A COLLABORATIVE UNDERGRADUATE FIELD SCHOOL FOR REGOLITH GEOSCIENCE AT FOWLERS GAP, WESTERN NSW: 2004 A REGOLITH ODYSSEY

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INTRODUCTION

Regolith geoscience is an emerging component of undergraduate Earth science courses in Australia. This is largely because of growing recognition that Australia is a continent dominated by regolith materials and as such most mineral exploration and resource management challenges, and associated graduate employment opportunities, require knowledge of this subject. The increasing integration of regolith geoscience into undergraduate university courses, however, needs to happen within institutional environments of limited resources, variable student numbers and limited availability of suitably qualified staff members to teach this subject at higher levels of undergraduate courses.

To overcome these limitations, inter-departmental and inter-university collaborations are being developed to help ensure that relevant, high quality courses within CRC LEME core party universities. This collaboration has been occurring at Honours and postgraduate level for the past 4 years within the Minerals Council of Australia (MCA) – Minerals Tertiary Education Council (MTEC) geoscience tertiary education network (Roach 2003), but in 2004 collaboration has also been extended to undergraduate level. Such successful collaborations enhance the learning experience for students by broadening their horizons and improve teaching and learning outcomes as well as reduce the total institutional costs for field teaching.

From September 17 to 21, 2004, a regolith geoscience field trip was run at Fowlers Gap, western NSW, for 3rd year undergraduate students from both the Australian National University (ANU) and University of Adelaide (AU). Thirty two students (10 from ANU and 22 from AU), six tutors and 3 lecturers attended the field trip. This builds upon a larger, integrated and collaborative Honours and postgraduate regolith teaching program that has been based in western NSW for several years (Hill & Roach 2003a).

GENERAL OUTLINE

The field trip was mostly based at the Fowlers Gap Arid Zone Research Station, which is administered by the University of New South Wales. Fowlers Gap is approximately 100 km north of Broken Hill, on the Silver City Highway between Broken Hill and Tibooburra. Student accommodation was within the 32-bed (bunk-style) dormitory, with tutors and staff staying at the Quarters (twin-share style). Food was self-catered for the trip, with students encouraged to form food groups to minimise congestion within the kitchen area and to attend to their own dietary needs. Further details of Fowlers Gap can be found at http://bioscience.babs.unsw.edu.au/fgap.

Coordinating the field program prior to arrival at Fowlers Gap was a major challenge for the field trip organisation. Both groups were travelling from different parts of the continent and the only partial overlap of mid-semester non-teaching periods without clashes from other field trips at both ANU and AU made the final timing of field days a very delicate and opportunistic operation. It was therefore decided that some of the AU group would meet all of the ANU group at 2 pm on the Friday in Broken Hill, leaving the remainder of the AU group (who had class commitments for that morning) to join the group that evening at Fowlers Gap. Travel for the ANU group was within a 20-seater bus, and the AU students travelled in three 12-seater mini-buses with one "luggage van".

Lectures on regolith-landform mapping, remote sensing of regolith, regolith materials, landscape evolution and basic field safety were given in the weeks immediately before the field class. Student field mapping was undertaken within 9 groups of 4 students that were determined by ballot, with at least one ANU student allocated to each group to ensure that the two student groups mixed. The approximately 2.5 km^2 mapping area corresponded to the central portion of Conners Paddock, which is approximately 1 km east of the station and provides a large diversity of regolith-landform units with all-weather access from the station accommodation by foot, and good access by vehicle (Figure 1).

