REGOLITH-LANDFORM MAPPING, LEUCITITE BASALT AND THE LANDSCAPE EVOLUTION OF THE BYROCK REGION, NW NSW.

D. Hugh Glanville[1], Ian C. Roach[2] & Kenneth G. McQueen[1,3]

[1]CRC LEME, Department of Geology, Australian National University, Canberra, ACT, 0200
[2]MCA Lecturer, CRC LEME, Department of Geology, Australian National University, Canberra, ACT, 0200
[3]Division of Health, Science and Design, University of Canberra, ACT, 2601

INTRODUCTION

The Byrock region is approximately 50 km NNE of Cobar in northwestern NSW. Valley-filling leucitite basalts (leucitites) occur northeast of Cobar, at El Capitan, and to the west of Byrock (Figure 1). The Byrock leucitites occupy an area of ca. 8 km^2. They occur as moderately weathered basaltic rises up to 35 m high in a low-relief area dissected by an ephemeral drainage system, including the north-trending Mulga Creek lying in the east of the mapping area. The Byrock leucitite is a part of the eastern Australian leucitite suite, which is a linear, age-progressive intraplate volcanic province that parallels the better known central volcanoes, which also form age progressive suites southward through eastern Australia. The leucitite province forms a line from Byrock in the north to Cosgrove, Victoria, in the south, which has been K-Ar dated from 16.8 Ma to 6 Ma (Sutherland 1983).

The Byrock leucitite forms three main outcrops: Bye Hill, a lava mound of ca. 5 km^2 and 35 m relief; and two much smaller disconnected outcrops forming low rises to the N and NE. Other small remnants of leucitite float (up to about 100 m^2) have been discovered during mapping traverses undertaken during the course of this research. The main outcrop of leucitite, Bye Hill, is cut through by a quarry on its western flank, allowing for cross-sectional examination and interpretation. The quarry faces are slightly to moderately weathered and it is difficult to interpret internal flow structures and to differentiate flow layers. Small pods of pink-coloured porcelainite, presumed to be explosively-incorporated lacustrine sediments, occur in the lower parts of the quarry faces, allowing some differentiation of flow boundaries.

The erupted leucitites provide a time marker in the landscape evolution of the Byrock area. This can help constrain regional studies aimed at understanding the landscape evolution and regolith development to assist mineral exploration.

