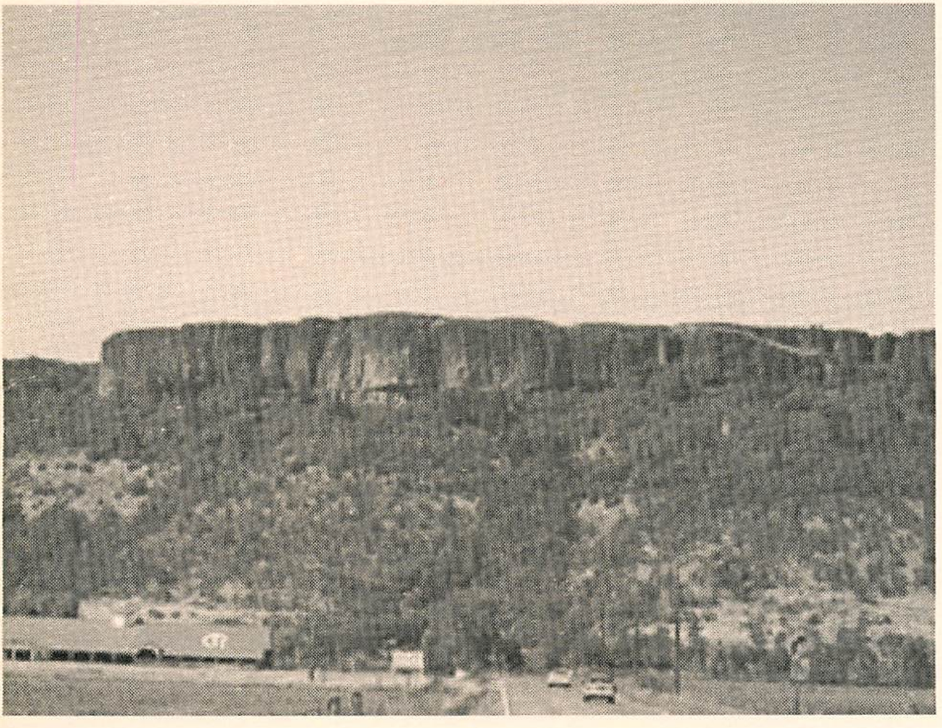
# The Edinburgh Geologist

Magazine of the Edinburgh Geological Society

Issue No. 41 Autumn 2003



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**Cover illustration**

Lower Table Rock, Oregon

Late Miocene alkaline trachyandesitic lavas form the table top overlying early Palaeogene marine deposits in this feature near Medford, Oregon.

see articles on Geological Tables on page 19 of this issue;
the piece on Table Rocks, Oregon is on page 30.

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**Editor**
Alan Fyfe
Struan Cottage
3 Hillview Cottages
Ratho
Midlothian
EH28 8RF

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# Editorial

### by Alan Fyfe

The fourth edition of *The Geology of Scotland* crossed my desk this summer, sent to me by the publishers for review in this magazine. Before I sent it off to my reviewer, I had a quick look inside. How Scottish geology has changed since I was a lad! The most striking difference is probably the introduction of the concept of terranes. I contacted the editor, Nigel Trewin, to ask about this and, for those to whom this is a new concept, he gave me the following definition:

> A terrane is a mappable structural entity which has a stratigraphic sequence, and an igneous and metamorphic history distinct from adjacent terranes, from which it is separated by a distinct structural break. Continents consist of a number of terranes generally accreted as a result of plate motions.

In fact, this was not the first I had heard of terranes. In the 1980s, I read James Michener's mega-novel, *Alaska*, in which he describes the history of that part of America, starting from, well, before Alaska was there! The first chapter is entitled *The Clashing Terranes* and a more dramatic treatment of the subject you are never likely to read. Michener talks of 'lofty mountains and stern shorelines', he talks of 'massive subterranean plates which move restlessly about' and he describes the accretion of continental fragments on to the Alaskan foreland in terms of how 'wandering terranes... sometimes as big as Kentucky... would creep relentlessly north from somewhere and bang into what was already there.' It is great stuff, perhaps the most accessible geological guide for the general public ever written.

But to the rest of this issue of THE EDINBURGH GEOLOGIST. The first article is by our President, Peter Dryburgh, a biographical account of Nicolaus Steno. Well, I hadn't heard of him either, but he is arguably the father of palaeontology as well as mineralogy. In these days of high specialisation, this may be hard to grasp, but there was a time when it was possible to know all that was known in a wide range of subjects. No longer so!

The second article is from a contributor of many an interesting essay during the years that THE EDINBURGH GEOLOGIST has been published. Phil Stone has provided us with a fascinating account on fossils discovered on the Scottish National Antarctic Expedition led by John Speirs Bruce in 1902. This expedition has been heralded in *History Scotland* as well as in a number of documentary articles on *Radio Scotland*. Phil provides us with a personal account.

Norman Butcher and I received a number of comments on the article that appeared in the last issue entitled *A complimentary dinner*. We had a letter, a phone call and an e-mail message, providing more information on D. Haldane. Thank you to all of you. I have tried to set the record straight here.

By some sleight of hand, I have managed to combine the *Geo-vineyards* article with *What's in a Name?* Following his sending me the *Flat Rock* label that appeared in the last issue, Vic Loudon sent me a label featuring *Devil's Rock*. I researched this on the web and, as well as finding a site with scantily-clad men and women standing on the same feature, I found some more geological information. Its name in German is *Teufelstisch*, meaning 'Devil's Table'. This set me off thinking of other geological tables (not the sort that fill pages of mineralogical theses) and I have managed to commission a selection of contributions from around the world on Table Mountain, the Atherton Tablelands of Queensland, Australia, Table Rocks of Oregon and Macleod's Tables in Skye... as well as *Teufelstisch*, of course.

To follow all these tables, we have the tenth *Rocksword*, compiled by Angela Anderson, while the *Poet's Corner* for this issue comes from the late Piet Hein, a mathematician and scientist as well as an artist and poet. This grook (from the equally novel Danish word *gruk*) presents an interesting view of the Earth in space.

There are three book reviews for this issue. First of all, as I mentioned earlier, there is the fourth edition of *The Geology of Scotland*. This has been reviewed by Dan Evans, himself no stranger to editing major publications. There is also a review of Con Gillen's *Geology and landscapes of Scotland*, a new book that provides an accessible introduction for non-experts as well as an excellent summary of Scottish geology for those with more knowledge. It is interesting to have these reviewed together. Lastly, after reaction to the reviews in the Spring edition, I have a new review of the RIGS Barns Ness leaflet. It can now be described as written by children, written for children and reviewed by children.

This rounds off a magazine in which I hope there is something for everybody.

Editor: Alan Fyfe
Struan Cottage
3 Hillview Cottages
Ratho
Midlothian
EH28 8RF

Telephone/fax: (0131) 333 4471
E-mail: eg_editor@edinburghgeolsoc.org

**The copy date for the next issue of** THE EDINBURGH GEOLOGIST **is Monday 1st March, 2004.**

# Nicolaus Steno
# and the Foundations of Geology

**by Peter Dryburgh**

Nicolaus Steno is perhaps best known in connection with the crystallographic law which states that the angle between two faces of a crystal is the same as the angle between the two corresponding faces of any other crystal of the same substance. Indeed, some text-books refer to this law as Steno's Law. What is much less widely appreciated is Steno's enormous contribution to the establishment of the whole science of geology. In order to understand his involvement in geology, it is helpful to know something of his background and the reasons for his international standing as a scientist, which arose initially from his work as an anatomist.

**Steno's early life and student days**

Although he is known universally by the latinized version of his name, Nicolaus Steno, he was born in Copenhagen in January 1638 and named Niels Stensen. His father, Sten Pedersen, was a prosperous goldsmith and lapidary who died in 1644, after which Steno's brother-in-law, Jörgen Carstensen, was appointed his guardian. After Pedersen's death, his workshop was taken over by his daughter's husband, Jakob Kitzerow, although Steno stayed on in his mother's house and was sent to the Metropolitan School when he was about ten. During his schooldays, he developed a love of mathematics and it is clear also that he was so familiar with metalworking, lens polishing and instruments that a biographical note by Scherz states that 'the workshop was undoubtedly the boy's first school.'

During the eight years for which Steno attended the grammar school, a quarter of the population of Copenhagen perished in an epidemic but, ironically, this early part of the seventeenth century was a period when the study of medicine was flourishing in Denmark. Upon leaving school in 1656, Steno matriculated in the University of Copenhagen to study anatomy and medicine. His tutor was the great anatomist Thomas Bartholin, a member of the family which dominated academic life in Denmark for three generations and included Erasmus Bartholin, who discovered double refraction in calcite in 1669.

Academic life was severely disrupted in 1667 by the war with Sweden but Steno pursued his studies with diligence and intense concentration. The 'Chaos Manuscript', found in a library in Florence in the nineteen-fifties, consists of ninety pages of Steno's own notes from his time at the University of Copenhagen. There are detailed comments about his many experiments in different fields of study and his reflections on Christianity and philosophy. There are copious notes from a huge variety of sources and descriptions of the construction of different instruments and of chemical and metallurgical experiments. Of particular interest in a geological context, are his reflections on the problems of geomorphology and his emphatic declaration of the importance of practical observation.

In the autumn of 1659, Steno left Copenhagen, which was still under siege, and travelled through northern Germany to Amsterdam on the first stage of his academic tour. It was during his first year in Amsterdam that he discovered the parotid salivary duct still known as the *ductus Stenonianus* and started his detailed study of the chemistry and physics of hot-springs.

By 1660 he had moved on to Leiden and, after matriculating at the University, he commenced his extensive research into glands, muscles and comparative anatomy, one of his fellow students being the Scottish naturalist Sir Robert Sibbald. In 1664, before obtaining his doctorate, he returned to Copenhagen following the death of his mother's fourth husband and was in great hope of being offered a university post. However, university politics and nepotism prevailed, so the post was given to a man who had produced no original work and was in all respects Steno's academic inferior but was related to an influential professor. Steno then collected together all his anatomical work in a treatise, which he dedicated to the king of Denmark with a plea for help but, when another university post became available, he was again passed over. His mother died later in the year and he left Copenhagen to visit Paris and Montpellier. In December 1664, the University of Leiden conferred on him the degree of Doctor of Medicine.

When he received the news of this honour, he was already in Paris where he associated with all the most distinguished scholars of the day and carried out important research into embryology and the anatomy of the brain. At this time, the theory of Descartes concerning brain function was widely accepted. Although an eminent mathematician and philosopher, Descartes had little knowledge of practical anatomy or physiology and one of the cornerstones of his theory was the unique occurrence of the pineal gland in the human brain. In a famous lecture, Steno showed that the pineal body existed in all the animals he had dissected and so disproved the theory. This refutation of the Cartesian theory greatly enhanced Steno's reputation, and it was published some years later (1669).

Steno left Paris in 1665 to go to Montpellier, at that time a major centre of intellectual activity. It was there that he came into contact with such English scientists as Martin Lister and John Ray and became acquainted indirectly with other members of the Royal Society and their activities. Early in 1666, Steno left France for Italy and was received in Pisa at the winter residence of the Medicis by Grand Duke Ferdinand II of Tuscany, an enthusiastic patron of the arts and sciences. Ferdinand encouraged him to pursue his research and provided him with generous support and assistance, which continued when he moved on to Florence.