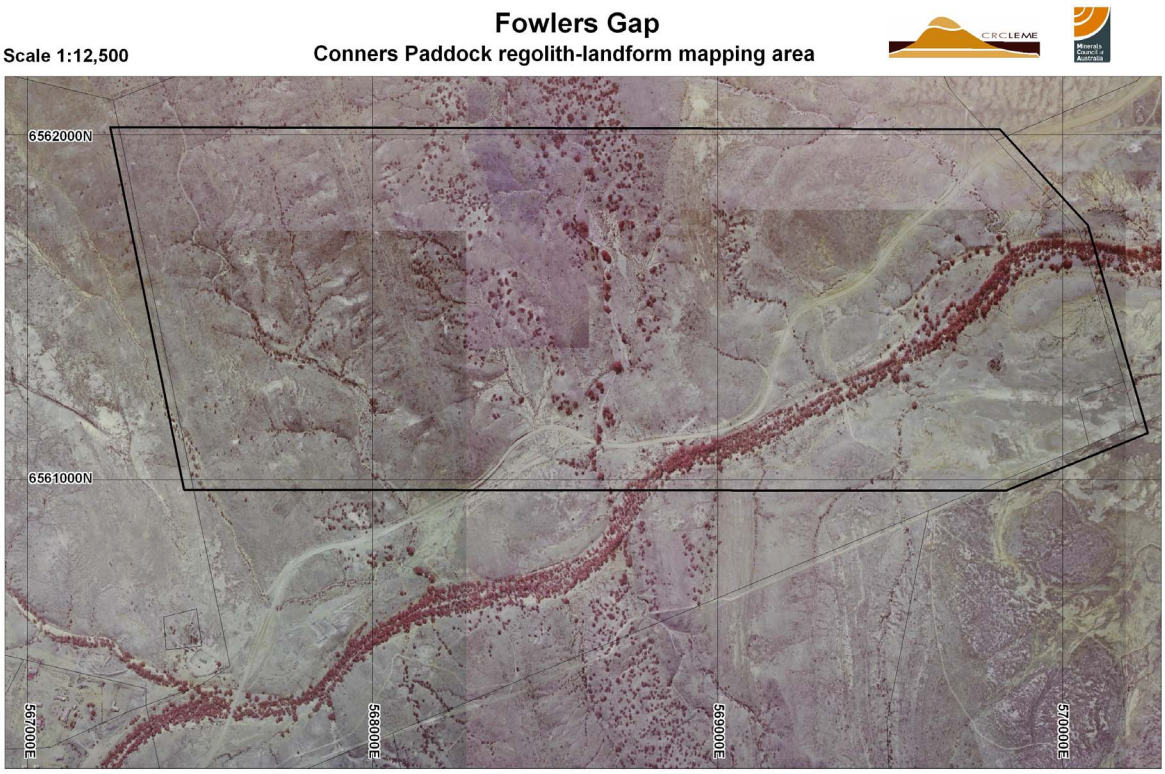

Figure 1: Infra-Red extended colour airphoto mosaic basemap used by students in the field class. Fowlers Gap station is in the lower left corner. Some confusion was caused by the realignment of the Silver City Highway (running diagonally SW-NE across the map) since 1981! Photographs from Qascophoto, 1981, georeferenced to the Australian Map Grid 1966, AGD66, by ICR. Not to scale.

The general program for the field trip included:

- Friday September 17 - arrival and settling in:
  - ANU students tour regolith-landforms of the Broken Hill Line of Lode, Flying Doctor catchment (Thomas *et al.* 2003, Hill *et al.* 2003) and Haydens Tank (Barratt & Hill 2003, Foster & Hill 2003); and,
  - BBQ dinner at Fowlers Gap.
- Saturday September 18 - regional overview of regolith and landscape:
  - Sandstone Paddock silicified palaeo-valley with plant fossils (Hill & Roach 2003b);
  - Sandy Creek Gorge and range-front showing neotectonic landscape evidence;
  - Preliminary introduction to the mapping area;
  - Allocation of student mapping groups; and,
  - Air photograph and other remote sensing interpretation.
- Sunday September 19 - First day of field mapping:
  - Field mapping of Conners Paddock; and,
  - After dinner informal group presentations of the day's activities, highlights and challenges and the proposed mapping plan for the next day.
- Monday September 20 - Last day of field mapping:
  - Field mapping of Conners Paddock; and,
  - Submission of draft maps for preliminary marking that night (student quiz night organised by tutors while maps were marked).
- Tuesday September 21: Final day;
  - ANU staff and students depart for Canberra early; and,
  - AU students tour regolith-landforms of Yanco Glen, Broken Hill Line of Lode, Mundi Mundi range-front (Hill & Kohn 1999) and Silverton Hotel, before departing for Adelaide.

