Fossil vertebrate tracks from the Gorman Creek Formation, northeastern B.C.

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The currently known record of pre-Quaternary fossil vertebrate tracks in western Canada consists of track sites from over twenty geologic formations representing a time span that extends from the Upper Jurassic/Lower Cretaceous (Tithonian/Berriasian) to the middle Paleocene. For the most part this ichnological record is, with the exception of intervals of marine deposition, reasonably complete. There are a few substantial gaps in the vertebrate ichnological record of western Canada though. There have been no published reports of footprints from between the middle Paleocene and the Quaternary. There is only a scant track record between the Turonian and Maastrichtian. There is also a notable absence of prints between the Berriasian and the Aptian. There is no known record of tracks from pre-Tithonian sediments of western Canada.

In the late 1970s a large-scale vertebrate track site was discovered from the Gorman Creek Formation (Lower Cretaceous: Valanginian) along the Narraway River in northeastern British Columbia, close to the border of Alberta (Stott, 1998). This site was investigated by Phil Currie in 1981 and a number of slide images were taken, but the track face itself was inaccessible. A large number of small bipedal trackways (probably theropod) and one large theropod trackway were visible from the ground (Sampson and Currie, 1996). The large theropod trackway was especially remarkable as it was one of only two known sites that recorded a large theropod changing direction. A follow-up visit to the Narraway River site by Phil Currie over a decade later revealed that this important track face had been almost completely destroyed by a slope failure. This represented a significant loss to science as it was at the time the only record of Valanginian tracks in western Canada, and one of a very few known worldwide. Given the remote location of the previous track site (helicopter, or very difficult ground access through dense forest), it seemed unlikely that any institution would have the resources to prospect for new sites.

Fortunately, a group of hunters made a discovery of another major track site just to the south of the Narraway River locality in Kakwa Provincial Park (Campbell, 2004; Fraser, 2004). B.C. Parks and its palaeontology advisory committee requested a formal survey of the palaeontological resources at the site. This survey was completed in the summer of 2005 (McCrea and Buckley, 2005). More detailed research was conducted in the summer of 2006 over a three-and-a-half week period (McCrea and Buckley, 2006). Due to the high snow accumulation during the winter of 2006/2007 research plans for summer 2007 were tentative. A brief visit to Kakwa Provincial Park by the authors in early August, 2007 confirmed that there were still large amounts of snow and ice in association with the track site and plans to continue research in 2007 were reluctantly cancelled. The results presented herein are primarily from the research trip of 2006.

The 60° track face required use of ropes and a few days of preparation of the area above the face before research could commence. Three rope stations were set up allowing access to a portion of the track surface. The main track wall has a high diversity and density of footprint types (Figure 1). Footprints of both quadrupedal and bipedal dinosaurs were present on the track wall. Non-dinosaurian prints have yet to be identified from the track wall or talus to date, though not all of the exposed surfaces and multiple track-bearing bedding planes have been fully investigated yet.

Figure 1. Aerial photo of a portion of the track face in Kakwa Provincial Park (for scale the largest tridactyl prints are 55 cm in length).

The most prominent tracks on the wall are prints produced by large quadrupedal dinosaurs. The large pedal prints (average foot lengths of over 60 cm) show the impressions of four digits, while the smaller manual prints (with a distinct crescentic posterior margin) possess five digit impressions. These footprint features and the pattern of the trackways indicate large ankylosaurs were the most likely track makers (Figure 2). There is good evidence of very much smaller ankylosaur tracks and trackways from this locality as well.

A single small quadrupedal trackway was observed on the track wall. The pes prints show at least three digit impressions which at first appear very much like small theropod prints. However, each pes print is paired with a small multi-digit manual print, and manual impressions from theropods of any size are extremely rare (McCrea *et al*., 2002). From observations of similar tracks collected from the talus below the main track wall (Figure 3) it appears that the track makers had four pes digits (three main digits and one reduced) and that the manual prints had five digit impressions. The digit pattern and quadrupedal gait suggest the track maker was likely a small ornithopod. This assignment is

