

The Karst features of the SW Nullarbor – Mardabilla Plain & adjacent localities

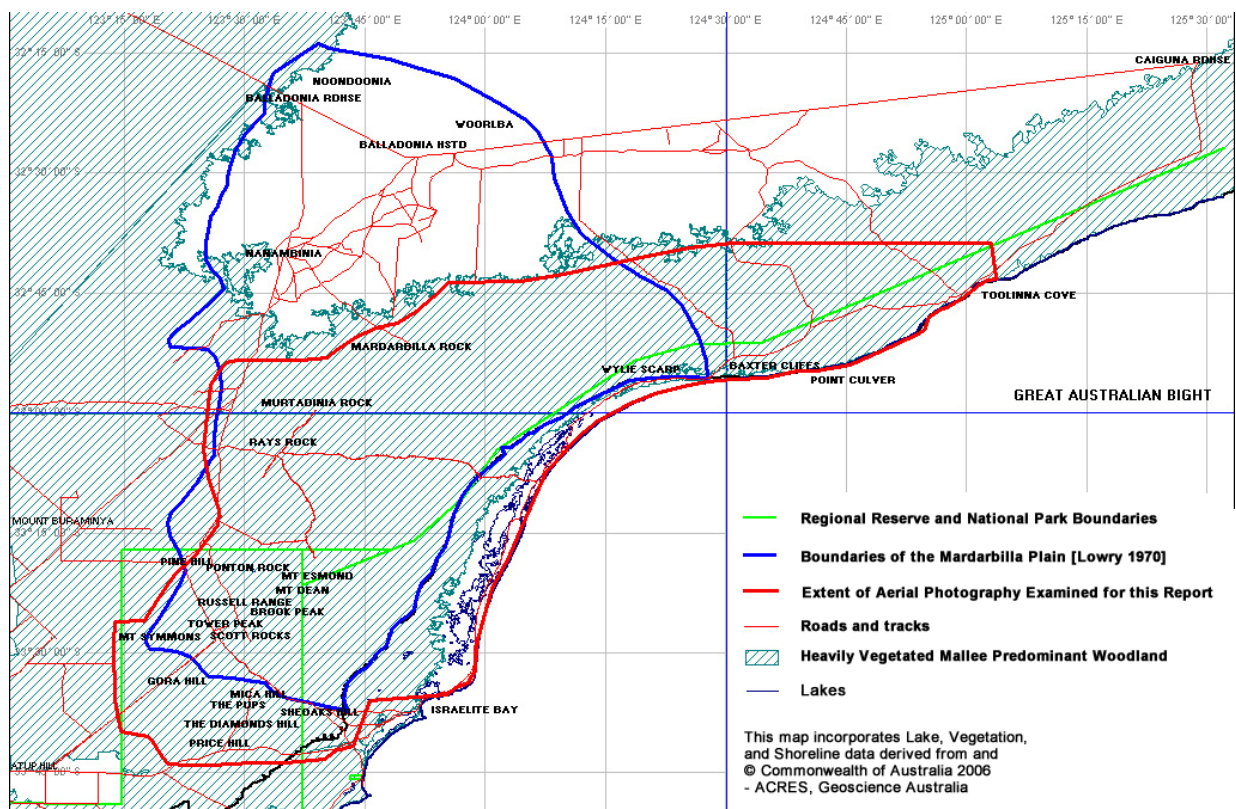
Paul Devine

Abstract

The Southwest portion of the Nullarbor is an area known as the Mardabilla Plain. The vegetated area consisting of the southern half of the Mardabilla Plain and an adjacent portion of the Hampton table land comprises an area of circa 7000km² and is typified by gently, undulating karst terrain, isolated outcrops of basement rock in the western half, but also by dense vegetation. As a result of the latter, it has received only limited karst exploration or documentation. Prior to 2005 only 50 features appear in records [KIDSA] for this area, and $\frac{1}{3}$ of these have never been visited on the ground. A far higher number of features for this area has been eluded by the previous work and discoveries of both David Lowry and Joe Jennings. By using remote sensing it has been possible to locate a very large number of new karst features. A systematic stereoscopic study of the area was completed using modern aerial photography. This was then compared on Google Earth imagery. As a result over 1000 new defined karst features have been located. These new features consist of collapse and erosion dolines, with a smaller number likely to access shallow caves.

Introduction

The Southwest Portion of the Nullarbor is named the Mardabilla Plain [Lowry 1970] after Mardabilla Rock. The area detailed in this report circa 7000 km²



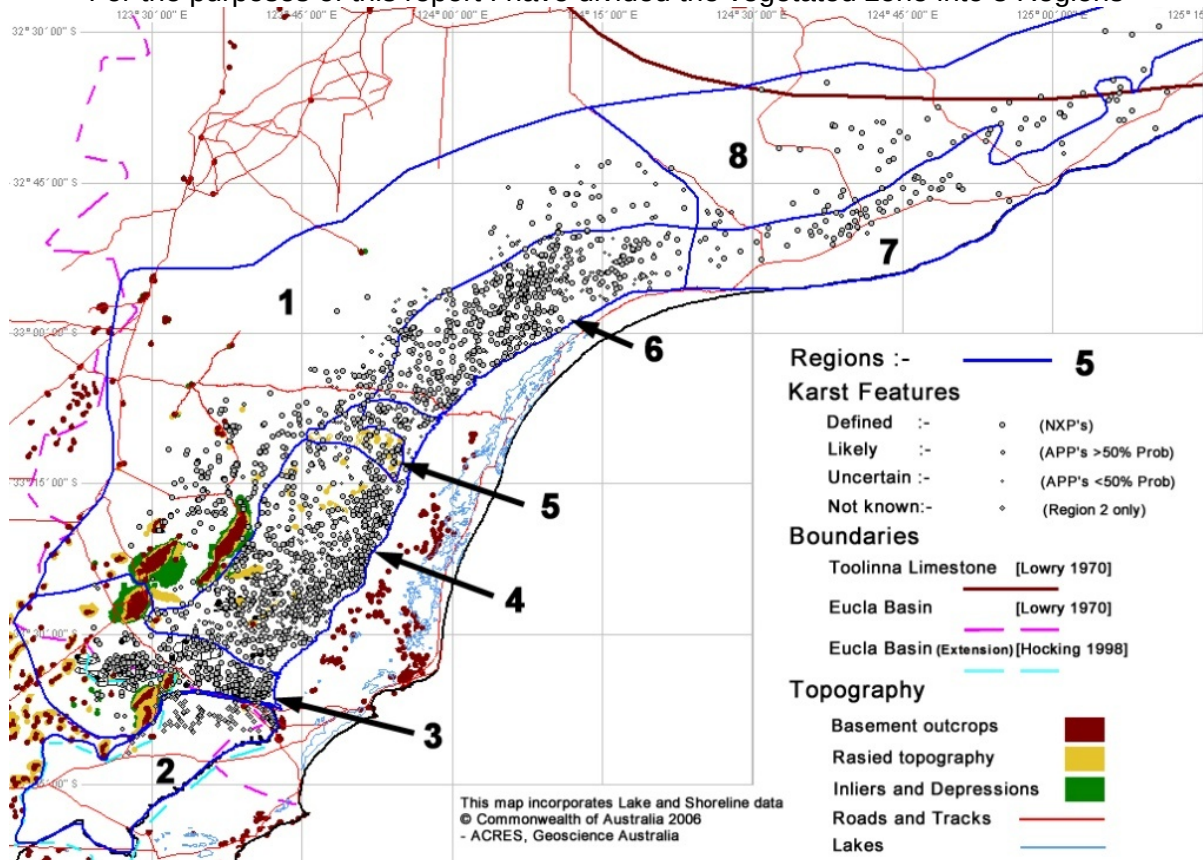
(Figure 1) comprises of the vegetated zones to the East and South of Mardabilla Rock lying principally in the southern portion of the Mardabilla Plain. It overlaps three 250 thou map sheets, the SW portion of the Culver SI51-04 map sheet, the southern portion of the Balladonia SI51-03 map sheet and the Malcolm map sheet SI51-07. By systematically searching this area stereoscopically using Air Photos, I have located an extensive number of new Karst features referred to herein collectively as MPF's - Mardabilla Plain Features, and identified individually as NXP Numbers or APP (Air Photo Point) Numbers.

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Regional Setting

For the purposes of this report I have divided the vegetated zone into 8 Regions



(Figure 2) which are defined by surface topography, feature type and occurrence.

The setting for the MPF's is they lie within the area formed principally of Toolinna limestone [Lowry 1970]. This area is bounded along its southern margin in the east by the Baxter Cliffs, the Wylie Scarp in the SE and Precambrian basement in the West and SW. The general height of the Plain in this region is between 60m adjacent to the Baxter Cliffs in the east and increasing in height to around 150m in the West and SW.

There is also a corresponding increase in outcropping bedrock strata in the southern and western parts. This increase in bedrock outcropping is also shown clearly on the wave cut platform of the Israelite Plain.

The bedrock outcrops that break the surface of the Mardabilla Plain lie chiefly within Region 1 the western portion, and are described [Doepel 1969] as being principally two types. NNE trending Metasediments, that form the prominent peaks of the Mt Ragged/Russell Range and Brook Peak/Mt Esmond range, along with the lower Hills forming the Mica to Price Hill group.



(Figure 3)

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The second type composed of granite & gneiss forms the more numerous but subdued relief outcrops. Examples include Rays, Ponton, Scott, Murtadinia, and Mardabilla Rocks to name a few.

Mardabilla Rock and shallow moat



The elevated ranges and to a lesser extent a number of the granitic outcrops have depressions or “moats” surrounding their base. The bases of these moats are generally 6-10m lower than the surrounding plain [Lowry 1970]. Region 1 is typified by a thicker layer of calcareous soil cover. Lineation in vegetation is not reflected in surface relief. Surface relief is typically flat with only minor undulations in areas away from inliers and outcrops, and a scattering of more widely dispersed shallow flats.

