Understanding the landscape

by J. R. Gozzard

From the stability of the Darling Plateau to the dynamic coastal environments, the landscapes of the Perth Region have influenced the development of Perth from earliest colonial times. In 1829, Captain James Stirling established the Swan River Colony, later to become Perth, on the north bank of the Swan River, describing it as ideal for establishing a permanent settlement. In particular, he recognized the defensive prospects of Mount Eliza, situated as it is where the Swan River narrows, which would make defending the fledgling colony from gunships easy, with just a few cannons.

The landscape is intimately related to the nature of the underlying geology and many striking landforms and geological sections in the Perth Region provide insights into the geological history of the region, and to the development of the landscape as we see it today. The landforms of the coastal areas record the fluctuating sea level and are the result of the glaciations of the Pleistocene; exposed river-banks and subtle landforms of the Swan Valley reveal the history of the migrating river systems of the past; sedimentary rocks of marine origin at the foot of the Darling Scarp are evidence for an ancient shoreline, when the ocean covered all of what is now the Swan Coastal Plain; and quarries on the Darling Plateau reveal the complex history of the Yilgarn Craton, where metamorphic belts were intruded by large volumes of granitic rocks, and then eroded and deeply and intensely weathered over millions of years.

However, the landscape is many things to many people — to mining companies it is a source of mineral wealth; to farmers a source of agricultural wealth; to construction companies a setting for major infrastructure projects; to waste disposal providers a receptacle for rubbish; to government, industry and environmental lobby groups a challenge of sustainable development whereby competing land uses can be combined with a respect for the natural environment.

There is also a growing public appreciation of the need to understand landscapes and the importance of geology as the underpinning framework. In this regard, GSWA recognizes that it has a vital role to play in community education and assisting with increasing the awareness of schools and the general public about the importance of geoscience by making geoscience as accessible as possible. One of the ways GSWA is achieving this is by presenting geoscience information in a form suited to a range of non-specialist users.

GSWA is currently producing a book that provides a concise and informative guide to the geology and landscapes of the Perth Region (Gozzard, in prep.). For the purposes of the guide, the Perth Region includes most of the Perth Metropolitan area between the Indian Ocean to the west and the Darling Plateau to the east, and extends about 150 km from Moore River and Gingin Brook in the north to Mandurah in the south.

The guide is aimed at those in secondary and tertiary education who require resource materials for teaching, and those with a basic understanding of geological principles, but it is also readily accessible to the layperson. The guide provides an insight into the range of natural features that characterize the Perth Region. It describes the geological setting of the Perth Region from its beginnings in warm, shallow, ancient seas about 3170 million years ago to the youngest sedimentary rocks of the Perth Basin that formed during erosional and depositional events related to periods of higher and lower sea levels caused by glaciation during the Pleistocene and Holocene. It then goes on to explain the origin and evolution of the various landscapes found in the Perth Region and describes those landscapes in relation to the underlying geology.

It has not been possible in the guide to describe all localities within the Perth Region that merit consideration. Instead, only a selective, but nonetheless representative, number of localities are discussed in detail. Many of the sites described in the guide have been nominated for protection as sites of special geological significance (Lemmon et al., 1979).

The guide describes in detail the geology and landforms of nine areas across the Perth Region. It puts each area into the geological and geomorphological framework of the Perth Region described in the introductory chapters of the guide. In each area, locations of particular interest are identified on easy-to-read maps and access directions and any constraints to access are provided. The geological and geomorphological details for each location are described in detail. In this way, readers are readily able to gain an understanding of both the characteristics of each area and how these details can be fitted together like a jigsaw to provide a picture of the landscape history of the Perth Region.

For example, the Cottesloe – Mosman Park area is an ideal place to observe the results of sea-level changes that have occurred over the last 300 000 years or so, at a time when the Earth experienced dramatic climate changes and underwent its last period of glaciation. Evidence of these fluctuating sea levels is recorded by the presence of interfingering shallow-marine limestones within the overall dune limestones of the Tamala Limestone. These and similar deposits along the coast of Western Australia have been used to determine the sea-level history of the coast during this period (Price et al., 2001).

At Peppermint Grove, there is a section that records the continuing retreat of the sea (regression) from a shallow-marine environment to a beach environment (Fig. 1). At the base of the section is a medium-scale, cross-bedded limestone that indicates deposition offshore in shallow-marine water. In this environment, water currents cause ripples in the sediment to migrate and the orientation of the cross-beds indicates the direction of the currents. This shallow-marine limestone is overlain by a ripple-bedded limestone that formed as a result of the oscillating motion of waves in a near-shore surf zone. The ripple-bedded limestone is overlain by a planar-bedded limestone, which indicates high-energy movement of sediment in a beach environment.

