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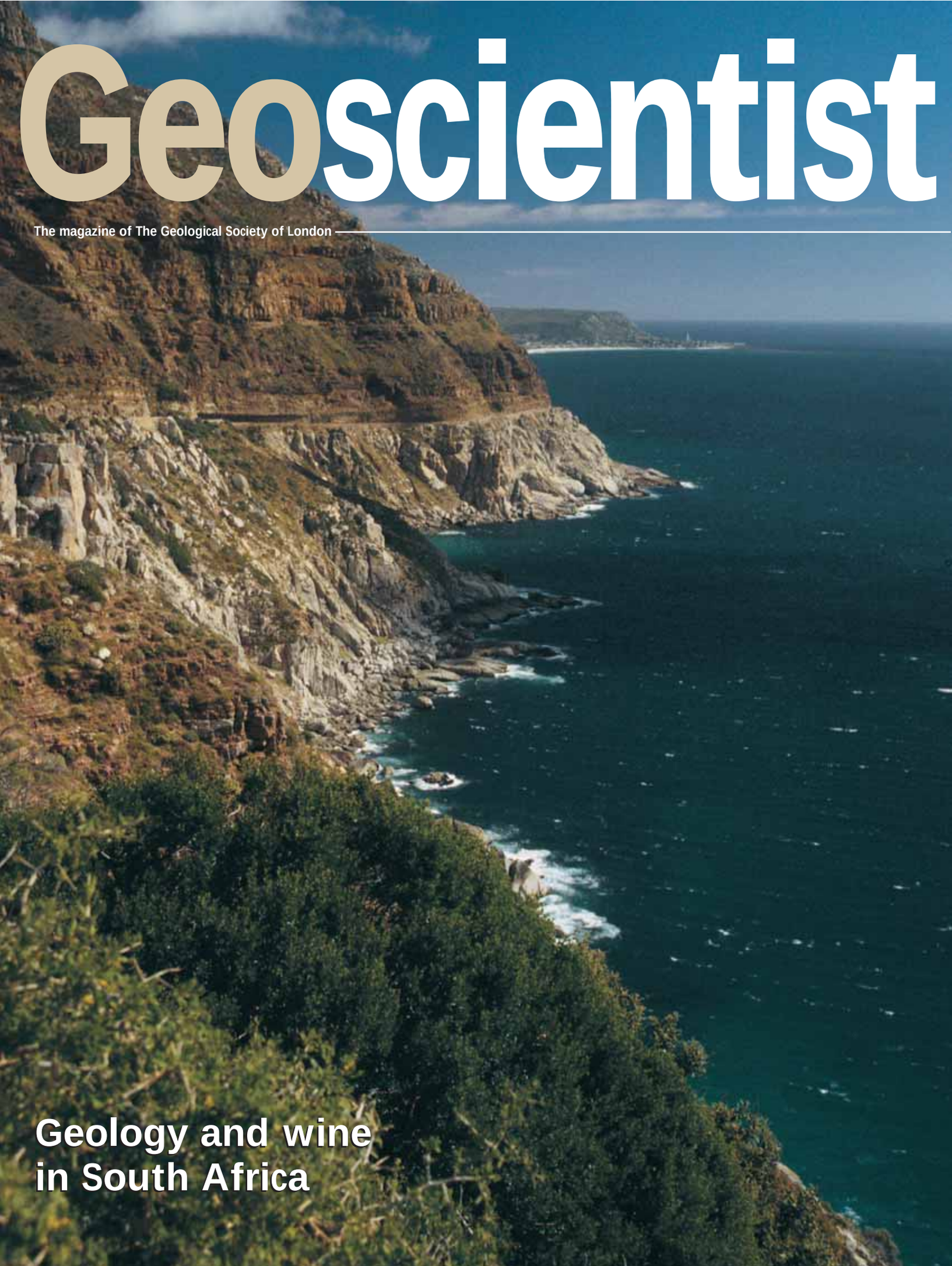

