Alberta Palæontological Society Bulletin

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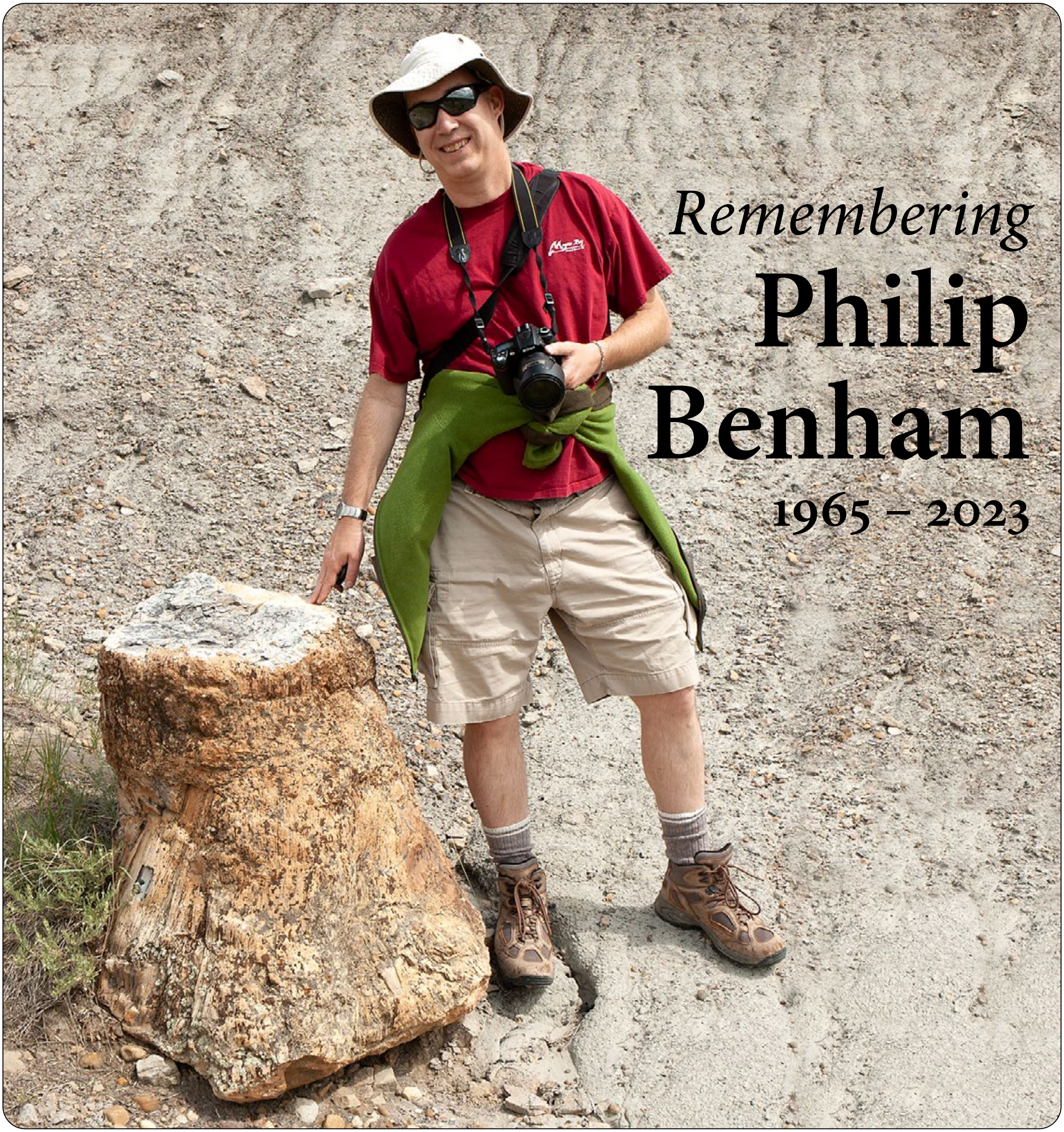


Remembering Philip Benham

1965 – 2023

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**
Family or Institution	**$25.00 annually**

SOCIETY MAILING ADDRESS:
Alberta Palaeontological Society
PO Box 68024, Crowfoot PO
Calgary, AB, Canada T3G 3N8
www.albertapaleo.org

THE BULLETIN IS PUBLISHED QUARTERLY: March, June, September and December. Deadline for submissions is the 15th of the month prior to publication. Material for the *Bulletin* should be sent to:

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

Requests for missing *Bulletin* issues should be directed to the Editor. Back issues are available at **www.albertapaleo.org/bulletinarchive.html**
Send changes of contact information to the Membership Director.

Upcoming APS Meetings

Meetings take place at 7:30 P.M. in **Room B108, Mount Royal University,** 4825 Mount Royal Gate SW, Calgary, Alberta.

Friday, April 21, 2023—Dr. Emily Bamforth, Philip J. Currie Dinosaur Museum.
Fifty years at Pipestone Creek: What northern Alberta's Wapiti Formation is revealing about boreal dinosaur palaeoecology (See Page 6).
and
Tako Koning, Geological consultant.
Exploring for algal stromatolites in North America and Africa—the journey continues (See Page 7).

Friday, May 12, 2023—Dr. Meagan Gilbert, Saskatchewan Geological Survey.
Depositional history and palaeoecology of the Calf Creek Locality (Cypress Hill Formation) in southwestern Saskatchewan, Canada: Reconstructing environmental shifts during the Eocene-Oligocene transition (See Page 9).

Check the APS website for updates! www.albertapaleo.org/meetings.html

ON THE COVER: Life Member Philip Benham in his element, posing with a fossil tree stump on an APS field trip in the Red Deer River badlands near East Coulee, July 2014. Photo by Howard Allen.

Philip Benham

1965–2023

APS Life Member

It is our sad duty to report the untimely passing—at only 58 years—of our good friend and long-time member, Philip Benham on March 3, 2023. His family posted an obituary to his Facebook page, which is reprinted here in its entirety (thanks to President **Cory Gross**).

Philip Benham April 21, 1965 – March 3, 2023

It is with great sadness that we announce Philip's passing on Friday March 3rd, 2023 at the Dulcina Hospice in Calgary where he was surrounded by his loving family. Philip fought a courageous battle with CNS Lymphoma, remaining ever positive and always with his quick-witted humour and generous personality that we all knew and loved.

Philip will be greatly missed by many from across the globe. He was a devoted husband, father, son, brother, uncle, friend and colleague, a passionate scientist, an enthusiastic teacher, and an intrepid explorer driven by curiosity for the world and people around him. In his last months Philip truly enjoyed the time spent with loved ones, sharing memories and stories, listening to music, reuniting with family, friends and colleagues. He continued to amaze us all with his great mind and his ever present love of learning. Thank you to all for you messages, phone calls and visits during this time—Philip was truly grateful for your love, support and appreciation.

Philip encouraged us all to live a life of adventure. Whether it was climbing volcanoes, exploring the arctic tundra, working with lemurs in Madagascar, observing fantastic bugs in Borneo or immersing himself in new cultures—he inspired us all. He was passionate about education and as a Chief Geologist for Shell and a lifetime member of the Alberta Palaeontological Society he enjoyed the many opportunities for writing articles and leading field trips around the world. Writing about the many geological hiking sites in his two home provinces of British Columbia and Alberta had a special place in his heart and is a lasting gift for all of us.

A Celebration of Life will be held April 23, 2023. In the meantime to honour Phil, take some time to do one of his favorite things: listen to music (Pink Floyd would be a terrific choice), take a stroll in nature (mountains, deserts, forest or fossil hunting), read a book (anything science to science fiction) or perhaps just take time to sit and observe geology, the landscape outside your door, the world that surrounds us.

Warmly, Philip's Family.

Phil joined APS in May 1997 and took on the role of Program Coordinator in May 2000, a position he excelled in until September, 2011. In those years the Program Coordinator's role included organizing the annual symposium.

Phil with Dr. Eva Koppelhus at the 2006 APS symposium. Photo from the Les Adler collection.

Phil shares a laugh with Wayne Braunberger (L) and the late Dr. Russell Hall, February 2003. Photo from the Les Adler collection.

Though many of us remember his contributions, it is astonishing to see—when placed together—the range of interests that Phil indulged in, actively participated in, and shared with The Society's membership. Here are some of the topics he spoke on, between 1999 and 2011:

- Stratigraphy and palaeontology of Bylot Island, Nunavut, based on his own field work.
- The natural history of Komodo dragons of Indonesia (presented with then-10-year-old son Peter), based on a Benham family trip to the area.
- A history of man's interactions with wildlife dur-

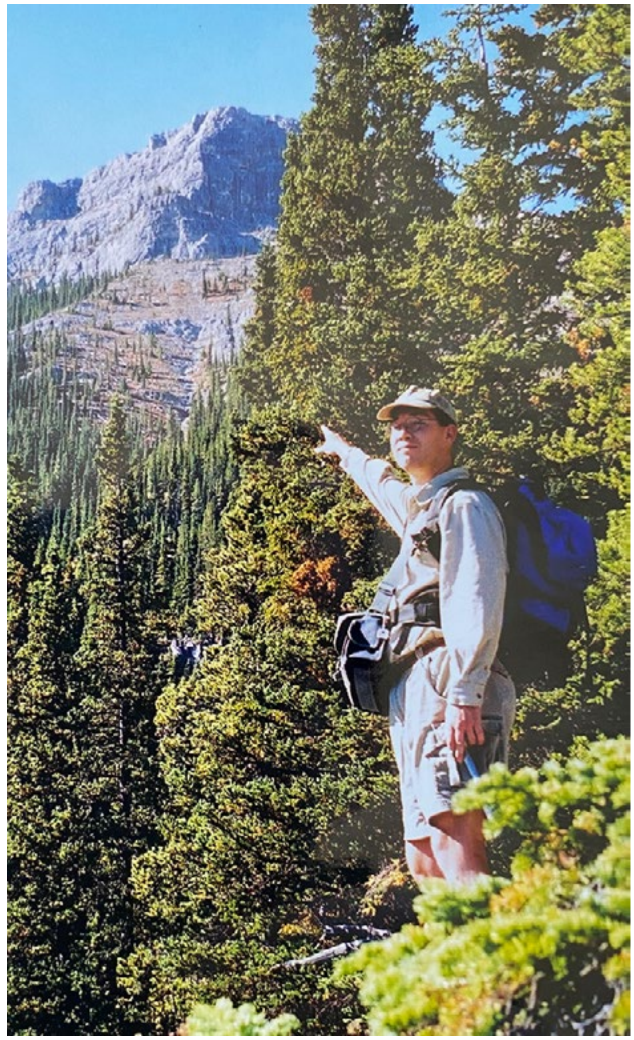
ing the early migration from Asia to Australia.
- Wildlife of Madagascar, based—of course—on his personal experiences on a trip he made there. (A talk he repeated on short notice when a speaker was unable to attend the 2006 symposium.)
- A geological and historical travelogue of his personal adventures in Egypt and Jordan.
- Geology and wildlife of the African Rift Valley, backed up with personal experience.
- Cultural adaptations of South Pacific islanders to living in the volcanically active "ring of fire." Yes, he was there, too.

You can see that Phil was no armchair scholar. And these are just topics that he spoke to us about. He wrote numerous articles and reviews for the *Bulletin*, on subjects as diverse as fossil localities in western Canada; palaeontology-oriented internet sites; exposures of ancient caribou dung and indigenous artifacts in Yukon; ancient human dispersal across southeast Asia; bronze casting of fossils (in Kelowna, BC—documented first-hand, of course) for an installation at the Calgary airport; a children's dinosaur book review (with son Peter); recovery of ice-age mammal bones from Yukon gold fields; a report of talks he gave to schoolchildren on Madagascar wildlife and his contribution to a charity to assist people in Madagascar; a proposal to visit volcanoes in Rwanda; the 100th anniversary of the discovery of the Burgess Shale (and if I recall correctly, he was a prime mover in having a special beer, "Shale Ale" brewed to celebrate the occasion!). He was the *Bulletin* Editor's number one contributor of "Fossils in the News" items over the past two-and-a-half decades.