In 1666, Steno had reached the age of 28 and had an international reputation as an anatomist and zoologist but two momentous events occurred in that year, one of which turned his attention to the systematic study of geology and another which changed the entire direction of his later life even more radically. The first event was the chance landing near Lavorno of a great white shark (*Carcharodon rondeletti*) by fishermen, and the second was his conversion to Roman Catholicism.

The giant shark was such an unusual specimen that the Grand Duke ordered the head to be transported to Florence for Steno's anatomical studies. The resulting dissection and analysis were carried out with the thoroughness for which Steno was renowned and his acute powers of observation and meticulous recording provided a mass of new information on functional anatomy.The report of the dissection was appended to his important treatise on muscles, *Elementorum Myologiae Specimen*, published in 1667.The feature of greatest interest from a geological point of view is Steno's extensive digression on sedimentation and fossilisation.

**The birth of palaeontology**

The need to include a geological digression in an anatomical treatise arose from Steno's controversial comparison of the shark's teeth with the tonguestones (glossopetrae) which were commonly found in Malta and other places. Although fossils had been found and discussed for centuries, there was no general support for the idea that they were preserved relics of living creatures. After painstaking examination of the shark's teeth, Steno listed eleven observations and six conjectures and with cautious but relentless logic established beyond doubt that the glossopetrae had indeed been sharks' teeth and that accompanying mollusc shells were the remains of formerly living creatures. His discussion of sedimentation processes reveals also an appreciation of the cyclic nature of erosion and deposition. His style of expression was free from dogmatic assertion and he concluded:

> Nothing seems to contradict the theory that the bodies excavated from the earth and which resemble parts of animals must also have been parts of animals.

This simple statement, following the first unequivocal proof of the nature of fossils, may be seen as heralding the birth of palaeontology. In an address to the British Association in 1881, Thomas Huxley acknowledged some of the earliest work on the organic origin of fossils but stated that the true interpretation of fossils was

> stated in a manner that left nothing to be desired in the latter half of the seventeenth century. The person who rendered this good service to palaeontology was Nicolaus Steno.

**Steno's religious conversion and the 'Prodromus'**

After many years of religious reflection and theological study, Steno decided finally to embrace Catholicism and was formally received into the Church in 1667. On the same day, he received a communication from King Frederik III of Denmark asking him to return to Copenhagen and offering him an annual pension. He hesitated to accept the offer, probably because he was unsure about the effect his conversion might have upon it: Denmark was a strictly Lutheran country at this time.

The Grand Duke had approved of an extensive programme of work proposed by Steno and agreed to support him. As a result, much of the year 1667-68 was spent in geological excursions and travels, especially in Tuscany, and Steno visited mines and quarries and studied the sedimentary rocks of Elba. At the end of 1668 he abruptly gave up his rooms in Florence and started upon a long and circuitous journey back to Copenhagen. The reason for his unexpected departure is unknown but may have been the result of discrete pressure by King Frederik. Whatever the reason for his leaving Florence, he acknowledged that he would be unable to complete the agreed programme of research so, largely in the spirit of an apology, he decided to write for the Duke an outline or extended synopsis of the major treatise which he had originally intended to write. This publication, entitled '*De Solido Intra Solidum Naturaliter Contento Dissertationis Prodromus*' (The Prodromus to a Dissertation Concerning a Solid Enclosed by Process of Nature Within a Solid) appeared in 1669. The Prodromus, as it is usually called, is one of the most amazing works in the history of geology and foreshadows many aspects of the subject that did not become established until more than a century after its publication.

The book's rather obscure title gives no inkling of the wealth of ideas and observations which it contains. Under the general heading of 'solids contained within solids', Steno includes fossils, agates and crystals in rocks and also the strata which form the earth's crust in Tuscany: a typical bed lies between higher and lower beds and so may be regarded as enclosed. No summary of the Prodromus can convey the concentrated brilliance of the work and Steno's style of writing is so precise and economical that it is difficult to summarise without significant loss. There are few superfluous words. Steno never indulged in the unsupported speculation so common amongst his contemporaries but went into the country to study the rocks themselves and deserves to be regarded as the first field geologist. The outline of selected topics which follows is given in an attempt to convey the breadth and importance of this monumental work.

**The geological content of the Prodromus**

The Prodromus is formally dedicated to The Most Serene Grand Duke (Ferdinand II) and the introductory preamble reveals much of Steno's attitude to geological investigation. After a detailed apology for failing to complete all the work planned, Steno outlines the four parts of the proposed dissertation and discusses some general principles, the first of which defines a general problem:

> Given a substance endowed with a certain shape, and produced according to the laws of nature, to find in the substance itself clues disclosing the place and manner of its production.

Later in the introduction he observes:

> There seem to me two main reasons underlying the fact that in the solution of natural problems not only are many doubts left undecided but also most often the doubts multiply with the number of writers.
>
> The first is that few take it on themselves to examine all those difficulties without whose resolution the solution of the investigation is left marred and imperfect...
>
> The second reason, which nourishes doubts, seems to me that in considering the natural world, those things which cannot be determined with certainty are not kept separate from those that can be so determined

In the main text, Steno extends his original proof of the origin of fossils and extends it to include plant remains. He observes that all strata were deposited originally from a fluid medium subject to the effects of gravity and enunciates three principles of stratigraphy. First, in any vertical sequence of beds, the oldest bed must be at the bottom and the youngest at the top (principle of superposition). Second, from the observation that sediments were deposited from a fluid, all beds must have been originally horizontal, so inclined beds must have been tilted after their consolidation (principle of original horizontality) and third, horizontal beds would have extended in all directions, so similar beds separated by a valley must have been originally continuous (principle of original lateral continuity).

In the following text he distinguishes between marine and fluviatile beds and, in discussing the origin of mountains, shows that they do not grow like trees but classifies them as block or fault mountains, volcanic mountains, mountains of erosion and folded mountains. He points out that sedimentary and volcanic rocks are different because they are produced by different processes.

The reconstruction of the geological history of Tuscany (opposite) is presented in the form of a sequence of sketched sections with notes referring to them:

1. Rocky strata are whole.
2. Huge cavities have been eaten out by water or fire while upper strata are unbroken.
3. Mountains and valleys have been caused by the breaking up of upper strata.
4. New strata have been made by the sea in the valley.
5. A portion of the new strata has been destroyed while upper strata remain unbroken.
6. Hills and valleys have been produced by breaking up of upper strata.

As well as being the first recorded use of stratigraphical sections, Steno's diagrams and their explanatory notes reveal a huge extension of the accepted timescale and an appreciation of the continuity of geological processes.

Steno discusses the origins of ores and gems and shows that crystals grow by accretion of fresh material onto the existing planes from outside and not, as many writers then supposed, by organically growing like plants from within. By considering various irregular basal sections of quartz crystals, he established that the interfacial angles were constant. (Although Steno made no claim to the generality of this law, it is always attributed to him. The concept of a crystal as a type of solid was introduced by Höttinger in 1698 but in Steno's time, the word referred exclusively to quartz. It was not until after the invention of the contact goniometer in 1780 and the comprehensive measurements made by de L'Isle that the constancy of interfacial angles was established as a general law).

The text of the Prodromus sparkles with insights and ideas of astonishing originality but everything is based upon careful and critical observation. To anyone interested in the history of science, particularly of geology, this is a fascinating work. In view of the fact that it was only a hastily composed, preliminary synopsis of the intended treatise, it is probably fair to suggest that the completion of the full work might have advanced the development of geology by at least a hundred years.

## Steno's travels and work after the Prodromus (1668-1671)

As soon as he had arranged for the printing of the Prodromus, Steno embarked upon the long journey back to Denmark. His route was far from direct and he travelled extensively in Italy, Austria, Hungary, Bohemia and Germany, studying geology and amassing a large collection of specimens. He arrived in Amsterdam in 1670 and learned of the death of King Frederik, which was followed quickly by news of Grand

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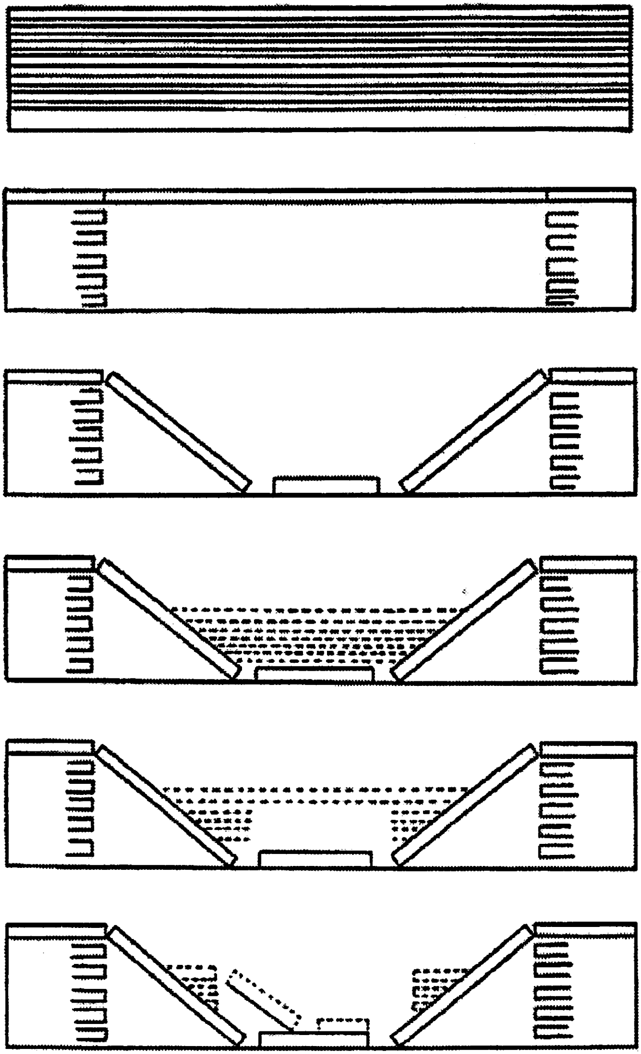

*The geological history of Tuscany according to Steno (1669)*

*'The dotted lines represent sandy strata with which various quantities of clay and rocks may be mixed. The rest represents strata of rocks, though strata of softer substances may be mixed with them.'*

Duke Ferdinand's serious illness. These sad events caused him to abandon his journey to Copenhagen and return to Florence but, before he arrived, Ferdinand was already dead. Fortunately, Ferdinand's successor, Cosimo III, gave Steno the same level of enthusiastic support as had his father and provided him with a house beside the Arno and apartments in the Palazzo Medici.

With Cosimo's permission Steno did no scientific work for six months but occupied himself in writing a theological treatise. In the summer of 1671, he studied various grottos in the Alps and showed that the ice inside them was not caused by the contrasting summer heat outside, so refuting the popular but superficial Aristotelian theory of 'antiperistasis'. He reported his findings to the Grand Duke in two letters which were effectively his last geological writings.

For the second time in his life, he received a royal invitation from Copenhagen – this time from King Christian V – and arrived there in 1672 to teach and study anatomy once again but was not allowed to become a professor because the Lutheran orthodoxy demanded religious conformity. The restrictions on his work caused by religious intolerance soon made his position miserable and, having obtained permission from the King, he returned to Florence in 1674 to take up the position of tutor to the Medici court.

