery (1991)	14 places	principally geological

concentrated on a particular theme:-

Willis (1993)	172 places (62 detailed)	vertebrate palaeontology

or on a single theme in one region:-

Osborne (1998)	77 places (not all significant)	regional karst study

This makes for the whole of New South Wales a total number of 505 geoheritage places identified by previous studies of which 275 have been documented.

Places of geological heritage in the Australian Capital Territory identified by the ACT Division of the Geological Society of Australia Inc have not been considered in this report.

While the original aim of the project was to identify, assess and document to RNE standards sites of geoheritage significance for four RFA regions in New South Wales, it became clear very early in the project that identifying a representative sample of potential geoheritage places in the study area was well beyond the resources being applied.

2 METHODOLOGY

The project has been undertaken over a period of three months entirely as a desk survey with data obtained from compilations, scientific papers and maps.

2.1 REGIONAL REVIEWS

Regional reviews for each of the four RFA areas have been prepared and form Part 2 of this report.

The concept of *geodiversity units* was developed in order to facilitate place classification and gap identification. The idea of geoheritage units is an extension and formalisation of the thematic approach to regional assessment proposed by Osborne (1997).

A *geodiversity unit* is defined as :-

> **land that exhibits particular and related geodiversity characteristics (eg geological/geomorphic history, rocks, landscape, soil, hydrology etc)**

Areas of land forming a single geodiversity unit will often be discontinuous. While geoheritage units may correspond to traditional geological and geomorphic units, they also may cross tectonic and stratigraphic boundaries.

An important characteristic of geoheritage units is that they facilitate *predicting* where places with particular types of geoheritage significance are likely to be found.

2.2 DATA SOURCES

The data audit was undertaken in the following manner:-

1 potential places were identified from the following heritage compilations:-

Geological Heritage of New South Wales (Pervical, 1979)
The Geological Heritage of New South Wales, Volume 2 (Stevenson, 1981)
The Geological Heritage of New South Wales, Volume 3 (Schon, 1984)
The Geological Heritage of New South Wales, Volume 4 (Goldbury, 1991)
Vertebrate (Tetrapod) Palaeontological Sites in New South Wales (Willis, 1993)

2 potential places were identified from the following compilations:-

Australian Karst Index (Matthews, 1985)
Petrography of Australian Igneous Rocks (Joplin, 1968)
The Silurian System in New South Wales (Pickett, 1982)

3 potential places were identified from a survey of the following journals:-

Australian Journal of Earth Sciences, Vols 24-45
Journal and Proceedings of the Royal Society of New South Wales, Vols 75-130
Proceedings of the Linnean Society of New South Wales, Vols 50-117
Records of the Geological Survey of New South Wales,Vols 1-23
New South Wales Department of Mines, Annual Report, 1876-1894

3 potential places were identified from published notes for Geological and Soil Landscape Maps.

4 potential places were identified from an examination of published geological, soil landscape and topographic maps for the regions.

2.3 DATA AUDIT METHODOLOGY

Scientific Journals

Journals were searched for papers that made reference to places located in the RFAs under examination and the relevant papers were photocopied. Each paper was then examined for place-related information that was likely to identify potential places of geoheritage significance. The following types of places were entered into spreadsheets:-

Places where features were illustrated in the papers by diagram or photograph

Places identified in the text as having particular geodiversity characteristics

Places from which evidence critical to a particular scientific hypothesis or explanation was obtained.

Places described as having the characteristics of a particular type of geoheritage feature (e.g. locations for particular types of igneous rocks described by Joplin, 1968)

Places that were:-
- stratigraphic type sections
- described stratigraphic sections
- type localities for igneous or metamorphic rocks
- fossil localities
- geochemical sampling localities
- dating localities
- soil reference localities

Geological Maps

Published geological maps were examined and features like the following were identified and entered into the spreadsheets:-
- volcanic centres
- plutons forming hills or depressions
- metamorphic aureoles
- cuesta topography
- unconformities
- basalt valley fills
- basalts overlying Tertiary sediment
- alluvial deposits related to faults

Topographic Maps

1:100 000 topographic maps were examined and features like the following were identified and entered into the spreadsheets:-
- waterfalls
- gorges
- lakes
- swamps
- hanging swamps
- incised meanders
- mesas
- prominent rock outcrops
- singular mountains
- topographic features that are known scenic localities

Potential Places Identified

By the end of April the following numbers of potential places were identified:-

UPPER NORTH EAST	105
LOWER NORTH EAST	293
SOUTH	530

EDEN	142
	1070

It was decided to abandon literature searches at that stage and concentrate on entering place data into spreadsheets, locating the potential places, identifying duplicates and using the regional reviews to identify gaps.

It became very clear at that stage that the number and types of potential places identified was far too small to be representative of the geodiversity of the study area and far too large to document to Register of the National Estate Standard using the templates provided by Environment Australia.

Locating Potential Places

The location of each potential place by grid reference on 1:100 000 topographic sheets was determined as precisely as the published information would allow. This proved to be extremely time consuming and often difficult. The spreadsheet lists were then checked for multiple reporting of the same place.

2.4 DATA CLASSIFICATION

Classification by AHC Criteria and Geodiversity Unit

Potential places were linked with the National Estate Criteria (A 1, A 2, A 3, B 1, B 2, C 1, E 1, H 1) which they were most likely to fulfil and the geodiversity units identified in the regional reviews. Places that were only likely to meet Criterion C 1 were listed separately.

Classification by Size

Places were classified into the following **approximate** size categories :-

1 area of 1 Ha or less
2 area between 1 Ha and 100 Ha
3 area between 1 km^2 and 10 km^2
4 area greater than 10 km^2
L linear place of minimal width
X insufficient size data available

Classification by Value and Location Data Availability

Places were classified into four groups depending on the availability of data on values and location:-

1 The values and location of the place can be determined from the available data
2 There is insufficient data available at this time to the values at the place.
3 There is insufficient data available as to the location of the place

It must be noted that **a lack of suitable data does not mean that these places lack significance or that with more detailed literature and/or field investigation their status could not be satisfactorily established in the future.**

Classification by Sensitivity

Dixon *et al* (1997) ranked the sensitivity of geoheritage sites in Tasmania on a scale of 1 to 10, with 10 being the most robust and 1 being the least robust. The information available in this study will not support such a fine delineation of place sensitivity.

A 4 step scale was applied which corresponds to the extreme ends of the scale used by Dixon *et al* , but lumps together those places likely to be sensitive to mechanical excavation and disturbance at any scale:-

1 Places sensitive to unintentional human impact (Dixon *et al* classes 1 & 2)

2 Places sensitive intentional human impact including use of hand tools.This includes those places sensitive to sampling, collecting or vandalism (Dixon *et al* class 3)

3 Places sensitive to mechanical interference at any scale (Dixon *et al* classes 4 - 9)

4 Places generally immune to human interference (Dixon *et al* class 10)

X insufficient sensitivity data available

It took the whole of May and most of June to enter all the potential places into the spreadsheets, locate and classify them. During the whole of the process new places were being entered as data became available and existing places were grouped into single places when this appeared to be logical.

By the second week in June the following numbers of potential places were identified, classified and entered into the spreadsheets:-

UPPER NORTH EAST	168
LOWER NORTH EAST	396
SOUTH	997
EDEN	185
TOTAL	**1746**

2.5 THRESHOLDS

The following set of guidelines were developed to allow application of National Estate Criteria to places of Geoheritage significance:-

Criterion A
Its importance in the course, or pattern, of Australia's natural or cultural history

A.1 Importance in the evolution of Australian flora, fauna, landscapes or climate.

Bishop (1998) has remarked that “the geosciences, including geomorphology, are essentially concerned with telling stories about places, or narratives about sites.” Seen in this light Criterion A1 places are those from which stories about “the evolution of Australian flora, fauna, landscapes or climate” can be told.

The following types of places were considered to reach the threshold for A1:-

i Places where evidence is found from which a significant story concerning the evolution of Australian flora, fauna, landscapes or climate can be told.

ii Places where evidence is found which contributes to telling a significant story concerning the evolution of Australian flora, fauna, landscapes or climate.

A.2 Importance in maintaining existing processes or natural systems at the regional or national scale.

Most active natural earth processes in the study area are of a small-scale and are unlikely to important from a geoheritage point of view at a regional or national scale. The main exceptions are hydrological processes in river systems and coastal sand systems.

Some geoheritage places will however be of importance in maintaining biological systems at a regional and national scale. These will include places such as wetlands used by migratory birds and caves used by migratory bats.

A.3 Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features.

The following types of places were considered to reach the threshold for A3:-

i Places where the variety of features significantly exceeds that which is normally found at places of this class.

ii Places where the abundance of a particular type of feature is significantly greater than normal.

Criterion B
Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history

B.1 Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or phenomena, or as a wilderness.

The following types of places were considered to reach the threshold for B.1

i The place has attributes that are rare at an absolute (eg global or national) scale
ii The place has attributes that are rare at a regional scale
iii The place has attributes that are contextually rare
iv The place has significant geoheritage features that are threatened or fragile

Threshold iii is not considered to be less important than i, as in some circumstances out of context features may be more significant than rare features.

Criterion C

Its potential to yield information that will contribute to an understanding of Australia's natural or cultural history

C.1 Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site, teaching site, type locality, reference or benchmark site.

The following types of places were considered to reach the threshold for C.1:-

- i Published Stratigraphic Type Sections
- ii Published Igneous and Metamorphic Rock type localities
- iii Published geochemical sample localities
- iv Published isotopic dating localities (some may also rank under A1)
- v Published fossil collection localities
- vi Published soil reference sites
- vii Places which have been studied over a significant period of time either by one geoscientist or by a succession of geoscientists.
- viii Places with a significant history of use as a teaching site.
- ix Places which are used as illustrations in text books. (see also D1)

Criterion D

Its importance in demonstrating the principal characteristics of:

(i) a class of Australia's natural or cultural places; or

(ii) a class of Australia's natural or cultural environments

D.1 Importance in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class.

The following types of places were considered to reach the threshold for D1:-

- i Places described in standard published works as examples of a particular feature or class of feature.
- ii Places recognised by specialists as examples of a particular feature or class of feature.
- iii Places recognised by the community as examples of a particular feature or class of feature as demonstrated by:-
  - promotion as a tourist attraction
  - construction of a lookout or access

installation of interpretive facilities
publication in post cards, tour guides, coffee-table books etc.

Many of these places will also have aesthetic values, Criterion E.

Criterion H
Its special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history

H.1 Importance for close associations with individuals whose activities have been significant within the history of the nation, State or region.

The following types of places were considered to reach the threshold for H1:-

i Places that have a more than trivial association with the life or work of a significant geoscientist.

ii Places where a significant geoscientist carried out research over a sustained period of time.

iii Places which contributed to conceptual or theoretical progress by a significant geoscientist.

THRESHOLDING

At the only meeting of the Geoheritage Reference Panel, held on Tuesday June 9, it was resolved to abandon any attempt to threshold the places and to concentrate on improving the data on the places already identified, making clear those classes of places and geographic areas not represented in the data so far acquired.

PART 2 REGIONAL REVIEWS

UPPER NORTH EAST NSW CRA REGION,
GEOHERITAGE REVIEW

GEOLOGY

The Upper North East CRA Region consists of the Demon and parts of the Woolomin-Texas and Nambucca Blocks of the New England Fold Belt, terraines of Devonian-Permian strata which docked along major faults during the Mid Permian. The Demon and Woolomin-Texas Blocks are separated by the Demon Fault System a major north-south trending structural feature which bisects the region. Deposits of Quaternary sediments resulting from interference with drainage by the fault suggest that there has been relatively recent movement along parts of the Demon Fault System.

The Devonian-Permian strata are intruded by Late Permian Granites of the New England Pluton and overlain unconformably by terrestrial sediments of the Triassic-Cretaceous Clarence-Moreton Basin. The north-east of the region is dominated by the Tertiary Mt Warning Central Volcanic Complex and lavas and pyroclastics of the associated Lamington Volcanic Suite.

SILURIAN to CARBONIFEROUS MARINE SEDIMENTS

The oldest rocks exposed in the Upper North East CRA Region are Silurian to Carboniferous marine sediments deposited in the Woolomin Slope and Basin. These include the Moonbil Beds, Neranleigh Fernvale Beds, Willowie Creek Beds, Coffs Harbour Beds and Coramba Beds.

These sediments have been significantly deformed and regionally metamorphosed. In the Boyd River area, east of Newton Boyd the deep water sediments of the Coffs Harbour Beds form the Gundahl complex tectonic melange where intense deformation indicates deposition in an accretionary prism at a subducting plate boundary.

WONGWIBINDA METAMORPHIC COMPLEX

Migmatites and Schists of the Carboniferous Wongwibinda Metamorphic Complex outcrop in the south of the Region east of Wards Mistake and at Rampsbeck after which the Rampsbeck Schist is named.

CARBONIFEROUS TO PERMIAN MARINE SEDIMENTS & VOLCANICS

Carboniferous marine sediments are exposed in the north west and south west of the region. These include the shallow-water sequence of the Texas Beds west of Tenterfield, the Sandon Beds near Bundarra and the intensely folded and mineralised Emu Creek Formation and associated Mount Carrington Volcanics outcropping along the Clarence River.

PERMIAN GORDONBROOK SERPENTINITE BELT

A large tectonically emplaced serpentinite body, with associated asbestos deposits is located at Baryulgil.

PERMIAN DEEP MARINE SEDIMENTS

Intensely deformed deep marine sediments of the Nambucca Beds, deposited in the Nambucca Slope and Basin are exposed in the Aberfoyle and Guy Fawkes River areas to the west of the Demon Fault. These mudrocks, sandstones and conglomerates are intensely deformed and regionally metamorphosed to form slates, phyllites and schists.

PERMIAN MARINE SEDIMENTS

Shallow water Permian marine sediments deposited on the Drake and Yessabah Shelves are exposed in the North and West of the Region. These sediments and associated volcanic unconformably overly older units.

PERMIAN VOLCANICS

Andesitic- silicic volcanoes erupted on the Drake Shelf during the Mid Permian producing the Drake, Emmaville and related Volcanics which crop out in the western parts of the region. These volcanics consist of andesitic and dacitic tuffs, breccia and flows.

PERMIAN TO TRIASSIC GRANITES

Three groups of granitic rocks are recognised in the Region. The south of the Region is intruded by syn-tectonic granitiods of the Early to Mid Permian Hillgrove Plutonic Suite which includes foliated lithotypes.