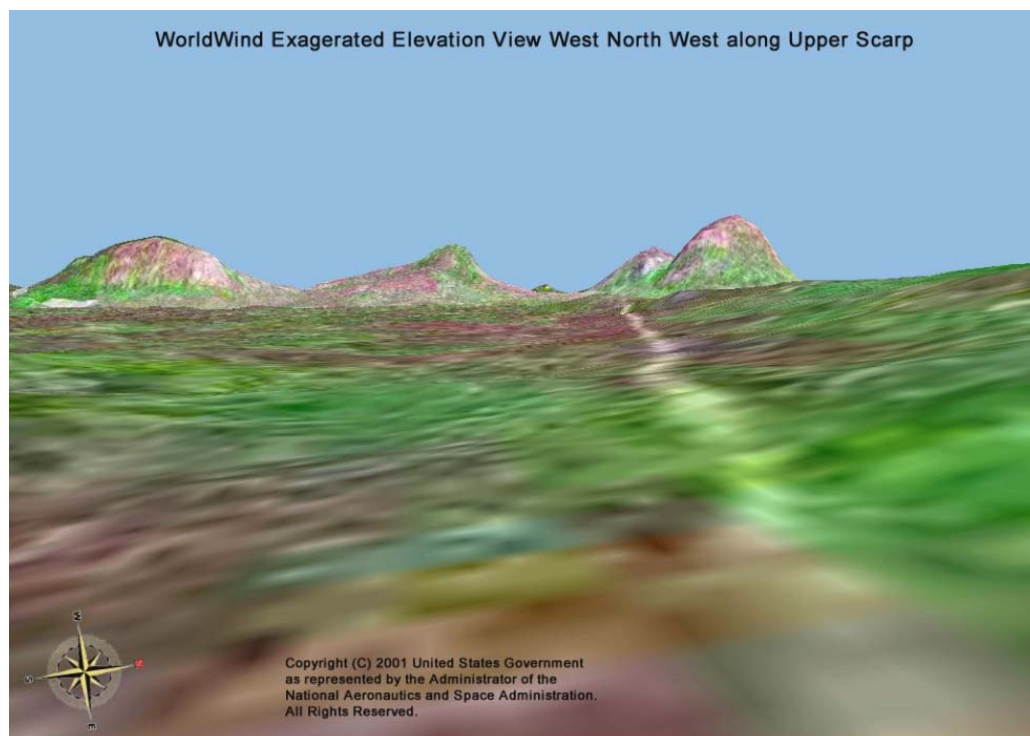
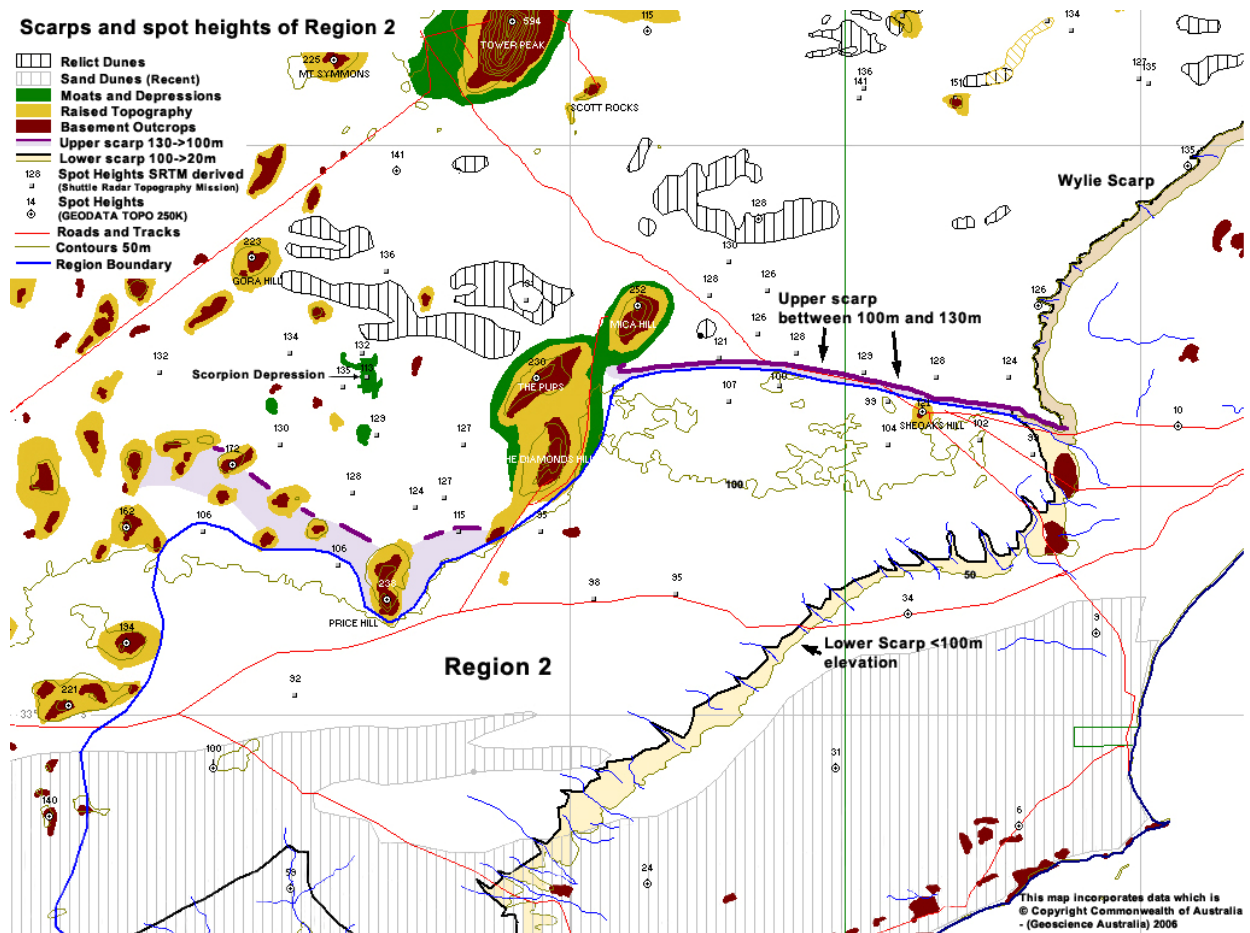
To the SE of Mica Hill is an area mostly excised by Lowry [Lowry 1970] but now included as part of the Eucla Basin [Hocking 1994]. This area - Region 2 is bound by two identifiable scarps.

The lower is the southern end, and more indistinct extension of the Wylie Scarp [Lowry 1970], being formed by the sea level incursion which created the Israelite plain. This lower portion of the Wylie Scarp starts to the SE of Sheoaks Hill and it has a maximum height less than 100m. Compared to the main portion of the higher >125m elevation section of the Wylie Scarp to the north, this southern portion has a more rounded, deeply incised form reflecting a loss or reduction of the near surface indurated layer present on the Mardabilla Plain.

The second scarp is a low perpendicular scarp running WNW toward Mica Hill from the southern end of the higher portion of the Wylie scarp near Sheoaks Hill. The Mardabilla Plain ends at the top of this upper scarp where there is a drop in elevation of around 25m. The drop in elevation trends Southwest along the base of the Mica to Price Hill outcrops, then it trends WNW again becoming irregular and ill-defined in amongst more numerous bedrock outcroppings on the Eastern side of Balladonia Road. This higher scarp near Sheoaks hill is suggested to represent the northward limit of an incursion of a higher sea level at around 15-20m below the level of the Mardabilla plain. This is at a height above current sea level of approx 110-105m in this area. The area to the south of this higher scarp is uniformly undulating at an average close to 95m in elevation.

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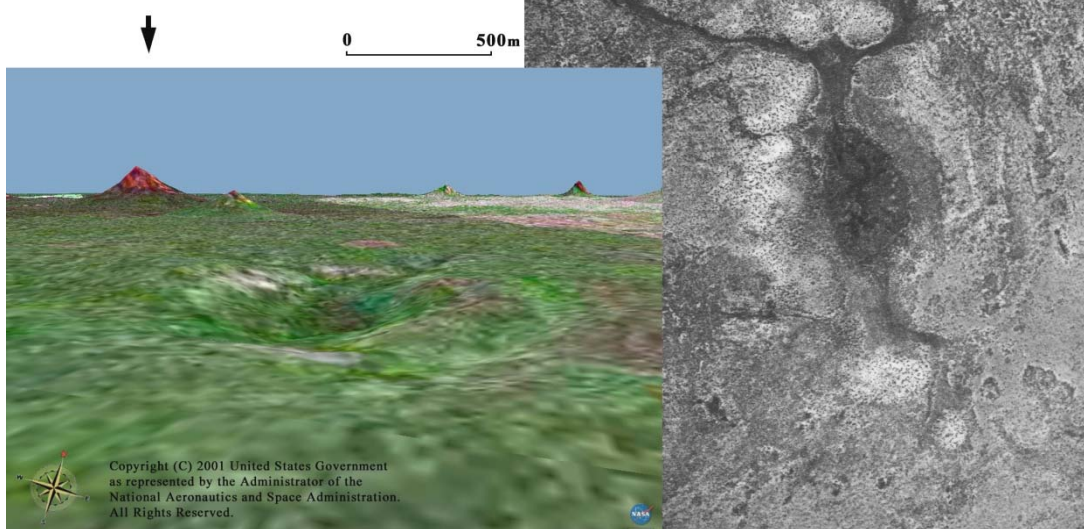
The area immediately to the north of this low E-W scarp in Region 3, shows an irregular surface, limited visual jointing control, and large areas of remnant dunes that appear mostly weathered and not well defined at ground level. In the western part there are at least two large enclosed depressions which drop more than 15m below the level of the Plain. The larger scorpion like shaped depression is 1400x750m and between 20-25m deep.

