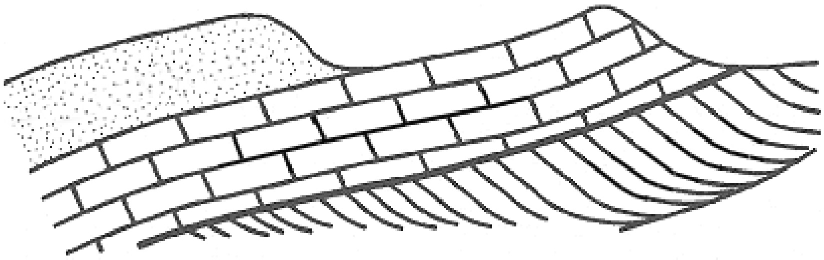
# Farnham Geological Society

[ www.farnhamgeosoc.org.uk ]

*Farnhamia farnhamensis*



*A local group within the GA*

Vol. 7 No.3 **Newsletter** November 2004

<u>**INSIDE THIS ISSUE**</u>



I don't want to lecture, but this edition has gone to print with only one article contributed by a member other than your Committee. Half of this Newsletter is taken up by an account of the trip to Northwest America, and it is hoped that the 90+ members who did not go on this memorable trip will nevertheless enjoy reading about it. A few "*Letters to the Editor*" about this or any other topics would be very welcome; either write to me at my home address (given in Members Address List) or e-mail to: olivia@cottono.freeserve.co.uk.

The year 2004 has, apart from the recent trip to America, been relatively routine with 9 monthly lectures, the members' evening in July, the Society dinner in October, and the GA reunion in Cardiff in November still to come. The September lecture by Prof. Richard Selley was followed on the Saturday by a visit to the vineyard at Dorking.

It is with great sadness that I record the deaths of two of our members, Geoffrey Levett in August and John Linse in October. Both will be sorely missed within the Society Many friends from the Society attended the funerals, Geoffrey's at Westcott and John's at Headley . Our deepest sympathies go to Margaret and Lyn. Donations were made by the Society to charities of their choosing, for which they send their thanks and also for the support of members.

Since this is the last issue this year, the Committee wish you a happy Christmas and New Year, and look forward to seeing you at December's Christmas-party meeting and at the AGM on 14 January 2005.