Phil contributed to APS in just about every way a member possibly could. He donated at least a dozen books to the APS library. He organized—and, of course, conducted—field trips to the Yahatinda Formation in the Ghost River wilderness, and to Rat's Nest Cave near Canmore. He organized a Christmas photo contest. He secured funding from Shell Canada for the annual symposium. He donated a microscope, a fluoroscope and books to sell at a silent auction. He donated specimens to the Society's fossil collection. What more could one possibly do?

Keith Mychaluk relates a couple of humorous anecdotes involving Phil.

"One of Phil's favourite stories was of a trip we took about twenty-five years ago to explore the Pinhorn for fossils. We were driving on a lonely dirt road south of the Milk River near the Sweet Grass Hills. We saw a plume of dust in the distance, heading our way—but it was moving very slowly. As we climbed over a rise we finally saw what was headed our way. It was a horse-drawn cart—with an outhouse strapped to the back! Naturally, we had to stop and ask the driver what this was all about. He was a character, with leathery old skin and I swear he had a hayseed in his mouth. A friendly old fella, he explained that there was a big group of people on a trailride somewhere ahead of us. But after providing much detail about the trailride, he neglected to answer the question about the outhouse. When we pressed him again he laughed and replied 'well, you gotta keep the ladies happy' and off he went. I remember Phil took a photo of the outhouse and cart, which was entered into an APS Christmas photo contest, under the category 'Palaeontology Humour.' I don't recall if it won or not, but it was one of his favourite stories."



Phil points to the destination of an APS exploration field trip/bushwhack he guided to a fossiliferous exposure of the Yahatinda Formation in September, 2000. Photo courtesy of Keith Mychaluk.

"In an 'after hours' portion of his February, 2006 APS talk on the lemurs of Madagascar, he wanted to share his experience of correctly identifying a growing parasite egg-sack on his foot that he somehow picked up while in Madagascar. It was a grotesque story so he omitted it from his main lecture, allowed those with weak stomachs to flee for the exits and elaborated for those of us with morbid curiosity who stayed late.

He explained that he had an itch on his foot upon returning from his trip, then soon after felt something moving inside. Upon inspection he could see an 'air tube' sticking out of the sore spot and could see something moving around, which he concluded was some sort of insect egg-sack. He then correctly identified the parasite and discussed it with his doctor who initially scoffed and said there is no way he had such an exotic thing in his foot. He went to a specialist who concluded 'yep, that's what it is' and they needed to extract it. Because it was so unusual they asked Phil if he would be willing to have the procedure done at a U of C training facility so that medical students could watch, as they would be unlikely to see this again in their careers. Naturally, Phil jumped at this 'opportunity' and had the procedure filmed, too, which we all got to watch. Pretty horrifying was my conclusion—but Phil was absolutely giddy about the whole thing. That's the type of guy he was. He could turn a negative experience into a learning opportunity for many.

Phil was a tireless booster for the APS, CSPG, Alberta palaeontology specifically and science in general. He never stopped learning and was always so eager to share his knowledge with others. A week before his passing he was in amazing spirits still trying to get ideas and information out of his head and into the hands of others, which was far beyond the call of duty, considering his health. What a terrific person and a role model for all of us. I will miss him very much."

Yet another project that Phil was keen on—just in case he didn't have enough things to do—was his *Go Take a Hike* book, a CSPG-published field guide to geology-oriented hikes around western Canada. When I talked to him in January of this year he was proud to tell me that *Go Take a Hike* had attained the status of the best-selling publication in CSPG history. At the same time he roped me and several others into contributing to a photographic supplement of rocks and minerals of western Canada, to be published in the CSPG *Reservoir*. It's sad that he won't get to see it, but we intend to carry it to completion, in Phil's memory.

Phil's family suggested that we might honour his memory by listening to some Pink Floyd. I will second that advice. An obvious place to start would be *Wish You Were Here*.

—Howard Allen ❏

Thank you!

We'd like to thank **Peter Meyer** for making a financial donation to APS to help defray the costs of *Bulletin* production and distribution, as did **Dr. Garnet Fraser**. And thanks go to our Social Director, **Virginia Goodman** for her work in setting up coffee and snacks at the monthly meetings. ❏

Price increase for *Vertebrate Fossils* book

By Mona Trick

Last October, when I ordered another box of our APS publication, *Guide to Common Vertebrate Fossils from the Cretaceous of Alberta*, I was shocked to learn that the printing cost had jumped by more than $5.00 per book. As a result, APS is forced to increase the price of this book by $5.00. Effective immediately, APS members will now pay $30.00 per book and non-members $35.00. I was expecting the price to increase at some point, because the printer had kept the price the same since the book was originally published in 2009. The new price equals that of our other APS publication, *Now There Was a Lady!*

Also shocking is the increased cost of postage, due to the new fuel surcharge. Mailing a single book to southern Alberta last December cost $21.65. As a result, APS will no longer offer a flat-rate mailing fee for either publication. Instead, those who want a book shipped must provide their address to me, **giftshop@albertapaleo.org** or call or text **(587) 578-4579** and I will quote the appropriate shipping fee. Postage varies substantially depending on the destination; postage fees are lower when mailing to major hubs; higher to isolated or rural communities. ❏

Online palaeo talks

The **Philip J. Currie Dinosaur Museum** hosts a series of online talks by palaeontology researchers. Visit their "Virtual Speaker Series" page [currently slightly outdated . . . *ahem*]: **https://dinomuseum.ca/virtual-speaker-series**. Upcoming talks are streamed live on Zoom, past talks can be watched on YouTube: **https://www.youtube.com/@PhilipJCurrieDinosaurMuseum/featured** ❏

Upcoming Events

April

Dr. Emily Bamforth

Philip J. Currie Dinosaur Museum and University of Saskatchewan,
Department of Geological Sciences

Fifty years at Pipestone Creek: What northern Alberta's Wapiti Formation is revealing about boreal dinosaur palaeoecology

Friday, April 21, 2023, 7:30 P.M.
Mount Royal University, Room B108

[*This 15-minute presentation will precede our main speaker,* **Tako Koning**.]

The Pipestone Creek Bonebed, located just outside the small town of Wembley in northwestern Alberta, was discovered in 1973 by Al Lakusta, a local high school teacher. He had stumbled on one of the densest dinosaur bonebeds in North America, with an average of 100 to 300 fossils per square metre and with an estimated size of three football fields.

The rhinoceros-sized ceratopsian dinosaur that made up the bulk of the bonebed specimens was described as a new species, christened *Pachyrhinosaurus lakusti*. Subsequent palaeontological interest in the region led to the discovery of other dinosaur bonebeds, several microvertebrate localities, dinosaur trackway sites and hadrosaur specimens displaying soft-tissue preservation.

In 2015, the Philip J. Currie Dinosaur Museum opened in Wembley, with an aim to inspire and educate visitors about the Pipestone Creek Bonebed, and about Canada's northwestern dinosaur communities.

There are still many questions to explore in the Wapiti Formation. The formation is Late Cretaceous (80 – 68 Ma) in age and stretches from northwestern Alberta to northeastern British Columbia. The formation is divided into five units, with Unit 3 and Unit 4 being the most fossiliferous. The dinosaur communities within these terrestrial units are significant because they fill the "Bearpaw Gap," a time interval when southern Alberta was covered by the Western Interior Sea.

Outside of two *Pachyrhinosaurus* bonebeds, the dinosaur faunas of the Wapiti Formation are dominated by the hadrosaurs *Edmontosaurus* and *Lambeosaurus*. Theropods and ankylosaurs are known from footprints and teeth, but their diversity remains largely unknown. The palaeoflora that has been studied from the Wapiti Formation suggests a largely deciduous forest with little evergreen vegetation, which experienced strong seasonality associated with a varying photoperiod. Given that these floras would have provided the dietary basis for dinosaur megaherbivores, it lends support to the theory that these animals were migratory. Understanding the seasonal nature of the Late Cretaceous boreal forests and floodplains through palaeofloral analyses and isotope geochemistry may help to elucidate inferred behaviours such as herding and migration and may provide clues as to the environmental tolerances of some of Canada's most northerly dinosaur communities.

Figure 1. Angiosperm leaf from the Spring Creek Palaeofloral Site, 2022. Photo by Emily Bamforth.

Biography

Dr. Emily Bamforth is a palaeontologist and museum curator at the Philip J. Currie Dinosaur Museum in Wembley, Alberta, Canada. Her research focuses on Cretaceous palaeoecology, with a focus on dinosaurs, microvertebrates and palaeobotany. She also has an interest in early life, specifically the Ediacaran Period. Dr. Bamforth received a B.Sc. in evolutionary biology from the University of Alberta in 2005 and went on to do a M.Sc. in Precambrian Invertebrate Palaeontology at Queen's University (Kingston, ON) with **Dr. Guy Narbonne**. In 2008 she began her Ph.D. at McGill University under the supervision of **Dr. Hans Larsson**, exploring pre-extinction biodiversity trends immediately prior to the K-Pg extinction in Saskatchewan. In 2014, she started work as a researcher and curatorial assistant with the Royal Saskatchewan Museum, and accepted the position of Museum Curator at the Philip J. Currie Dinosaur Museum in 2022. She has been an Adjunct Professor with the University of Saskatchewan Geology Department since 2021. Dr. Bamforth has published numerous papers and conference abstracts on Ediacaran and Cretaceous palaeontology and was the recipient of the YWCA's 2019 Women of Distinction Award for Science. She loves field work and being outdoors and is often accompanied by her trusty "paleo pooch," Aster.

Tako Koning

Geological Consultant, APS and CEGA Member

Exploring for algal stromatolites in North America and Africa—the journey continues

Friday, April 21, 2023, 7:30 P.M.

Mount Royal University, Room B108

This presentation is based on my exploring for algal stromatolites in North America and Africa. Accordingly, this can be described as a personal "journey" which hopefully will continue for another decade or two. The presentation begins with a brief overview of the occurrences of stromatolites over time—from the Precambrian to present day. The overview will be mainly about stromatolites which grew in marine environments; but also to be discussed will be stromatolites which flourished in nonmarine, lacustrine environments. Included also is a short review of the world-renowned stromatolites which continue to thrive in Shark Bay, Western Australia.

The presentation will then provide detail on the five locations where I have been fortunate to view stromatolites in outcrop.

1) Great Slave Lake, Northwest Territories. A half century ago in the summer of 1971, while involved in a mining exploration program, I discovered stromatolites on an island in the East Arm of Great Slave Lake near Fort Reliance. These stromatolites occur in unmetamorphosed limestones dated 1.8 billion years old, which is Early Proterozoic in age. This led to my abiding interest in stromatolites.

Figure 1. Stromatolite found in 1971 near Great Slave Lake, NWT. Limestone dated at 1.8 billion years old. Photo by Tako Koning.

Figure 2. Precambrian stromatolites, Lubango Plateau, Angola, Africa. Photos by Dr. Louis Jacobs, Southern Methodist University, Dallas, TX, USA.

2) Angola, West Africa. My next discovery of stromatolites was in 2005 in southern Angola where the stromatolites occur in Precambrian, Middle Proterozoic limestones age dated at 1.1 billion years old. These occur in the Lubango Plateau just west of the city of Lubango. The stromatolites have been little

studied due to logistical challenges and the impact of Angola's long civil war from 1975 to 2002. An exposure of Upper Cretaceous thrombolites discovered in 2014 along the coast of Angola will also be shown. Thrombolites are similar to stromatolites since they are microbial accretionary structures which were formed in shallow water by cyanobacteria and have a non-laminated, clotted internal fabric.

3) Gatineau, Quebec. In 2018 I learned in the literature about well-exposed Ordovician-age stromatolites located across the river from Ottawa in Gatineau, Quebec. This led to my travelling there to find those stromatolites. The Gatineau stromatolites have been described in the literature as "one of the best-known displays of stromatolites in Canada and certainly in an urban area."