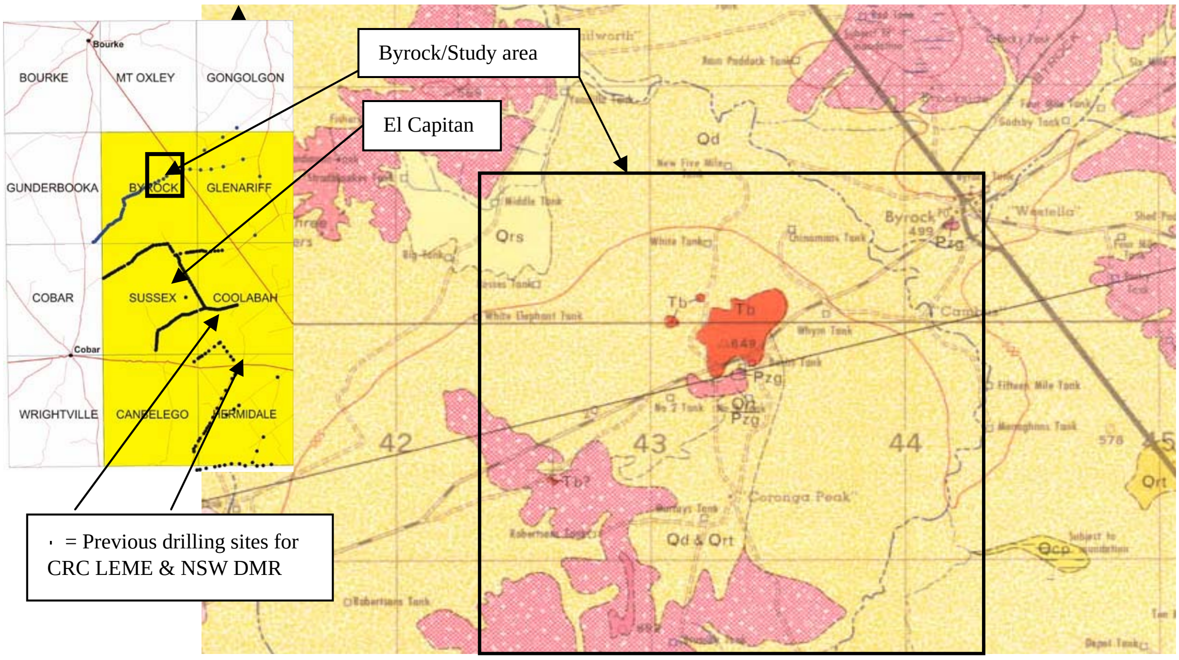

Figure 1: study area location showing the major leucitite outcrops (labelled "Tb") at Byrock, and their location with respect to Cobar and Bourke. Images are from the Bourke 1:250,000 geological sheet (Anderson *et al.* 1967) and Discovery 2000.

The aims of this study were to:

- Investigate the regolith-landform features surrounding and including the Byrock leucitite basalt.
- Establish the paleodrainage network of the area prior to eruption of the leucitites.
- Use this information to construct a landscape evolution model for the area.

CLIMATE

Mean maximum temperatures for Bourke are 36.4°C in summer (January) and 17.9°C in winter (July). The mean minimum temperatures are 20.9°C in summer and 4.7°C in winter. The average annual rainfall is approximately 355 mm (Bureau of Meteorology 2003.), placing Byrock in the semi-arid zone. Byrock lies approximately half-way between Cobar and Bourke, but probably experiences a more Bourke-type climate given its geographic position. Cobar sits over the Menzies Line equivalent, which is the eastern extension of the Menzies Line (Gentilli 1971, Hill *et al.* 1998). The Menzies Line is a zone which divides Australia into regions dominated by summer or winter rainfall. To the north of Byrock, Bourke receives a clearly summer-dominated monsoonal rainfall pattern. Cobar, however, receives rainfall that is a fusion between summer and winter dominated rainfall, resulting in nearly equal rainfall year-round (Figure 2).

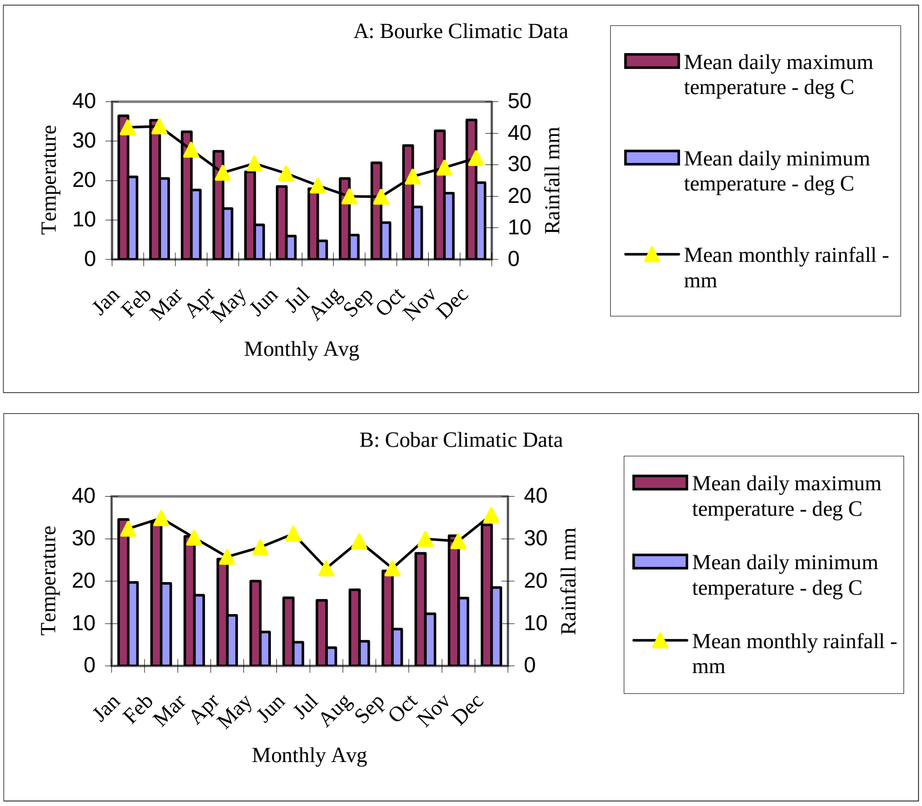

Figure 2: Climatic data including rainfall and minimum and maximum temperatures for: A) Bourke; and B) Cobar (Bureau of Meteorology 2003).

