Relict Palaeorivers of the Western Nullarbor and their associated Karst Features

Paul Devine

Abstract

The more northern portion of the Nullarbor shows evidence of a number of relict palaeoriver systems. These systems have been known for many years, along with approx 41 karst features that are in close proximity to one of the main systems near Haig. Statistical relationship between 2 caves of deeper origin and these palaeoriver regions along with the location of new closely related, shallow karst features prompted a closer examination of the 2 main palaeorivers in WA. This has resulted in the location of a large number of previously unrecorded karst features. Features examined appear similar in form and origin to previously recorded features.

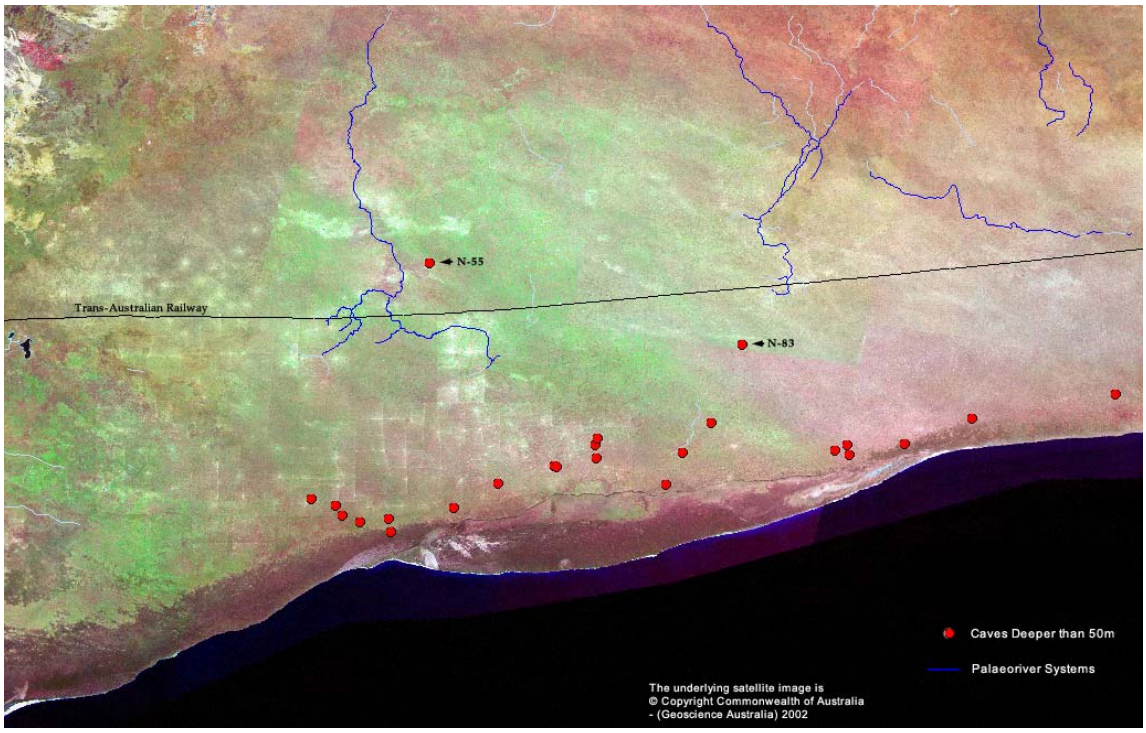

Figure 1 Deeper cave distribution on the Nullarbor - 50m or deeper

Introduction

All known deep caves on the Nullarbor occur well south of the Trans continental Railroad.

Reasons for this were postulated by Jennings, due to rainfall gradient, [Lowry& Jennings 1974] and counter postulated by [Benbow & Hayball 1992] to be a lack of upward stopping or previous stable water table levels. In the WA portion of the Nullarbor only two known exceptions to the southern trend of deep cave distribution are known, one is Old Homestead Cave (N-83), and the other, the only known deep cave north of the Rail, Haig Cave (N-55).

Haig Cave's formation and origins are not fully explained. While there is no direct link, its proximity to or possible relationship with one of the Nullarbor's largest relict palaeoriver systems has not been examined or explained. These ideas if nothing else provided the impetus for a broader examination of the areas associated with the two main relict palaeorivers in the WA portion of the Nullarbor the Haig and Forrest systems.

Background

Modern river systems that do have periodic flood flows to the peripheries of the Nullarbor do not extend far onto the Plain, instead they form lakes such as Lake Boonderoo. This particular lake fills from the Raeside palaeodrainage system that only flows during major flood events through Ponton Creek to the western edge of the Nullarbor.

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The outlying palaeorivers that surrounded the Nullarbor and flowed into the Eucla basin during its earlier stages of formation are thought to have been largely inactive post the emergence of the Plain during the middle Miocene [Van de Graaff et al 1977].

Figure 2 rivers wide and external inc active

Since the 1960's sections of relict palaeorivers have been recognised on the Nullarbor Karst.

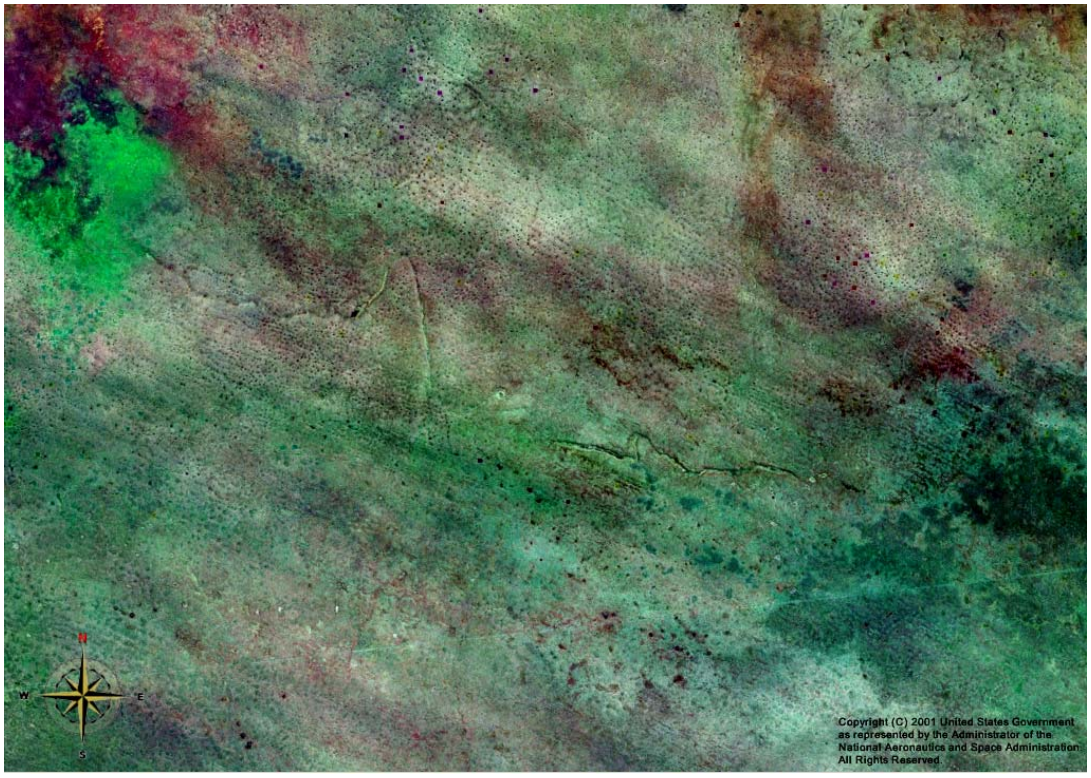

Figure 3 The Dip World Wind Satellite View

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"The Dip" first described by Joe Jennings [Jennings 1967] is a system approx 130km long originating in WA and ending near Cook in SA.

