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OFFICERS

President
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Vice-President
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DIRECTORS

Editor
Howard Allen — **editor2@albertapaleo.org** — (403) 274-1858

Membership
Howard Allen — **membership@albertapaleo.org** — (403) 274-1858

Programs
Harold Whittaker — **programs1@albertapaleo.org** — (403) 286-0349

Field Trips
Keith Mychaluk — **fieldtrips@albertapaleo.org** — (403) 809-3211

COMMITTEES

Fossil Collection
Howard Allen — **editor2@albertapaleo.org** — (403) 274-1858

Library
Georgia Hoffman — (403) 228-7729

Public Outreach
Cory Gross — **president1@albertapaleo.org** — (403) 617-2079

Social
Virginia Goodman — (403) 252-3122

Symposium
Mona Trick — **giftshop@albertapaleo.org** — (587) 578-4579

Website
Vaclav Marsovsky — (403) 547-0182

THE SOCIETY WAS INCORPORATED IN 1986
as a non-profit organization formed to:

1. Promote the science of palaeontology through study and education.
2. Contribute to the science by: discovery; responsible collection; curation and display; education of the general public; preservation of palaeontological material for study and future generations.
3. Work with the professional and academic communities to aid in the preservation and understanding of Alberta's heritage.

MEMBERSHIP: Any person with a sincere interest in palaeontology is eligible to present their application for membership in the Society. Please enclose membership dues with your request for application.

Single membership	**$20.00 annually**
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SOCIETY MAILING ADDRESS:
Alberta Palaeontological Society
PO Box 68024, Crowfoot PO
Calgary, AB, Canada T3G 3N8
www.albertapaleo.org

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Howard Allen, Editor, APS
7828 Hunterslea Crescent, NW
Calgary, AB, Canada T2K 4M2
editor2@albertapaleo.org

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Upcoming APS Meetings

Held in webinar format until further notice.

No meetings in June, July and August. See Field Trips, Page 24.

Friday, September 17, 2021—Tako Koning, Geological Consultant.
Observations on the K/P (formerly K/T) mass extinction event in outcrops in Angola, Cuba, North Dakota, Saskatchewan and Alberta.

COVID-19 has affected our operations.
Watch the APS website for updates!

www.albertapaleo.org/meetings.html

ON THE COVER: Alberta fossils! Abundant horn corals, probably *Faberophyllum* sp., in limestone of the Lower Carboniferous Opal Member, Mount Head Formation, Opal Range, Alberta. Photo by Howard Allen.

Petrified Forest National Park, Arizona

More than just wood!

Article and photos by Pete Truch

Among the millions of people who have visited this incredible site over the years since its inception in 1962, our reason for passing this way in 2017 was the fact that Historic Route 66, which we were driving, passed right through it. We would have diverted to visit, even if Route 66 wasn't a part of it, just as we had done, for example, in Amarillo, Texas to visit Palo Duro Canyon State Park, or White Sands Missile Range and White Sands National Monument south of Albuquerque, New Mexico. Much like watching wood petrify, we are slow to complete things, due in no small part to these diversions. It took us a total of two months to drive the whole 3,644.8 km (2,278 miles) from Chicago to Santa Monica Pier (the current official end/start points—for a map of the route, see **https://www.britannica.com/topic/Route-66**). This was the second leg of our journey down the "Mother Road," a phrase coined by John Steinbeck in his 1939 epic novel *The Grapes of Wrath*.

The first leg of the journey—Chicago to Tulsa—began at the corners of Adams Street and Michigan Avenue (Begin Route 66 sign) and Jackson Street and Michigan Ave (End Route 66 sign), which is a modern quirk that developed after Cyrus Avery set the first Route 66 alignment in 1926. The modern quirk is simply a result of incorporating one-way streets, which did not exist in 1926. At the time, the overall length of road was 2,448 miles (3,916.8 km), stretching from Chicago to downtown Los Angeles.

For the first leg we had to stop at Tulsa (Avery's hometown) and had used that focal point in the journey back to our Calgary home to visit Ashfall Fossil Beds State Historic Park in Nebraska and completed our tour of palaeo sites by visiting the Canadian Fossil Discovery Centre in Morden, Manitoba. This unique museum is housed in the same building as the hockey arena and was described in APS President **Cory Gross**' 10 minute presentation, *Sea Monsters on the Prairies—A Visit to the Canadian Fossil Discovery Centre* on February 9, 2018. The essence and beauty of Ashfall was shown in a 10-minute presentation I gave to the Society in "the good old days" when we had live pre-

Figure 1. At top of page, a polished cross-section of of a former tree that, from its roundness, appears to have been fully petrified before it was deeply buried. Note the white and black colours.

Figure 2. Park sign with sample petrified log section. Doreen Truch for scale.

obligatory sign photos (Figure 2). Touring the facility, we saw many examples of the natural beauty displayed in the form of petrified wood and gained an insight to the incredible landscapes of the Painted Desert, together with previews of what we would see as we drove the 45 km (28 miles) of Park roadway and hiked the many trails. We also confirmed that Park hours are strictly enforced—closing time being 5:00 P.M. Apparently part of the Rangers' duties involves riding herd on tourists: late in the day we heard from a Ranger on patrol that it was a half-hour to closing time!

The Park is divided into two portions, North and South, by I-90 (= Route 66). There is also a strip of privately held land on the west side of the Park. The northern half contains the bulk of the Painted Desert, but also has some petrified logs visible from some of the viewpoints. The biggest concentrations of petrified wood can be found in the southern portion, especially at Crystal Forest, but it too has many Painted Desert landscapes exposed.

sentations, on October 19, 2018. Not that I am noted for making a short story long, but I think it took 20 minutes.

When Cyrus set up Route 66 he had no idea that just two years later (1928) it would be the site of an 84 day marathon run; 10 years later it would all be paved and in 1960 to 1964, for those of us old enough to remember, would become the icon it is through the television series of the same name starring Martin Milner, George Maharis and, of course, a Corvette. However, I don't recall an episode involving the Petrified Forest National Park (it became a park halfway through the life of the television series); nor the mere 21 km of the roadway in Kansas, the shortest length of the eight states it passes through.

Back to the Petrified Forest, which we visited after rejoining Route 66 in Tulsa. A detailed map of the Park can be found at the Park website: **https://www.nps.gov/pefo/planyourvisit/maps.htm**. Since we were travelling east to west, we entered the Park at the Painted Desert Visitor Center after first stopping for

North portion

Our first view is from Tiponi Point (Figure 3). As explained on a display board, what we are viewing in the Park is a mere snippet of the Painted Desert, which actually "covers 7,500 square miles (19,425

Figure 3. Tiponi Point view of the sandstones and mudstones of the Chinle Formation.

Figure 4. View from the Chinde Viewpoint of red weathering, sedimentary Chinle Formation capped by the grey, basaltic Bidahochi Formation, igneous rock erupted from a nearby volcanic vent.

km^2) across northeastern Arizona.”

As seen in Figure 3, the Chinle Formation consists of sandstone and mudstone laid down “by a vast river in a forest ecosystem” in the Late Triassic Period (227 to 205 million years ago) and subsequently buried, uplifted and eventually eroded to what we are viewing today. Like all badlands, a good portion of the beauty in the formations is found in the colours. As explained in simplicity on the display board, “All of the colours you see are caused by the iron in the sediments. During deposition, drier climates allow the minerals to be exposed to oxygen, rusting the iron and creating red, brown, and orange colours. Wetter climates can ‘drown’ the sediments, allowing little or no contact with oxygen, causing the layers to be blue, gray, and purple.”

As with most geology, there are complications. Figure 4, taken from Chinde Point, further down the road, clearly displays a cap rock. The dark grey cap turns out to be volcanic basalt lining the rim of the viewpoint. The basalt was erupted from a nearby volcano vent which spewed its molten lava between 16 and 5 million years ago. The resultant formation, called the Bidahochi, lies atop the much older Chinle (Late Triassic), so there is a big age gap between the formations. The contact between two formations of different ages is termed an unconformity and represents missing (eroded) formations, in this case an estimated 305 m (1,000 feet) of missing rock! However, this gap is small in comparison to the Great Unconformity found in the Grand Canyon and other localities.

Anything volcanic reminds me of **Philip Benham**’s wonderful presentations over the years on active volcanoes he has visited. I’m also reminded of our own very fortunate helicopter flight we took over an active piece of Kilauea, Hawaii, earlier in 2017, and ground visits in 2018. To that end refer to two separate submissions I have prepared called “Fire on Kilauea—Aerial View” and “Fire on Kilauea—Hawaii

Figure 5. Pueblo Revival style of the restored Painted Desert Inn, a registered National Historic Landmark.

Figure 6. Complex Hopi mural by Fred Kabotie, painted on an interior wall of the Painted Desert Inn. A faint crack visible in the upper left corner is evidence of the Inn’s structural problems.

