TEILTA, WESTERN NEW SOUTH WALES

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INTRODUCTION

The Teilta area contains regolith and landforms typical of many of the low relief and transported regolith-dominated landscapes of south-eastern central Australia. Although knowledge of the underlying bedrock is limited, it is interpreted to include highly prospective Palaeo-Proterozoic Willyama Supergroup lithologies associated with a possible northwestern extension of the Broken Hill and Euriowie blocks (Cameron, 1993a and b). The knowledge of the regolith materials and their landscape evolution context are therefore very important for mineral exploration programs here, and for understanding mineral exploration approaches in areas with transported regolith types.

PHYSICAL SETTINGS

Location

The Teilta area conforms to the area of the Teilta 1:100 k scale mapsheet. Teilta is named after an abandoned homestead now incorporated into Avenel Station, approximately 120 kilometres north-northwest of Broken Hill. The area extends from the western margins of the Barrier Range and flanking sheetwash-dominated gibber plains, through to the Strzelecki Desert dunefields as far west as the NSW-SA border.

Geology

Mineral exploration drilling and geophysics have interpreted the underlying bedrock to include the Palaeo-Proterozoic Willyama Supergroup and Neo-Proterozoic Adelaidean metasediments and metavolcanics (Cameron, 1993a and b). Relatively little is known about the bedrock geology here because transported regolith materials extend across most of the landscape. To the east, Neoproterozoic Adelaidean bedrock is extensively exposed within the northwestern parts of Barrier Ranges. Quartzite exposures further west at Bull Hill, and previously undescribed exposures near Teilta and Joulnie homesteads are probably Adelaidean metasediments. Pelitic metasediments (phyllites) occur in some creek exposures in the central south (e.g. south of Teilta homestead), and are possibly from the Paragon Group of the Palaeo-Proterozoic Willyama Supergroup (Richard Barrett, NSW DMR, pers. comm., 2004).

The main structural feature of the area is the northern end of the N-S trending Mundi Mundi Fault. This structure subdivides the bedrock-dominated terrain to the east, from sheetwash and aeolian regolith-dominated landscapes to the west. Other structural lineaments can be detected from subdued range-fronts, rises and linear drainage patterns within the regolith-dominated terrain in the west, particularly along the western margins of the Woowoolahra Range, west and southwest of Teilta homestead (Figure 1). The western margins of the Woowoolahra Range are associated with a northerly continuation of the Kantappa Fault (Hill and Kohn, 1999). Between the Mundi Mundi Fault and the Woowoolahra Range regolith depths have been drilled up to 60 m, whereas west of the Woowoolahra Range they have been drilled to up to 178 m (Cameron 1993a and b).

BHP Minerals conducted the most detailed mineral exploration in the area for Cu-Au and Ag-Pb-Zn mineralisation during the early 1990s (Cameron, 1993a and b). Their approach was to initially define regional aeromagnetic targets from regional Bureau of Mineral Resources data and then conduct more detailed, low level aeromagnetic and radiometric surveys and grided ground surveys. Limited drilling (including RC and diamond drilling) tested some of the magnetic targets. Assays of basement and the basement-'overburden' interface had low base metal contents over moderate to wide intervals (Cameron 1993a and b).

The area is within the southeastern parts of the Mesozoic Eromanga Basin (Krieg and Rogers, 1995) and the Cainozoic Lake Eyre Basin (Alley, 1998). The Mesozoic Eromanga Basin sediments in this area mostly include marginal and shallow marine sediments. Although extensive towards the northwest of the area, their surface expression is poor due to aeolian dunefield cover or shallow gibber surface lags associated with surficial sheetwash sediments. In the northeast near Floods Creek and near Tarango Tank in the south, silicified fossil wood fragments derived from Mesozoic sediments are a component of surface gibber lags. The Lake Eyre Basin sediments in the area include the transported regolith materials described here. The most prominent of the older sediments from this basin are silicified, rounded and polished quartzose gravels and sands equivalent to the Palaeogene Eyre Formation.