In much of the west of the region, particularly in the New England Plateau, granitiods of the Late Permian-Early Triassic New England Batholith are exposed. The New England Batholith consists of granitic rocks with a range of compositions and a number of formally named Granites, Adamellites, Leucoadamellites and Granodiorites are recognised within it. One notable feature of the New England Batholith is the Torrington Pendant, a roof pendant of Permo-Carboniferous sediments on the Mole Granite associated with tungsten and tin mineralisation.

Smaller bodies of granite with less certain association have also intruded the region.

PERMIAN TO TRIASSIC BASIC INTRUSIVES

Permian basic intrusion are scattered throughout the western parts of the Region with concentrations near Baryulgil, Drake and Emmaville. Near Baryulgil they intrude the Permian Dumbudgery Creek Granodiorite.

CLARENCE-MORETON BASIN

The Clarence-Moreton Basin, which forms much of the eastern half of the Region, consists of horizontally-bedded sediments deposited in a terrestrial intermontaine depression in Triassic to Cretaceous times. Dominant lithologies are sandstones and shales along with with coal measures and fossil-wood bearing strata. The lower units of the sequence include basalts and silicic volcanics. Incised sandstone plateau landforms are developed where resistant units crop out.

GEOMORPHOLOGY and TERTIARY-RECENT GEOLOGY

There are five major geomorphic elements in the Region, The New England Plateau, The Great Escarpment and associated Incised Zone, Border Ranges - Mt Warning Volcanic Province, the Coastal Plain and the Coast itself.

NEW ENGLAND PLATEAU

The New England Plateau is an elevated (700-1 000 m+) fairly flat surface, cut across and relatively independent of quite variable underlying bedrock. Features in this surface have been filled with Tertiary sediment and covered with extensive flows of Tertiary basalt. The Tertiary sediments have been important sources of alluvial gold and gemstones and some contain plant fossil remains. Other Tertiary deposits are significantly laterised. The Tertiary basalts have in places altered drainage patterns, forming small lakes.

GREAT ESCARPMENT, REMNANT PLATEAUS & INCISED ZONE

In the Upper North East Region the Great Escarpment is located over 100 km inland from the coast. The Escarpment is significantly indented by head ward erosion along the valleys of major streams, particularly the Clarence and its tributaries. Ollier (1982, Fig 2) plotted the location of the Great Escarpment in the Upper North East Region on the Warwick, Drake, Tenterfield, Newton Boyd and Ebor 1:100 000 topographic sheets. Relief in the Escarpment is in the order of 650 m . The Escarpment is marked by numerous waterfalls.

Much of the land to the east of the Escarpment is not a coastal plain, but a zone of incision with ridges, hills and plateau remnants up to 800 m high.

LAMINGTON VOLCANIC SUITE and the BORDER RANGES

The Miocene Lamington Volcanic Suite consists of lavas extruded from the Mt Warning Central Volcano and associated smaller centres in a radius of up to 50 km from Mt Warning and separated from it by a distinctive erosion caldera with a radius of some 15 km. Resistant ridges of the volcanics form the Border Ranges, separating NSW from Queensland in the north, the Tweed Range in the west and the Night Cap Range and neighbouring ranges near Nimbin in the south. A distinctive radial drainage pattern, with Mt Warning at its focus, is developed on the Lamington Volcanics.

MT WARNING CENTRAL VOLCANIC COMPLEX

The remnants of the main feeder of the Mt Warning Central Volcano are preserved as the present edifices of Mt Warning and Mt Terragong.

COASTAL PLAIN

Extensive alluvial deposits from the flood plains of the major rivers in the region, particularly the Clarence and Richmond.

COASTAL BEACH AND DUNE DEPOSITS

Most of the shoreline of the region consists of beach-barrier systems. Lakes and wetlands are common behind the barriers. Heavy mineral deposits, including gold, are associated with beach and dune sands. Rocky coasts are limited in extent.

UPPER NORTH EAST REGION

GEODIVERSITY UNITS	PREDICTED PLACE TYPES
A SILURIAN to CARBONIFEROUS MARINE SEDIMENTS	
	Stratigraphy
	Marine Sedimentary Structures
	Structures
	Tectonic Melange Features
	Metamorphism
	Fossils
	Landforms
	Soils
B CARBONIFEROUS TO PERMIAN MARINE SEDIMENTS & VOLCANICS	
	Sedimentation & Stratigraphy
	Structures
	Fossils
	Landforms
	Soils
C GORDONBROOK SERPENTINITE BELT	
	Petrography & Geochemistry
	Structures
	Mineralisation
	Soils
D PERMIAN DEEP MARINE SEDIMENTS	
	Sedimentation & Stratigraphy
	Structure
	Metamorphism
	Wongwibinda Metamorphic Complex
E PERMIAN MARINE SEDIMENTS	
	Sedimentation & Stratigraphy
	Structures
	Fossils
	Landforms
	Soils
F PERMIAN VOLCANICS	

Petrology & Geochemistry
Stratigraphy
Volcanic features
Structures
Landforms
Soils

G PERMIAN TO TRIASSIC GRANITES

Petrography & Geochemistry
Plutonic Features
Torrington Pendant
Dating
Granitic Landforms
Soils

H PERMIAN TO TRIASSIC BASIC INTRUSIVES

Petrography & Geochemistry
Intrusive Features
Dating
Landforms
Soils

I CLARENCE-MORETON BASIN

Sedimentation &Stratigraphy
Volcanism
Fossils
Landforms
Soils

J LAMINGTON VOLCANIC SUITE

Petrography & Geochemistry
Volcanic features
Landforms
Soils

K MT WARNING CENTRAL VOLCANIC COMPLEX

Petrography & Geochemistry
Volcanic features
Landforms
Soils

L NEW ENGLAND PLATEAU

Landforms & Landform History
Tertiary Sediments
Tertiary Volcanics

Quaternary sediments
Soils

M GREAT ESCARPMENT, INCISED ZONE & REMNANT PLATEAUS

Landforms & Landform History
Tertiary Sediments
Tertiary Volcanics
Quaternary sediments
Soils
Active Processes

N COASTAL PLAIN

Landforms & Landform History
Fluvial Landforms
Quaternary sediments
Soils
Active Processes

O COAST

Beaches
Dunes
Headlands
Rocky Coast
Active Processes

LOWER NORTHEAST NSW CRA REGION, GEOHERITAGE REVIEW

The Lower North East CRA Region is both geologically and geomorphologically diverse and complex. It includes parts of five major units of the New England Fold Belt (Woolomin-Texas Block, Nambucca Block, Kempsey Block, Port Macquarie Block and Tamworth Synclinorial Zone) the Lorne Basin, the northern part of the Sydney Basin and the southeastern margin of the Great Australian Basin. Major landform features of the region include sections of the the Great Escarpment, New England Plateau, Coast, Coastal Plain, Hunter Valley and Hornsby Plateau.

Many of the large tectonic units of the New England Fold Belt, particularly the Tamworth Synclinorial Zone are extremely complex and are themselves divisible into a number of smaller discrete units bounded by faults. As a consequence the review that follows and the division of the region into geodiversity units is a gross oversimplification.

CAMBRIAN to CARBONIFEROUS MARINE SEDIMENTS, WOOLOMIN SLOPE & BASIN

Marine sediments deposited in the Woolomin Slope and Basin are exposed west of Armidale and in three separate zones to the west of Yarras. These are principally deep marine sediments containing cherts, jaspers and mudstones. Much of the mudstone has been regionally metamorphosed to schists, slates and phyllites. Small bodies of limestone, such as that in which the significant karst at Comboyne is developed, have been interpreted as seamount deposits. Cambrian trilobites and brachiopods are found in small limestone pods in the Woolomin Beds near Woolomin.

SILURIAN to CARBONIFEROUS MARINE SEDIMENTS, TAMWORTH TROUGH

Units of the Tamworth Trough are exposed in a northwesterly trending zone between Barrington Tops and the northwest boundary of the Region. These are largely deep water marine sediments, cherts and greywakes, of the Silurian Hawkes Nest Beds and the Devonian Tamworth Group. Significant karsts are developed in the Crawney and Timor Limestone Members, which may be allochthonous blocks within the deeper water sequence.

The Tamworth Group is unconformably overlain Late Devonian and Early Carboniferous marine sediments and volcanics deposited in the Mandowa Unstable Shelf.

WONGWIBINDA METAMORPHIC COMPLEX

Migmatites and Schists of the Carboniferous Wongwibinda Metamorphic Complex outcrop in the north of the Region between Round Mountain and the Dorrigo-Guyra road.

CARBONIFEROUS MARINE SEDIMENTS & VOLCANICS

Carboniferous marine sediments and volcanics are found in the Woolomin Texas Block west of Armidale, in the centre of the Kempsey Block, and form much of the eastern portion of the

Tamworth Synclinorial Zone. These rocks , deposited in the Ayr Basin and on the Kullatine Shelf are principally composed of continentally-derived clastics, silicic and andesitic volcanics, and minor deposits of crinoidal and oolitic limestones.

Significant karsts are developed in the Wallanbah Formation exposed between Gloucester and Myall Lake.

PERMIAN DEEP MARINE SEDIMENTS

Deep water Permian Marine sediments underlie much of the northern part of the Region and are exposed along the coast between Stuarts Point and Urunga. These rocks, grouped as the Nambucca Beds, consist of intensely deformed and metamorphosed fine-grained, deep water marine sediments. Traditionally known as the Nambucca Slate Belt the intense deformation is well displayed by coastal outcrops at Nambucca Heads.

PERMIAN MARINE SEDIMENTS

Permian shallow marine sediments deposited on the Yessabah Shelf are exposed in the Parrabel Anticline in the northern margin of the Kempsey Block west of Kempsey. Similar sediments are found in the southern part of the Kempsey Block near Taree.

The sequence near Kempsey includes the Yessabah Limestone which is important for its karst and for skarn mineralisation associated with thermal highs. The sequence near Taree includes the Cedar Party Limestone is which smaller-scale karst features are developed.

PERMIAN VOLCANICS

Permian volcanics of similar age to the Drake Volcanics in the Upper North East Region are found in the Armidale area

PERMIAN TO TRIASSIC GRANITES

Four groups of Permo-Triassic granitoids are found in the Lower North East Region. Syn-tectonic granites of the Hillgrove Suite are exposed in the north of the region. Post tectonic leucoadamellites of the Bundarra Suite are exposed in the far northwest of the region and post tectonic granitic rocks with a range of compositions belonging to the New England Batholith are exposed west of Armidale, at Oven Mountain and Mt Werrikimbe.

Other important granitoids in the region include the Barrington Tops Granite and the microgranites forming the Brothers and Diamond Head near Laurieton.

PERMIAN SERPENTINITES & BASIC INTRUSIVES

Serpentinites are found along thrust faults at the boundaries of the major tectonic blocks. They have been interpreted as altered fragments of ocean floor. Significant serpentinite deposits occur along the western boundary of the Kempsey Block near Yarras and Mt George, in a series of deposits near Nowendock and form the Great Serpentine Belt along the Peel Thrust forming the eastern boundary of the Tamworth Synclinorial Zone. A number of unusual mineral deposits are associated with the serpentinites.

Permian basic intrusives are found with similar tectonic relationships to the serpentinites, for example near Pigna Barney, Nowendock and in the west of the Port Macquarie Block.

PERMIAN OF THE STROUD-GLOUCESTER & MYALL SYNCLINES

The Stroud-Gloucester Syncline and Myall Synclines contain silicic volcanics of the Early Permian Alum Mountain Volcanics unconformably overlain by sediments of the Late Permian Dewrang Group and the economically significant Gloucester Coal Measures.

While the Permian sediments have eroded to form a valley with gentle topography along the axis of the Stroud-Gloucester Syncline, the Alum Mountain Volcanics form prominent resistant outcrops of scenic importance at the Gloucester Buckets and Alum Mountain.

SYDNEY BASIN

The Sydney Basin in the Lower North East Region can be best considered in two sub units, the Hunter Valley and the Hornsby and Associated Plateaus.

In the Hunter Valley Permian marine and coal-bearing sediments have been eroded to form an area of low relief. Marine fossils are abundant in the older units with coal and plant fossils common in the younger rocks.

The southern side of the Hunter Valley is marked by sandstone cliffs forming the northern edge of the Blue Mountains and Hornsby Plateaus. Shale lenses in the sandstones contain significant plant, fish and amphibian fossil localities. Here resistant sandstones of the Triassic Narrabeen Group and the Hawkesbury Sandstone have been eroded to from incised sandstone plateaus.Tertiary basalt caps are found on hills in the plateaus. The southern boundary of the Region is the dramatic ria valley of the Hawkesbury River.

GREAT AUSTRALIAN BASIN

The Jurassic Comiala Shale, forming the southeastern margin of the Mesozoic Great Australian Basin, outcrops in small areas between Sandy Hollow and Bunnan in the southwest of the Region.

LORNE BASIN

The Triassic Lorne Basin in a relatively small sedimentary basin located to the south west of Port Macquarie and centred on the village of Lorne. The sediments in the Basin form the Triassic Camden Haven Group. These consist of coarse conglomerates, brown and purple coloured volcaniclastic sandstones and shales. These sediments unconformably overlie Carboniferous strata of the Hastings Block and are overlain by Triassic volcanics.

The Basin is intruded by Triassic granites which form the North Brother, Middle Brother, South Brother and Charlies Hill and by Tertiary trachytes forming features such as Big Nellie.

The sedimentary rocks of the Lorne Basin crop out in a skeletal incised plateau landscape, with cliffed ridges at the southern margin of the Basin north of Landsdowne and in sea cliffs at Perpendicular Point.

MESOZOIC VOLCANISM & PLUTONISM

Jurassic diatremes are located in the Sydney Basin just north of the Hawkesbury River and Small bodies of Jurassic microgranites have been identified in the Stroud area.

NEW ENGLAND PLATEAU

The New England Plateau lies to the west of the Great Escarpment and to the north of the Hunter Valley. Tertiary sediments and overlying Tertiary Basalts fill an older landsurface eroded into the plateau .

GREAT ESCARPMENT, INCISED ZONE & REMNANT PLATEAUS

The Great Escarpment has quite a complex shape in the Lower North East Region. It moves a considerable distance inland with the complex incised valleys of the Macleay and Manning Rivers leaving behind two peninsular plateaus (Dorrigo Plateau and Carrai Tableland) and two completely isolated plateaus (Bulga Plateau and Comboyne Plateau). Other smaller plateaus (eg Moonabung Plateau) are developed in the northern Hunter Valley.