In the following year he became a priest and, for the rest of his life, his dedication to religion displaced all other interests. He became a bishop in 1677 and died in Schwerin in 1686, admired and respected throughout Europe for his piety, intelligence and honesty. Cosimo III had his coffin transported to the crypt of the Medici church in Florence, San Lorenzo.

### Steno's Indice

One of his last tasks before leaving the study of geology had been the preparation of a detailed catalogue of the Medici collection of minerals and related items, supplemented considerably by the addition of his own collections, gathered during his extensive travels. This catalogue is known as 'Steno's Indice' and is a model of meticulous recording. The specimens are divided roughly into numbered groups; 1-29 quartz crystals; 30-92 emeralds, diamonds and ores; 93-114 pyrites and other minerals; 115-216 marine stones, mussels, snails, fossils etc.; 217-258 corals; 259-304 earth and rock specimens, volcanic products, ores etc. This large collection is now mostly lost and can be assessed only by Steno's description but it has been observed that it was a collection specifically for the purposes of geological research and not merely a random collection of curios. Professor R. Spärck noted in 1956:

> It thus seems to me that this Steno collection has been composed for a quite special purpose of research, which can very seldom be said about contemporary collections, if there is any example of this kind at all.

It is consistent with everything that Steno did that, even in assembling a collection, he contributed something new and original to geology.

**Epilogue**

After Steno's death, his work fell into obscurity and was not rediscovered until late in the nineteenth century. In 1881, the Second International Congress of Geologists in Bologna laid a wreath on Steno's grave and erected a marble plaque to his honour in the cloisters of San Lorenzo.

In the second half of the twentieth century, scholars such as Gustav Scherz have explored the work of this extraordinary man and a symposium on Steno and brain research in the seventeenth century was held in Copenhagen in 1965. An important result of this symposium was the bringing together of research workers who recognised the international importance of Steno and decided to publish a complete edition of his geological works. This appeared in 1969 and is referred to in the list of further reading given below.

**Further Reading**

Eyles, V.A. 1954. Nicolaus Steno, Seventeenth-century Anatomist, Geologist & Ecclesiastic. *Nature*, Volume 174, pp. 8-1

Garboe, A. 1958. *The Earliest Geological Treatise by Nicolaus Steno (1667)*, Macmillan & Co. London.

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*Peter Dryburgh is a physical chemist by profession but has always had an interest in earth science and in its history. He retired from the University of Edinburgh, where he was a lecturer in the Electrical Engineering Department a couple of years ago and is currently the President of the Edinburgh Geological Society.*

# Fossils from the South Atlantic

## the geological legacy of the Scottish National Antarctic Expedition, 1902-1905

**by Phil Stone**

It was the chance discovery of some unusual fossils in the Falkland Islands that set me to researching the results of the Scottish National Antarctic Expedition during its centenary year. Late in 1902 and led by Dr. William Speirs Bruce, that intrepid team sailed from Troon aboard a barque-rigged, ex-whaling ship, renamed *Scotia*, to make a generally unrecognized contribution to the 'heroic' era of polar exploration. Recent publicity surrounding the expedition's centenary has gone some way to redress the previous neglect, but it's still hard to imagine that on 22nd July 1904, thousands of people welcomed the *Scotia* back to the Clyde, where Dr. Bruce received a telegram of congratulations from King Edward VII.

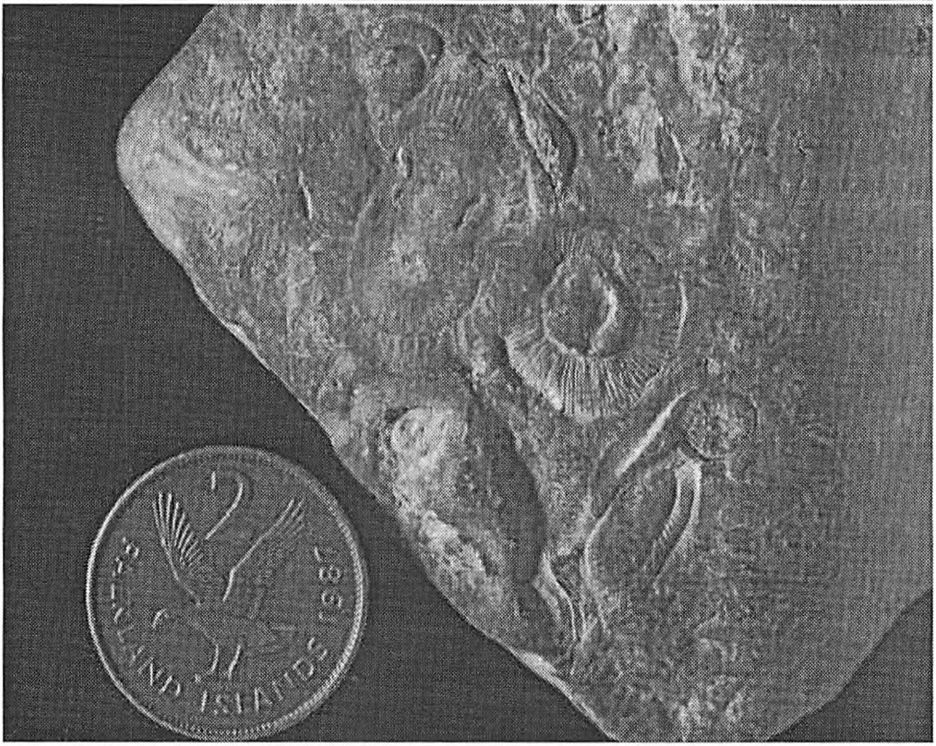
The main emphasis of the expedition's scientific work was on biology, meteorology and oceanographic surveying. The latter aspect has provided the most prominent memorial to the *Scotia* following the discovery and naming of the eponymous submarine ridge that links South America and the Antarctic Peninsula via the islands of the 'Scotia Arc' and encloses the 'Scotia Sea'. Geology was the responsibility of Dr. J. H. H. Pirie, who was also the expedition's medical officer and carried out bacteriological research. They established a base in the South Orkney Islands, which were virtually unknown at the time, and Pirie carried out some pioneering geological reconnaissance work. Sadly, one of the least successful observations is also one of the best known – the misidentification of graptolites that confused regional interpretations for decades. This story has been told by Ian Dalziel in an early edition of *The Edinburgh Geologist.*

Not that Pirie should take all the blame. Although his 'graptolites' turned out to be Triassic plant material, they were inspected by no lesser authorities than Ben Peach and Gertrude Elles; the latter, the doyenne of British graptolithologists, went so far as to pronounce them as species of *Pleurograptus*. Pirie's subsequent paper based on all this was communicated on his behalf to the Royal Society of Edinburgh by another well-respected figure, John Horne. But then, maybe we shouldn't be too surprised since Pirie found his fossils in a greywacke-shale sequence which, as every Scottish geologist of that time would have believed, were invariably Lower Palaeozoic in age.

My interest was not aroused by the non-graptolites however, but by the Expedition's associations with the Falkland Islands, one direct and one rather tenuous. The *Scotia* put into Stanley in early January, 1903, and the next three weeks were spent taking on stores. During that time the expedition's scientists were entertained by the Governor, Mr (later Sir) William Grey-Wilson, who presented Bruce with a collection of local Falklands fossils. It included various species of Devonian brachiopods, crinoid ossicles, and two small fragments of trilobite thorax, all contained in a brown, micaceous sandstone. Bruce also acquired one other specimen of sandstone with crinoid impressions from a poorly-defined locality in the far west of the Falklands archipelago. These specimens are now housed in the Royal Museum, Chambers Street, Edinburgh, and from a modern perspective seem pretty unremarkable. However, in 1904 they were only the third set of Falklands fossils to be brought to Britain. The two previous collections were by Charles Darwin in 1833-34, and by members of Sir Wyville Thomson's Challenger expedition in 1876, so Bruce and Pirie were keeping pretty good scientific company. All three collections even came from the same place – Port Louis Harbour, East Falkland – with the sole exception of Bruce's West Falkland sample. The latter provided the first evidence for the more widespread outcrop of fossiliferous strata that modern survey work has subsequently confirmed.

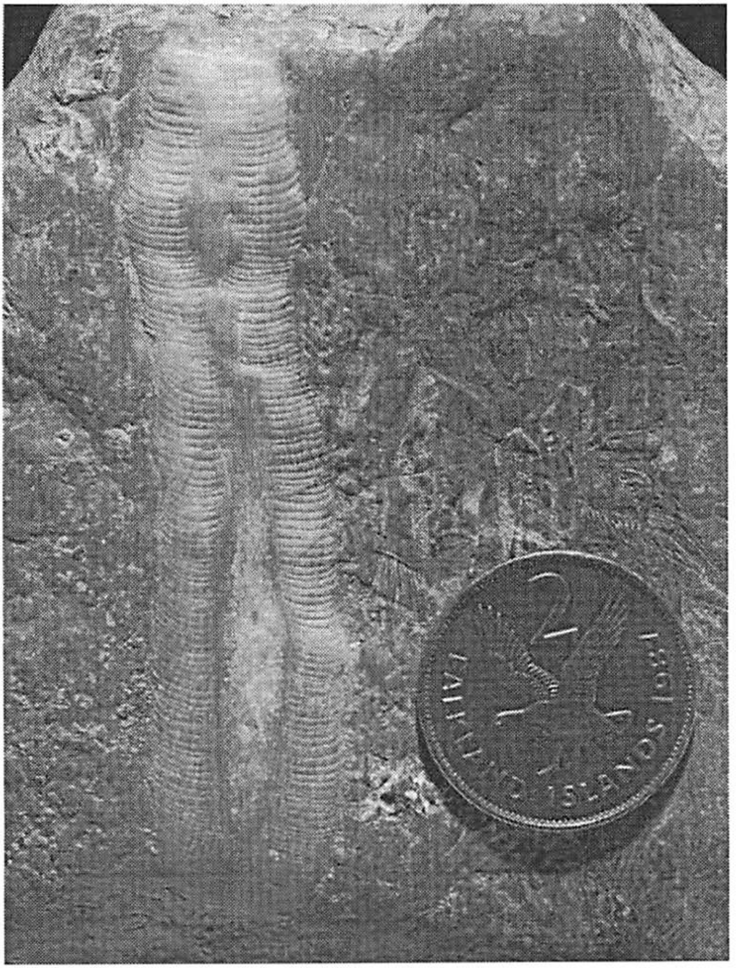
The 'Scottish' Falklands specimens were fully described by E. T. Newton in a paper published in the *Proceedings of the Royal Physical Society of Edinburgh* in 1906. Newton remarked on the great similarity between the Falklands brachiopods and those then being discovered in South Africa and South America. We now recognise this faunal assemblage as defining a 'Malvinokaffric Realm' spanning the margins of the Palaeozoic supercontinent of Gondwana. As Gondwana broke up and the southern hemisphere continents drifted to their present locations they each carried with them a portion of the originally continuous faunal province. Although they didn't know it at the time, the Scottish National Antarctic Expeditioners contributed to our present understanding of plate tectonics and continental drift.

