DINOSAURS AND COAL IN THE RED DEER COUNTRY, ALBERTA, CANADA[1]

IN the spring of 1884 I received instructions from the director of the Geological Survey of Canada to make a geological examination of the country between the Bow and Saskatchewan Rivers in what is now the province of Alberta. The area lay in a general way between north latitudes 51°, 30′ and 54°, and longitudes 110° and 115° west of Greenwich, embracing an area of about 45,000 square miles. This area covers the part of the valley of Red Deer River which has since proved to be the richest collecting ground for Dinosaurian bones in the world, and therefore a short account of their discovery may be of interest.

That western country was just beginning to be opened up. The Canadian Pacific Railway was built from Montreal to the Rocky Mountains, but it had not been connected through British Columbia to the shores of the Pacific. The townsite of Calgary had been decided on, but as yet the town consisted only of a few scattered houses, stores and stables in the vicinity of the railway station. A cable ferry, operated by current, made the crossing of the Bow River possible.

The Canadian government had adopted a regular system of survey for Manitoba and the North West Territory, consisting of meridian lines, run every fourth degree of longitude, between which base lines, nearly parallel to lines of latitude, were to be surveyed about twenty four miles apart. Between these base lines township boundaries were to be surveyed forming blocks six miles square, after which the included townships were to be subdivided into sections each a mile square. The surveys on this system had been begun, some of the base lines, as well as some of the township boundaries had been run, but no comprehensive maps had been prepared, and the maps with which I was furnished were based on a map made in 1813 by David Thompson, the old astronomer, surveyor and fur-trading partner in the North-West Company, with additions by Palliser and Hector in 1857 to 1860. It was therefore necessary for me while making geological investigations to do my own geographical surveys.

On the 12th of May I left Ottawa and on the 24th arrived at Calgary and proceeded to secure an outfit, the main items of which consisted of a wagon and buckboard, four or five horses, a canvas boat, tents, blankets and such like equipment. Rifles and shotguns must not be forgotten, for it was necessary for us to augment our food supply from the wild game of the country. In fact the expeditions of Dr. Dawson, Mr. McConnell and myself were at the time sometimes facetiously referred to in Ottawa as *Geological Cavalry*. My surveying instruments consisted of prismatic compass, odometer, to be attached to the wheel of the buckboard, tape line, watch, aneroid, sextant and artificial horizon.

To drive the team, pitch camp, do the cooking, etc., three men were engaged, two of them being halfbreeds and brothers named Mathew and Joseph Cook, and the other named Fitzpatrick, who had been in the American army in the west. Later in the year Mulligan and Gough were engaged to take the places of the Cooks.

In 1883, I had acted as assistant to Dr. G. M. Dawson on his geological survey of the Rocky Mountains and their eastern foot-hills, between the 49th parallel of latitude and the Bow River, but this was my first experience as the independent head of a geological survey party, and as we crossed the ferry on May 30th and drove out over the apparently limitless grass-covered plains, I could realize something of the feeling of the young mariner who wishes to sail his ship within sight of shore rather than strike out across the boundless ocean. At that time the whole country was a vast solitude, and one would travel for weeks at a time without seeing any white man, or in fact any human being.

After four days driving northward we arrived at the Red Deer River about eight miles, measured in a straight line, above the mouth of Paskapoo or Blind Man River. Red Deer River itself runs through the middle of the area which we were to explore, and consequently I thought it advisable to see it first in order to obtain a general impression of the work that was before me. Here sending two men with

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the horses, buckboard and wagon to meet us at the mouth of Rosebud Creek, 120 miles farther down the stream, Mathew Cook and I took the canvas canoe and started down the river itself, keeping a rapid survey as we went. At the mouth of Blind Man River the brown sandstones of what I afterwards called the Pascapoo formation at the base of the Tertiary are very well exposed, while farther down the stream the white and light gray clayey sandstones, with coal seams, of what I afterwards called the Edmonton formation, at the top of the Cretaceous, compose the banks.

On June 9, after having spent a long and hot summer morning on the river, estimating the thickness of the various beds in the upper part of the Edmonton series, and endeavoring to correlate them one with another in the succession of cliffs as we passed down the stream, and their relation to two coal seams that could be detected now and then, Mathew Cook and I stopped for lunch on the east bank of the river under the shade of some cottonwoods, just south of north latitude 52°, in what is now section 11, township 35, range 21, west of the fourth Meridian. After lunch I walked eastward for three-quarters of a mile across the valley and climbed its eastern side. At an elevation of about 200 feet above the river, scattered among a large number of nodules and irregular masses of brown ironstone which formed conspicuous objects on the hillsides of white sandstone, I found and made a small collection of Dinosaurian bones, being the first of such bones found or collected in the valley of Red Deer River.

Next day we stopped for lunch beside the river where the steep sandstone banks of the valley are 300 feet high. Here Dinosaurian bones were again found to be abundant, and it was here that , five years later, Mr. T. C. Weston, the collector of the Geological Survey of Canada, found the second skull of *Dryptosaurus incrassatus*.

From there downwards similar bones were noticed in a number of places, being especially abundant on the steep hillsides east of the river, a short distance above the mouth of Knee Hills Creek.