*Peter Cotton*

<u>**COMMITTEE**</u>

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Robert Gott
01483 - 235422

**Treasurer:**
Peter Luckham
01428 - 607229

**Business Secretary:**
Lyn Linse
01428 - 712350

**Programme Secretary:**
John Gahan
01252 - 735168

**Field Secretary:**
Position vacant

**Membership Secretary:**
Michael Weaver
01252 - 614453

**Newsletter Editor:**
Peter Cotton
01428 - 712411

**GA Representative:**
Shirley Stephens
01252 - 680215

**General Representatives:**
Janet Burton
01420 - 22190

## FGS monthly meetings and field trips - 2004/05

Nov 12 Dr Steve Toothill, Ashstead Geological Society

***A View of Geology through seismic data***

Dec 10 Dr Ian Jarvis, Kingston University

***20Ma of disasters - do deep-sea muds hold the key?***

**2005**

Jan 14 AGM followed by Prof. Eddie Bromhead, Kingston University

***Landslide and landslide dams in the Venetian pre-Alps***

Feb 11 Mike Coates, Chief Warden RSPB, Surrey Heath

***The RSPB Farnham Heath project***

Mar 11 tba

Apr 8 John L Morton, author *'Strata'* on the life story of William Smith

***William Smith, the father of English geology***

May 13 tba

June 10 Dr Paul Craddock, British Museum, London

***Early mining and extractive metallurgy***

July 8 ***Members evening & presentations***

Aug 12 Summer break - no meeting

Sept 9 John Atkinson, Portsmouth Water Company

***Water supply with regard to Cretaceous strata***

Oct 14 tba

Nov 11 tba

Dec 9 tba

**Outstanding Field Trips 2004**: 5 - 7 November - GA meeting in Cardiff

**Future Field Trips**: October 2005 - Tunisia; May 2006: France (Languedoc region)

## A preliminary geological report for the RSPB on Farnham Heath, Surrey

**Copy of the report prepared by John Gahan and sent to Ken Baker, RSPB, 6th November 2003**

### 1. Geological setting

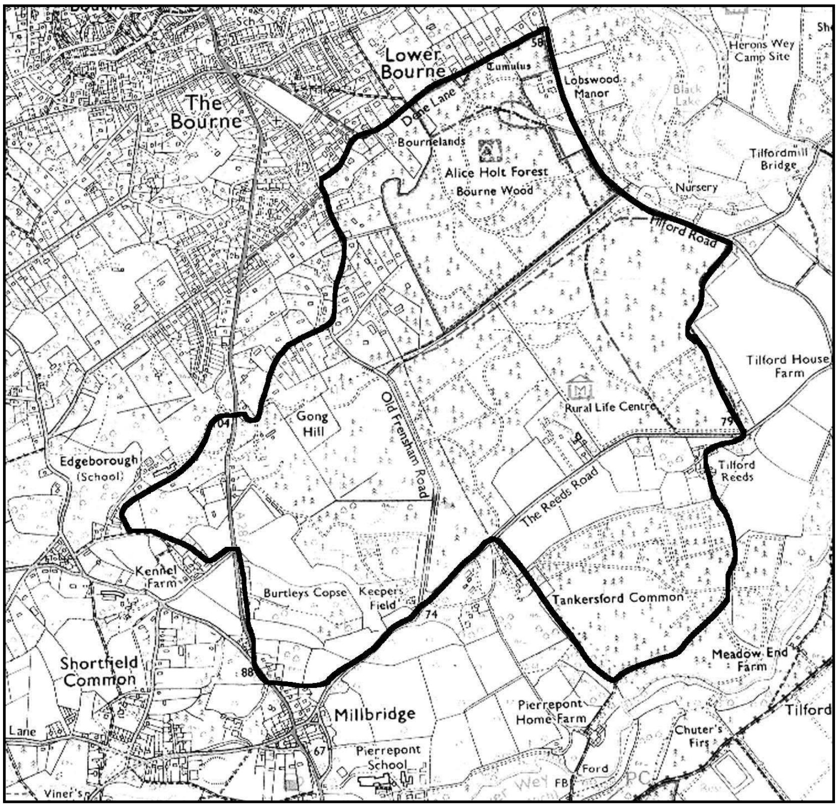
Farnham Heath, an area of heathland south-east of Farnham and encompassing Tilford Reeds, Tankersford Common and Gong Hill (locally known as 'The Bourne Woods') is marked by low hills and dense woodland. Geologically the area comprises underlying weathered sediments of 'rusty' porous sands and sandstones of the so-called **Folkestone Beds**. The Folkestone Sands or Beds are of intrinsically low fertile quality and therefore unsuitable for agricultural purposes. Hence the area is given over to the plantation of trees and forestry production. Small deposits of superficial Upper Terrace gravels cover some areas of the higher ground.

### 2. Geomorphology

Quaternary ice age freeze/thaw shattering and drainage meltwaters from deep permafrost are the likely causes of erosion that exposed the Folkestone Beds in the area. In the main it is a sandy facies underpinned by extensive ferruginous ironstone veins known locally as **'carstone'**. This is a type of basal ironstone formation which is responsible for much of the hilly terrain in the area. Because of the low hills and prominent woodland the local authority has recently named the area **'The Surrey Hills'** region of west Surrey. Many surface areas are strewn with carstone fragments of varying sizes and may in some small way contribute to soil aridity.

### 3. Folkestone beds

The Folkestone Beds are at their thickest and most widespread in the western Weald where Farnham Heath is located - a part of the Surrey Hills area. Otherwise they follow a narrowing irregular belt around the Wealden District from west to east.




In the western Weald the Folkestone Beds are referred to by the **Soil Association** as 'E' & 'F' type soils which classifies them as **argillaceous** (type 'E'), that is to say, coarse loamy and loamy brown earths. **Podzols** (type 'F') are the sandy brown earths and brown sands interspersed throughout the area (McRae & Burnham – 1975). In the main, the coarse sandy outcrops are limonitic and as a result most acidic with some clayey top-soils in valleys and gullies where run-off is prevalent.

The origin of the ironstone hard-caps or carstone within the beds is derived from secondary mobilisation of iron-rich ground waters into thin voids or reservoirs at depths of ~ 1 to 5 metres particularly where the sandstone beds are glauconitic. Over-time subsequent capillary action, tree root expansion and seasonal erosional activities have a tendency to fracture the deep-seated festooned ironstone formations. In turn this forces the carstone to the surface as cylindrical or tabular chunks in the form of brown mottled hardpan slabs.

Geologically the Folkestone Beds represents a facies transgression within the so-called Lower Greensand series laid down ~ 110 ma (millions of years) during the Mesozoic when southern Britain bordered an epicontinental marine shoreline.

### 4. Current usage

The region was formally open heathland but is now firmly rooted with an abundance of coniferous and secondary tree species. Generally the area is used for recreational purposes such as rambling, dog walking and in recent times outdoor film and television productions. As stated elsewhere, the topography is of sometimes steep but mainly shallow hills in extensive woodland. The conifers were probably planted during the past hundred years or so for timber production. A local history of the area suggests the land was once grazed by a variety of cattle in addition to cultivation by broomsquires and farmers. William Cobbett, the 18th century parliamentary radical and local boy made good, once described the region as, *'Rascally heathland'*

### References


**Gallois R.W. –** 1965 ***'The Wealden District'*** 4th Edn (1992), British Geological Survey, HMSO London (1965)

**McRae S.G. & Burnham C.P**. – 1975 ***'Soils of the Weald'*** Proceedings of the Geologists Association, Vol 86 Pt 4, No 11, pp 598 - 599.

**Middlemiss F.A**. – 1975 '***Studies in the sedimentation of the Lower Greensand of the Weald'* a review 1875-1975** Vol 86, Pt 4, No 4, pp 457 – 474.

