

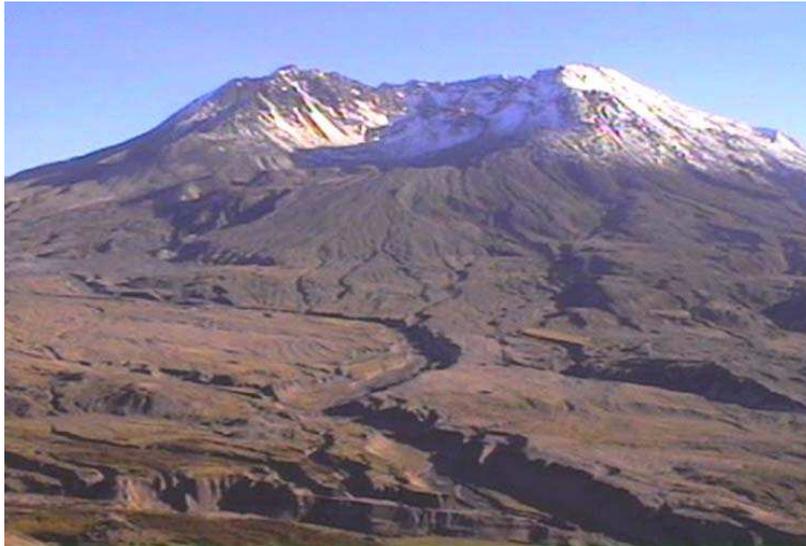
FGS field trip to North West America - September 2004

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 possibly cover all of the interesting and complex geology of the North Cascades, the Omnic 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 - courtesy U.S. Forest Service, Gifford Pinchot National Forest, & Mount St. Helens National Volcanic Monument: 24 September 2004](#)] 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 through 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.

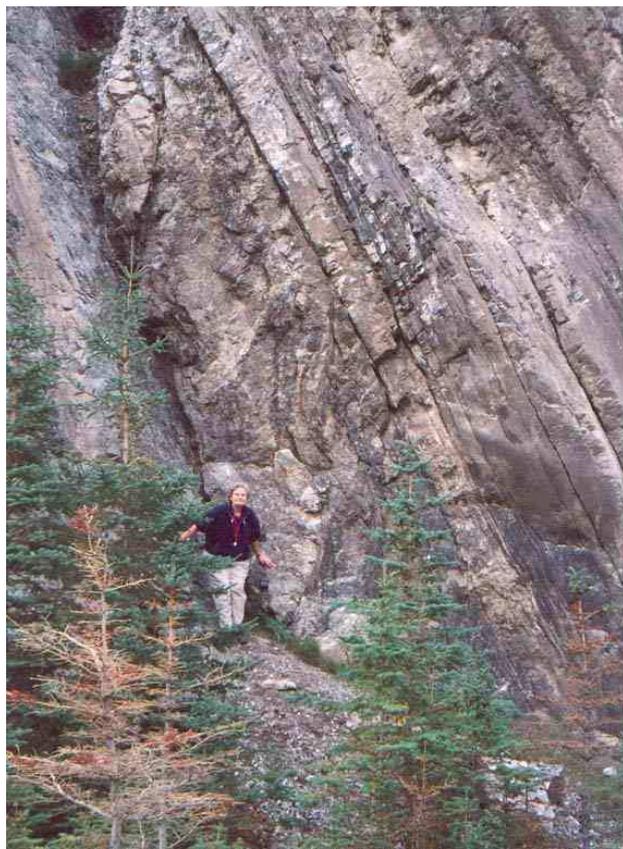


We were now rapidly approaching the Rockies but first of all we needed to cross the Rocky Mountain Trench, which comprises a series of faults running for 1,600 miles from Alaska to Montana. The coach continued on to the Icefield Parkway which is a fabulous road running 116 miles from Lake Louise to Jasper and passing through 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 photo].

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

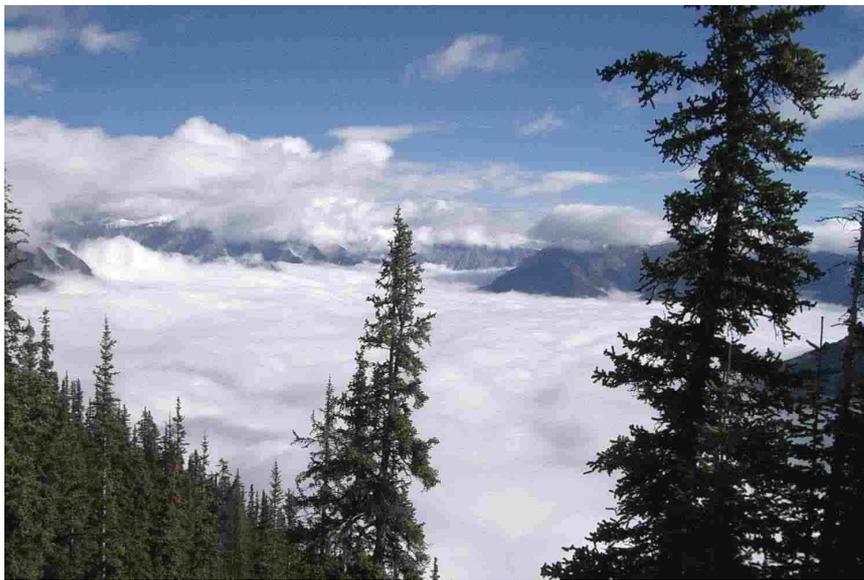
to the glacier, where an area free from crevasses has been roped off for walking on. A more detailed account of the Columbia Icefield will appear in the next newsletter, together with a general explanation about the formation of glaciers and their ongoing activity. Suffice it to say that this icefield 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 Mesozoic 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 19th 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! 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](#)] 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