Much of the land to the east of the Great Escarpment is significantly incised with streams and ridges following structural trends. The edge of the escarpment and the plateau remnants is marked by cliffs and waterfalls and is incised by steep gorges.

TERTIARY VOLCANIC RANGES

The Tertiary basalt ridges of the Mount Royal and Liverpool Ranges are located in the south west of the Region.These eroded remnants of extensive volcanic outpourings show dramatic radial drainage patterns near Barrington Tops and form skeletal eroded ridges between Mt Square Top and Walcha.

Features of these ranges include volcanic vents, zeolite minerals, boles, cliffs, salients, waterfalls, caves and volcanic-derived soils, both black earths and krasnozems.

COASTAL PLAIN

The coastal plain in the Lower North East Region is composed largely of Quaternary alluvial deposits filling the drowned valleys and forming the flood plains of major rivers. Most of the plain has been formed by processes that occurred after the most recent rise in sea level some 6,000 years ago.

Raised beaches and inland incursions of marine clays indicating higher sea levels are found in a number of localities on the coastal plain. Remnants of older alluvial deposits are found on river terraces at significant elevations above the present river levels. Many of the areas in the coastal zone contain acid sulfate soils.

COAST

The coastline in the Lower North East Region is dominated by barrier bar systems connecting rocky headlands. Stretches of rocky coast are short and limited, with one of the longest being the cliffed coast between Broken Bay and The Entrance. Coastal lagoons and associated wetlands are prominent features of the coast. Significant dune fields are developed on the barriers and many of the sand bodies contain deposits of heavy metals.

RECOGNITION OF GEODIVERSITY UNITS

Classification of this region into a workable number of geodiversity units has proved to be difficult due to the great deal of geological and geomorphological variation present. Many of the units described below could easily have been subdivided to recognise what quite important geological and geomorphological associations. The Sydney Basin, for instance, could easily have been split into two units, one for the older strata and lower relief found in the Hunter Valley and another for the dissected plateau topography associated with the Narrabeen Group and Hawkesbury Sandstone in the Hornsby Plateau area.

LOWER NORTH EAST REGION

GEODIVERSITY UNITS	PREDICTED PLACE TYPES
A CAMBRIAN to CARBONIFEROUS MARINE SEDIMENTS, WOOLOMIN SLOPE & BASIN	
	Stratigraphy
	Marine Sedimentary Structures
	Structures
	Tectonic Melange Features
	Metamorphism
	Fossils
	Landforms
	Soils
B SILURIAN to CARBONIFEROUS MARINE SEDIMENTS, TAMWORTH TROUGH	
	Stratigraphy
	Marine Sedimentary Structures
	Structures
	Tectonic Melange Features
	Metamorphism
	Fossils
	Landforms
	Karst
	Soils
C CARBONIFEROUS MARINE SEDIMENTS & VOLCANICS	
	Sedimentation & Stratigraphy
	Volcanic Features
	Structures
	Fossils
	Landforms
	Karst
	Soils
D PERMIAN SERPENTINITES	
	Petrography & Geochemistry
	Tectonics & Structures
	Mineralisation
	Landforms
	Soils
E PERMIAN DEEP MARINE SEDIMENTS	

NAMBUCCA SLOPE & BASIN

Sedimentation & Stratigraphy
Structure
Metamorphism

F PERMIAN MARINE SEDIMENTS
YESSABAH SHELF & DRAKE SHELF

Sedimentation & Stratigraphy
Structures
Fossils
Landforms
Karst
Soils

G PERMIAN VOLCANICS

Petrology & Geochemistry
Mineralogy
Stratigraphy
Volcanic features
Structures
Landforms
Soils

H PERMIAN-TRIASSIC GRANITES

Petrography & Geochemistry
Plutonic Features
Dating
Granitic Landforms
Soils

I PERMIAN-TRIASSIC BASIC INTRUSIVES

Petrography & Geochemistry
Intrusive Features
Dating
Landforms
Soils

J PERMIAN OF THE STROUD-GLOUCESTER & MYALL SYNCLINES

Volcanics
Coal Measures
Mineralogy
Fossils
Landforms (Buckets)

K SYDNEY BASIN

Sedimentation &Stratigraphy
Fossils (marine invert, plant, fish)
Landforms (plateaus, ria coast)
Tertiary Basalts
Soils

L LORNE BASIN

Sedimentation &Stratigraphy
Fossils
Landforms
Soils

M MESOZOIC VOLCANISM

Petrography & Geochemistry
Volcanic features
Dating
Geomorphic history implications
Soils

N NEW ENGLAND PLATEAU

Landforms & Landform History
Tertiary Sediments
Tertiary Volcanics
Quaternary sediments
Soils

O GREAT ESCARPMENT, INCISED ZONE & REMNANT PLATEAUS

Landforms & Landform History
Tertiary Sediments
Tertiary Volcanics
Quaternary sediments
Soils
Active Processes

P TERTIARY VOLCANIC RANGES

Petrography & Geochemistry
Minerals (including zeolites)
Volcanic features
Dating
Landforms (basalt caves)
Geomorphic history implications
Soils

Q COASTAL PLAIN

Landforms & Landform History

	Fluvial Landforms
	Quaternary sediments
	Soils
	Active Processes

R	COAST	Beaches
		Dunes
		Headlands
		Rocky Coast
		Sea Caves
		Active Processes

SOUTH NSW CRA REGION,
GEOHERITAGE REVIEW

The South Region encompasses a large portion of the Lachlan Fold Belt. In this area rocks of Early Palaeozoic age which have been significantly folded by east-west compression are exposed. The folding has produced a distinctive north-south structural grain which is largely followed by major faults. This north-south grain and has guided much of the topographic development and drainage with strike ridges being common, and many rivers having long north-south tracts prior to turning either to the east or the west.

The other major geological province in the South Region is the Sydney Basin.

The South Region includes highly variable topography and includes an number of important geomorphic units; the coast, coastal plain (including the southern section of the Illawarra Plain), the Great Escarpment and a wide incised zone between it and the coastal plain, the Sassafras Plateau, Southern Highlands, Monaro Plain, the High Country (Australian Alps) and the western slopes between Tumbarumba and Holbrook.

NAROOMA TERRAINE

The Narooma Terraine is represented by a small finger-shaped area of intensely folded rocks forming a plunging synform between Narooma and Eurobodalla on the coast, close to the southeastern boundary of the South CRA Region and another area forming the coastline at Batemans Bay between Burewarra Point and Durras.

The age and relationships of this group of rocks, which form the Wagonga Group, has been a major geological controversy with datable fossils indicating an Ordovician age first being reliably described in 1982. The current interpretation is that these areas are parts of a fault-bounded tectonic terraine that docked with the Lachlan Fold Belt.

The Narooma Terraine contains a number of study sites, particularly places where intense folding is easily visible, and some unusual mineral localities.

ORDOVICIAN FLYSCH

Ordovician deep marine sediments, greywakes and shales, dominate the Lachlan Fold Belt in the South Region. These sediments, many of which are now included in the Adaminaby Group, are intensely deformed and regionally metamorphosed to form slates and phyllites. Graded-bedding and other deep water sedimentary structures are common and graptolite fossils are found in a number of localities. Quartz veins are common in these rocks and on occasions contain gold mineralisation.

The flysch is easily eroded and in areas of incision forms steep v-shaped valleys in which soil creep is common, separated by narrow ridges. Thin clay soils predominate.

ORDOVICIAN METAMORPHIC COMPLEXES

Zones of intensely metamorphosed rocks form the Cambalong, Cooma, Jerangle and Wagga Wagga Metamorphic Complexes, all located towards the south of the Region. A number of outcrops of these complexes are important research, teaching and reference sites showing a range of metamorphic rock types and structures. Some of the metamorphic rocks at Cooma have been locally used as building stones.

EARLY SILURIAN CLASTICS

The Ordovician Flysch is unconformably overlain at a number of localities by early Silurian clastics such as those of the Yalmy Group.

SILURIAN VOLCANICS AND LIMESTONES

During the Late Silurian and Earliest Devonian the South Region contained a number of andesitic to silicic volcanic islands surrounded by shallow seas. Volcanic rocks and associated limestones are significant features of the Region. Some of the volcanoes, such as that from which the volcanics of the Duro Group near Yass were erupted, must have been very large. While many of the limestones were deposited in the Latest Silurian the early Late Silurian Quidong Limestone unconformably overlies Early Silurian clastics.

The Silurian volcanics frequently contain significant economic mineral deposits such as those at Woodlawn, near Goulburn. The limestones and associated shales contain many significant fossil deposits such as those at Hattons Corner and Rainbow Hill, near Yass. Many of the best known karst caves in New South Wales such as those at Bungonia, Jenolan, Wombeyan and Yarrangobilly are developed in Latest Silurian limestones. These caves also contain significant vertebrate fossil localities for example the Broom Breccia deposit at Wombeyan Caves.

SILURO-DEVONIAN SYN & POST TECTONIC GRANITES

After the Ordovician flysch, Siluro-Devonian granites are the next most common type of bedrock in the Lachlan Fold Belt in the South Region. These include granites of both

S and I type that were emplaced both syn and post tectonically.

Important intrusions include the Kosciusko Batholith which forms much of the high country in the Snowy Mountains. Foliated syn tectonic granites include the Corryong Granite near Tumbarumba the Wyangala Batholith and some units of the Murrumbidgee Batholith.

While some of the granitoids such as the Clear Ridge Granodiorite of the Murrumbidgee Batholith stand out in the landscape forming prominent ridge others, such as the Braidwood Granite, are deeply weathered and erode to form depressions.

OCEANIC LITHOSPHERE

Three elongate bodies of altered basic rocks, interpreted as representing ancient oceanic lithosphere, are found in the southwest of the Region. These include the southern part of the Coolac Serpentinite and related Honeysuckle Beds east of Tumut, the Tumut Pond Serpentinite Belt which runs along the western side of Talbingo Dam and the Ordovician Kiandra Beds which outcrop north of Batlow.

EARLY AND MID DEVONIAN VOLCANICS

Early and Mid Devonian silicic volcanics are found in a number of parts of the South Region. These include the Bindook Porphyry Complex, the Black Range Group and the Snowy River Volcanics. Eruptive textures and explosive volcanic centres such as the Yerranderie Volcano and Bowning Hill have been recognised in these complexes. The volcanics include rocks of variable strength, with strong dacite porphyries forming cliffs, gorges and waterfalls, while other units are deeply weathered and erode to form rounded hills.

EARLY DEVONIAN LIMESTONES

Late Early Devonian Limestones of the Murrumbidgee Group outcrop in the Burrinjuck Dam area. These have been the subject of historically significant research and contain important fossil localities. Folds, such as the Devils Elbow, are easily visible making them important teaching localities. Significant karst features are developed at Wee Jasper, Taemas, Narrangullen and Waroo.

LATE DEVONIAN CLASTICS

Late Devonian terrestrial and marginal marine sediments unconformably overlie older rocks in the Lachlan Fold Belt. While the older rocks are intensely folded, the Late Devonian sediments have been compressed more gently into large open folds. While much of these deposits has been eroded away by more recent events, north-south trending synclinal ridges have tended to survive and form important landscape features such as the Minuma and Crookbundoon Ranges. These ranges are characterised by thin sandy soils and frequently have particular flora associated with them. Plant fossils are frequently found in the shaley units.

CARBONIFEROUS POST-TECTONIC GRANITES

Late Carboniferous post-tectonic granites intrude the Lachlan Fold Belt at a number of localities in the northern part of the South Region. At its northern extremity the Region includes parts of the Bathurst Batholith which has eroded to form a marked depression in the landscape. At its margins the granite has metamorphosed the surrounding rocks. Smaller intrusions occur slightly south in the Oberon district, including the Kanangra Granite near Kanangra Walls. While these granites generally develop a subdued topography in the Highlands Plateau, east of Jenolan Caves a deep gorge has formed where the Jenolan River has cut through a Carboniferous stock.

SYDNEY BASIN

The South Region includes outliers of the western margin of the Sydney Basin near Jenolan Caves, at Kanangra Walls and as far west as Bunnaby, which provide evidence for the palaeotopography of the area prior to the deposition of the Basin.

The southern portion of the Sydney Basin occurs in the northeast corner of the South CRA Region. While the northeast of the region includes the most southerly remnants of the Triassic Hawkesbury Sandstone and Narrabeen Group in mesas such as Broughton Head and Tapitalee Mountain, the Sydney Basin in the Region is dominated by units of the Permian Shoalhaven Group. Near Marulan the valleys filled with the Carboniferous Tallong Conglomerate are exposed in the walls of the Shoalhaven River Gorge.

South of the Shoalhaven River the landscape is dominated by the resistant Nowra Sandstone and Snapper Point Formation which have been eroded to form the dissected plateau landscape of the Sassafras Plateau, including features such as Pigeon House Mountain and The Castle.

Along the coast Permian marine and glacial-marine sediments are exposed. Significant fossil and glendonite localities are found in a number of sea cliffs and rock platforms.

MESOZOIC VOLCANISM

The Jurassic Myalla Road Syenite Complex south of Cooma represents the remnants of a silicic volcanic centre. At Snodgrass Plain, northwest of Delegate, breccia pipes of Jurassic age contain mantle xenoliths.

At Central Tilba the Cretaceous Mount Dromedary Monzonite Complex intrudes the Ordovician Flysch. The centre of the Complex forms the edifice of Mount Dromedary while lava flows close to sea level provide important palaeogeographic information. The Monzonite Complex is also exposed at sea to the north where it forms Montague Island.

At Milton and Bawley Point the Cretaceous Milton Monzonite intrudes Permian Rocks of the southern Sydney Basin. Small Mesozoic intrusions such as the Budderoo and Good Dog Lamprophyres occur in the northeast of the Region.

MONARO PLAIN

The Monaro Plain is an area of relatively low relief located between Canberra and Bombala. North of Cooma the Plain is developed on Silurian volcanics and limestones between the granitic Clear Range on the west and the Tinderry Mountains on the east. South of Cooma the Plain broadens and is developed on volcanic, flysch and granitic bedrock.

Tertiary basalts produced from numerous vents cover much of the Plain between Cooma and Bombala. These overlie older Tertiary sediments and formed lakes in the Tertiary such as Lake Bunyan containing lake sediments and the Polo Flat diatomite deposit north of Cooma. Basalt-filled palaeokarst features are located found near Cooma and an effervescent spring, presumably related to the volcanism, is located at Rock Flat.