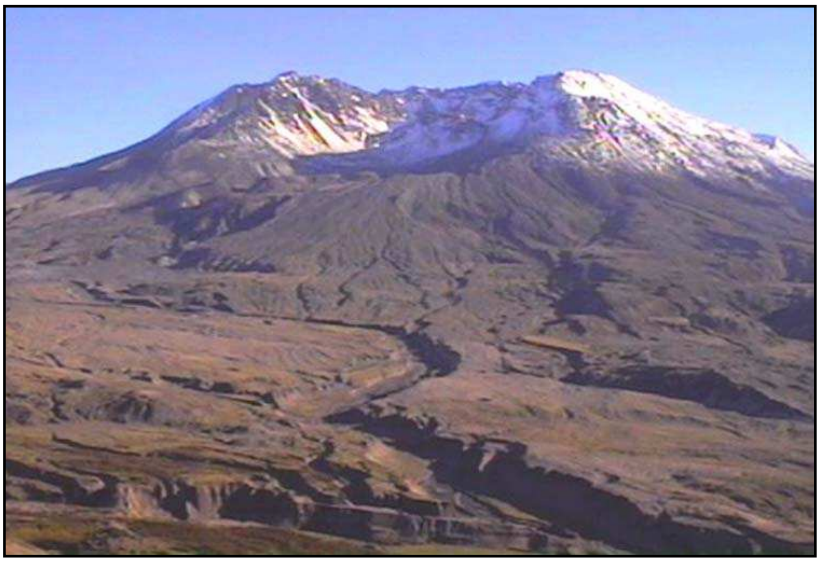

*John Gahan*

## FGS field trip to North West America - September 2004

On 1st September thirty eight members of the society [see photo] began a 17-day trip which would take them through Washington State, across into British Columbia and Alberta, and back over the border into Montana and Wyoming. In all, this trip involved 3,300 miles of coach travel with stops at nine hotels in the United States and Canada. Throughout the trip John Williams was our guide, professor and friend; his knowledge of the area, gained from several previous visits, was of great value.


This relatively brief account of the extensive visit cannot possible cover all of the interesting and complex geology of the North Cascades, the Omnica and Intermontane Provinces, the Rocky Mountains and the areas to the east of the Rockies including Yellowstone and the Grand Teton. The intention is that in the next two newsletters more detailed articles will be written to cover the history of the Western Mountain Development; the Washington state volcanoes of Mt Rainier and Mt St. Helens; the vast Columbia Icefield and its associated glaciers; Yellowstone and Grand Teton National Parks. It is necessary, however, in this opening article to give a rough idea of how the areas visited fit into the overall geology of the American Continent.

After the break-up of the super continent of Pangea, the old North American craton (the Canadian Shield), with its associated collection of accreted terranes, was split from Northern Europe. During Jurassic and Cretaceous times a series of land masses (terranes) drifted in from the Pacific Ocean and attached themselves to the western seaboard of the old continent. These collisions had a profound effect and two in particular, the Sevier and Laramide Orogenies, stand out, the latter being responsible for the upthrusting of the Rocky mountains in a series of asymmetric folds.



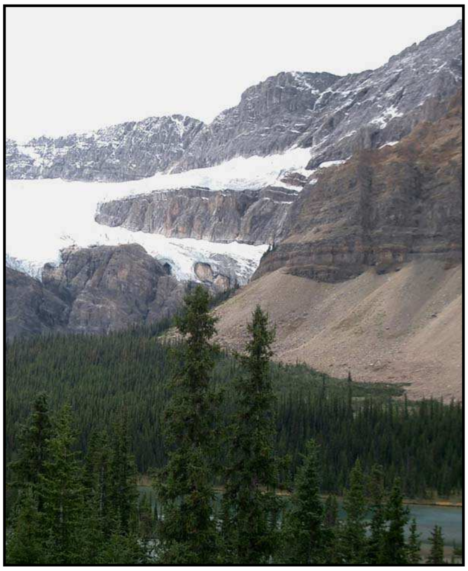
The first visits of the tour were to two of the fourteen volcanoes that make up the Cascade Mountain Range. This chain stretches for 600 miles from Northern California into British Columbia. As already mentioned, these two volcanoes, Mt.Rainier and Mt.St.Helens, will be covered in more detail in later newsletters. Since our visit, Mt.St.Helens [see photo] has shown signs of renewed volcanic activity. Having seen the devastation caused by the 1980's eruption and the recovery of this beautiful area in the last 25 years, it is to be hoped that nothing of the same magnitude happens again. A major factor in the 1980's catastrophe was the melting of the glacier ice, which in turn created mud flows of enormous power that spread westwards to the coast. These flows were in addition to the pyroclastic emissions and the lava flows, the combined effect of which was the devastation of some 220 square miles of countryside. It should be noted that the lofty peaks of the Cascade Mountains were covered with glacier ice some 1.5 ma when the first Mt.Rainier lavas broke through to the surface. Today Mt.Rainier, at 14,400 feet, has the greatest number of glaciers of all the Cascades, 30 in all.

Following our two days of visits to the volcanoes, we headed north for a long drive through the North Cascades to the glacial Okanagan Valley over the border in British Columbia. A very significant feature of the North Cascade Mountain range is its role as a climatic barrier to moisture-laden winds from the Pacific, which drop 720 inches of snow per annum on the mountains. In the rain shadow to the east, a dry environment, together with fertile soils, provide ideal conditions for fruit-growing and vineyards which rolled by as we travelled up the valley. As well as fruit growing, the Okanagan Valley is a favourite recreational area with its succession of lakes used for water sports. Not surprisingly this is also a favourite place to live and the population is the highest in British Columbia.