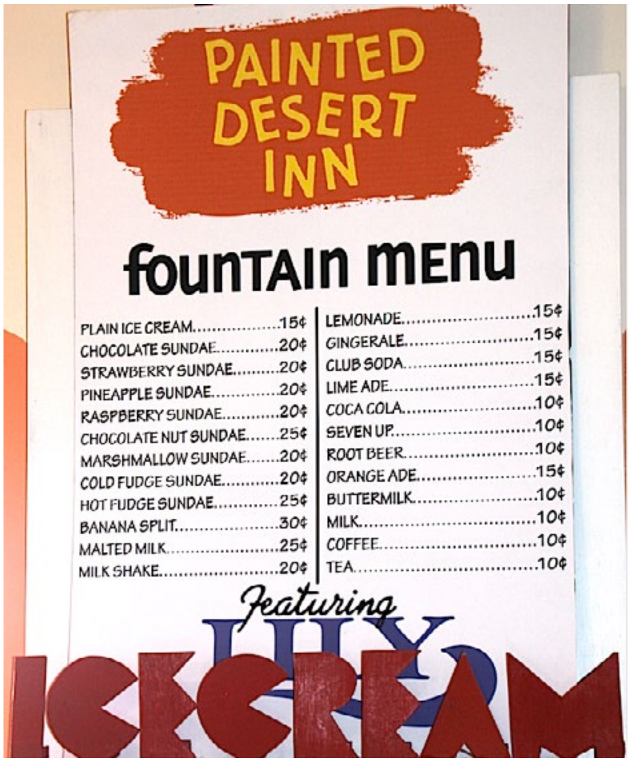

Figure 7. Nostalgic prices for those of us old enough to remember. I don't know if I ever saw Coke below 15¢ in Canada, but I do remember coffee and tea at 10¢—ouch!

Volcanoes National Park." See link on Page 14.

In traversing the Park from east to west the next item of interest is neither geological nor palaeontological, but historic—the Painted Desert Inn (Figure 5), declared a National Historic Landmark in 1987 after first appearing on the National Register list in 1976 to avoid a proposed demolition.

The Inn's owner and builder, Herbert David Lore, officially registered the building in 1924. His land and building were outside the 1906 boundaries of the then National Monument. Herbert had incorporated petrified wood and native stones in the construction of his home and tourist resort. He built it with a foundation resting, in part, on a seam of bentonite clay. As anyone who has walked in the badlands knows, wet bentonite acts liked greased lightning, making it almost impossible to walk with any kind of dignity. For foundations, the wet clay swells and then shrinks as it dries, resulting in structural cracks in walls, etc. Despite the structural problems, the Inn hosted Route 66 travellers with food, lodging and escorted Black Forest-Painted Desert tours.

Herbert was able to unload the building and four sections of land to the Monument in 1936. As "make-work projects" during the Depression, the building was redesigned in the Pueblo Revival style featuring stuccoed masonry, thick walls, earth tones, flat roofs, and projecting roof beams called *vigas*, all apparent in Figure 5. In 1947 an interior designer, Mary Elizabeth Jane Colter, of the La Posada Hotel in Winslow Arizona fame, and one of the "Harvey girls," gave the Inn its colour schemes and big windows for sweeping views of the desert landscape. In the same time frame, she hired a Hopi artist, Fred Kabotie, to paint murals reflecting Hopi culture (Figure 6) and the soda fountain bar (Figure 7) was redone. Today the Inn is restored to its 1949 appearance.

Meanwhile, in the desert, the beauty unfolds once again at Kachina Point, with the Bidahochi Formation basalt prominent in the foreground. We spot our first petrified log, likely *in situ*, on the lower slopes of the Chinle Formation (Figure 8). The surrounding soil colours suggest this petrifaction may have taken place in a wet environment. As to species:

"Much of the park's petrified wood is from *Araucarioxylon arizonicum*, an extinct conifer tree, while some found in the northern part of the park is from *Woodworthia arizonica* and *Schilderia adamanica* trees. At least nine species of fossil trees from the park have been identified; all are extinct." (Wikipedia, 2021a).

Figure 8. Our first glimpse of a petrified log *in situ*, species unknown.

The identification of the dominant species as *Araucarioxylon arizonicum* dates back to initial work by Knowlton in 1889 and further work by Scott in 1961. In a recent presentation by **Vaclav Marsovsky** on Oct 16, 2020 titled *Araucariaceae: A family of conifers from southern continents* (*Bulletin*, September 2020, p. 3), his research indicated this might not be the case. In fact (Savidge, 2007): ". . . following descriptions of *Arboramosa semicircum-*

trachea Savidge & Ash, 2006, *Protocupressinoxylon arizonicum* Savidge, 2006, and *Ginkgoxylpropinquus hewardii* Savidge, 2006, this study further increases the region's number of woody plant morphotaxa and indicates that a diversity of large conifer species were co-evolving with cycads and ginkgo-like trees during Late Triassic. . . A fourth morphotaxon, *Protopiceoxylon novum* (Savidge, 2006) is mentioned later in the study. . . Several other taxa are also discussed."

Thanks are due to Vaclav for providing access to that technical source. Volcanoes played a major role in the petrifaction process. As per the simple description in Wikipedia (2021a):

"During the Late Triassic, downed trees accumulating in river channels in what became the park were buried periodically by sediment containing volcanic ash. Groundwater dissolved silica (silicon dioxide) from the ash and carried it into the logs, where it formed quartz crystals that gradually replaced the organic matter. Traces of iron oxide and other substances combined with the silica to create varied colours in the petrified wood."

Further, from Savidge (2007, p. 302): "The distribution of those petrified logs among the generally horizontal strata of the Late Triassic Chinle Formation is non-uniform, rather concentrated to its lowermost Shinarump Member (conspicuous in southeastern Utah) and in the overlying Sonsela Member (exposed in the southern half of PEFO [= *Petrified Forest National Park; the Sonsela Member is approximately 223 to 213 million years old*] within the southern half of the Colorado Plateau."

For most, if not all of our APS membership, who hasn't found a nice example of petrified wood? Even I have found some decent examples in local areas such as Sage Creek and Blindman River. However, sometimes the best are simply finds by someone else willing to sell their treasures. Look in any shops, especially for great deals if you are travelling in Arizona, because the sheer amount available drives down the price. Figure 9 is one such example of a large piece of petrified wood that I purchased (for a very cheap price—I hope it isn't "hot" but the owner assured me it was legal) at Jack Rabbit's Trading Post further down Route 66. I love the sample as it is unpolished and has most of the colours associated with the petrifaction process. Bear in mind that those groundwaters involved in the petrifaction process themselves fluctuate, exposing all sediments to wetter and dryer conditions through time virtually *in situ*. To elaborate from a fact sheet obtained at the Park (with reference to Figures 1, 9 and 23) [*Editor's note: some of the "facts" are oversimplified and inaccurate, so should be taken with a grain of salt, like all tourist literature*]:

"Red and pink—Iron, dissolved in groundwater, moved through the tree and came in contact with oxygen. Precipitating, it became hematite (Fe_2O_3), which was incorporated into the wood cell walls."

"Yellow, brown and orange—These colours are produced by the presence of goethite. The chemical composition of goethite is $HFeO_2$ and Fe_2O_3. Goethite is a hydrated iron oxide that is derived by weathering from iron bearing minerals. It crystallizes into tablets, scales and needles, radial and concentric aggregates."

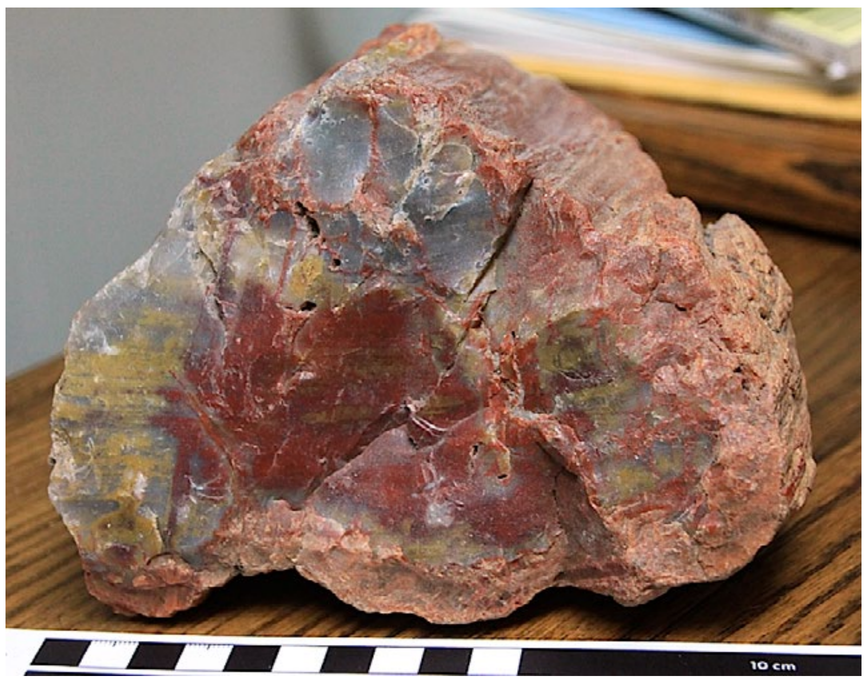

Figure 9. Large sample of petrified wood obtained at the Jack Rabbit Trading Post for the grand sum of CDN$19.20.