Forrest and Haig palaeoriver systems were noted and described by David Lowry [Lowry 1970] along with small fragments of river near Naretha.

Several smaller systems have been noted in the eastern portion of the Nullarbor [Jennings and Lowry 1974] and [Benbow et al 1995b].

The link or continuity between the Nullarbor systems and the inactive palaeodrainage systems lying outside the plain is noted by Jennings and Lowry [Lowry & Jennings 1974] for the Haig, Forrest, and one east of Cook

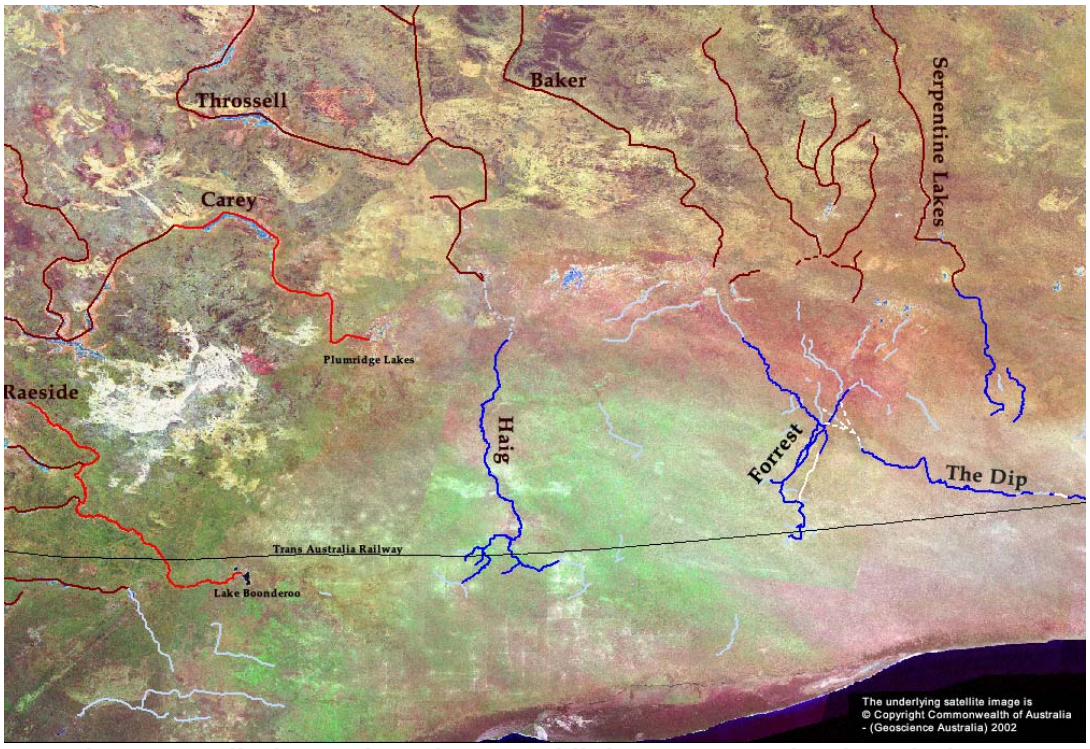

Figure 4 Nullarbor Palaeorivers and links to External Palaeodrainage

The two western ones correspond to the Throssell, and the Baker palaeodrainage systems. Beard [Beard 1973] also proposed a link with the Carey system to Haig palaeoriver.

More recently for sections of a paleoriver north of the Dip in South Australia, a continuous link has been shown to the Serpentine Lakes palaeodrainage system to the north [Benbow et al 1995a].

Flows of the palaeoriver systems on the Nullarbor that deposited sediments are said to have occurred in a number of stages, the first at the period at emergence of the Plain and later more sporadic flows during the Pliocene [Benbow et al 1995a]. These later flows during wetter periods in the Pliocene are evidenced by clays and sediments associated with palaeochannels in SA and at Haig in WA [Benbow et al 1995a,b]. It is also suggested that a period of greater precipitation in the Late Pliocene occurred at a similar time to the deposition of red-brown karst breccias and calcite speleothems [Benbow et al 1995a]. It appears there are a number of stages of calcite deposition [Geode et al 1990]. The most recent initial results of U-Pb dating of one stage of Nullarbor calcites, at 4.1-3.8my [Woodhead et al 2006] starts to provide a link for the timing of a period of greater precipitation and possible palaeoriver flow.

Both of the major palaeoriver systems in Western Australia, the Forrest and the Haig, are largely south trending and they both break into a series of distributaries at their southern ends. These southward trends are associated with large areas of remnant surface cover [Lowry 1970].

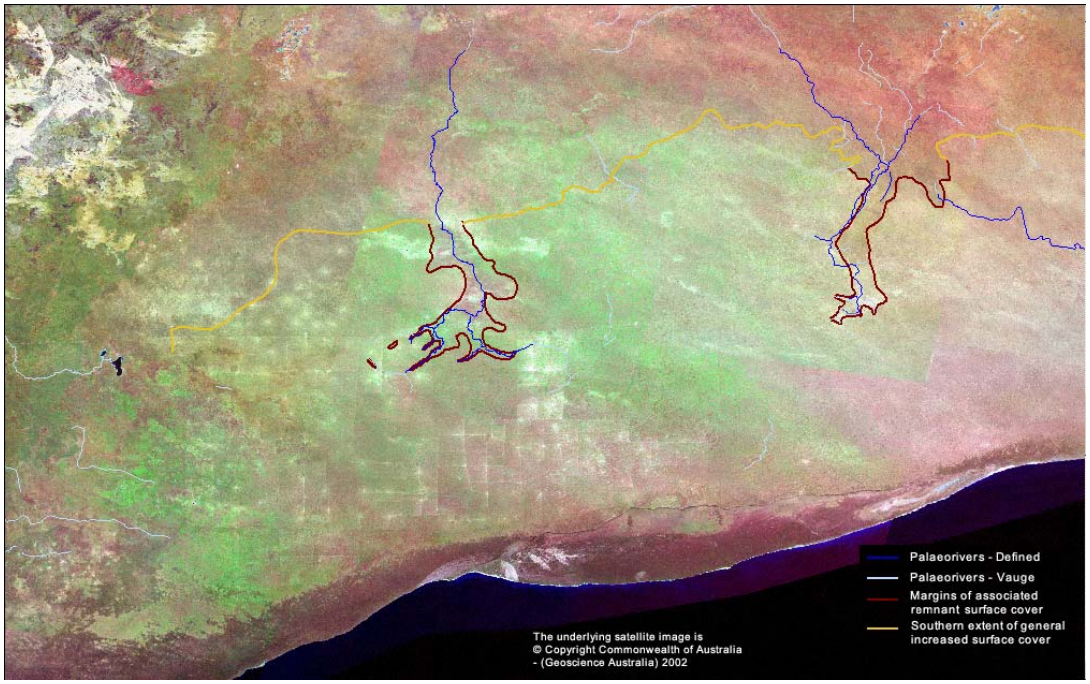

Figure 5 Belts of soil cover surrounding Nullarbor Palaeoriver Regions

In the case of the Haig palaeoriver this consists of deep calcareous soil underlain by calcretes that can vary up to several metres in thickness [Lowry 1970]. The remnant surface cover is associated with widespread vegetation consisting predominantly of Myall. Throughout the margins of the lower Haig Palaeoriver Region in areas were soil has been deflated large surface expanses of oolitic calcrete are exposed.