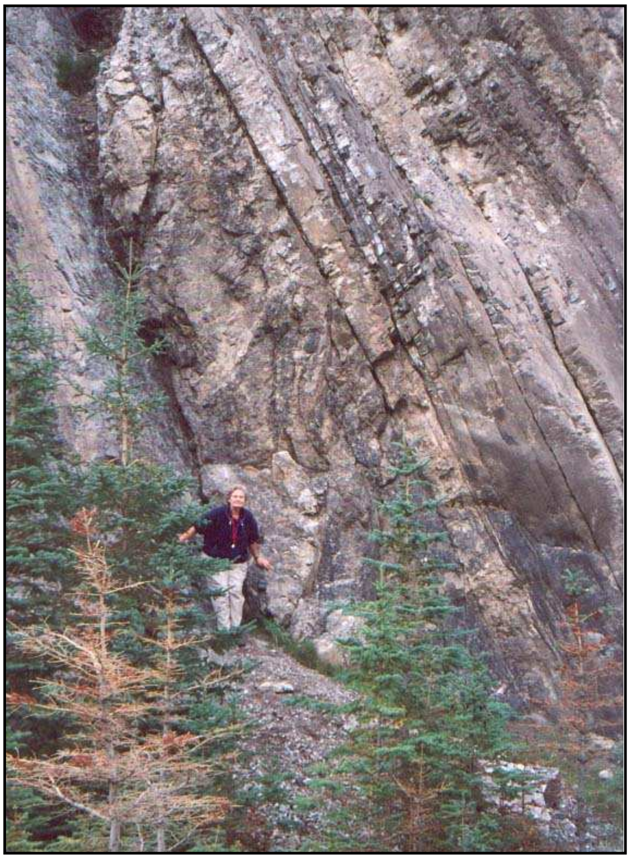
From a geological standpoint the Okanagan Valley forms a boundary between the Cascades and the next physiographic unit, the Omineca-Intermontane province. Traversing this whole area the geology is so complicated that, despite John Williams' heroic attempts to point out the various features from the coach and stop from time to time for hands-on inspection, one can only gain general impressions. The fact of the matter is that the effect of the terrane accretions and subsequent events has left a melange of severely folded metamorphic rocks intruded by plutons. Sequences of rocks are repeated by a series of thrust faults and, in the case of the Cascades, the central section consists of mica schists, marble and quartzite. At the eastern and western edges of the 40-mile wide range are sedimentary rocks of Cretaceous age which have also been metamorphosed.

We were still heading eastwards on this leg of the trip and heading for our overnight stop in the small settlement of Golden. En route we came to the important Columbia River and at Revelstoke we visited a huge hydroelectric power station where a dam has been built across the river. Ahead was a steady climb over the Rogers Pass at 4,300 feet and a drop into Golden. The next day the route took us though the Yoho National Park in which the world famous Burgess Shales are located high upon a mountain. Some members of the party have on a previous visit made the very strenuous climb to see the Shales with their full range of complex fossils dating from around 550 ma.

We were now rapidly approaching the Rockies but first of all we needed to cross the Rocky Mountain Trench, which comprises a series of faults running for 1,600 miles from Alaska to Montana. The coach continued on to the Icefield Parkway which is a fabulous road running 116 miles from Lake Louise to Jasper and passing though several National Parks. The towering 9,000 feet snow capped peaks of the Rockies stretch out along the western side of the Parkway, revealing glaciers that reach back to the Columbia Icefield which we were to visit later in the week. Several stops were made before reaching Jasper including one at the North Saskatchewan River crossing which had been a route for the Indians wishing to cross the Rockies in past times. Another stop was made to see Lake Peyto which is of the most beautiful turquoise hue owing to the presence of ground-up rock particles from glaciers which act as light reflectors. An interesting observation when looking at the mountains along the Icefield Parkway was how useful snow can be in picking out the layering of the rocks and their folding [see photos].

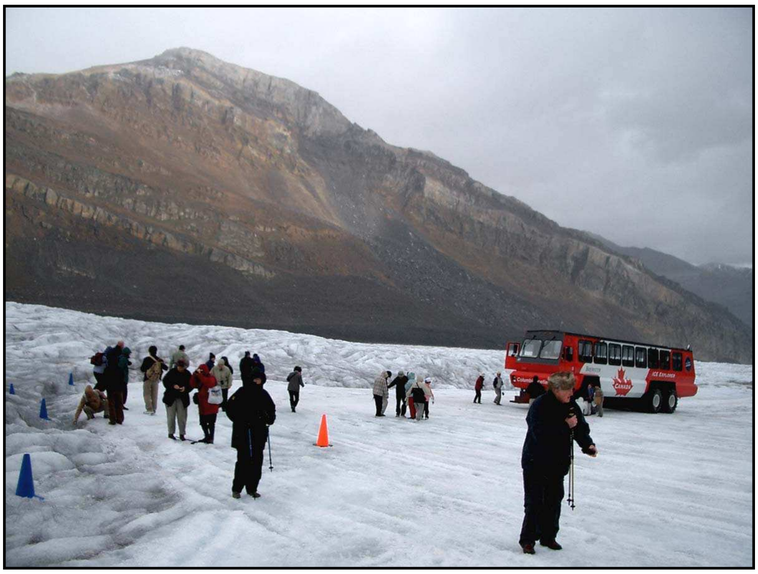


Three nights were then spent at Jasper. On the first day at Jasper, John Williams had planned an interesting trip across the entire width of the Canadian Rockies, taking us from the eastern side (the front ranges), through the main ranges and on to the western ranges, an overall distance of some 80 miles. During the course of this trip we saw a range of rocks from Pre-Cambrian through to Pleistocene, but with no rocks from the Silurian period, which is absent in the Rockies. These rocks were mostly sedimentary in origin but they have been subjected to thrust faulting and metamorphism [see photo]. An interesting feature of thrust faults in the Canadian Rockies is that the rocks above the fault are everywhere older than those immediately below. At the western end of the cross-Rocky tour we visited Mt. Robson, the highest peak of the range, but clouds concealed the peak. Further west we reached the Rocky Mountain Trench which runs all the way along the western side.



