SELWYN DISTRICT, QUEENSLAND

J.R. Wilford
CRC LEME, Geoscience Australia, PO Box 378, Canberra, ACT 2601
John.Wilford@ga.gov.au

INTRODUCTION

The Selwyn district is located approximately 140 km southeast of Mt Isa and covers part of the SELWYN (7054) and Mt MERLIN (6954) 1:100 000 map sheets. The Selwyn mine is situated approximately in the centre of the area (Figure 1). The following summary is largely based on regolith–landform mapping performed by Wilford (1997) and geological investigations performed by Grimes (1972, 1979), Noon (1976), Senior *et al*. (1978), Smart *et al*. (1980) and Blake *et al*. (1983).

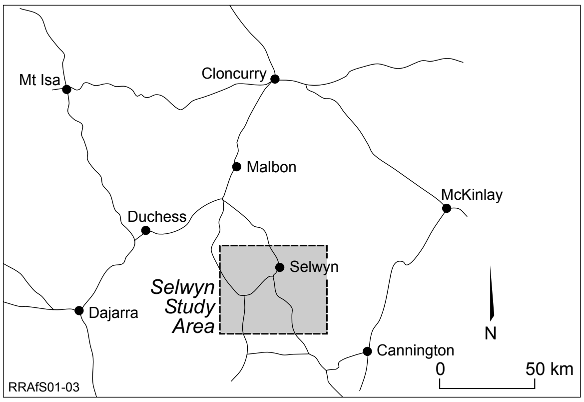

Figure 1. Location of Selwyn study area.

PHYSICAL SETTING

Geology

The bedrock geology of the Selwyn region consists of Proterozoic rocks of the Mt Isa Inlier, Cambrian sediments of the Burke River Structural Belt and Mesozoic sediments of the Eromanga Basin (Blake *et al*., 1983).

The Proterozoic rocks of the Mt Isa Inlier include variably foliated granites, metadolerites, metabasalts, meta-arenites, amphibolites, slate, phyllite, schist, gneiss, felsic granofels, quartzite and quartz-hematite beds. Cambrian sediments of the Burke River Structural Belt are generally flat lying to sub-horizontally bedded sandstone, siltstone, shale, chert and limestone, with minor conglomerate and breccia. The Proterozoic and Cambrian rocks are unconformably overlain by Mesozoic sediments of the Eromanga Basin, which consist mainly of terrestrial sandstone and conglomerate and shallow marine sandstone, siltstone and mudstone (Smart *et al*., 1980). Since the Late Cretaceous the basement rocks have been extensively weathered and eroded.

Geomorphology

The Selwyn area comprises eight major landform types. These are: colluvial plains and minor footslopes, alluvial plains and floodplains, pediments and erosional plains, rises, low hills, hills, escarpments and plateaux. High relief landforms consisting of plateaux, mesas, scarps, hills and low hills occur in the northeast and central parts of the Selwyn region (Figure 2). Low relief, colluvial plains, pediments and erosional plains are associated with the Mort River and Mistake Creek catchments (Figure 2). The highest point (~480 m AHD) and steepest slopes occur over dissected ferruginous Mesozoic plateaux over the northeast corner of the Selwyn area.

A major drainage divide located about 13 km north of the Selwyn mine separates rivers flowing south into the Lake Eyre basin from those draining north into the Gulf of Carpentaria. Dendritic and trellis drainage patterns are common, with the latter pattern dominantly following north–south joints and cleavage planes in the underlying Proterozoic bedrock.

Climate and vegetation

The area has a semi-arid, monsoonal climate with distinct wet and dry seasons. Most of the rainfall (approximately 375 mm/year) occurs in the summer months between November and March. Summer rainfall is unpredictable and droughts are common. The mean maximum and minimum temperatures in December are approximately 35 and 25°C, respectively, with the winter temperatures being some 10 to 15 degrees cooler (Blake *et al*., 1983). Vegetation consists largely of spinifex, acacia shrubs and scattered low eucalyptus trees.