"Green—This colour is produced by pure native iron, rare in terrestrial rocks (because it so readily combines with oxygen), but common in meteorites. "Native iron combines with chlorophyll to give tree leaves and plants their green colour."

"Purple and blue—Produced by manganese dioxide, MnO_2. This is a secondary material formed when

Figure 10. Panoramic overview from Chinde Point. The Pinnacles are to the left of centre and just discernable as two tiny black objects on the green background.

'fire mineral,' an allusion to the fact that it gives off sparks when struck."

At Chinde Point, the vast panorama of what has been dubbed the "Black Forest" reveals its beauty (Figure 10). From the Bidahochi basalt in the foreground to Chinde Mesa on the horizon (80 km distant), many landscape features reveal themselves, especially with a telephoto lens. Two small, dark features called The Pinnacles are 2.6 km distant. The telephoto shot (Figure 11) shows what appear to be heavily eroded basaltic remnants of volcanic activity. Nearby a dry river with its mix of basalt and sandstone for its bed, is etched across the landscape. Such dry rivers actively run with snowmelt and occasional flash floods during the rainy season of July to September.

water leaches manganese from igneous rock and redeposits it as a concentration of manganese dioxide."

"White [refer to Figure 1]—Produced by pure silica (SiO_2). Both silica and oxygen are two of the most common elements in the Earth's crust so petrified wood is also referred to as silicified wood, each cell having being replaced by silica."

"Black [refer to Figure 1]—Produced by either organic carbon or pyrite (FeS_2). This mineral formed in the petrified wood when hydrogen sulfide from decaying organic matter interacted with iron, which in turn formed pyrite inside the wood. Pyrite means

Figure 11. The Pinnacles viewed from Chinde Point.

Figure 12. A crow enjoys the scenery.

The first evidence of any wildlife in the Park we encountered is seen in Figure 12, a common crow. Or, he might be a raven, as they are also common in the area. At least he has something to crow about as he gazes at these beautiful views of the Chinle Formation, the bright reds suggestive of drier depositional conditions.

The junction point of old Route 66 and the modern Interstate 90 within the Park roughly demarcates the border between the North and South portions of the Park. In a tribute to the historic roadway, which brought so many visitors to the original Monument, the Park placed an old car body, which was unidentified at first (Figure 13); a concrete border with

Figure 13. A 1932 Studebaker (likely a Dictator Coupe) body rusting in place as a tribute to Route 66.

Route 66 stamped on it; a Cadillac car front-end bumper and a display plaque. Obviously, the budget was limited. When I first saw the car body I didn't recognize it, so applying palaeontology practices, I tried to determine "genus" and "species" of the old "fossil." From what I can make out it is likely a 1932 Studebaker (genus verified first in a digital search and later confirmed in a Park brochure), with the species being likely the Dictator Coupe (based on several physical characteristics I defined such as body shape, front fenders, grille, etc.).

South portion

After driving through a couple of kilometres of grassland and scrub brushes, one encounters some more modern structures of recent historic significance, but more striking is a feature dubbed with the modern cultural name of Newspaper Rock (Figure 14). A unique concentration of more than 650 petroglyph images includes zoomorphs (animal depictions), anthropomorphs (human-like figures), hand or footprints, geometrics and spirals (life symbols).

Such figures, often carved after vision quests, were created by Puebloan people living as close as 1 km away, "farming and hunting along the Puerco River between 650 and 2,000 years ago." Carving simply means chipping away the natural black patina to reveal lighter sandstone beneath.

From a Park display board: "This patina consists primarily of iron and manganese oxides with clay particles and organic material. The exact meaning behind each petroglyph is unknown, but collaboration with contemporary American Indians provides insight into the significance of these glyphs. Modern groups interpret petroglyph themes to include family or clan symbols, territorial boundaries, important events, and spiritual meanings. The movements of the sun, moon and stars are also charted in a special group of glyphs used to manage ceremonial and agricultural calendars."

In order to try and prevent damage to the glyphs, Newspaper Rock is not identified; there are no trails to it and signs abound warning of no access. **Dr. Emily Bamforth** suggested similar solutions to vandalism problems in her presentation, *Where the wild things are: Palaeontology and partnership in Grasslands National Park, Saskatchewan* on November 20, 2020. I finally spot the Rock, and with my telephoto lens, capture some of the symbolism. It is thus a bit protected by non-accessibility except by telephoto shots only. Figure 14 shows some damage with a missing piece in the lower right and some modern alphabet characters on the left side of the image. The Rock is not the only piece of sandstone that has been incised with images. All of those I discovered with my telephoto lens, with obviously no damage to the items. Of course, the Puebloan peoples also made use of the abundant petrified wood by flintknapping appropriate pieces into useful

Figure 14. Petroglyphs on Newspaper Rock. Note the damage on the far right. It appears that it was an attempt to chisel out the rock and poach a slab of glyphs. On the mid left it appears that some modern alphabet characters have been scratched over older glyphs.

Figure 15: Petrified log split off exposing a detailed face.

tools ranging from hide scrapers to arrowheads.

More fossil wood appears for our visual pleasure (Figure 15). This photo illustrates what we see a lot of—a full tree *in situ* and eroded such that large segments break off and tumble down the slopes. Note the ellipsoidal shape of the petrified log. This shape, as opposed to the circular shape of the specimen in Figure 1, suggests that parts of the log's interior rotted away before petrifaction could take place.

A few kilometres beyond Newspaper Rock, we encounter The Tepees (Figure 16). Visible is the second oldest member of the Chinle Formation, namely the Blue Mesa Member, at 225.2 – 223 Mya. Only the Mesa Redondo Member, at 227 – 225.2 Mya is older. Wetter conditions prevailed through the lower levels and drier conditions took over later. Near the Tepees is also found the first reference to pioneering palaeontologists working in the Monument. A Park display board reads:

"In the summer of 1921, heiress and explorer Annie Montague Alexander and her research partner Louise Kellogg set off into the badlands in front of you. Intrigued by fossils discovered by John Muir fifteen years earlier, Annie and Louise unearthed numerous specimens including phytosaurs and metoposaurs. The work of these women pioneered the science of vertebrate palaeontology in Petrified Forest National Park. They were assisted by Dr. Charles Camp from the University of California's Museum of Palaeontology that was funded by Alexander in 1921. Camp went on to work in the area for nearly a decade."

"Since that time, research teams from organizations such as the American Museum of Natural History and the Smithsonian Institution have worked in the Blue Forest collecting fossil vertebrates. Annie Alexander's legacy lives on through the work of scientists who continue to make discoveries here about life in the Triassic."

More on the fossils discovered (Wikipedia, 2021b):

> Phytosaurs . . . are an extinct group of large, mostly semi-aquatic Late Triassic archosauriform reptiles . . . Phytosaurs were long-snouted and heavily armoured, bearing a remarkable resemblance to modern crocodilians in size, appearance, and lifestyle, as an example of convergence or parallel evolution. The name "phytosaur" means "plant reptile," as the first fossils of phytosaurs were mistakenly thought to belong to plant eaters. The name is misleading because the sharp teeth in phytosaur jaws clearly show that they were predators.

Figure 16. "Tepees" displaying colour bands that result from deposition under wetter or drier conditions, together with a light volcanic ash layer especially useful for radioactive dating.

> Phytosaurs had a nearly global distribution during the Triassic. Fossils have been recovered from Europe, North America, India, Morocco, Thailand, Brazil, Greenland and Madagascar."

> "*Metoposaurus* meaning 'front lizard' is an extinct genus of . . . amphibian, known from the Late Triassic of Germany, Italy, Poland, and Portugal. This mostly aquatic animal possessed small, weak limbs, sharp teeth, and a large, flat head. This

Figure 17. Large fossilized tree *in situ*. As modern erosional forces take place and underlying support disappears, large sections break off.

highly flattened creature mainly fed on fish, which it captured with its wide jaws lined with needle-like teeth. *Metoposaurus* was up to 3 m (10 feet) long and weighed about 450 kg (1,000 pounds). Many *Metoposaurus* mass graves have been found, probably from creatures that grouped together in drying pools during drought."

More of the Blue Mesa Member stratigraphy, as found near the Tepees, is seen in Figure 19. The Jasper Forest is found near the Blue Mesa area. Figure 18 shows a typical scene of the many fossilized trees eroded out of the formation.