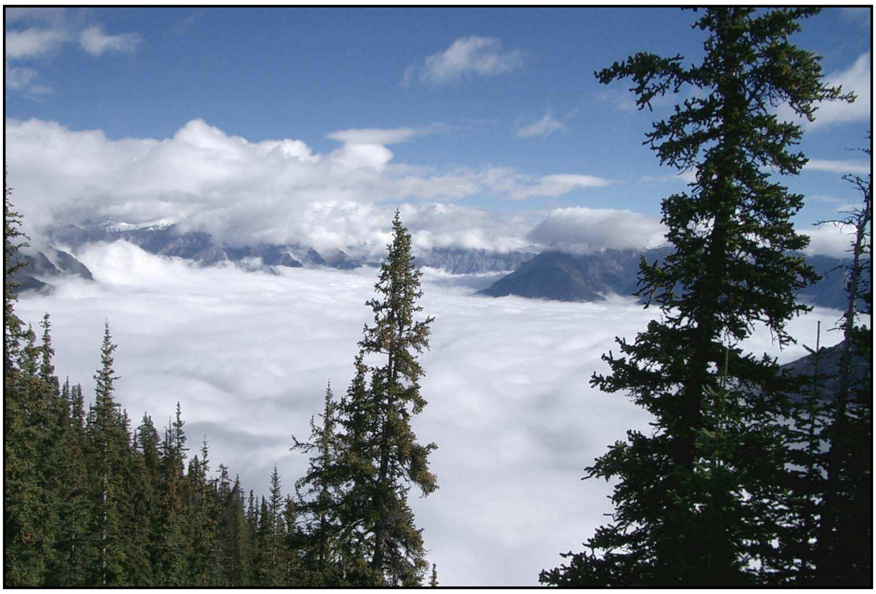
Before returning to the hotel in Jasper we visited a hanging valley that we had seen from the main Athabasca River valley we had been following. This is the Maligne Valley, which is a deep valley containing Maligne Lake and the Maligne River. It is about 58 km long and intercepts the Athabasca River near Jasper. The canyon [see photo]has cut down to the Athabasca through limestone and the river is fed from the lake which is the largest glacier-fed lake in the Rockies. The party revealed its differential fitness by the distance members clambered down into the canyon before returning to the coach

For the second day from the base in Jasper we joined the Icefield Parkway to head back south to the Icefield Centre at the foot of the Athabasca Glacier, which is fed from the Columbia Icefield. There we transferred into powerful "ice buses" and taken up onto the glacier itself. [see photo]. This was an unforgettable experience, climbing up steep gradients past the lateral moraines and on to the glacier, where an area free from crevasses has been roped off for walking on. A more detailed account of the Columbia Icefield will appear in the next newsletter, together with a general explanation about the formation of glaciers and their ongoing activity. Suffice it to say that this icefield is the largest in America's sub-Arctic interior, covering 325 square kilometres of the Main Ranges of the Rockies at an average elevation of 10,000 feet and a greatest thickness of 1,200 feet. Regarded as a giant reservoir for the supply of water to British Columbia, this is the hydrographic apex of North America and the rivers flow to each of the three oceans - via the Saskatchewan to the Atlantic, the Columbia to the Pacific, and the Athabasca to the Arctic.



From Jasper the coach once more returned to the Icefield Parkway which is, by the way, banned to heavy commercial traffic through the Jasper and Banff national Parks. Our destination on this 8th study day was Canmore, located on the Trans-Canada Highway to the south east of Banff, where we were to stay for 2 nights. On the way, John stopped the coach from time to time for closer inspection of roadside geological features including a dolerite dyke near to Crowfoot Glacier, which is unique because it is the only igneous outcrop to be seen in the Rockies.

A "tourist" stop was made at the well-known Lake Louise (named after one of Queen Victoria's daughters) with its Chateau Louise hotel. A great number of boutiques are sited in a wing of this establishment, selling expensive goods including jumpers made from musk-ox wool, one of which was given to Queen Elizabeth as a present during her 2002 visit.



While staying in Canmore we had a "*free day*" in Banff. John suggested we might like to take a trip on the Banff Gondola which travels to the summit of Sulphur Mountain. Weather conditions at the base did not look particularly favourable for viewing the scene at the summit 7,500 feet above sea level. However, the gondolas broke through the cloud into bright sunshine three quarters of the way up. The view from the summit platform of the surrounding mountain peaks was "*awesome*", their bases all hidden in cloud [see photo]. A scene reminiscent of what it must have looked like during the Ice Age. Returning to the ground we all went our separate ways in this very pleasant and prosperous town, visiting museums, shopping and seeing the sights. One of the museums is entirely devoted to the Indian tribes who inhabited the area. It was interesting to be reminded of these early inhabitants who had travelled far and wide along the river valleys through to the Pacific and had established routes which were to be expanded by the White Settlers in the 18th and 19th centuries.