Geomorphology

The area contains a variety of landscape types representative of large parts of western NSW. The western margins of the Barrier Ranges form the most prominent landscape feature in the east of the area. The highest point here is at Mt Westwood and adjacent peaks, which rise to about 240 m above sea level. A lower, N-S trending ridge of rises and low hills of the northern part of the Woowoolahra Range extend through the central-southern parts of the area south of Joulnie homestead (Kenny, 1934). The central parts of the area are dominated by alluvial and sheetwash sediment plains covered with gibber. These plains extend westwards from the Barrier Ranges and east and west from the

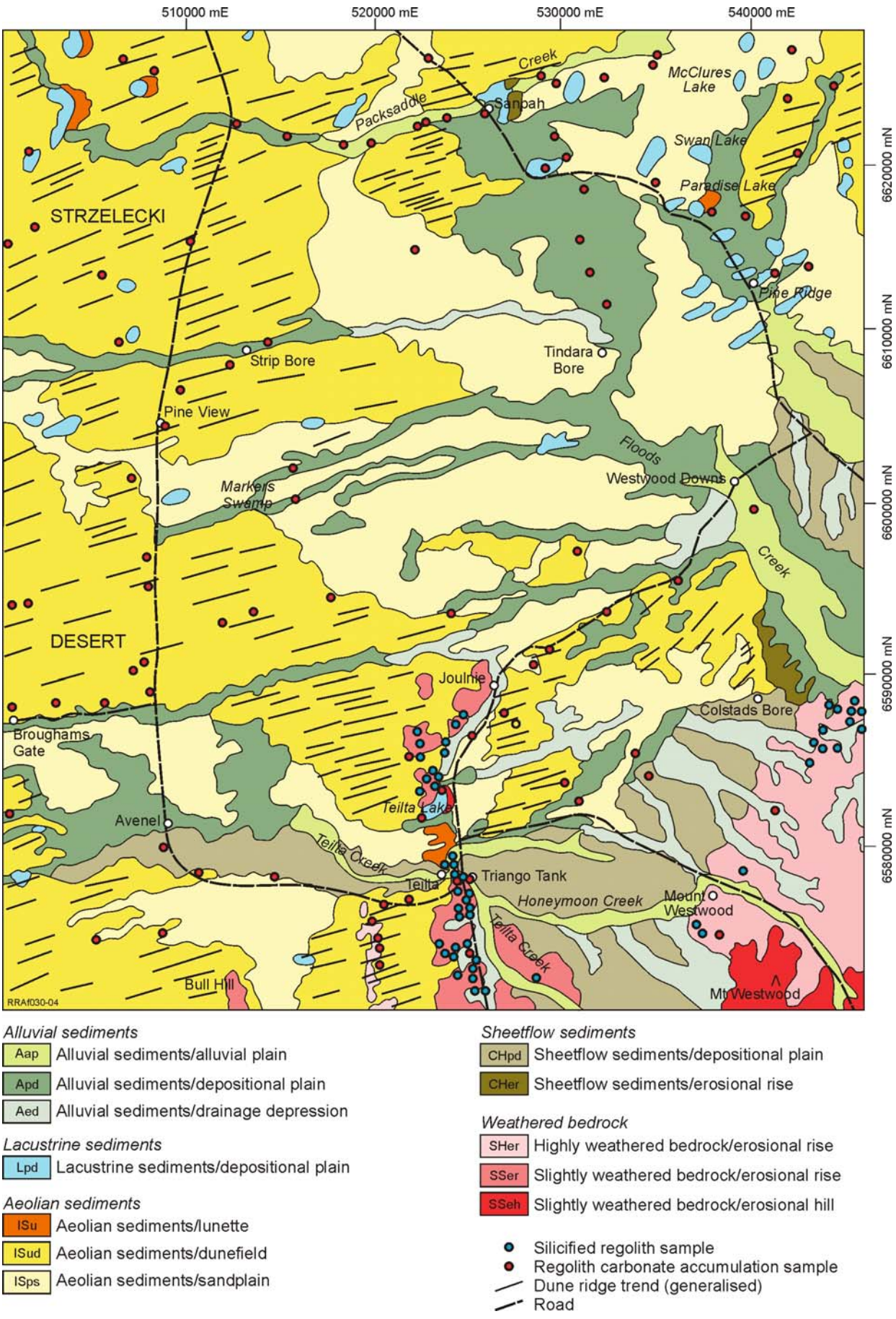

Figure 1. Simplified regolith-landform map of Teilta 1:100,000 sheet area.