We encountered only our second example of wildlife for the day (slim pickings), namely a pronghorn antelope, *Antilocapra americana*. Actually there were two, but only one that bothered standing up for a photo shoot (Figure 20). One log subject to direct human interference is found in the form of Agate Bridge, a 33 m (110 foot) log that has a concrete bridge built in 1917 to support it; otherwise it would have suffered the fate of all other logs found throughout the park and been relegated into a jumble of pieces.

Nearby is Crystal Forest (Figure 21), the largest concentration of wood in the Park. The original Triassic forest must have been a sight indeed. As per a Park display board:

". . . At that time this area resided on the supercontinent Pangea at approximately 10° north of the equator—the same latitude as present day Costa Rica. As Pangea broke apart, the North American continent drifted northward. Some 218 million years later, the Crystal Forest is at 35° latitude. The Colorado Plateau uplifted slowly over millions of years, raising the parkland about a mile above sea level. This is why the park is so arid today."

During the life of the forest, dead trees accumulated in the delta of a large floodplain, often criss-

Figure 18. Collection of eroded and broken tree segments tumbled down a slope.

Figure 19. Topography in the Blue Mesa area is similar to Drumheller Alberta scenics, but with different colours. The purples and greys are the result of deposition in a reducing environment. Logs and chunks of petrified wood are strewn across the landscape.

Figure 20. Pronghorn antelope.

Figure 21. The Crystal Forest covers a vast area, with petrified wood scattered across the landscape.

crossing each other as they were buried in river sediments. "Through time silica-enriched groundwater percolated through the logs, replacing the organic molecules in the wood, and creating a replica in quartz." Modern erosion has exposed those logs, which appear to have been cut. "Because it is the shortest distance for the crack to grow, the logs break perpendicular to their length, like a piece of brittle chalk. The repeating perpendicular breaks make the logs look like they were sawed or cut."

Figure 22. Full view of Old Faithful with Doreen Truch looking to see which way the wind that "took down the tree" is blowing.

As for species in both Jasper and Crystal Forests, Savidge (2007, pg. 324) states:

"The evidence supports the conclusion that Late Triassic petrified logs in the region of Petrified Forest National Park represent a broad diversity of species, many of which probably remain to be discovered [Savidge lists fourteen of them in his Appendix] . . . The naming of each 'species' or morphotaxon can never be regarded as an absolute or final determi-

Figure 23. Superb example of petrified wood with a US $1,100 price tag to match.

nation, because taxonomy is merely imposition of informed scientific opinion upon the diversity existing in the biological world, the aims being to achieve ordered, objective and mutually agreeable ways of analysis and communication."

The "final" major stop within the Park boundary, at least in the direction we were travelling, is the Giant Logs (Figure 22). This group contains the largest petrified trees in the Park, including "Old Faithful," relatively famous for people who posed with it. On March 1, 1931 Dr. and Mrs. Albert Einstein graced the foreground, with the 35 foot (10.6 m) tree in the background. The photo is revered and proudly displayed in the Rainbow Forest Museum and featured in a brochure. **Doreen Truch** poses in Figure 22 in a more modern version of the photo, taken in 2017. In 1961, perhaps as a gesture to a famous energy equation derived by Einstein, the tree attracted a huge bolt of lightning which shattered the base. I won-

Figure 24. Doreen is dwarfed by this giant specimen at Geronimo's further down Route 66.

der if any fulgurites or "petrified lightning" were created. These fused cylindrical shapes are often hollow and consist of sand exposed to super high temperatures. The first and only sample I ever saw and handled was one found at the Wally's Beach site near Cardston, Alberta and identified by **Dr. Len Hills** back in the late 1990s.

The Park decided to repair the lightning damage by mortaring the shattered fragments of silica back into place and, like Agate Bridge, provided some concrete support, visible on the left side of Figure 22. As stated in a brochure: "Attitudes about resource management in our national parks have changed over the years: a log would not be glued back together today."

We just had time to complete the Giant Logs Trail before the Park closed—this is strictly enforced—and the Rangers herded us out. It felt just like the old last call at the bar: "It's time, gentlemen, please"; enough time to finish the one you were downing, but leaving you thirsting for more.

But this is Arizona, so petrified wood put to use does not stop at the Park boundary, starting with the "Welcome to Holbrook" sign (Figure 25). Within Holbrook, I find a large piece on display on the grounds of the historic Wigwam Motel, and many beautiful pieces at Jim Gray's Petrified Wood Company, including the obligatory memento jewellery (Figures 23 and 26). Further down Route 66 we find huge examples of logs (Figure 24), pottery and

Figure 25. "Welcome to Holbrook," a typical Arizona sign utilizing local materials—in this case petrified wood.

Figure 26. Another pendant: prized travel reminder of the Petrified Forest visit.

a human attempt at a unique flowerpot at Geronimo Trading Company.

If Petrified Forest National Park is on your bucket list, be sure to allow at least one full day in order to appreciate all the diversity it has to offer (two days if you want to hike all the trails), and do spend some time shopping around.

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Relocation of a lost 1913–1914 AMNH ankylosaur quarry

in Dinosaur Provincial Park, Alberta, Canada and retrieval of new bones therein

By Darren H. Tanke*

It is a well-established fact that the early collectors of Late Cretaceous dinosaurs in Alberta, Canada, kept poor fossil site locality data for many important specimens[1] (but see Sternberg, 1936, 1950 and Currie and Koppelhus, 2005) and did not photograph all sites, making relocation of these now heavily eroded old quarries, for subsequent multidisciplinary studies, difficult (*e.g.* Maganuco, 2004; Ryan and Evans, 2005; Eberth *et al.*, 2013; Cullen and Evans, 2016; Bertozzo *et al.*, 2017; Lowi-Merri and Evans, 2019).

Work by the author in the Drumheller Valley, first assisting the late Loris S. Russell in the 1980s (Russell, 1986) and others subsequently, especially Maurice Stefanuk (Tanke, 2018a) assisting the author there; and then the author mostly working alone in Dinosaur Provincial Park (DPP), has solved about eighty lost quarries or identified "mystery quarries" in both field areas from 1997 to present (Tanke, 2001, 2004, 2005a-b, 2006, 2010, 2013, 2018b, 2019a; Tanke and Evans, 2014, Tanke and Ralrick, 2009, 2010; and Tanke and Russell, 2012). Because of this, the author's research has shown some established palaeo-history lore to be untrue or needing minor correction; some facts, while true, have been updated with new information; and some entirely new (to us) facts have emerged. This bad record keeping has, to a degree, also necessitated a small rewriting the history of palaeontological field activities in the province.

Further complicating the issue is the growing awareness of the incomplete collecting or sampling of major dinosaur skeletons and bonebeds. Some skeletons were "head-hunted" (Tanke and Russell, 2012; Bramble *et al.*, 2016; Tanke, pers. field observation), had whole limbs removed (*e.g.* Kaisen, 1910; August 9 – 10), or skeletons exposed at the surface could potentially also have had single or several bones selectively removed to replace "missing parts" of more complete skeletons going on display. Scattered bones in monospecific bonebeds can also yield elements to fill in missing parts of more complete skeletons.

Subsequent erosion can eliminate all evidence of this prior small-scale digging and give a future false impression of true specimen completeness (for skeletons) if rediscovered by future workers. Bones sampled from a bonebed would become more useful for research if the same bonebed is being studied by someone later on. Some of Sternberg's "headless wonder" hadrosaur skeleton finds, attributed to taphonomic processes (Sternberg, 1970) or headless skeletons found today could plausibly have been head-hunted by earlier expeditions.

Significantly, disarticulation of skeletons prior to final burial play a role in the unintended incomplete collection of major specimens. Individual bones or portions of rotting carcasses were scattered about by scavengers and/or water currents and drifted a short distance (or further) away from the main bone concentration. These elements, fully hidden under the rock, escaped the eyes of early collectors. One hundred or more years of rain, wind, and snowmelt erosion later, the relatively soft and poorly-cemented sandstone and silt/clay-dominated outcrops have receded up to 1 m, exposing the forgotten bones to

* Senior Technician II, Royal Tyrrell Museum of Palaeontology, Drumheller, AB.

Acronyms used in the text.

AMNH: American Museum of Natural History, New York, USA. FARB: Fossil Amphibians, Reptiles, Birds.
DPP: Dinosaur Provincial Park, Alberta.
ROM: Royal Ontario Museum, Toronto.
TMP: Royal Tyrrell Museum of Palaeontology, Drumheller.
UALVP: University of Alberta Laboratory of Vertebrate Palaeontology, Edmonton.

