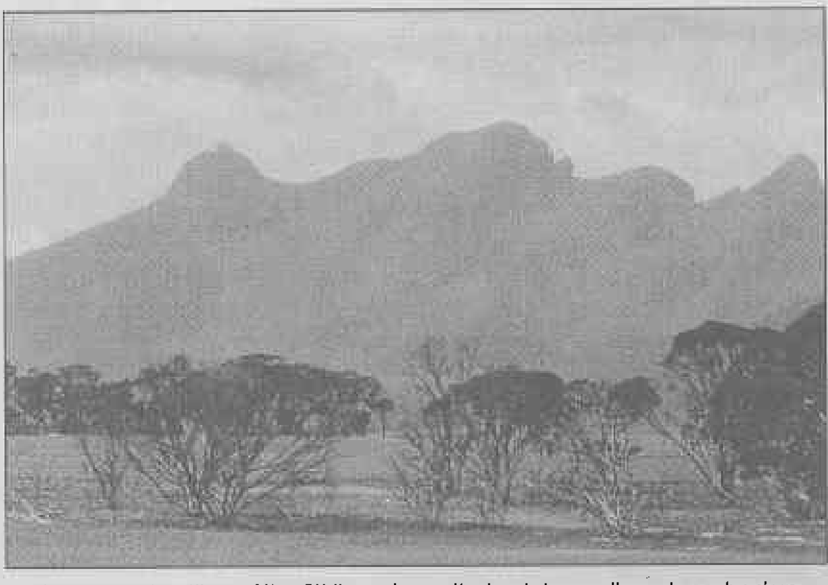
LANDFORM

HOW SOUTH-WEST WA'S LANDSCAPES FORMED

by Jim Barrow

TWO obvious things can be said about the south west of WA: it's very sandy and it's very flat. Actually there are some important and interesting exceptions. But let us look at the obvious characteristics first. Both of them arise from the fact that the land surface is very old indeed.

When the earth was young, it took a long time to organize the constituents that had come together from interplanetary dust. The heavy (and meltable) material had to find its way to the centre and the rather small proportion that we walk on and call the continents had to come to the surface as a "scum". Relative to the rest of the earth, this material was rather light. It contained a good deal of silica - the oxide of silicon. Geologists refer to material with a lot of silica as "acidic". Beneath this acid scum was (and still is) a layer of rock with less silica, more calcium and more phosphate - a more "basic" rock.



The rugged outline of the Stirlings shows their origin - sediments pushed up as the south west corner was squeezed between Antarctica and the granite block of the Yilgarn. The poor soils, and diversity of plants also originates from the poor substrate of the sediments. photo: P. Hussey

Fortunately for us, this scum wasn't smeared uniformly across the surface. If it were, the whole of the earth would be level and would therefore be covered by water. It seems that convection currents in the semi-molten rock gave rise to lines of scum that came together to form rafts. Weathering was pretty fierce of course and there was a lot of churning so that there was some mixing of the scum with the basic rock. This is a very simplified description of the processes that gave rise to the eastern section of the south west - the eastern goldfields. The greenstone belts are the remnants of this early churning and they tend to run in more-or-less north-south lines.

Once these early rafts started to form, they seemed to serve as zones alongside which there were further accumulations of silica-rich rock. Building of this area lasted until about 2 billion years ago with the western section rather younger than the eastern.

The rocks cooled from a molten state very slowly. This meant that there was plenty of time for decent-sized crystals to grow. In very simplified terms, three different kinds of crystals formed in the rocks. One kind was largish, glass-like crystals of silica, which we call quartz. The second kind was semi-rectangular crystals of a potassium aluminium silicate called feldspar, and the third was black mica, looking like a stack of thin leaves. Have a look at a lump of granite one day with a hand lens. You can easily see these separate minerals. Mind you, that is a pretty gross oversimplification. For example, the term "feldspar" covers a suite of minerals with various amounts of potassium, calcium, magnesium and sodium. And there can be some other black minerals.

Granite doesn't break down all that quickly. That is why it is often used in monuments. But we have had a very, very long time. Most of the area has been very stable. There has been almost no volcanic activity, no major uplift and faulting, and no glaciation at least for the last 250 million years or so (unlike northern Europe that was scraped clean little more than 10 000 years ago). The mica goes first and in the process gives rise to some clay. Somewhat slower is the feldspar and it too produces some clay. The clay also continues to weather and when it is very old most of it has turned into the white clay we call kaolin. It tends to move down through the soil to lower levels leaving the quartz particles, the sand, behind. Just how this happens has been the subject of much debate. One idea is that it is a similar process to that which enables walnuts to come to the top of a mixture of nuts when they are shaken. As the