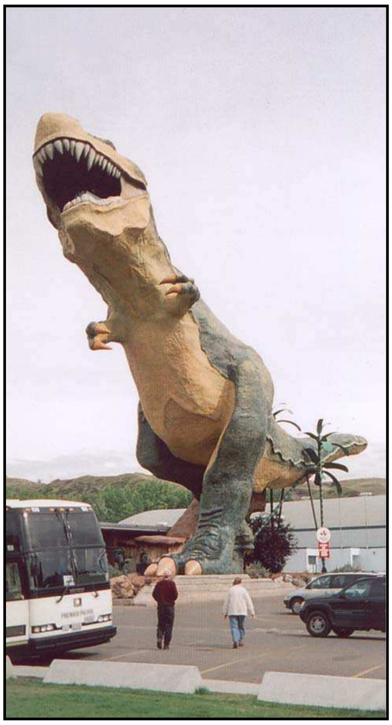
From Canmore our route went through the eastern foothills of the Rockies on to the Great Plains through Calgary. The sudden change from mountain to prairie took some acclimatisation, but travelling mile after mile through cereal and beef-farming told us that we had indeed said goodbye to the main ranges of the Rockies which were now behind us.

Looking back to the front ranges of the Rockies the mountain front is a wall of limestone rising over 4,000 feet out of the foothills. The foothills themselves consist of sandstone and shales, a non-marine sediment of Tertiary and late Cretaceous age. Glacial Drift covers most of the bedrocks.

To the east of the foothills is the large sedimentary foredeep basin of Alberta which contains a large number of oil and gas fields as witnessed by the many "nodding donkeys" to right and left of the coach [see photo]. Extraction takes place from considerable depths, up to 5,000 feet, where the Devonian limestones act as the reservoir rock overlain by Tertiary and Mesosoic layers.

Our destination for the night was Drumheller some 150 miles east of Banff  Much of the scenery in this area is "*Badland*" because the Red Deer River has cut down into soft sediments and created a pattern of side canyons.  We made a stop at Horseshoe Canyon to inspect at closer range this "*Badland*" scenery [see photo].

However, the main attraction in Drumheller is the Royal Tyrrell Museum named after J B Tyrrell who found the bones of large dinosaurs near to Drumheller in the 19$^{th}$ century.  Since then vast quantities of dinosaur remains have been found in the Alberta badlands and Drumheller is littered with plastic dinosaurs including a giant one some 80 feet high! [see photo]  The museum is well laid out in many different halls devoted to particular subjects including: dinosaurs, plants of the Cretaceous period on which dinosaurs fed, models of other  extinct animals, the Burgess Shales magnified to twelve times actual size, etc.



The eleventh day of the trip necessitated a very long drive from Drumheller via Medicine Hat on the Trans-Canada Highway and then south across the border to Great Falls in Montana.  This is still prairie scenery but, now heading south, one is aware that the Rocky Mountains Chain which follows a north-west / south-east orientation, looks much closer again.  En route we visited the Writing on the Wall Provincial Park where there is a remarkable feature in the landscape above the Milk River.  This river would have originally flowed into the Cretaceous sea that divided the American continent into two parts; the sediment deposited in this sea resulted in the sandstone layers of this whole area.  As a result of differential erosion of these sandstone rocks, a fantastic assembly of pillars of rock with a hard stone capping has been left [see photo].  These pillars have the Indian name of "Hoodoos" representing spirit figures.  Blackfoot Indians regarded this as a mystic place and carvings on the sandstone faces depict animals, plants and other things on which they relied for their existence .

Great Falls was the site of a huge glacial lake over 500 feet deep. This was also a volcanic region associated with the Laramide Orogeny referred to earlier as one of the two major events in the creation of North West America. The Adel Mountains to the west of our route were the source of extensive feeder dykes stretching 30 miles from the batholith and now appearing in the landscape as buttes. When the water was released from the Great Falls Lake it flowed through the channel now occupied by the Missouri River. A photo-stop allowed us to climb up 72 steps to a viewing platform above the river which has been formed upstream from the conjunction of three rivers at a place appropriately named Three Forks. From Great Falls the Missouri flows eventually into the Mississippi at St Louis

Continuing south through Helena the road passes through outcrops of Pre-Cambrian rock. Further south in this area a huge batholith was emplaced in Tertiary times and its metamorphic aureole is the source of mineral exploitation which continues today around the town of Butte, where a huge open-cast copper mine is still working. Near to the town is the location of The World Museum of Mining situated near to what was once described as "*the richest hill on earth*". As well as copper, other minerals exploited have been gold, silver and zinc and the riches of this enterprise have been used to build the prosperous town of Butte. At the Museum of Mining a whole mining settlement called Hell Ravin' Gulch has been reconstructed with its shops, school, church and various professional establishments such as solicitors and doctors. During the course of our visit to this old settlement there was a heavy hailstorm rattling the roofs of the buildings in which we had to take refuge. Throughout the tour we had not been blessed with particularly fine weather and our sun-tan lotions were not needed.

From Butte we headed for West Yellowstone and on the way we stopped at the site of the massive 1959 earthquake near Hebgen Lake. The resulting landslide descended from the south wall of the valley, engulfed a camping site with loss of life and dammed the valley for 3 weeks forming Earthquake Lake. Landslides are a common feature of the whole of the areas we visited and we noticed when travelling along the Icefield Parkway that many roads and rail tracks are protected by "roofs" or go-through tunnels.