ONLINE REFERENCE AND MAPPING MATERIALS

There is a growing acceptance of on-line resources to augment teaching and learning programs within universities, and the teaching program associated with this field trip was no exception. The difficulty in providing on-line resources within the traditional university framework is that students need to be enrolled at individual universities in order to access facilities like WebCT or MyUni. Where groups come from more than one university, resources would normally need to be duplicated at each site, however, in this case we were able to use the CRC LEME WWW site to store reference materials including PDF versions of research papers and mapping images for student's free download. Details of the website (http://crcleme.org.au/fowlers/) were given to students prior to the field class, and they were all strongly advised to download and read the research materials.

In addition to the availability of digital data, students were also given laminated printouts of:

- The airphoto mosaic base map (Figure 1);
- A compilation of available satellite and geophysical imagery (aeromagnetics, radiometrics, Landsat TM and ASTER) (Figure 2);
- Part of the Fowlers Gap 1:25,000 topographic sheet;
- Part of the Fowlers Gap – Torowangee 1:100,000 geological map;
- Notes on the dominant vegetation species in the area from Cunningham *et al.* (1991), Brooke & McGarva (1998) and Kutsche & Lay (2003);
- The Sandstone Paddock 1:10,000 regolith-landform map (Hill & Roach 2003b); and,
- The Flying Doctor 1:10,000 regolith-landform map (Hill *et al.* 2003, Thomas *et al.* 2003).