margins of the Woowoolahra Range. A linear dunefield, with minor alluvial outwash swamps and lakes, and playas, of the Strzelecki Desert occurs the west. Bull Hill forms a bedrock-dominated, low hill rising above the dunefield in the southwest. The lowest parts of the study area are within playa depressions in the northwest, at approximately 50 m above sea level.

Drainage systems mostly extend from the western margins of the Barrier Ranges and flow west, terminating in alluvial swamps and lacustrine depressions within the Strzelecki Desert dunefield. Major drainage systems include Packsaddle Creek in the north of the area; Floods Creek in the central parts of the area; and, Honeymoon and Teilta creeks in the south (Figure 1).

Climate

The nearest meteorological station is at Broken Hill. The region has a semi-arid climate, with warm to hot summers and cool winters, and an erratic and generally low, annual rainfall. The average annual rainfall for Stephens Creek Reservoir is 220 mm, with average maximum and minimum temperatures of 32.7^{o} C and 18.1^{o} C in summer (January) and 15.5^{o} C and 3.8^{o} C in winter (July) (Bureau of Meteorology, 2003). Teilta occurs close to the transition between winter-dominated seasonal rainfall to the south and summer-dominated seasonal rainfall to the north. Rainfall is expected to be slightly lower than that of Broken Hill and maximum temperatures slightly higher. In summer, winds are mostly from the S and SE. South and SE winds also prevail in autumn but tend to be of moderate velocity, with stronger winds originating from the N and W. Strong winds predominate in winter and mostly come from the N and S. Generally moderate to strong winds originate from all directions in spring.

Vegetation

The vegetation communities are very closely associated with the major landform settings. The general characteristics include:

- Barrier Ranges hills and rises are mostly colonised by chenopod shrublands dominated by saltbush (*Atriplex spp.*) and bluebush (*Maireana spp.*), with some areas of open woodland with mulga (*Acacia aneura*), belah (*Casuarina pauper*) and rosewood (*Alectryon oleofolius*) trees. Major drainage channels host a river red gum (*Eucalyptus camaldulensis*) riparian woodland, and smaller streams are colonised by small trees of prickly wattle (*Acacia victoriae*).
- Colluvial and alluvial outwash plains are mostly colonised by barley mitchell grass (*Astrebla pectinata*) grasslands and chenpod shrublands dominated by saltbush (*Atriplex spp.*) and bluebush (*Maireana spp.*). Major drainage channels host river red gum (*Eucalyptus camaldulensis*) riparian woodlands in the south (e.g. Honeymoon Creek), while to the north (e.g. Floods Creek) they also include coolabah (*Eucalyptus microtheca*), beefwood (*Grevillea striata*) and river coobah (*Acacia stenophylla*) trees.
- Aeolian dunefields include open woodlands dominated by white cypress pine (*Callitris columellaris*) and belah (*Casuarina pauper*), with some mulga (*Acacia aneura*) and rosewood (*Alectryon oleofolius*) trees. Aeolian sandplains are mostly colonised by shrublands dominated by hopbush (*Dodonaea spp.*). Drainage channels and alluvial swamps within the dunefields host riparian woodlands dominated by black box (*Eucalyptus largiflorens*) and occasional river red gum (*Eucalyptus camaldulensis*) and beefwood (*Grevillea striata*) trees. Playas within the dunes are sparsely vegetated with their fringes hosting chenopod shrublands typically dominated by samphire (*Arthrocnemum halocnemoides*).