4) Helen Lake, Banff National Park. In 2020 I had the opportunity to hike up into the alpine to Helen Lake and view some splendidly exposed Middle Cambrian stromatolites. The stromatolites cover an area of about 800 m in length by 10 m in width. These have been dated to 510 million years old. Despite their age and the impact of alpine weathering, these stromatolites are breathtakingly well preserved. Their elliptical shape reflects the dominant tidal currents at the time of deposition in the shallow Middle Cambrian sea.

5) Waterton Lakes National Park. In 2022 I visited beautifully exposed Precambrian stromatolites in Red Rock Canyon in Waterton Park. These stromatolites are found in the Siyeh Formation and are dated as 1.3 billion years old.

I will also reveal my "bucket list" of locations of stromatolites I still hope to visit, which include the thrombolites of Cambrian age at Flowers Cove, Newfoundland, as highlighted by Wayne Laturnas' photograph in the January, 2019 CSPG calendar. I also hope to see the 2.0 billion-year-old stromatolites in the Belcher Islands, a remote archipelago in the southeast part of Hudson Bay.

Biography

Tako Koning is Holland-born but Canada-raised with a B.Sc. in Geology in 1971 from the University of Alberta and a B.A. in Economics in 1981 from the University of Calgary. After a fifty-year career in the oil industry, he is semi-retired and living in Calgary.

He leads field trips for APS to visit the fossil-rich Ordovician Tyndall Stone cladding various buildings in downtown Calgary, Kensington and the Southern Alberta Institute of Technology (SAIT). He also leads an APS summer field trip to study the K-Pg mass

Figure 3. Ordovician stromatolites. Ottawa skyline is seen on the horizon. Photo by Bruce Starling, OttawaRiverKeepers.ca

extinction boundary at Knudsen's Farm near Huxley, Alberta.

Tako leads similar field trips for the Canadian Energy Geoscience Association (CEGA; formerly CSPG). He also volunteers for the Alberta Wilderness Association (AWA) through their Adventures for Wilderness program by leading an annual summer field trip to visit orphan oil and gas wells and abandoned oil and gas producing infrastructure in southern Alberta. As most Albertans are aware, the issue of orphaned and long-time suspended oil and gas wells is a major issue for Alberta. For the AWA he also annually leads a field trip north of Cochrane to view two magnificent glacial meltwater channels. Attendees also have the opportunity to view the multi-company rapidly expanding Lochend area Upper Cardium oil production play whose success is dependent on multi-stage hydraulic fracking. The field trip also views the environmental impact of some mega-size gravel mining operations in the area. Tako volunteers by being a board member of the Calgary Justice Film Festival and he writes monthly restaurant reviews for the *Rosedale Reporter*, the publication of the Rosedale Community Association where he lives in Calgary.

Your Society Wants Volunteers!

Please THINK about volunteering for APS!

Positions are opening! Elections will be held in May.

See Page 9. ☞

May

Dr. Meagan Gilbert

Saskatchewan Geological Survey, Regina, SK.

Depositional history and palaeoecology of the Calf Creek Locality (Cypress Hills Formation) in southwestern Saskatchewan, Canada: Reconstructing environmental shifts during the Eocene–Oligocene transition

Friday, May 12, 2023, 7:30 P.M.
Mount Royal University, Room B108

The Eocene to Miocene Cypress Hills Formation (CHF) spans 28 million years, forming the conglomeratic caprock of the Cypress Hills plateau in southwestern Saskatchewan. The formation records one of the last significant sedimentation events in the western plains of North America at a time of major global climate fluctuations. The CHF contains the only high latitude, non-polar mammalian fossil assemblage known in Canada, spanning the Late Eocene to Early Miocene (Uintan to Hemingfordian land mammal ages).

The Late Eocene (Chadronian 2) Calf Creek Locality is the most prolific Paleogene multitaxonomic bonebed in Canada, with numerous field campaigns producing a robust collection of approximately sixty fossil vertebrate families. This includes various carnivores and creodonts (e.g. *Hyaenodon horridus*, *Hesperocyon regarius* and *Daphoenus* sp.), early horses and tapirs (*Mesohippus westoni*, *Mesohippus propinquus*, *Miohippus grandis*, *Colodon occidentalis*), small rhinos and deer (*Hyracodon priscidens*, *Leptomeryx* sp.), various "insectivores", brontotheres (*Megacerops coloradensis*, *M. kuwagatarninus*) and numerous freshwater fish, amphibians and reptiles.

Presented is a detailed sedimentologic and palaeoenvironmental profile of the Calf Creek Locality, serving as a foundation for further studies that may be conducted utilizing the site's extensive collections. A palaeoenvironmental reconstruction is accomplished using cenograms, a graphic plot of mammalian body size of each species in a community excluding chiroptera and carnivora. The resulting shape of the cenogram can be interpreted based on their slope and continuity, providing insight into palaeoclimate and palaeoenvironment. This study is part of a larger, ongoing work to establish a detailed regional stratigraphic and environmental framework to unravel the notorious complexity of the CHF deposits, which host one of the most significant Cenozoic mammalian faunas in Canada.

Biography

Meagan Gilbert was raised on a cattle ranch in the Cypress Hills north of Eastend, Saskatchewan where the landscape and its many earthly treasures profoundly shaped her passion for science at an early age. This interest was fostered by proximity to the *T. rex* Discovery Centre, where as a teen she worked as a tour guide and palaeontology volunteer with the Royal Saskatchewan Museum. She completed her B.Sc in palaeontology and geology (2012) and Ph.D. (2019) at the University of Saskatchewan. Meagan is now a Research Geologist at the Saskatchewan Geological Survey with expertise in Upper Cretaceous to Paleogene vertebrate palaeontology, stratigraphy, biostratigraphy and depositional systems. ❑

Notice of Annual General Meeting of Members

To the Members of the Alberta Palaeontological Society:

Take notice that the Annual General Meeting (AGM) of the Members of the Alberta Palaeontological Society (hereinafter called "The Society") **will be held** before the main guest presentation on **Friday the 12th day of May**, 2023, at the hour of 7:30 o'clock in the evening, local time, to deal with the following business to be brought before the Meeting:

1. **Adoption of agenda.**
2. **Minutes of 2022 AGM.**

   Members will be asked to adopt the minutes of the 2022 AGM, which may be reviewed at the APS website: **http://www.albertapaleo.org/agm.html**.
3. **Treasurer's presentation of the audited statement of the financial position of The Society.**
4. **Appointment of the auditors.**

   Auditors nominated by the Treasurer for appointment are **Gilles Fournier** and **Anita Reilander**.

5. Election of Officers to the Board of The Society.

All APS members 18 years and older are entitled to vote. Officer positions are 1 year terms and directorships are 2 year terms. Nominations are being solicited for the following positions:

Officers	President
	Vice-President
	Secretary
	Treasurer
Directors	Program Coordinator
	Membership Coordinator
	Editor
	Field Trips Coordinator

In addition to the elected positions The Society has a number of committee chairs which are appointed by the board. Terms for these chairs are unlimited:

Committee	**Current Chairperson**
Fossil Collection	Howard Allen
Library	Georgia Hoffman
Public Outreach	Cory Gross
Social	Virginia Goodman
Website	Vaclav Marsovsky

Terms for all positions begin September 1. If you would like more information about Board positions or are interested in chairing or participating on a committee, please contact Past President **Wayne Braunberger** at **(403) 278-5154** or by e-mail, **pastpres@albertapaleo.org**. All inquiries will be kept confidential if requested.

6. New Business.

If you have any items of New Business to be brought forward contact Society President **Cory Gross** at **(403) 617-2079** or by e-mail, **president1@albertapaleo.org**. ❑

2023 Field Trips

By Keith Mychaluk

Winter is in the rear-view mirror so that means the summer field-trip season is coming up! We have a great assortment of trips—big and small—for 2023 and we hope there is something for everyone. Trips previously postponed and long-promised are finally happening this year. We are finally going to visit the Devil's Coulee dinosaur egg site near Warner, Alberta and will venture into the USA and travel all the way to Kemmerer, Wyoming! Our friends at the University of Alberta will show us the Danek hadrosaur bone-bed in their backyard and provide a tour of their lab, too. We will also revisit the Cretaceous-Paleogene boundary site at Knudsen's Farm and see Ordovician-aged fossils in building stone at some Calgary landmarks. This year's line-up would not have been possible without the help of fellow APS members **Mona Trick** and **Tako Koning**. Thank you Mona and Tako!

Please watch the *Bulletin* and the website for further updates as these plans may change. **Remember, you have to be a member to participate** in a Society field trip.

Trip 2023-1. Saturday, June 17, 2023
Devil's Coulee Museum and field tour, Warner, Alberta

Leader: Mona Trick

Mona will lead us to the famous Devil's Coulee dinosaur egg site in southern Alberta. In the morning, we will enjoy a guided tour of the Devil's Coulee Dinosaur Heritage Museum (located in Warner, Alberta). In the afternoon we will have an extended tour of the Devil's Coulee badlands, where dinosaur eggs were first discovered in Canada. We will also have time to search for Late Cretaceous (Campanian) fossils such as dinosaur eggshell, but **we will not be able to keep anything we find**, as this is a protected site. The price includes admission to the museum and the guided tour of the egg site. Due to the restricted amount of parking at the egg site we will carpool for the 30 minute drive from the museum to the egg site.

This field trip is just one day in length and Warner is about a 3-hour drive from Calgary. Registration is limited to 40 people and the **deadline for registra-**

tion is June 1. For additional details, including camping and motel information, contact **Mona Trick** at **giftshop@albertapaleo.org** or phone **(587) 578-4579**.

FEES

$40 per adult (includes $30 admission fee and $10 insurance fee).

$30 for child (12 years old and younger) (includes $30 admission fee).

Time—10:00 A.M. to 4:00 P.M. on Saturday, June 17.

Trip 2023-2. July 8, 2023
K/Pg boundary, Knudsen's Farm, Huxley, Alberta

Leader: Tako Koning

If you missed this tour last year, Tako will again lead us to the famous Cretaceous-Paleogene boundary (formerly the "K/T boundary") site on Knudsen's farm near Huxley, AB. This site is the best location in Canada to view the K/Pg mass extinction boundary. It marks the event when dinosaurs and 75 percent of the Earth's creatures and plants died almost instantaneously. Extensive academic research at this site has contributed materially to our knowledge of what happened to the world at that time. Huxley is about a 2-hour drive from Calgary. This is a single-day trip and the **registration deadline is July 1**.

Trip 2023-3. July 14 to 16, 2023
Green River Formation, Kemmerer, Wyoming, USA

Leader: Keith Mychaluk

We have been planning this trip for a number of years and finally it is here! The Green River Formation is world-famous for fossil fish, rays, palm leaves and even prehistoric horses and birds preserved in stunning detail in Eocene lake sediments. This trip will take place over three days—excluding the long drive to and from Wyoming—in order to accommodate everything we hope to see and do. Kemmerer, Wyoming is a 13.5 hour drive from Calgary (excluding the time required to cross the USA-Canada border; which can be quite variable). Participants will have to find their own way to and from Kemmerer and I strongly recommend splitting-up the drive over (at least) two days in each direction.

Here is the proposed itinerary:

Friday July 14

1:00 P.M. Tour of Fossil Butte National Monument (no admission cost).

4:00 P.M. Drive to Kemmerer (about 20 mins from Fossil Butte) and check-into hotel(s).

Saturday July 15

8:00 A.M. to 12:00 P.M. Half-day dig at Warfield's Quarry (US$70 per person fee payable upon arrival; cash or cheque only). All tools, including rock saws, are provided.

Afternoon free—A good time to rest and/or visit Ulrich's Fossil Gallery in town.

6:30 P.M. to 12:00 A.M. OPTIONAL nighttime "V.I.P. Dig" at Warfield's Quarry. There is no cost for those observing, but will cost US$500 per person to participate and keep a fossil (see more below).

Sunday July 16

Half-day dig at either Warfield's or at a different quarry (again, US$70 per person).

5:00 P.M. Official end of trip.