Recent lakes have been formed by the basalt include Dukes, Avon and Beards Lakes. Vertebrate fossils have been found in Quaternary sediments deposited on the Plain.

SOUTHERN HIGHLANDS

The Southern Highlands makes up much of the South Region. This is an elevated area ranging in elevation between 800 and 1300 metres. The Highlands have a relatively subdued relief on which strike ridges of Late Devonian clastics and some granites stand out. In places horst and graben structures have resulted from relatively recent movement along regional faults. These have formed lakes such as Lake George and dammed small bodies of Recent sediment.

Tertiary sediments, in places dammed by basalt, are common on the highlands. Often these have been altered to silcrete, ferricrete or managanocrete and some contain plant fossils.Tertiary basalts not only cover flat areas of the Highlands and form caps on hill tops, they may also follow the former course of rivers, as is the case with the upper Lachlan. The evidence from most areas of the Highlands suggests that the natural erosion rate has been relatively slow during the Tertiary and Quaternary.

HIGH COUNTRY, AUSTRALIAN ALPS

The Australian Alps are considered to be the land generally south of Canberra, east of Tumbarumba, west of Cooma and continuing into Victoria as far south as Healesville with an elevation above 1000 m. This includes the highest elevations in Australia, up to 2228 m at Mt Kosciusko, and all areas of mainland Australia that are now considered to have been subject to Pleistocene glaciation. Topographically the area is an incised plateau with resistant ridges standing above large flat areas called high plains, which frequently contain peat bogs.

Glacial landforms including cirques, moraines and lakes are restricted to a small area of land with an elevation above 1850 m while periglacial features such as block streams and solifluction mantles occur in a significantly larger area.

GREAT ESCARPMENT & INCISED ZONE

In the South Region the Great Escarpment moves from being close to the coast at the northern end to up to 60 km inland in the south. The Shoalhaven River has cut back through the Escarpment. Basalt flows which drape over its gorge and fill the palaeovalley of the Endrick River provide evidence for the age of Shoalhaven and associated landscapes.

South of the Sassafras Plateau a wide incised zone is developed between the Escarpment and the coastal plain. This includes the steep valleys and ridges formed by the Tuross, Clyde and Moruya River systems.

COASTAL PLAIN

The coastal plain in the South Region begins as a broad area in the north and then narrows, almost ceasing to exist south of Ulladulla. Between Ulladulla and Sunpatch there is no coastal plain with the incised zone extending directly to the coast. At Ulladulla and Lake Conjola Tertiary sediments are found on the coastal plain. At Durras Lake a barrier bar has impounded water within an incised zone valley.

Between Sunpatch and Muranna Point sediments behind barrier beaches have formed small patches of coastal plain, the most significant being at Moruya. Tertiary sediments are found on the western margin of the plain north of Moruya and near Bodalla. Tertiary Basalt flows and Tertiary sediments occur close to sea level at Coila Lake and Ulladulla

COAST

The coast line of the South Region is marked by the sedimented mouth of the Shoalhaven River, the prominent rocky headlands with cliff and caves forming Jervis Bay, long stretches of rocky coast and stretches with barrier beaches enclosing lagoons and estuaries. Batemans Bay, at the entrance of the Clyde River is the only estuary without a significant sand bar.

SOUTH REGION

GEODIVERSITY UNITS — PREDICTED PLACE TYPES

A NAROOMA TERRAINE
- Sedimentology & Stratigraphy
- Structure
- Fossils
- Landforms
- Soils

B ORDOVICIAN FLYSCH
- Sedimentology & Stratigraphy
- Structure
- Fossils
- Landforms
- Soils

C ORDOVICIAN METAMORPHIC COMPLEXES
Cambalong, Cooma, Jerangle and Wagga
- Petrography
- Metamorphic features
- Soils

D EARLY SILURIAN CLASTICS
- Sedimentology & Stratigraphy
- Structure
- Fossils
- Landforms
- Soils

E SILURIAN VOLCANICS AND LIMESTONES
- Volcanic features
- Sedimentology & Stratigraphy
- Fossils
- Karst
- Cainozoic Vertebrate Fossils
- Soils

F SILURO-DEVONIAN SYN & POST TECTONIC GRANITES
- Petrography & geochemistry

Plutonic Features
Contact Metamorphism
Dating
Landforms
Soils

G OCEANIC LITHOSPHERE
Kiandra Beds, Coolac Serpentinite, Honeysuckle Beds, Tumut Pond Serpentinite Belt

Petrography & geochemistry
Structure
Mineralisation
Soils

H EARLY & MID DEVONIAN VOLCANICS

Petrography
Volcanic Features
Landforms
Soils

I EARLY DEVONIAN LIMESTONES

Sedimentology & Stratigraphy
Marine Invertebrate Fossils
Fish Fossils
Structures
Karst
Cainozoic Vertebrate Fossils
Soils

J LATE DEVONIAN CLASTICS

Sedimentology & Stratigraphy
Structure
Fossils
Landforms
Soils

K CARBONIFEROUS POST-TECTONIC GRANITES

Petrography & geochemistry
Plutonic Features
Contact Metamorphism
Dating
Landforms
Soils

L SOUTHERN SYDNEY BASIN

- Sedimentology & Stratigraphy
- Structure
- Fossils
- Landforms
- Hanging Swamps & Peat
- Soils

M MESOZOIC VOLCANISM

- Petrography
- Volcanic features
- Landforms
- Soils

N MONARO PLAIN

- Landforms & Landform Evolution
- Tertiary Sediment
- Lake Deposits
- Tertiary Volcanism
- Vertebrate Fossils
- Soils

O SOUTHERN HIGHLANDS

- Landforms
- Neo Tectonism
- Tertiary Sediment
- Tertiary Basalt
- Lakes
- Lake Deposits
- Wetlands & Peat
- Quaternary Deposits
- Active Processes

P HIGH COUNTRY, AUSTRALIAN ALPS

- Glacial Landforms
- Periglacial landforms
- Wetlands & Peat

Q GREAT ESCARPMENT AND INCISED ZONE

- Landforms & Landform History
- Tertiary Sediments
- Tertiary Volcanics
- Quaternary sediments
- Soils
- Active Processes

R COASTAL PLAIN

Landforms & Landform Evolution

Tertiary Sediment

Dunes

Riverine deposits and landforms

Soils

Active Processes

S COAST

Beaches

Headlands

Rocky Coast

Sea Caves

Active Processes

EDEN NSW CRA REGION,
GEOHERITAGE REVIEW

The Eden CRA Region comprises the south eastern portion of the Lachlan Fold Belt in New South Wales. Most of the region lies in the Capertee Mallacoota Zone, while the western portion lies within the Hill End-Cooma Zone. The Region includes five major geomorphic zones; the coast, a fragmental coastal plain, an incised zone, the Great Escarpment and the Monaro Plain.

ORDOVICIAN FLYSCH

The oldest rocks in the Eden CRA Region are Ordovician flysch; turbidites, sandstones, mudstones and shales attributed to the Ordovician Adaminaby Group, which crop out over a significant portion of the region. These rocks are intensely folded, frequently intersected by hydrothermal quartz veins, and generally regionally metamorphosed to slates and phyllites. North of the Bemboka Granite rocks of the Adaminaby Group are contact metamorphosed to hornfels.

The Adaminaby Group are deep water flysch facies in which graptolites are the most important fossils. Adaminaby Group rocks are typically eroded into deep v-shaped valleys, often with structurally-controlled drainage patterns, separated by narrow ridges.

JERANGLE METAMORPHIC COMPLEX

The Jerangle Metamorphic Complex crops out in the far northwest corner of the Eden Region as a fault-bound zone trending north from Nimmitabel. The complex has formed by the metamorphism of turbidites and consists of biotite, andalusite and corderite schists, often with knotted fabrics.

LATE SILURIAN VOLCANICS AND LIMESTONES

Late Silurian volcanics and limestones of the Bredbo Group crop out in four small areas of the Eden CRA Region, two in the north west between Kybean and Rock Flat, in a elongate fault-wedge near Buli Mountain and along the Glenbog Fault north of Brown Mountain. These rocks unconformably overlie the Adaminaby Group and the Jerangle metamorphic Complex.

The Bredbo Group consists of shallow water marine sediments and intermediate to silicic volcaniclastics. A small, but significant, karst is developed in limestones at Kybean.

LATE SILURIAN TO EARLY DEVONIAN GRANITES

The Late Silurian to Early Devonian Bega Batholith intrudes much of the Eden CRA Region. These granitic rocks and the Adaminaby Beds are the most common rocks outcropping in the region. A number of suites of varying composition are recognised within the Batholith, which includes both S and I type granites. The most extensive suite in the Batholith is the Bemboka Granodiorite which forms much of the west of the Region between Browns Mountain and Wog Wog River.

MID DEVONIAN VOLCANICS

Rocks of the Boyd Volcanic Complex unconformably overlie the Adaminaby Beds in various localities near the coast, south from Gaolen Head. These include silicic volcanics, ignimbrites basalts and interbedded sediments. The volcanics were erupted into a terrestrial environment and lake sediments within the volcanics contain significant plant, fish and invertebrate fossils.

LATE DEVONIAN CLASTICS

Sandstones, mudstones and conglomerates of the Late Devonian Merimbula Group unconformably overlie older rocks and occur as scattered remnants, some of considerable size, over the whole of the Eden CRA Region. The Merimbula Group sediments were deposited in shallow marine to terrestrial conditions and contain significant deposits of fish and plant fossils.

The rocks are folded into broad open folds which generally have little structural influence on topography. Where strong sandstone and conglomerate units are exposed they can form prominent peaks which may be cliffed.

MESOZOIC INTRUSIONS

Two Mesozoic intrusions occur in the Eden Region. In the northeast near Tanja the Cretaceous Tanja Syenite Complex is located. This is a body of mafic and felsic rocks about 5 km in diameter intruding Ordovician Flysch. It is partly covered by Tertiary sediment.

The Jingera Rock Syenite Complex, named after its most prominent outcrop feature,is located east of Burragate in the Egans Peaks Nature Reserve. The complex is composed of a range of syenites and monzonites and intrudes both granitic rocks and Ordovician flysch.

MONARO PLAIN

The Monaro Plain forms the western portion of the Eden Region. It is a relatively flat elevated area bounded on the east by the Great Escarpment. Much of the Plain is covered by Tertiary basalts, some of which overly Tertiary sediments. Small lakes and swamps are common, some of which, such as Nunnock Swamp, contain significant peat deposits. Quaternary sediments are also present, some of which have been dammed by the basalt.

GREAT ESCARPMENT & INCISED ZONE

In the Eden Region the Great Escarpment is a significant distance, up to 40 km, inland from the coast. Between the Escarpment and the coastal plain is a broad incised zone where the coastal streams have cut back deeply into the edge of the highlands. The only significant area of flat land east of the Great Escarpment is in the Bega Valley where Quaternary alluvium has filled an incised valley and the Bega River has eroded a significant area of lowland in the Bemboka and Kameruka Granodiorites.

COASTAL ZONE

Apart from the Bega Valley and a few areas of alluvium deposited behind barrier beaches, there is really no coastal plain in the Eden Region. There is, however, what might be called a coastal zone which contains areas such as that followed by the Princes Highway between the Victorian Border and Eden with elevations generally lower than 200 m. Tertiary sediments occur at a variety of elevations close to the coast, ranging from near sea level at Pambula Lake and Tira Beach to 300 m at Table Hills.

COAST

The coast in the Eden Region consists of significant stretches of rocky coast with barrier bars blocking or partly blocking most estuaries. Twofold Bay and Disaster Bay are the major bedrock-bound features in the coast. Much of the rocky coast is cliffed and numerous sea caves have been identified along the coast south of Eden.

EDEN REGION

GEODIVERSITY UNITS	PREDICTED PLACE TYPES
A ORDOVICIAN FLYSCH	Structure
	Fossils
	Landforms
	Soils
B JERANGLE METAMORPHIC COMPLEX	
	Metamorphic features
	Soils
C LATE SILURIAN VOLCANICS AND LIMESTONES	
	Volcanic features
	Sedimentology & Stratigraphy
	Fossils
	Karst
	Vertebrate Fossils
	Soils
D EARLY DEVONIAN GRANITES	
	Petrography
	Plutonic Features
	Landforms
	Soils
E MID DEVONIAN VOLCANICS & SEDIMENTS	
	Petrography
	Volcanic Features
	Sedimentology & Stratigraphy
	Fish Fossils
	Soils
F LATE DEVONIAN CLASTICS	
	Sedimentology & Stratigraphy
	Structure
	Fossils
	Landforms
	Soils
G MESOZOIC INTRUSIONS	

Petrography
Intrusive features
Landforms
Soils

H MONARO PLAIN

Landforms
Tertiary Sediment
Tertiary Volcanism
Soils

I GREAT ESCARPMENT & INCISED ZONE

Landforms & Landform History
Tertiary Sediments
Tertiary Volcanics
Quaternary sediments
Soils
Active Processes

J COASTAL ZONE

Landforms
Tertiary Sediment
Riverine deposits and landforms
Soils
Active Processes

K COAST

Beaches
Dunes
Headlands
Sea Caves
Active Processes

PART 3 RESULTS, CONCLUSIONS & RECOMMENDATIONS

3.1 GENERAL RESULTS AND CONCLUSIONS

3.1.1 METHODOLOGY

The data collection and classification methods used in this project have been successful in identifying a large number of places with geoheritage significance. Regional reviews and geoheritage units have allowed places to be classified meaningfully by type and have proved to be an important tool in gap analysis.

3.1.2 COVERAGE BY REGION AND MAP SHEET

Analysis of the data by Region and map sheet, see Appendix B, shows that the process used in this project has identified on average 19 places of geoheritage significance per 100 000 scale topographic map sheet. While in both the South and Eden Regions the average number of places per map sheet was above average for the project (South 25, Eden 33 and South/Eden overlap 56) the number of places identified in both the Upper and Lower North East Regions was distinctly below average (Upper NE 8, Lower NE 12 and UNE/LNE overlap 9). The high average number of places in the South and South /Eden overlap reflects the large number of places identified on a small number of map sheets (Cooma [overlap] 114 and Yass [south] 83).