Scorpion Depression

Air photo view

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Exaggerated Elevation
WorldWind View



Prominent Lineation of Surface Corridor Relief in Region 4 (as exposed in fire scars)



To the east of Mt Dean in Region 4, the Plain shows prominent parallel joint controlled shallow corridors.

These corridors are separated by low rises differing in elevation by only 3m increasing to approx 6m in the numerous shallow flats that are generally oriented but not limited to the corridor structures. Lineated corridors become less defined in the north of Region 4 but lineation is still strongly expressed in vegetation. Region 4 has a uniform structure expressed in its surface excepting isolated limestone knolls that protrude up from the surface in the region of 10-20m. A number of these knolls are tentatively suggested to define close to surface rises in bedrock strata that do not outcrop.

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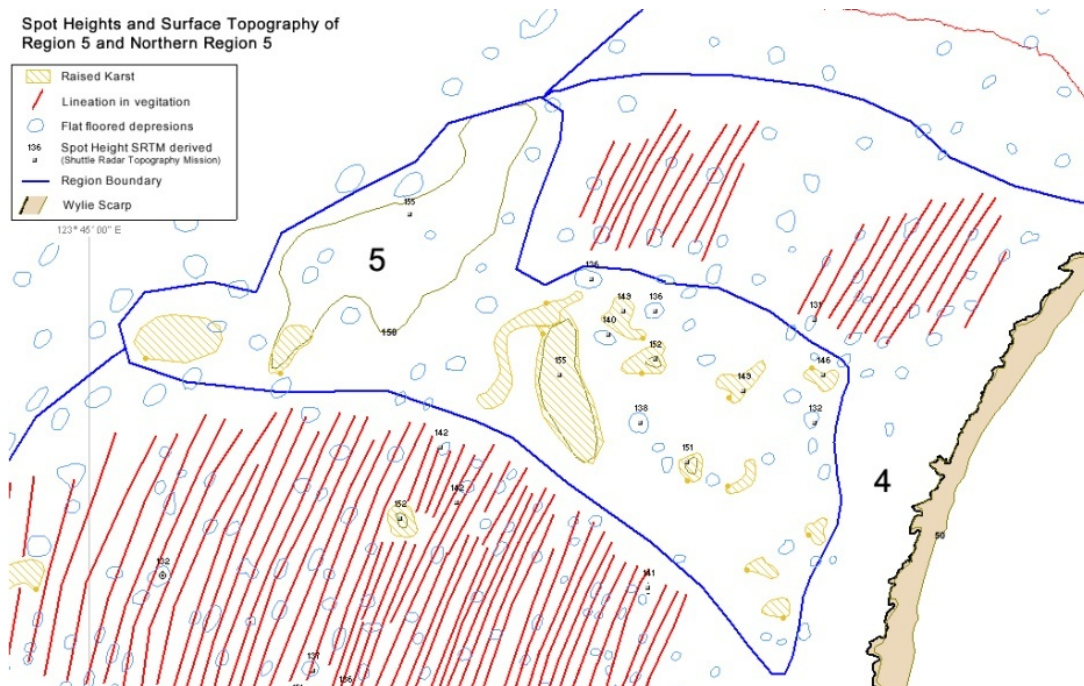
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Crest of Wylie Scarp at north end of Region 4



The scarp to the east shows a structure of a hard surface cap overlying layers of friable weathered limestone.

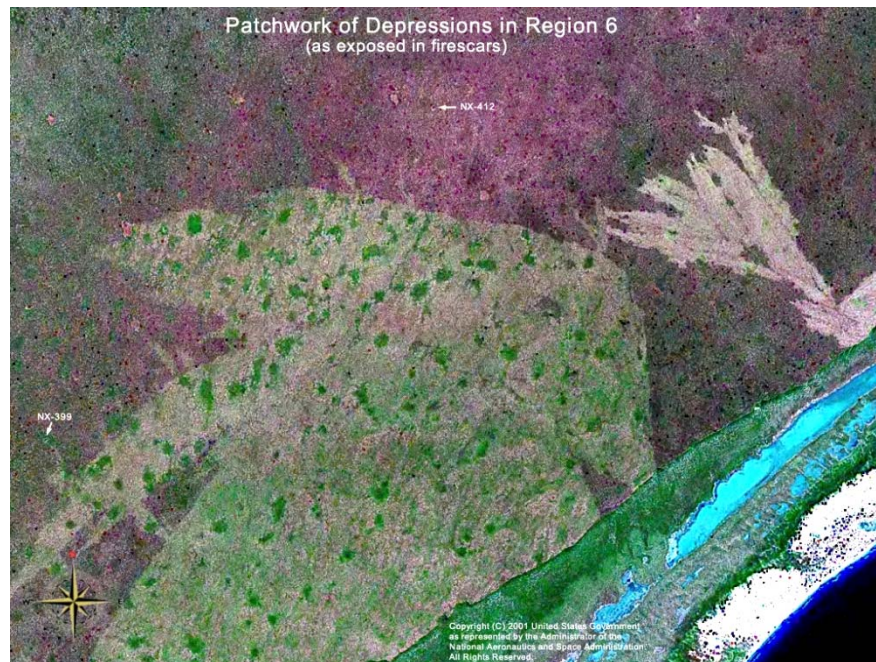
At a Point approx 45 km to the north of Sheoaks hill in Region 5, the level of the plain rises by approx 10m and the strongly lineated surface evident to the south disappears replaced with a more random patchwork of depressions surrounded by higher ground



The difference in elevation between the depressions and the rises increases to 10-16m.

The area adjacent to the Wylie scarp the SE of Mardabilla Rock in Region 6, has an undulating terrain between a more random patchwork of large rounded donga like depressions

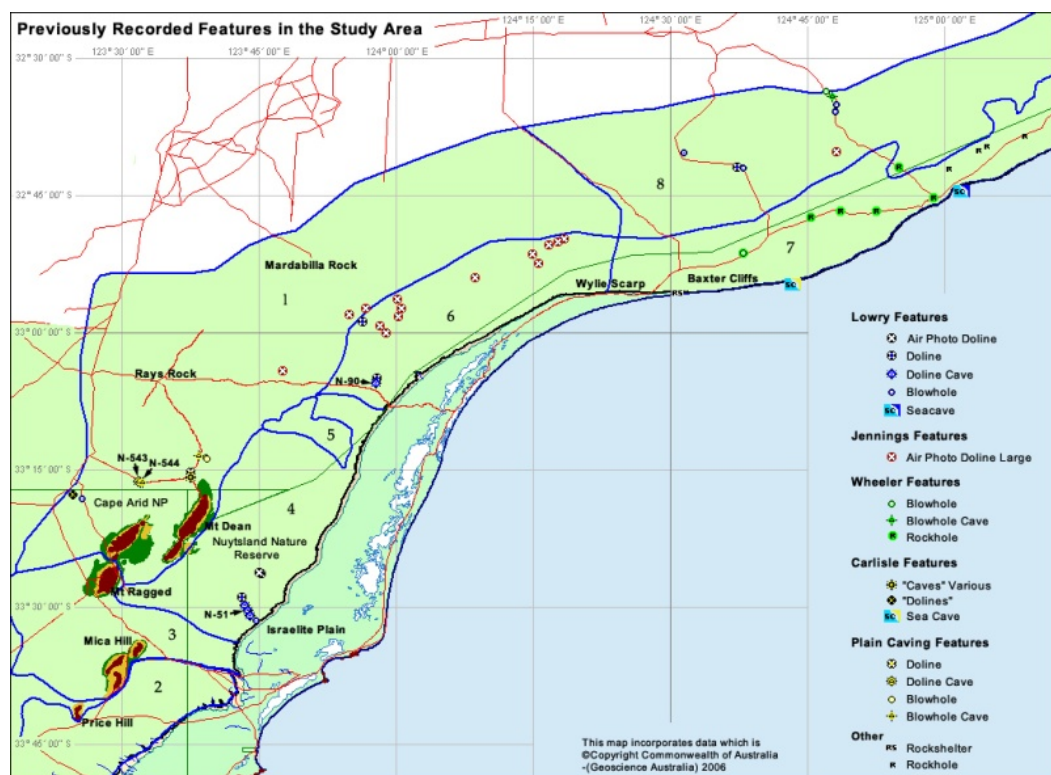
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(Figure 11). Surface lineation is more subdued and for the most part is not expressed in surface relief. Further east in Region 7 toward the Baxter cliffs and beyond there is an increase in near coast sand dunes, and a change to an eroded more exposed karst surface along with a reduction in elevation close to the coast. This more exposed karst consists of a patchwork of limestone ridges and flats with lineal joint control. Both Regions 7 & 8 lie outside the Mardabilla plain. The less eroded karst further from the coast Region 8 is similar to the NE of region 1, having an increased surface soil cover than the coastal regions and an a patchwork of shallow bare flats.