Geology and wine in South Africa

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Geology and wine

*By Christopher J Bargmann**

Since its return to democracy South Africa has become a significant player in the world wine industry. The industry, based around the towns of Stellenbosch, Franschhoek (main picture) and Paarl, Western Cape Province, has a long wine-making tradition dating back to 1659. Then the Dutch East India Company first planted European vines, and the tradition was developed by French Huguenot settlers. As with most wine producing regions the soils and geology of the vineyards are a much-discussed topic and this paper will detail some of the features which potentially make vineyards unique. More detailed information can be obtained from the author's recently published paper in *Geoscience Canada* (Bargmann 2003).

The role of soils and the geology of the underlying bedrocks is an important component of *terroir,* the French term describing the natural environment influencing the grape vine and ultimately the taste and quality of the resultant wine. This is particularly true in the "old world" wine producing countries of Europe. Possibly the best documented examples are Burgundy and Bordeaux (France); however the importance of unique geological settings has spread to the "new world", for example Coonawarra (South Australia) and the Rutherford Bench in California's Napa Valley.

South Africa's winelands can be broadly divided into four geographical zones. These are the Coastal Region, centred on Cape Town, Stellenbosch and Paarl, the more inland Breede River Region around Worcester and Robertson, the Olifants River Region to the north of the Coastal Region, and finally the vineyards adjacent to the Orange River and its tributaries in the Northern Cape. The most significant areas from the point of view of the geology are those of the Coastal and Breede River regions, which will be discussed in more detail.

The distinction between the role of bedrock geology and that of the overlying soil horizons is often confused. Generally speaking the soil is the major influence on the growth of the vine as it provides three basic functions: a supply of water, anchorage in the ground, and a source of nutrition. The bedrock is usually (but not exclusively) solid, unweathered material from which plant roots derive little benefit. The nature of the bedrock can however influence important soil factors such as the nutrient content and pH levels. For example, areas with granite bedrock form acidic soils, where root growth can be restricted.

For successful viticulture the soil must possess good drainage qualities yet should also be capable of supplying water to the vine throughout the year, including dry periods, if irrigation (if allowed at all) is to be avoided. The soil's structure (its physical nature) and texture (the effects of soil particle size - clay and sand soils have opposing textures) are vitally important as they impact directly on the soil's ability to support plant life (through aspects such as the porosity and permeability).

In South Africa three main types of vineyard soil are important. First come the residual and colluvial soils (where soil movement on a local scale has occurred) produced as a direct result of the weathering

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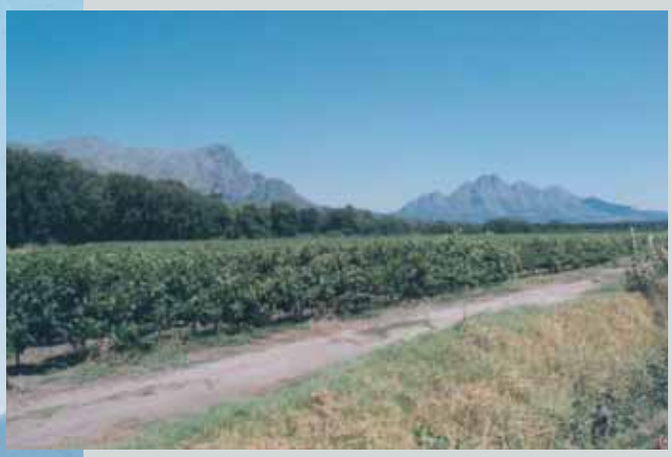
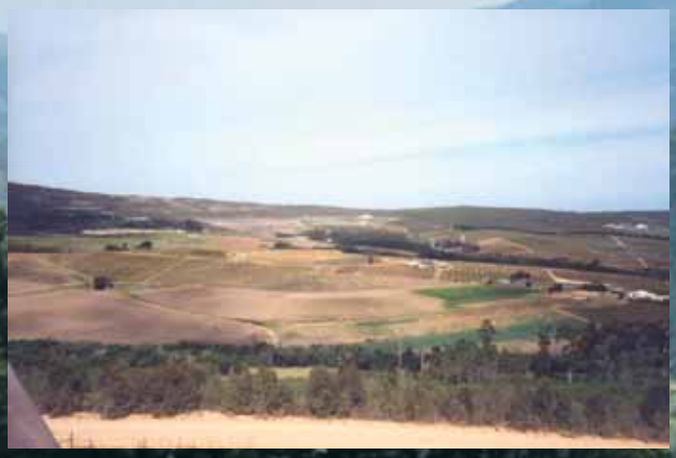
Photo: © Ted Nield