REGOLITH-LANDFORM RELATIONSHIPS

Weathered Bedrock

Weathered bedrock is mostly buried by transported regolith within the area. The main exposures are associated with hills, rises and erosional plains of the Barrier Ranges in the southeast. Minor weathered bedrock exposures occur on the flanks of rises and within drainage depressions in the Woowoolahra Range (Figure 2), and at Bull Hill. Bedrock lithologies more resistant to weathering and erosion (such as quartzites) are most prominently expressed in the landscape as hills and rises, whereas more labile lithologies are buried or exposed within deeply incised drainage depressions.

Alluvial Sediments

Alluvial sediments associated with contemporary drainage systems include channels, swamps, depositional plains, and drainage depressions. Most of the drainage systems flow from east to west, terminating in alluvial swamps and lacustrine depressions within the Strzelecki Desert.

Silicified, quartzose alluvial sediments cap the crests of erosional rises in the central and northeastern parts of the area (Figure 3). Most exposures of these sediments are topographically inverted from their original low-lying valley settings to now occur on rise crests. Palaeocurrent direction indicators are poorly preserved in these sediments, however some cross-bedding measurements, as well as the field context of the sediments and the gradient of basal unconformities, suggest that they were mostly part of drainage systems that generally flowed towards the west and northwest.

Colluvial Sediments

The most dominant colluvial sediment type forms broad plains with shallow overland flow, including sheetwash. These extend westward from the Barrier Ranges as well as eastwards and westwards from the Woowoolahra Range. A large, multi-lobed, sheetflow fan extends westward for about 15 km from near Mount Westward homestead to Triango Tank, east of Teilta Homestead. The sheetflow fans have a distinctive ‘contour band’ surface pattern defined by pebbly bands with sparse vegetation cover