The expedition's Malvinokaffric fossil collection provided the direct link with the Falkland Islands, but rather more interesting from my point of view was the less direct link, also involving fossils but this time of Cambrian age. Now, the oldest *in situ* fossils in the Falkland Islands are from the Devonian, Malvinokaffric assemblage as presented to Bruce by the Governor. However, stratigraphically above the Devonian sequence is a tillite, a glaciogenic unit dating from the extensive Permo-Carboniferous glaciation of southern Gondwana. As you might expect, the tillite contains a wide variety of exotic clasts and recently a few of them have been identified as Cambrian limestone. We know the limestone is Cambrian because it contains fossil archaeocyathids, an extinct and exclusively Cambrian phylum related to sponges. A couple of examples are illustrated here.



*The figures above and opposite show archaeocyathids from a limestone cobble in the Fitzroy Tillite Formation, Port Purvis:* above: *cross-sections showing circular structure of the double perimeter wall enclosing a central cavity, at least two different species are present;* opposite: *lateral section showing detail of stucture within the perimeter wall. The Falklands 2-pence piece is 2.5 cm in diameter.*

Where though does the Scottish National Antarctic Expedition come in? Well, in 1903 archaeocyathids were very poorly known with very few records (actually, over most of the world, things haven't changed much in 100 years). Australia had provided most examples, and it must have caused some surprise on the *Scotia* when a lump of archaeocyathid-bearing limestone was dredged from the bed of the Weddell Sea, to the east of the South Orkneys and at a depth of 1775 fathoms. Maybe they didn't fully realize what they had found because the specimen was not passed on to W. T. Gordon for description until 1913; with the distraction of the First World War his paper in the *Transactions of the Royal Society of Edinburgh* did not appear until 1920.




In the meantime, Shackleton's British Antarctic Expedition (1907-09) had discovered archaeocyathid limestones on the opposite, Ross Sea, side of Antarctica; the first record from that continent. Gordon was thus able to compare the Weddell Sea specimen with other archaeocyathids described from Antarctica and Australia. He rightly deduced that the dredged limestone block had most probably been carried northwards by ice from a source in Antarctica, and commented on the striking similarities between the Australian and Antarctic faunas. Once again, a hesitant step was taken along the intellectual pathway that was eventually to lead to a re-assembly of Gondwana from the southern hemisphere continents.

That same path also winds back towards the Falklands archaeocyathids. They link with similar examples in Permo-Carboniferous tillites from South Africa and the Antarctic to provide more evidence for the previous juxtaposition of those regions in Gondwana. We take that kind of reconstruction for granted these days but can only speculate as to whether Bruce, Pirie, Newton or Gordon glimpsed the wider implications of their work in the development from 1912 onwards of Alfred Wegener's hypothesis of continental drift. Nevertheless, from that starting point, the discoveries of the Scottish National Antarctic Expedition can be seen to have contributed small clues that, with many others, eventually led to our modern theory of plate tectonics. I'm sure that the expedition's members, and their scientific collaborators, would have been delighted by that outcome. It certainly provides them with a far more fitting geological epitaph than that unfortunate business with the graptolites.

A good general account of the Scottish National Antarctic Expedition was published recently in *History Scotland*:

Duncan, Allison. 2002. Science for a talisman and Scotland on the flag. The Scottish National Antarctic Expedition 1902-1904. *History Scotland*, Volume 2, No. 5 (Sept/Oct), pp. 24-31.

**Scientific bibliography**

Dalziel, I. W. D. 1979. The mythical graptolites of the South Orkney Islands. *The Edinburgh Geologist*, Issue no 6, pp. 2-9.

Gordon, W. T. 1920. Scottish National Antarctic Expedition, 1902-1904: Cambrian organic remains from a dredging in the Weddell Sea. *Transactions of the Royal Society of Edinburgh*, Volume 52, pp. 681-714.

Newton, E. T. 1906. Notes on fossils from the Falkland Islands brought home by the Scottish National Antarctic Expedition in 1904. *Proceedings of the Royal Physical Society of Edinburgh*, Volume 16, pp. 248-257.

Pirie, J. H. H. 1905. On the graptolite-bearing rocks of the South Orkneys. *Proceedings of the Royal Society of Edinburgh*, Volume 25, pp. 463-470.

Stone, P. and Thomson, M. R. A. in press. An archaeocyathid-bearing limestone block of likely Antarctic origin in Gondwanan tillite from the Falkland Islands.

*Phil Stone is a long-timc contributor to this magazine. He works for the British Geological Survey in Murchison House, mainly on rocks of the Southern Uplands of Scotland and northern England. He also acts as geological advisor to the Falklands Islands Government's Department of Mineral Resources.*

# A complimentary dinner
## Leftovers

*I am grateful to several readers for their comments on the dinner menu that appeared in the last issue of* THE EDINBURGH GEOLOGIST.

The first to make comment was Bob (R.V.) Wilson who rang and left a message on my answer machine:

> You say you didn't know who D. Haldane was. I think you'll find that it is D. H. Haldane, who was a Survey member. He retired just after the War. The way to find out about these people is to look up Slate's *History of the Geological Survey*. It is held in the BGS Library and in it you'll find a staff list.

The second was in an e-mail sent by Richard Smith of BGS:

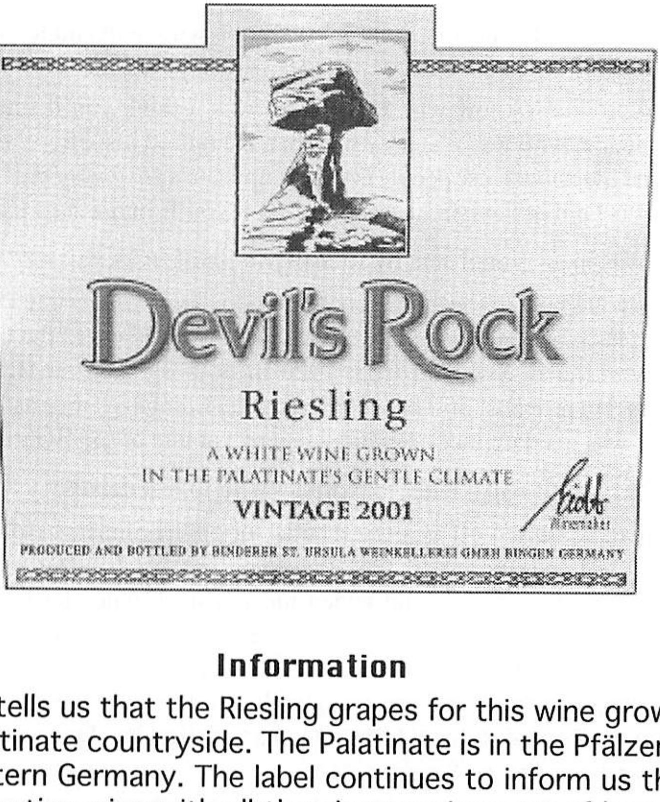
> Just to let you know in the article on *A complimentary dinner* the D. Haldane you didn't have any info on is most likely to be D. Haldane of the Geological Survey working in Scotland from 1920 in both the Central Belt and the Highlands. He probably still has relatives in the Edinburgh area as I have met (I think it was his daughter or grand daughter) at one of the BGS open days.

Lastly Howel Francis sent a letter to Norman with fullest details:

> David Haldane started off as a fossil collector on the Survey before the First World War. I was given to understand that after joining up, he was commissioned, was gassed and ended the war as a major on the staff. On rejoining the Survey, they couldn't very well put him back to the relatively menial job of fossil collector and so he was rushed through a degree at Edinburgh and re-employed as a field geologist. He spent the interwar years mainly in the Central, Fife and Clackmannan coalfields... During the Second World War, he produced *Sands and Gravels of Scotland, Part IV* and, with J. B. Simpson, *Limestones of Scotland, Area 111*. He retired just after the end of the war and was an occasional visitor to the Survey thereafter, though he died, I think, in the early 1950s.
>
> As was the custom in those days, Haldane also took part in Highland surveys, but his work on Skye (I think) and Shetland never saw the light of day thanks to the war. In the star-studded company that the Edinburgh Survey sported in the 1920s and 1930s, Haldane was never going to shine and, to tell the truth, his maps show him as being a trifle ham-fisted. But he did an honest job of work and deserves that much recognition at least.

*Indeed he does. BGS owes a credit to people like him, though if he was 'a trifle ham-fisted' as Howel says, that still leaves open the question of who was the* DH *that drafted the menu for Pringle's complimentary dinner!*

# Geo-vineyards




**Information**

The label tells us that the Riesling grapes for this wine grow in the warm Palatinate countryside. The Palatinate is in the Pfälzerwald in southwestern Germany. The label continues to inform us that this is an innovative wine with all the zingy excitement of lemons and grapefruit. The wine is full of fruit when young but with a structure for aging, intense and balanced:

> 'Devil's Rock stands out like the geological landmark in the Palatinate that lends it its name.'

---

*Thanks to Vic Loudon and Richard Batchelor who both saw this and sent me labels. I have since seen it in* TESCO*'s who must surely be including it in their range because of leaked information that the wine was to be featured here.*

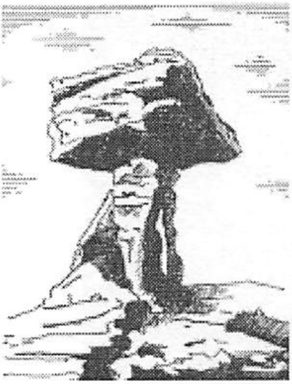
*You will be pleased to know that I already have a label with a geological slant lined up for the next issue, but keep them coming in!*

# *What's in a Name?*

## Geological Tables

### a tour of tabular landscape features

**compiled from contributions by Joachim Rohn, David Stephenson, David Reid & Peter Whitehead**



The Geo-vineyards contribution has prompted me to commission a number of articles on geological 'tables'.

The Devil's Rock of the label is actually *Teufelstisch*, which translates as Devil's Table, a geological feature in the region of Pfälzerwald in southwestern Germany. **Joachim Rohn** of the Department of Applied Geology of Karlsruhe University has written about it and sent some beautiful photographs.