Of the 94 Map sheets covered by the project no places were identified on 12 sheets (13%) and less than five places were identified on 28 sheets (30%). The greatest number of sheets with no places identified was in the South Region, 5 (16%) while places were reported on all map sheets in the Eden Region and Eden/South overlap.

3.1.3 COVERAGE BY PLACE TYPE

3.1.3.1 <u>C1 Only Places</u>

The first type of analysis by place type is also based on Appendix B which distinguished between places whose value is only in relation to Criterion C1 and those whose values relate to other criteria or to Criterion C1 *and* other Criteria.

C1 only places include Stratigraphic Type Sections, igneous and metamorphic rock Type Localities, Soil Reference Sites and sample collection localities (rocks, fossils, geochemical etc). Initially it was anticipated that this survey would identify a large number (and high proportion) of these places, however, Appendix B shows C1 only places as representing 25% of the total number of places identified. The number of C1 only places identified is distinctly below average in the Upper North East (10%) and just below average in the South/Eden overlap (20%).

To some extent the low representation of C1 only places is an artifact of the data collection method, scientific journals were given a higher priority over geological map explanatory note and soil landscape notes. There are also problems with the published data itself, many stratigraphic units not having Type Sections defined and very poor location (or no usable) location data being given for a range of reference and collecting localities. The low number of C1 only places in the Upper North

East can be rectified by accessing data held by the Geological Survey and DUAP (Soil Conservation Service), however this was not possible in the time available to this project.

3.1.3.2 Geodiversity Units, Place Type and Gap Analysis

A more detailed analysis of the coverage of types of places can be gained from Appendix C. The assessment of the quality of coverage is based on an assessment by the consultants of the degree of coverage relative to the likely abundance of each place type.

3.2 RECOMMENDATIONS

3.2.1 USE OF DATA GENERATED

The data generated by this project are the first elements of a Geoheritage Database for New South Wales. This data should become integrated into State and Federal and Local Government Heritage Registers.

Every effort should be made to ensure that a process is devised so that a permanently managed and comprehensive Geoheritage Database for New South Wales emerges from this data.

3.2.2 CONTINUATION OF CRA PROCESS

It is recommended that in order to properly address the issue of geoheritage conservation in the New South Wales Comprehensive Regional Assessment Process the following work should be undertaken :-

IMMEDIATE TIME FRAME

3.2.2.1 CONTINUATION OF DESKTOP IDENTIFICATION AND GAP ANALYSIS

The present desktop survey should be extended using the methodology outlined in this report for a further period of three months in 1998 so that an adequate coverage of geoheritage places can be identified from published literature, reports and maps and so that the gap analysis can be refined.

FIVE YEAR TIME FRAME

3.2.2.2 GAP FILLING PROJECT

A project should be begun in early 1999 to fill the gaps in identified places by type and geographic region as identified in this report and the findings of the project proposed in “2” above. This project should particularly focus on gaps in forested regions.

3.2.2.3 DOCUMENTATION AND ASSESSMENT PROJECT

A five year project should be undertaken to document to RNE standard, assessed against the RNE criteria and make management recommendations for those places identified with values other than C1 only and not already listed in the Register of the National Estate. This project will of necessity involve field work, should be undertaken on a regional, thematic basis and will require significant funding and staffing. Priority should be given to places identified in forested parts of the CRA Regions.

3.3 SPREADSHEETS

The geoheritage places identified in each RFA Region are listed in the spreadsheets below.

Each **row** in the spreadsheets records a **report** of a place of geoheritage significance in the literature (including places on maps). Many places are reported more than once in the literature for the same values or are reported for different values. Where the same place is reported more than once or where adjacent reported places can be sensibly grouped together they are considered to be a single place.

Places listed in **bold** on the spreadsheets are listed, or are known to have been nominated for listing, in the Register of the National Estate.

The columns have list the following data:-

Column A COUNT
This column is used to **count** the number of places identified in each Region. Multiply-reported single places and adjacent places that have been grouped together have the same count number in column A of the spreadsheets.

Column B SITE NO.
Each place identified has been assigned a **unique site number** within each region to allow plotting on maps etc.Multiply-reported single places and adjacent places that have been grouped together have the same site number in column B of the spreadsheets. An asterisk (*) against the Site Number indicates that the location given in Columns K, L, M & N is an estimate.

Column C PLACE NAME
Each place has been given a **place name**. Where possible, these are Geographic Names and/or Formal Stratigraphic Names. Synonymous names are listed where this aids place recognition.

Column D TYPE
Each place has been given a **descriptive place type.**

Column E CRITERIA
The **RNE Criterion/ia** against which this place is most likely to be evaluated is/are listed in Column E.

Column F UNIT
The letter symbol for the **Geodiversity Unit** to which the place belongs is listed in Column F.

Column G TYPE NO.

Where possible, places have been classified using the alphanumeric group codes included in the Geoheritage Consultants Kit.

Column H REFERENCE
This lists the **author/s and date** the source literature from which the place was identified. The literature is listed in the Bibliographies for each Region in Part 5.

Column I PAGE
Column I lists the **page number** in the literature which gives the best description of, or location data for, the place.

Column J 100 00 TOPO
Gives the **name** of the standard 1:100 000 topographic sheet/sheets on which the place is located.

Column K EAST
Gives a four-digit grid number for **easting** of the place in AMG 66.

Column L NORTH
Gives a five digit grid number for **northing** of the place in AMG 66.

Column M LAT
Gives the **latitude** of the place to the nearest minute.

Column N LONG
Gives the **longitude** of the place to the nearest minute.

Column O SIZE CLASS
Gives the **area** of the place according to the following approximate size classes:-

1 area of 1 Ha or less
2 area between 1 Ha and 100 Ha
3 area between 1 km^2 and 10 km^2
4 area greater than 10 km^2
L linear place of minimal width
X insufficient size data available for classification

Column P DATA STATUS
Classifies the **data quality** for the place using the following classes:-

1 The values and location of the place can be determined from the available data.
2 There is insufficient data available at this time as to the values at the place.
3 There is insufficient data available as to the location of the place.

Column Q FRAGILITY

Classifies the **fragility** of the place using the following classes:-

1 Sensitive to unintentional human impact (Dixon *et al* classes 1 & 2).

2 Sensitive to intentional human impact including use of hand tools.This includes those places sensitive to sampling, collecting or vandalism (Dixon *et al* class 3).

3 Sensitive to mechanical interference at any scale (Dixon *et al* classes 4 - 9).

4 Generally immune to human interference (Dixon *et al* class 10).

X insufficient sensitivity data available for classification.

3.3.1 IDENTIFIED PLACES UPPER NORTH EAST REGION

See attributes in spatial layer provided

3.3.2 IDENTIFIED PLACES LOWER NORTH EAST REGION

See attributes in spatial layer provided

3.3.3 IDENTIFIED PLACES SOUTH REGION

See attributes in spatial layer provided

IDENTIFIED PLACES EDEN REGION

See attributes in spatial layer provided

PART 4 APPENDICES

APPENDIX A JOURNALS SEARCHED

APPENDIX A

JOURNALS SEARCHED

JOURNAL	YEAR	VOLUME	PART	NUMBER
Journal & Proceedings of the Royal Society of NSW				
Journal & Proceedings of the Royal Society of NSW	1941	75		
MISSING VOLUME 76 TO VOLUME 77				
Journal & Proceedings of the Royal Society of NSW	1944	78		
Journal & Proceedings of the Royal Society of NSW	1945	79		
MISSING VOLUME 80				
Journal & Proceedings of the Royal Society of NSW	1947	81		
Journal & Proceedings of the Royal Society of NSW	1948	82		
MISSING VOLUME 81 TO VOLUME 88				
Journal & Proceedings of the Royal Society of NSW	1955	89		
Journal & Proceedings of the Royal Society of NSW	1956	90	1	
Journal & Proceedings of the Royal Society of NSW	1956	90	2	
Journal & Proceedings of the Royal Society of NSW	1956	90	3	
Journal & Proceedings of the Royal Society of NSW	1957	91	1	
Journal & Proceedings of the Royal Society of NSW	1957	91	2	
Journal & Proceedings of the Royal Society of NSW	1957	91	4	
Journal & Proceedings of the Royal Society of NSW	1958	92	1	
Journal & Proceedings of the Royal Society of NSW	1958	92	2	
Journal & Proceedings of the Royal Society of NSW	1958	92	3	
Journal & Proceedings of the Royal Society of NSW	1958	92	4	
Journal & Proceedings of the Royal Society of NSW	1959	93	1-2	
Journal & Proceedings of the Royal Society of NSW	1959	93	3	
Journal & Proceedings of the Royal Society of NSW	1960	94	2	
Journal & Proceedings of the Royal Society of NSW	1960	94	3	
Journal & Proceedings of the Royal Society of NSW	1961	94	5	
Journal & Proceedings of the Royal Society of NSW	1961	94	6	
Journal & Proceedings of the Royal Society of NSW	1961	95	3-4	
Journal & Proceedings of the Royal Society of NSW	1961	95	1	
Journal & Proceedings of the Royal Society of NSW	1961	95	2	
Journal & Proceedings of the Royal Society of NSW	1962	95	5	
Journal & Proceedings of the Royal Society of NSW	1962	95	6	
Journal & Proceedings of the Royal Society of NSW	1962	96	1	
Journal & Proceedings of the Royal Society of NSW	1963	96	2-6	
Journal & Proceedings of the Royal Society of NSW	1964	97	6-A	
Journal & Proceedings of the Royal Society of NSW	1964	97	6-B	
Journal & Proceedings of the Royal Society of NSW	1963	97	1	
Journal & Proceedings of the Royal Society of NSW	1964	97	2	
Journal & Proceedings of the Royal Society of NSW	1964	97	3	
Journal & Proceedings of the Royal Society of NSW	1964	97	4	
Journal & Proceedings of the Royal Society of NSW	1964	97	5	
Journal & Proceedings of the Royal Society of NSW	1965	98	1	
Journal & Proceedings of the Royal Society of NSW	1965	98	3	
Journal & Proceedings of the Royal Society of NSW	1966	99		

Journal & Proceedings of the Royal Society of NSW	1966	100	3 - 4	
Journal & Proceedings of the Royal Society of NSW	1966	100	1	
Journal & Proceedings of the Royal Society of NSW	1966	100	2	
Journal & Proceedings of the Royal Society of NSW	1968	101	3-4	
MISSING VOLUME 102 TO VOLUME 116				
Journal & Proceedings of the Royal Society of NSW	1985	117	3-4	
Journal & Proceedings of the Royal Society of NSW	1985	118	1-2	
Journal & Proceedings of the Royal Society of NSW	1985	118	3-4	
Journal & Proceedings of the Royal Society of NSW	1985	119	3-4	
Journal & Proceedings of the Royal Society of NSW	1986	119	1-2	
Journal & Proceedings of the Royal Society of NSW	1987	120	1-2	
Journal & Proceedings of the Royal Society of NSW	1987	120	3-4	
Journal & Proceedings of the Royal Society of NSW	1988	121	1-2	
Journal & Proceedings of the Royal Society of NSW	1988	121	3	
Journal & Proceedings of the Royal Society of NSW	1988	121	4	
Journal & Proceedings of the Royal Society of NSW	1989	122	1-2	
Journal & Proceedings of the Royal Society of NSW	1989	122	3-4	
Journal & Proceedings of the Royal Society of NSW	1990	123	1-2	
Journal & Proceedings of the Royal Society of NSW	1990	123	3-4	
Journal & Proceedings of the Royal Society of NSW	1991	124		
Journal & Proceedings of the Royal Society of NSW	1992	125	1-2	
Journal & Proceedings of the Royal Society of NSW	1992	125	3-4	
Journal & Proceedings of the Royal Society of NSW	1993	125	1-2	
Journal & Proceedings of the Royal Society of NSW	1993	126	1-2	
Journal & Proceedings of the Royal Society of NSW	1993	126	3-4	
Journal & Proceedings of the Royal Society of NSW	1994	127	1-2	
Journal & Proceedings of the Royal Society of NSW	1994	127	3-4	
Journal & Proceedings of the Royal Society of NSW	1995	128	1-2	
Journal & Proceedings of the Royal Society of NSW	1995	128	3-4	
Journal & Proceedings of the Royal Society of NSW	1996	129	1-2	
Journal & Proceedings of the Royal Society of NSW	1996	129	3-4	
Journal & Proceedings of the Royal Society of NSW	1997	130	3-4	

Proceedings of the Linnean Society of NSW

Proceedings of the Linnean Society of NSW	1896	21	2	82
MISSING VOLUME 22 TO VOLUME 49				
Proceedings of the Linnean Society of NSW	1925	50	2	201
Proceedings of the Linnean Society of NSW	1926	50	3	207
Proceedings of the Linnean Society of NSW	1927	52	2	211
Proceedings of the Linnean Society of NSW	1928	53	3	217
Proceedings of the Linnean Society of NSW	1928	53	4	218
Proceedings of the Linnean Society of NSW	1929	54	2	222
Proceedings of the Linnean Society of NSW	1929	54	3	223
Proceedings of the Linnean Society of NSW	1929	54	4	224
Proceedings of the Linnean Society of NSW	1930	55	2	228
Proceedings of the Linnean Society of NSW	1930	55	4	230
Proceedings of the Linnean Society of NSW	1931	56	2	234
Proceedings of the Linnean Society of NSW	1931	56	2	235
MISSING VOLUME 57 (1) TO VOLUME 65				