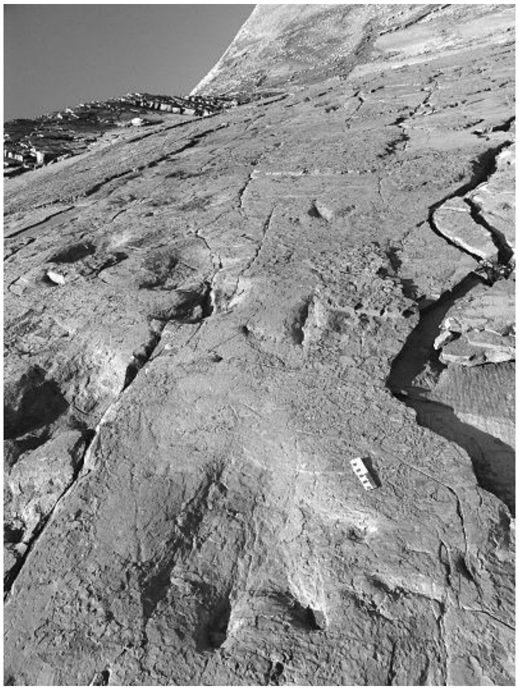

Figure 2. **A large ankylosaur trackway (10 cm scale).**

strengthened by the similarity of these prints to those of previously described small ornithopods such as *Anomoepus* which were initially described from Lower Jurassic sediments of the Connecticut River Valley (Hitchcock, 1848). Similar prints from the Tithonian/Berriasian of southeastern British Columbia, Africa and southeast Asia have been recently described by Lockley *et al.* (in press).

There are numerous types and sizes of tridactyl prints produced by bipedal dinosaurs on the track face, almost all of which may be confidently assigned to theropods. The largest tridactyl prints have an average length of 55 cm and strides nearing 3 m in length (Figure 4). Two to three types of "medium-sized" tridactyl tracks and track ways are also present (Figure 5). We observed small tridactyl tracks (~10 cm length) and track ways from small theropod track-makers (Figure 5).

Many tracks and trackways are quite deeply impressed, while others are very shallow and only noticeable when the sun's light is oblique to the surface (in the morning to early afternoon). There is variation in footprint depth even within the same trackway indicating that some areas of the surface that the dinosaurs were walking upon were not of uniform consistency. Some areas must have been wet and soft allowing footprints to be deeply impressed, while other areas were relatively dry and firm and did not allow footprints to be impressed as deeply.

Detailed examination of the stratigraphic context of the track beds was not possible on these initial trips as the study of the track beds was the priority. However, brief surveys of some of the adjacent exposed beds were made down-slope of the main study area. From preliminary observations of the sediment composition of the main track surfaces and adjacent strata it appears that the track layers in the main study area were associated with a very low energy freshwater body which eventually succeeded the track layer as evidenced by the over-

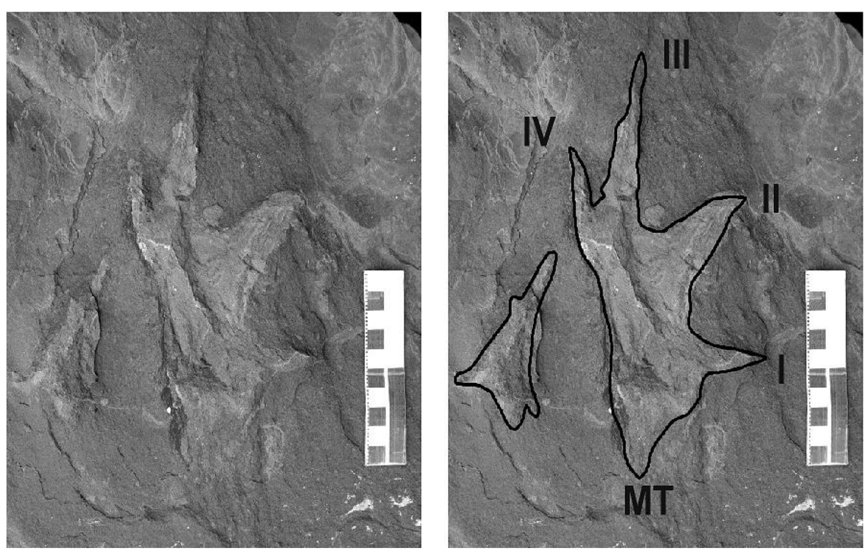

Figure 3. **A manus/pes set of a small ornithopod (10cm scales). Left image of prints as seen in the field. Right image with outline of prints and digits (small manual print on the left and larger pes print on the right).**

lying fine-grained sediments containing small bivalve fossils (Figure 6) similar to those recognized by Haggart (2005) as being part of a new freshwater bivalve fauna. Down slope and stratigraphically below the bivalve layer is a surface with a poorly preserved quadrupedal trackway (probably ankylosaur) as well as several small articulated bivalves with valves open in death position. The fresh water body in turn is overlain by coarser-grained sediments initially displaying thin parallel laminations which lead up to cross-bedding of current-borne sediments topped with fine-grained sediments indicating transition from a shoreline to a lacustrine depositional environment that was overlain by fluvial sediments (Figure 7).