REGOLITH–LANDFORM RELATIONSHIPS

A regolith–landform map at 1:50 000 scale was compiled using aerial photographs, gamma-ray spectrometric images, Landsat TM and field traverses (Wilford, 1997). Four principal regolith groups are recognised: duricrusts, saprolith, and alluvial and colluvial sediments (Figure 3).

Ferruginous and siliceous duricrusts are associated with ancient landforms including mesas, butes, plateaux and dissected plateaux. Ferruginous duricrusts occur with massive, slabby (sub-horizontal layering) and brecciated (angular, highly ferruginous lithic fragments) textures. Siliceous duricrusts occur as silcrete (microcrystalline and cryptocrystalline silica) and as silicified iron-stained and mottled saprolite.

Exposed saprolith is associated with erosional landforms, such as erosional plains, rises and low hills. However, in many places saprolith is partly covered by skeletal soils and lags. Saprolith is dominantly saprolite that varies from completely weathered to moderately weathered bedrock.

Colluvial sediments are mostly associated with erosional plains, pediments, depositional plains and minor footslopes. They consist of unconsolidated polymictic gravels and gravel lags with various proportions of sand and clay. Less common alluvial sediments consist of varying proportions of sand, gravel, clay, silt and minor cobbles.

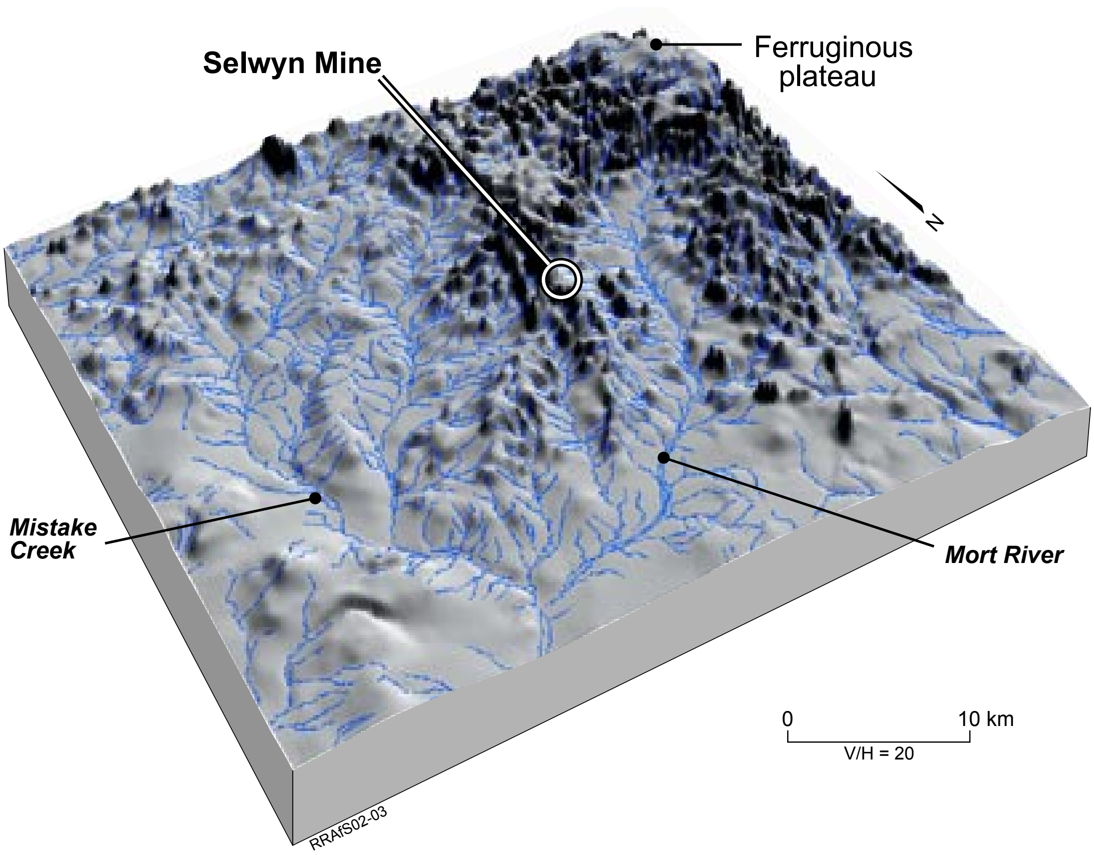

Figure 2. Digital elevation model perspective drape and streams for the Selwyn study area.