Proceedings of the Linnean Society of NSW	1941	66	1-2	293-294
Proceedings of the Linnean Society of NSW	1941	66	3-4	295-296
Proceedings of the Linnean Society of NSW	1941	66	5-6	297-298
Proceedings of the Linnean Society of NSW	1942	67	3-4	301-302
Proceedings of the Linnean Society of NSW	1943	68	1-2	305-306
Proceedings of the Linnean Society of NSW	1943	68	5-6	309-310
Proceedings of the Linnean Society of NSW	1944	69	1-2	311-312
Proceedings of the Linnean Society of NSW	1944	69	3-4	313-314
Proceedings of the Linnean Society of NSW	1944	69	5-6	315-316
MISSING VOLUME 70 (1) TO VOLUME 80				
Proceedings of the Linnean Society of NSW	1956	81	3	382
MISSING VOLUME 81 (4) TO VOLUME 89				
Proceedings of the Linnean Society of NSW	1965	90	1	407
MISSING VOLUME 91 (2) TO VOLUME 105				
Proceedings of the Linnean Society of NSW	1982	106	1-2	465-466
Proceedings of the Linnean Society of NSW	1983	106	3-4	467-468
Proceedings of the Linnean Society of NSW	1983	107	1-2	467-468
Proceedings of the Linnean Society of NSW	1983-84	107	3-4	471-472
Proceedings of the Linnean Society of NSW	1983-84	108	1-2	473-474
Proceedings of the Linnean Society of NSW	1985-86	108	3-4	475-476
Proceedings of the Linnean Society of NSW	1986-87	109	1-2	477-478
Proceedings of the Linnean Society of NSW	1986-87	109	3-4	479-480
Proceedings of the Linnean Society of NSW	1987-88	110	1-2	481-482
Proceedings of the Linnean Society of NSW	1988-89	110	3-4	483-484
Proceedings of the Linnean Society of NSW	1989	111	1-4	485-488
Proceedings of the Linnean Society of NSW	1990	112	1-4	489-492
Proceedings of the Linnean Society of NSW	1992	113	1-4	493-496
Proceedings of the Linnean Society of NSW	1994	114	1-4	497-400
Proceedings of the Linnean Society of NSW	1995	115		
Proceedings of the Linnean Society of NSW	1996	116		
Proceedings of the Linnean Society of NSW	1997	117		

Journal of the Geological Society of Australia

Journal of the Geological Society of Australia	1977	24	1-2
Journal of the Geological Society of Australia	1977	24	3-4
Journal of the Geological Society of Australia	1977	24	4-5
Journal of the Geological Society of Australia	1978	24	7-8
Journal of the Geological Society of Australia	1978	25	1-2
Journal of the Geological Society of Australia	1978	25	3-4
Journal of the Geological Society of Australia	1978	25	5-6
Journal of the Geological Society of Australia	1979	25	7-8
Journal of the Geological Society of Australia	1979	26	1-2
Journal of the Geological Society of Australia	1979	26	3-4
Journal of the Geological Society of Australia	1979	26	5-6
Journal of the Geological Society of Australia	1979	26	7-8
Journal of the Geological Society of Australia	1980	27	1-2
Journal of the Geological Society of Australia	1981	28	1-2
Journal of the Geological Society of Australia	1981	28	3-4
Journal of the Geological Society of Australia	1982	29	1-2

Journal of the Geological Society of Australia	1982	29	3-4
Journal of the Geological Society of Australia	1983	30	1-2
Journal of the Geological Society of Australia	1983	30	3-4
Australian Journal of Earth Sciences	1984	31	1
Australian Journal of Earth Sciences	1984	31	2
Australian Journal of Earth Sciences	1984	31	3
Australian Journal of Earth Sciences	1984	31	4
Australian Journal of Earth Sciences	1985	32	1
Australian Journal of Earth Sciences	1985	32	2
Australian Journal of Earth Sciences	1985	32	3
Australian Journal of Earth Sciences	1985	32	4
Australian Journal of Earth Sciences	1986	33	1
Australian Journal of Earth Sciences	1986	33	2
Australian Journal of Earth Sciences	1986	33	3
Australian Journal of Earth Sciences	1986	33	3
Australian Journal of Earth Sciences	1986	33	4
Australian Journal of Earth Sciences	1987	34	1
Australian Journal of Earth Sciences	1987	34	2
Australian Journal of Earth Sciences	1987	34	3
Australian Journal of Earth Sciences	1987	34	4
Australian Journal of Earth Sciences	1988	35	1
Australian Journal of Earth Sciences	1988	35	2
Australian Journal of Earth Sciences	1988	35	3
Australian Journal of Earth Sciences	1988	35	4
Australian Journal of Earth Sciences	1989	36	1
Australian Journal of Earth Sciences	1989	36	2
Australian Journal of Earth Sciences	1989	36	3
Australian Journal of Earth Sciences	1989	36	4
Australian Journal of Earth Sciences	1990	37	1
Australian Journal of Earth Sciences	1990	37	2
Australian Journal of Earth Sciences	1990	37	3
Australian Journal of Earth Sciences	1990	37	4
Australian Journal of Earth Sciences	1991	38	1
Australian Journal of Earth Sciences	1991	38	2
Australian Journal of Earth Sciences	1991	38	3
Australian Journal of Earth Sciences	1991	38	4
Australian Journal of Earth Sciences	1991	38	5
Australian Journal of Earth Sciences	1992	39	1
Australian Journal of Earth Sciences	1992	39	2
Australian Journal of Earth Sciences	1992	39	3.1
Australian Journal of Earth Sciences	1992	39	3.2
Australian Journal of Earth Sciences	1992	39	4
Australian Journal of Earth Sciences	1992	39	5
Australian Journal of Earth Sciences	1993	40	1
Australian Journal of Earth Sciences	1993	40	2
Australian Journal of Earth Sciences	1993	40	3
Australian Journal of Earth Sciences	1993	40	4
Australian Journal of Earth Sciences	1993	40	5
Australian Journal of Earth Sciences	1993	40	6

Australian Journal of Earth Sciences	1994	41	1
Australian Journal of Earth Sciences	1994	41	2
Australian Journal of Earth Sciences	1994	41	3
Australian Journal of Earth Sciences	1994	41	4
Australian Journal of Earth Sciences	1994	41	5
Australian Journal of Earth Sciences	1994	41	6
Australian Journal of Earth Sciences	1995	42	1
Australian Journal of Earth Sciences	1995	42	2
Australian Journal of Earth Sciences	1995	42	3
Australian Journal of Earth Sciences	1995	42	4
Australian Journal of Earth Sciences	1995	42	5
Australian Journal of Earth Sciences	1995	42	6
Australian Journal of Earth Sciences	1996	43	1
Australian Journal of Earth Sciences	1996	43	2
Australian Journal of Earth Sciences	1996	43	3
Australian Journal of Earth Sciences	1996	43	4
Australian Journal of Earth Sciences	1996	43	5
Australian Journal of Earth Sciences	1996	43	6
Australian Journal of Earth Sciences	1997	44	1
Australian Journal of Earth Sciences	1997	44	2
Australian Journal of Earth Sciences	1997	44	3
Australian Journal of Earth Sciences	1997	44	4
Australian Journal of Earth Sciences	1997	44	5
Australian Journal of Earth Sciences	1997	44	6
Australian Journal of Earth Sciences	1998	45	1
Australian Journal of Earth Sciences	1998	45	2

Records of the Geological Survey of NSW

Records of the Geological Survey of NSW	1889	1
Records of the Geological Survey of NSW	1890-92	2
Records of the Geological Survey of NSW	1892-93	3
Records of the Geological Survey of NSW	1894-95	4
Records of the Geological Survey of NSW	1896-98	5
Records of the Geological Survey of NSW	1898-1900	6
Records of the Geological Survey of NSW	1900-04	7
Records of the Geological Survey of NSW	1905-09	8
Records of the Geological Survey of NSW	1909-19	9
Records of the Geological Survey of NSW	1921-22	10
Records of the Geological Survey of NSW	1969-70	11-12
Records of the Geological Survey of NSW	1971	13
Records of the Geological Survey of NSW	1972	14
Records of the Geological Survey of NSW	1973	15
Records of the Geological Survey of NSW	1974-75	16-17
Records of the Geological Survey of NSW	1976-80	18-19
Records of the Geological Survey of NSW	1980-81	20
Records of the Geological Survey of NSW	1983-	21
Records of the Geological Survey of NSW	1986-90	22-23

Annual Report of the NSW Department of Mines

Annual Report of the NSW Department of Mines 1876
Annual Report of the NSW Department of Mines 1877
MISSING 1878
Annual Report of the NSW Department of Mines 1879
Annual Report of the NSW Department of Mines 1880
Annual Report of the NSW Department of Mines 1881
Annual Report of the NSW Department of Mines 1882
Annual Report of the NSW Department of Mines 1883
Annual Report of the NSW Department of Mines 1884
Annual Report of the NSW Department of Mines 1885
Annual Report of the NSW Department of Mines 1886
Annual Report of the NSW Department of Mines 1887
Annual Report of the NSW Department of Mines 1888
MISSING 1889
Annual Report of the NSW Department of Mines 1890
Annual Report of the NSW Department of Mines 1891
Annual Report of the NSW Department of Mines 1892
Annual Report of the NSW Department of Mines 1893
Annual Report of the NSW Department of Mines 1894

APPENDIX B ANALYSIS OF PLACES BY MAP SHEET

APPENDIX B

ANALYSIS OF PLACE NUMBERS BY MAP SHEET

MAP SHEETS UPPER NORTH EAST REGION ONLY

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	ASHFORD	1	0	1
2	BALLINA	4	0	4
3	BARE POINT	32	0	32
4	BONALBO	1	1	2
5	CLIVE	7	0	7
6	COALDALE	0	0	0
7	COFFS HARBOUR	0	0	0
8	DRAKE	20	0	20
9	GLEN INNES	1	1	2
10	GRAFTON	10	3	13
11	INVERELL	5	0	5
12	LISMORE	15	10	25
13	MOUNT LINDESAY	2	0	2
14	MURWILLUMBAH	3	0	3
15	NEWTON BOYD	6	0	6
16	STANTHORPE	0	0	0
17	TENTERFIELD	9	0	9
18	TWEED HEADS	12	0	12
19	WARWICK	0	0	0
20	WOODBURN	15	0	15
	TOTAL PLACES	**143**	**15**	**158**
	MEAN/SHEET	**7.2**	**0.8**	**7.9**
	% 0F PLACES	**90.5%**	**9.5%**	

SHEETS WITH NO PLACES	**4**
% SHEETS WITH NO PLACES	**20%**
SHEETS WITH < 5 PLACES	**11**
% SHEETS WITH < 5 PLACES	**55.0%**

MAP SHEETS SHARED UPPER AND LOWER NORTH EAST REGIONS

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	BUNDARRA	0	0	0
2	DORRIGO	7	4	11
3	EBOR	15	0	15
4	GUYRA	6	2	8
	TOTAL	**28**	**6**	**34**

PLACES MEAN/SHEET	**7.0**	**1.5**	**8.5**
% 0F PLACES	**82.4%**	**17.6%**	

SHEETS WITH NO PLACES	**1**
% SHEETS WITH NO PLACES	**25.0%**
SHEETS WITH < 5 PLACES	**1**
% SHEETS WITH < 5 PLACES	**25.0%**

MAP SHEETS LOWER NORTH EAST REGION ONLY

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	ARMIDALE	9	0	9
2	BENDEMEER	1	0	1
3	BULAHDELAH	9	19	28
4	CAMBERWELL	3	2	5
5	CAMDEN HAVEN	5	0	5
6	CARRAI	22	2	24
7	CESSNOCK	21	10	31
8	COBBADAH	0	0	0
9	COWARRAL	5	9	14
10	DUNGOG	2	12	14
11	ELLERSTON	16	3	19
12	FORSTER	0	0	0
13	GOSFORD	10	6	16
14	HOWES VALLEY	7	0	7
15	KEMPSEY	27	4	31
16	LAKE MACQUARIE	5	4	9
17	MACKSVILLLE	6	1	7
18	MOUNT POMANY	1	0	1
19	MURRURUNDI	1	0	1
20	MUSWELLBRO OK	3	5	8
21	NAMBUCCA	2	0	2
22	NEWCASTLE	40	8	48
23	NUNDLE	15	19	34
24	PORT STEPHENS	7	0	7
25	ST ALBANS	3	5	8
26	SYDNEY	9	0	9
27	UPPER MANNING	4	3	7
28	WALLERAWANG	2	0	2
29	WINGHAM	13	2	15
30	YARROWITCH	8	2	10
	TOTAL PLACES	**256**	**116**	**372**

MEAN/SHEET	**8.5**	**3.9**	**12.4**
% 0F PLACES	**68.8%**	**31.2%**	

SHEETS WITH NO PLACES	**2**
% SHEETS WITH NO PLACES	**6.7%**
SHEETS WITH < 5 PLACES	**7**
% SHEETS WITH < 5 PLACES	**23.3%**

MAP SHEETS SOUTH REGION ONLY

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	ARALUEN	13	1	14
2	BATEMANS BAY	50	4	54
3	BERRIDALE	19	28	47
4	BLAYNEY	0	0	0
5	BRAIDWOOD	23	2	25
6	BRINDABELLA	39	19	58
7	BURRAGORAN G	18	1	19
8	CANBERRA	27	19	46
9	CORRYONG	0	0	0
10	CROOKWELL	3	2	5
11	GOULBURN	24	13	37
12	GUNNING	11	5	16
13	HOLBROOK	0	0	0
14	JACOBS RIVER	1	2	3
15	JERVIS BAY	30	1	31
16	KATOOMBA	12	0	12
17	KIAMA	6	3	9
18	KOSCIUSKO	50	0	50
19	MICHELAGO	14	12	26
20	MOSS VALE	51	4	55
21	NUMBLA	6	27	33
22	OBERON	12	0	12
23	ROSEWOOD	1	0	1
24	TALLANGATTA	0	0	0
25	TANTANGARA	13	7	20
26	TARALGA	20	2	22

27	TARCUTTA	0	0	0
28	TUMUT	8	3	11
29	ULLADULLA	54	5	59
30	YARRANGOBILLY	22	2	24
31	YASS	42	41	83
	TOTAL PLACES	**569**	**203**	**772**
	MEAN/SHEET	**18.4**	**6.5**	**24.9**
	% 0F PLACES	**73.7%**	**26.3%**	

SHEETS WITH NO PLACES	**5**
% SHEETS WITH NO PLACES	**16.1%**
SHEETS WITH < 5 PLACES	**7**
% SHEETS WITH < 5 PLACES	**22.6%**

MAP SHEETS EDEN REGION ONLY

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	BEGA	40	15	55
2	CRAIGIE	11	13	24
3	EDEN	36	15	51
4	GREEN CAPE	1	0	1
	TOTAL PLACES	**88**	**43**	**131**
	MEAN/SHEET	**22.0**	**10.8**	**32.8**
	% 0F PLACES	**67.2%**	**32.8%**	

SHEETS WITH NO PLACES	**0**
% SHEETS WITH NO PLACES	**0.0%**
SHEETS WITH < 5 PLACES	**1**
% SHEETS WITH < 5 PLACES	**25.0%**

MAP SHEETS SHARED SOUTH AND EDEN REGIONS

	MAP SHEET	PLACES NOT C1 ONLY	PLACES C1 ONLY	TOTAL PLACES
1	BENDOCK	0	2	2
2	BOMBALA	31	10	41

3	COBARGO	19	12	31
4	COOMA	91	23	114
5	NAROOMA	89	2	91
	TOTAL PLACES	**230**	**49**	**279**
	MEAN/SHEET	**46.0**	**9.8**	**55.8**
	% 0F PLACES	**82.4%**	**17.6%**	