in South Africa

Main image: Pinot Noir grapes growing at Dieu Donné winery, overlooking Franschhoek Valley, South Africa. Photo: Ted Nield

Inset images: ©Bargmann

Top row, left:
Table Mountain viewed from the slopes of the Jordan Winery in the Bottelary Hills outside Stellenbosch. The winery has loam soils derived from the weathering of the Cape Granite Suite. The vineyards of Constantia, on the slopes of Table Mountain, benefit from cooler conditions than those of the Stellenbosch Region

Top row, right:
The Simonsberg (on RHS) and Drakenstein (on LHS) viewed from the vineyards of the La Motte Estate in the Franschhoek Valley. The vineyards are on alluvial soils of the Berg River. The mountains are an important factor in this area having high rainfall.

Bottom row, left:
The Hamel en Aarde valley near Hermanus. Planted since the 1980s as a cool wine growing region, this area has a good reputation for its Pinot Noir and Chardonnay.

Bottom row, right:
The old Serina Kaolin mine at Fishhoek on the Cape Peninsula. Vineyards have been planted as part of mine rehabilitation. The vineyards of this area have been pioneered over the last ten years and have developed a good reputation for Sauvignon Blanc.

and chemical breakdown of the local bedrock. Here there is a direct association between the soil and the geology. In the Western Cape stable geological conditions have existed for the last 65 million years resulting in well-developed residual soils of considerable antiquity.

The second important group are the alluvial soils, which have been deposited by the action of water – predominantly rivers. Alluvial soil characteristics vary widely, ranging from gravel deposits to clay layers, sometimes over short distances. These are important for vineyards in the Berg, Breede and Olifants river valleys.

Soils deposited by wind action form the third type of soil. These aeolian soils are sandy, and typically cover a residual clay subsoil layer. They feature in some vineyards in the Bottelary and Koelenhof areas to the north and west of Stellenbosch. In both of these cases the soil characteristics are normally unrelated to the immediate bedrock geology, as the soil material has been transported, often for large distances, from its source.

Coastal Region

The Coastal Region occupies the coastal plain between the Atlantic Ocean in the west and the north-south trending mountains such as the Hottentots–Holland and the Stellenboschberg in the east. Climatically the area is well suited to vines with a typical Mediterranean climate. Generally wetter and cooler conditions prevail in more coastal areas, while hotter and drier conditions occur inland and to the north. The oldest geological units present are the Precambrian rocks of the Malmesbury Group (950–550Ma). These largely shaly rocks were deposited under marine conditions in an ancient ocean bordering a landmass known as the Kalahari craton. Subsequently, during the Cambrian period, continental collision occurred and volcanic activity took place, marked by 550–510Ma granites of the Cape Granite Suite. These largely S-type granites form large batholiths and have a significant role as the parent geology of many Stellenbosch area vineyards. One of these is the granite making up the Paarl Mountain, which features on the cover of the *Annual Report 2004,* distributed with this issue. During this period the 540–522Ma sediments of the Klipheuwel Group were also deposited as a result of uplift and erosion. The Klipheuwel consists largely of conglomerates and shales and crops out in the area between Paarl, the Simonsberg Mountain and Franschhoek.