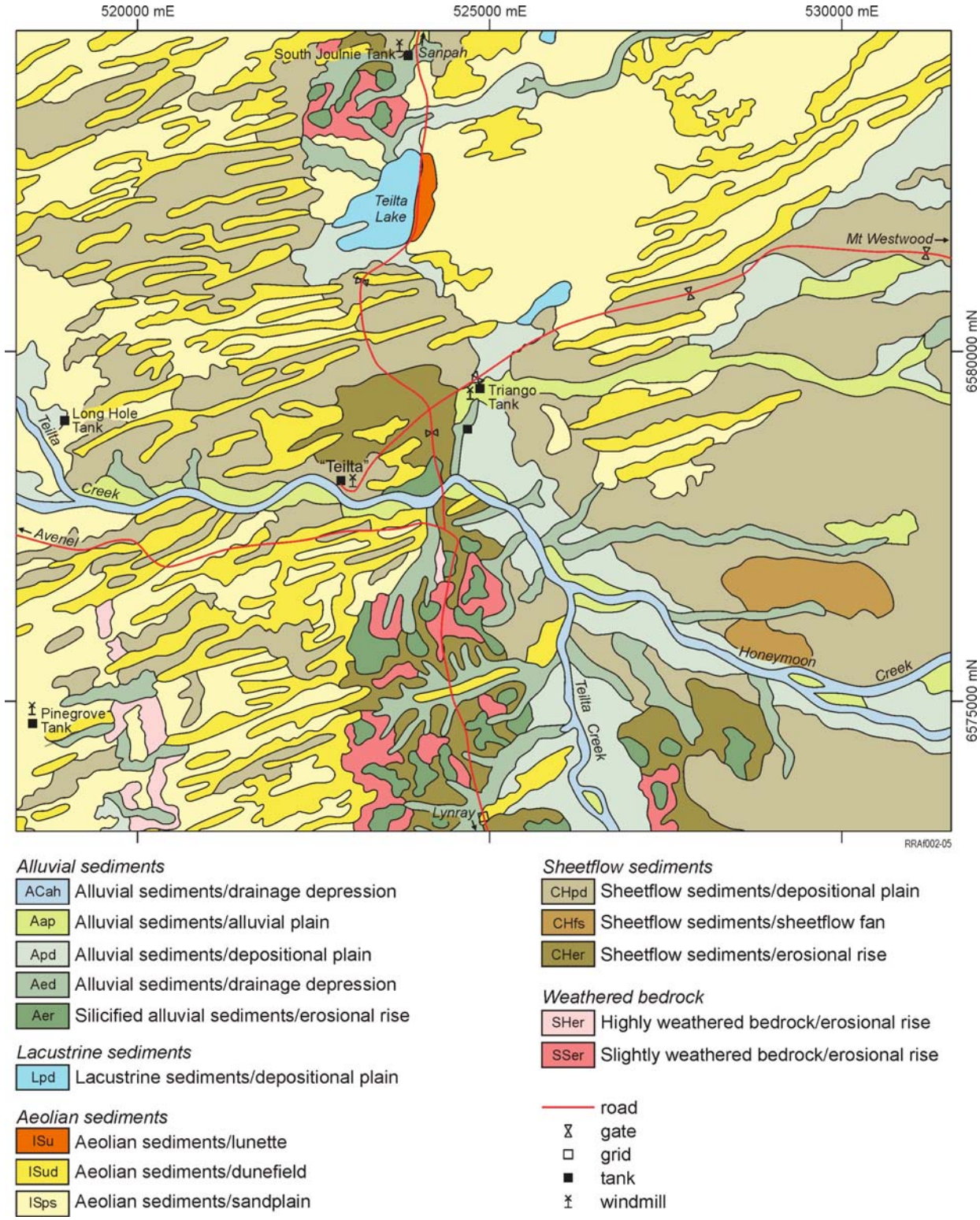

Figure 2. Detailed regolith-landform map of the Teilta homestead area.

a)

d)

b)

e)

c)

f)

Figure 3. Photographs of regolith-landform features of the Teilta area. **a)** slightly weathered bedrock exposure on erosional rise otherwise dominated by sheetflow sediments (AMG66: 526924mE / 6574424mN); **b)** lake shore and depositional plain of Paradise Lake (AMG66: 538618mE / 6615276mN); **c)** gibber plain with pebbles of silicified sediments. Gibber clasts are deposited by sheetflow within a depositional plain (AMG66: 544939mE / 6600427mN); **d)** topographically inverted silicified sediments exposed on an erosional rise (AMG66: 544007mE / 6584840mN); **e)** alluvial sediments associated with the Floods Creek depositional plain colonised by coolabah woodland near Tindara Bore (AMG66: 531679mE / 6607872mN); **f)** red brown sands within linear dunes of the Strzelecki Desert (AMG66: 509386mE / 6575775mN).

interspersed with more densely vegetated bands composed of red-brown sands and silts. Rises and low hills flanking the plains host more localised but steeper gradient sheetflow sediment transport. Minor creep and rockfall talus deposits flank erosional rises and hills, particularly in the southeast of the area.

Aeolian Sediments

Aeolian sediments are at least a minor component of surficial regolith, as well as dominating many landforms. Linear dunes within the Strzelecki Desert dunefield trend ENE-WSW across the western and northern parts of the area. Most dunes range from several metres to up to 10 – 20 m high, with most aeolian cover being less than 10 –20 m thick (with underlying materials exposed in many dune swales). The eastern margins of the dunefield and some areas flanking drainage channels consist of aeolian sandplains. These represent former extensions of the dunefield that have been reworked by overbank flow, such as along the outwash margins of Teilta Creek west of the Woowoolahra Range. Lunettes are crescentic, transverse dunes that have mostly formed on the eastern margins of lacustrine depressions, in particular near Sanpah homestead and at Paradise Lake.

Lacustrine Sediments

Numerous playas and lakes occur mostly within the north and west. The two main types include: 1) irregular-shaped and sparsely-vegetated playas, mostly isolated from drainage channels, particularly in the far northwest; and, 2) round, circular and oval-shaped swamps and lacustrine depressions typically flanked by black box (*Eucalyptus largiflorens*) trees, and associated with alluvial channels and outwash swamps. The playas receive only localised surface water inputs as well as groundwater discharge, whereas the swamps and lacustrine depressions mostly receive surface water inputs associated with major drainage channels. The underlying bedrock structure and lithology influences the development of some lacustrine depressions, such as at Teilta Lake which is largely constrained by exposures of resistant quartzites on its western margins. Lakes in the northeast, such as McClures Lake, Swan Lake and Paradise Lake occur along a northern extrapolation of the Mundi Mundi Fault, suggesting the possibility of underlying structural controls.