Figure 4. Aerial photograph of a portion of the track surface. The largest tridactyl prints and trackways were produced by large theropods.

The Gorman Creek Formation vertebrate ichnofauna is intermediate in age between the Mist Mountain Formation (Jurassic/Cretaceous: Tithonian/Berriasian) ichnofauna of southeastern British Columbia (the oldest known track-bearing formation in western Canada to date) and the Gething Formation (Aptian) ichnofauna of the Peace Region of British Columbia. The compositions of the Mist Mountain Formation and Gething Formation ichnofaunas are strikingly different from each other (McCrea and Buckley, 2007). The Gorman Creek (Lower Cretaceous: Valanginian) ichnofauna has elements that are common to both the older Mist Mountain Formation and the younger Gething Formation and is an important transitional record of vertebrate ichnology of western Canada. For example, the Mist Mountain Formation exposures have small quadrupedal ornithopod tracks and trackways similar to those found in the Gorman Creek Formation, though these are absent in the Gething Formation which has only large ornithopod tracks and trackways (Sternberg, 1932). The Gething Formation was previously the oldest record of ankylosaur tracks and trackways in western Canada (Sternberg, 1932). Ankylosaur tracks are also an important component of the Gorman Creek Formation, though no ankylosaur tracks have yet been recognized from the Mist Mountain Formation. Certain large theropod tracks (*Irenesauripus acutus*) were first described from the Gething Formation (Sternberg, 1932) and similar (though much smaller) tracks were found in the Mist Mountain Formation. It was not surprising that cf. *I. acutus* tracks are also a component of the Gorman Creek Formation. Other differences and similarities exist between the ichnofaunas of these and other western Canadian formations, and these will be documented and detailed in peer-review publications in the future along with comparisons to contemporaneous vertebrate ichnofaunas on a global scale.

Figure 5. A mix of medium and small tridactyl (theropod) prints on the track wall.

Future Research Activities

The known palaeontological sites within the immediate study area of the park will require a multi-