A period of erosion followed, lasting until 450Ma when the Ordovician-Devonian quartzitic sandstones of the Table Mountain Group were deposited in a shallow sea. These form the basal formation of the Cape Supergroup. A well-developed unconformity marks their base where they rest on the older shales or granites. This unconformity is well exposed on the Cape Peninsula (cover picture). The 440Ma late Ordovician glacial deposits, comprising tillite and shales of the Pakhuis and Cederberg Formations, mark the only variation to this sandstone-dominated sequence.

A later period of continental collision at 250Ma resulted in the formation of the Cape Fold Belt, which produces much of the dramatic mountain scenery of the modern Cape. The final phase of the geological history of the Coastal Region is marked by erosion for the last 65Ma, which has produced the residual soil horizons and river gravels seen today. The most desirable soils are clay-rich loams, an important factor as this allows for water to be retained for plant use during the dry summer months. Two scenarios of river gravels are present, firstly the modern river floodplains of the Berg and Eerste rivers, and secondly through the presence of ancient gravel terraces above the current river level, which are noted in the Eerste River west of Stellenbosch.

A feature of the Coastal Region is the acidic and potassium rich soil derived from the weathering of the granites. The weathering of granite also produces other specific characteristics. The first of these is the presence of large amounts of the clay kaolin, which is locally called “pot clay”. Significant accumulations of kaolin are recorded near Stellenbosch and Cape Town and are possibly unique in terms of vineyard soils. On the Cape Peninsula rehabilitation of the Serina Kaolin mine at Fishhoek has included the establishment of vineyards. The second

feature is weathering of granite bedrock to produce saprolites below the soil profile. In simple terms saprolites represent a stage of chemical weathering whereby the granite bedrock has not completed the transition from rock to becoming a soil horizon. Saprolites form an important part of many vineyard soils and their role may be understated.

The predominantly shaly Malmesbury Group rocks are also noted for their acidic and potassium rich soils, and the presence of hornfels in contact with the plutons of the Cape Granite Suite. This is locally significant as it results in the formation of resistant hills in areas such as Durbanville and Bottelary. Also of significance from the *terroir* point of view are the occasional areas of limestones within the Malmesbury group, particularly near Riebeek Kasteel and Piketberg, with potential for alkaline rather than acidic soils.

Breede River Region

As a contrast the Breede River Region covers the intermountain valley of the Breede River and includes the towns of Worcester, Robertson and on geographical and geological grounds the Tulbagh Region. Tulbagh is included in the Coastal Region under Wine of Origin legislation as it forms part of the Paarl Municipal area. To the south of the Breede River Region lies the mountainous Overberg Region; both share similar geology. Climatically the area is more varied than the Coastal Region. The northwestern parts of the valley between Tulbagh and Worcester experience the hottest temperatures and receive the most rainfall. Between Worcester and Robertson the climate is hot with low rainfall. The southeastern areas between Robertson and Bonneville are the coolest portion of the valley, influenced by breezes and fog from the Indian Ocean. The Overberg Region with its vineyards near Hermanus and Elgin are the coolest vineyard areas in South Africa.

A major geological fault, the Worcester fault, is the most significant feature defining the geology of the Breede River. Across this fault a total movement of up to 6km has occurred and the fault system is still active (as the 6.3 Richter Tulbagh earthquake of 1969 testifies). On the eastern side of the fault the geology is the same as the Coastal Region. On the western side however, the 400–340Ma Devonian marine sandstones and shales of the Bokkeveld and Witteberg Groups are present. These form the upper units of the Cape Supergroup above the Table Mountain Group. They are best developed between Worcester and Bonnivale in the Breede River Valley and in the Overberg Region at Elgin and the Hamel en Aarde valley. Overlying these sediments are the 300–275Ma (Permo-Carboniferous) sediments of the Karoo, comprising the Dwyka tillite and the shaly Ecca Group. The famous Dwyka tillites were deposited during the last major glaciation to affect southern Africa.