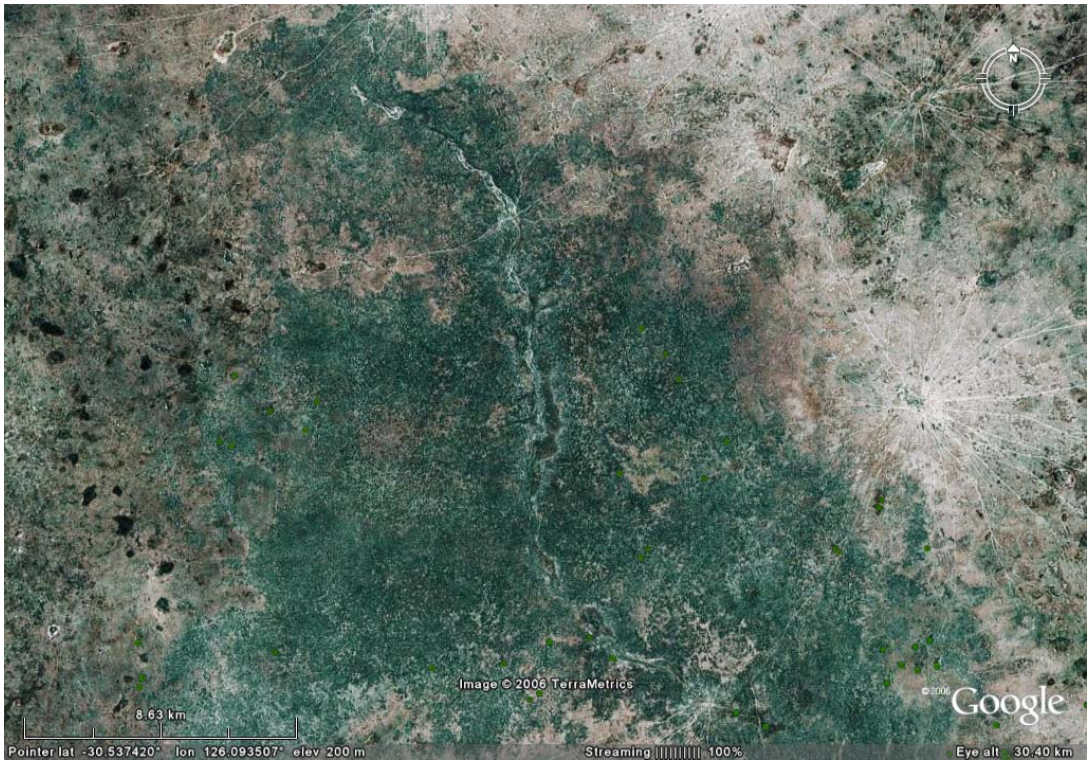

Figure 6 Haig Palaeoriver veiw of associated belt of vegetation

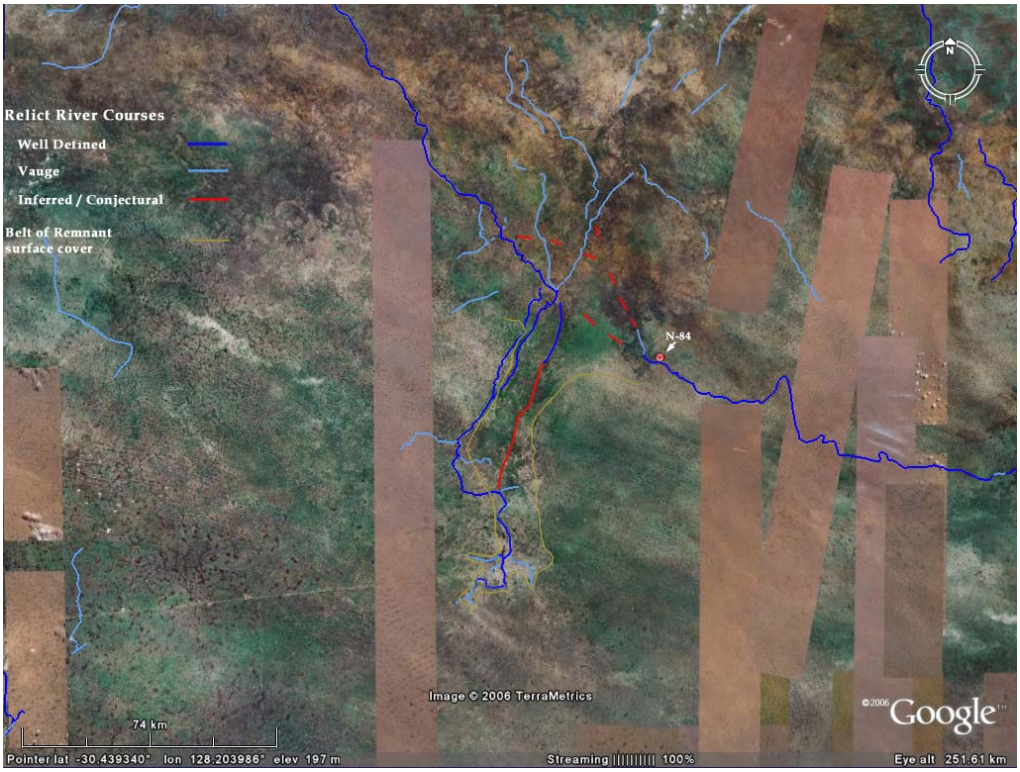

Figure 7 Visible Palaeorivers Complex in the Forrest and Dip System

The Forrest palaeoriver suggests a number of various stages, like the Haig river further west, the Forrest river is surrounded by the belt of remnant soil cover. In the case of Forrest this was deposited in an earlier stage as the river later broke from this area and deviated west and rejoining the belt further south [Lowry 1970]. Although the Forrest palaeoriver has a raised area of remnant surface deposits, it however mostly lacks the pronounced vegetation cover that is present at the Haig region. The upper portion of the Forrest Palaeoriver appears complex and multi-channelled. It is likely that The Dip, which becomes discernable from a point near Decoration Cave (N-84), is an easterly flow from one of the stages of the Forrest palaeoriver. Like sections of other palaeorivers the link for this system is no longer well defined.

Palaeoriver courses have undoubtedly undergone substantial post flow modification such as solution modification [Lowry& Jennings 1974] and deflation [Lowry 1970]. Overall the development of the relict river systems on the Nullarbor appears complex and multi staged.