Much higher up the section is another shelly marine limestone that is up to 7.3 m above present sea level. This indicates that there was a later episode of marine deposition during which the sea level was about 7.5 m higher than it is today (Playford et al., 1976)

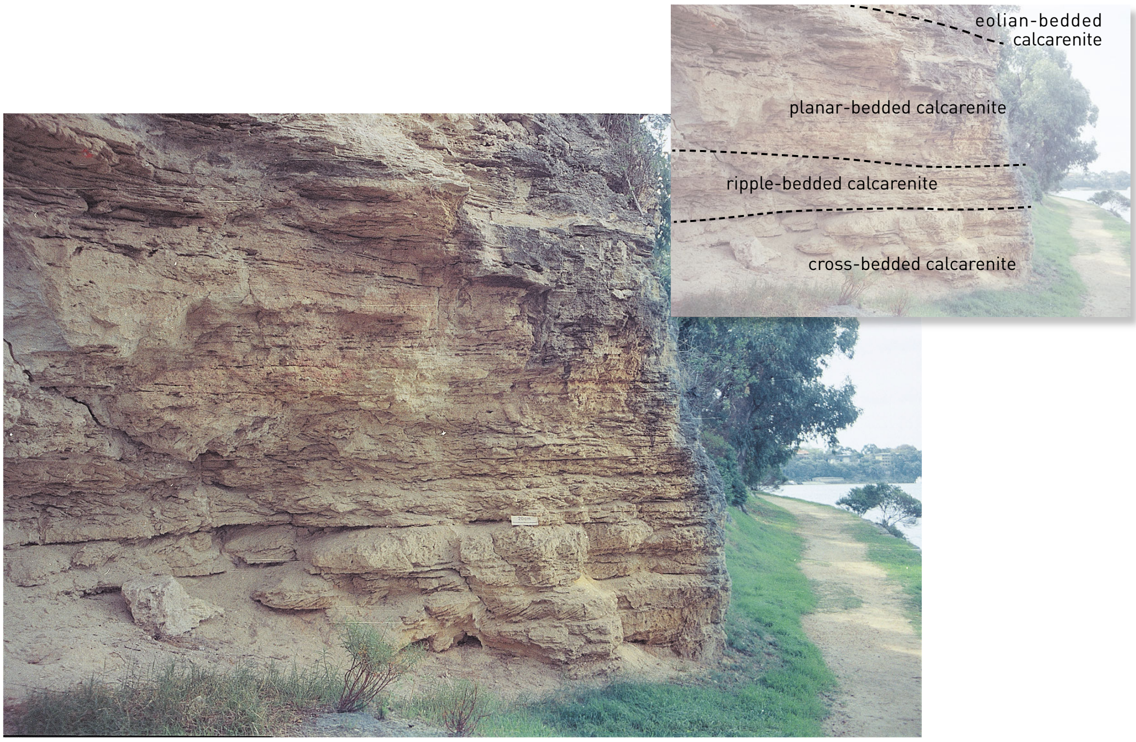

***Figure 1.** Shallow-water, cross-bedded and ripple-bedded marine limestone grading up into planar-bedded beach limestone at Peppermint Grove (MGA 384020E 6459370N)*

A thick sequence of large-scale, cross-bedded dune limestone overlies the complete marine sequence and indicates that a major dune-building episode followed the period of marine and shoreline deposition.

Absolute ages of the marine units (Hewgill et al., 1983; Murray-Wallace and Kimber, 1989) indicate that the upper marine limestone was deposited in the second-last interglacial period, between 240 000 and 190 000 years ago. The age of the lower marine sequence is more problematic. It could have been deposited during the same interglacial period as the upper shell unit or earlier, in the third-last interglacial period between 340 000 and 300 000 years ago (Kendrick et al., 1991).

In contrast, a disused railway cutting at Jarrahdale on the Darling Plateau is the ideal site to observe the development of a thick lateritic profile over granitic and doleritic rocks. Lateritic profiles result from a combination of deep and intense weathering of near-surface material in seasonally tropical climates with relatively high temperatures and rainfall.