VEGETATION

There is a strong correlation between regolith-landforms and vegetation communities in the Byrock area. There are two dominant vegetation communities throughout the mapping area, which are:

1. woodland consisting dominantly of Mulga (*Acacia aneura*); and
2. areas with a more diverse species association, which form Bimble Box (*Eucalyptus populnea)* woodland.

Common species associated with the Mulga (*Acacia aneura*) woodland include forbs (burrs and grasses). Common species associated with the Bimble Box (*Eucalyptus populnea*) woodland include Coolibah (*Eucalyptus microtheca*), Budda (*Eremophila mitchellii*), Wilga (*Geijera parviflora*), Wild Orange (*Capparis mitchellii*), Emu Bush (*Eremophila longifolia*), Silver Cassia (*Cassia artemisioides*), Turpentine (*Eremophila sturtii*), Wild Hops (*Acetosa vesicaria*) and Galvanized Burr (*Bassia birchii*) as well as other forbs and grasses.

Vegetation on the leucitites is dominated by Beefwood (*Grevillea striata*), Kurrajong (*Brachychiton populneus*), Wilga (*Geijera parviflora*) and Paddy Melons (*Cucumis myriocarpus*) as well as forbs and grasses. Ephermeral swamps are dominated by Warrior Bush (*Apophyllum anomalum*) and Lignum (*Muehlenbeckia cunninghamii*), which occur in small numbers. White Cypress Pines (*Callitris columelaris*) are rare in the local area, and tend to be associated with sandy regolith.

METHODS

Mapping was conducted primarily using aerial photo interpretation (API) and ground truthing with point sampling and description. This was augmented with Landsat and ASTER imagery, published maps and reports, and aeromagnetic data from the Discovery 2000 dataset (Discovery 2000). Detailed descriptions of each regolith-landform unit (RLU) was made using the Geoscience Australia RTMAP (Pain *et al.* 2002) symbology, with vegetation and associated materials used as modifiers. These data were then combined to construct a regolith-landform map of the area. This, along with aeromagnetic (Figure 3), radiometric, geochemical and geological data, allowed the construction of a landscape evolution model for the area.

Air core and reverse-circulation drilling was carried out by the NSW DMR through the mapping area. This has provided three dimensional information on the regolith and bedrock lithologies. The surface and drill hole information, together with K-Ar age data on the leucitites, have been used to construct a landscape evolution model for the area.

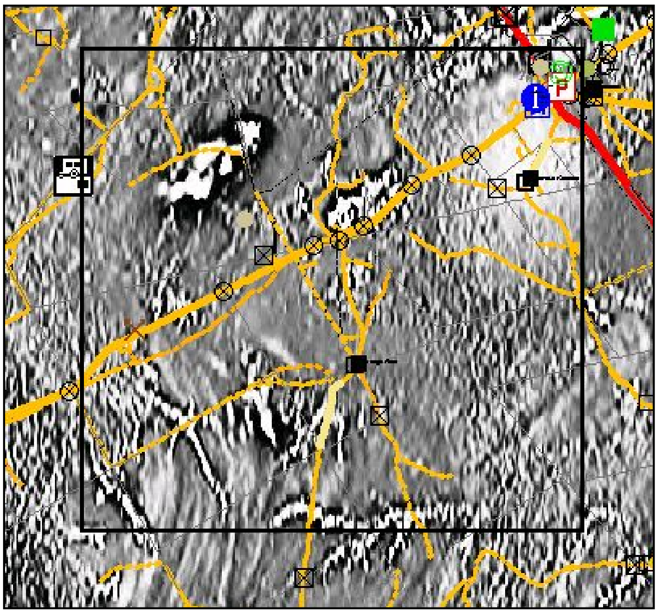

Figure 3: Aeromagnetic 1.5VD image from the Discovery 2000 dataset, with study area delineated (Discovery 2000).

REGOLITH-LANDFORMS

Landforms in the Byrock area are dominantly low relief and consist of: low rises; alluvial channels and depressions; and colluvial and alluvial plains. There are scattered moderately to highly weathered bedrock units in the mapping area, which in most cases form the landscape highs.