On June 12, while passing the site of the present town of Drumheller, where now 1,000,000 tons of coal are annually mined; I landed on the north side of the river and examined and measured the seams outcropping there, and took a sample from the outcrop of the thickest seam. As far as I know that was the first time that these coal seams had been examined. In all probability coal is now the most important product of that district to the people living on the plains, but nevertheless the Red Deer valley is better known throughout the world for its Dinosaurs than for its coal.

After completing our canoe trip on the Red Deer River, we took the horses and drove in a wide circle, first eastward and then northward and northwestward to Edmonton, and then southward back to Calgary to refit and replenish our supplies. One evening, during the course of this journey we rode up to within a hundred yards of a herd of about twenty buffalo, probably one of the last herds of wild buffalo to come north into Canadian territory.

On July 22, we again left Calgary, and this time we first went westward up along the north side of Bow River into the foot-hills of the Rockies, thence we turned northeastward along the edge of the wooded country to the headwaters of Rosebud River, and thence we followed the banks of that river to its mouth in the Red Deer Valley, five miles below the site of the present town of Drumheller. On August 8, one of the last days of this trip, the axle of the wagon broke, and we were obliged to replace it by one hewn out of a green spruce tree. This served our purpose for a while, but we were always faced with the uncertainty of how long it would last, and the certainty that it would not last very long.

On August 11 we turned northward from Rosebud creek on an old Indian or halfbreed trail across the prairie. Following this for twelve miles we descended into the deep gorge-like valley of Knee Hills Creek, which we reached two and a half miles above its mouth, and a short distance below the mouth of Horseshoe Canyon, which joins the valley from the south. It was probably a mile or two below the station or siding of Gatine on the Drumheller branch of the Canadian Pacific Railway. The creek is about twenty-five feet wide and eighteen inches deep. We camped that night on a beautiful green sheltered flat with wood, water and grass in abundance to provide for the needs of ourselves and our horses. At and

near the bottom of the bank were fine large poplar trees, with a few spruce, while Service or Saskatoon berries and cherries were growing in great abundance. The banks of the valley were rocky, delighting the heart of the geologist who was sated with the undulating grassy plains, but it was too late to examine them that night.

The next day, however, I walked up the bank close to camp, and at an elevation of between forty and eighty feet above the creek found a number of Dinosaurian bones in an excellent state of preservation, though very brittle. Most of them were heavy and massive, such as those of the limbs, etc., but among these was a large and fairly perfect head of Laelaps (Dryptosaurus) incrassatus, a gigantic carnivore. We spent the afternoon excavating these bones from the rock, but unfortunately we had no appliances but axes and small geological hammers. We worked with all the care that the tools and the time at our disposal would allow, but in spite of all we could do some of the bones, teeth, etc., were broken. Then after we had managed to get them out of the rock, we had no proper means of packing them, and no boxes but the wagon box to put them in. However, we got together the skull and some of the best of the leg and other bones and then found that we had a heavier load than we were able to carry with us. We were therefore obliged to leave a small pile of bones at the bottom of the bank just north of the creek, on the chance that we might be able to pick them up at a later date, which fortunately we were able to do two months afterwards when returning from another expedition. After completing this work, and packing up our precious collection as well as we could, we started in a cold drizzling rain on our way to Calgary. First we were obliged to climb up to the top of the bank of the valley and it was so steep that with three horses we were not able to haul up much more than the empty wagon, while the fossil bones that we were able to take with us were packed up to the top of the bank on the backs of the horses.

Our journey to Calgary took us a week, for we were obliged to drive slowly and carefully, both on account of having the poor spruce axle in the wagon and because we were anxious not to jar the brittle Dinosaurian bones any more than necessary, though the riding could not be made very easy, since our course for the most of the way was over the rough unbroken prairie, and not on a road or trail. Our regular geological survey of the country passed through was also carried on as usual, for an exploring geologist rarely ever has the opportunity of seeing a particular place or tract of country twice. This survey included an examination of the banks of the valley of Knee Hills Creek from our Dinosaur camp upwards, for they furnish an excellent series of sections of the Edmonton and lower Pascapoo rocks. While making this examination of the valley, and when at a point about five miles above Dinosaur camp, we found one end of a large limb bone, the piece preserved being twenty-six inches long, four and a quarter inches across the middle of the shaft, and eight and one half inches across the end or head.

At Calgary the bones were packed in boxes and shipped to the director of the Geological Survey in Ottawa, whence they were sent to Professor Cope in Philadelphia for examination and description. The skull, along with another similar one obtained by Mr. T. C. Weston in 1889, who was sent out on my suggestion and solicitation by the director of the Geological Survey of Canada, for the especial purpose of collecting Dinosaurian bones in the same vicinity, was described by Professor Cope, and afterwards with illustrations by Mr. L. M. Lambe, but the other bones were probably not sufficiently perfect for identification, and as far as I know have never been described.

After the collection was shipped, I started back with the little party of men and horses to continue the exploration of the district allotted to me.

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EXPLOSIVE ERUPTIONS OF KILAUEA

OWING to the spectacular character of the fire fountains of Kilauea, but little attention seems to have been given to the evidences of explosive eruptions of the genuine Vesuvian type, and this volcano has become known for quiet, well-ordered activity. Some recent field studies of the writer indicate that there are evidences of four explosive eruptions, probably separated by considerable time intervals,