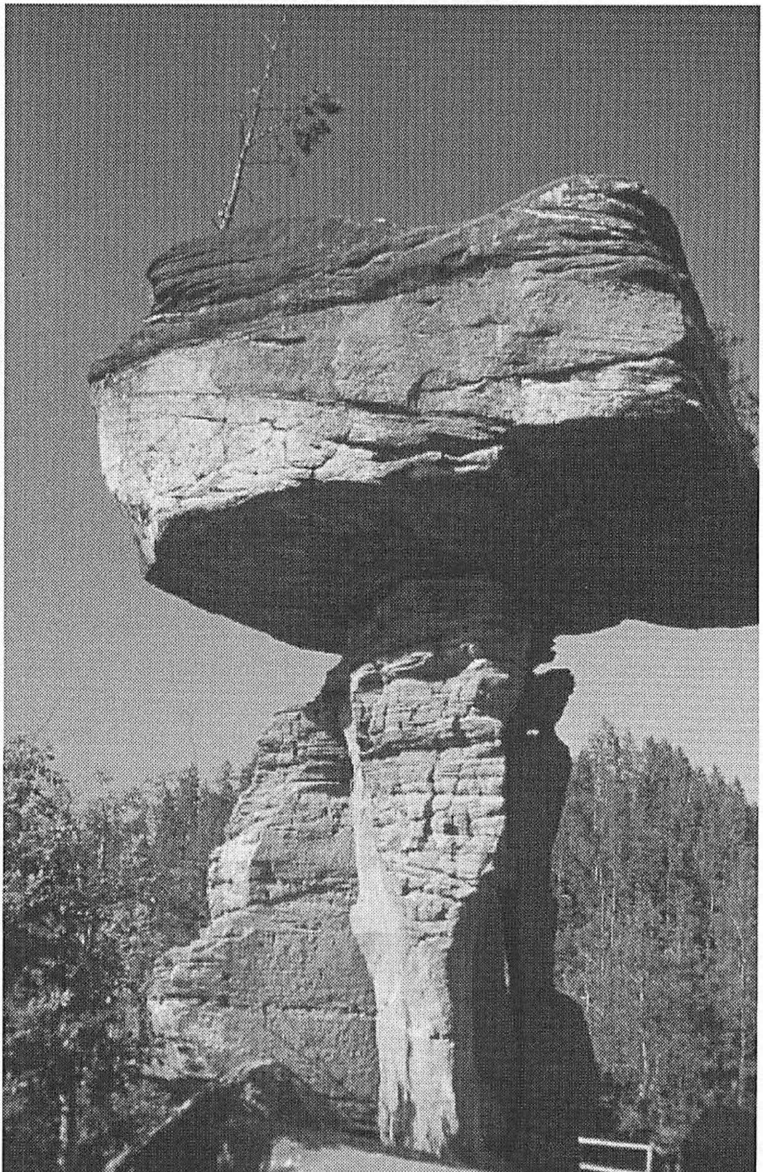
Before going worldwide, we take a look at Scotland, where we have our own Macleod's Tables on Skye. **David Stephenson** of the British Geological Survey has kindly put together an article on these well-known features of the landscape.

Perhaps the best-known Table feature in the world's landscape is Table Mountain in South Africa. On browsing the Internet, I came across an excellent web site and tracked down the author as **Professor David Reid** of the Department of Geological Sciences in the University of Cape Town. He has given permission for the site to be used as the basis for a contribution and here it is.

Staying in the southern hemisphere, Australia boasts the Atherton Tablelands in Queenstown. **Peter Whitehead** of James Cook University has kindly contributed an article, together with a couple of excellent photographs which are reproduced here. Readers who want to see them in full colour should look at the web version of this article to be published later in the year.

Moving east again, I would have liked to be able to stop off at the Lost World, H.G. Wells's fantastical table-island of dinosaurs and ape men, but this is a purely factual trip, so we end up on the western coast of the United States. Here, in Oregon, there are the Table Rocks.This contribution has been put together using information on two web sites: www.sou.edu/geology and www.or.blm.gov/medford, to which the reader is directed for further information.

My thanks to all contributors. I hope that you enjoy reading this tabular compendium!



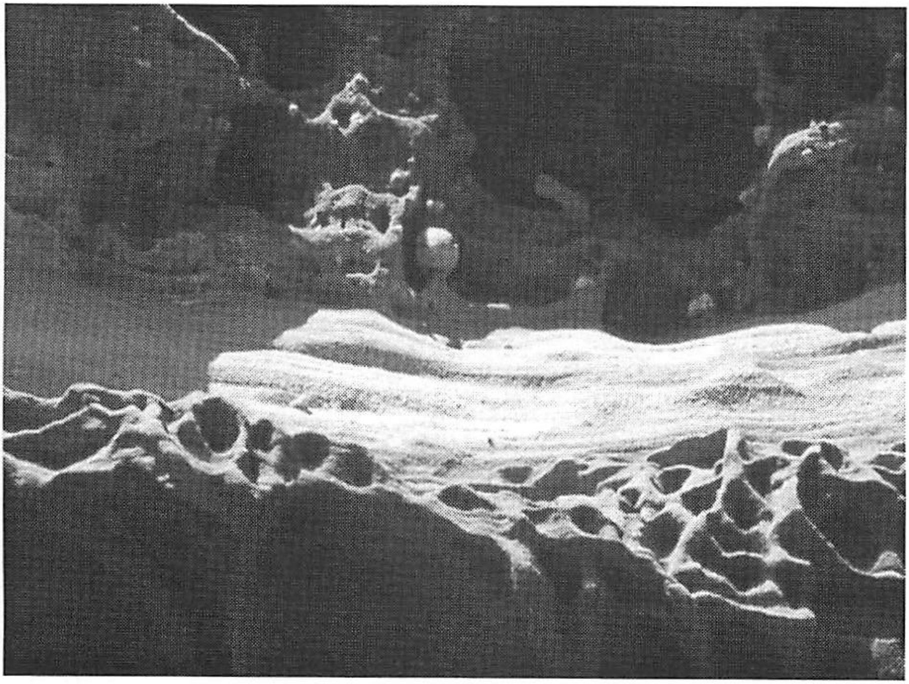
*Figures: above:* Teufelstisch, *the Devil's Table formed by Rehberg layering*
*opposite: honeycomb weathering, an erosional feature of the Devil's Table*

## *Teufelstisch* - the Devil's Table

The *Teufelstisch* is a geological formation of Triassic red sandstone and one of the best known natural monuments in the region of Pfälzerwald in southwestern Germany. It comprises an almost square block (the table-top) resting on three sandstone legs.

The characteristic erosion of the sandstone is due to the development of *Rehberg Schichten* (Rehberg-layers). These result from inter-stratified aeolian and ephemeral flood sands, originally deposited in a semi-arid environment, gravels and sands accumulating after periodic rainstorms and aeolian dune sediments at other times. The Rehberg layers are a diagenetic feature resulting from alternating sequence of hard, silicified, fluvial layers and weak, virtually non-silicified, dune sediments.

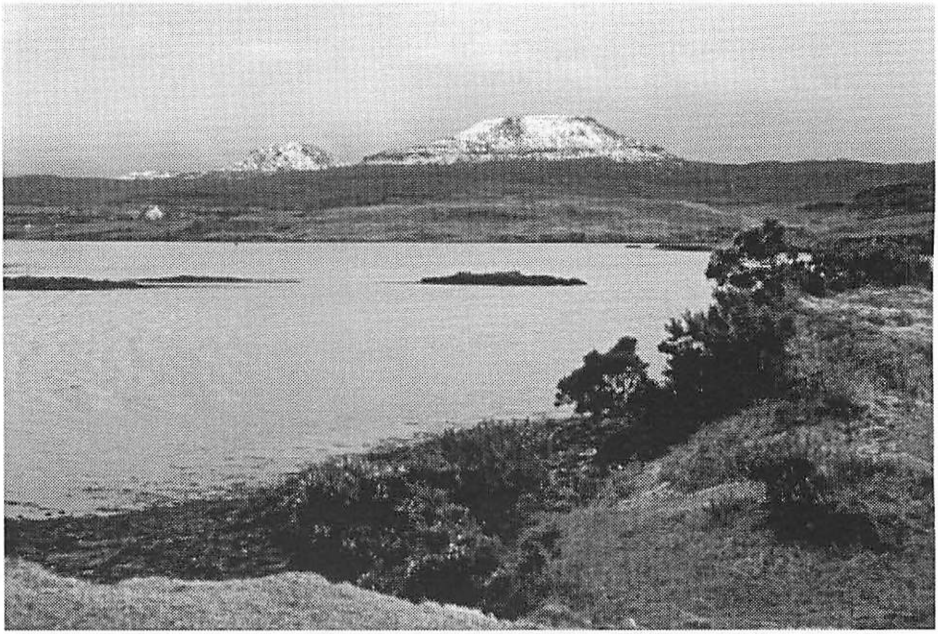
In the Devil's Table itself, a thick silicified layer forms the top of the table protecting the weak layers beneath from erosion. The nearly rectangular form of the 7 m x 7 m big table top is caused by natural joints in the sediment. The weak base of the table is eroded except for the meagre remains you see in the picture. Salt erosion causes additional surface structures in the sandstone, known as honeycomb weathering.



## Macleod's Tables

The Duirinish Peninsula of Skye is dominated by twin flat-topped conical hills, some two kilometres apart, which are well seen on the approach from Dunvegan. Healabhal Bheag, at 488 m, is actually the higher of the two hills, but Healabhal Mhor (469 m) has the most extensive flat top and hence the grander name. The Gaelic names, like many others in the Inner Hebrides, sound as if they have a Norse origin and it has been suggested that they may be a corruption of 'Helgi Fjall' (Holy Fell), possibly alluding to the resemblance of their flat tops to alters. The hills are better known collectively as Macleod's Tables, allegedly in honour of a particular sixteenth Century chief of the Clan Macleod who held a great feast on one of the summits to demonstrate to a visiting Lowland Earl that Skye had a bigger and better table than any palace in the Kingdom.

Tradition has it that the hills acquired their shape in the sixth Century, when they crumbled and flattened to provide a resting place for St Columba, who had been denied hospitality elsewhere in the area. But their present overall conical shape had probably been determined some 15 000 years ago during the retreat of small local glacier systems that had developed during the main late Devensian glaciation.



*Macleod's Tables from Ullinish; flat-lying Palaeogene lavas.*

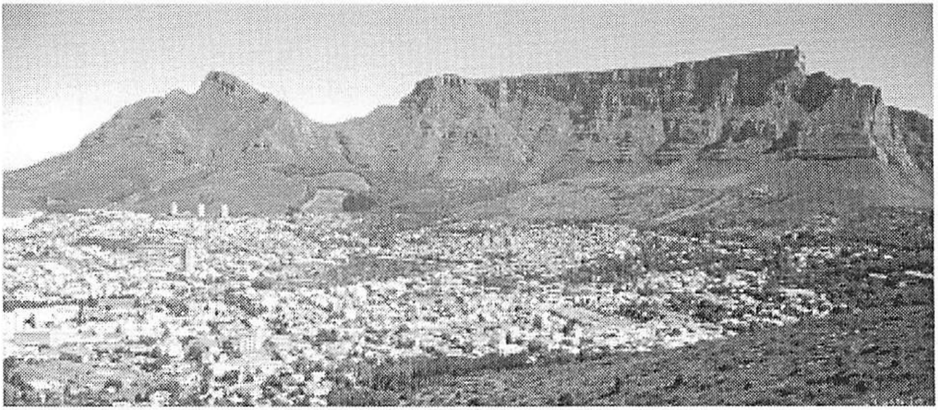
The hills are carved out of flat lying, predominantly basaltic lavas that were erupted 58 million years ago, during the Palaeogene, and which crop out over virtually the whole of the Duirinish Peninsula and over most of western and northern Skye. The detailed topography, probably acquired mostly in post-glacial times, is characterised by a series of steps and near-horizontal benches, commonly known as 'trap features', which are largely a result of variations in texture and degree of alteration within each lava flow. The central part of each flow is commonly the most massive and the least altered and hence gives rise to the steep steps in the hillside and any crag features. The tops and bottoms are rubbly, autobrecciated and with abundant zones of amygdales, resulting from the infilling of gas bubbles, 'frozen' during the escape of volatiles from the magma. Such zones are particularly prone to hydrothermal alteration, are more-easily eroded, and hence form the poorly exposed benches between the steps. The twin summits of Macleod's Tables are merely the resistant central parts of lava flows, composed of olivine basalt in the case of Healabhal Bheag and of a more-fractionated mugearite at Healabhal Mhor. The fact that different lavas, representing different levels in the lava stratigraphy, occur close together at a similar altitude is a result of post-eruption faulting.