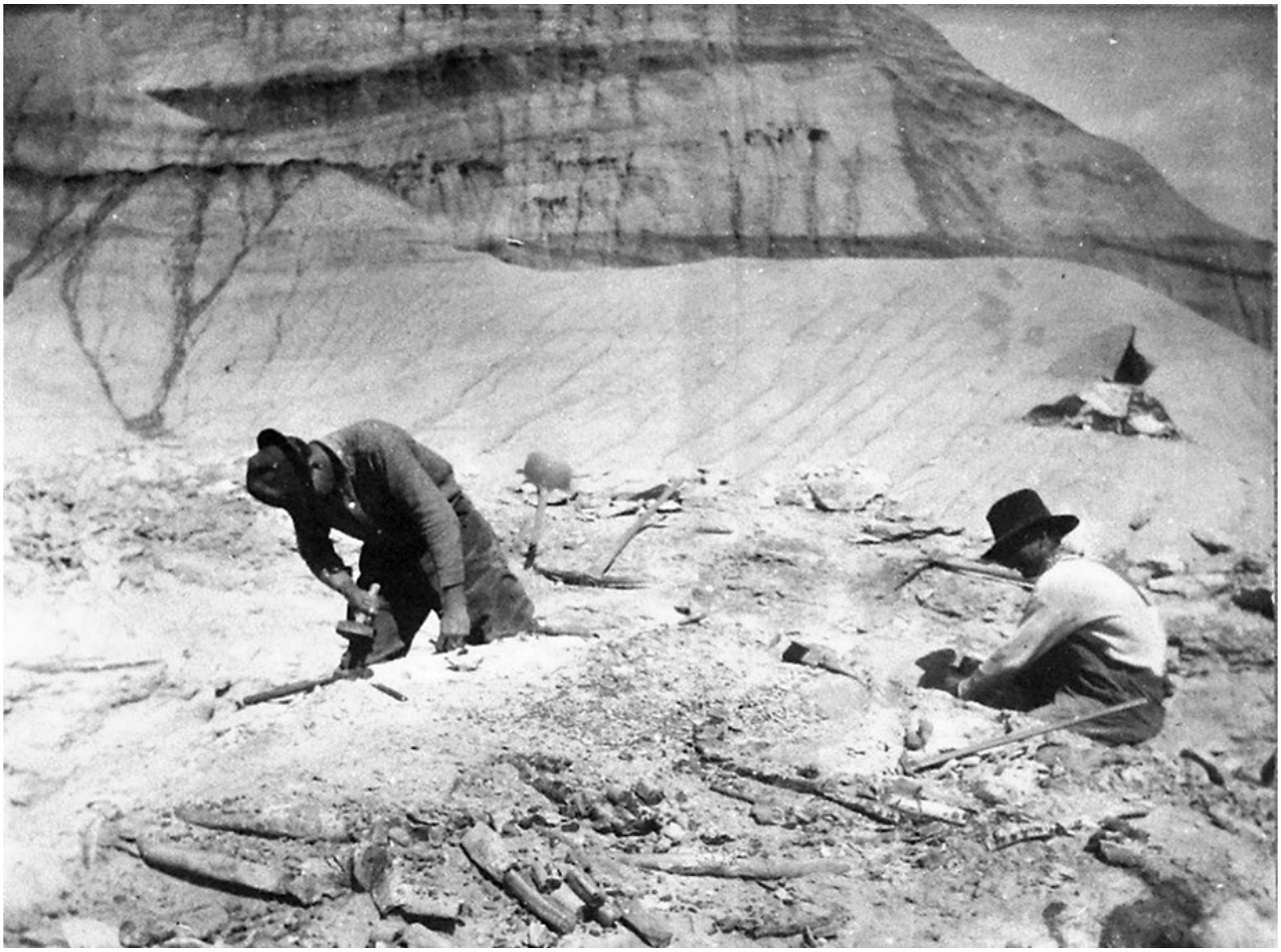


Figure 1. Field locality for AMNH FARB 5337 (AMNH field number 1914-2) *Euoplocephalus tutus* in 1913 (this page) and photo matched 105 years later in 2018 (opposite page), looking roughly east. Among the author's resolved lost/mystery quarries, this site bears the distinction of having the longest time interval between excavation and rediscovery, 104 years. Erosion of the low white sandstone ridge immediately behind the quarry has lowered it more than 0.5 m, but overall the scenery remains much the same, even minor rills with small ironstone fragments seen on the left. The site is now numbered as Quarry 273 and is within DPP boundaries in the restricted preserve area at UTM 12U 464140, 5621204 (WGS 84). 1913 photo courtesy of the AMNH.

the modern field worker. Several dozen quarries in Alberta with abandoned or forgotten bones are known; one such example is related here.

On July 4, 2007 the author found fourteen short lengths of thin wire (one twisted into a loop at one end), a nail and part of a tin can rim scattered, but associated, over a 3 – 4 m^2 area in the DPP badlands. This junk lay on the edge of a large, nearly flat area of *in situ* white sandstone near the base of a low sandstone ridge. A taller sandstone-dominated outcrop with a thin wedge of dark clay was visible in the immediate background. No quarry or bones were visible, though an old ceratopsian quarry, without an identifying quarry stake (Tanke, 1994) was present about 30 m to the southeast.[2] The metal waste was considered to have possibly been associated to that quarry.

On July 25, 2018 the wire site was revisited by Dr. Caleb Brown (TMP) and the author. The distal end of an ankylosaur tibia was seen protruding from the sandstone. It had not been visible in 2007. Isolated ankylosaur tibiae are rarely seen in DPP so it was decided to collected it. Within minutes of digging around, a second ankylosaur limb bone, a femur, was found close to the tibia in loose articulation. Uncovering and trenching them revealed small ankylosaur ossicles (small armour pellets of bone).

The metal waste now assumed more significance. Was it related to the ankylosaur bones—that is, was it the remnants of an old dinosaur quarry? No quarry was visible but the white sandstone rock was of a type the author has seen to erode quickly. A careful look at the ground where the wire was found revealed a tiny (~ 2 mm) piece of plaster of Paris, suggesting that this was indeed an old quarry, but one where nearly all traces of it had been lost.

A new quarry was opened (Quarry 273; TMP 2018.012.0151). At the site a day or two later, the au-

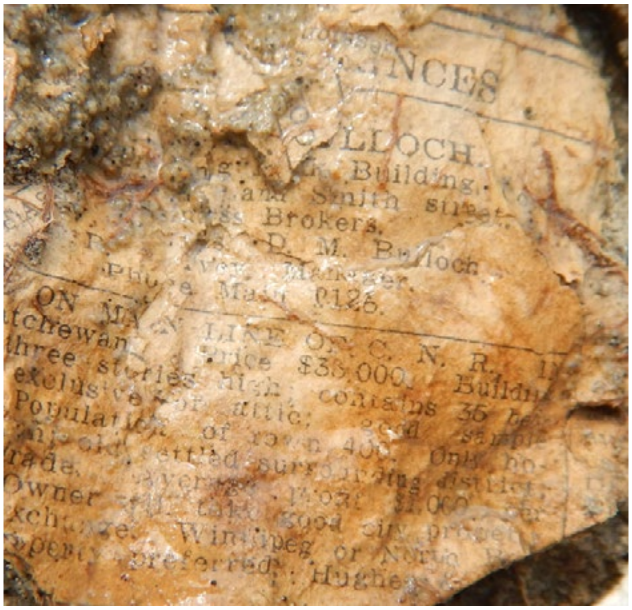
thor had an epiphany. Turning around and looking at the exposures behind the dig site, I realized that I had seen an old AMNH ankylosaur photograph, dated 1913, that showed a similar thin clay wedge visible in the large outcrop nearby. Someone had emailed the image to me. Searching through my old work emails showed that the image had been sent four years and two months earlier. Was it the same site? A copy of the 1913 photograph was printed and taken into the field and compared to the quarry we were working. Remarkably, it was indeed a match (Figure 1): even some of the minor rills with loose ironstone pellets remaining unchanged after 105 years.

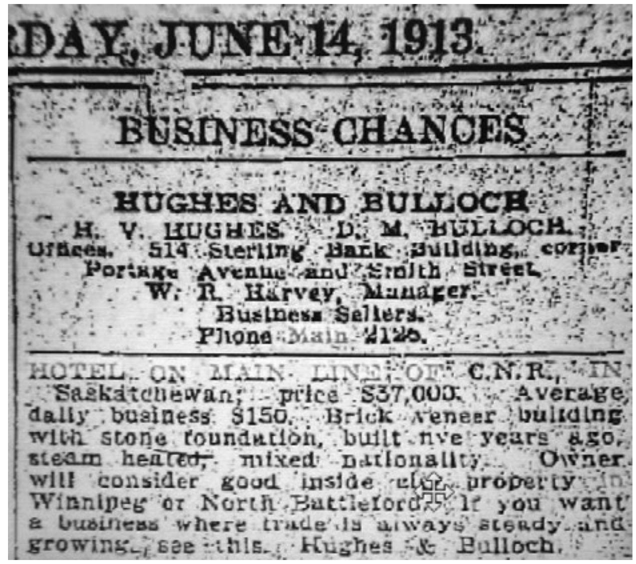
While digging a drainage trench, pieces of a 1913 *Manitoba Free Press* newspaper (Figure 2) were found underground. That newspaper date and the 1913 date of the photograph seemingly confirmed that this was indeed a 1913 quarry.