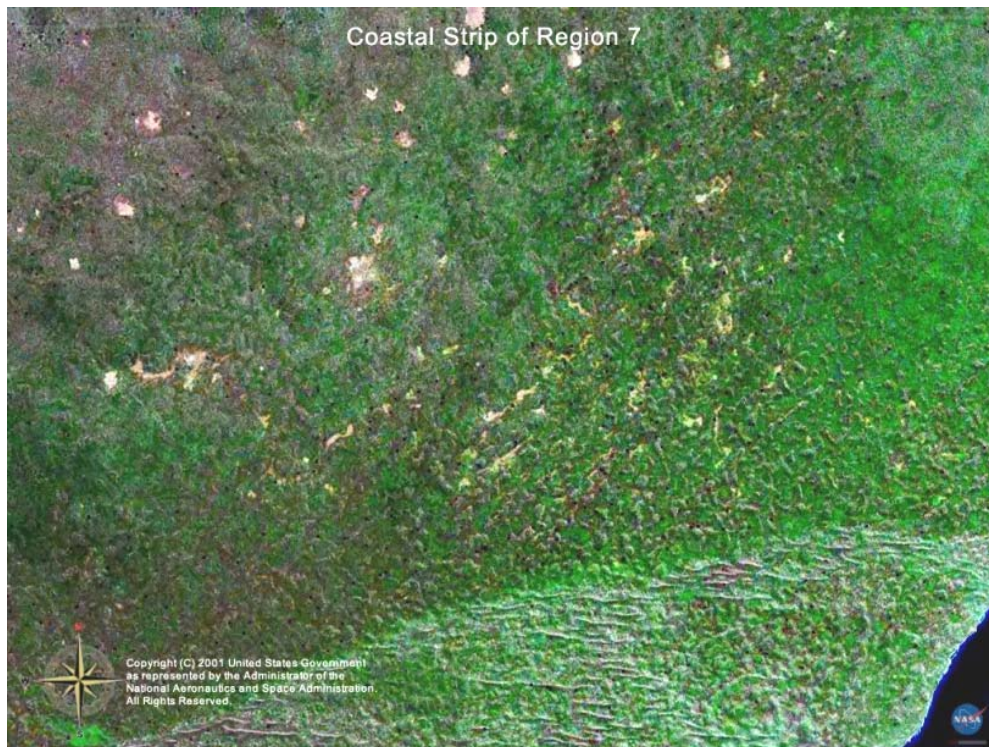
Previous Features

In the area studied there are roughly 65 historical and described karst features (this does not include 8 records mostly of rockholes occurring in granite).



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David Lowry recorded 13 features:- Gecko Cave - N-51^{ABC} that has an approximate 13m of passage, 5 other dolines^{BC}, 3 with shallow caves to approx 10m N-86, N-87, N-90, 2 without caves^{BC} N-88, N-89 he also recorded 5 blowholes^C N-318, NX-749, NX-750, NX-759, NX-760. He also mentions a number of other features were visited in the area, most of these were evidently not described. He did however, describe one doline Lowry Point-87^B, in the vicinity of NX-402, and he also circled 2 features on 1960 photography^B, these correspond to NXP-1005 and APP-A6/5177-02.

Joe Jennings whilst examining 1960 series air photos noted 17 features^C. They are NX-396 – NX-412. To date it appears none of these features have been visited.

Harry Wheeler recorded 11 features^C:- 4 blowholes including one cave, one doline with holes and 6 rockholes N-1149 to N-1152 and N-1155.

John Carlisle eludes to a number of features^C, one is NX-223 a sea cave. He mentions (NX-186^C) there are dolines in country east of road between Juranda RH and Pine Hill, and he also mentions (NX-282^C) that a number of caves exist in the vicinity near Kangawarie Rockhole. These are likely to also be included in around 8 features visited by members of Plane Caving^D in the mid 1990's in this locality. Three of these features include N-543, to N-545 and access the longest recorded caves in the entire search area of this report at 35, 120, and 30m respectively^C.

One feature NX-374, a rock shelter in the Wylie Scarp is noted by Alex Baynes^{CE}.

A far higher number of features should exist in this area as indicated by the number of features located on the traverses completed by David Lowry.

The existence of these karst features is noted in statements David Lowry makes:- "East of Mt Ragged the surface of the plateau is broken by numerous craters 5 to 20 feet deep. Caused by the collapse of kankar crust into shallow caves." [Lowry 1970] and also "The air photos* indicate scores of other shallow dolines in the vicinity (of Gecko Cave) distributed along joints trending in a NE direction" [Lowry 1966].

**1960's Malcolm SI51-07 Aerial photography was 1:50000 scale, Balladonia along with the rest of the Nullarbor was a much lower resolution 1:83000 scale.*

Data reference: ^A [Lowry 1966], ^B [Lowry 1964], ^C [KIDSA 2006], ^D [Norton 2004], ^E [Baynes 1987].

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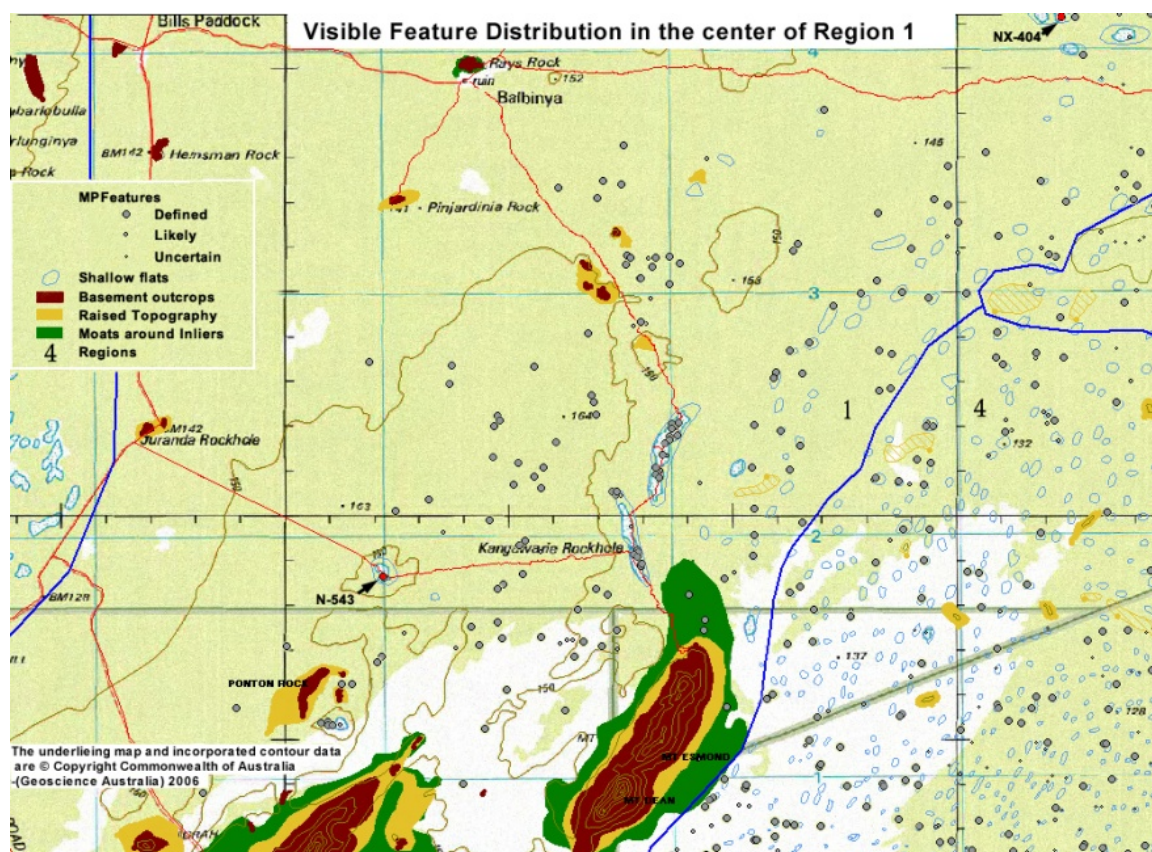
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Methods

I made a detailed examination of the region using 1:50000 1990 series Black & White aerial photography, and followed this up by a further re-examination and recording of accurate positions for new MPF's by using Mosaiced & ortho-rectified SkyView imagery [LANDGATE 2003] along with Google Earth as hi resolution cover became available.

MPF Features

To date I have located roughly 1600 more clearly defined MP features along with around 1000 spurious possibilities APP's (Air Photo Points). The majority of the visible MPF's are more concentrated in the more eroded areas adjacent to the Scarp where jointing is most prominent and the karst surface is more relict.