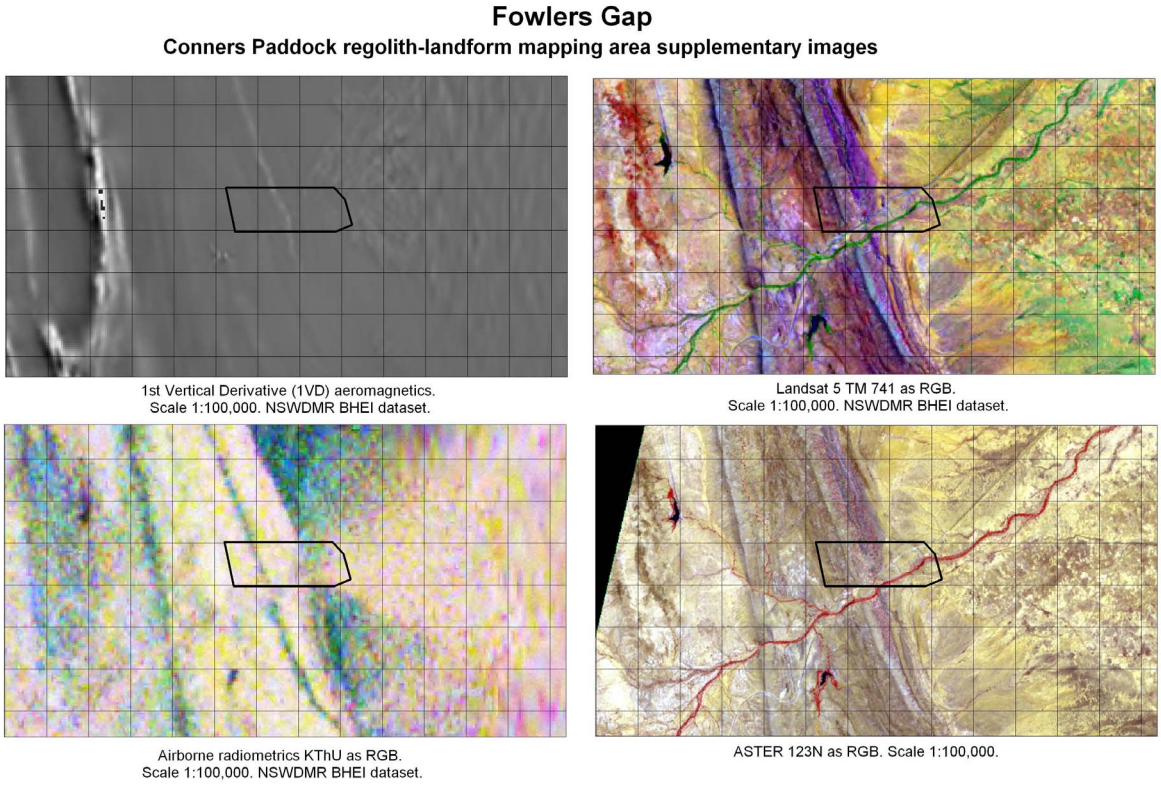

Figure 2: Accompanying remote sensing data given to students, at reduced scale with the mapping area highlighted. Data include: 1st Vertical Derivative aeromagnetics, radiometrics and Landsat TM from the NSWDMR BHEI Koonenberry version 1 data set; and, Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) from the NASA EOS data distribution centre. Images were to augment the airphoto mosaic, and highlight the different regolith materials and their dispersion and varying resolutions.

STUDENT ASSESSMENT ASSIGNMENT

For assessment, students were asked to submit a draft copy of their field maps for marking on the final night of the field trip. Following the field trip a final map and report was required for assessment. Students were advised that the final report should include the following sections:

- Introduction. Including location and setting and aims and nature of the study;

- Description and outline of each Regolith-Landform Unit (RLU). For each RLU mapped this includes brief descriptions of: dominant regolith lithology; landform expression; minor regolith attributes; dominant vegetation community and species; and, potential geohazards such as rabbit warrens, erosion styles and vegetation health (of particular concern at Fowlers Gap);
- Interpreted regolith and landscape evolution of Conners Paddock;
- Conclusion; and,
- References.

FIELDWORK HEALTH & SAFETY

Students were familiarised with their university's and CRC LEME's Occupational Health & Safety procedures for fieldwork in remote areas. Students were advised about aspects of personal safety, group safety, vehicle safety and fieldwork etiquette. They were also advised of a risk assessment specific to the Fowlers Gap area, which particularly included dehydration and sunburn dangers. Other risks included concealed holes, unstable slopes and rocky surfaces (hence sturdy footwear was recommended), bites and stings, spiny plants, and general care and hygiene around the camp.

To maximise field safety the student group was subdivided into nine field mapping groups each containing four students, which also corresponded to the nine staff and tutors on the field trip. Each group was issued with an UHF radio and additional sets were issued to each staff member and tutor. Radio communication used channel 39 during the exercise, and Fowlers Gap station staff could be directly contacted on channel 16 in emergency. Radios were recharged each evening and transmission and reception were tested regularly throughout the day. Fluorescent vests were issued to each student and staff member, increasing visibility of colleagues in the field and also for motorists travelling along the Silver City Highway, which traversed the mapping area. Before entering the field each day students were reminded to apply and reapply sunscreen, wear adequate clothing as cover from the sun (including a broad brimmed hat) and to carry adequate water for the conditions (up to 1 litre per hour). All staff and many of the students carried personal first aid kits, plus additional kits and extra drinking water were available in each of the field vehicles, which were strategically parked at the east, west, north and centre of the field area. Fowlers Gap Station also maintains two Royal Flying Doctor Service (RFDS) medical chests, and in the case of a medical emergency the 24-hour medical line of the RFDS (08 8088 1188) covers the region.

REGOLITH-LANDFORM MAPPING

The mapping area is approximately approximately 2.5 km^2. It contains a diversity of regolith-landforms extending from the margins of the bedrock-dominated Barrier Ranges, across its eastern range-front and into the regolith-dominated margins of the Bancannia Trough. The main regolith-landforms of the area include:

- Alluvial sediments (from both contemporary and palaeo-drainage systems);
- Colluvial and sheetflow sediments; and,
- Weathered bedrock ranging from slightly to highly weathered grades and forming erosional landforms such as plains, rises and hills.