A typical lateritic profile on the Darling Plateau is distinctly zoned. In a complete profile there is a general upward sequence of: parent bedrock; saprock, which is the zone of slightly weathered rock; saprolite, which is composed mainly of white, sandy kaolinitic clays that retain some of the parent rock fabric; an earthy, mottled zone; cemented ferruginous duricrust, rich in gibbsite and hematite; and loose, superficial iron-rich nodules, fragments, and pisoliths. Margins between zones are commonly diffuse. The influence of bedrock on the materials of the overlying lateritic profile can be most pronounced and it is possible to distinguish the lithology of the bedrock from examination of the weathered material.

The railway cutting at Jarrahdale is 650 m long and up to 15 m deep. Bedrock in the railway cutting consists of Archean gneissic metagranitic rocks that are monzogranitic in composition, and intruded by northeasterly to northwesterly trending metamorphosed quartz dolerite dykes. However, fresh bedrock is only exposed over a distance of about 125 m, about half way along the cutting. The remaining sections of the cutting expose white and mottled kaolinitic saprolite clays — the weathering products of granitic rocks.

In the central part of the cutting, developed over the fresh bedrock, is a complete lateritic profile. Despite the intensely weathered nature of the materials in the exposed profiles, simple visual examination reveals the significant differences between the profile developed over granitic rocks and that developed over doleritic rocks. It is clear that, even in the uppermost parts, the profile retains characteristics that can be related to parent material. Figure 2 shows the contact between the gneissic metagranite and the main intruding dolerite dyke. The sharp contact between these rock types is clearly seen at the base of the cutting, and the contrasts in colour and texture of the weathered material above the fresh bedrock allow the intrusive contact to be identified and followed up the weathered profile. Close examination shows that, even in the ferruginous duricrust at the top of the profile, the contact is preserved.

Quartz is dominant throughout the profile developed over granitic rock, even up to and including the ferruginous duricrust, whereas quartz is almost totally absent throughout the profile developed over the dolerite. Other mineralogical and geochemical patterns are also apparent (Sadleir and Gilkes, 1976) and have been used to confirm that the intensely weathered lateritic profiles exposed in the Jarrahdale railway cutting have developed in situ over contrasting rock types.

In these times of greater environmental awareness, many people have become interested in all aspects of the landscape, because understanding the landscape is the first step in appreciating its value and the need to use and

Figure 2. Contact between metagranitic rocks (g) and the main dolerite dyke (d) in the Jarrahdale railway cutting (MGA 414735E 6426400N) traceable through the lateritic profile

manage it sustainably. The Perth Region guide is designed to help interested laypersons understand and appreciate their local landscape. Visiting the localities described in the guide offers insights into geological processes in the past that have shaped the landscape and provides an awareness of how similar processes may shape our future. For example, understanding the effects of past sea-level changes will help us understand the possible effects of sea-level changes predicted for the coming century as a result of climate change.

References

GOZZARD, J.R., in prep., Geology and landforms of the Perth Region: Western Australia Geological Survey.

HEWGILL, F. R., KENDRICK, G. W., WEBB, R. J., and WYRWOLL, K. -H., 1983, Routine ESR dating of emergent Pleistocene marine units in Western Australia: Search, v. 14, p. 215–217.

KENDRICK, G. W., WYRWOLL, K. -H., and SZABO, B. J., 1991, Pliocene–Pleistocene coastal events and history along the western margin of Australia: Quaternary Science Reviews, v. 10, p. 419–439.

LEMMON, T.C., GEE, R.G., MORGAN, W.R., and ELKINGTON, C.R., 1979, Important geological sites in the Perth and southwestern area of Western Australia: A report on their scientific significance and future protection: Geological Society of Australia (WA Division), 1979.

MURRAY-WALLACE, C. V., and KIMBER, R. W. L., 1989, Quaternary marine aminostratigraphy — Perth Basin, Western Australia: Australian Journal of Earth Sciences, v. 36, p. 553–568.

PLAYFORD, P. E., COCKBAIN, A.E., and LOW, G. H., 1976, Geology of the Perth Basin, Western Australia: Western Australia Geological Survey, Bulletin 124.

PRICE, D. M., BROOKE, B. P., and WOODROFFE, C. D., 2001, Thermoluminescence dating of aeolianites from Lord Howe Island and south-west Western Australia: Quaternary Science Reviews, v. 20, p. 841–846.

SADLEIR, S. B., and GILKES, R. J., 1976, Development of bauxite in relation to parent material near Jarrahdale, Western Australia: Journal of the Geological Society of Australia, v. 23, p. 333–344.