DURICRUSTS

Iron and siliceous duricrusts typically form the uppermost part of the most deeply weathered profiles in the area. The duricrusts commonly overlie zones of mottled saprolite, saprolite, saprock and fresh bedrock. The mottled saprolite and saprolite zones are locally silicified. However, in different parts of the landscape, one or more of the underlying weathering zones may be poorly developed or absent. These highly weathered profiles reflect a long history of chemical weathering and landscape stability (low geomorphic process rates).

The ferruginous duricrust consists largely of hematite and goethite and has developed by vertical and lateral concentration of Fe oxides. Clay in the mottled zone is dominated by kaolinite with hematite and goethite in the mottles. Other minerals in the mottled zone include quartz and mica. The bleached zone consists largely of kaolinite, quartz, secondary silica and minor amounts of mica and goethite. Saprock composition largely reflects bedrock mineralogy and geochemistry — common minerals include quartz, feldspar, kaolinite and minor goethite. Many of the ferruginous duricrusts have developed *in situ* as indicated by quartz veining and gradual transitions to the underlying mottled saprolite. Although weathering has largely occurred in place, iron oxides may have been sourced some distance laterally.

Silcrete and silicified saprolite formed on Proterozoic bedrock are typically impregnated by iron to varying degrees in the form of hematitic mottles and diffuse staining. Silcretes consist of massive, grey, indurated crusts which typically exhibit columnar jointing. They also form 0.2-1.0 m wide pods supported by a partly cemented sandy matrix. Silcretes may be fine-grained with a microcrystalline texture, or coarse-grained where silica has cemented sand and gravel. Mottled saprolite beneath the silcrete is often weakly silicified. Silicification is also associated with ferruginous duricrusts where silica has cemented the mottled and kaolinised zone of the weathering profile.

EXHUMED SURFACES

In many places the pre-Cretaceous land surface has been re-exposed or exhumed (Twidale and Campbell, 1993; Wilford, 1997). The exposed pre-Cretaceous surface may be highly weathered, bleached and silicified. The age of exhumation is younger than the Proterozoic basement affected by the erosion and older than the Cretaceous sediments that once covered the basement rocks. Several stages of exhumation can be recognised in the Selwyn region depending on the relative rates of erosion and the initial thickness of the Cretaceous sediments.

DATING

The ferruginous duricrusts have not been dated. However, they probably formed from continual weathering during the Tertiary with the rates of formation responding to changing climatic conditions (i.e. humid versus arid). The brecciated duricrusts