The area of remnant surface cover surrounding the palaeorivers is referred to as the Haig & Forrest PRRegions (Palaeoriver Regions) respectively in this article.

Previous Features

Prior to 1998 in the Haig PRRegion, 36 karst features were listed in CEGSA records. Comprising of 26 N number allocated features and 10 unallocated NX features. Subsequent relocation of NX numbers during trips to the area made between 1998 and 2003 along with further research has shown that approximately 41 features (Table 1) were visited or recorded by cavers prior to 1998.

Table 1: - List of features in records prior to 1998 for the Haig Palaeoriver Region

Number	*Located by*	*Date*	*Recorded by*	*Date Rec*	*Reference*
N-55	**Eileen Fletcher? (Pilot)** **AJ Carlisle (on ground)**	**1937**	**Harry Wheeler** **David Lowry**	**1958** **1965**	**KIDSA2006** **Lowry1965**
N-*1551*, *N-1655*, *N-1658* ***N-2515*, *N-2517*, NX-81**	**AJ Carlisle**		**Harry Wheeler**	**1958**	**KIDSA2006 &Devine2003**
N-1552, N-1553, N-2139	**AJ Carlisle**		**Max Meth**		**KIDSA2006**
N-141, N-142, *N-2238*	**Joe Jennings**	**1964**	**David Lowry**	**1965**	**Lowry1965**
N-2237*, *N-2238 [1]	**Joe Jennings**	**1964**			**Meth1997**
N-143, *N-1554*, *N-1657* ***N-2138***	**David Lowry**	**1965**	**David Lowry**	**1965**	**Lowry1965**
N-540, N-541	**?**		**Max Meth**		**KIDSA2006**
N-496 to N-517	Plane Caving	**1990**			**KIDSA2006**

[1] ***N-2238 was circled by Lowry on Air Photos.*** ***Numbers in italics were listed as NX prior to 1998***

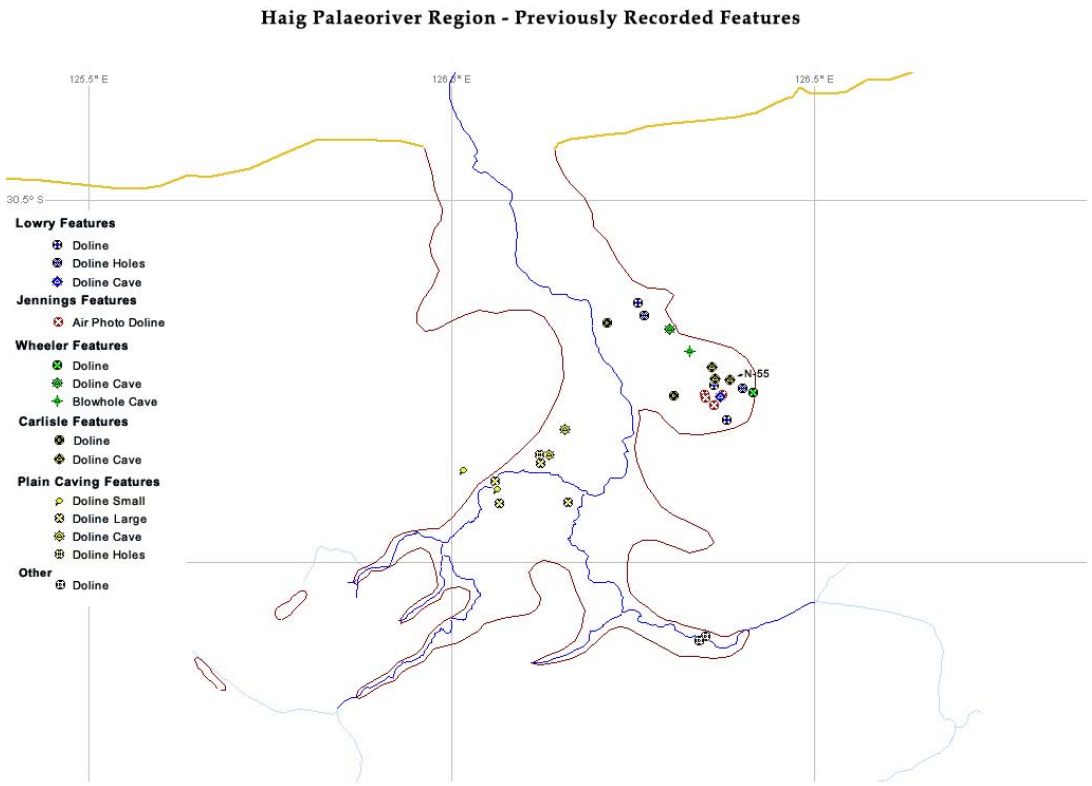

Figure 8 Map of Previous Features in the HaigPRRegion

Most of the previously recorded features are scattered throughout the Haig PRRegion

A higher number is indicated by the description of several of these dolines as breakaways* by local pastoralists, who refer to them as being numerous.

*(These “breakaways” as coined by the locals differ completely in their formation from the true cliff-line breakaways occurring elsewhere – including the breakaways described by Lowry which lie further north on the margin between the Nyanga and Carlisle Plains [Lowry 1970]. Instead of simple process of mechanical undercutting and erosion away from a cliff-line, these pseudo-breakaway features are formed by slumping, shallow collapse and effects of drainage into the clifflines and the associated underlying cavities)

New Observations

In early 1999 new 1:50 000 scale air photos became available and I purchased photography covering the Balgair region. 30 features were initially identified off these photos, (N-1604 to 1611, N-1613, N-1629 to 1631, N-1634 to 1636, NXP-26 to 32, NXP-36, NXP-96 to103). Of which nineteen are located on the banks of the Haig relict palaeoriver (N-1604 to 1610, NXP-26 to 32, NXP-96 to103). A further examination of the additional air photos has allowed me to define around 200 larger surface features in the Haig PRRegion.

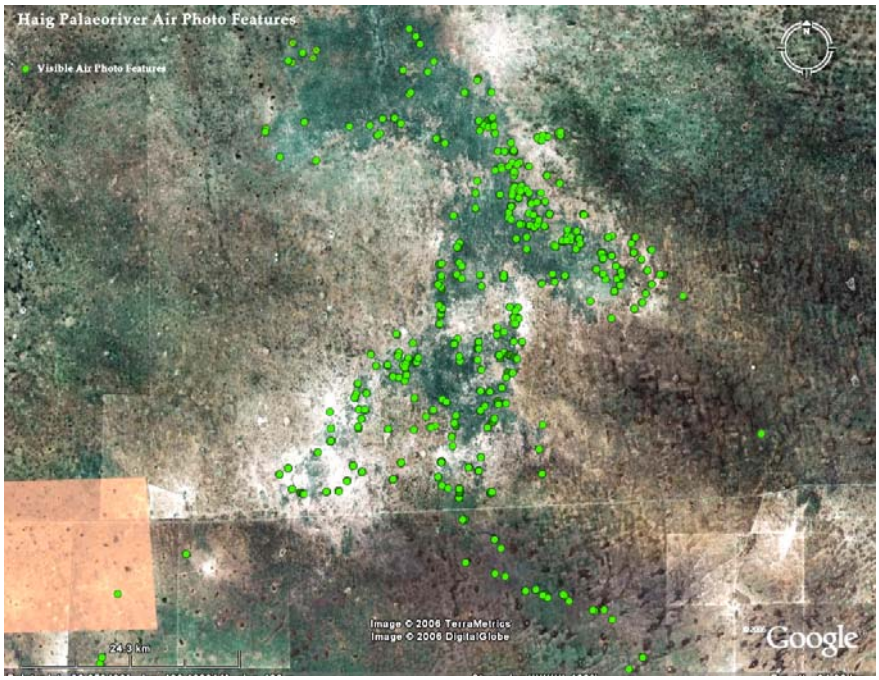

Figure 9 New Visible AirPhoto Featuresof the HaigPRRegion

By enlarge most of these features are visible due to the greater depth of surface cover in this region. It is the surface expression of cover erosion or cover collapse into underlying cavities that stands out in sharp contrast to the surrounding landscape.