Examination of AMNH field records showed that they had an excellent summer of work that year, including the recovery of a remarkable number of major ankylosaur specimens—nine all told. But which of the AMNH specimens was ours? The crude site location system used by the AMNH long ago recorded that our quarry was about "12 miles below [the hamlet] of Steveville, right [south] bank." By a simple process of elimination, any 1913 AMNH ankylosaurs collected on the left (north) bank, and/or significantly less or more than twelve miles (19.3 km) below Steveville were eliminated. This left us with two possibilities: AMNH FARB 5404 and AMNH FARB 5405. One of these, AMNH FARB 5404, already had a quarry stake or marker (Tanke, 1994), correctly identifying it as Quarry 89 on the Steveville fossil quarry map (Sternberg, 1936, 1950). This left *Euoplocephalus tutus,* AMNH FARB 5405, an important research specimen utilized in many scientific papers, which consists of much of a skeleton and a partial tail club.

Back at Quarry 273, late in the summer, a presumed major osteoderm (plate) of a tail club was found, but as our field season was winding down it was heavily glued with acryloid thinned in acetone and left in place over the winter. It was assumed that the major plate was an isolated one and would fit onto the partial tail club of AMNH FARB 5405. But as we would soon see, this guess was totally wrong!

On July 8, 2019 the author and crew returned to





DAY, JUNE 14, 1913.

BUSINESS CHANCES

HUGHES AND BULLOCH
H. V. HUGHES D. M. BULLOCH.
Offices, 514 Sterling Bank Building, corner Portage Avenue and Smith Street.
W. R. Harvey, Manager.
Business Sellers.
Phone Main 2125.

HOTEL ON MAIN LINE OF C.N.R., IN Saskatchewan; price $37,000. Average daily business $150. Brick veneer building with stone foundation, built five years ago, steam heated, mixed nationality. Owner will consider good inside city property in Winnipeg or North Battleford. If you want a business where trade is always steady and growing, see this. Hughes & Bulloch.

Figure 2. *Manitoba Free Press* (Winnipeg) newspaper found buried in the AMNH FARB 5337 quarry rubble (left) and a close, but not exact match (right) to the same piece found on a Manitoba Free Press newspaper pay site dated June 14, 1913. The hotel for sale advertisement ran over much of the summer and fall of 1913 with many variations (but the first line always remaining the same); an exact match could not be found unless the author paid a subscription fee. This item and other quarry trash recovered from historical dinosaur quarries in Alberta will eventually find their way into the Royal Alberta Museum through the Archaeological Society of Alberta.

the site. The author began uncovering the major osteoderm. It just kept on going and going into the rock and within a few hours revealed itself to be a complete and beautifully preserved tail club. Work over the next days revealed it to preserve the fused caudal vertebrae that form the "handle" of the club; the entire tail club is about 1.8 m long.

So, unless the animal had two tails, this skeleton could not have been AMNH FARB 5405, as first believed. This caused some consternation on the author's part as the research to identify the site was believed to have been thorough.

Delving into more obscure AMNH in-house paperwork as well as online newspapers, the mystery was at last truly solved. From an archived AMNH internal annual report (Brown, 1913) not seen previously, and two newspaper articles (Anonymous, 1913, 1914), it was learned that this and several other dinosaur sites had been worked in late 1913, then covered up over the winter and finished in 1914. This work practice was unusual, as the AMNH normally started and completed a quarry each summer prior (1910 through 1912) and later (1915), on their last expedition to these badlands.

The AMNH field records showed that only two ankylosaurs had been found and worked in the summer of 1914. One, AMNH FARB 5347, was identified as: "Ankylosaur abdominal plates, skin impression; skeleton too poor to be collected," but some parts had been sampled. The second, AMNH FARB 5337, was the only good match of two ankylosaurs collected that summer. AMNH FARB 5337, is a two-thirds complete *Euoplocephalus* and another important research specimen, recently redescribed as the holotype of *Platypelta coombsi* (Penkalski, 2018).[3] Curiously, in his paper Penkalski associates an isolated tail club to the new genus, speculates on the occurrence of two dinosaur skeletons in one DPP quarry (our *Euoplocephalus* AMNH FARB 5337 and *Corythosaurus* AMNH FARB 5338),[4] and gives elevation data for AMNH FARB 5337—all without basis. The precise locality and stratigraphic context of the AMNH FARB 5337 *Euoplocephalus* quarry had been lost until 2018, but even then it was initially thought that the site yielded AMNH FARB 5405; the knowledge that it yielded AMNH FARB 5337 was not understood until 2019 (Tanke, 2019a), a year after Penkalski's paper was published. In light of these findings, the true status of *Platypelta* as a new genus based on anatomical and/or stratigraphic grounds will need to be reappraised. Certainly a revised and updated anatomical description of AMNH FARB 5337 is now in order.

AMNH (1913 – 1914) and TMP excavations (2018–2019) on *Euoplocephalus* skeleton AMNH FARB 5337/TMP 2018.012.0151) have recovered the following elements (Figure 3):

AMNH FARB 5337: skull, one mandibular ramus, two cervical half rings, eleven presacral vertebrae and ribs (AMNH records say they were "connected," presumably meaning articulated/fused), scapula/coracoids, humeri, ulnae, radii, six osteoderms and other armour, and a nearly complete pelvis missing one ischium.

TMP 2018.012.0151: about four disarticulated osteoderms and about six ossicles; an *ex situ* tendon, an ischium, femur, tibia (with astragalus in articulation), metatarsal, two rows of caudal tendon bundles, and a complete tail club (found upside-down).

Fieldwork on site by TMP was planned for 2020 and possibly 2021 but the COVID-19 pandemic barred that. Future fieldwork may reveal additional elements. Currently, the following elements are still missing: manii; right mandible, predentary, pedes; cervical vertebrae and ribs; transitional and free caudal vertebrae and more armour. Of the latter, there is an unusually low number of large and small osteoderms recovered by both the 1913 – 1914 and 2018 – 2019 excavations, for a specimen this complete. Perhaps the animal had been positioned upside-down as is frequently the case (Sternberg, 1970; Mallon *et al.*, 2018); then water currents slid the rotting carcass off its pointy back armour that was pressed into and anchored into the river bottom sediments. Even if nothing more is found, AMNH FARB 5337/TMP 2018.012.0151 will still be one of the most complete ankylosaurs recovered from DPP.

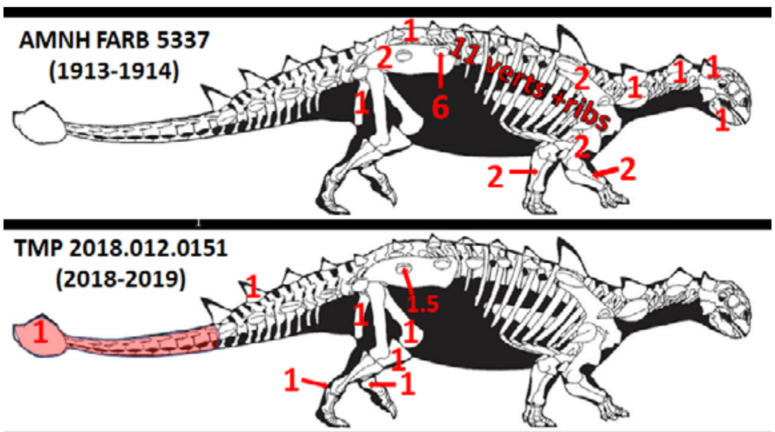


Figure 3. Two skeletal representations of *Euoplocephalus tutus* (modified from Greg S. Paul) with bones and numbers thereof found by the AMNH (top) and TMP (bottom).

While finding even more of an important dinosaur skeleton is undoubtedly a good thing, adding anatomical information as well as spatial and stratigraphic context, it also raises some troubling issues. We now realize that there are significant numbers of skeletal elements from a single animal curated in two widely-spaced institutions and with two differing catalogue numbers.

It is possible that subsequent expeditions (post-1914) working the beds in this area sampled the same site, unaware that it had been previously excavated. Single disarticulated bones of this animal could have been collected as just that—single bones, losing their true significance. As the AMNH FARB 5337 quarry was excavated on nearly flat terrain, the dig pit would have filled quickly with washed-in sediments, hiding clues that others had dug there previously. And as has been seen during the present pandemic, by Park staff visiting the site on the author's behalf, the sharp-edged remnants of our quarry walls, made by jackhammers, pickaxes, hammers and awls are already being eroded away. It is quite possible that all evidence of our quarry will have vanished within ten years, reclaimed by Mother Nature (Figure 4).