Please view the videos on Warfield's website, **www.fossilsafari.com** to give you an idea of what to expect. Most exciting is the opportunity to watch the professionals excavate fossils at nighttime from the famous "18 Inch Layer" during their "V.I.P dig". Artificial illumination helps the pros spot subtle clues in the rock indicating where fossils are located. Then they excavate with special shims, chisels and rock saws. It should be quite the learning experience. For those willing to pay an optional fee, you will be able to keep one fossil fish recovered during the night dig. I understand these are quite remarkable; however, the nighttime experience is optional whether you are paying or simply observing.

We have already reserved a block of rooms at the Fossil Country Inn (Best Western Plus) in Kemmerer, Wyoming at a group rate discount. Each room is non-smoking with two queen beds. Details will be provided once you have completed registration on a first-come, first-served basis. There are other accommodations in Kemmerer but not nearly as nice as the Best Western. I am also told by many sources to **BOOK ROOMS EARLY** as there are several large industrial construction projects in the region and rooms are disappearing fast. The next nearest town for accommodations is Evanston, Wyoming, which is an hour to the south of Kemmerer. However there are many campgrounds within and near Kemmerer as another option.

Please register early and ONLY if you are serious about attending. Expect hot weather! There are no restrictions for attendance but motel space could be a limiting factor. **The registration deadline is July 1 but I highly recommend registering early**. Please contact **Keith** at **(403) 809-3211** or **fieldtrips@albertapaleo.org** if you have any questions.

Trip 2023-4. August 19, 2023
Danek Bonebed and University of Alberta Palaeo-Lab tour, Edmonton, Alberta

Leader: Keith Mychaluk

Our gracious host, **Dr. Eva Koppelhus** of the University of Alberta, will guide us to a hadrosaur bone-bed located within the city limits of Edmonton. The Danek Bonebed is used to teach students enrolled in the palaeontology program at the University of Alberta as their field school. Eva has also arranged for us to have a backrooms tour of their palaeo-lab so we can better appreciate how fossils are prepared and studied. Normally closed on weekends, we will also be provided special access to the University of Alberta Palaeontology Museum, which houses the university's fossil collection.

Participants may also wish to tour the Royal Alberta Museum across town on their own schedule. Due to limited physical space at both the bone-bed and the lab, registration is limited to 20 participants. This is a single-day field trip. **Registration deadline is August 1.**

Trip 2023-5. September 16, 2023
Fossils-in-Tyndall building stone walking tour, Calgary, Alberta

Leader: Tako Koning

Once again, Tako Koning has agreed to conduct his popular tour of Calgary buildings clad with Ordovician-aged Red River Formation limestone originally quarried in Tyndall, Manitoba. See impressively preserved fossils of corals, gastropods, starfish, orthocones and even algae at Calgary landmarks like the historic Bank of Montreal building. This will be a walking tour of several buildings in downtown Calgary, the community of Kensington and the SAIT campus and is suitable for all ages. **Registration deadline is September 1.**

For more information on any of the field trips contact **Keith Mychaluk** at **(403) 809-3211** or by email: **fieldtrips@albertapaleo.org**. A field trip registration form is included with this 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. Any membership applications received after May 1, 2023 will not be reviewed and voted on by the Board of Directors until September, 2023. Therefore, if you are a non-member and would like to join be sure your application is received prior to May 1, 2023.

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. Registrations are accepted on a first come, first served basis so sign up early to avoid disappointment. For the 2023 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 address is 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.

Trip Participant Responsibilities

It is understood that risk is inherent to some degree in outdoor activities. Before registering for a trip please ensure you understand the risks involved and are prepared to accept them.

- As a participant you are responsible for your own safety and equipment at all times.
- Inform the trip leader of any medical conditions they should be aware of in an emergency.
- Ensure that your previous experience, ability and fitness level are adequate for the trip. ❑

More online palaeo talks

The **Royal Tyrrell Museum of Palaeontology** also has an online speaker series, accessible here: **https://tyrrellmuseum.com/whats_on/special_events/speaker_series**. Previously recorded talks can be viewed on their YouTube channel: **https://www.youtube.com/c/RoyalTyrrellMuseumofPalaeontology**.

Dinotour 2023

Excavate dinosaur fossils in the Pipestone Creek Bonebed while supporting dinosaur research!

By Mona Trick

Have you ever dreamed of exploring and discovering a dinosaur fossil with some of the world's greatest dinosaur hunters? This is your opportunity to register for Dinotour 2023 Grande Prairie (Alberta, Canada) to be held July 7 to July 10, 2023, inclusive. During this four-day, family-oriented event you will—

- Learn about the dinosaurs of northern Alberta from world-renowned scientists **Dr. Philip Currie**, **Dr. Eva Koppelhus** and **Dr. Corwin Sullivan** (all from the University of Alberta) and experienced amateur **Mona Trick**.
- Tour the Philip J. Currie Dinosaur Museum galleries, collections and preparation areas. Search for microfossils such as teeth, vertebrae and scales from dinosaurs, fish and reptiles using microscopes at the Philip J. Currie Dinosaur Museum. Enjoy free time to explore the museum on your own.
- Excavate dinosaur fossils from the Pipestone Creek Bone Bed under the supervision of staff from the Philip J. Currie Dinosaur Museum.
- Raft down the Wapiti River with experts from the Philip J. Currie Dinosaur Museum.
- Explore a nearby dinosaur quarry. Hike and explore the Kleskun Hill Natural Area.
- Enjoy group meals every evening including a farewell dinner on Monday night.

Dig in the Pipestone Creek Bonebed. Photo provided by Travel Alberta, © 2014.

The Tour includes:

- Guided tour including bus transportation to and from our hotel (Holiday Inn Express) in Grande Prairie, Alberta.
- 5 nights accommodation (double occupancy) at the Holiday Inn Express, including the night before the tour (July 6) and each night of the tour (July 7, 8, 9 and 10).
- All meals over the 4 days of the tour (July 7 to July 10)
- Admission to the Philip J. Currie Dinosaur Museum for all 4 days.
- Fees for Pipestone Creek Bone Bed excavation and for the rafting excursion on the Wapiti River.
- Guidebook, T-shirt and goodie bag.
- Canadian charitable tax donation receipt for a portion of the fees.

The tour costs (including GST):
CDN $2295.00 per person (minimum age 12).
CDN $370.50 single supplement.

Get a registration form from Mona Trick at **dinotour@DinosaurResearch.com** or select **https://dinosaurresearch.com/images/Dinotour2023TrifoldBrochure.pdf**. Your spot will be reserved once we receive your deposit of CDN $500 for each registration (by cheque, money order, Visa or MasterCard credit card or INTERAC e-transfer to **info@dinosaurresearch.com**). The balance of the tour cost and signed waiver form is due by June 1, 2023. Note that registration is limited and the tour is already 30% full.

Proceeds generated from this tour support the work of the Dinosaur Research Institute (DRI), a non-profit charitable organization which finances dinosaur research in western Canada by graduate students and scientists.

For more details, contact **Mona Trick**. E-mail: **dinotour@DinosaurResearch.com**, phone or text **(587) 578-4579**. ❏

Tour the Philip J. Currie Dinosaur Museum. Photo provided by Travel Alberta. Copyright © 2023.

Tyndall Stone honoured,
Designated a Global Heritage Stone

By Tako Koning
Senior Geologist, Consultant

On October 28, 2022 the International Union of Geological Sciences (IUGS) announced that Manitoba's Tyndall Stone has been designated a IUGS Heritage Stone after having been approved by the Subcommission of Heritage Stones as a global heritage stone resource. Tyndall Stone is a fossil-rich Ordovician-age (450 million years old) limestone that is quarried at the Garson Quarry, 30 km northeast of Winnipeg. Tyndall is used for decorative building purposes throughout Canada due to the stone's beautiful tan to cream colouring, extensive mottling and abundant fossils representing a variety of species.

Canada is the only source in the world for Tyndall Stone and the Gillis Quarry in the village of Garson is the only location where it is quarried. Tyndall Stone is named for the nearby village of Tyndall, where the stone was loaded onto the Canadian Pacific Railroad for delivery to sites across Canada.

Tyndall Stone is rated as one of the most beautiful decorative stones in the world. In Ottawa it clads the interior of the Parliament Building, in Gatineau, Quebec the exterior of the Museum of Civilization,

Figure 1. Front of the Bank of Montreal Building (now Goodlife Fitness) on the northeast corner of 1st Street and 8th Avenue S.W. (Stephen Avenue Mall), in downtown Calgary. The columns and façade are entirely Tyndall Stone. Photo by Tako Koning.

Figure 2. Donna Gillis, co-owner and production manager, Gillis Quarry, Garson, Manitoba. Photo by Tako Koning.

in Winnipeg and Regina it clads the outside of the Provincial Legislature buildings as it does the Rimrock Hotel and Chateau Lake Louise in Banff National Park, the Empress Hotel in Victoria, the Canadian High Commission (embassy) on Trafalgar Square in London, and many more locations.

In the CBC's press coverage of the nomination on January 24, 2023, Donna Gillis, the co-owner of the Gillis Quarry, along with her brother Keith, told the CBC "It's an honour. We've always said it's not like other limestones. There are other limestones in Canada but this is a unique deposit and the fossilization is really different."

The nomination of the Tyndall Stone was spearheaded by **Dr. Brian Pratt**, Professor of geology at the University of Saskatchewan in Saskatoon, along with **Dr. Graham Young**, Curator of geology and palaeontology at the Manitoba Museum in Winnipeg. The Winnipeg Free Press on January 24, 2023, ran the headline: "A Manitoba icon has become an international rock star." In an interview with the Winnipeg Free Press on January 24, Dr. Young said "There was no Canadian stone on the list. They had Carrara Marble that Rome was built on. They had Portland Stone that London was built from. They had Tennessee Marble that was used across North America. There was no Canadian stone."

Professor Pratt was invited to provide comments for this article and he noted, "I was encouraged to lead the nomination by having been invited to join the board of what later became the Subcommission of Heritage Stones. I was excited to do so, not just because the stone is so iconic here in Canada but also because it still brims with scientific questions. It is an incredible teaching resource. What geologist is not drawn to examine building and dimension stones!"

For those wishing more information on the Tyndall Stone, please see the author's article in the December 2020 *Bulletin*: "Tyndall Stone—Hunting Ordovician fossils in downtown and inner-city Calgary." The author also presented on the quarrying of the Tyndall Stone in a PowerPoint presentation given to the APS on April 8, 2022 that was based on a visit to the Gillis Quarry in October, 2021. This PowerPoint is available to anyone by contacting the author at **tako.koning@gmail.com**.

The author leads an annual half-day field trip for APS to view Tyndall Stone in downtown Calgary, study fossils in blocks of Tyndall Stone in front of the Safeway store in Kensington, and view a variety of amazing of fossils in Tyndall Stone which entirely

Figure 3. Professor Brian Pratt examines fossils in "The Memorial Wall," a wall made of Tyndall Stone in the Geology Department at the University of Saskatchewan, dedicated to eight geology students who fell in the Second World War. Photo by Kristen McEwen.

clads the Senator Patrick Burns building at SAIT (Southern Alberta Institute of Technology). This year's field trip will be held on September 16, 2023 (see Page 12).

Queen Elizabeth and Tyndall Stone

In 2002 Queen Elizabeth and Prince Philip made an official visit to Manitoba to mark the Queen's Golden Jubilee. The Royals attended an event at the Manitoba Legislative Building where tens of thousands of Manitobans came out to catch a glimpse of

Her Majesty. This visit received extensive coverage by the media.