SHEETS WITH NO PLACES	**0**
% SHEETS WITH NO PLACES	**0.0%**
SHEETS WITH < 5 PLACES	**1**
% SHEETS WITH < 5 PLACES	**20.0%**

ALL FOUR REGIONS		**PLACES NOT C1 ONLY**	**PLACES C1 ONLY**	**TOTAL PLACES**
	TOTAL PLACES	**1314**	**432**	**1746**
94	**MEAN/SHEET**	**14.0**	**4.6**	**18.6**
	% 0F PLACES	**75.3%**	**24.7%**	

SHEETS WITH NO PLACES	**12**
% SHEETS WITH NO PLACES	**12.8%**
SHEETS WITH < 5 PLACES	**28**
% SHEETS WITH < 5 PLACES	**29.8%**

APPENDIX C ANALYSIS OF PLACES BY TYPE

APPENDIX C

GEOHERITAGE PLACES BY TYPE

PLACE TYPE	REGION UNE	LNE	SOUTH	EDEN	TOTAL PLACES	ESTIMATED COVERAGE
NAROOMA TERRAINE						
Stratigraphy	X	X	X	X	0	NIL
Palaeontology	X	X	1	X	1	POOR
Dykes	X	X	10	X	10	GOOD
Basalts	X	X	2	X	2	FAIR
Spring	X	X	1	X	1	FAIR
Coarse-Grained Pegmatites	X	X	1	X	1	FAIR
ORDOVICIAN FLYSCH						
Sedimentology/Stratigraphy	X	X	39	2	42	FAIR
Type Localities/Sections	X	X	12	0	12	POOR
Tuff	X	X	1	0	1	FAIR
Ordovician Lavas/Breccias	X	X	2	0	2	FAIR
Trachyte Dykes	X	X	1	0	1	FAIR
Contact	X	X	1	0	1	FAIR
REGIONAL METAMORPHISM						
Wongwibinda Metamorphic Complex	0	X	X	X	0	NIL
Manning Group Metamorphism	X	3	X	X	3	POOR
Cooma Metamorphic Complex	X	X	41	0	41	V GOOD
Cambalong Complex	X	X	3	X	3	POOR
Jerangle Metamorphic Complex	X	X	X	0	0	NIL
Wagga Wagga Metamorphic Complex	X	X	0	X	0	NIL
SILURIAN & DEVONIAN VOLCANICS & SEDIMENTS						
Type Localities/Sections	0	15	70	3	88	GOOD
Dykes	0	0	2	1	3	POOR
Tuff/Volcanic Ash	0	0	10	5	15	FAIR
Breccia	0	0	7	1	8	FAIR
Conglomerate	0	0	1	2	3	FAIR
Rhyolite	0	0	2	3	5	FAIR
Limestone	0	0	33	0	33	GOOD
Marble	0	0	3	0	3	FAIR
Flysch	0	0	0	1	1	POOR
Jasper	1	0	0	0	1	POOR
Tholeiites	0	0	0	1	1	POOR
Columnar Concretion in Ignimbrite	0	0	0	1	1	POOR
Stratigraphic	0	0	19	0	19	POOR
Sedimentology	0	0	11	0	11	POOR
Acid Volcanic Mineralisation	0	0	2	0	2	POOR
Yass Porphyry	X	X	2	X	2	POOR
Dacite/Rhyodacite	0	0	6	0	6	POOR

Squamiform Flute Casts	0	0	1	0	1	POOR
Gorge	0	0	1	0	1	POOR
Volcanic Neck/Lava Flow	0	0	2	0	2	POOR
Volcaniclastics	0	0	5	0	5	POOR
Reticulate Cleavage	0	0	1	0	1	POOR
CARBONIFEROUS & PERMIAN VOLCANICS & SEDIMENTS						
Truncations	3	0	X	X	3	V POOR
Wavy Bedding	3	0	X	X	3	V POOR
Tuff	1	2	X	X	3	V POOR
Epithermal Mineralisation	14	0	X	X	14	FAIR
Megacryst-bearing Lavas	0	1	X	X	1	FAIR
Stratigraphy	0	2	X	X	2	V POOR
Rhyolite	0	2	X	X	2	V POOR
Toscanite	0	2	X	X	2	V POOR
Alunite	0	1	X	X	1	V POOR
Tachylite	0	1	X	X	1	V POOR
Pillow Basalts	0	1	X	X	1	V POOR
Type localities/Sediments	0	52	X	X	52	FAIR (UNE, NILL)
Radiometric Dating Site	0	1	X	X	1	POOR
Dykes	0	0	1	X	0	NIL
Evidence for glaciation	0	4	X	X	4	FAIR
OCEANIC LITHOSPHERE/SERPENTINITES						
Gordonbrook Serpentinite Belt	0	X	X	X	0	NIL
Weraerai Terrane	X	1	X	X	1	POOR
Great Serpentine Belt	0	6	X	X	6	FAIR
Eucrite gabbro	0	1	0	0	1	FAIR
Eclogite Inclusions	0	1	0	0	1	POOR
Dismembered Ophiolite Suite	0	8	0	0	8	FAIR
Nephrite (Jade)	0	2	0	0	2	POOR
Kiandra Beds	X	X	0	X	0	NIL
Coolac Serpentine Belt	X	X	1	X	1	POOR
Honeysuckle Beds	X	X	0	X	0	NIL
Tumut Ponds Serpentinite	X	X	0	X	0	NIL
Geochemical Study Site	0	0	3	0	3	POOR
GRANITES						
Type Localities	0	0	76	50	126	GOOD (NIL NE)
Geochemical Sample Sites	0	1	28	0	29	POOR
Typical Exposures/Outcrop	0	1	25	1	27	POOR
Dating	0	2	0	0	2	POOR
Stratigraphy	0	0	2	0	2	POOR
GRANITIC LANDFORMS						
Tors	0	0	0	0	0	NIL
Taffoni	0	0	0	0	0	NIL
Granite Caves	0	1	0	0	1	V POOR

Waterfalls	2	2	0	0	4	POOR
Metamorphic/Igneous Intrusives	4	0	11	0	15	FAIR
Granitic Dome	0	3	0	0	3	FAIR
Dykes	0	1	4	0	5	POOR
Residual Hills & Razorback/Strike Ridge	0	1	0	0	1	POOR
Active Landslide	0	1	0	0	1	POOR
Granite Porphyry	0	0	1	0	1	POOR
Rift & Grain	0	0	1	0	1	POOR
Granite Hill	0	0	1	0	1	POOR
Granite Knob	0	0	1	0	1	POOR
CONTACT METAMORPHISM						
Torrington Pendant	0	X	X	X	0	NIL
Skarn Mineralisation	0	3	3	0	6	FAIR
Thermal Highs	14	3	0	0	17	FAIR
Nepheline Hawaiite	0	1	0	0	1	POOR
Calcium Borosilicate Mineralisation	0	1	0	0	1	POOR
Quartz Porphyries	0	1	1	0	2	POOR
Deformed Phyllites	0	1	0	0	1	POOR
Contact Aureole	0	1	0	0	1	POOR
Sedimentary/Igneous Contact	0	1	0	1*?	2	POOR
Quartz Veining	0	0	0	2	2	POOR
Metamorphic Core Complex	0	0	2	0	2	POOR
Pelitic, Psammitic & Calcareous Sediments	0	0	1	0	1	POOR
Cordierite-Hornfels	0	0	1	0	1	POOR
Metamorphic Axinite Paragenesis	0	0	1	0	1	POOR
	* = Mt. Wog Wog Site					
ORE MINERAL DEPOSITS						
Gold	15	0	24	2	41	FAIR
Silver	14	0	2	0	16	POOR
Graphite	1	0	0	0	1	POOR
Coal	2	0	1	0	3	POOR
Bauxite	1	0	3	0	4	POOR
Tin	2	0	1	0	3	POOR
Bismuth in Pipes	1	0	0	0	1	POOR
Molybdenite in Pipes	1	0	0	0	1	POOR
Copper	0	1	3	0	4	POOR
Tungston	0	1	3	0	4	POOR
Turquoise	0	0	4	0	4	POOR
Lead	0	0	3	0	3	POOR
Zinc	0	0	3	0	3	POOR
Diamantiferous Deposit/Eclogite	0	0	3	0	3	POOR
Platinum	0	0	1	0	1	POOR
STRUCTURES & STRUCTURAL LANDFORMS						
Faults	0	0	12	1	13	POOR
Sediment Deposits on Faults	0	0	4	0	4	POOR
Horsts	0	0	0	0	0	NIL

Grabens	0	0	0	0	0	NIL
Synclines	0	0	0	0	0	NIL
Anticlines	0	2	1	0	3	POOR
Folding	1	5	15	15	36	FAIR
Cuestas	0	1	0	0	1	V POOR
Unconformities	0	4	6	3	13	FAIR
Gundahl Complex Structural Features	7	X	X	X	7	FAIR
Crossbedding	0	0	0	1	1	V POOR
High-Strain Zones	0	0	1	0	1	V POOR
Fracturing & Shearing	0	0	2	0	2	V POOR
Jointing	0	0	1	0	1	V POOR
PALAEONTOLOGY						
Palaeozoic Plant	0	16	1	2	19	FAIR
Mesozoic Plant	4	0	0	0	4	POOR
Cainozoic Plant	7	1	9	0	17	FAIR
Cainozoic Invertebrate	1	2	1	0	4	POOR
Deep Lead Fossil Deposits	0	0	0	0	0	NIL
Palaeozoic Invertebrate	1*	36	97	4	138	FAIR
Fish	0	2	2	6	10	FAIR
Tetrapod Vertebrate	1	5	25	1	32	GOOD
Shells from kitchen middens/Shell Heaps	3	0	1	1	5	POOR
Diatomaceous Earth Deposits	1	0	0	0	1	POOR

* = Ingalbar Creek Limestone (Invertebrate Fossil)

SYDNEY BASIN						
Sedimentology	X	8	9	X	17	POOR
Glendonites	X	3	4	X	7	EXCELLENT
Seepage Minerals	X	1	0	X	1	POOR
Burning Coal Seam	X	1	0	X	1	COMPLETE
Buchite	X	2	0	X	1	COMPLETE
Diatreme	X	1	0	X	1	POOR
Stratigraphic Type Section	X	1	3*+	X	4	POOR
Torbanite	X	1	0	X	1	POOR
Basic Sills	X	3	0	X	3	POOR
Basalts	X	0	11	X	11	FAIR
Dolerite	X	1	3	X	4	POOR
Diorite	X	0	2	X	2	POOR
Sodalite-Bearing Aphanite	X	0	1	X	1	POOR
Conglomerate	X	0	3	X	3	POOR
Coal Seams	X	0	1	X	1	POOR

* = Pigeon House Creek Siltstone

+ = Yadboro Conglomerate

SYDNEY BASIN PLATEAU LANDFORMS						
Cliffs	X	0	O	X	0	NIL
Dykes	X	1	11	X	12	POOR
Mesas	X	0	2	X	2	V POOR
Solitary Rocks	X	0	0	X	0	NIL

Hanging Swamps	X	1	1	X	1	V POOR
Waterfalls	X	0	0	X	0	NIL
Canyons	X	0	0	X	0	NIL
Sandstone Caves	X	0	0	X	0	NIL
Solutional Landforms	X	0	0	X	0	NIL
Tesselated Pavements	X	5	0	X	5	GOOD
Basalt Caps	X	10	0	X	10	FAIR
Volcanic Necks/Basalt Plugs	X	2	0	X	2	POOR
Cave Shelters	X	1	0	X	1	V POOR
LORNE BASIN						
Sedimentation & Stratigraphy	X	0	X	X	0	NIL
Fossils	X	0	X	X	0	NIL
Landforms	X	0	X	X	0	NIL
Soils	X	0	X	X	0	NIL
CLARENCE-MORTON BASIN						
Sedimentology	4	X	X	X	4	V POOR
Volcanic Feature	1	X	X	X	1	V POOR
Sandstone Landforms	2	X	X	X	2	V POOR
Cainozoic Sediments	3	X	X	X	3	V POOR
MESOZOIC IGNEOUS ACTIVITY						
Type Localities/Sections	0	0	1	2	3	FAIR
Dykes	0	0	0	1	1	POOR
Diatremes	0	0	1	0	1	POOR
Lamprophyres	0	0	2	0	2	POOR
Milton Monzonite Complex	X	X	7	0	7	GOOD
Mount Dromedary Monzonite Complex	X	X	7	0	7	GOOD
Myalla Road Syenite Complex	X	X	1	0	1	GOOD
Wog Wog Complex	X	X	X	1	1	GOOD
Volcanic Necks/Plugs	0	7	3	0	10	FAIR
Pyro-Intrusive Veins	0	1	1	0	2	FAIR
HIGHLANDS						
Stratigraphic Type Section	0	0	1	0	1	V POOR
Tertiary Volcanic Landforms	1*	2	4	0	7	V POOR
Tertiary Basalts (incl. Type Sections)	0	0	17	0	17	POOR
Tertiary Volcanic Centres	0	1	0	0	1	V POOR
Tertiary Stratigraphy	1	0	4	0	5	POOR
Basic Intrusions	0	0	3	0	3	POOR
Lava Flow Geochemical Site	0	0	5	0	5	FAIR
Lavas overlying sediments	1	4	0	0	5	FAIR
Quaternary Stratigraphy	O	1	1	0	2	POOR
Highland Lakes	O	0	0	0	0	NIL
Peat Swamps & Bogs	O	0	0	0	0	NIL
Basalt Dating Site	2	1	0	0	3	POOR
Tertiary Sediments	0	0	1	0	1	V POOR
Quartzose Rocks/Quartzites	0	0	3	0	3	POOR