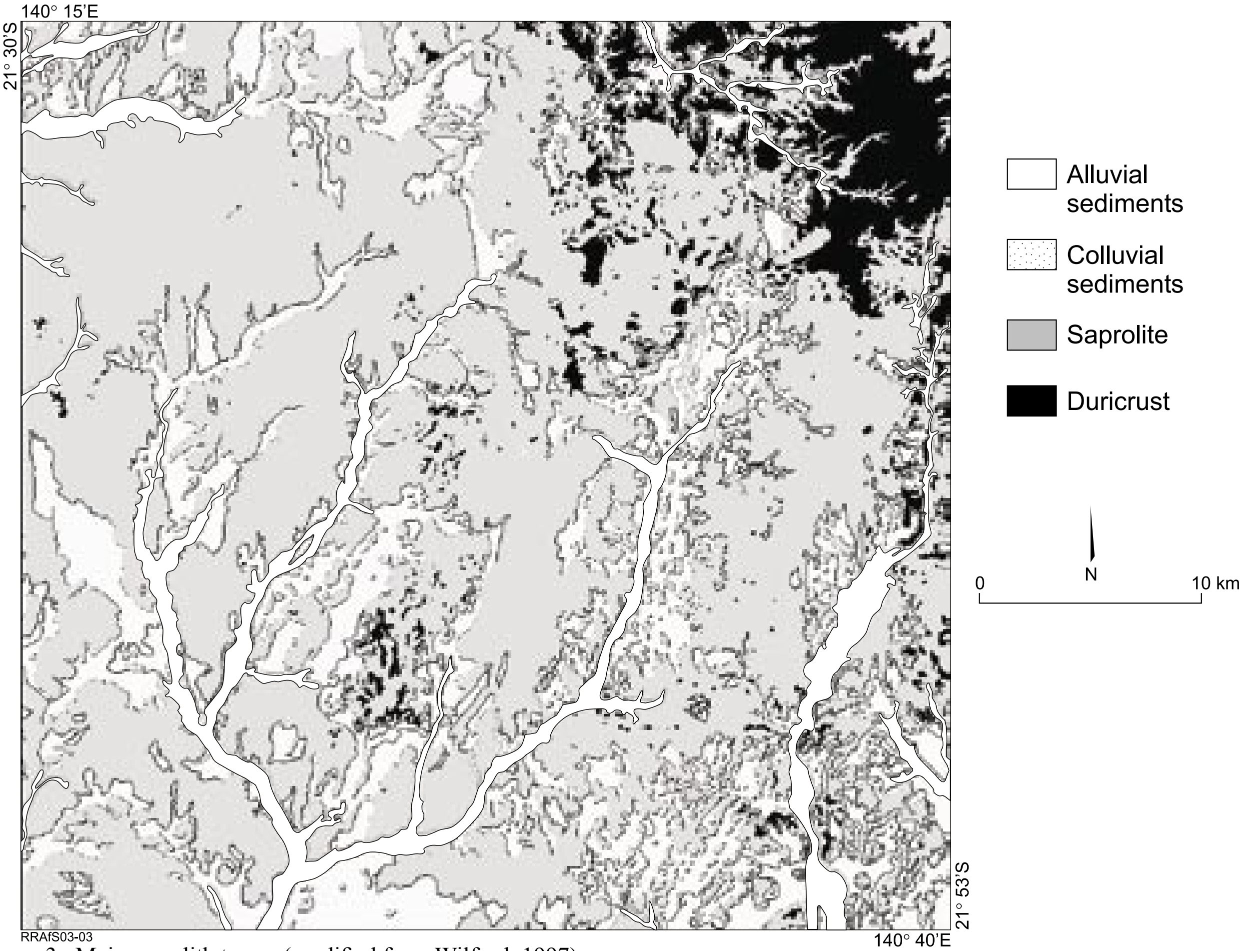

Figure 3. Major regolith types. (modified from Wilford, 1997)

in the Selywn area have many similarities with the Canaway weathering profile in the Eromanga Basin described by Idnurm and Senior (1978). The Canaway profile has a palaeomagnetic date of Late Oligocene. However, palaeomagnetic dating of ferruginous duricrust north-northwest of Mt Isa indicates that weathering imprints of 40, 70 and 80 Ma may also be present (Pillans, pers. comm., 2002).

PALAEODRAINAGE

Drainage evolution in the Selwyn region has been long and complex. Ancient river systems were intrinsically related to some of the most highly weathered regolith in the landscape. Furthermore, palaeo-hydrology is also likely to have had a major influence in the formation and distribution of indurated materials (Wilford, 1997). Sinuous, silicified, concordant and dissected plateaux with cemented quartz sands and pebbles and/or silicified saprolite occur approximately 4 km west of the Selwyn mine. The cemented quartz sands and pebbles are thought to represent old valley floor alluvium, whereas the silicified saprolite is thought to be associated with the precipitation of silica from groundwater beneath the old valley floor. Silicification and hardening of sediments has led to differential erosion and relief inversion.

REGOLITH EVOLUTION

The sequence of events (Figure 4) is based on conclusions drawn from regolith mapping over the Selwyn and Buckley River–Lady Loretta areas (Wilford, 1997; Anand *et al.,* 1997). However, due to the lack of regolith dating around the Selwyn area, age relationships and correlations are at best speculative.