Silicified Regolith

Silicified regolith occurs as small pods up to several 10s of metres wide, capping erosional rises and erosional plains composed of ancient alluvial sediments. The most prominent exposures occur along the Woowoolahra Range and within rises in the southeast between Mount Westwood homestead and the channel of Floods Creek to the north. As discussed earlier, these materials had a former landscape expression associated with palaeovalley systems that have since been topographically inverted.

Ferruginous Regolith

Ferruginous regolith is mostly associated with ferruginised saprolite exposed on the flanks of erosional rises typically consisting of shale units within the Adelaidean metasediments. It is not widespread in the area, but is most typically exposed in the southeast within the Barrier Ranges. Ferruginised Mesozoic sediments also occur along the margins of rises in the Woowoolahra Range.

Regolith Carbonate Accumulations (RCAs)

Nodular and powder RCAs occur within linear dunefields and sandplains in the west, especially where they have been incised by major alluvial channels and drainage depressions. These RCAs are interpreted as pedogenic RCAs. Minor hardpan coatings are associated with weathered bedrock and silicified regolith interfaces on erosional rises in the southeast of the area and within the Woowoolahra Range. These RCAs form from soil water ponding along hydromorphic boundaries. Low mounds of massive, tabular accumulations are associated with some lacustrine depositional plains, particularly in the northeast of the area, such as at McClures Lake and east of Sanpah homestead. This type of RCA is interpreted as forming from palaeo-groundwater discharge and evaporation within lakes.

Gypseous Regolith

Gypseous regolith typically underlies alluvial depositional plains, particularly overlying weathered bedrock near drainage constrictions such as near Teilta, and exposed in drainage depressions and excavated station tanks (e.g. Tarango Tank). Near Teilta homestead, polycrystalline gypsum aggregates have indurated up to 3 m of alluvial sediments overlying weathered bedrock. Minor gypsum aggregates are also typically associated with many exposures of ferruginised Mesozoic siltstone, suggesting that the weathering of sulphides (such as pyrite) is at least a local chemical source for gypsum in some cases. Silt-size gypsum crystals are also associated with playa floors and flanking lunettes (kopi) in the northwest.

Halite-Rich Regolith

Halite is mostly associated with irregularly shaped playas in the northwest, and as efflorescence along the banks of many channels and drainage depressions. This is most notable along the banks of Honeymoon Creek upstream of Mount Westwood homestead. In this case, saline waters have ponded upstream of the stream knickpoint defined by a locally resistant Adelaidean quartzite unit trending transverse to the drainage channels and the alluvial plain. Patches of dead river red gums at this site suggest that this saline ponding is a relatively recent development.

REGOLITH CHARACTERISATION

Weathered Bedrock

Highly weathered bedrock in this area consists of kaolin and quartz in many cases with ferruginous (hematite and goethite) induration. The preservation of primary bedrock fabrics such as quartz veins and schistosity are diagnostic features. Moderately weathered bedrock typically has some iron-oxide staining and kaolin. This is mostly associated with Adelaidean pellites in the southeast. Slightly weathered bedrock (saprock) is typically associated with quartzite and quartz vein exposures, where very few of their primary minerals are weathered, although joints and fractures may be slightly opened.

Alluvial Sediments

Alluvial sediments associated with contemporary alluvial systems include gravels, sands, silts and clays, with both lithic and quartzose clasts. More ancient alluvial sediments are composed of silicifed quartzose gravels and sands. The quartz clasts in these sediments consists of rounded milky vein quartz and clear metamorphic and igneous quartz.