On the next day we drove into Yellowstone park [see photo] in a snowstorm that brought out snow ploughs to clear some of the roads. Snow on the geyser fields and trees enhanced the beauty of Yellowstone and in no way deterred the operation of the major geysers such as Old Faithful and the geysers of Norris Basin. There was plenty of wildlife including herds of bison, deer and two wolves but no bears of any sort. As stated at the beginning of the account, Yellowstone is to be covered by a separate article in a future newsletter. Suffice it to say now that it is the centre of one of the earth's largest volcanic fields in which all the activity has taken place over the past 2.5 million years. The whole of the Park is located within three overlapping calderas and is at an average height of about 8,000 feet, which means that deep snowfalls close all roads except one in the Park from November

to April each year.

The final day of the tour took the party from Yellowstone through Grand Teton National Park to an overnight stay at Jackson Hole from where a plane would take us to the North West Airline's hub at Minneapolis. The Grand Teton Range [see photo foot of previous page] is the youngest part of the Rockies and is a classic example of fault block mountains where a massive block of Pre-Cambrian crust is now exposed along the Teton fault as the east face of the Range. The upfaulted block of the mountain towers up to 7,000 feet from the downfaulted floor of Jackson Hole Valley and stands at 14,000 feet above sea level. Subsequent erosion has produced an area of Alpine topography similar to the European Alps. It was through this magnificent scenery that the group took its last walk before setting off for home on the following day.

Thank you John for a magnificent trip. *Peter Cotton*

## Predicting changes in sea-level

**Summary of the Society's May 2004 lecture given by Prof. Michael Tooley, University of Durham**

The main thrust of Prof. Tooley's lecture was to question the claim made by the IPCC that global sea levels over the next 100 years will rise by about 7 metres. In his view, average global rises will not nearly approach this figure, and that the exaggerated IPCC figure is drawn solely from modelling exercises that attempt to link sea-level to temperature/$CO_2$ levels in the atmosphere, but take no account of empirically derived field data.

Prof. Tooley's hypothesis is that if one can determine accurately changes in sea level that have occurred over recent time, say past 100,000 years, then one is likely to have sound evidence as to the changes that are likely to occur in the near future. In order to derive these data, Prof. Tooley and his team have analysed core samples up to 10 metres in depth taken from sea-bordering lowlands from a number of sites around the world, ranging from Lancashire to Bangladesh, Papua New Guinea and the Maldives.

In all the places investigated, core analysis showed that, over recent times, there has been a continuing cyclic pattern of rising sea-levels followed by falling ones, as identified by the repeated layers of silt/sand (indicating marine conditions) followed by 'peaty' material (indicating more terrestrial conditions). Identification of micro and macro fossils within the core layers can give an accurate indication of conditions pertaining when the deposits were laid down, and carbon-dating provides the time frame.

For example, in Bangladesh, core analysis has shown that land-level is actually rising (Dacca was on the coast 4000 years ago) even though the delta region is subsiding, because the rate of deposition of sediment being brought down by the country's great rivers is building up land faster than the sea is overwhelming it!

All the data collected by Prof. Tooley indicate that, contrary to IPCC assumptions, there is no simple relationship between sea-level, temperature and $CO_2$ levels, and that there are complex geographic and geological interactions that must be taken into account if accurate predictions of future sea level changes are to be arrived at.

*Michael Weaver*

## The East African rift - how to break a continent

**Summary of June 2004 lecture given by Prof. Cindy Ebinger, Royal Holloway.**

Throughout earth history, continental plates subjected to forces applied within, beneath, and on their boundaries have ruptured to produce new ocean basins. A wealth of academic and industry data from ancient rupture sites (passive continental margins) provides physical and kinematic constraints on break-up processes, yet data from actively deforming rifts are also needed to assess fully the localisation of strain and magmatism prior to the onset of seafloor spreading. The East African rift system encompasses rift sectors in all stages of development, providing a natural laboratory for continental break-up above anomalously hot asthenosphere/plumes.

Prof. Ebinger reviewed consistent patterns in the geometry and kinematics of rift basins across a range of tectonic provinces; these patterns indicate that the thermal-mechanical properties of the continental lithosphere largely determine the geometry of basins prior to break-up. During the initial rifting stages, strain localises along border fault systems, which accommodate large displacements. The spatial arrangement of these border faults produces a characteristic along-axis segmentation that scales with the mechanical plate thickness. As lithospheric thinning via stretching and heating progresses, strain localises to narrow zones of magma injection, and the border faults become much less active. This new, 'magmatic' along-axis segmentation is similar to that of slow-spreading mid-ocean ridges, suggesting that transitional crust and thick, seaward-dipping volcanic sequences observed along passive continental margins are emplaced during the late rift stages.

*Prof. Cindy Ebinger*

## Members' evening

**Summary of the talks given and exhibit shown at the Society's members' evening in July 2004**

Two slide presentations were made, one by Janet Catchpole recording a visit to Alaska, and one by Lyn Linse showing pictures of her visits to Yellowstone National Park.

Janet's pictures of Alaska revealed the beauty of this Northern state of the USA, which is often thought of as being a cold and forbidding area. Lyn has visited Yellowstone on a number of occasions, her last being on the Society's trip to North Western America in September 2004. Her slides showed the great variety of natural features to be seen in this huge National Park which is still recovering from two disastrous fires, one in the 1950's and the other in the 1980's.