During the Late Jurassic–earliest Cretaceous the relief was more subdued than today (Figure 4a). Rainfall was probably high with deep chemical weathering and active rivers flowing to the Carpentaria and Eromanga basins. Rising sea level in the Early Cretaceous caused alluviation in the lower stretches of the main rivers and, eventually, sediments buried all but the highest parts of the local topography (Figure 4b). As the sea fell during the Late Cretaceous the sea floor was exposed. Drainage channels were initiated on the sea bed sediments, flowing north to the subsiding Carpentaria Basin and south-southwest to the Eromanga Basin (Figure 4c).

By the early Cenozoic, the Cretaceous sediments were largely eroded except in the northeast, southeast, and southwest parts of the Selwyn area (Figure 4d). Locally, pre-Cretaceous weathered Proterozoic rocks were exhumed. Weathering and differential erosion from the Late Cretaceous through the Cenozoic formed most of the present day landforms. Up-warping of the Selwyn highlands was active in the Late Cenozoic (Twidale, 1966). Some valley floors and sides became cemented by iron and silica.

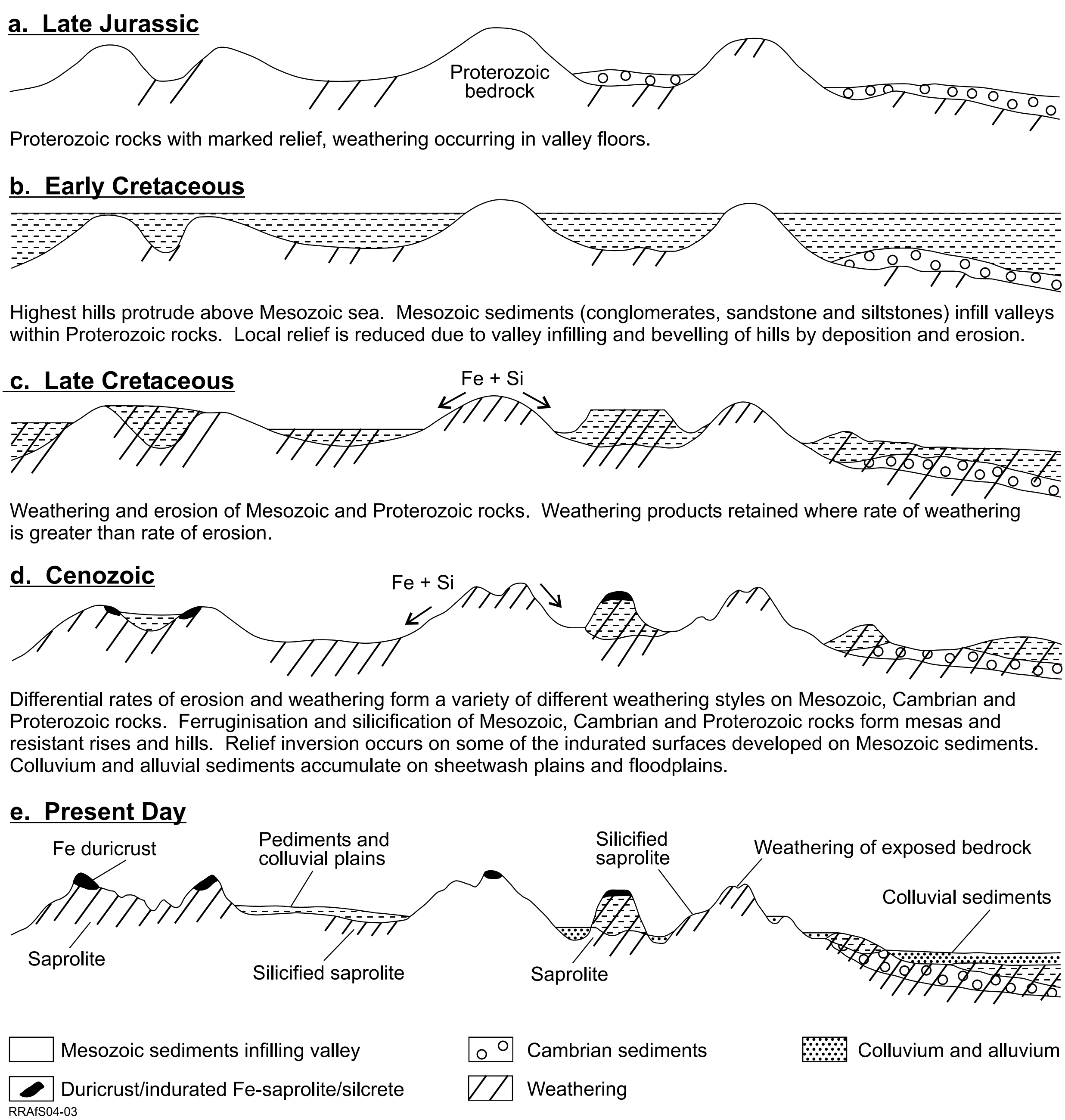

Figure 4. Stages in landscape evolution of the Selwyn district.

Subsequent erosion has left these very resistant siliceous and ferruginous duricrusts as inverted relief (Figure 4e).

During the Tertiary, weathering continued with varying intensity depending on changing climatic conditions (i.e., humid versus arid). Deep weathering and duricrusts formed on exposed stable parts of the landscape (Figure 4d, e). Duricrusts also developed in response to lateral water flow associated with valley floors and valley sides. Silicification of weathering profiles became more common as climatic conditions became more arid from the Late Miocene to the present day.

REFERENCES