Wall Conglomerate	0	0	1	0	1	POOR
Sedimentology	0	0	1	0	1	POOR
Dolerite Intrusion	0	0	1	0	1	POOR
Dykes	0	0	3	0	3	POOR
Nepheline-Tinguaite	0	0	1	0	1	POOR
Geomorphic Features	0	0	1	0	1	V POOR
Metamorphic Intrusives	0	0	1	0	1	POOR
Monzonite	0	0	2	0	2	POOR
Basalt Covered Leads	0	0	1	0	1	POOR
* = Devils Chimney Breccia Pipe						
MONARO PLAIN						
Type Sections/Localities	X	X	3	0	3	FAIR
Volcanic Centre	X	X	0	5	5	GOOD
Tertiary Basalt Overlying Sediments/Lava FLows	X	X	2	7	9	GOOD
High Level Swamps/Wetlands	X	X	0	4	4	POOR
Lakes	X	X	0	5	5	FAIR
Tertiary (Plaeo) Lakes	0	0	1	0	1	FAIR
Sedimentology	X	X	4	4	8	FAIR
Soil Landscapes	X	X	0	1	1	POOR
Peat Bog	X	X	0	1	1	POOR
Plugs/Necks	X	X	8	1	9	GOOD
Dolerite Outcrop	X	X	4	0	4	FAIR
Mineral Spring	X	X	1	0	1	EXCELLENT
GLACIAL & PERIGLACIAL LANDFORMS						
Varved Sediments	X	X	0	X	0	NIL
Cirques	X	X	7	X	7	GOOD
Glacial Valleys	X	X	6	X	6	FAIR
Moraines	X	X	1	X	1	FAIR
Stratigraphy	X	X	0	X	1	FAIR
Glacial Erratics	X	X	5	X	5	FAIR
Glacial Lake	X	X	4	X	4	FAIR
Upland Swamps	X	X	5	X	5	POOR
TWEED VOLCANIC COMPLEX						
Shield Volcano	1	X	X	X	1	FAIR
LAMINGTON VOLCANIC SUITE						
Basalts	4	X	X	X	4	FAIR
Lava Vents	8	X	X	X	8	GOOD
Landforms	4	X	X	X	4	POOR
Waterfalls	1	X	X	X	1	POOR
Cliffs	2	X	X	X	2	POOR
Type Localities	9	X	X	X	9	GOOD
LIVERPOOL & MT ROYAL VOLCANIC RANGES						
Dating	X	0	X	X	0	NIL

Petrography & Geochemistry Locations	X	0	X	X	0	NIL
Vents	X	0	X	X	0	NIL
Zeolites	X	0	X	X	0	NIL
Boles	X	0	X	X	0	NIL
Cliffs	X	0	X	X	0	NIL
Salients	X	0	X	X	0	NIL
Waterfalls	X	1	X	X	0	NIL
Krasnozems	X	0	X	X	0	NIL
Black Earths	X	0	X	X	0	NIL
Basalts	X	1	X	X	1	
ESCARPMENT, ISOLATED PLATEAUS & INCISED ZONE						
Waterfalls	7	17	1	2	27	POOR
Cliffs	0	2	1	2	5	POOR
Gorges	3	1	4	0	8	POOR
Canyons	0	0	5	0	5	POOR
Rapids	0	3	0	0	3	POOR
Tertiary Volcanics/Basalts	4	5	3	0	12	FAIR
Tertiary Sediments	0	2	1	1	4	POOR
Plateaus	0	6	1	1	8	FAIR
Sedimentology/Stratigraphy	0	0	1	0	1	POOR
Palaeogeographical Features	0	0	2	0	2	POOR
KARST & SIMILAR						
Cavernous Karsts	0	27	44	1	72	GOOD
Non-Cavernous Karsts	0	2	1	0	3	FAIR
Non Limestone Caves/Cave Areas (non sea /Sydney Basin)	0	1	0	0	1	POOR
Deep Holes (not in limestone)	0	0	2	0	2	COMPLETE
Historic Lime Kiln	1	0	0	0	1	?
Bird Guano Deposit	0	0	1	0	1	?
COASTAL PLAIN						
Tertiary Sediments	3	0	1	9	13	GOOD
Tertiary Basalt	0	0	2	0	2	GOOD
Raised Beaches	1	6	0	0	7	GOOD
Wetlands/Swamps	37	15	0	4	56	FAIR
River Terraces	0	0	0	0	0	NIL
Tertiary Terrace Deposits	0	0	0	0	0	NIL
Oxbows	1	0	0	1	2	POOR
Meanders	0	0	0	0	0	NIL
Interbarrier Creeks	3	0	0	0	3	POOR
Badlands	X	X	X	1	1	FAIR
Lateritic Weathering/Soil	0	0	0	2	2	POOR
Alluvial Flat	0	0	0	1	1	V POOR
Silcrete, Ferricrete or Quartzite	0	0	6	0	6	NIL(EDEN OK)
COASTAL GEOMORPHOLOGY						
Spits	0	0	0	0	0	POOR

Sandy Beaches	3	1	2	1	7	POOR
Cobble Beaches	0	0	1	0	1	POOR
Boulder Beaches	0	1	0	0	1	POOR
Auriferous Beach Sands	3	0	0	0	3	POOR
Beach Ridges	0	0	0	0	0	POOR
Dunes	4	0	0	0	4	POOR
Dune Fields	0	0	0	0	0	POOR
Dune-Swamp Complexes	1	0	0	0	1	POOR
Lagoons/Coastal Lake	0	0	5	0	5	POOR
Headlands	7	5	22	2	36	FAIR
Rocky Coast	0	2	2	0	4	POOR
Geos	0	0	0	0	0	POOR
Sea Caves	0	1	2	18	21	POOR (EDEN GOOD)
Tied Island	0	1	0	0	1	POOR
Stratigraphic Complex	0	0	0	1	1	POOR
Ria Valleys	0	0	0	1	1	POOR
SOILS						
Soil reference sites	0	0	0	15	15	NIL (EDEN GOOD)

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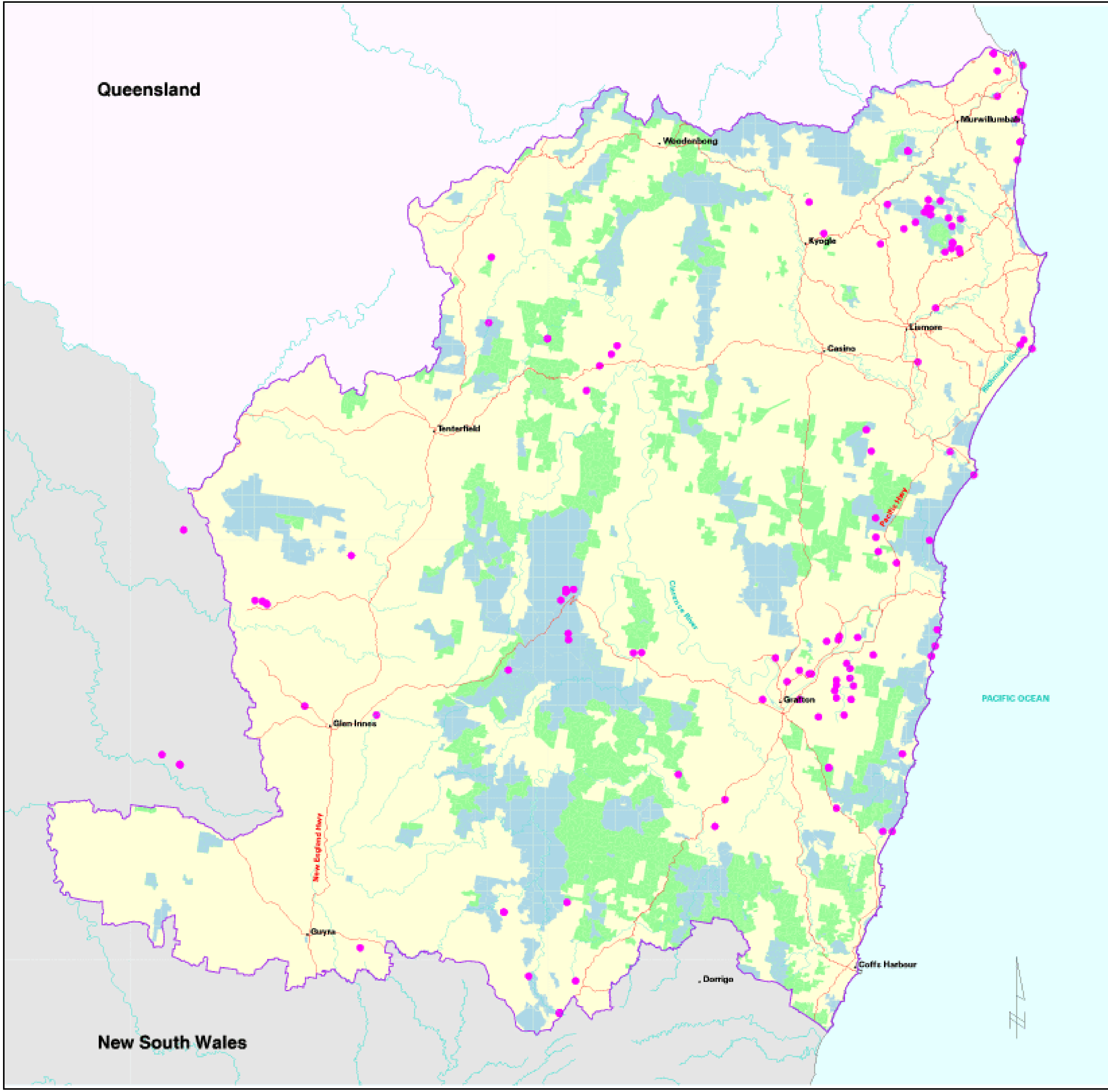

UPPER NORTH EAST

Comprehensive Regional Assessme

MAP 23

Areas Identified for Geoheritage Value

- Areas Identified for Geoheritage Value
- National Parks and Reserves
- State Forest
- RFA Boundary
- Rivers
- Roads

SOURCES:
NSW UNE CRA National Estate Assessments - Environment Australia
NSW UNE Regional Forest Agreement - Upper North East RFA Boundary - 1998
TOPO 250K - AUSLIG
Drainage and Roads - LIC
Places - AUSLIG

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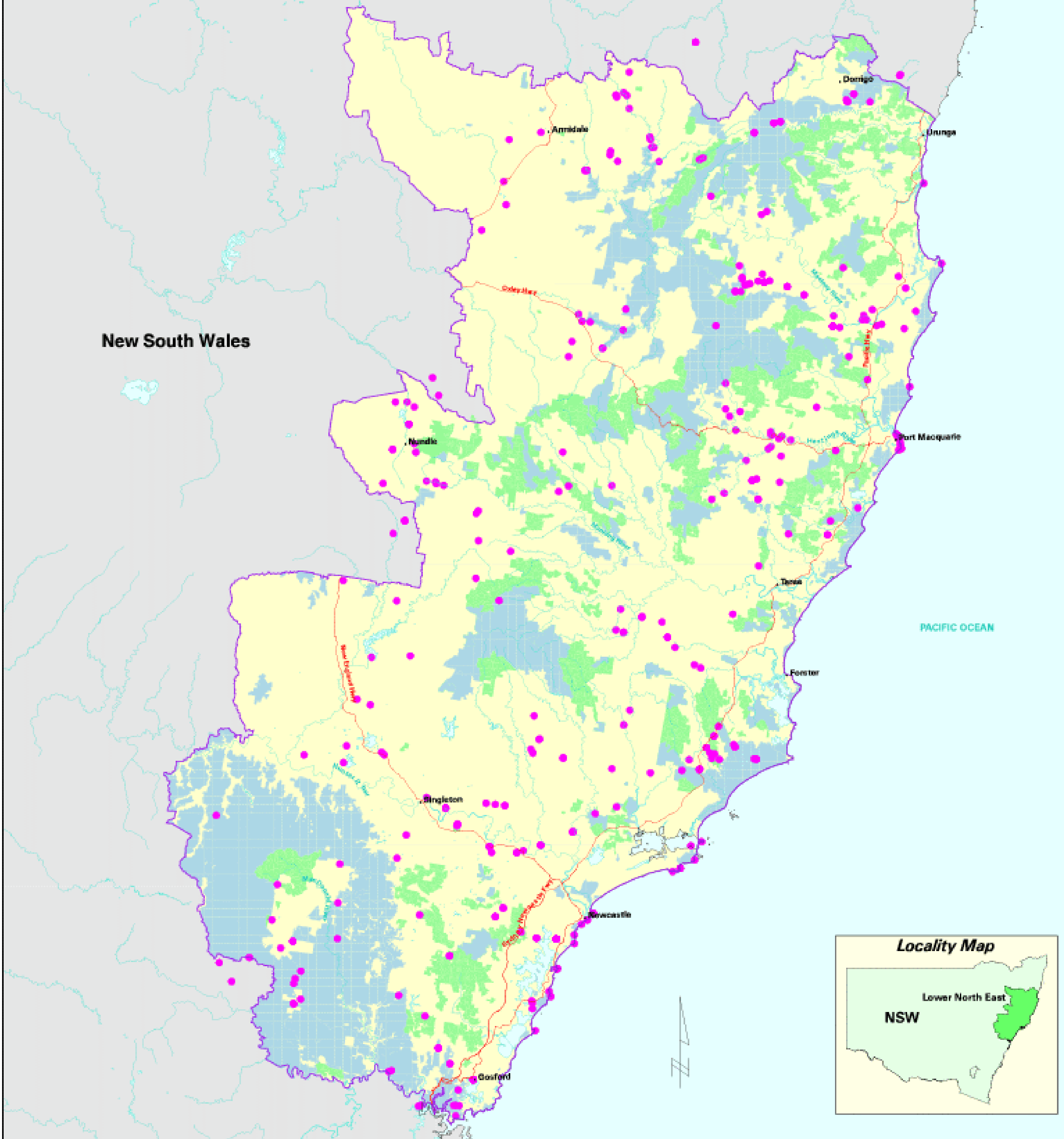
Environment Australia - Version: 22 June 1999
File Reference: ne_geoher

Locality Map

Scale 1:335000

5 0 5 10 15 20 25
Kilometres

Projection - AMG Zone 56



LOWER NORTH EAST
Comprehensive Regional Assessment

MAP 23
Areas Identified for Geoheritage Value

Areas Identified for Geoheritage Value

National Parks and Reserves

State Forest

RFA Boundary

Rivers

Roads

SOURCES:
NSW LNE CRA National Estate Assessments - Environment Australia
NSW LNE Regional Forest Agreement - LNE RFA Boundary - 1998
Drainage and Roads - LIC
Places - AUSLIG
TOPO 250K - AUSLIG

Produced by Environment Australia - Version: 22 June 1999
File Reference: geoher

5 0 5 10 15 20 25
kilometres

Scale 1:1300000
Projection - AMG Zone 56