It would be desirable for the AMNH and TMP to arrange a swap of some sort as repatriation of original materials is unlikely. Spatial and stratigraphic data have been shared with colleagues at the AMNH. Ultimately it would be desirable to share casts of each institution's original bones of AMNH FARB 5337 and TMP 2018.012.0151 or 3D print outs from photogrammetry models of the same. This way each institution gains a more complete *Euoplocephalus* skeleton composed of original bones and casts or 3D printouts. This would benefit current and future researchers with exemplars of this important specimen being available on opposite sides of the continent.

Accumulations of historical trash found in flat badlands terrain and in the apparent absence of a quarry may represent a quarry site at that spot or nearby, excavated long ago and subsequently infilled with sediment or eroded away entirely. Such trash sites warrant closer attention. This was also the case for the holotype of the hadrosaur *Gryposaurus incurvimanus* (Parks, 1920), ROM 764: no visible quarry, flat terrain, but only some rusty nails and 1918 newspaper remnants to suggest someone had been there previously, which was confirmed by 1918 field photographs (Tanke and Evans, 2014).

Discovery of the AMNH FARB 5337 site also provides a useful clue to the field presence and collecting activities of the 1913 – 1914 AMNH field crews. It is known from the author's research that a *Centrosaurus* (Tanke, 2006) and several tyrannosaur skeletons were collected by them in the immediate vicinity. Not only had the AMNH been exploring a new field area in 1913 – 1914, giving them first dibs on the best-preserved specimens, but they also happened to be excavating specimens preserved in the best, most easily workable matrix in this field area—a fact not previously considered. So finding their lost quarries, such as *Euoplocephalus* AMNH FARB 5337, may help us link and find or identify any lost/mystery quarries in the same general area.[5]

This case serves as an excellent example of the confusion that can result when incomplete collecting (sampling), poor locality data recording, incomplete labelling of a field photograph, and the passage of 100+ years of time and erosion are combined. All of these circumstances conspired to confuse us at first. Current TMP field protocol on collecting disarticulated specimens is, where geographically feasible, to dig 1 m past the last bone in search of others. Had the AMNH crew done this, they would have found the hind leg bones and tail tendons within ~0.5 m of where they had stopped. And the tail club was a mere ~0.25 m beyond that.[6] Care must be taken to record and preserve accurate spatial and stratigraphic data. Plenty of photographs of the site must be taken—with the skyline included—and properly archived so that future generations of researchers can extract crucial information from these typically long abandoned and forgotten sites. It would have been so easy to add "AMNH 5337" to the "1913 AMNH ankylosaur" label on the old field photograph and save the author and others much sleuthing: admittedly fun, but tempered with worrisome uncertainty.

Figure 4. Part of Quarry 273 where the complete tail club was collected in 2019. Initially the pit seen here was 2–3 times deeper, having been largely filled with naturally eroded sediment after only one year. The rough edges of the pit, in white sandstone, are already smooth. A tumbleweed (*Amaranthus albus*) has sprouted and matured. Other parts of the quarry were similarly affected.

Fortunately the rediscovery of the AMNH FARB 5337 site increases the specimen's historical and scientific value with its spatial and stratigraphic context now known. It also makes one of the most complete ankylosaurs found in Alberta even more complete for future anatomical studies. Given that the new material is in a disarticulated state, it is possible that the AMNH FARB 5337/TMP 2018.012.0151 ankylosaur site will produce new bones for many years to come; and as we have seen here, for the more widely scattered bones, perhaps even a century or more into the future. Accordingly, future generations of fieldworkers should, on relocating an old quarry, do a quick examination and recover any newly exposed material, especially cranial material.

"Newly discovered" dinosaur skeletons may have to be viewed with a more critical eye. It is quite possible that they had been found by earlier expeditions who had uncovered all or part of a skeleton, then decided to abandoned it. All traces of their overburden removal may have since eroded away, considering the high rock erosion rates in DPP.[7] Or, a skeleton may have been uncovered, then for any number of reasons only portions of it were selectively removed, perhaps to provide bones missing from other skeletal museum mounts, for a comparative fossil collection, or for educational or specific research projects.

Two one-hour online talks by the author that discuss this project can be found here:

https://www.youtube.com/watch?v=C6YlIAm_0eE
https://www.youtube.com/watch?v=crfu8pQ9-GQ

Acknowledgements

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staff and volunteers, and DPP staff, all for their assistance and support on this project.

Endnotes

1. (Page 15) The exact whereabouts of more dinosaur sites excavated in Alberta, post-WWII and as recently as 1975, are still lost. In 2017 the author resolved one from 1964 (Tanke, 2018b). Photographs of a lost 1968 Provincial Museum of Alberta tyrannosaur quarry (TMP 1968.003.0001) have recently appeared on the internet. These images included the skyline and distinctive strata with a solitary coal seam (Lethbridge Coal Zone?) and proved useful in this site's recent rediscovery. In the bigger picture there are still many pre-WWII quarries lost, especially in the Drumheller Valley and particularly AMNH sites. By the author's own tabulation (Tanke, in prep.), from 1884 to 1939, 146 major vertebrate specimens were collected by various expeditions in the Drumheller Valley. Of these, only about three dozen (about 25%) have good locality data. Precise site data for many type specimens is still lost.
2. (Page 16) Limited but compelling evidence suggests this might be a George F. Sternberg quarry from 1920 that produced a cf. *Centrosaurus* left lower hind limb, UALVP 42. Sternberg noted the rest of the skeleton was too eroded to collect and much ceratopsian bone scrap remains there today. He noted UALVP 42 was near *Chasmosaurus* skull UALVP 40 (Gilmore, 1923; Konishi, 2015), and by GPS measurement, these two sites are just 164 m apart. The author recovered a complete, disarticulated *in situ* ceratopsian right posterior dorsal rib from this site in 1993 (TMP 1993.036.0076) and in 2019 he observed a small jaw fragment with fragmentary but undisputed ceratopsian teeth in the quarry. The presumed UALVP 42 quarry is located within DPP boundaries in the preserve area at UTM 12U 464163 5621193 (WGS 84).
3. (Page 18) Ankylosaur researchers and others the author is in contact with consider *Platypelta coombsi* synonymous with *Euoplocephalus tutus* so this older name is used here.
4. (Page 18) While the two specimens do have sequential catalogue numbers, there is no significance in this. Countless curated museum specimens and artifacts of all types in museums globally have sequential numbers: in most cases it signifies nothing more than one specimen catalogued after another. Measured on Google Earth, the AMNH FARB 5337/TMP 2018.012.0151 and AMNH FARB 5338 quarries are about 1.40 km apart—not together, as posited by Penkalski (2018).
5. (Page 20) One site under investigation is a mystery quarry that yielded a partial skeleton or parts thereof, of a large tyrannosaur in (an) earlier expedition(s). The outline of a square quarry can be seen and old plaster is on site. A hard sandstone concretion with presacral vertebrae is present, with ribs in articulation. Much bone is in the scree slope. Two pathologically fused basal cervical vertebrae, a partial axis centrum and a chunk of bone that appears to represent the distal end of a quadrate and part of an articular were collected in 2019 (TMP 2019.012.0148). While recently preparing these bones, the author realized two other large and pathologically fused tyrannosaur cervical vertebrae in TMP collections (TMP 1979.014.0332) from the old general DPP collection and quite possibly collected by **Hope Johnson** in the late 1960s or early 1970s (Tanke, 2019b, pp. 133 – 134) might be associated. This second set of fused cervicals had come from a same-sized animal, had the same bone colour, the exact same state of preservation and same attached matrix (colour and grain size with uniquely-coloured grey clay balls, and same response to air scribe and air abrasive preparation treatment) as the TMP 2019.012.0148 material. If this reassociation is true, this single skeleton or parts thereof could have numerous catalogue numbers: those by the still unresolved original excavator(s), the catalogue numbers noted above and possibly others. Once the pandemic is over, the author hopes to get back onto this project and finally resolve it.
6. (Page 20) These comments can be made with certainty based on the observed bones in the 1913 field photograph (Figure 1) and especially the distribution of *in situ* rock and *ex situ* rock at the site created by the 1913 – 1914 diggings, the latter subsequently buried and preserved by washed-in sediments. The *ex situ* rock seen so far allows visualization of part of the eastern edge of the original quarry.
7. (Page 20) As a casual test of the erosion rate in DPP, in the early 1990s the author chose a typical white sandstone outcrop and squirted a liberal amount of thin cyanoacrylate glue into the top of it. About six months later, in what was a rainy year, the site was re-examined and a 9 mm tall "hoodoo" had formed, the glue forming the "caprock."

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❏

Thank you!