*Opposite: Macleod's Tables dusted with snow, April 1994*

***Acknowledgements:*** *The picture opposite is published with permission of Geoff Cryer from the web site www.geoffspages.co.uk, the picture above with permission of Andy Stables from the web site http://SkyeSelect.com*

## Table Mountain

An appreciation of the magnificent sea and mountain views of the 'fairest cape' can be enriched by knowledge of its geological foundations. But you need not be a geologist to recognise the layers of hard sandstone forming the steeper cliffs, or the crevices and forested ravines etched out by erosion along fractures and faults, or the rounded boulders of the crystalline granite basement exposed by wave erosion along the shoreline.



*Sandstone layers form ramparts overlying Precambrian slates and granite*

**Precambrian sedimention and igneous activity**

The late-Precambrian age **Malmesbury Group** is the oldest rock formation in the area, consisting of alternating layers of dark grey fine-grained greywacke sandstone and slate, seen along the rocky Sea Point and Bloubergstrand shorelines. These sediments were originally deposited on an ancient continental slope by submarine slumping and turbidity currents. The sequence was subsequently metamorphosed and folded tightly in a NW direction so that the rock layers are now almost vertical. Many tall buildings in Cape Town are founded on these rocks, which were, in most places, scoured by wave action during past periods of higher sea level.

About 630 million years ago, a huge batholith was intruded into the Malmesbury Group and this is now known as the **Peninsula Granite**. This crystallized deep in the earth but has, since then, been exposed by prolonged erosion. Preferential weathering along intersecting fractures results in the characteristic spheroidal shapes of the granite boulders. These are particularly well displayed around Llandudno and Simonstown. Close up, the granite is a coarse-grained rock consisting of large (2-5 cm) white or pink feldspar crystals, glassy brown quartz and flakes of black mica containing xenoliths of dark Malmesbury hornfels. In some places, intense weathering has altered the granite to kaolin clay soils that cause slope stability problems in road cuttings. High quality kaolin is mined near Fish Hoek and Noordhoek.

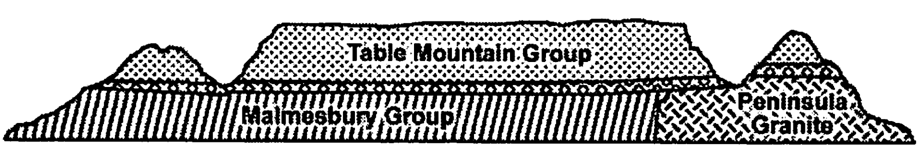
The contact zone where the Malmesbury Group was intruded by molten granite can be seen at Sea Point and was made famous by Charles Darwin during his voyage of scientific discovery on H.M.S. Beagle in 1844. Here, slivers of dark coloured rocks of the Malmesbury Group, altered by intense heat, are intermingled and folded with the pale coloured intrusive granite to form a complex migmatite. Large feldspar crystals occur in both the granite and dark hornfels layers.

Though initially intruded at great depth, prolonged erosion eventually exposed the granite at surface and it now forms a basement upon which younger sedimentary rocks of the Table Mountain Group were deposited.

**Ordovician sedimentation**

**Table Mountain Group** sandstones were deposited on this eroded surface of granite basement, in the stream channels and tidal flats of a coastal plain and delta environment that extended across the region about 450 million years ago. The sand, silt and mud deposits were lithified by pressure and then folded in the Cape Fold Belt, extending along the southern coast. The spectacular Chapman's Peak roadway has been constructed along the contact unconformity between granite and the overlying Table Mountain sequence.

The basal **Graafwater Formation** (300-450 m thick) consists of interlayered pale brown sandstone, laminated pink siltstone and dark maroon coloured shale. It is best seen in road cuttings on the slopes of Table Mountain and along Chapmans Peak drive. Closer examination shows deposition cycles from current-bedded channel sandstones to increasing proportions of fine-grained maroon shales at the top, deposited in flood plains and lagoons.




*Simplified geological cross-section through Table Mountain*

The **Peninsula Formation** (800-1500 m thick) consisting of hard, light grey, coarse pebbly quartz sandstone, dominates the steep mountain cliffs. Current bedding and pebble layers suggest that it was originally deposited as migrating sand bars in broad river channels.

The **Pakhuis Formation** tillite (a lithified glacial outwash gravel) occurs on the highest points of Table Mountain, such as Maclears Beacon. It contains clusters of angular boulders and pebbles and was deposited at a time when the Gondwana continent, of which Africa is a part, was situated close to the south pole.

### Later modification of the landscape

Faults cut across and displace the rock layers. These more easily eroded zones are marked by ravines, for instance, cross-cutting faults separate multiple peaks of the Twelve Apostles. In some fault zones the crush breccia is re-cemented by dark brown coloured iron and manganese oxide minerals. This provided a rich manganese ore that was mined in and around Hout Bay in the last century.

The present landscape is formed by prolonged erosion having carved out deep valleys, removing parts of the once continuous Table Mountain Group sandstone cover from the Cape Flats and leaving high residual mountain ridges.

Almost half of the Cape Peninsula and Cape Flats area is blanketed by weakly cemented marine sands. Sea-levels fluctuated between -120 to +200 m from present mean sea level during the Pliocene and subsequent Pleistocene ice-age as a result of fluctuating global temperature and variable amounts of water accumulated in polar ice caps. At times the sea covered the Cape Flats and Noordhoek valley and the Cape Peninsula was then a group of islands. Beach sands with shell fragments and estuarine muds were deposited and later overlain by calcrete-cemented dune sands as the sea retreated. 'Dune rock' that was deposited during a Pleistocene interglacial period about 120 000 years ago is now being eroded in the sea-cliffs near Swartklip where fossil remains of the extinct giant Cape Horse (*Equus capensis*) have been found.

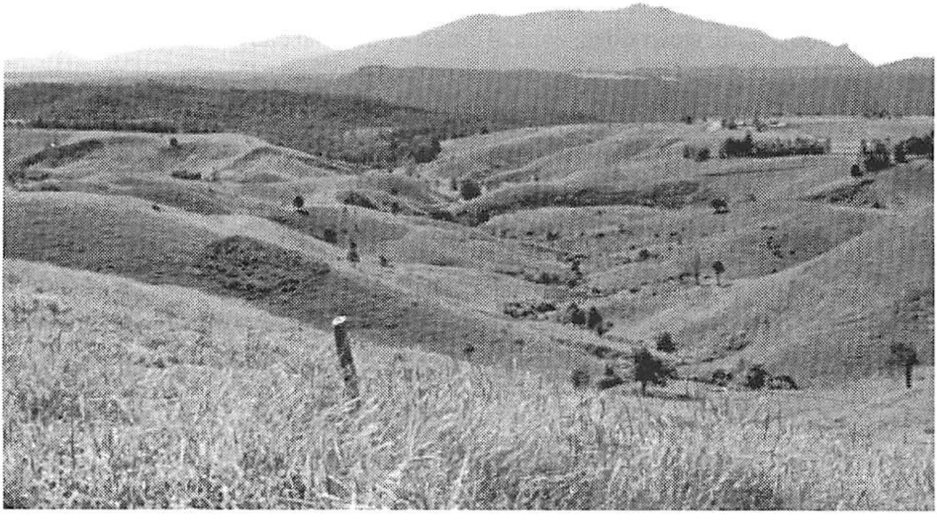
### Further information

This article is based on a web page on the University of Cape Town (UCT) web site, which was produced for schools and general public information and can be accessed on http://www.uct.ac.za/depts/geolsci/cape.html.

## The Atherton Tablelands

The Atherton Tablelands rise up west of the town of Cairns on the east coast of Australia's Queensland. Travelling west from Cairns will take you up through an escarpment on to a dissected plateau some 600 metres high and many thousands of square kilometres in area. This plateau rises to 800 metres in the west and reaches over 1000 m on the tops of the remnants of shield volcanoes. It is an area of tropical rain forest, in which man has carved out land for agriculture because of the rich volcanic soils. These soils are derived from recent volcanic activity, but the geological history of the area stretches back some 420 million years. At that time, the coastline of the continent was about 150 km to the west of the present coast, and the area of the Atherton tableland was a deep ocean basin. Continental sediments were deposited into this off-shore basin and, with continual subsidence, around 10 kilometres of sediments accumulated over some 60 million years.

About 360 million years ago, the region changed from being an extensional regime to one of compression and the sediments were uplifted to form high mountains of metamorphic rocks such as slate and schist. In the period from 310 to 230 million years ago, episodes of heating led to deep-seated magmatism and the development

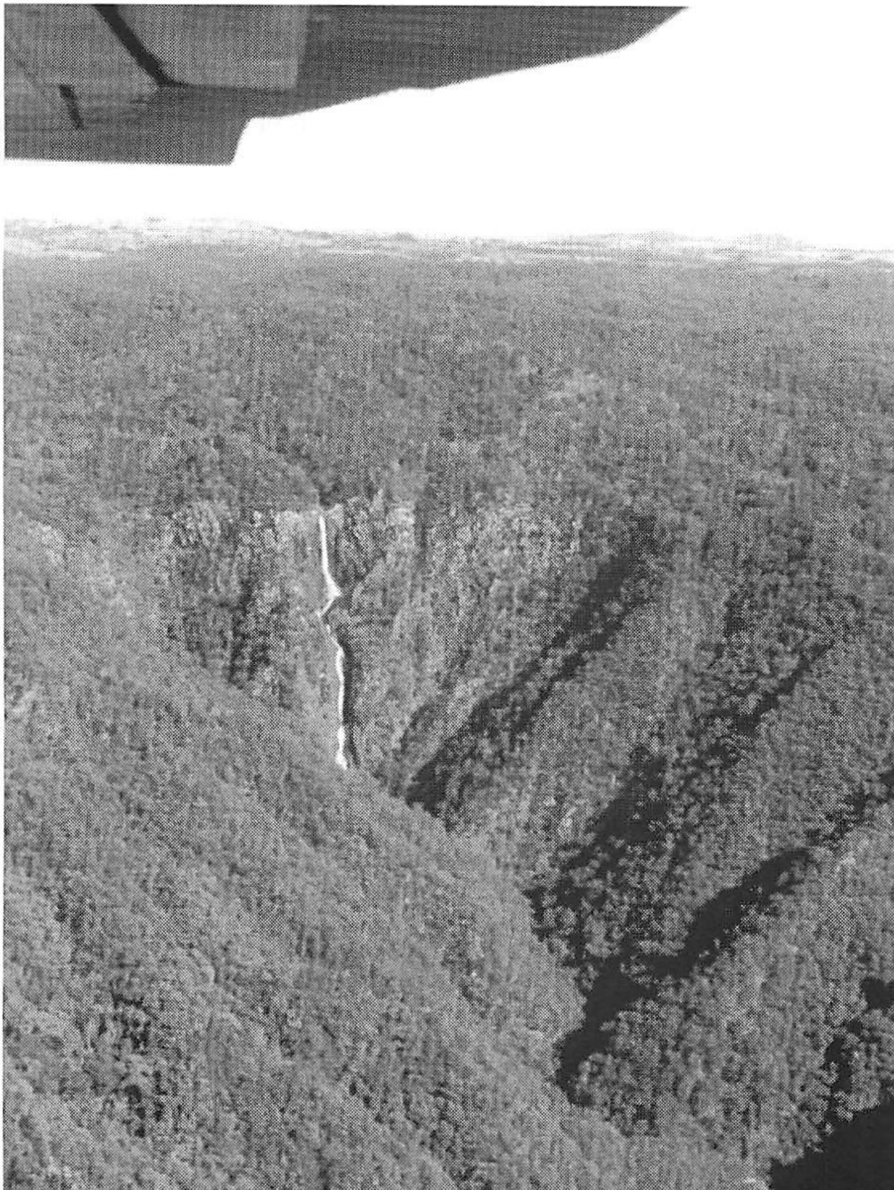


*The Atherton Tablelands from the air close to Bartle Frere* of granite. In some areas, the acidic magma found its way to the surface, where it produced violent eruptions, producing welded ash flows. After erosion removed the surrounding rocks, the granites remained and formed the large mountain ranges such as Bartle Frere, Queensland's highest mountain, Bellenden Ker, the mountains north of Lake Tinaroo and the coastal ranges to the east. Some of the resulting volcanics now form the ranges on the western edge of the tableland.