Being a geologist with a strong interest in palaeontology, I found highly interesting the portrait taken by **Christopher Wahl**, a well known Toronto-based professional photographer, showing the Queen standing in front of a wall of Tyndall Stone. Tyndall is characterized by extensive mottling. Some describe the mottling as the "tapestry" within the stone. Indeed, the pattern of the Queen's outfit unintentionally blends in with the tapestry of the Tyndall that almost embraces her. The photograph reminds me that Queen Elizabeth was the United Kingdom's longest reigning monarch, beloved by many, and here she stands in front of an ancient limestone, much favoured by architects, builders and residents of Canada from coast to coast. ❑

Figure 4. "The Queen, Winnipeg" by Christopher Wahl. To see the full-size image, click the photo or go to **https://ffoto.com/collections/christopher-wahl/products/the-queen-winnipeg**

Book review

By Vaclav Marsovsky

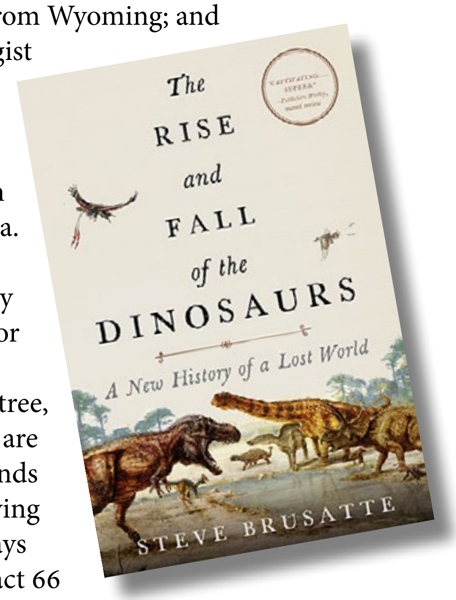
***The Rise and Fall of the Dinosaurs: A New History of a Lost World*. By Steve Brusatte. Harper Collins, 2018. ISBN 978-0-06-249042-1. CDN $24.99 (paperback).** 404 pages of which 48 are notes on sources and the index.

The dinosaur story is presented in a chronological context from their rise in the Triassic to their demise and extinction (except for the birds) at the end of the Cretaceous. The book begins with Steve Brusatte as a graduate student of palaeontology traveling all over the world, meeting interesting people in his dinosaur studies. Most topics are covered at a high level without getting into any subject in great depth. But that is the nature of choices made by authors—otherwise books turn into encyclopaedias.

Brusatte drops more than a hundred dinosaur names over the pages, naming the representatives of the periods without going into their unique characters or showing their pictures. Some names I had never heard before—such as *Kileskus*, *Siats* and *Balaur*. I think even elementary school students would be stumped by some of these names.

Brusatte begins his book in Poland where he documents the evolution of dinosaurs from dinosauromorphs by studying their footprints. The line from dinosauromorphs to true dinosaurs is blurry. Geological forces which caused a climate change (mostly warming) is presented as the cause of the Permian/Triassic and Triassic/Jurassic extinctions. (Siberia being the locus of the former and the break-up of Pangea the latter). These theories are presented as having been settled, with no hints of alternative explanations as the causes of the mass extinctions.

Although most of the book is presented chronologically, there are a few interesting side-stories that I had not read elsewhere, such as the story of "Big Al," the *Allosaurus* from Wyoming; and about a palaeontologist named Baron Franz Nopcsa, an aristocrat who dug up dinosaur bones from what is now Romania. No dinosaur species are dwelt upon to any great extent except for the evolution of the Tyrannosaur family tree, to which sixty pages are devoted. The book ends with dinosaurs evolving into birds and the days after the bolide impact 66 million years ago.



The writing style of Steve Brusatte is easy going, no big technical language, no heavy-duty anatomy lessons. The font chosen and line spacing are easy on the eyes. Perhaps one downside is the lack of colour photographs. The book includes a few black-and-white photos and diagrams. If they were in colour, they would make the book much better. This choice was probably made to keep the cost down. The palaeogeographic positions of the continents during Permian, Triassic, Jurassic and Cretaceous, shown near the start of the book, would be more informative in colour for readers who are not familiar with such maps: in greyscale they are hard to interpret.

A big THANK-YOU to **Harold Whittaker**, who donated a copy of the book to the APS library in January, 2023. ❑

Technical aspects on phase one of the excavation in the largest dinosaur skeleton quarry ever worked in Dinosaur Provincial Park, Alberta, Canada

By Darren H. Tanke*

Figure 1. Dr. Brian Pickles (University of Reading, UK; L) and Dr. Caleb Brown (RTMP) with the exposed bones, now glued, visible as three dark patches. The articulated skeleton lies on its left side, the head faces to the right, bottom of animal faces the viewer. Between the men are (left to right) midsection of tail, distal ischia and lower leg and foot. Image courtesy of the Royal Tyrrell Museum of Palaeontology, ©2021. Used with permission.

Introduction and discovery

On August 12, 2021 Teri Kaskie, a Calgary-based biologist and Dr. Brian Pickles (University of Reading, England) discovered a subadult hadrosaur skeleton (**Figures 1, 2**; King, 2022) in Dinosaur Provincial Park (DPP). Teri was volunteering with Dr. Pickles as a research assistant collecting preliminary data for a joint University of Reading (Reading, England) and University of New England (UNE; Armidale, Australia) vertebrate palaeontology field school. This field school, headed by Drs. Phil Bell (UNE) and Brian Pickles, was due to start in summer 2020 after an exploratory visit in June 2019 but was delayed by the COVID-19 pandemic.

The 2021 activities were initiated by Dr. Pickles to re-examine multi-taxic bonebeds that were initially identified in 2019 as holding promise for the field school and he took volunteers Teri Kaskie and Melissa Dergousoff, an Edmonton-based biologist, as his field crew. 2022 marked the first year the field school got off to a serious start with eight undergraduate students, three staff from Reading, three postgraduate students and one staff member from UNE. Students learn about various aspects of Late Cretaceous vertebrate palaeontology; attend a public palaeontology lecture or two given by a RTMP staff member; work in a Late Cretaceous multi-

* Senior Technician II, Royal Tyrrell Museum of Palaeontology, Drumheller, AB T0J 0Y0. **darren.tanke@gov.ab.ca**

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Written by a real *Homo sapiens* who was there, not AI!

Figure 2a. The Kaskie hadrosaur (TMP 2021.012.0004) exposure just after discovery, looking roughly south. The large amount of sandstone overburden to be removed is readily apparent. White outline indicates area of Figure 2b. Photos by the author.

taxic bonebed where they uncovered, collected and identified skeletal elements; prospected for fossils; and assisted on the waste rock removal at a dinosaur quarry, the main topic of this paper.

While prospecting for fossils, Kaskie and Pickles first found the mid-section of an articulated tail eroding out of the strata. Nearby, distal ischia, appearing to be expanded or "booted" (suggesting a lambeosaurine or crested hadrosaur like *Lambeosaurus* or *Corythosaurus*) were seen, and further along a distal tibia, fibula and ankle bones protruded out of the sandstone rock; an articulated metatarsal angled back into the rock (**Figure 1**).

Thin skin impressions preserved in ironstone covered parts of the exposed skeleton, namely the tail (**Figure 3**) and lower leg. The author later discovered a small, hollow pocket behind the metatarsal that was plugged with dried mud. Cleaning that out, skin impressions from part of the underside of the foot were revealed. This skeleton, known as the "Kaskie hadrosaur," is catalogued at the Royal Tyrrell Museum of Palaeontology (RTMP) as TMP 2021.012.0004. The author has nicknamed the animal "Ferris" in recognition of the Cretaceous ferrous-rich mud that later turned into ironstone that preserved the beautiful skin impressions on the skeleton.

The area where it was found has not been prospected much by current generations of palaeontology field workers. There are no recognized bonebeds in

Figure 2b. Detail of exposed Kaskie hadrosaur. Tail exposed on left, head end to right. For scale, pick is 55 cm. long.

the area and lots of grass, so at first glance it does not present an inviting place to explore. Yet some significant finds have been located not far away. In 1914 the American Museum of Natural History found the plesiotype of *Corythosaurus casuarius* (AMNH 5338; Quarry 111) less than 100 m to the west. The same year the then-named palaeontology division of the Geological Survey of Canada secured a fine *Chasmosaurus belli* skull and partial skeleton (CMN 2280; Quarry 10) about 300 m to the southeast. In 1969 the University of Alberta collected a complete *Centrosaurus apertus* skull, *sans* mandibles (UALVP 11735; Quarry 135) about 200 m to the northeast. The Kaskie hadrosaur is about 100 m south of an east-west trail that runs to the Quarry 143 *Centrosaurus* bonebed, scene of intensive RTMP digging opera-

Figure 3a. TMP2021.012.0004, articulated mid-caudal (tail) vertebrae, tendons and skin impressions. Anterior is to the right. Image courtesy of the Royal Tyrrell Museum of Palaeontology, ©2021. Used with permission.

Figure 3b. Close-up of smaller area of Figure 3a showing 3D pebbled skin impressions on tail. Image courtesy of the Royal Tyrrell Museum of Palaeontology, ©2021. Used with permission.

tions from 1979 to 1989, then 1991 to 1993 and visited by well over 50,000 tourists on guided hikes since 1979.

DPP has long been recognized for its abundant hadrosaur fauna, be it rare eggshell fragments (Zelenitsky and Sloboda, 2005); ichnites (McCrea *et al.*, 2005; Therrien *et al.*, 2015); countless isolated bones; a few monospecific bonebeds (Eberth and Evans, 2011; Eberth *et al.*, 2014; Tanke, pers. observ.) and hundreds of partial to full skeletons, most from adult-sized individuals (Dodson, 1983; Evans, 2001; Ryan and Evans, 2005). Remains of small hadrosaurs, ranging from hatchlings and neonates (Sternberg, 1955; Tanke and Brett-Surman, 2001), young (Waldman, 1969) to half-grown have also been recovered there, with some of the latter being named as new taxa by earlier researchers. These, *Procheneosaurus praeceps* (AMNH 5340 (type); Matthew, 1920; **Figure 4**); *Tetragonosaurus erectofrons* (Parks, 1931) and *T. cranibrevis* (Sternberg, 1935) were later recognized as immature individuals of previously known taxa such as *Corythosaurus* and *Lambeosaurus* (Dodson, 1975; Evans *et al.*, 2005; see also Martyniuk, 2013 and Anonymous, 2022a for general taxonomic reviews/discussion). AMNH 5340 is particularly useful here as it is the most complete juvenile lambeosaurine (missing only one forelimb), known from DPP at 4.31 m in length, now referred to *Lambeosaurus* sp. (Evans, 2010) and is roughly the size of the Kaskie hadrosaur if the latter constitutes a full skeleton.

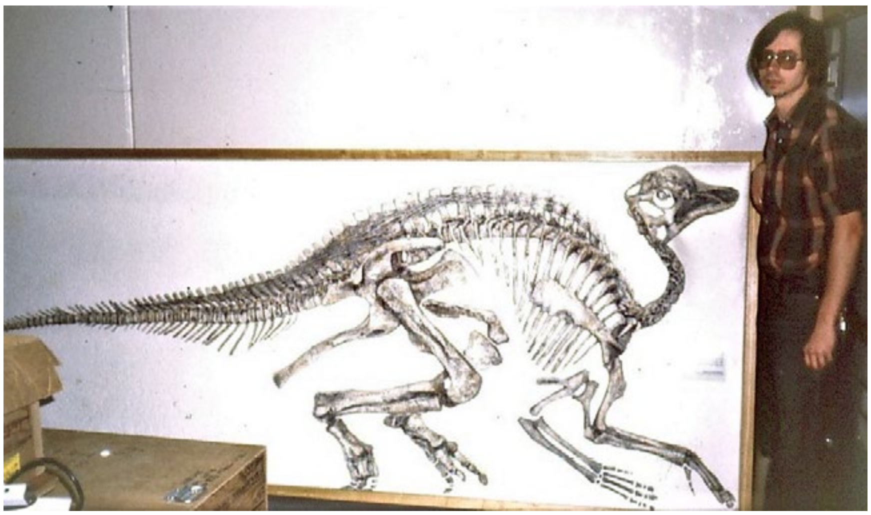


Figure 4. The author (6′/1.83 m tall) about 1985 with a RTMP cast (TMP 1985.008.0004) of AMNH 5340, the type of *Procheneosaurus praeceps* as found in its death pose. The image has been reversed here to match the field orientation of the Kaskie hadrosaur, TMP 2021.012.0004. The specimen was recovered in the Steveville district of DPP in 1914, though the precise quarry locality is currently unknown. Author's photograph.

