GIRILAMBONE SYNTHESIS

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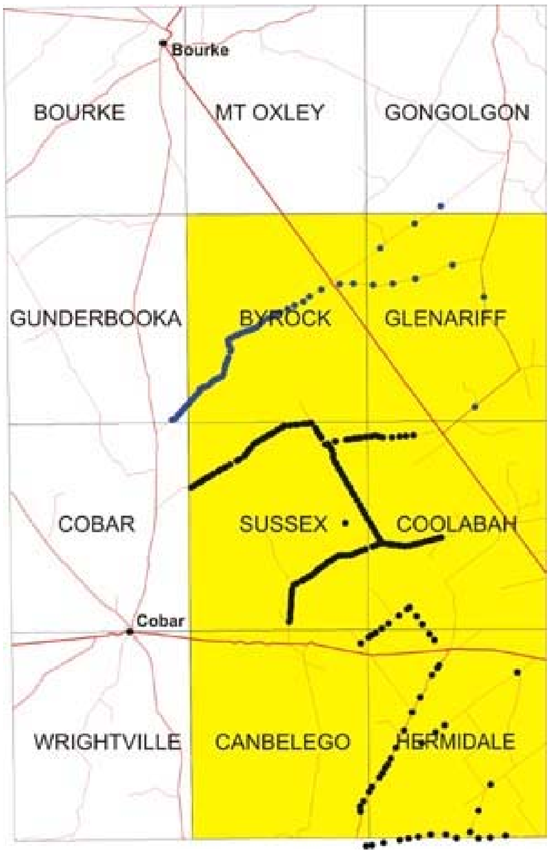
The Girilambone Project is one of CRC LEME's regional studies, centred in the western Lachlan Fold Belt of eastern Australia (Figure 1). It provides a model for an integrated, multi-disciplinary approach to understanding the landscape history and the major regolith controls on geochemical dispersion in an area of shallow to moderate regolith cover. The project is a collaborative venture between CRC LEME and the New South Wales Department of Mineral Resources and has involved a team of nine researchers from six core parties including geologists, geochemists a geomorphologist, geophysicist and soil scientist. The area has also been the focus for a number of student studies including five Honours and three PhD projects.

The area of study is located between Cobar, Nyngan, Bourke and Nymagee and is underlain by a poorly mapped and understood basement comprised of ?Ordovician Girilambone Group rocks with in-faulted slices of probable Early Devonian rocks, intruding granites and some Late Devonian outliers or down-faulted blocks. In the east there are a number of Alaskan-type mafic-ultramafic complexes. The Girilambone-Cobar-Nymagee region is one of the riches mineral provinces in New South Wales. Major deposits occur in the Cobar Basin, around Girilambone and at Canbelego and Nymagee. However, apart from the recent discovery of the Tritton polymetallic deposit, just south of Girilambone and the re-opening of the Mt Boppy gold mine as an open pit, there has been very little modern exploration activity in region of the Girilambone Terrain. This has been largely due to the extensive regolith cover as well as poor knowledge of the underlying geology. A major aim of this



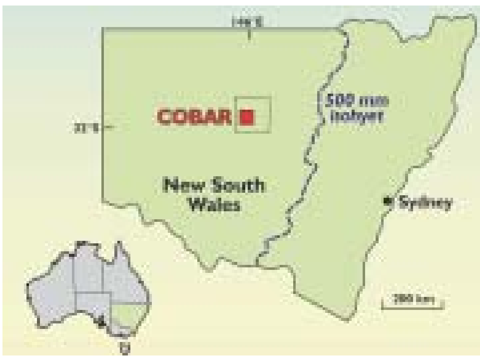


Figure 1: Location of the Girilambone Project in western New South Wales. Large map shows the position of air core drilling traverses and the 1:100 000 sheet areas.

project was to stimulate and assist exploration activities in this region through better knowledge of the regolith and the covered basement rocks.