Not much happened here for the next 100 million years or so, except for erosion gradually lowering the highlands to a plain of low relief and exposing the granites. About 100 million years ago, rising convection currents in the earth's mantle heated the crust, doming it upwards. Plate tectonic movements pulled the crust apart, until, about 65 million years ago, the continent split and the Coral Sea was created. The eastern side subsided beneath the sea, but the western side remained as highlands with a steep eastern escarpment. Since then, the escarpment has retreated west, through continual erosion, forming the present landforms of the coastal plain, escarpment and tablelands, with resistant granite ranges rising above them.

About 3 million years ago, basalt volcanoes started erupting lavas over the tablelands. Some of the most voluminous flows poured over the escarpment down a pre-existing valley formed by the Johnson River. These flows form the relatively gentle ramp up the escarpment that is utilised by the Palmerston Highway. The original course of the Johnson River was blocked, and two new valleys, the North Johnson and the South Johnson were formed on either side of the flows. More recently, from about 1 million years onwards, smaller volcanoes have erupted relatively minor basalt flows, but have built small, steep sided, conical cinder cones that can be seen dotted around the Atherton tableland. One notable group is located between Atherton and Yungaburra and contains nine separate vents. Consequently it is called the Seven Sisters.

Some of the most recent eruptions have been the most spectacular, producing maar volcanoes of small height, but with very wide craters. When the eruptions cease, these craters become crater lakes, the best known examples being Lake Barrine and Lake Eacham. Another spectacular volcanic vent can be seen in Hypipamee National Park and is simply known as 'the Crater'. This volcano has reamed a spectacular vent through the surrounding granite. The eruption would have involved large amounts of gases, with the extrusion of only minor amounts of basalt. Volcanic activity has been intermittent on the tableland for the past 3 million years, with the most recent eruptions being perhaps as recent as 10 000 years ago or so. Given the age range and the intermittent nature of the volcanism, it is likely that some volcanism will occur in the future, although we may still need to wait a few thousand years or so.



*The Atherton Tablelands from the air showing Christmas Falls*

## Table Rocks, Oregon

The American Table Rocks are found in the Rogue River Valley of southern Oregon. They comprise two horseshoe-shaped 'tables' and a number of minor monolths standing 250 m above the valley floor. The flat summits of these tables are formed from alkaline trachyandesite and are remnants of a much more significant lava flow that once filled the valley.

During the early Palaeogene, the Rogue Valley was submerged and accumulated a sequence of marine and littoral silts and sands. During the mid to late Palaeogene, tectonic uplift brought the Rogue Valley and Younger Cascade Mountain Ranges to their current position. As uplift continued through the late Palaeogene and early Neogene, a number of canyon features were developed, the ancestral Rogue River Canyon being one of these.

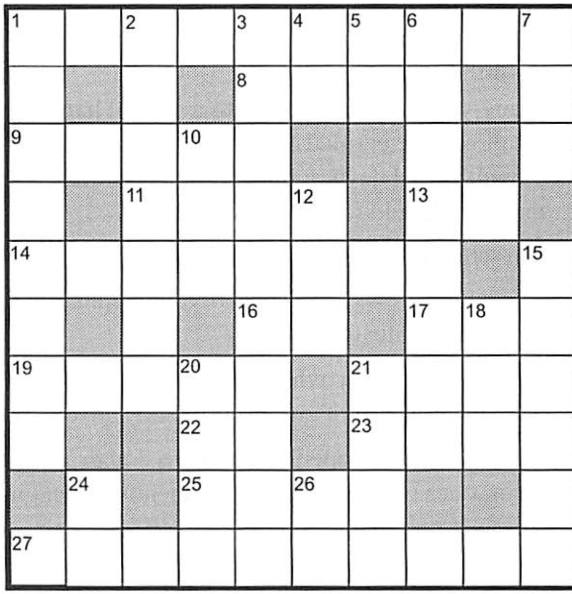
Late Miocene shield volcanic activity in the Cascade Mountains to the east formed a number of features such as Crater Lake, now a National Park, and the Devil's Peak, not to be confused with Devil's Tower, Wyoming, where *Close Encounters of the Third Kind* was filmed. Around 7.5 million years ago, alkaline trachyandesite lava was erupted from a vent near Lost Creek Reservoir. This spread as a sheet flow over the area and, finding the Rogue River Canyon, chose this as a natural conduit, filling the valley.

During the Pliocene and Pleistocene, the Rogue River once again asserted its claim and began, slowly at first, to erode down through the lava flow. Meltwaters from the Cascades increased the effect of the river in eroding the rock and now only a few remnants are left, 90% of the lava having been removed by erosion. Two of these remants are known as the Table Rocks of South Oregon.

*Late Miocene lavas forming the table top on Lower Table Rock, Oregon*

# Rockswords Puzzle No. 10

**compiled by Angela Anderson**



**Clues across**

1. Placed hoop round belemnite (10 letters)
8. In a lad yet a lass (4)
9. Sitting untruly (5)
11. Minimum tide (4)
13. Hidden in mind (2)
14. Led lotex back and sang the praises of (8)
16. Lost the way in byway (2)
17. A Gilbert and Sullivan princess (3)
19. All ears (5)
21. Sound of a stream knitting (4)
22. Thus solo less lo (2)
23. A nitrite to ease the heart (4)
25. Count vote for head tax (4)
27. Messy logo I turn around for earthshaking study (10)

**Clues down**

1. Scare lad into deep depressions (8)
2. Indicator (7)

3, 16. Global loam suddenly around on water surface (5, 5)

4. Comes before te doh (2)
5. Initially an overdose (2)
6. I dig up my trilobite tail (8)
7. Not night (3)
10. New prefix (3)
12. Apply in a layer (3)
15. See 18 down
16. See 3 down

18, 15. Very lady L. up opposite a wet ridge (3, 6)

20. Pass over Cleopatra's pets (4)
21. Help all in, become wearisome (4)
24. First person were in us (2)
26. Solo less so (2)

*This is Angela's latest puzzle, marking a total of ten geological crosswords since her first in Spring 1999, at least ten* Rockswords *because Angela had compiled an earlier puzzle in Autumn 1983. I am very grateful for all her efforts... long may they continue!*

*The answers to this puzzle are on page 40 of this issue.*

# Poet's Corner

The poem in this issue of THE EDINBURGH GEOLOGIST is a grook.

"A what?" I hear you ask.

"A grook."

Many years ago I walked into a second hand book shop and came out with a small volume entitled *Still more grooks* by Piet Hein. It was a gem and, search though I did, I never found any books entitled 'Grooks' or even 'More grooks' that I could add to my collection.

But what is a grook? Well, it is defined on the back cover in dictionary-style:

> **grook** (grewk) n. a short rhyming epigram, usually accompanied by a relevant illustration

and that is exactly what it is! The interesting thing is that over the years, I have never heard of grooks written by anyone but Piet Hein. So who was he?

He was born in Copenhagen in December 1905. Not only was he a poet, Piet Hein was a mathematician and scientist, an engineer and inventor, or, to put it simply, a polymath. Little known outside Denmark, though he wrote in English with equal ease, he also invented the Soma Cube and, with John Nash, created the game of Hex. He died in 1996.

There is a quote in the flyleaf of the book by A.P. Herbert, in which he says:

> ... the rhymed epigram ... is a most hazardous enterprise. It must have wit, or wisdom - preferably both - compressed into a tiny space, yet [be] perfectly intelligible. Your obscure 'modern' will write no memorable epigrams ... it must have rhyme and it must scan.

while Martin Gardner of *Scientific American* fame writes:

> Piet Hein has one of those rare and psychologically mysterious minds, possessed by so many great creative scientists such as Einstein and Niels Bohr, a mind going straight to the heart of the problem, seeing all its aspects in a single unity, then finding a solution that is as unexpected as it is beautiful.

I took the book down from my shelf recently and discovered (or rather I should say re-discovered) a grook with a particularly geological slant. It goes under the unlikely title of ***Astro-gymnastics*** and I encourage you all to read it and maybe even try it out one clear, starlit night!

It is published here by kind permission of Piet Hein's son, Hugo Piet Hein.


## ASTRO-GYMNASTICS

Do-it-yourself grook

Go on a starlit night,
 stand on your head,
leave your feet dangling
 outwards into space,
and let the starry
 firmament you tread
be, for one moment,
 your elected base.

Feel Earth's colossal weight
 of ice and granite,
of molten magma,
 water, iron, lead;
and briefly hold
 this strangely solid planet
balanced upon
 your strangely solid head.

Piet Hein

# BOOK REVIEWS

*I have three reviews for this issue. Two of these make an interesting pair: the first is the fourth edition of* The Geology of Scotland, *edited by Nigel Trewin, who has taken over the reins from Gordon Craig, editor of the first three editions; the second book is something new,* Geology and landscapes of Scotland, *aimed at a less technical audience. It is a privelege for* THE EDINBURGH GEOLOGIST *to offer these two reviews together. The third review is a second opinion on the RIGS leaflet on Barns Ness.*

## The Geology of Scotland - fourth edition — review by Dan Evans

It is now almost forty years since the first edition of *The Geology of Scotland* was published, and as a schoolboy studying A-level geology in the mid-1960s I can remember regarding that book with considerable awe. We now have a fourth edition that clearly reflects the advancements that have been made in our knowledge of Scottish geology since the title first appeared. This latest edition comprises 576 pages of closely spaced text with a large number of diagrams and plates, and involved 34 contributors.

The editor of this fourth edition is Nigel Trewin from Aberdeen University, and he presents an interesting preface that gives much background to the project. It is evident that there is currently a rapid evolution of ideas regarding the geology, especially for the older rocks that are the subject of new isotope dating techniques. Nigel makes no secret of some differences of opinon between authors, and indeed he quite rightly emphasizes the importance of presenting a range of ideas. As he states in relation to the issue of the origin of the thrust belt in the Southern Uplands…'It is likely that there is no 'correct' answer', a viewpoint that is surely applicable to many geological questions. We have to be grateful to Nigel for pulling together another impressive edition, no doubt often in trying circumstsnces that we can only guess at!