Qing-Wei *et al.* (2015) consider the type of *P. praeceps* as a late juvenile stage-sized individual. The "Kaskie hadrosaur" is unique in having thin ironstone skin impressions of exquisite quality preserved on the mid-tail and ankle regions. Prior to discovery, much of the skin impressions had already flaked off from erosion, but it is suspected and hoped that more skin, undamaged by weathering, remains inside the host rock attached to the rest of the skeleton. The remaining skin impressions are beautiful and appear "shrink-wrapped" onto the bones and tendons in places.

This paper speaks little about the science of the specimen but focuses more on its history and the logistical issues regarding the uncovering of the specimen, the jacketing, hypothetical ways of removing it from the field to an awaiting transport truck, and its placement in the fossil preparation lab at the RTMP. Performing all this with a potentially very large jacket, being mindful of safety of all personnel involved, safety of the specimen, and of the protected Park environment are highest priorities.

Technical issues

Upon seeing the site for the first time the author and field project leader realized that collecting this specimen would be an epic undertaking, one that would result in the largest single dinosaur skeleton quarry in DPP. There were overburden thickness issues (about 8 m); a large quantity had to be removed—not once, but twice. Overburden is usually just dumped downhill, but at this site it would quickly pile up and block access to the specimen. Jackhammered waste rock, breaking up further as it tumbled downhill, had to be transported elsewhere.

If the skeleton was extensively covered with skin impressions it could not be divided into smaller plaster-of-Paris blocks as is usually done for larger skeletons: skin impressions would be destroyed if that was done. A single field jacket would be required to collect it: very large and very heavy. Getting such a block out of the badlands will create technical and environmental challenges. Some of these issues have already been dealt with but others remain for the summer 2023 field season. Damage to the exposed bones and skin impressions would happen during overburden removal and this would necessitate them being covered and strongly protected. On-site personnel health and safety and safe specimen extraction, the latter with special environmental consideration, are issues discussed separately below.

Personnel safety

Having just taken a worksite safety course that included fall restraint, the author realized that some sort of on site fall protection system would be needed. We hired someone to help on the safety training, body harnesses, adjustable rigging and other matters to meet industry standards and get the overburden removal job done safely without fear of falling from the steep exposures. Details will be described elsewhere (Lambert *et al.*, accepted).

Specimen safety and site mitigation

In the summer of 2021 the fossil bones and skin impressions had been fully glued with an acryloid preservative dissolved in acetone. The thinned glue to solvent ratio was such that the exposed bone and skin impressions were well coated and the glue penetrated deeply into the trabecular bone for strengthening and stability. Some vertebrae and a number of chevrons had already been completely eroded away. The nature of the bone is such that exposed pieces do not break off in chunks that can be reassembled later. The trabecular bone tends to be soft and poorly consolidated, typical for young animals whose bones can be poorly ossified. It disintegrated into small, poorly-consolidated crumbs on exposure. A thorough visual search for pieces and wet-sieving of matrix below the skeleton recovered little. Curiously, the ironstone skin impressions appear better preserved and more durable than the bone itself. The bones were fully exposed in places and some of the rock beneath the specimen was undercut. The bones would be seriously damaged or destroyed by falling rock during the extensive overburden removal process, even with a plaster jacket covering. The uniqueness of the specimen demanded extra protective measures which are described here.

Loose clay from a nearby outcrop was collected, put into a bucket and water added. This was allowed to soak for a few minutes and then mixed thoroughly by hand to make a thick, putty-like material. The author began experimenting with this "mudding" technique in the 1990s. The mud was then manually pressed into the rock hollows under the bones to build the eroded rock surface back up to bone level. Deeply eroded adjacent rills in the rock were also filled. As a separator, toilet paper, then paper towel, was wetted and applied to the exposed bones, dabbed down with paint brushes. Then more mud was mixed, this time of a thinner consistency. It was smeared on top of the paper separator and pressed into any remaining hollows, making almost everything flush with the rock surface.

In the next step a single plaster and burlap jacket made from extra strong Hydrocal® FGR 95 gypsum cement (hereinafter just FGR) was made to cover the entire specimen. This alone would protrude slightly from the rock wall and would incur repeated strikes from falling rock during the overburden removal phase of work.

Additional protection was needed. The author devised the first-time use in DPP of deflector shields. Five layers of wet FGR and overlapping burlap pieces were laid out on the flat sandy ground, which once dried, created two strong and rigid sheets, each measuring 1.2 × 0.9 m (4 × 3 ft). One sheet was temporarily held up in place with a handmade ladder on the rock surface, covering and above the previously made jacket. It was then nailed to the sandstone outcrop across the top with strong concrete nails and a crack hammer. Once held firmly in place, the second deflector shield was similarly positioned next to the first and nailed in place. Then additional wet FGR/burlap strips were laid across the narrow gap between the two shields, forming a single, rigid structure. More FGR and burlap strips were angled down on both ends of the shield to the nearby outcrop, sealing off both ends. Four short lengths of two-by-four wood blocks for bottom support were positioned between the bottom of the deflector shields and the rock outcrop and were simply plastered into position. At this point the top of the shield was still open, with the rills in the outcrop passing deeply underneath. These gaps were filled by the application of more mud stuffed into any hollows until they were level with the surrounding rock and shields, sealing the gaps. The mud fill was feathered upward into the outcrop contours. Plaster of Paris (and later FGR) and burlap bandages were then placed atop the drying mud and feathered or blended upwards into the outcrop. Once dry, more concrete nails were hammered through the top and sides of the shield into the sandstone rock (see images in Anonymous, 2022e; Royal Tyrrell Museum, 2022).

The protective jacket was now safely cocooned under the deflector shield, though the bottom remained open as it was unnecessary to seal off this area. During overburden removal, this relatively light and inexpensive system resisted countless rock strikes with some bouncing pieces weighing as much as 45 kg. During overburden removal the deflector shields needed some spot repairs with more FGR and burlap on two occasions where the shields were wearing thin or suffered partial punctures. When it had finished serving its function, it could be cut in half and transported for use elsewhere if required.

Excavation work

Excavation of the overburden started on the late morning of August 18, 2022. Two gasoline powered Honda™ electric generators ran two electric Hilti™ jackhammers. Two people operated the jackhammers. A third person with a shovel or rake discarded debris over the edge. Initially, gravity proved useful in clearing the site. Very large pieces of rock (up to ~225 kg) pushed or levered over the edge were mostly broken up into smaller pieces by tumbling and impact with the valley floor below. Personnel were kept well away from the fall zone during this work.

Toward the end of each day, after jackhammering ceased and/or early in the morning as RTMP workers were donning their climbing harnesses and getting ready to descend to the working face, the University of Reading, UNE, and remaining RTMP staff and other volunteers shovelled waste rock into five large wheelbarrows which were then dumped a short distance away downslope. Use of multiple wheelbarrows allowed for rapid removal of rock waste; as many as four were active at any one time. The number of wheelbarrow loads was carefully recorded; loads removed per day (full days unless otherwise noted) were:

August	18	(1/2 day)	43	loads
	19	(1/2 day)	95	
	22	(1/2 day)	70	
	23		212	*
	24		181	
	25		161	
	26	(1/2 day)	72	
September	6	(1/2 day)	8	

*51 of these were jackhammered loose on August 22.

A total of 842 wheelbarrow loads were moved in a combined 5.5 days.

Such rapid removal in a short time seems remarkable, almost impossible. The mostly white sandstone overburden exhibited vertical cracks and subhorizontal bedding surfaces that separate easily, as the author has observed on prior digs in southern Alberta. Sandstones of this type can be removed in large pieces, some chunks weighing tens to hundreds of kilograms. These rock properties can be used to advantage in rapidly removing overburden. Work started high on the slope and a succession of three stepped benches, increasing in width, were cut down toward the specimen. By the end of August a bench 8.2 m × 2.6 m had been established about 1 m above the specimen.

Despite rapid progress, it was decided later in the season to slow down and leave the rock with the dinosaur inside mostly still attached to the exposure at the back and along the sides; but not until rain and snowmelt drainage trenches had been created. Had the skeleton been trenched all the way around and then left until the next field season, the sides of the block of rock would be unsupported for about ten months. Vertical joints in the rock would allow the matrix to calve away, much like icebergs forming at the toe of a glacier. This would seriously endanger the skeleton and skin impressions inside. Leaving it attached to the larger supportive rock outcrop provides stability and eliminates the need for regular on-site monitoring and possible emergency mitigation efforts during the fall 2022-spring 2023 period.

The deflector shield was left up, but as the quarry floor was now at the level of the shield top and it had separated slightly from the in situ rock, a series of FGR and burlap bandages, three layers thick, were laid onto the floor of the quarry near the edge and draped a short distance down the front of the deflector shield. This will help hold it down in case of high winds, but is more to help shed any rainwater or snowmelt away from the jacketed specimen below.

Waste rock weight calculation

Given the epic nature of the dig we were interested to know how much rock, by weight, would be jackhammered and removed from the site. Large wheelbarrows, all of the same volume capacity, were used each day to move and pile up the waste rock on slightly lower ground nearby to the north. The rock weight per wheelbarrow load was estimated by filling a plastic five-gallon pail (18.9 l) with site waste rock and then weighing that on a former commercial weigh scale in the DPP Field Station public

Figure 5. The "Kaskie hadrosaur" (TMP 2021.012.0004) locality before (left) and after the jackhammering and wheelbarrow removal work. The white, rectangular mass in the right image is the plaster and burlap deflector shield constructed to protect the exposed portions of the skeleton. Author for scale. The site is well inside the restricted preserve area of DPP at UTM 12U 465320 5622130 (WGS 84) and accessible only by RTMP field crews or with direct DPP staff guidance. Photos by the author.

gallery. The scale was first "calibrated" by weighing an unopened 22.7 kg (50 lbs) bag of plaster. The pail contents weighed exactly 22.7 kg. Back at the site we filled the same pail with waste rock, then dumped it into an empty wheelbarrow, repeating this process until the latter was full. A full wheelbarrow carried five full pails or 113.5 kg of rock. Applying this figure to the number of wheelbarrow loads (n= 842) we calculated that roughly 95.6 t of rock were removed in just 5.5 days in 2022 (**Figure 5**). This averaged to 17.4 t of rock moved daily. On the best day, August 23, 212 wheelbarrow loads equalled 24 t of rock moved. A time-lapse video recorded the massive effort. See the video, along with more photos of the operation at **https://royaltyrrellmuseum.wpcomstaging.com/2022/09/01/skin-deep-how-a-unique-fossil-find-brought-together-an-international-team/**

Work in 2023 will result in more rock removal, but not in the numbers recorded above. Time-lapse video of the 2023 dig will be also be recorded and attached to the 2022 work, so as to record the full history of the excavation work. The extraction of the jacket will be similarly recorded.

Excavation of this site, even though only partly finished, is already the largest single skeleton dinosaur quarry ever worked in DPP. Province-wide this quarry is also a contender for one of the largest ever excavated by hand or with smaller hand tools. The Huxley, AB *Tyrannosaurus* (TMP 1981.012.0001) and Crowsnest Pass *Tyrannosaurus* (TMP 1981.006.0001) quarries might be a bit bigger volume-wise, but both were worked with heavy pneumatic jackhammers run off a truck-towed air compressor. Quantifying this size comparison is now impossible; the Huxley site later slumped and the quarry was buried and the Crowsnest Pass site (figured in Anonymous, 2022b) is now partly submerged by dammed lake waters.

Media coverage

The discovery and quarry work generated much media interest. CBC television from Calgary visited the site on August 25. Their stories first aired on August 31 on radio, television and internet. Stories were picked up by many media and soft science outlets beginning on September 1, too many to list them all here (e.g. Anonymous, 2022c, h; Irete, 2022; Luntz, 2022; Young, 2022). Notable internet postings are Anonymous (2022f) and White (2022) which includes timelapse footage of the overburden removal phase of the dig. This footage was taken by RTMP technician Dawson Lambert at the author's request. Work on a dig of this size needed to be recorded for posterity. Other social media platforms like Facebook and Twitter also carried the story.