A display of rocks and minerals from the Society's collection, supplemented by specimens from Peter Cotton's own collection, attracted much attention before and after the refreshments.

*Peter Cotton*

## Geology of Saturn's small moon Phoebe

Saturn's small moon Phoebe, like a woolly mammoth trapped in Arctic ice, may be a frozen artefact of a bygone era some four billion years ago. The finding is suggested by new data from the Cassini spacecraft now orbiting Saturn.

In reviewing data from the space-craft's 11$^{th}$ June 2004 flyby of the diminutive moon, Cassini scientists conclude Phoebe is likely a primordial mixture of ice, rock, and carbon-containing compounds similar in many ways to material seen on Pluto and Neptune's moon Triton. It is believed that bodies like Phoebe were plentiful about four and a half billion years ago in the outer reaches of the solar system.

These small bodies (icy planetesimals) formed the building blocks of the outer solar system. During this process, gravitational interactions ejected much of this material to distance objects joining a native population of similar bodies to form the Kuiper Belt. Phoebe stayed behind trapped on orbit around the young Saturn waiting eons to reveal it's secret.

All the evidence leads the scientists to conclude that Phoebe's surface is made of water ice, water-bearing minerals, carbon dioxide, possible clays and primitive organic chemicals at different locations on the surface. Also seen are spectral signatures of materials not identified as yet. Cassini's observations gave scientists the first detailed look at one of these primitive icy planetesimals.

Phoebe's mass was determined from precise tracking of the spacecraft and optical navigation, combined with an accurate volume estimate from images. The measurements yielded a density of about 1.65 grams per cubic centimetre. (100 pounds per cubic foot), which is much lighter than most rocks however more than pure ice at approximately 0.94 grams per cubic centimetre **(**58 pounds per cubic foot). This suggests a composition of ice and rock similar to Pluto and Triton.

Spectral measurements, light intensity as a function of colour or wavelength, confirmed the presence of water-ice previously detected by Earth based telescopes. The measurements provided evidence for hydrated minerals on Phoebe's surface, and detected carbon dioxide and solid hydrocarbons similar to those found in primitive meteorites.

Measurements taken by the composite infrared spectrometer were used to generate temperature maps. The maps show the surface of Phoebe is very cold, only about 110 degrees above absolute zero (minus 163 degrees Celsius). Even colder night-time temperatures suggest a fluffy, porous surface layer.

*John Linse*

## Newspaper snippet - Asteroid impact 250 million years ago key to mass extinction

A massive asteroid bigger than Mount Everest slammed into the earth 250 million years ago causing the greatest mass extinction in record, say the scientists who believe they have found the "smoking gun" of the collision. Geologists located the huge undersea crater off the Australian coast where they think the asteroid hit with the force of 1 million nuclear bombs, an impact that almost snuffed out life on earth. About 90 per cent of marine organisms and 80 per cent of land animals and plants died out at the end of the Permian and the beginning of the Triassic periods, for reasons that had not been explained. If the asteroid impact is confirmed as the cause of the "Great dying", it will be the second example of an extra-terrestrial object being linked with a mass extinction. The other was the demise of the dinosaurs some 65 million years ago.

Luann Becker, of the University of California at Santa Barbara, and colleagues at the Australian National University in Canberra said that they have gathered extensive evidence of a 125-mile wide crater off the north-west coast of Australia. Dr Becker said that her team had found fragments of a meteor in a geological layer that corresponded to the date of the Permian mass extinction 250 million years ago. Analysis of geological cores drilled by oil companies prospecting in the region had also revealed convincing data to suggest that the crater was created by a massive object from outer space. The scientists have found melted rock and shocked-quartz crystals that contain the tell-tale fractures that they believe are the result of a cataclysmic collision involving a huge explosive force. *"Few earthly circumstances have the power to disfigure quartz, even high temperatures and pressures deep inside the earth's crust*", Dr Becker said.

The study, published in Science journal, relied on two oil-company cores drilled in the Seventies and Eighties through a geological feature called "*The Bedout High*", which had not been previously analysed. When the scientists started to investigate the cores, which had been stored untouched by the Geological Survey of Australia, they soon realised that they had probably been drilled through an impact crater.

The great dying at the end of the Permian period is the greatest of the five known mass extinctions. No type of life was spared. plants, insects, reptiles, fish, molluscs and microbes were all affected. Some scientist have suggested that severe volcanic eruptions at the time may have sent soot and ash into the atmosphere and shut out the sunlight for years. Others have suggested that climate change, brought about by the formation of a giant supercontinent, was the cause.

Originally it was thought that the mass extinction took place over millions of years but more recent studies suggest that it could have occurred in less than 10,000 years - a very short period in geological history. "*I think palaeontologists are now coming full circle and leading the way in saying that the extinction was extremely abrupt*", Dr Becker said. A similar impact crater has been found at Chicxulub in Mexico, which scientists have dated to about 65 million years ago - the time when the dinosaurs became extinct - which was also marked by a period of intense volcanic activity.

Dr Becker added. "*We think that mass extinctions may he defined by catastrophes like impact and volcanism occurring synchronously. With the discovery of the Bedout, 1 don't think we can call such catastrophes occurring together a coincidence any more*".

*Steve Connor, Science Editor of The Independent, Friday 14 May 2004*