As with the Coastal Region 250 million years ago the Cape Fold Belt arose from folding of the whole sequence. In response to fault movements as the Atlantic began to open at 140Ma, the Jurassic Enon conglomerate was deposited. Dolerite dykes, known as the False Bay Dolerites, were also intruded at this time. The preservation of the Karoo and Enon sediments is restricted to small portions of the Breede River Valley, notably the Nuy, Vinkriver and Ashton/Bonnivale areas; even so, they have significant impacts on viticulture.

How geology impacts the vine

Three geological scenarios are significant for vineyard location. Traditionally, vineyards were planted in the flood plains of the Breede River and its tributaries. As the rainfall in the region is predominantly low, access to irrigation water is important. The Springfield Estate near Robertson is noted for its gravely soils and is unusual in that it is now producing widely acclaimed wines from these alluvial soils. As the region moves towards non-irrigated cultivation a significant portion of vineyards are now being planted on non-alluvial loam soils with calcareous layers. These are located further away from the river, in areas where rocks of the Bokkeveld, Witteberg, Dwyka groups and Enon Formation occur as the bedrock.

The calcareous layers are formed as a result of excess evaporation over precipitation in this low rainfall region. These soils are unique in South Africa as they represent

the only naturally alkaline vineyard soils to have been developed on a significant scale. Finally, the vineyards in the Breede River Valley and Overberg are higher-lying residual soils derived from shales (which can be Malmesbury - Bokkeveld - or Witteberg). These soils are similar to those in the Coastal Region, in that they do not contain the calcareous layers.