The regolith-landforms of the area also included contribution of aeolian sediments as well as indurated regolith including silicification (silcrete), ferruginisation (ferricrete), gypseous regolith (gypcrete), and regolith carbonate accumulations (calcrete).

The regolith-landform mapping approach was consistent with that outlined by Pain *et al.* (in press), Hill (2002), and Hill & Roach (2003b).

REGOLITH AND LANDSCAPE EVOLUTION MODEL

The interpretation and integration of regolith-landform mapping results and descriptions enable the discussion of a regolith and landscape evolution model for the study area. For a localised area there are a large array of concepts and aspects that can be incorporated into these models. These include:

- The contributions and interactions of substrate lithology, structure and tectonism, Mesozoic eustacy, climate change, biota and time on regolith and long-term landscape evolution;
- The genesis, palaeolandscape and stratigraphic interpretations associated with regolith induration;
- Important geobotanical relationships of the rare curly mallee (*Eucalyptus gillii*) in the study area;
- Reconstruction of upland (Barrier Ranges) and basin evolution (Lake Bancannia Basin) and palaeodrainage history;
- The recognition and constraining neotectonic activity; and,
- Applications of these models for mineral exploration and natural resource management, in particular rangeland management.

ASSESSMENT FOR STUDENTS NOT ATTENDING THE FIELD TRIP

Students from AU not attending the field trip were asked to complete the mapping exercise and discuss the regolith and landscape evolution of the area based on mapping conducted by remote sensing and further reading of the existing regolith and landscape evolution literature relating the greater region.

TEACHING AND LEARNING OUTCOMES

Many of the teaching and learning outcomes of this activity are planned and designed but a great many are achieved intuitively because of the nature of this exercise, and the passionate way that ongoing research is integrated with the teaching program. Some of the significant outcomes achieved include:

- Recognition of the important distinction between scientific description and interpretation and how all interpretations should be based on sound description;
- Scientific skill and knowledge in the discipline of regolith geoscience;
- The recognition and assessment of scientific controversy and debate, not only at times between different staff members and students but also from the scientific literature;
- Integration of research and teaching. The concept of working at the frontier of the scientific knowledge of a landscape was exciting and inspiring to many students, and illuminated a pathway into future research programs and the integration of research results and skills into potential employment beyond university;
- Working in a remote landscape and the experience of Australian "outback" lifestyle and its landscapes;
- Working within teams, both with their own university colleagues but also people from across different institutions;
- Integration and interpretation from several data sets and the multi-disciplinary knowledge base required in both the regolith-landform mapping and the subsequent interpretations of regolith and landscape evolution;
- Oral and written presentation skills, both informally and as part of the assessment items; and,
- Obtaining direct feedback (with assessment during the field trip) that also allows students to develop and improve their skills while completing tasks.

A Barrier Daily Truth article (BDT 2004, Figure 3) also served to promote the course to the local Broken Hill community and further promote the course to students on the field trip, both of the home universities and other stakeholders such as the minerals industry and natural resource management organisations.

Figure 3: Happy mappers at Fowlers Gap. This picture appeared on page 3 of the Barrier Daily Truth, Broken Hill's daily newspaper, on Tuesday 21 September, with a press release by ICR describing the field camp and outcomes for the exploration potential of the Broken Hill area. Photo by ICR.

FUTURE DEVELOPMENTS

It is hoped that this field school can be expanded to also include staff and students from Curtin University of Technology (CUT), although this has been largely constrained by the need for funding to enable these students to travel to this field area, as well as the identification of common teaching breaks and compatible course content between institutions. It is also hoped that this activity can continue at both ANU and AU, with

both the development of a new undergraduate curriculum at AU, and the challenging proposal to only teach regolith geology every second year at ANU. It will be a further challenge to maintain regolith geology and field activities such as this within the university curriculum over the longer-term when most of the staff involved here are employed on fixed term contracts.

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