We thank **Holly Crawford** for her donation of a small collection of fossil specimens assembled by her late father. Holly's donation is being evaluated and prepared for accession into the APS collection. ❏

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2021 Field Trips

By Keith Mychaluk

Planning is underway for this year's trips. A tentative outline is detailed below. We are as excited as you are about getting back and safely viewing fossils in the field. We feel the following trips can be safely conducted obeying current physical distancing guidelines. Please note we are going to postpone the Kemmerer, Wyoming and Devil's Coulee, Alberta trips until 2022 when we hope the COVID-19 pandemic restrictions are finally behind us. Please watch the *Bulletin* and website for further updates as the plans outlined here may change. Remember, you must be a member to attend a Society field trip.

Trip 2021-3, July 10, 2021
***Albertosaurus* quarry near Huxley, Alberta**

Back in 1910, Barnum Brown of the American Museum of Natural History discovered remains of the carnivore *Albertosaurus* in what is now Dry Island Buffalo Jump Provincial Park. Interestingly the collected material showed evidence of more than one individual which is very rare for a carnivore bonebed. After Brown's initial work the site essentially went unnoted for almost 90 years until **Dr. Phil Currie** and team from the Royal Tyrrell Museum "rediscovered" the site and conducted extensive excavations from 1998 to 2010. The subsequent study of this unique bonebed greatly enhanced our knowledge of Cretaceous theropods. This trip requires a long hike through rugged badlands. Dry Island is about a 2 hour drive from Calgary. **Registration deadline is July 1.**

Trip 2021-4, August 21, 2021
Stanley Glacier, Kootenay National Park, BC

This hike will take us to a recently identified site with soft-bodied preservation of Cambrian biota similar to the Walcott Quarry and nearby "Marble Canyon" localities of the Burgess Shale. Join us to learn about the geological conditions that created this unique deposit while traversing breathtaking scenery. Be aware that this is a long and strenuous climb (10 km, 450 m elevation gain) taking approximately 8 hours (round trip) depending on your conditioning. This is bear country, too and don't forget that weather conditions, even in August, can change very rapidly so be prepared. Children under 8 years old are not recommended to attend. Stanley Glacier is about a 2 hour drive from Calgary and the **registration deadline is August 1**.

Trip 2021-5, September 11, 2021
Tyndall building stone tour, Calgary, Alberta

Once again, **Tako Koning** has agreed to conduct his popular tour of Calgary buildings adorned in Ordovician age Tyndall limestone, quarried near Tyndall, Manitoba. See impressively preserved fossils of corals, gastropods, nautiloids and "weird wonders" at Calgary's historic landmarks (see *Bulletin*, December 2020, p. 27). This will be a walking tour of several buildings in downtown Calgary, the community of Kensington and the SAIT campus. **Registration deadline is September 1.**

For more information please contact Keith Mychaluk at **(403) 809-3211** or email **fieldtrips@albertapaleo.org**. A field trip registration form was included with the March issue of the *Bulletin* and is available on the APS website (**www.albertapaleo.org/fieldtrips.html**). All fees are due at the time of registration. Fees for trips are $10.00. **Non-members and unaccompanied minors will not be allowed to attend field trips.** All participants are required to have their membership in good standing. All participants will be required to read and sign a release form (waiver). Detailed information will be provided to all those registered shortly after the registration deadline. After the registration deadline no refunds will be given; however, you will receive the guide for the trip. **No late registrations will be accepted.** Registrations are accepted on a first-come-first-served basis so sign up early to avoid disappointment.

For the 2021 field trips I will be sending you the waiver and medical forms along with the trip information. This information will be sent to you via email or Canada Post. Please ensure that your addresses are correct and legible when sending in registration forms. When you arrive at the meeting place please have all forms completed. All participants are required to have fully completed all waiver and medical forms in order to attend the trip. There will be no exceptions. All personal information is held in confidence and ultimately destroyed. ❑

APS Revenue & Expenses for 2020 For January 1, 2020 to December 31, 2020

Revenues		Expenses	
US$ Exchange	7.57	Bulletin Printing	230.49
2020 Single + Family Memberships	1615.00	Bulletin Postage	151.36
2021 Single + Family Memberships	405.00	Meeting Speaker expenses	35.00
Bank interest + GICs cashed	16681.87	Membership expenses	109.49
T-shirts (member + non-member)	10.00	Field Trip Expenses	35.91
Book: Common Vert Fossils (mem+non)	1155.00	Symposium Workshop	120.55
Book: Hope Johnson (mem + non)	1327.75	Symposium Speaker	0.00
Handling fees: Book Common Vert Fossil	152.41	Symposium Abstract Printing	0.00
Handling fees: Book Hope Johnson	115.00	Book: Common Vert Fossils	673.11
APS Guides (field trip + old abstracts)	6.00	Book: Hope Johnson print	713.73
Other books (China-Canada)	0.00	Postage: Common Vert Fossils	109.78
Refreshment donations	13.90	Postage: Hope Johnson	93.83
Field trip fees	210.00	Website domain and hosting fees	674.04
Donations (General to APS)	0.00	Refreshments	5.00
Symposium 2020 Abstract sales	0.00	Bank Charges+GIC purchase	16400.00
Symposium Donations	0.00	Postbox rental	181.65
Symposium workshop fees	90.00	Insurance	1875.00
Library income	0.00	Hope Johnson award	250.00
Public Outreach income	0.00	Public Outreach expenses	0.00
Hope Johnson award income	0.00	Library expenses	0.00
Subtotal Revenues	**21789.50**	**Subtotal Expenses**	**21658.94**
Plus Revenue Received in 2019 for 2020		**Plus Expenses paid in 2019 for 2020**	
2020 Membership Fees	590.00	2020 Insurance	1875.00
Savings for 2020 Symposium	2725.00		
Symposium 2020 Workshop Fees	40.00		
Savings for Library	725.25	**Minus Expenses paid for 2021**	
Savings for Public Outreach	706.23	Website for 2021 and 2022	449.36
Savings for Hope Johnson award	1855.23	2021 Insurance	1875.00
Savings for Insurance (incl 2020 donation	3377.20		
Savings for T-shirt purchase	573.05		
Subtract Revenue Received in 2020 for 2021			
2021 Memberships Fees	405.00		
Savings for 2022 Symposium	2734.00		
2022 Symposium Workshop Fees	0.00		
Savings for 2021 Library	725.25		
Savings for 2021 Public Outreach	706.23		
Savings for 2021 Hope Johnson Award	1605.23		
Savings for Liability Insurance	3551.29		
Savings for future T-shirts	573.05		
Total Revenues	**22081.41**	**Total Expenses**	**21209.58**
Excess of Revenues over Expenses	**871.83**	**GICs**	**16,400.00**
Inventory Cost	**$2,148.86**	**Dec. 31, 2020 Bank Account:**	**15,026.18**
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Printed Name: Gulnara Machitova **Signature:** [illegible] **Date:** Feb 12, 2021

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Guide to Common Vertebrate Fossils from the Cretaceous of Alberta

By the **Alberta Palaeontological Society** with illustrations by naturalist and artist **Hope Johnson, LL.D.** Foreword by Dr. Donald Brinkman, Royal Tyrrell Museum of Palaeontology.

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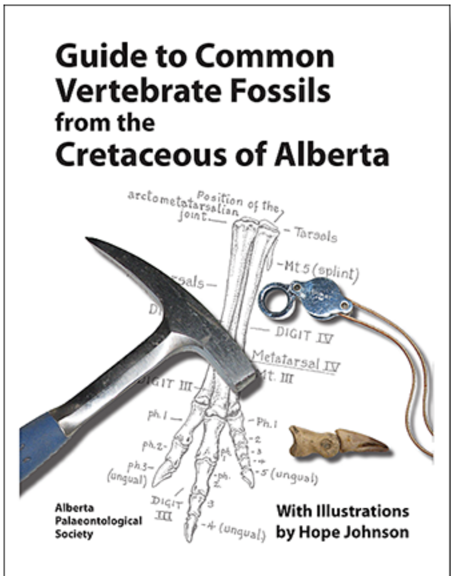
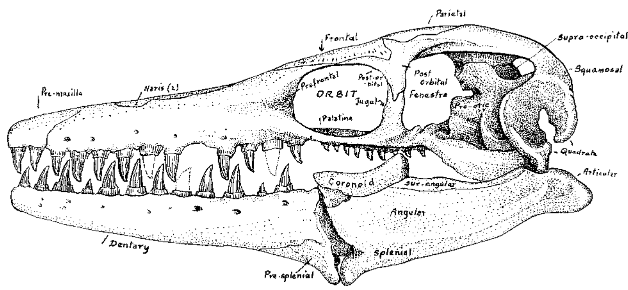


Hope Johnson's illustrations are the inspiration for this publication. Her passion for nature and contributions to the science of palaeontology have brought Alberta's natural history to life.



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