The dominant surficial regolith material throughout the mapping area is a combination of lag (lithic, vein quartz and maghemite) and red-brown fine sands and silts, visible in background of Figures 4 & 5. The silts and sands consist of silt-sized clay aggregates and quartz. Gonzalez (2001) showed that this was derived from both the weathering of local bedrock as well as aeolian addition. The aeolian component of both clay and quartz material is evident not only in the colluvial and alluvial regolith-landforms but is also a major component of the regolith material overlying the fresh leucitite basalt. Quartz, which does not occur in the basalt, is a large component of the soil on the basalt (Gonzalez 2001).

ALLUVIAL SEDIMENTS

The main drainage system through the mapping area is Mulga Creek, which flows northward along the eastern edge of the mapping area towards the Darling River, which in turn drains into the Murray Basin. Alluvial sediments in the area are deposited in ephemeral channels, floodplains, swamps and lakes. These sediments are dominated by red/brown fine sands and silts, the aeolian component common throughout much of the area. There are many small closed alluvial depressions throughout the mapping area, which periodically fill with water. These form stagnant alluvial swamps and pools with small alluvial channels draining into some of these areas or joining them. These alluvial swamps and their associated channels are remnants of the Mulga Creek alluvial system, which now runs further to the east along the border of the mapping area (Figure 1). The alluvial depressions are characterised by regolith with a higher clay content than the colluvial units throughout the mapping area. Vegetation in these areas is dominated by Bimble Box woodlands, as shown in Figure 4.

Figure 4: An ephemeral alluvial swamp (Aaw). Regolith materials are dominated by red brown fine sands and silts with higher amounts of clay than in higher relief areas. Vegetation is dominated by Bimble Box woodland. Photo: ICR.

COLLUVIAL SEDIMENTS

Colluvial sediments occur on the majority of the RLUs in upland areas of the mapping area. These sediments are also dominated by red/brown fine sands and silts, the dominant aeolian component of the Byrock area, and overlying lag. Colluvial units consist of colluvial erosional rises, colluvial erosional depressions, colluvial erosional plains, colluvial depositional plains, and colluvial sheet wash areas. In many areas colluvial movement (and sheet wash) across these landforms can be determined by vegetation patterns, where it forms bands of sheet wash debris such as stick dams. Lag and quartz occurring on the surface can also give indication of colluvial movement.

WEATHERED BEDROCK

There are four weathered bedrock units in the mapping area:

1. Leucitite, forming four distinct units in the central region of the mapping area (Figure 5);
2. Quartzite, forming a NNE-trending unit of bedrock, which outcrops in small-elongated units through the mapping area;
3. Ordovician Girilambone Group, which is a north trending unit consisting of phyllite, metasandstones, quartz rich sandstone, siltstone slate and chert (Chan *et al*. 2003); and,
4. Granite.

The leucitite and quartzite units form landscape highs of both ridges and hills/plateaus. The Girilambone Group is exposed in roadside borrow pits and lower lying areas, as well as directly below leucitite in some areas. The granite in the mapping area forms pavements of low relief, subcropping near the township of Byrock. The finer regolith materials in these areas are also dominated by red/brown fine sands and silts.

A LANDSCAPE EVOLUTION MODEL FOR THE BYROCK LEUCITITES

Preliminary results indicate that, at the time of eruption of the Byrock leucitites, the paleo-Mulga Creek flowed along a northward course through the area currently occupied by the leucitites. The creek was dammed by the erupting leucitite, resulting in the formation of a lake on the upstream (south) side. This is indicated by maghemite-rich channels in the 1.5VD aeromagnetic image (Figure 3), which disappear under basalts and lacustrine sediments and are re-arranged by the present drainage. Porcellanite (baked possibly lacustrine clay, under investigation) forming sub-horizontal lenses in the deeper parts of the leucitite (exposed in the quarry face) is further evidence of the eruption occurring in an alluvial/lacustrine environment. The porcelainite was presumably explosively incorporated into the leucitite flows during eruption by phreatic/phreatomagmatic activity.

Since the eruption, Mulga Creek has migrated eastwards in response to the newly-formed barrier of leucitite, leaving a series of stagnant alluvial plains and swamps forming inter-connected north-trending chains across the alluvial plain of the creek.

Figure 5: Photo of leucitite basalt with granitic inclusions and weathering rinds including fern like Mn-oxides precipitating along joint faces. Byrock Quarry. Photo: ICR.

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