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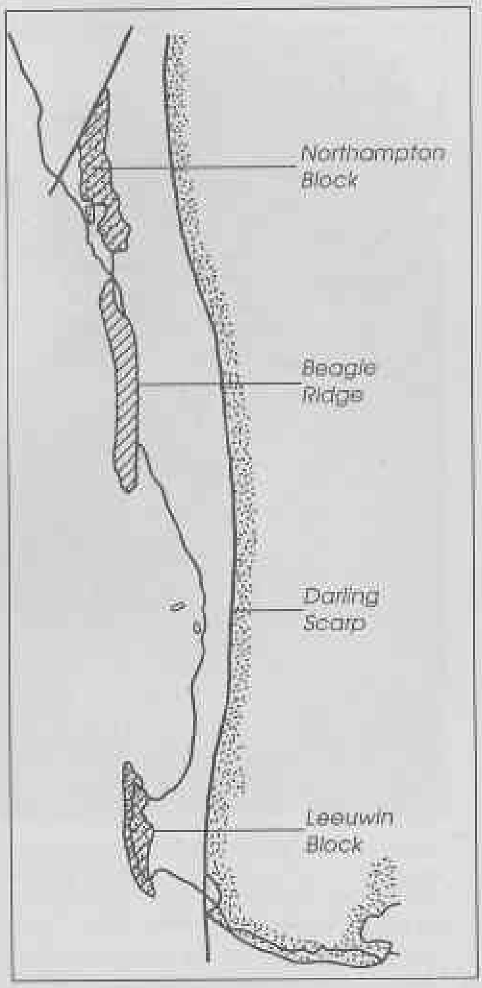
bigger particles jiggle, the smaller ones can slip past them. Whatever the cause, we finished up with large areas with sandy surface and with clay underneath. You see lots of evidence of this clay in road cuttings and in the white clay beside farm dams.

This gives the broad picture. But it is much more complex, and interesting, than this. Look at a map of south west WA. The first thing you see is the Darling Scarp running as a North-South line for almost 1000 km. We often say "Darling Range" but it is not a "range" - it doesn't go up and then down again but rather up then along. As you go towards the western edge of this low plateau, the streams run in steeper and deeper valleys. They are obviously younger here, or more accurately, rejuvenated.

Next you might notice the "chin" the bottom left hand corner between Cape Naturaliste and Cape Leeuwin that sticks out in a chin-like fashion. Then you might notice the southern ranges: the Stirlings, the Porongurups, and the Barrens. Finally you might notice that some of the soils in the south don't follow the pattern of being very sandy: the "Karri loams". And they grow a rather different vegetation. All these have a common explanation. In one word: Gondwana; in two words: continental drift.

The continents that seem so stable are actually racing around the globe. Australia is sprinting northwards - at about 5 cm a year, slightly faster than your fingernails grow. Five cm a year is 1 m in 20 years; 1 km in 20,000 years; 1,000 km in 20 million years; and about 3,000 km since Gondwana broke up about 60 million years ago. So it adds up.

Sometimes as the continents skitter about the globe they bang into each other. Just the other day India banged into Asia. What must happen then is that one of the continental crusts slides under the other. If it is a really big collision, as for India, enormous mountains are thrown up. We call them the Himalayas. An essential part of this collision is that with the tremendous forces involved, the basic rocks that underlie the granites are forced upwards and to a certain extent are mixed into the granites. The rocks show the evidence of this squeezing in the formation of parallel bands of minerals. We then call these rocks "Gneiss" (pronounced "nice"). With long-term weathering, these bands of rocks may become exposed as the "seam" showing where two continents once joined.



Map of the south west showing how the rocks of the "chin" line up with those near Northampton and with a sub-surface structure called the Beagle ridge. These rocks are the remains of the seam where land which is now in Tibet joined up to from part of Gondwana.

This is the origin of the "chin". It is the seam showing the join with what is now part of Tibet. It is no coincidence that the chin lines up with the hills near Northampton. These are the other end of the seam. Similar forces gave rise to the Porongurups. These too are part of a seam, but this time the join was to Antarctica. Because of the injection of some material from the basic rocks under the granite, the soils here are more fertile. The "Karri" soils at Manjimup and Pemberton also have had an injection of this basic material. They are not as sandy as much of WA and they are more fertile.

Continents can also split. Often this involves zigzagging straight lines. A series of such lines split South America from Africa. The split continued to open, giving rise to the Atlantic Ocean. The initial stage of these splits is a "linear sea" and the obvious one of them at the moment is the Red Sea. If you could have visited the south west about 250 million years ago, there would have been a linear sea off shore instead of the Indian Ocean. Somewhat earlier, more than 400 million years ago, there was a similar split a bit further north as another bit of Gondwana sailed off. Once the earth has opened up in this manner, the molten rock from below can sneak out. We have all seen wildlife programs about the volcanic activities in Kenya, where the earth is currently deciding whether to split or not. We had only the merest trace of such activity in the south west. You can see it on the beach at Bunbury where there is a small exposure of basalt dating from the time of the split.

Once these splits occur, the edges of the splits tend to slump in a series of parallel faults. One of these faults is the Darling Scarp. Many of us who live in Perth use it daily for quick orientation. And many are convinced there is nothing quite like it in the world. Well there is!