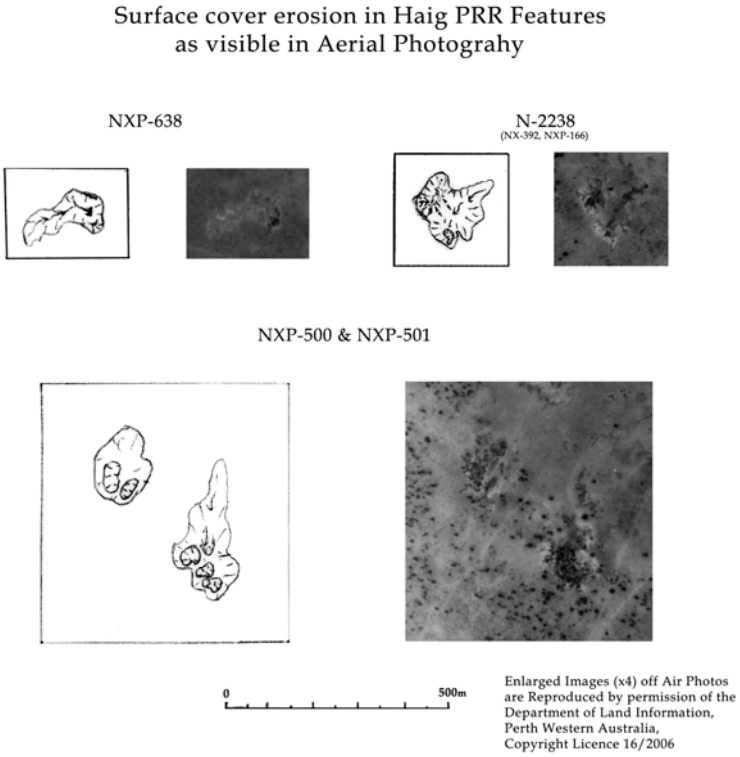

Figure 10 Surface cover erosion of HaigPR Features as visible in Air Photos

This is what highlights these features easily stereoscopically in aerial photography.

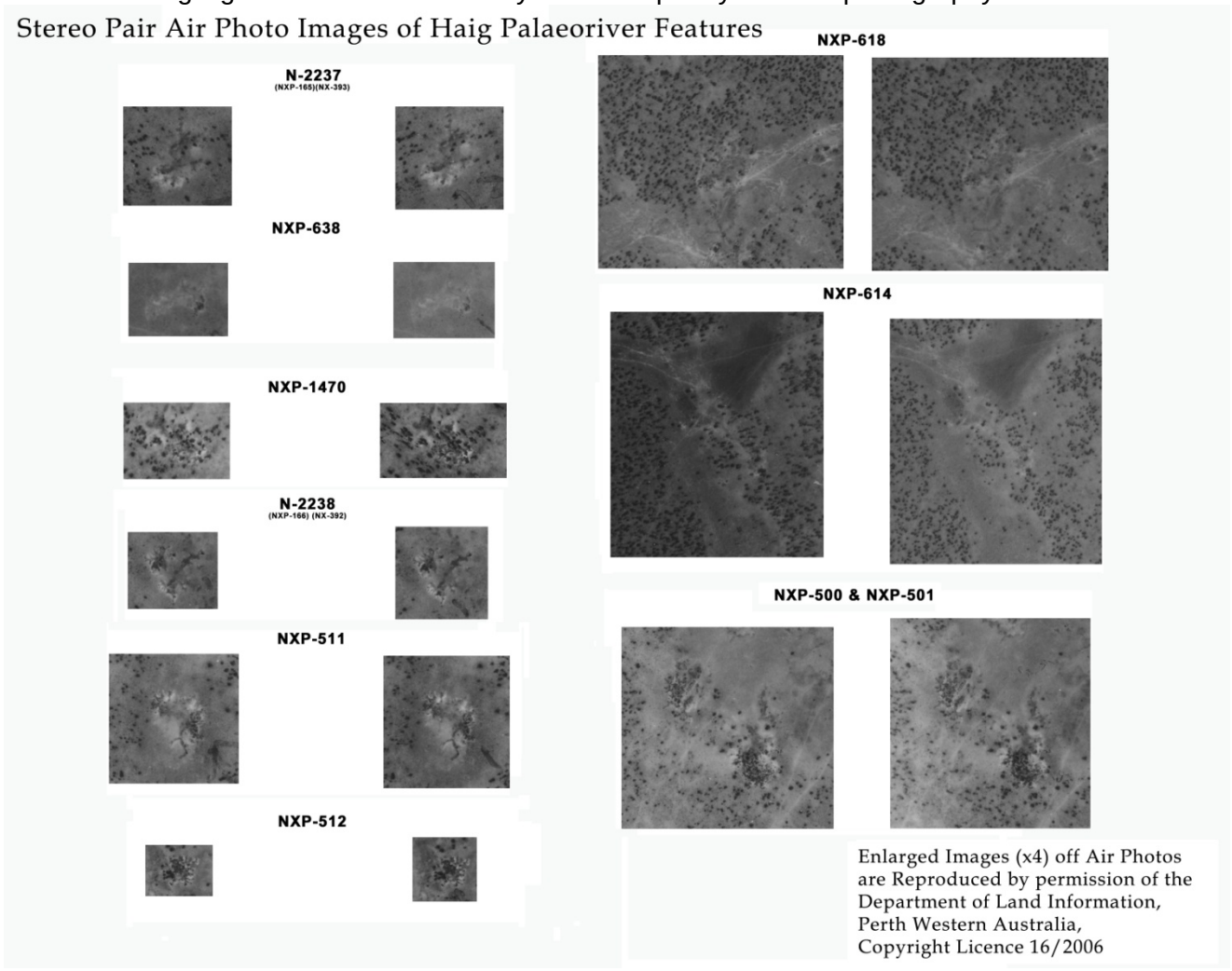

Figure 11 Stereoscopic images of HaigPRRegion features

The cover erosion dolines appear to be in various stages of formation, from sharply incised steep sided erosion dolines to more subdued degraded dolines eg similar to N-143.