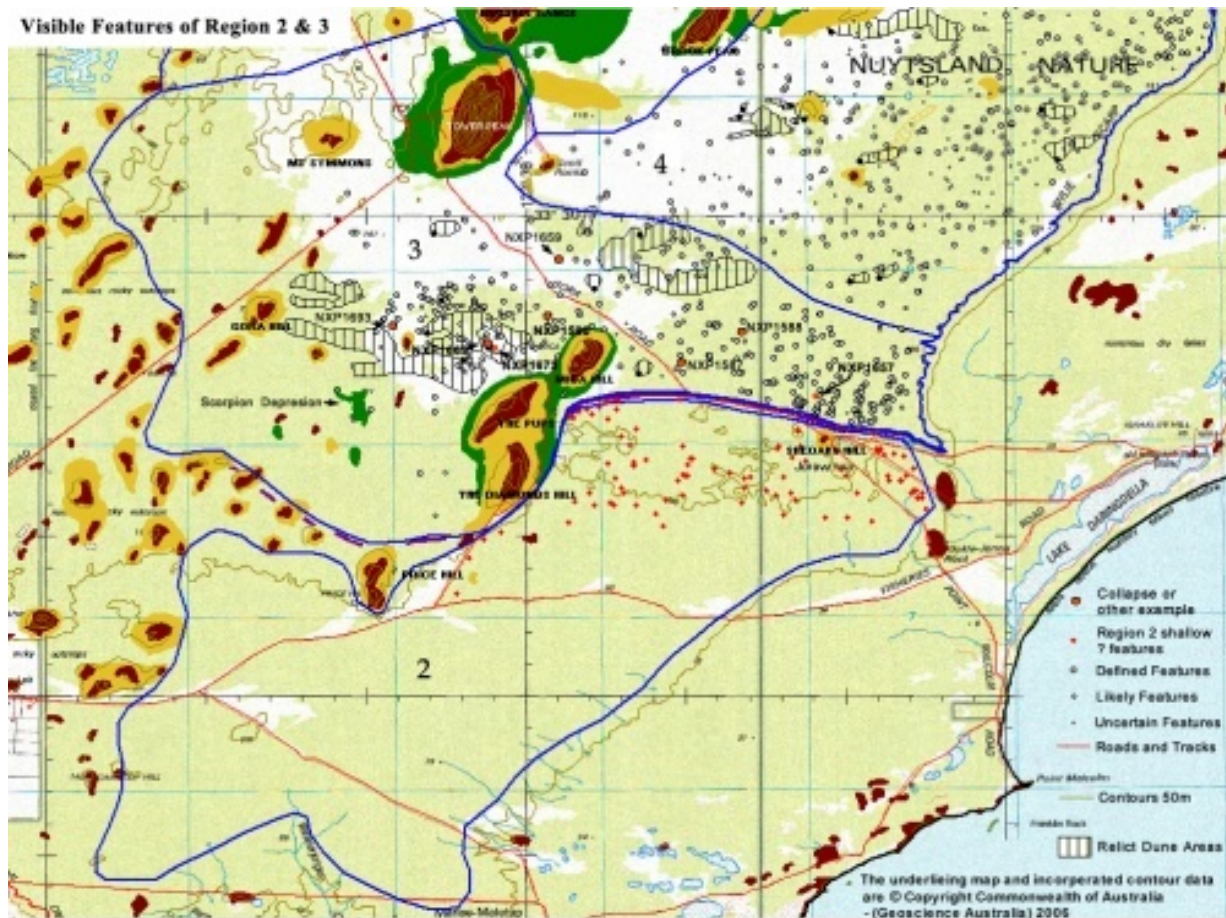


Visible features in Region 1 are overall less well defined. Defined features are commonly associated with bare shallow flats or areas adjacent to knolls of outcropping basement. The greatest concentration of visible features in Region 1 is in and adjacent to the flats near Kangawarie Rockhole. Within the moat areas surrounding basement outcrops, although a number of shallow drainage channels exist, there are only 3 visible dolines present. These 3 are in the moat of the Brook Peak/Mt Esmond range.

South of the 2nd perpendicular scarp in Region 2 there is a change to a surface with a scattered pattern of randomly sized enclosed donga like depressions (Figure 15). This change is also accompanied by the absence of clearly defined collapse and degraded dolines. A number of vague shallow apparent subsurface draining, smaller depressions are present often associated with the donga like enclosures. The presence of surface outcrops of limestone along Fisheries Road to the east of Price Hill, the occurrence of donga like enclosed depressions, and the presence of these smaller possible erosion dolines suggests cavity development cannot be ruled out for this southern plain.

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To the North of the 2nd scarp in Region 3 visible features appear more degraded.

Selection of Visible Features from Region 3

NXP-1669
Doline
Highly Degraded
typical in west
(bare after
second fire)



NXP-1657
Doline
Degraded
typical in east
(still vegetated
after one fire)



NXP-1590
Doline
exhibiting more
recent erosion



NXP-1673
Doline
with more
recent erosion



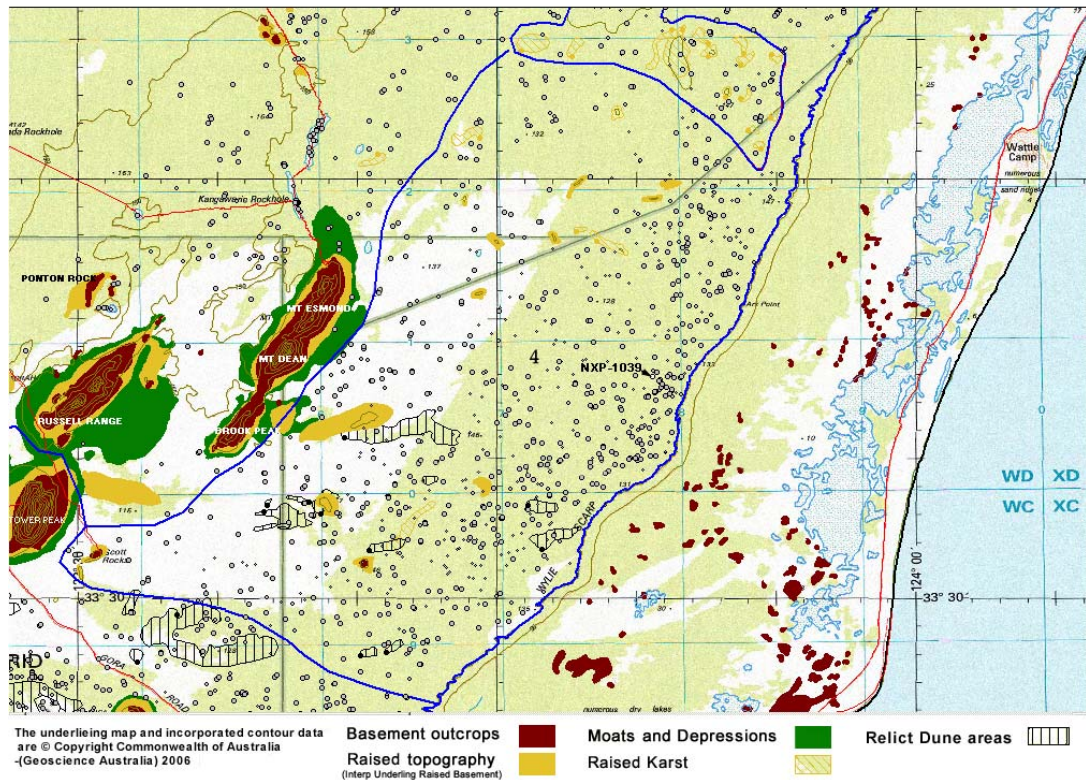
0 100m

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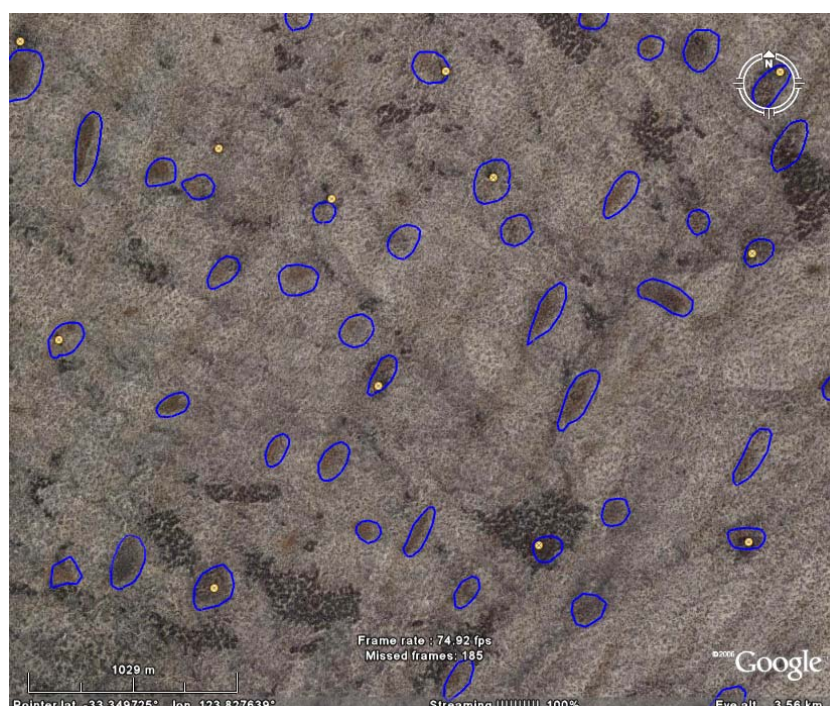
Collapse process is overall less prominent, and only a low percentage appear to exhibit recent erosion or collapse activity eg NXP-1587,1588. Degradation of features increases in the west and southwest. Of which there are a few exceptions such as NXP-1590 and NXP-1673.

Visible features in the joint controlled Region 4 lie in the area that Lowry defined as the region of Gecko Caves.