Colluvial Sediments

Sheetwash sediments consist of red-brown quartzose sands and silts with either quartz-rich (vein quartz and silicified clasts) gravels, or a mixture of quartzose (mostly vein quartz) and lithic gravels. The mixed lithic gravel deposits mostly occur within the sheetflow fans extending westward from the Barrier Ranges. Gravel clasts are mostly angular to sub-rounded, although rounded clasts become more significant to the west, probably because of increased contributions from palaeo-sediments in the Woowoolahra Range, as well as increased transport distances from source areas, which are mostly to the east.

Aeolian Sediments

The aeolian sediments consist of a range of materials, largely depending upon their landscape setting. The linear dunefields and sandplains mostly consist of red-brown quartzose sands. The sands typically have a paler red-brown colour on sandplains, largely because of alluvial and sheetwash reworking which removes the ferruginous component. Lunnetes flanking playas mostly consist of gypsum and clays, whereas lunettes flanking round and oval-shaped lacustrine depressions mostly consist of white quartzose sand.

Lacustrine Sediments

The composition of lacustrine sediments relates to the type of lacustrine depression. Playas are mostly composed of halite, gypsum, kaolin, smectite, organic materials and quartz, whereas the lacustrine depressions associated with surface drainage systems consist of quartz and minor kaolin and organic materials.

Silicified Regolith

Silicified regolith mostly occurs within quartzose sands and gravels. The cementing material is dominated by micro-crystalline quartz and minor anatase and hematite. Silicification is mostly massive, although nodular and 'glerp' morphologies also occur. They are mostly a light grey colour, although near Teilta homestead, some are distinctively bluish. Assays of some of the bluish silicified sediments show Cu contents up to 60 ppm.

Ferruginous Regolith

Minor occurrences of ferruginous regolith include ferruginised saprolite composed of variable amounts of primary bedrock minerals with hematite and goethite. Many of these materials have variable base metal contents that may be relatively high compared with other regolith types in the area, largely reflecting the ability of these materials to act as trace metal repositories.

Regolith Carbonate Accumulations

These include calcite-rich nodules, powder and minor hardpan and tabular accumulations. Trace element contents are variable, and include Au contents up to 8 ppb.

Gypseous Regolith

Gypseous regolith mostly consists of polycrystalline accumulations in some cases up to 2.5 m thick. Inclusions of detrital clasts are rare, suggesting that rapid displacement is associated with their development.

DATING

There has not been any systematic regolith dating research undertaken in this area other than the determination of relative ages derived from field relationships.

REGOLITH EVOLUTION

Some of the key components of the regolith and landscape evolution of this area include:

- *Weathering of bedrock*: Likely to have a long history of formation with weathering profiles developed in bedrock underlying Mesozoic sediments, and the quartzose composition of Palaeogene sediments suggest a highly weathered landscape existed at least by the Mesozoic.
- *Mesozoic marine incursion*: This was likely to have been important for both drainage baselevels and climatic controls on landscape evolution. The deposition of Mesozoic sediments appears to have been locally controlled by the bedrock ridge of the Woowoolahra Range, with a local depocentre forming immediately to the east of the range. Many of these sediments were pyrite-rich, influencing the materials involved in later weathering reactions, where acid-sulphate conditions associated with the weathering of pyritic sediments may be important in the development of silicified

regolith materials facilitating Al removal and local concentration of silica (Hill, 2000).

- *Cainozoic tectonics*: This is linked with sedimentary basin and hinterland upland evolution. Importantly, even in areas with widespread transported regolith, some underlying basement structures have a landscape expression (such as linear lacustrine depressions and swamps and subdued range-fronts). Topographically inverted, Eyre Formation sediments covered most of the Woowoolahra Range in the Palaeogene, and tectonism along the Kantappa Fault is likely to facilitated subsequent base-level change and erosion.
- *The predominance of aeolian and sheetflow sediments in the contemporary landscape.* Interactions between these processes in the past means that the margins of dune fields where sandplains now occur have had a complex history of regolith development. This has included dune development and reworking by sheetwash processes. Although the cover from these two sediment types is widespread, it is not very deep (typically < 10 m), suggesting that buried bedrock may have some expression in the surficial landscape.

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