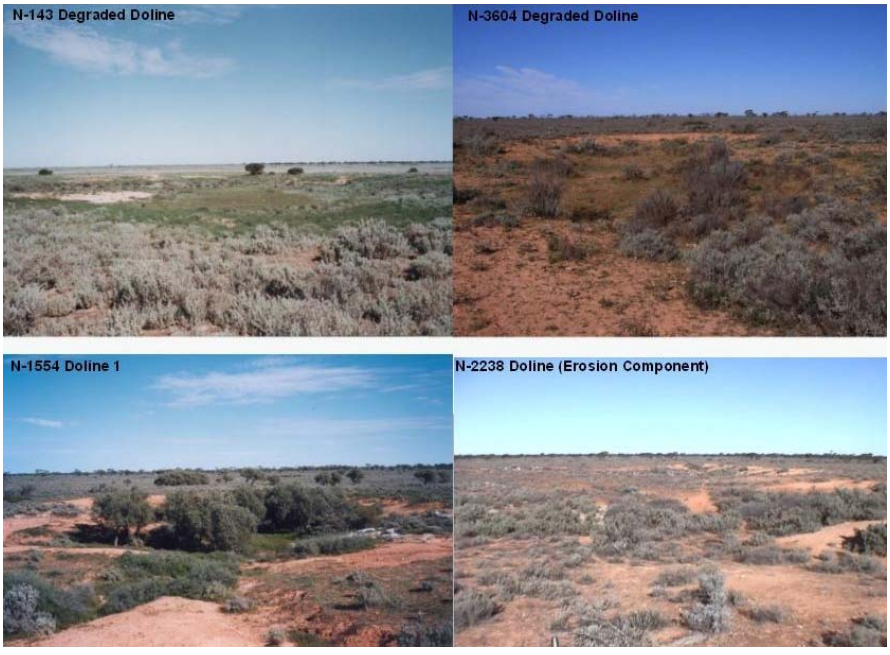

Figure 12 N-143 & Examples of Erosion Dolines

These features do not occur on raised areas of ground like that of Haig Cave instead they tend to occur in broader areas of lower relief. Only a small number of the 200 have been visited to date

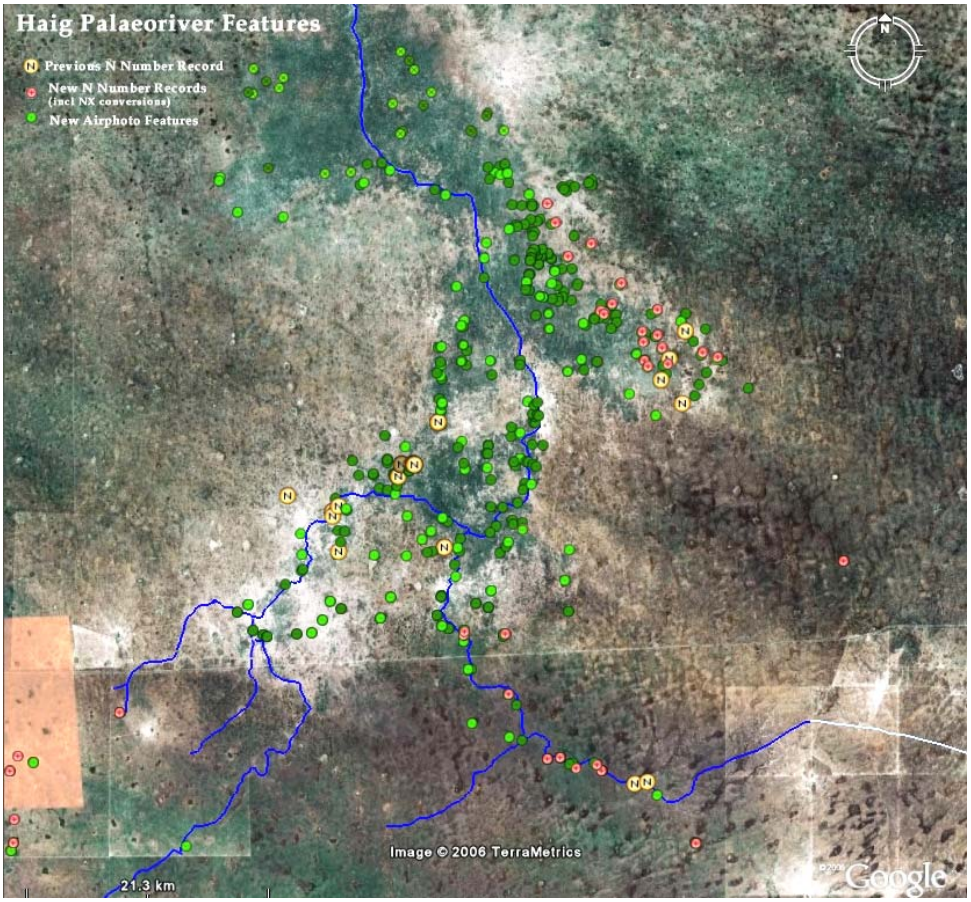

Figure 13 Features of the HPRRegion showing New visited and Previous N Features

Blowhole entrance to shallow collapse : N-2639

Slot entrance to shallow collapse : N-2642

Slumping Collapse : N-2238

Degraded Collapse area in N-2642

Figure 14 Examples of Stages of Process

The features to the west of Haig Cave (N-55) show the cause of the cover erosion to be the widespread upward shallow stopping collapse of underlying limestone.

Again there are many examples of various stages of process often present at the same location

Stages found include:

- Blowholes, slots (enlarged joint controlled entrances), and small collapse entrances, leading to shallow rockpile chambers, N-2637 – 2640 complex.
- Areas of exposed shallow surface slumping & collapse (N-2641).
- Highly degraded slumping or collapse, showing substantial modification of exposed limestone N-2642.

In this area large rounded cavities are evidenced in walls below ground and shows a number of different infill types including rarer massive gypsum occurring in nearer surface cavities, dark red brown, green-grey, or grey-white clays in cavities of varying depth.