The extensive regolith of the Girilambone region has formed during more than 60 million years of exposure, weathering and erosion. The cover includes intensely weathered *in situ* regolith and, superimposed transported materials of variable thickness, commonly in complex palaeochannel systems. The latter are preserved at different levels in the present landscape. Detailed regolith-landform mapping of key areas, combined with palaeomagnetic and apatite fission track dating, has established the landscape history and provided a framework for interpreting the regolith evolution. Better knowledge of the mineralogical and geochemical features of different regolith components (particularly the recognition and characterisation of the widespread transported regolith, not previously identified) can now greatly assist sampling and data interpretation for improved geochemical exploration.

A key feature of the project was the use of shallow air core drilling along a series of approximately east-west road traverses (Figure 1). This was designed to gain 3D information on the regolith, including petrographic, mineralogical and geochemical data down the profiles. It also allowed sampling of fresher saprock to help with bedrock mapping. A total of 247 holes were drilled and over 3360 samples analysed. This has provided a large data base of background geochemical compositions. This in turn has provided the opportunity to assess the level of background variation and establish element associations related to normal regolith-forming processes and different regolith host minerals. Some of these give rise to highly variable background levels for ore and pathfinder elements in different parts of the regolith, which may be confused with ore-related anomalies. The main associations include:

- an “evaporitic” association of Ca-Mg±Au, in some cases with Ba-Sr, related to regolith carbonate and barite accumulation in the near-surface regolith and at the base of palaeochannels and transported regolith;
- an association of Mn-Co-Zn±Ni-Cu±Au developed in redox boundary accumulations of manganese oxides/oxyhyroxides (particularly lithiophorite), commonly at around 20-30 m and at the present, deeper water table;
- an association of Fe-Cu-Zn with goethitic accumulations in the regolith;
- an association of Fe-As-Pb±Sb±Bi with hematite, particularly in ferruginous lag, paleochannel sediments containing ferruginous lag and in hematite rich mottles in the upper saprolite.

These and other regolith-controlled element associations can account for some of the background variation encountered when sampling the regolith of the region. Combined with information from previous case studies around Cobar and at Tritton it is now possible to develop a series of geochemical templates for different regolith materials that identify trends in multi-element relationships reflecting mineralised environments as distinct from normal background regolith concentrations and variations. This work has also established the important regolith host minerals and traps for dispersed pathfinder and target elements. With this knowledge it is possible to target the most appropriate sampling media for a given area and apply appropriate normalisation procedures to the data.

A number of different regolith materials are appropriate for sampling in areas of *in situ* or shallow transported cover in the Girilambone region. The typical soil is a relatively homogeneous red silty loam. It contains a major aeolian component of mainly quartz, clay and other resistate minerals such as zircon. In this region the aeolian component is mainly in the 60-80 µm size fraction and the +100 µm fraction is the most appropriate for geochemical sampling. Deeper sampling (>0.3 m) or sampling of the C horizon are other options, as the abundance of aeolian additions decrease with depth. Despite aeolian dilution and soil reworking/redistribution there is a significant bedrock-derived component in soils over *in situ* regolith related to bioturbation. In these settings soils are an appropriate and convenient sampling medium.

Lag is widespread in the region, is easy to sample and has been widely used as a sampling medium (generally the 3-15 mm size fraction), particularly at the reconnaissance level of exploration.

However, in many situations it has a complex transport history and variable mineralogy that can affect its usefulness. Bulk lag containing lithic and ferruginous fractions with a high goethite content is most useful where locally derived from *in situ* regolith. Lag transported directly from *in situ* regolith is useful for regional anomaly detection. Significant ore and pathfinder element fractionation has occurred during lag maturation and transport and some elements require normalisation to iron (hematite) content before interpretation. Micro lag (<150 µm) which includes dense and resistate mineral grains is also a useful sampling medium, particularly for gold.

Regolith carbonates are widespread in the lower part of the soil profile and as coatings on saprock/bedrock. This material accumulates gold and other elements and is useful for both regional and local anomaly detection. In areas with thin saprolite the upper generally more ferruginous zone below the soil or transported regolith can be a good geochemical sampling medium. In very strongly weathered profiles or where there has been marked erosional stripping saprolite geochemistry requires more careful interpretation. Iron oxide/oxyhydroxide concentrations in deeper saprolite commonly retain ore and pathfinder elements. Redox boundaries in well developed weathering profiles commonly show a regolith generated association of manganese and cobalt in some cases with zinc, copper and gold accumulation.