Anand, R.R., Fraser, S.J., Jones, M.R., Shu, L., Munday, T.J., Phang, C., Robertson, I.D.M., Scott, K.M., Vasconcelos, P., Wildman, J.E. and Wilford, J.R., 1997. Geochemical exploration in regolith-dominated terrain, north Queensland. CRC LEME, Perth. Report 63R. 130 pp.

Blake, D.H., Jaques, A.L. and Donchak, P.J.T., 1983. Selwyn Region Queensland. Map and commentary. 1:100 000 geological series. Dept of Resources and Energy, Bureau of Minerals and Resources, and Dept of Mines Queensland.

Grimes, K.G., 1972. The Mesozoic and Cainozoic geology of the Cloncurry 1:250 000 sheet area, Queensland. Bureau of Minerals and Resources (Geoscience Australia), Canberra. Record 1972/57.

Grimes, K.G., 1979. The stratigraphic sequence of old land surfaces in northern Queensland. Bureau of Minerals and Resources Journal of Australian Geology and Geophysics, 4: 33-46.

Idnurm, M. and Senior, B.R., 1978. Palaeomagnetic ages of Late Cretaceous and Tertiary weathered profiles in the Eromanga

Basin, Queensland. Palaeogeography, Palaeoclimatology, Palaeoecology, 24: 263-77.

Noon, T.A., 1976. Mineral exploration surveys in the Duchess 1:250 000 sheet area, northwest Queensland. Queensland Government Mining Journal, 77: 351-358.

Senior, B.R., Mond, A. and Harrison, P.L., 1978. Geology of the Eromanga Basin. Bureau of Minerals and Resources (Geoscience Australia), Canberra. Bulletin 167. 102 pp.

Smart, J., Grimes, K.G., Doutch, H.F. and Pinchin, J., 1980. The Mesozoic Carpentaria Basin and the Canozoic Karumba Basin, North Queensland. Bureau of Minerals and Resources (Geoscience Australia), Canberra. Bulletin 202. 73 pp.

Twidale, C.R., 1966. Late Cainozoic activity of the Selwyn Upwarp, Northwest Queensland. Journal of the Geological Society of Australia, 13: 491-494.

Twidale, C.R. and Campbell, E.M., 1993. Australian landforms: structure, processes and time. Gleneagles Publishing, Adelaide. 560 pp.

Wilford, J.R., 1997. Regolith–landform characteristics, evolution and implications for exploration over the Selwyn region, Mt Isa. CRC LEME, Perth. Report 44R. 83 pp.