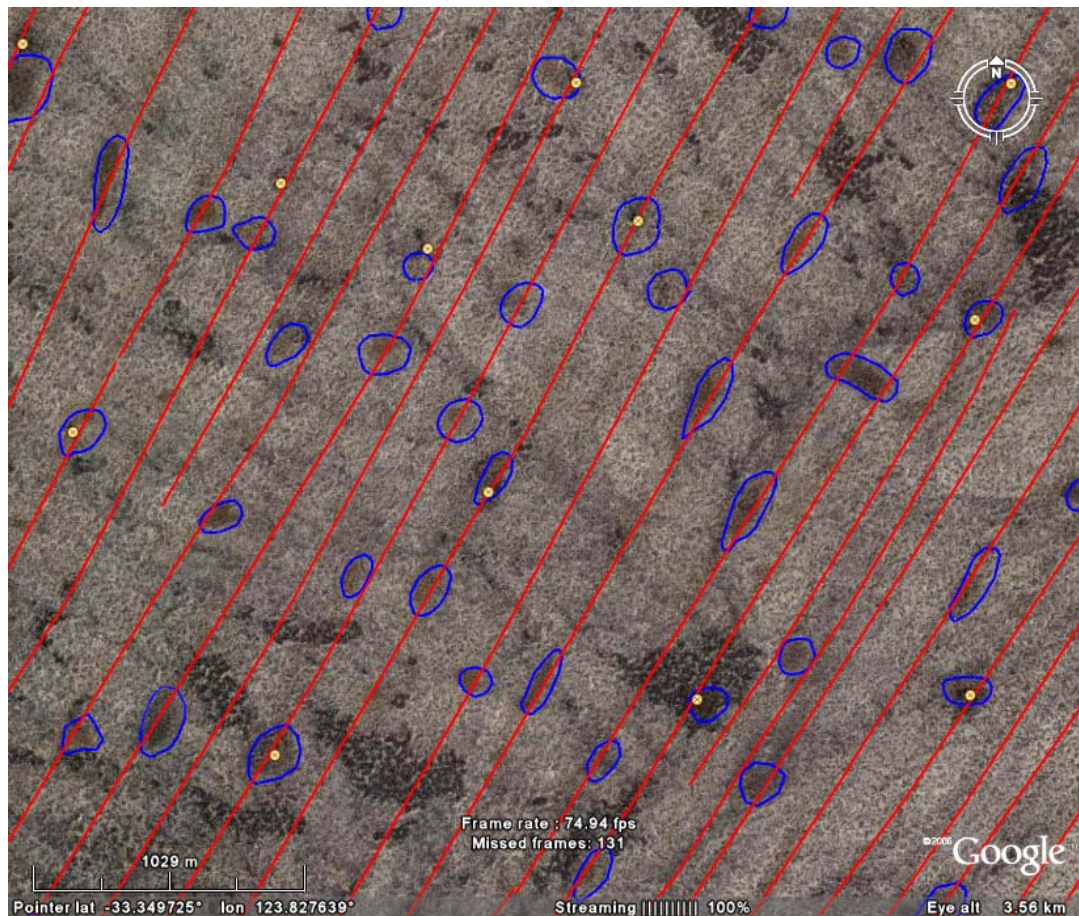
Visible Features in Region 4



The MPF's in this region are commonly found on the peripheries of shallow flats whilst their location on the edges of these flats appears random, there is a clear association with the central trends of the corridors.



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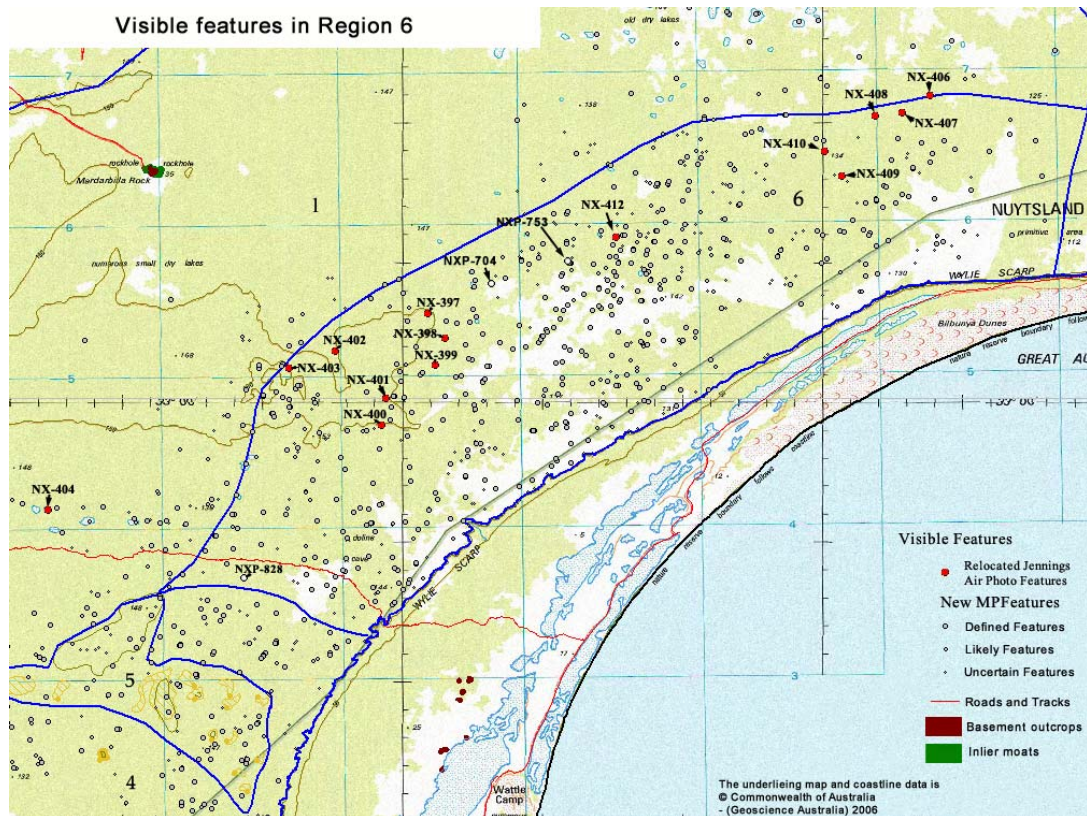
A lack of frequent prominent erosion surrounding features seems to suggest a shallower soil cover in depressed areas. Visible features in this region exhibit a range of from recent collapse such as in NXP-1039 to degraded collapse and various stages of sedimentation.



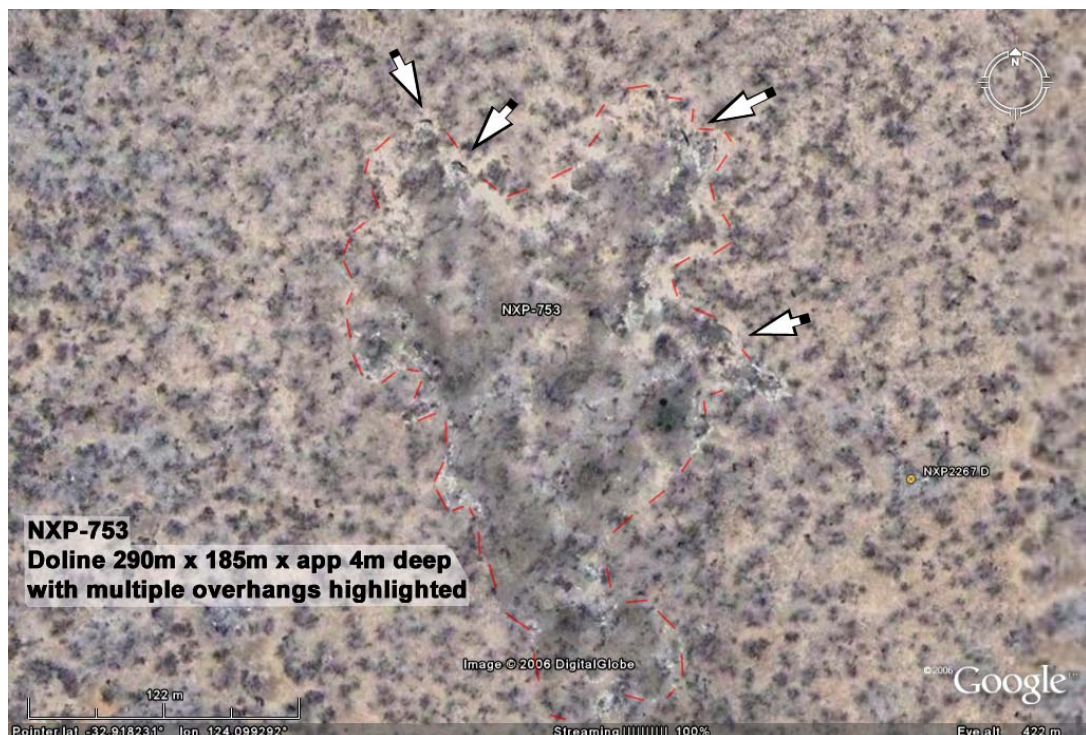
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In Region 5 the area of greater relief, visible features consisting of multiple collapses are more locally concentrated in a patchwork of larger depressions.

Within the features visible in Region 6 there is a high number of widely distributed well defined collapse features. A large number are complex features.



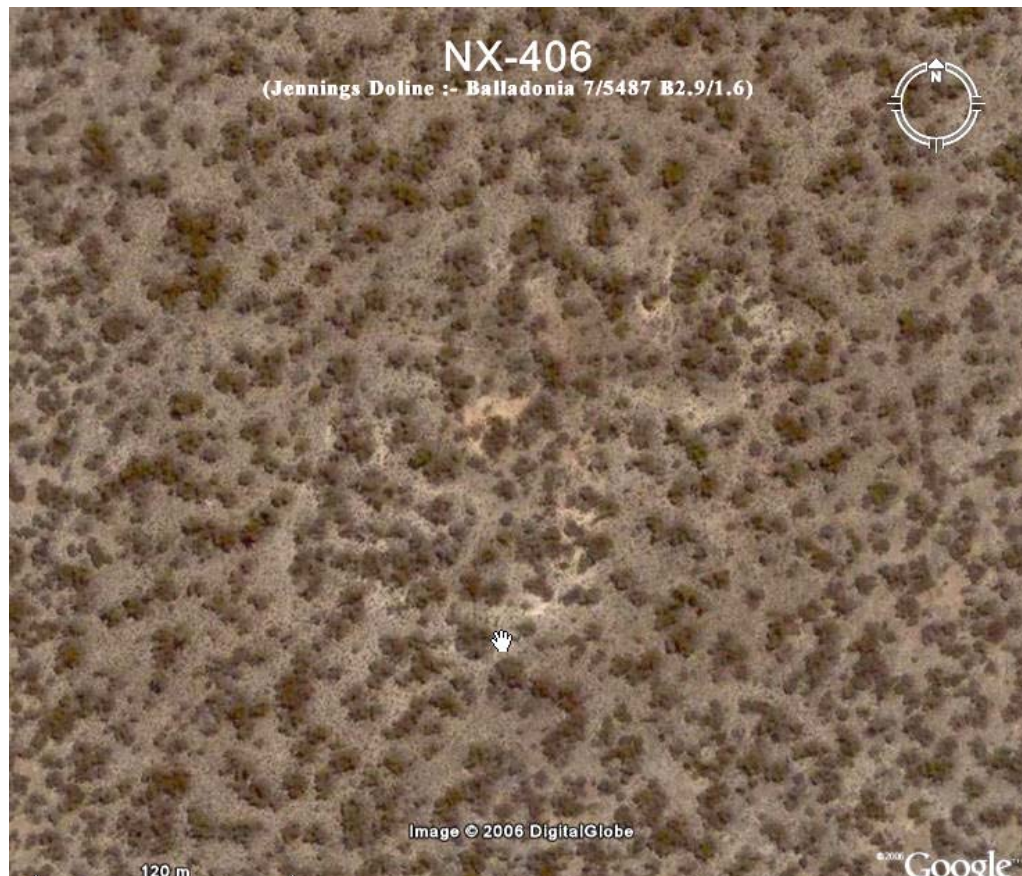
The largest feature which highlights this complexity is NXP-753 a feature 290x185m by and estimated minimum of 4m deep. This complex has at least 4 separate overhang areas with likely entrances.