As part of the project we have developed a methodology for regolith-landform mapping appropriate to the minerals industry and also suitable for routine application by government mapping agencies. Methods have also been developed to build derivative maps or exploration "go" maps, which highlight particular regolith attributes (e.g. *in situ* vs. transported origin; thickness of transported cover, source of transported regolith). These can be included in a GIS available for explorers and used in combination with the regolith landform base map to provide direct guides to sampling strategies.

An approach which integrates knowledge of the regolith and landscape setting, direct 3D information on the regolith, geophysical data on the surface and near-surface regolith and geochemical techniques is summarized schematically in Figure 2. Good regolith-landform mapping and visual, textural and spectral logging of regolith cuttings is essential for the appropriate 3D knowledge of the regolith and to identify consistent and appropriate sampling media.

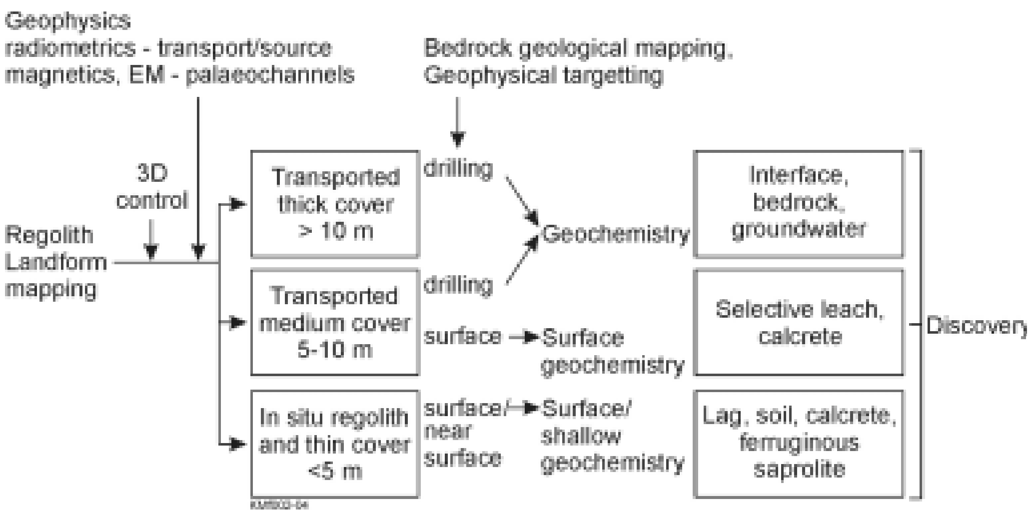


Figure 2. The role of regolith-landform mapping in an integrated approach to mineral exploration in regolith-dominated terrain.