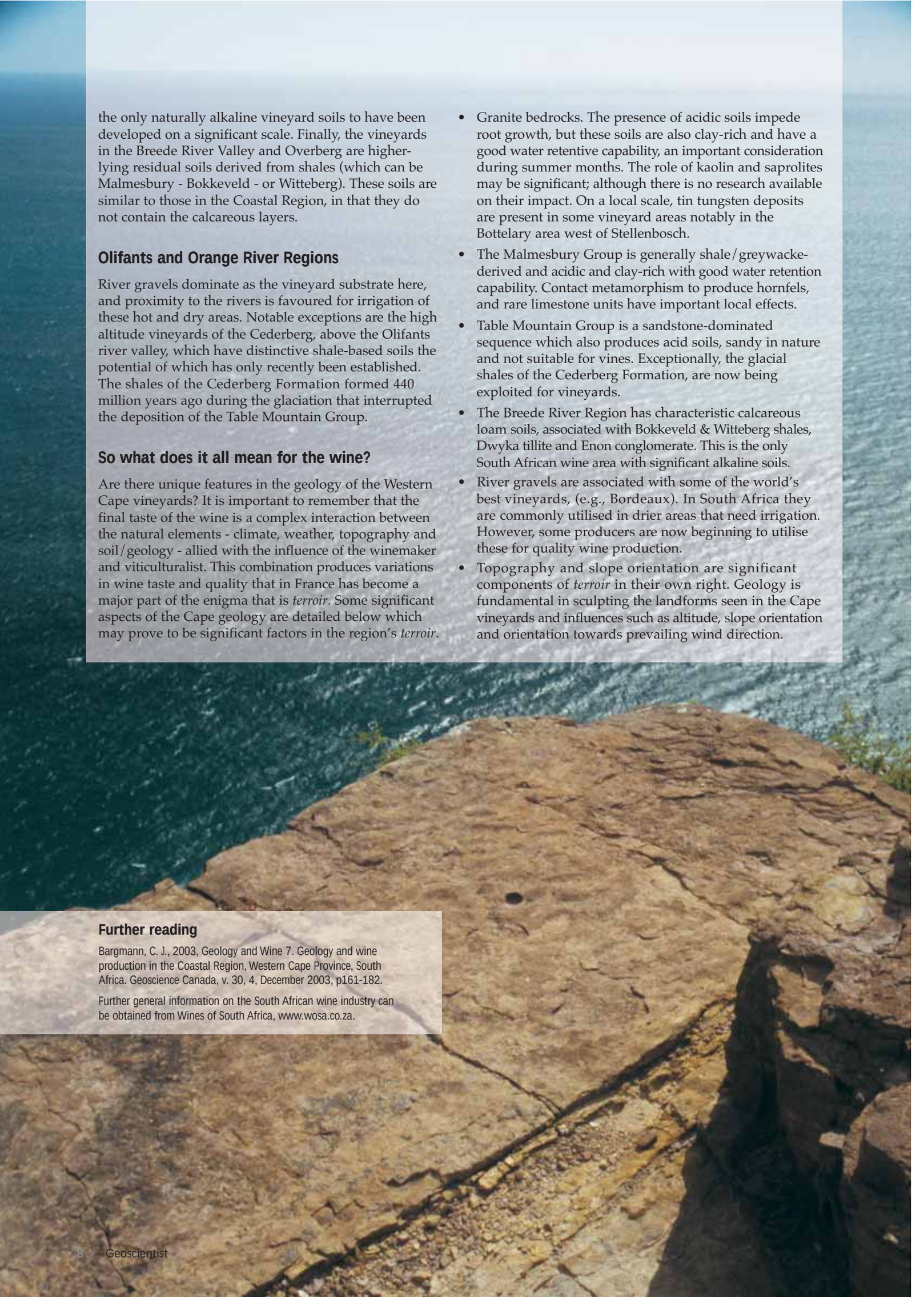
Olifants and Orange River Regions

River gravels dominate as the vineyard substrate here, and proximity to the rivers is favoured for irrigation of these hot and dry areas. Notable exceptions are the high altitude vineyards of the Cederberg, above the Olifants river valley, which have distinctive shale-based soils the potential of which has only recently been established. The shales of the Cederberg Formation formed 440 million years ago during the glaciation that interrupted the deposition of the Table Mountain Group.

So what does it all mean for the wine?

Are there unique features in the geology of the Western Cape vineyards? It is important to remember that the final taste of the wine is a complex interaction between the natural elements - climate, weather, topography and soil/geology - allied with the influence of the winemaker and viticulturalist. This combination produces variations in wine taste and quality that in France has become a major part of the enigma that is *terroir*. Some significant aspects of the Cape geology are detailed below which may prove to be significant factors in the region's *terroir*.

- Granite bedrocks. The presence of acidic soils impede root growth, but these soils are also clay-rich and have a good water retentive capability, an important consideration during summer months. The role of kaolin and saprolites may be significant; although there is no research available on their impact. On a local scale, tin tungsten deposits are present in some vineyard areas notably in the Bottelary area west of Stellenbosch.
- The Malmesbury Group is generally shale/greywacke-derived and acidic and clay-rich with good water retention capability. Contact metamorphism to produce hornfels, and rare limestone units have important local effects.
- Table Mountain Group is a sandstone-dominated sequence which also produces acid soils, sandy in nature and not suitable for vines. Exceptionally, the glacial shales of the Cederberg Formation, are now being exploited for vineyards.
- The Breede River Region has characteristic calcareous loam soils, associated with Bokkeveld & Witteberg shales, Dwyka tillite and Enon conglomerate. This is the only South African wine area with significant alkaline soils.
- River gravels are associated with some of the world's best vineyards, (e.g., Bordeaux). In South Africa they are commonly utilised in drier areas that need irrigation. However, some producers are now beginning to utilise these for quality wine production.
- Topography and slope orientation are significant components of *terroir* in their own right. Geology is fundamental in sculpting the landforms seen in the Cape vineyards and influences such as altitude, slope orientation and orientation towards prevailing wind direction.



Further reading

Bargmann, C. J., 2003, Geology and Wine 7. Geology and wine production in the Coastal Region, Western Cape Province, South Africa. Geoscience Canada, v. 30, 4, December 2003, p161-182.

Further general information on the South African wine industry can be obtained from Wines of South Africa, www.wosa.co.za.