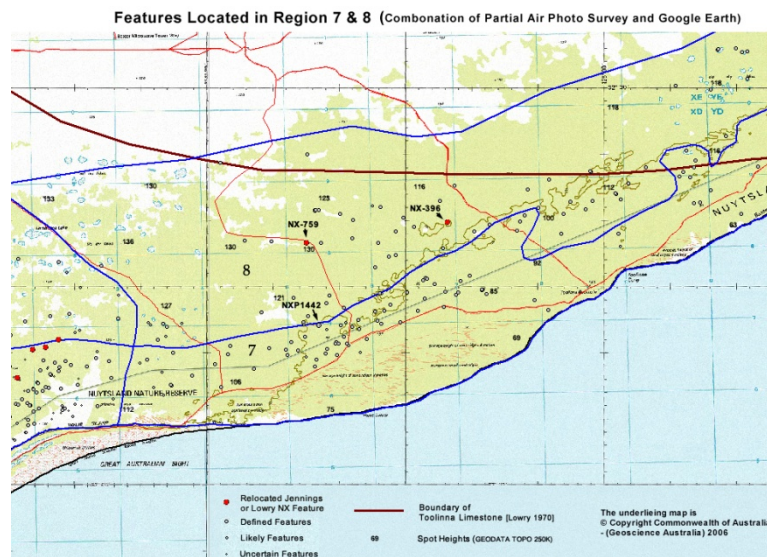
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Within Region 6 there is again an association with the peripheries of enclosed donga like flats. Although the karst surface topography does not display prominent lineal corridor control in vertical relief or vegetation, patterns of feature locations and structure still suggest a strong correlation between jointing and feature location on a $32/122^{\circ} \pm 5^{\circ}$ cross-jointing trend. There is an appearance of large erosion features such as NX-399 (200x150x5), NXP-828 (200x120x4m), NX-400, NXP-704, NX-412, suggesting an increase in soil thickness associated with the enclosed donga like depressions. A general increase in soil cover away from the coast in the NE of this area is reflected by the large highly degraded erosion dolines which form NX-410, 408 (210x150x3), 407, 406 (170x100x3)



Further east and north, well defined features become less frequent, less pronounced, and collapse appears to be largely absent.



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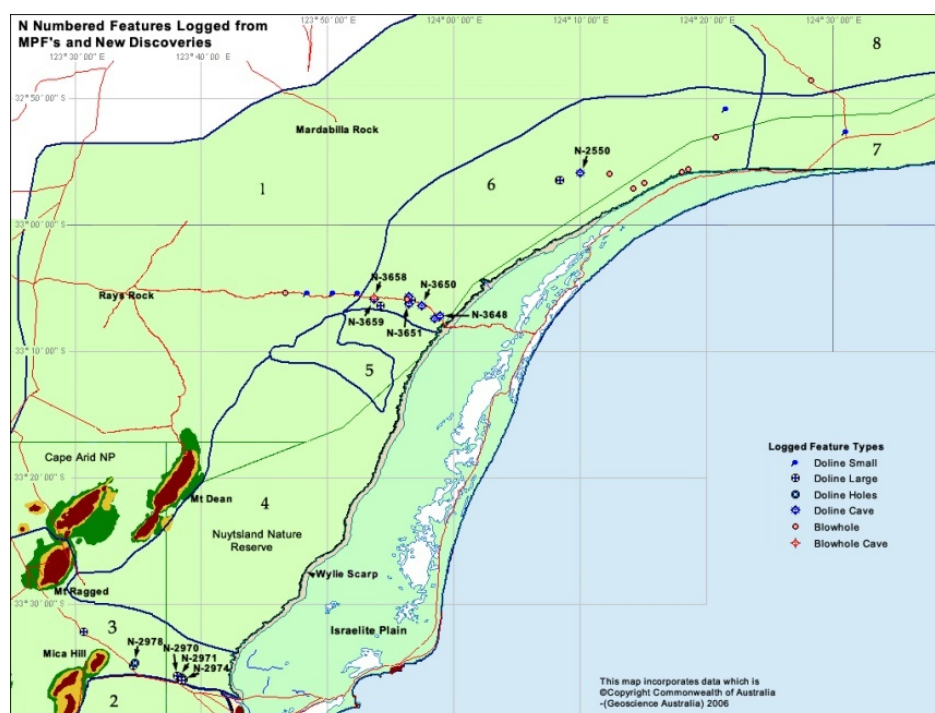
Visible features in Region 7 are more degraded in the exposed karst of the coastal strip but they show more detail from the northern margin. In Region 8 visible features appear predominantly as soil erosion dolines. The most pronounced erosion doline in this area is Jennings NX-396.



The only exception to the apparent lack of collapse in Region 7 & 8 is the 20m diameter NXP-1442.

Visited Features

To date I have visited the locations of 26 MPF's. 22 of these were actual features. In the process an additional 20 features were located which I had not recorded on Air photos or Google Earth, making a total of 42 new features visited in the study area.

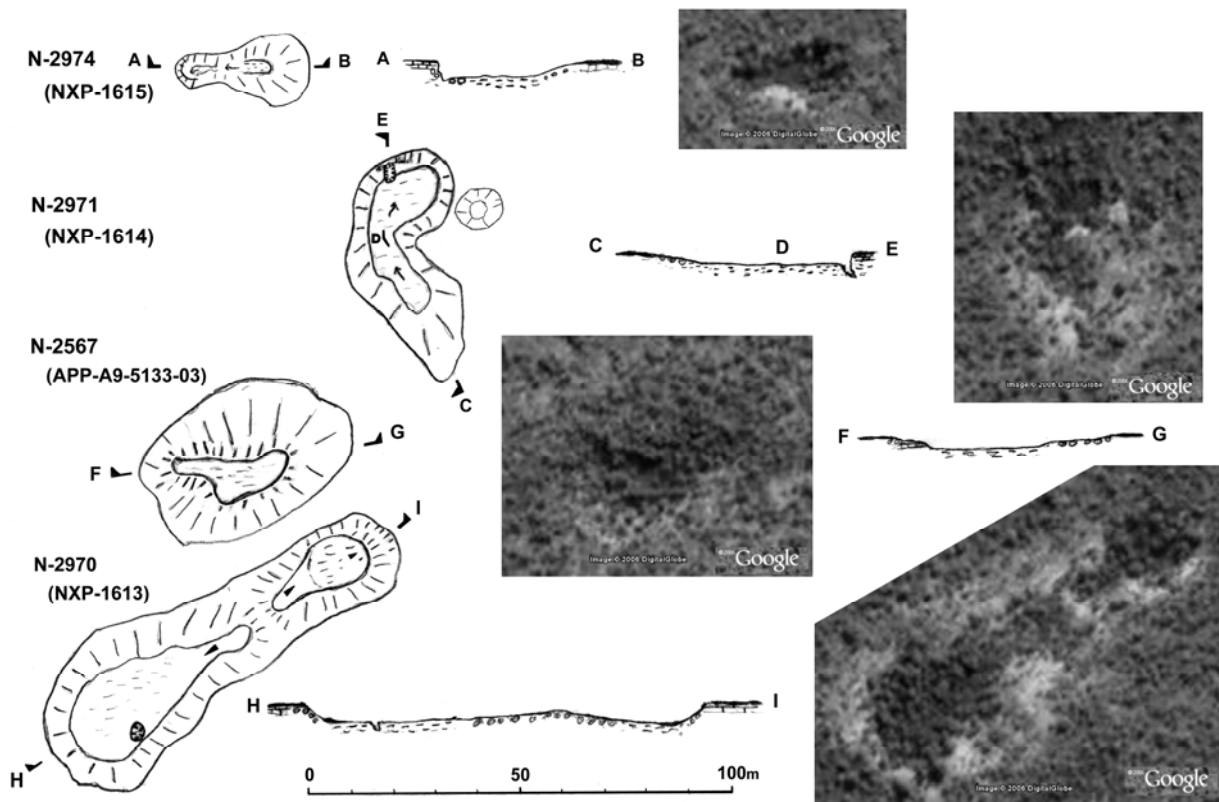


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In Region 3, 10 MPF's have been visited [Devine 2006], the 10 features located consisted of mostly degraded large dolines which ranged in depth between 2 to 4m; 3 dolines showed signs of recent activity; 2 were reactivation sinks N-2970 (NXP-1613), N-2971 (NXP-1614); and the other N-2978 (NXP-1587) had areas of recent collapse and (not entered) shallow development.