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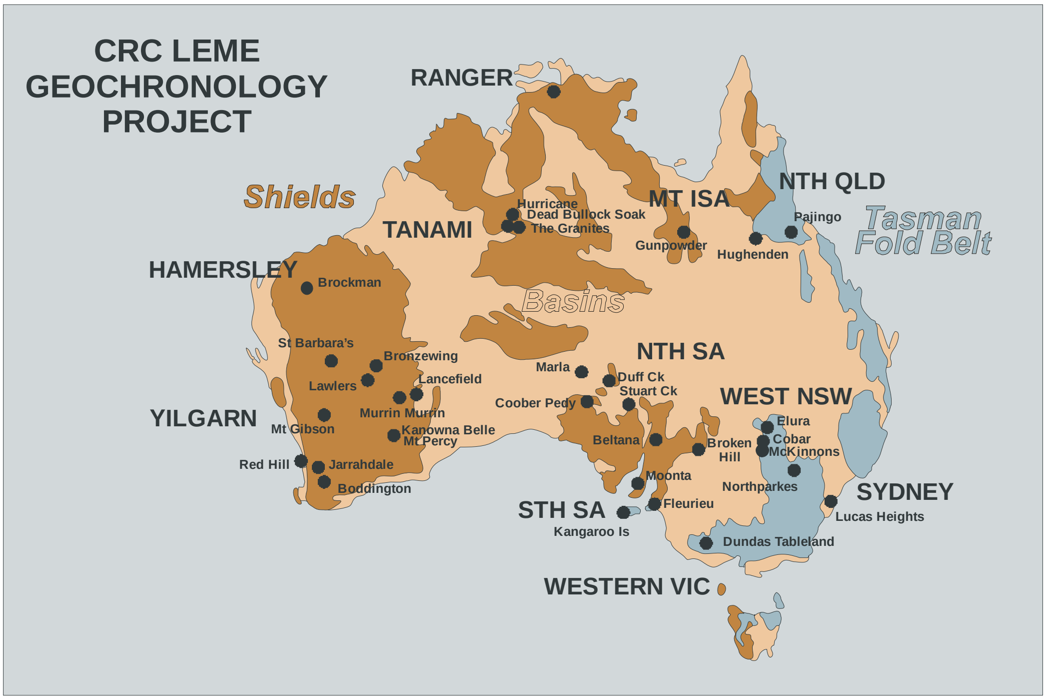

Figure 2. Location of sites where regolith ages have been obtained or which are currently being studied.

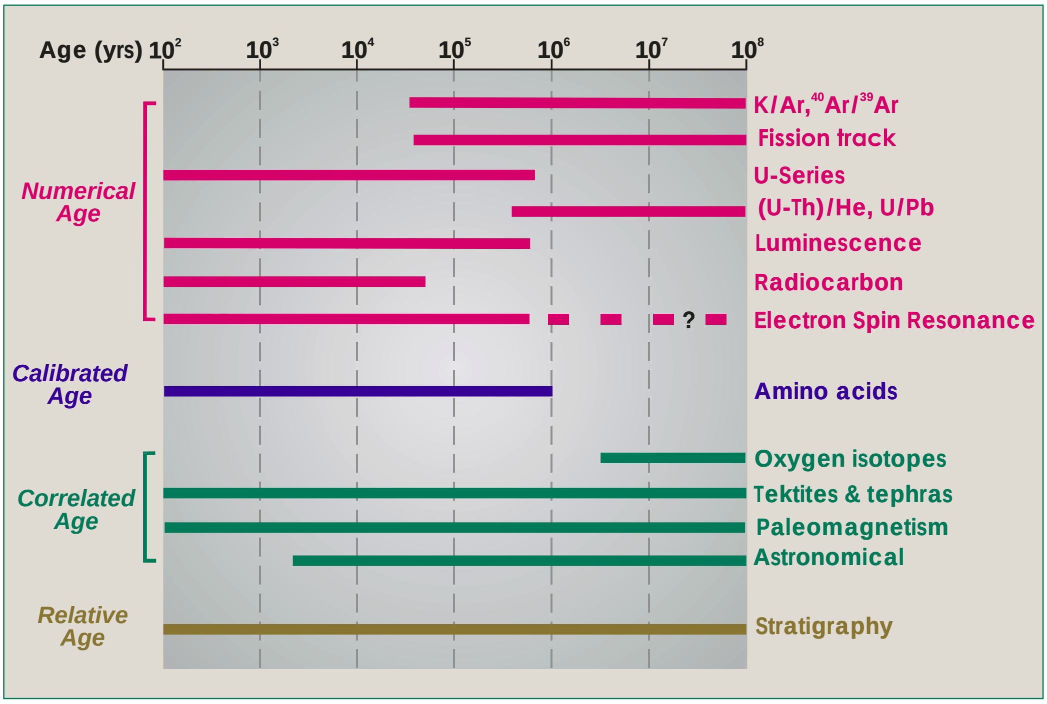

Figure 3. Age ranges over which regolith dating methods can be applied. Methods are grouped according to type of age result produced (after Pillans 1998).