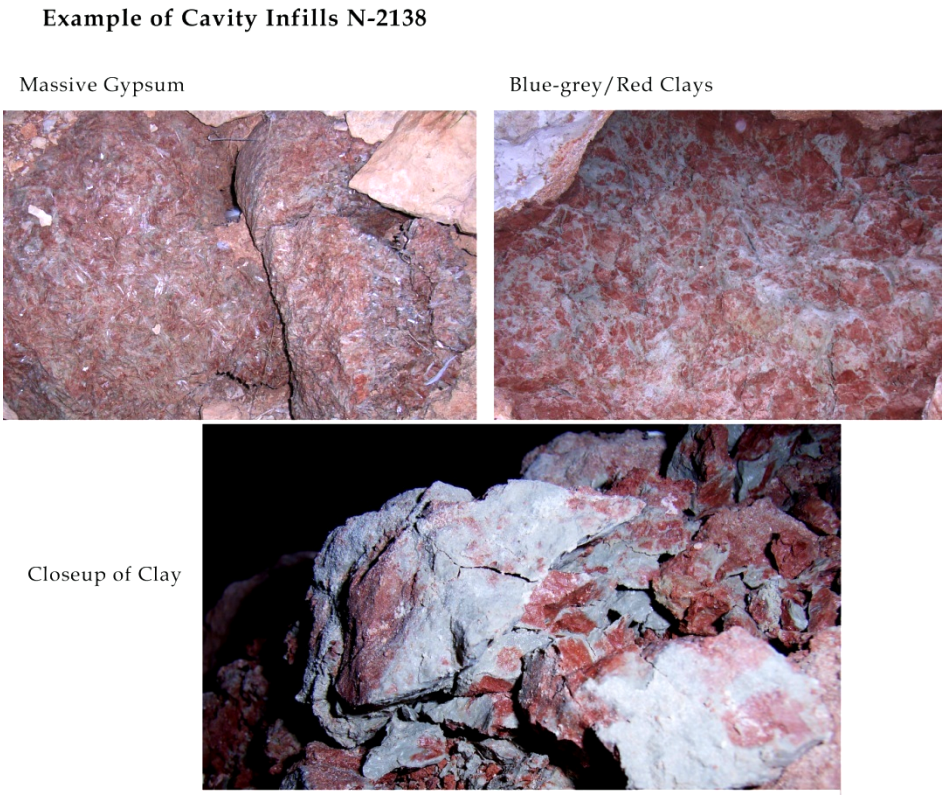

Figure 15 N-2138 Examples of Cavity infill types

This cavitation and infilling has created areas below the surface which in places are inherently unstable. An example is in N-142 where roof slabs have been noted having more clay content than limestone. Although no direct evidence has been found, it appears the collapse development originates from a relatively shallow level. Precursor development observed has been limited to minor shallow phreatics and enlarged cavitation. In features visited to date the level of precursor development is obscured by the nature of the widespread near surface collapse development.

These features by enlarge fit with the Lowry 1970 observation in regards to, - “N141 - N143, dolines formed by clay washing down joint openings in Nullarbor limestone. To cavities formed by solution when the water table was close to the surface, or vadose enlargement of cavities filled with clay.”

To the north of Family Dam there is a trend for features to be more concentrated on the margins of the Haig PRRegion. To the south of Family Dam the palaeoriver splits into distributaries. From this point and to the southeast a high proportion of the features are located on the edges of the river channel with a number appearing to drain or divert modern localised flood water flow.

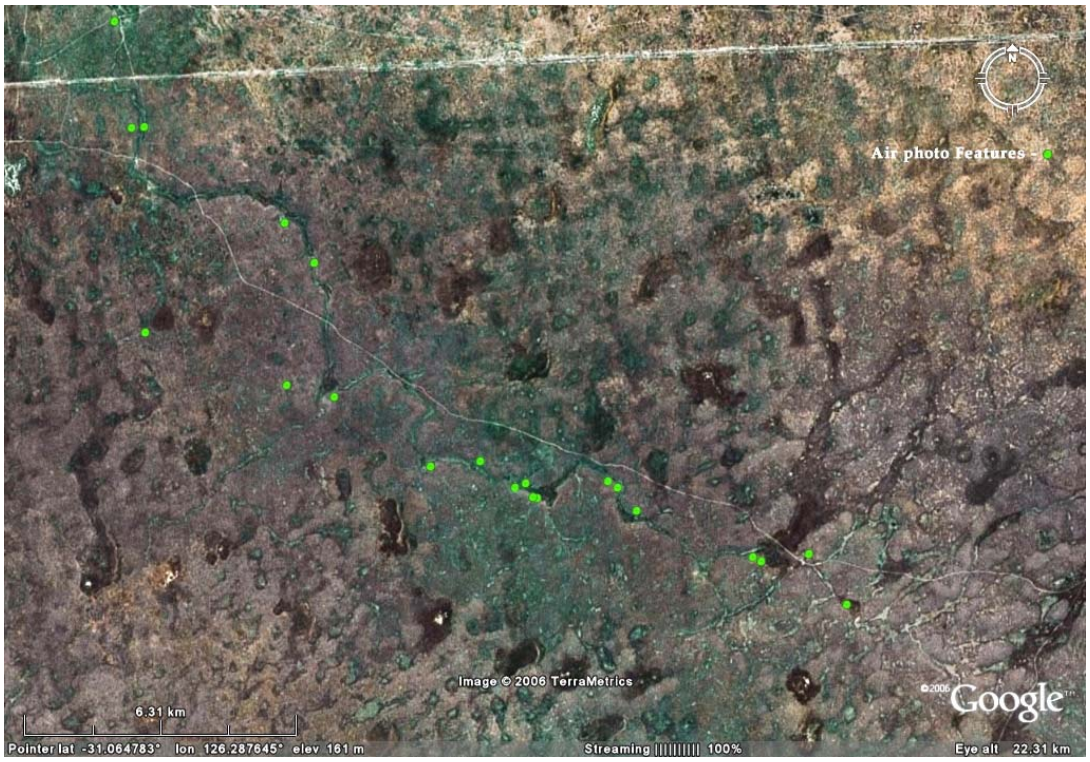

Figure 16 Features along the SE HPRiver Distributary

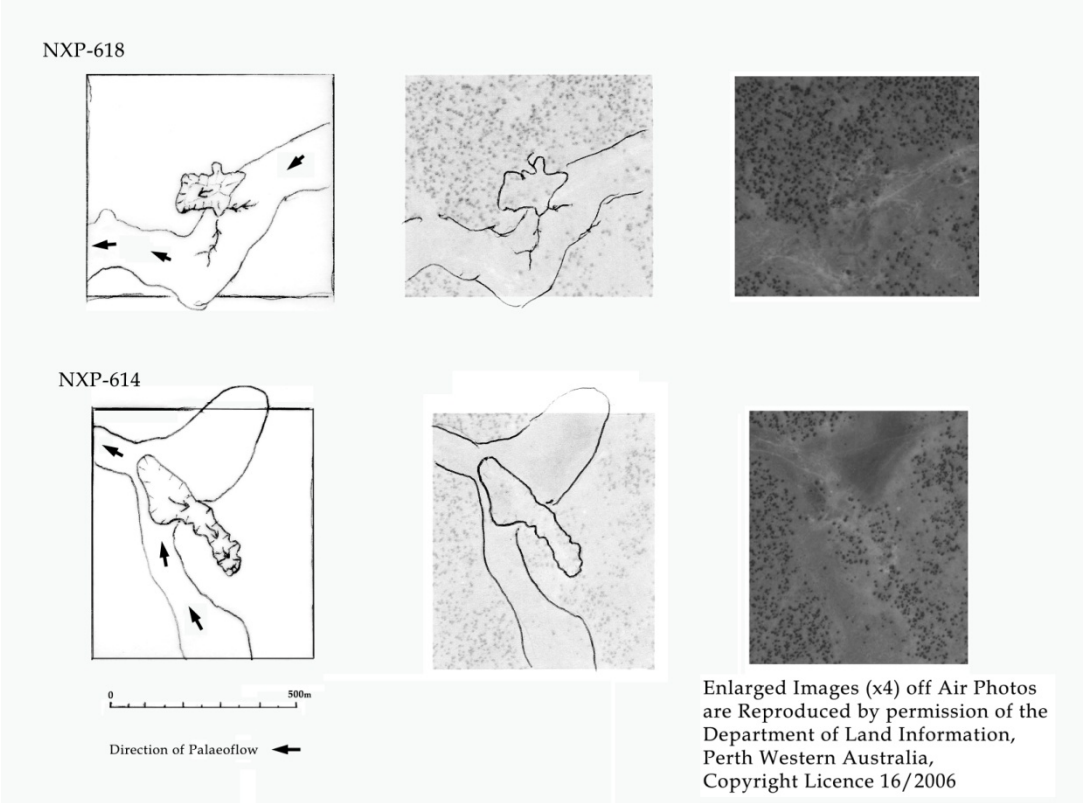

Figure 17 Examples of River Channel draining features

NXP-614 is a case where drainage of modern localised flood flow appears to be predominantly from the west. This is in a reverse direction to that of the original palaeoflow.