Future work at the site: Exposing the specimen, extraction strategies and transport to the Museum

2023 work at the Kaskie hadrosaur will face new technical and logistical challenges. Assuming the skeleton is all there, a large block of sandstone containing the skeleton will be exposed on the top, sides and back. While the general size of the animal and its rough orientation are known, its completeness and the exact orientation of three unseen limbs, a torso, neck, and head are unknown. The classic "death pose" in hadrosaurs results in the animal lying flat on its side, tail pointing straight back, both hind legs pulled up toward the body and knees strongly flexed. Orientation of the arms varies but they are often retracted or dangling, the neck typically retracted and curved into a swan-like posture (*e.g.* Faux and Padian, 2015; **Figures 4, 6**).

If the hoped-for full skeleton is present, the thin and fragile ironstone skin impressions may be extensively preserved. Therefore, the current plan is to collected the Kaskie hadrosaur skeleton in one large jacket. Such has been done with smaller dinosaurs—the 1995 DPP ornithomimid (TMP 1995.110.0001) collected by the RTMP for example—but not with a larger skeleton. Some larger marine reptile skeletons at ammolite mines have been taken out in large jackets but at such sites there was always trackhoe support with heavy lifting capabilities (e.g. Mitchell, 2013; Tanke, 2013, 2016).

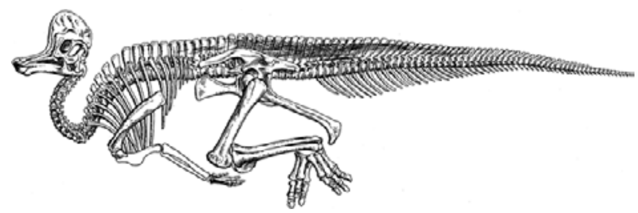
Because of the likelihood of extensive skin impressions, traditional use of hammer and awls to reduce the sandstone block as we get closer and closer to the specimen will prove problematic. Accidental damage to the skin impressions could occur. Use of thin bladed hand tools such as trowels or sharpened putty knives to systematically shave or scrape the loosely-cemented sandstone might prove more useful. Sharpened floor scrapers can be used deep on the underside of the block, avoiding the need for workers to be underneath.

Some parts of the exposed skeleton showed distinctive brown staining in the sandstone close to, but above, the ironstone-preserved skin impressions, in a kind of halo effect. This staining, if it occurs elsewhere, may prove a useful alert to the workers that unseen skin impressions lie just below their tools. Shaving the rock down from above and looking for the brown staining might also reveal the orientation of the forelimbs, neck and head. The rest of the animal could remain attached to the side and back walls for support until this aspect is better understood.

When as much sandstone matrix has been removed as possible—and a lot of time will be dedicated to this—numerous measurements and a photogrammetry model or detailed differential GPS model will be made to serve as references for weight estimation. The rock's specific gravity can be calculated from a sample on site.

Then jacketing with FGR and burlap will commence. Thickness of the field jacket will depend on how complete the specimen is. Calculated rock weight, and weights of water, FGR and stiffening wood splints will be carefully recorded. Data from the photogrammetry model and weight of water (~ 50% lost through evaporation; see endnote 9 in **Table 2**), and lumber will give us and a hired contractor, if used for moving the block, a relatively accurate idea of the total weight which could be up to 4.5 t, but hopefully less than 3 t—still a massive block. Some preliminary weight estimation of a single large field jacket, using a drawing of a similar-sized hadrosaur skeleton (AMNH 5340) in its death pose with a hand-drawn approximate outline for the jacket, some basic math, and a rock sample suggests 3.0 to 4.5 t, so weight mitigation will be required.

The skeleton presently sits about 1.75 m above the valley floor which will allow ample room for undercutting, jacketing and, if the skeleton is com-



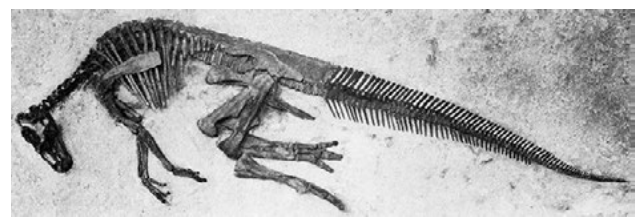


Figure 6. Death poses in two Alberta hadrosaurs. Top: AMNH 5240 adult *Corythosaurus casuarius*, Dinosaur Provincial Park. Below: CMN 8399 adult *Edmontosaurus regalis*. The neck is a bit straightened and tail added in CMN 8399. Top image from Brown (1916); Lower image from Sternberg (1917).

plete, turning the massive block over if needed. Alternatively, the specimen could be recovered by the box-like monolith method (Suzuki and Watabe, 2000; Watabe *et al*., 2004) used to great effect in the Gobi Desert. While resulting in a nice, squared-off product that appears easier to handle and load onto a truck, it would result in a heavier load to get out of the badlands.

In the fall 2016 the author led the palaeontology phase of a joint archaeological/palaeontological project to collect a large, *in situ* 1,600 year-old First Nations roasting pit at Head-Smashed-In Buffalo Jump Provincial Park (Hallson *et al*., 2017; Tanke *et al*., 2017). The archaeologists wanted the feature fully contained in a jacket, as is done for collecting dinosaur skeletons, but not rolled over, trimmed and sealed at the end as is usually done. They wanted it fully jacketed but left *in situ* the entire time. This called for some "outside the box" thinking. As the jacket was being undercut, stacks of lumber were placed under and around the jacket so it could not tip over. Each stack was removed one at a time, the necessary undercutting and plastering work done, then the stack was replaced. This process was repeated multiple times around the block until the entire mass was excavated, undercut and jacketed, atop a central cylinder of rock about the diameter of a coffee can. When the crew returned the next day, gravity had firmly settled the jacket onto the wooden supports. A gap between two wood stacks allowed access to pickaxe the last of the pedestal away and finish the plastering work. The resulting jacket, weighing 1.3 t, was lifted by a crane mounted on a heavy flat-deck truck without issues (Anonymous, 2016a; McCutcheon, 2016). The item became an exhibit in the First Nations section of the new Royal Alberta Museum in Edmonton. A similar excavation and jacketing technique might work for the Kaskie hadrosaur.

A number of dinosaur skeletons found in DPP are preserved in light grey sandstone underlain by friable, dark grey clay (Dodson, 1971; Tanke, pers. observ., 1979 – 2022). This makes undercutting and jacketing problematic, as the loosely-consolidated clay compresses under the weight of the jacket. In this sedimentological setting the Kaskie hadrosaur could not be collected by the method employed at Head-Smashed-In. Fortunately for us, the blocky and relatively indurated nature of the sandstone both above and below the Kaskie hadrosaur would allow us to use the Head-Smashed-In technique. Wet FGR bandages can be laid out on long planks (sheathed with plastic sheeting) and safely passed under the block to workers on the other side. Workers on each side pull the bandage up and it can be safely pressed onto the underside of the block with paint rollers mounted on long handles. We will be working "blind" at times, so use of a mirror to view the underside is anticipated. Once the jacket is turned over (if necessary), removal of any excess rock will have to be done to reduce the jacket's weight.

Extraction from the site

Once the cocooning field jacket is completed, it needs to be removed from the site. Physically moving the wrapped Kaskie hadrosaur from the quarry to a road requires much careful consideration. The technical and newspaper literature for vertebrate palaeontological field techniques is replete with instructions or imagery on how to properly make a supportive plaster of Paris and burlap field jacket and how to flip it over.

Much less is said about how to then get the completed block from the site to a camp or vehicle for transport. Small jackets can simply be carried by hand or in a backpack. Larger ones require some ingenuity of the field workers, be it some kind of stretcher, a stoneboat or sled pulled by horses (Camp and Hanna, 1937), a block on an old upside-down car hood acting as a sled and dragging by hand or truck-mounted winch (Lillegraven, 1969); or some inventive wheeled contraption (Carbone *et al*., 2016; Blanke, 2022) or the "Dino Wheel" (Makela and Leiggi, 1989; Leiggi *et al*., 1994). These methods are handy for lighter jackets, but it seems little has been written on how to move a super-heavy "megablock" from the site to a place where it can be hauled to the museum by motorized transport. Removing particularly heavy fossils or plaster of Paris "blocks" from the rugged badlands can prove vexing for field palaeontologists (Hone, 2013). A number of successful recoveries of heavy to super-heavy specimens by land, water and air are listed below in tables 1 and 2.

Dragging especially heavy jackets is particularly cumbersome, given the weight, rough terrain, slopes, distance, and especially friction. A massive plaster block containing a concentration of *Utahraptor* and iguanodont skeletons and weighing some 8 t, was collected in Utah in 2014. At first (Anonymous, 2013b), it was hoped to be moved by helicopter—but in the end it was dragged on a massive wooden sled over a purpose-made road (Anonymous, 2021; Utah Geological Survey, 2022).

Removing the Kaskie hadrosaur block from the badlands, despite its anticipated size and weight, may prove comparatively easier. The DPP bus tour road through the restricted badlands preserve area is only some 350 m away, with a clear line of sight to the quarry along roughly 200 m of the road. Fortuitously, between the road and the hadrosaur are some sparse badlands with little to no relief and mostly flat to low rolling grassy terrain. The interval includes a section of straight, grassed-over road, bladed through the area many years ago—perhaps in 1969 to access the University of Alberta *Centrosaurus* skull (Quarry 135; UALVP 11735), just about 100 m ENE from the Kaskie hadrosaur. Removing the anticipated large field jacket will be a major technical challenge, whether overland or by air. Both are considered below.

Overland extraction

The earliest dinosaur collectors in western North America used a variety of means to transport large jackets from the field. A thorough search of the older literature revealed little. Horse-drawn stone boats or buckboard wagons were used (Matthew, 1915; Silbernagel, 2016), the jackets raised and lowered by means of a sturdy wooden-post tripod and a chain block hoist. Most of these technologies/methods are no longer used, are unfamiliar to us today and should not be tried without proper training, or are insufficient to move an especially large field jacket.

Horses have been used on occasion in recent years **(Table 1)** but the Kaskie hadrosaur block will be too large and heavy. The last time horses were used in Alberta in a block dragging capacity was in 1954, pulling a stone boat. The horses, unfamiliar with the strange badlands terrain, were balky and skittish (Fotheringham *et al.*, 2014). Two Clydesdale horses were used in Saskatchewan in 1995 to flip a large block of the now famous *Tyrannosaurus* "Scotty," but it was reported to the author by witnesses that the motion and/or the sound of the block rolling over spooked the horses and they ran off, dragging the block behind them, the sound of which spooked them even further and they continued to run until exhausted.

In more recent decades, dedicated and innovative teams of field workers have removed large, very large, and truly monumental field jackets or "megablocks," some estimated as much as 18 t **(Table 1)**. These efforts employed massive wooden sleds, some prebuilt and reassembled on site (*e.g.* Maltese, 2009).

Other jobs involved the onsite welding of heavy steel support girders, construction of sleds or custom-made encapsulating metal frames (see Peterson *et al.*, 2000, Anonymous, 2023, and **Table 1**). All were then dragged out by powered construction equipment like bobcats, backhoes, trackhoes, front-end loaders, giant earthmovers, or lifted onto flat-decked trailers on site by heavy industrial cranes. Such moves sometimes necessitated the construction of a road, giving the heavy equipment access to the site and the megablock a route for safe extraction.

Figure 7. The RTMP's 2019 Ford F650 Super Duty truck with SL145 swap loader deck. The flat deck measures 3.79 m long and 2.19 m wide. A slightly downward angled rear end of the deck creates a longer platform (4.13 m). The tilting and removable deck stands 1.32 m above ground. The deck has two strong winches, each rated at 6.8 t. The hook lift on the truck can lift 6.3 t. Photo by the author.

The Kaskie hadrosaur does not have to move very far, only 350 m straight-line distance, after skirting the edges of nearby badland outcrops. However, about 80% of the proposed overland crosses protected habitat of fragile, sensitive grassland with scattered sage brush and greasewood.

Table 1 (Following pages). A chronology of select examples of heavy and superheavy fossil recoveries (and one archaeological feature using palaeontological jacketing techniques), mostly in North America, using animals (including people) and heavy machinery or by water (liquid/ice) at archaeological (N=1) and palaeontological sites, with further information.