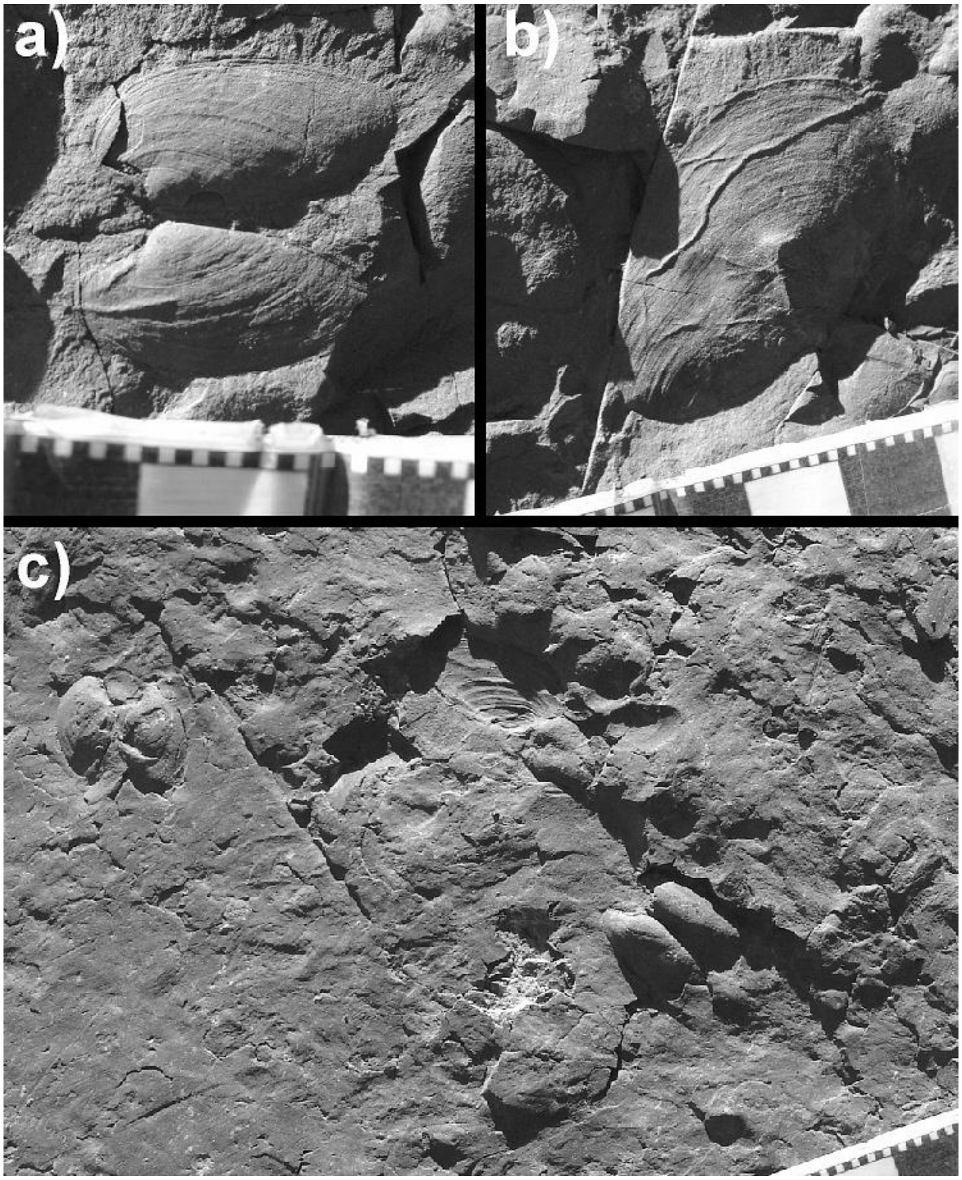

Figure 6. **A number of small bivalves found on the wall (10 cm scale with mm increments).**

disciplinary research presence over several years focusing on vertebrate ichnology, palaeobotany, stratigraphy/sedimentology and invertebrate palaeontology. The potential for palaeontological research on the Gorman Creek Formation is very promising due to the amount of exposure within and outside park boundaries. The next research phase planned for summer 2008 is a continuation of the documentation of the vertebrate ichnofauna on the main track surface by conventional means and by photogrammetry techniques which will create a permanent research-grade image database of the track surfaces. The database will also be of great assistance for monitoring changes which take place on the site from erosion and other factors.

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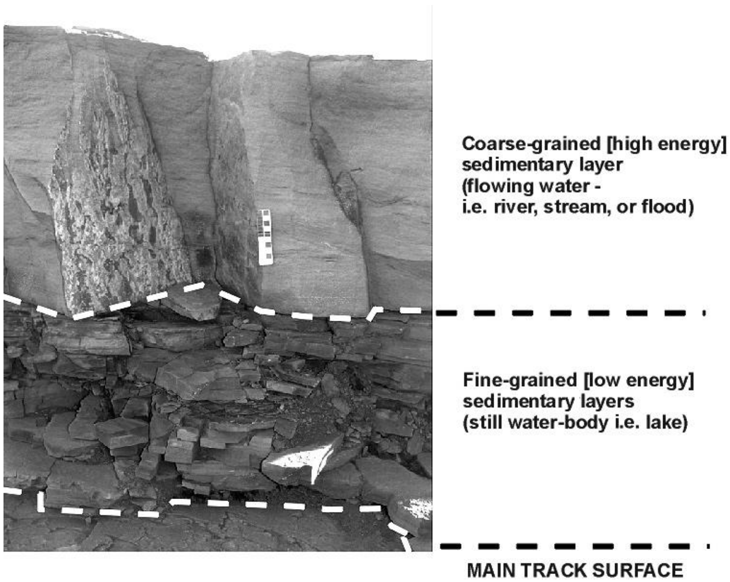

Figure 7. A portion of the beds overlying the track surface (10 cm scale). Note that 60° dipping beds have been horizontally oriented for the purposes of illustration.

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