There is a series of these faults to the west of the scarp, of course well buried in sediments. Beneath Perth, there is about 4 km of sediments

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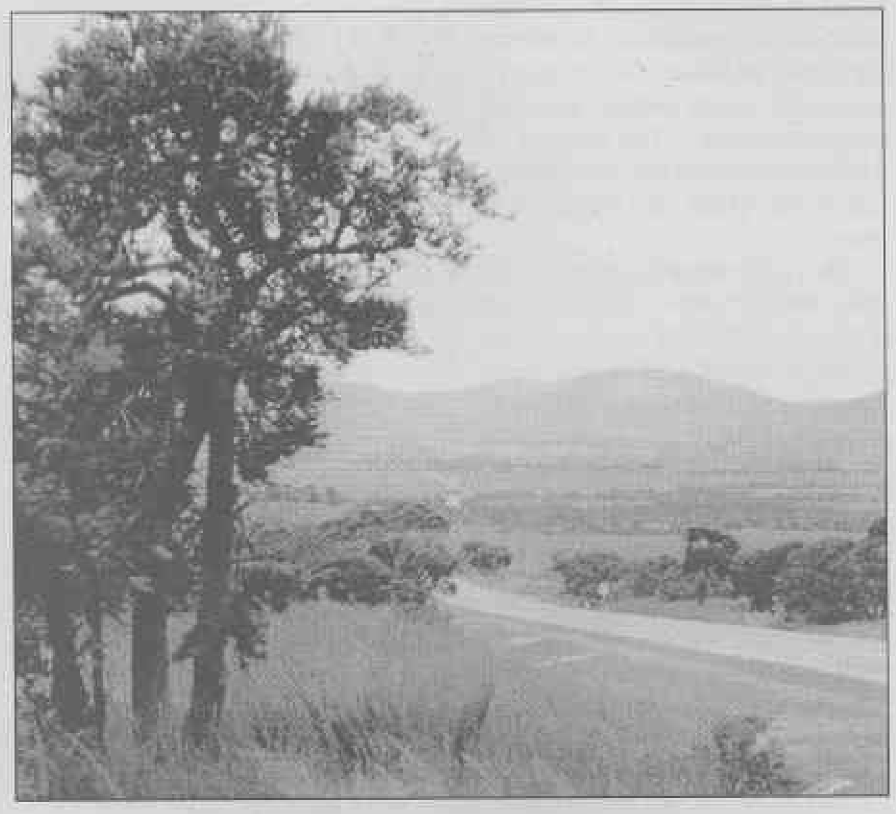
dating back to the Permian - about 250 million years ago. It is even deeper beneath Rottnest. As these sediments filled up the basin caused by the split, there was a chance that organic materials might have accumulated and given rise to oil deposits. That is why there was a lot of offshore drilling. The result is good knowledge of the sediments - but no oil. The more-northerly split also filled with sediments and these are now the red sandstones we know at Kalbarri.

It is of course a bit more complex. Sometime between 2 and 5 million years ago, there was an uplift along the Darling Scarp. The streams that had wandered across a flat plain were then presented with a sharp drop. So they started cutting back with deeper valleys. The streams were rejuvenated. Some of these valleys are relatively fertile, suggesting what WA might have been like had the geology been more active. The cutting back of the streams has reached a line that runs near Merredin. East of that line we still have the very broad valleys that are so flat that the streams don't know which way to flow.

Very much later than the western splits, about 60 million years ago, there was another split as Australia broke free of Antarctica and started its northward journey. The trailing edge tended to sink a bit and this lower region also received sediments both from the rivers that now flowed south and from sponges that grew in the shallow seas. Separating from Antarctica wasn't completely smooth and at one stage, our continent twisted so that the accumulation of sediments was jammed between Antarctica to the south and the mass of granite to the north. This pushed up the Stirlings and the Barrens. You can easily see how the sediments were pushed up and jumbled. So the neighbouring ranges of the Porongurups and the Stirlings have quite different origins: the Porongurups were formed when Gondwana came together; the Stirlings when it came apart.



The smoother outline of the Porongurups comes from its origin as part of the seam when Australia joined Antarctica. The better soils and more luxurious vegetation come from the injection of basic rock as the two continents collided.
photo: L. Barrow

That is a broad outline of the major features of our landscape. On a more detailed scale, a prominent characteristic is that we have a lot of ironstone gravel and a lot of mesa-like structures capped by massive ironstone. Tune in, same channel next quarter, to find how this came about!

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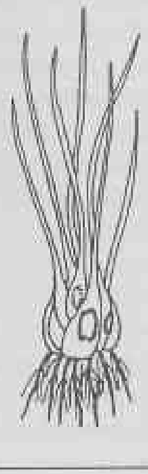
BUSH DETECTIVE

On granite rocks all over the south-west, as winter rains fill the pan gnammas, tiny plants grow from the muddy base. One widespread type looks like a tuft of bright green leaves, usually not more than 5 cm long. Visit your nearest granite outcrop and look in the gnammas - what sort of a plant is it?



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