Examples of Visited Features in Region 3



In Region 6, 11 MPF's were visited resulting in 10 features, along with an extra 14 features not seen via remote sensing. New features located consist primarily of blowholes (14) and smaller dolines (4). The 3 MPF's visited in the NE of Region 6 [Devine 2005], consist of collapse dolines to 6m in depth with associated shallow caves although none of the features at the time were fully explored. The general form is collapse of surface limestone containing limited residual kankar into voids in underlying friable layers.

N-2550 (APP-B14/5175-09) Chocolate Wattle Cave



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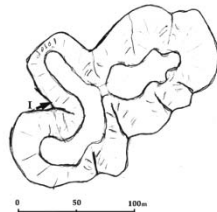
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MPF's visited in the SW of Region 6 consist primarily of collapse dolines, many are complex, nearly all have associated overhang caves in friable limestone.

One example was visited N-3657 (NXP828) of a large highly degraded (non active) doline N-3657 appears to be similar to a number of the larger Jennings Air Photo Dolines e.g. NX406-8, which are located further north. It was found to be 4.8m deep with the steepest side being $<45^\circ$ in the west. Off Google Earth the extent of erosion is roughly 195m x 120m.

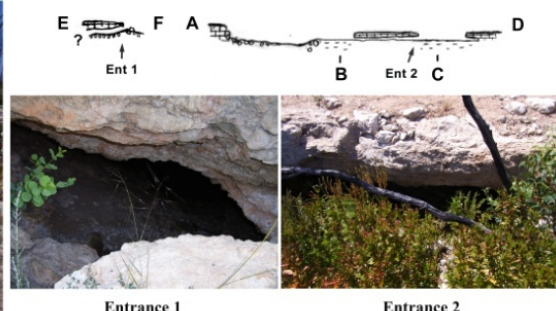
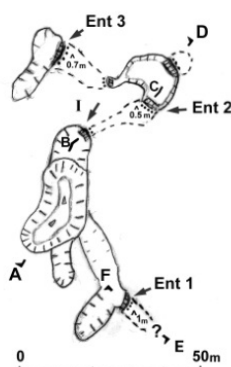
N-3657 (NXP-828)

Large Degraded Erosion Doline



The only feature examined which was definitely noted as being formed solely beneath a kankar cap was located amid the same prominent corridor structure in which N-90 lies, 1.4km to the NNE. N-3650 consists of a collapse complex with multiple shallow flattener entrances under a layer of brecciated and nodular Kankar.

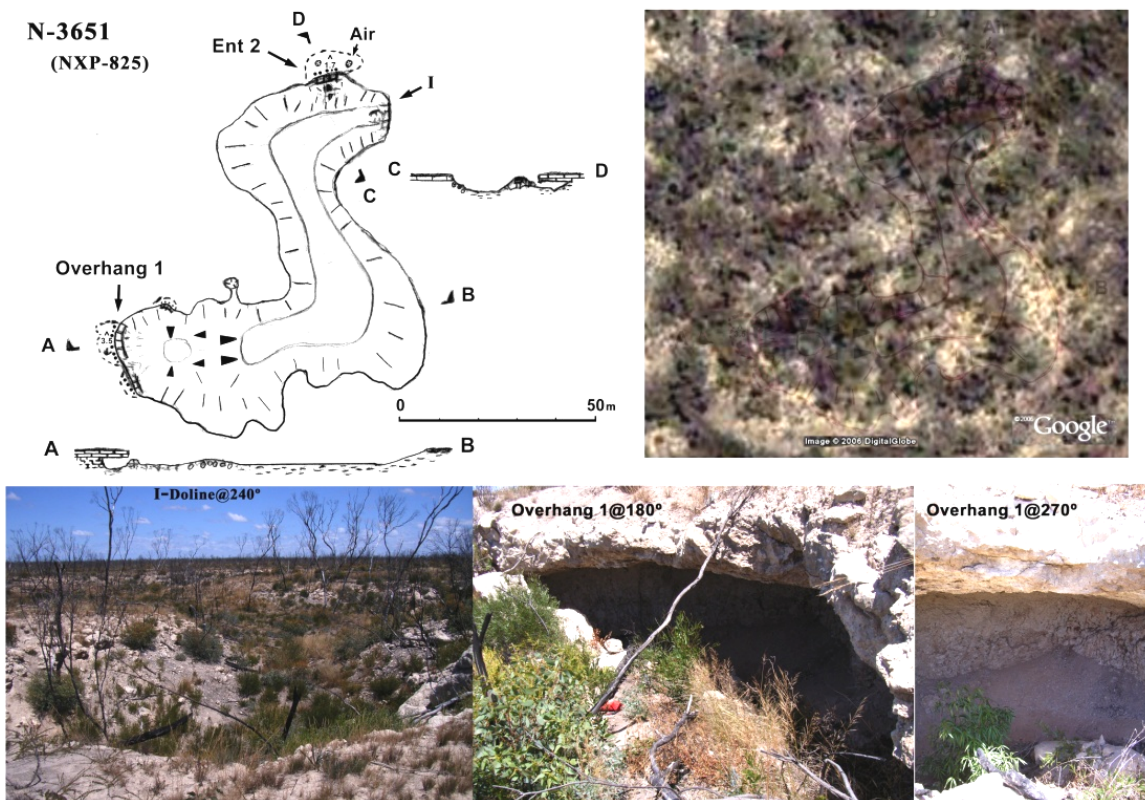
N-3650 - (NXP-2388) Doline shallow cave complex



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Most caves or entrances of examined MPF's appear to lack internal air movement unless it is caused by external sources, as with N-3650 where there are 2 connecting entrances. The only exception was in the north overhang cave of N-3651 (NXP-825) where exhaling air was present in floor sinks possibly indicating a further more significant extension to this system.



Overhangs extended up to 30m as read by disto from entrance of the still unexplored N-3659 (APP-A2/5254-07), and were found up to 25m in width.



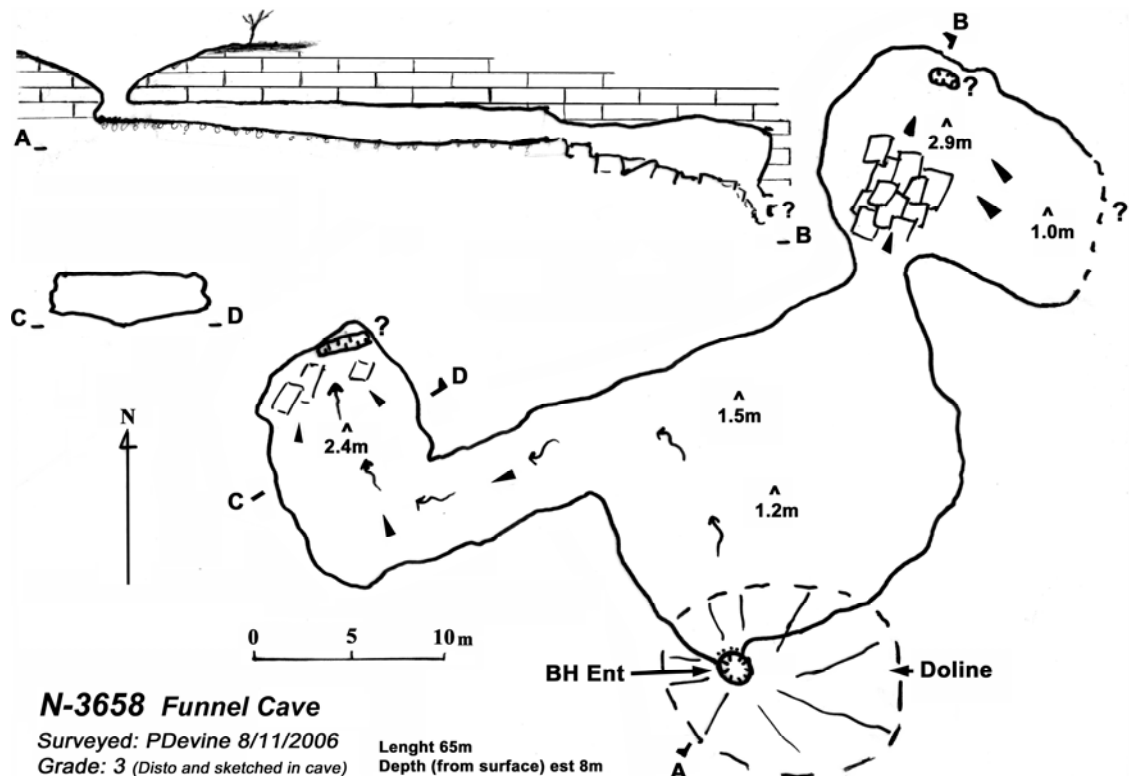
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N-3648 (NXP-2561).

The largest cave explored was N-3658 Funnel Cave



The cave is entered via a conical blowhole, with 34m of passage measurable from the entrance and another 30m of side passage mostly 5-8m wide and 1.5-2.5m in height. There are three remaining leads, two are down to possible lower development.

Conclusions

The low number of previously recorded features in this area reflects more the difficulties in locating and in accessing the area due to the thick vegetation, not the lack of karst development.

Larger numerous surface features are concentrated in the more coastal regions of the Mardabilla Plain. Features appear to many differing stages of collapse, sedimentation and finally reactivation.

The region of shallow karst development for this area can be substantially extended.

The lithological relationship by which Lowry defined Gecko Type caves as to developing beneath a harder kankar cap is questioned, as it restricts the regional inclusion of similar shallow features developed by the same process of cavity development in friable layers beneath a non kankar layer. Whether the surface layer shows a presence or absence of kankar, or limestone, or shows a combination of both seems not as relevant as cavern form, process and possible levels of initiating development.

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Lastly a further examination of these features is needed to establish the full subsurface extent for these systems, and hopefully reveal the level of precursor development.

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