Features visited further along the south eastern Haig distributary, access within these surface collapses is confined to the layer of oolitic and rubble calcrete cover with only minor outcrops of underlying limestone present. The surface features show no indication of the form of cavity development in the underlying limestone.

Figure 18 River Draining Feature N-1607 D@210º
& **Figure 19 River Draining Feature N-1608 D@50°**

In the area of the Western Haig distributary the surface mostly lacks the broader surface calcretes, instead only isolated patches are evident. In this area, only one shallow degraded surface collapse is present: N-2999.

Although a number of caves located nearby (N1536, N1611, N1612, N-1596) are more indicative of substantial shallow cavity development in both their size and subsurface collapse development, at depths accessible up to 14m.

To date I have only completed a detailed search of approximately two thirds of the Forrest PRRegion, but from this it is apparent there are far fewer large surface karst features, as only two have been located so far.

Figure 20 SW HPR Distributary Feature - Shallow degraded collapse N-2999D@65º

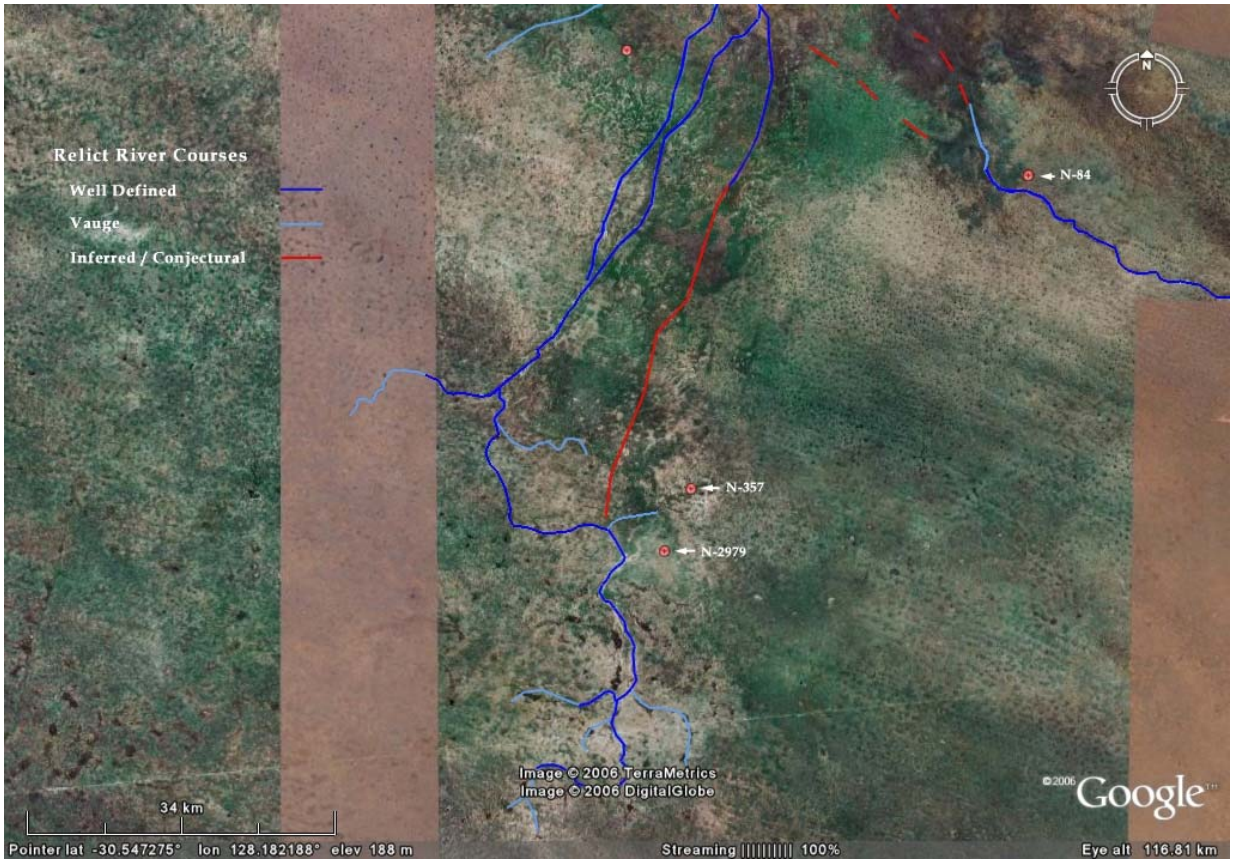

Figure 21 Forrest PRRegion and the two visible features N-357 and N-2979

Figure 22 N-2979 D1@30º Doline comlex with multiple slots & holes

One was known previously N-357, and one is new N-2979. N-357 appears to be a shallow collapse occurring in the base of a shallow E-W corridor on the eastern margin of the Forrest PRRegion and it differs substantially to the other feature N-2979 which is a complex of shallow dolines and holes where the deepest access is only 3m.

Areas studied outside and further removed from the Palaeoriver systems within the Loongana and Forrest Map sheets, do show a number of vague shallower surface features on Air Photos. They are numerous, but appear to be more random and much more widely scattered. A number visited show the cause to be shallow soil erosion areas around blowholes. These blowholes eg. N-3606 (NXP-559), and N-3607 (APP-L12/5032-04) seem to access more typical doming structures developed over “vuggy” macro-cavity layers with limited lateral extent. Visible surface collapse appears largely absent and the only exception located to date is N-2455 (NXP-177). This collapse does access a cave with more extensive shallow cavity development with approx 340m of shallow passage at depths to the surface of no greater than 8m [Devine 2007].

Conclusions

The depth of surface cover causes an enhanced size of surface doline expressions for the features located within the Haig PRRegion and is the reason these features are easily observed in Aerial Photography.

The underlying cause of these surface features appears to be areas of localised shallow collapse.

Areas of surface and underlying collapse appears to be more restricted to within, or in close proximity to the Haig PRRegion and its distributaries.

The Forrest system does not appear to have the same underlying karst development as the Haig system, or it could simply lack current surface activity.

Areas adjacent to the western portion of the Dip exhibit no easily recognisable features on Aerial Photography.

The areas examined are limited to the lower reaches of the Haig and Forrest systems and the western end of Dip, therefore a further examination of the palaeoriver regions both in Western and

South Australian Nullarbor is needed to show if the Haig system features are an isolated occurrence.

Finally the link between historical shallow water table levels seems to be supported by the widespread development of shallow karst features in the Haig region. Although further investigation of features shown in this report is needed to lead to direct evidence of the level of precursor development for these caves.

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