Perhaps the most striking change of format in this edition is that the pre-Old Red Sandstone chapters are described as a series of terranes (Hebridean, Northern Highland and Grampian, Midland Valley, Ballantrae and Southern Uplands) rather than by the traditional Scotland-wide Precambrian and Lower Palaeozoic stratigraphic divisions. I should perhaps explain at this stage that I am a marine geologist whose knowledge is very much at the younger end of the stratigraphic column. Perhaps consequently, my first reaction was one of slight alarm at this change, but anyone with a similar reaction can be comforted by the use of traditional stratigraphy within each of these chapters, and I believe that this new approach is indeed beneficial, although some colleagues have pointed out to me that descriptions of Southern Uplands granites have, perhaps as a consequence, fallen through the net. The final chapter in this 'building blocks' section of the book discusses the difficult issue of the assembly of these terranes into their present configuration, a topic that is a part of the emphasis on geological evolution in this edition.

Appropriately for Scotland, pre-Old Red Sandstone chapters take up almost half of the book, which tells you that for a book of this type, there is a good deal of detail. Certainly from my non-specialist perspective, these 'building blocks' chapters are not for the faint hearted, and perhaps some hard-rock geologists have similar feelings about the Quaternary. It is therefore very helpful that Trewin provides a synopsis of Scotland's geological history in the opening chapter.

A new topic introduced in Chapter 2 is that of the early history of Scottish geology. This is clearly a well-researched account that many readers will find of considerable interest. It is unfortunate that the 17 pages of this chapter do not include any illustrations, for the almost-A4-sized pages of this book, with their rather closely spaced text lacking any diagrams, may prove daunting to the more-casual reader. I should however stress that the remainder of the book has a very large number of diagrams, as well as photographs and a fine section comprising 33 colour plates. Furthermore, the standard of the illustrations is generally, if not uniformly, good.

Moving up the stratigraphic column, there are substantial chapters on the Old Red Sandstone and the Carboniferous, and as we move up into the Permian and Mesozoic the influence of offshore geology becomes evident, with separate chapters for the Jurassic and Cretaceous in this edition. It is the editor's stated aim to concentrate on the onshore evidence for Scotland's geological history and to use the offshore geology to help set the context. This is an admirable approach in view of the abundance of (dare I say excellent?) reference publications on offshore geology, and no doubt also a very practical one in terms of controlling the size of the book.

A chapter on Tertiary sedimentation is included, and it is surprising to see the use of this obsolete and informal stratigraphical term rather than the correct Palaeogene and Neogene. I also have another problem with this chapter that arises from the hopefully natural tendency to search through a book for reference to one's own work and areas of interest. The author helpfully introduces the chapter with a series of general references, but then includes very few references within his main description. This approach makes it impossible for the reader to dig deeper in the literature on specific points raised in the text, and negates its value as a reference text. A case in point is the Oligocene basins off the west of Scotland (page 370), for which the only specific reference quoted is for Lough Neagh, which is in Northern Ireland, whereas there are Scottish papers by Evans *et al.* that are in fact essential reading! Perhaps it is just bad luck for the author/editor that I was chosen as the reviewer for THE EDINBURGH GEOLOGIST, but I hope that this is not a widespread problem and, given the 33 pages of references provided, it seems likely that all the important ones are there.

Chapter 14 describes Tertiary igneous activity by taking the reader through the main features of all the onshore igeneous centres, with reference to those offshore. Although this well-illustrated chapter lacks a unifying stratigraphical diagram that might make the section on 'timing of igneous activity' more digestible, the individual descriptions of the centres are well organised.

The Quaternary chapter outlines the known history of glaciation in Scotland and its influences, and ends with some sobering comments on human influence on future climate. The subsequent chapters outline the economic resources of Scotland and its offshore area: metalliferous minerals, coal, bulk minerals, and hydrocarbons. The closing chapter is a new topic, environmental geology; its inclusion is most apposite in view of the modern requirement for geology to relate to societal needs.

This fourth edition of *The Geology of Scotland* will no doubt continue the tradition of being an essential reference volume for Scottish geology, and will fulfill the editor's ambition of stimulating interest in the topic from professional, student and amateur geologists alike.

**THE GEOLOGY OF SCOTLAND**
**fourth edition, 2002**
**edited by Nigel Trewin (Univeristy of Aberdeen, UK)**
**published by The Geological Society, London: £85 (hardback), £27.50 (softback)**
**ISBN (hardback) 1-86239-105-x**
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**Geology and landscapes of Scotland** **review by Alan Fyfe**

There are a lot of things I like about this book. It has been well thought-out, well written and is wonderfully illustrated – I would even say 'lavishly illustrated', but that is such a cliché nowadays. There are a couple of niggles, I'll come to these later on, but all-in-all, this is an excellent introduction to the geology of Scotland.

It is worthy of note that this book is published hot on the heels of the fourth edition of *The Geology of Scotland.* But they are quite different volumes: different in their intended audience, different in their approach and different in their content. *Geology and landscapes of Scotland*, written by Con Gillen, is aimed at the non-expert, to guide him or her through geological concepts to reach an understanding of how the landscape reflects the geology and how this tells us how our country was formed.

The first chapter is an introduction to earth science but it quickly sets the tone by drawing on examples from Scotland. The Pacific Ocean, the Himalaya and Andes are mentioned, but it is difficult to present plate tectonic theory without taking a slightly broader look. In its description of rocks, a proliferation of names is avoided. As Con says, 'there are no more than a couple of dozen important rock names and even fewer are used in this book.' And these, together with all the tricky terms used in the treatment of folds, faults and shear zones, all appear at the end of the book in a no-nonsense *Glossary of technical terms*.

Chapter 2 introduces us to the geological regions of Scotland. There is a map of these regions, showing the layout of terranes, though not using the term at this stage, simply referring to the underlying structure as 'something of a geological jigsaw puzzle'. There is an excellent table showing a brief history of Scottish geology. This, as with the table on the evolution of life in the previous chapter, is presented anti-stratigraphically, with the oldest ages at the top. I have mixed feelings on this – there would be some merit in informing novices that geologists tend to read from the bottom up, if only to stand them in good stead for further reading. It would also provide consistency with most of the other tables in the book.

Chapters 3 to 8 are a stratigraphical–geographical treatment of the geology of Scotland, leading us from **Scotland's oldest rocks – the far northwest**, through **The Caledonian Mountains** to **Lowland Scotland: after the mountains**. The Mesozoic is dealt with in **The North Sea and the Inner Hebrides** and the Cenozoic by **Tertiary volcanic rocks** and **Ice Age Scotland**. Each chapter is prefaced by a superb double-page landscape photograph illustrating some aspect of the geology. This is followed by an *Introduction* that reviews the geological history to be covered in that chapter and how it relates to the landscape. These introductions, if read sequentially, would give a reader a twenty-minute snapshot of Scottish geology. Each is then followed by further treatment of the geology, either stratigraphical or geographical as appropriate – Con does not fall into the trap of attempting to shoehorn each subject into a standard format.

Throughout the chapters, more difficult and peripheral concepts are dealt with in grey boxes, which can be ignored or read, depending upon one's level of interest. These include *Age dating of rocks*, *The Highlands controversy* and *The Rhynie Chert*. Strangely, these boxes are absent from the later chapters, but maybe this is because the geology is easier to understand. Each chapter is also well endowed with photographs and simplified geological maps. The photographs are well-chosen to illustrate the aspects of geology and landscapes covered. Actually, here is one of the niggles: all the photographs are in black and white, or, rather, a range of low-contrast greys. I am sure that this is for sound commercial reasons and, to tell the truth, monochrome images show the geology just as well as colour ones, but the book is, well, just a little less colourful because of it.

While I am dealing with niggles, the other is, I am afraid, a stratigraphic one. It is the use of the terms Tertiary and Quaternary. Curiously, Con explains the derivation of the latter as 'Latin: fourth; a reference to a previous subdivision of geological time into four units' but fails to say that this previous system is now passé. It is some years now since the international geological community generally abandoned these terms and, difficult though it is, we all have to try to fall into line.

To get back to the book, the final chapter is on Scotland's natural resources. This is an excellent treatment of a wide-ranging subject. Con starts his description of building stones by looking at Skara Brae and Callanish. His introduction to fossil fuels makes mention of carbon dioxide and global warming and there are grey boxes for *The origin of coal* and *Scotland's oil shale industry*. He completes the chapter and thus the book with a section on *People and the landscape*, neatly bringing us full-circle.

Well, that is not quite the end of the book, there is an *Appendix* followed by the *Glossary of technical terms*, a page of miscellaneous *Gaelic terms*, a *Bibliography* and *Indexes* of names and topics. The first of these includes places in Scotland and I took a pot-shot and looked up 'Peebles'. What I discovered was that much of the roofing slate for that town came from the Silurian slate quarries at Stobo and Innerleithen. And when I looked up 'Sleat', as well as reading about the subdued topography representing basement on which the later volcanic rocks were erupted, it told me that it should be pronounced as 'slate'. The book is an all-round education!

All-in-all, I would commend this book to everyone with an interest in the geology and landscape of this country of ours. Fellows of our Society may like to know that they can purchase a copy from the Publications Secretary at a price of £15, a substantial saving on what is anyway a very reasonable price for this volume.

**GEOLOGY AND LANDSCAPES OF SCOTLAND**
**first edition, 2003**
**by Con Gillen**
**published by Terra Publishing, Harpenden, Herts, England: £20**
**ISBN 1-903544-09-2**

# Barns Ness revisited

*I received a number of comments on the review on the RIGS Barns Ness leaflet that appeared in the last issue of THE EDINBURGH GEOLOGIST. It was pointed out that this leaflet was produced by children for children. Well, the text didn't say that and I had to stand by my reviewer's criticism. Nevertheless, to correct this, I decided that the thing to do was to ask a child to review it!*

*Laura visited Barns Ness with her mum and wrote to me with the following comments on the leaflet and how it had helped to explain the geology.*

My first impressions were that a lot of hard work had gone into designing the leaflet and I think that it is an excellent booklet for all ages of visitors.

The front cover is well designed with a very interestingly presented title but they could enhance the fact that it was made by children for children by putting their slogan on the front. The directions were excellent but I would suggest that they should carefully re-draw the map and instead include the shores, walks and the best places to view fossils. There were also some interesting information boards and it would have been very useful to mark these on the map. The information is very well written and is enough for amateur geologists but not too much for visitors. One other thing I think could be improved is the acid picture because to me it looks like baked beans with curry sauce but the information is very interesting.

The most interesting part of the leaflet is the chart showing the ages of the rocks and fossils but I reckon it would look better printed. I also think the names of the Guides dotted around are unnecessary but over all it was interesting enough to make me go there.

When we were there, we did find loads of fossils, though it would have been good to have a book to identify them all.

*I hope that this sets the record straight! Thanks to Laura for being so willing to pay a visit to Barns Ness and for writing this review... and her mum for taking her there!*

## Solution to Rocksword Puzzle No. 10

**Clues across**

1. CEPHALOPOD
8. LADY
9. LYING
11. NEAP
13. ID
14. EXTOLLED
16. BY
17. IDA
19. AURAL
21. PURL
22. SO
23. AMYL
25. POLL
27. SEISMOLOGY

**Clues down**

1. CALDERAS
2. POINTER
3,16. ALGAL BLOOM
4. LA
5. OD
6. PYGIDIUM
7. DAY
10. NEO
12. PLY
15. SEE 18 DOWN
16. SEE 3 DOWN
18, 15. DRY VALLEY
20. ASPS
21. PALL
24. WE
26. LO

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