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weight(s) (t, kg)	Transportation method	Road built?	Citations and Notes
1897	Bone Cabin Quarry, WY	Sauropods, etc.	Unstated, but large and heavy	Horse and wagon, railroad		Osborn, 1904
c. 1910 – 1923	Dinosaur National Monument, CO and UT	Various U. Jurassic dinosaur species	Very heavy blocks.	Mule teams, heavy freight wagons; 2 stretches narrow-gauge railway, primitive ferry on river; standard railway to Pittsburgh, PA	Yes	Anon, 2018
1915	Dinosaur Provincial Park, AB	Ankylosaur pelvis block	"Nearly a ton"/907 kg	"Block and tackle", wagon, railroad	No	Anon, 1916
1922	Dinosaur Provincial Park, AB	Headless adult lambeosaur skeleton; quarry 69	1.1 t	Horses and wagon, chain block/tripod, railroad	Yes	Anon, 1922; archival photos at TMP
1923	Dinosaur National Monument, UT	*Diplodocus* skeleton	2.7 t: largest block	Horses and wagons, railroad	Yes	Anon, 1923; Miller, 1929
1924	Uintah Basin, UT	Unspecified dinosaur bones	2.3 t combined weight	Four horses and wagon, railroad		White, 1977
1924	Jensen, UT	Five dinosaurs: sauropods, *Stegosaurus*, *Ceratosaurus*	27.2 t combined weight	20-25 four-horse freighting wagon teams, each carrying ~2500 lbs; 9-10 day trip	Yes (some), also on trails/ roads	Anon, 1924a-c; Webb, 2013
1931/02	Buffalo, NY	Mastodon skeleton	Skull (unstated, but heavy)	Ten men needed to lift it onto truck	No	Conroy, 1931
1931 – 1932	Emery Co., UT	Small dinosaur in conglomerate slab	> 2.4 t	Tripod, chain block, wagon with two horse teams **1**		Strong, 1933:20
1935	Near Spearfish, SD	Sauropod, *Morosaurus*	2.7 t combined weight	"Light pick up car"; seven loads		Anon, 1935
1936	Cook Ranch, Agate, NE	Fossil mammal slab of various species	2.7 t	Unstated		Anonymous, 1936a-b
1937	Unnamed coal mine, Cedaredge, CO	4 huge ornithopod ichnites in a line, est'd 4.6 m stride (later refuted). Plus large fossil plants (palm fronds)	27.2 t on collection, reduced in thickness on site (Anon); final shipping weight ~ 7.3 t (AMNH)	Nine experienced miners; rock drills, wood props, 5-ton block and tackle, mine car, museum truck, train	No	AMNH, 1937; Anon, 1937; Brown, 1938; Bird, 1985
1947	Albiquiu, Ghost Ranch, NM	*Coelophysis* mass mortality blocks	Unstated, appears to be > 907 kg	Caterpillar bulldozer, trucks, railroad	Yes	AMNH, 2015:@ 3:37 of online video; LeViness, 1947
1949/08	Albiquiu, Ghost Ranch, NM	*Coelophysis* mass mortality blocks	907 kg jacket	15 m tall crane to lower block into Univ. of NM basement lab	No	Anon, 1949a
1949/12	Blacksburg, VA	Ordovician *Dinorthis holdeni* brachiopod slab	2.7 t limestone slab	Unstated but road construction equipment present	No	Anonymous, 1949b; Stewart, 1949; found during highway construction
1958/08/13	Irvine, AB	*Chasmosaurus irvinensis* skeleton	"At least 2 tons"/1.8 t	Block flipped with Jeep station wagon winch and taken away by "local trucker"		Langston, 1958
1961, Easter	Near Seligman, AZ	Sandstone slab with probable synapsid, mostly *Chelichnus* (*Laoporus*) tracks (Permian)	Unknown, but heavy: 3.6 m × 1.5 m × 15 – > 30 cm thick	More than twelve people, pry bars, 4×4 posts, pipe rollers, gravity, 20-ton jack, large truck, and "many hours"	No	Lofgren et al., 2019:148-149; Farke, pers. comm., 2022/09/20
1965, Summer	Dinosaur Provincial Park, AB	*Corythosaurus* skeleton in rock slab, moved ~20 m for in-building exhibit	"About ten tons"/9.1 t	Skidded down hill by Caterpillar tractor	Yes	Fowler, 1965
1971/02/02	San Pedro, CA	Grey whale skull, ribs, vertebral column	Unstated, but large and heavy (2 blocks)	30-ton crane and truck	No	Dennis, 1971; Cabrillo Marine Aquarium, 2012
1977, Summer	Near Dry Island Buffalo Jump Provincial Park, AB	Hadrosaur skeleton; TMP 1977.005.0001	"Each section weighs several tons" (1.8 – 2.7 t)	Bulldozer hoped for in newspaper article, TMP 35 mm slides show a smaller-sized front end loader (farm tractor?) with stake truck; "hoisted" and "lifted" in Rickard, 1977	No	Rickard, 1977; Turner, 1977. Rickard (1977) shows a chained larger block, being moved but what the chain is attached to is not seen.
1972	Southwestern CO	Sauropod pelvis	> 1.8 t	"Heavy duty winch truck,"probably the "Dinosaur Jim" Jensen "supertruck"		Anon, 1972; Clarke, 1979 says "supertruck" can lift 3 tons/2.7 t
1973/07/09	Cambridge, England	Glacier-moved Jurassic septarian nodule with unspecified fossils	> 3.0 t	"Self-loading lorry"		Anonymous, 1973
1977/05	Dana Point, CA	4.6 m × 2.4 m slab w/ 17 m.y.o. invertebrate fossils	4.5 t	Crane		Emmons, 1977
1979/08/22 & 30	Sandy Point, AB	Hadrosaur skeleton, TMP 1978.016.0001	Largest block (torso) is 1.4 t	Alberta Government (Transportation Dept.) big front end loader	No	Tanke, 1979.
1979/11/02	Fort Peck Reservoir, near Jordan, MT	*Triceratops* skull **2**	1.4 – 1.6 t	Two pickup trucks, winch and "a lot of sweat."		Phillips, 1979; DeWolf, 1979
1981/08/29	Dinosaur Provincial Park, AB	Hadrosaur skeleton blocks; TMP 1981.015.0001	~680 kg	Two-ton flat deck truck with King crane.	No	None; blocks dragged up the hillside with difficulty.

Bold numbers refer to notes at end of table, Pages 31, 32.

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weights (t, kg)	Transportation method	Road built?	Citations and Notes
1981/09/18	Huxley, AB	*Tyrannosaurus*, TMP 1981.012.0001	~72.6 t (jackets combined weight) [3]	Four-axle truck with 35-ton crane loading a flat-deck semi-trailer. At museum in Edmonton, blocks lifted by AB Govt. heavy 3-axle flat-deck truck w/RO Corp. Stinger II crane.	No	Isbister, 1981; RTMP 35 mm slide telescoping crane extended in 3 sections, used w/wo lattice frame jib. Crane offloaded blocks directly onto flat-deck truck.
1981 – 1982	Albiquiu, Ghost Ranch, NM	*Coelophysis* mass mortality blocks	Unstated, some appear to be > 1.8 t	Caterpillar bulldozer.	Yes	Rinehart et al., 2009, fig. 3 a-f
1981/10/13	Haystack Butte, SD	*Tyrannosaurus* skull and partial skeleton	2.4 m long × 1.5 m around; "about a ton"/~ 907 kg	Large crawler lattice-boom crane.	No	Anon, 1981b; Hill Smith, 1983; Meler, 1981; Ritter, 1981.
1982	Crowsnest Pass, AB	*Tyrannosaurus* TMP; 1981.006.0001	Not recorded, but some multi-ton blocks	Crane.	No	
1982	Albiquiu, Ghost Ranch, NM	*Coelophysis* mass mortality blocks	9.1 t	Unstated; probably bulldozer pulling sled as per prior work.		Anon, 1987a
1985	Albiquiu, Ghost Ranch, NM	*Coelophysis* mass mortality block	7.3 t	Bulldozer pulling sled.	Yes	Bellinger, 1985
1987	Seymour Island, Antarctica	Whale skeleton	680 kg		No	Anon, 1987b
1990	Circle, MT	*Tyrannosaurus* pelvic block	3.2 t	Crane, front end loader, and flat-deck truck.	Yes	Dennison, 1990; Meister, 1990.
1991	McTaggart Wildlife Sanctuary, Edmonton, AB	*Edmontosaurus* bonebed blocks	~ 454 kg	Standard light tow truck.	No	
1991	Milk River badlands, AB	*Brachylophosaurus* body block; TMP 1990.104.0001	> 680 kg	Articulated and boom crane mounted on large flat-deck truck. [4]	No	
1992, Early	Dinosaur Provincial Park, AB	Subadult *Gorgosaurus* skeleton w/o tail, TMP 1991.036.0500, and hadrosaur blocks	~ 1.4 t	Caterpillar D7 bulldozer dragging big metal skip.	Yes [5]	None; jacketed in 1991.
1992/10/22	Smoky River Coals mine, N of Grand Cache, AB	*Tetrapodosaurus* manus/pes ichnite pair; TMP 1992.107.0001	500 kg	Heavy lattice boom mine crane.	No	None
1992/11	Weatherford, TX	*Acrocanthosaurus* dinosaur skeleton in six slabs	Unstated; images in Anon, 1992b and Baker, 1992 show some are multi-tonne in weight	Unidentified large crane.		Anonymous, 1992c-d; Baker, 1992
1994/10/07	Dunvegan bridge, Peace River, AB	*Tetrapodosaurus* footprints slab; TMP 1994.182.0001	Uncertain; large, thick sandstone block ~ 2.0 t	Standard tow truck [6] and crane.	No	Anonymous, 1994; Ferguson, 1994
c. 1995	Hood County, TX	*Sauroposeidon proteles* (*Paluxysaurus jonesi*) pelvis and sacrum block, FWMSH 93B-10-18	10.0 t	"Industrial crane."		Allen, 2009.
1995	West Runton, UK	*Mammuthus trongotherii* skeleton	Unstated, but large jackets	Mechanical excavator with caterpillar tracks used as a makeshift crane.	No (shoreline)	Larkin, 2010; Mostlymammoths, 2022
1995	Eastend, SK	*Tyrannosaurus* "Scotty" skull jacket flip	5.0 t	Four Clydesdale horses, CP Rail derailment crane loaded blocks on flat-deck trailer.	No	James McWilliams, pers. comm., 2022/09/14
1995/03/08	Brownfield, AB	*Gorgosaurus libratus* TMP 1991.163.0001, main body block	Unknown but large and heavy: sandstone, 3 m × 2 m × 1 m	Large front-end loader.	No	Caster, 1995; in marshy area, block removed in winter when ground frozen
1995/10/17	Oldman River, near Maycroft, AB	Ornithomimid tracks block TMP 1995.152.0001	3.6 t (Lowey); 8.2 t (Tanke and Hews); TMP records say 3.9 t	Heavy telescoping crane.	No	Lowey, 1995; Tanke and Hews, 2020
1996	Nanaimo, BC	Late Cretaceous palm or giant fern fossil, cf. *Phoenicites imperialis*	18 t	Heavy crane (two prior attempts failed due to great weight).	No (probably)	Murphy, 1996; Anonymous, 2008, 2010; recovered from a construction site.
1997	Near Glasgow, MT	*Tyrannosaurus* skeleton	Heavy large block	Mid-sized Caterpillar front-end loader to drag blocks.		DeAgostino, 1997
1998/08/05	Dinosaur Provincial Park, AB	Subadult hadrosaur, TMP 1998.058.0001	> 907 kg	Foremost Commander 8-wheeled oilfield truck with removable steel box. Gin poles on truck lifted jackets up and put in box on ground. Loaded box then winched onto truck.	No [7]	Shown under preparation in Royal Tyrrell Museum, 2021
1998	Maastricht area, Netherlands	*Prognathodon saturator* partial skeleton	~ 6 t	"Lifted"; otherwise unstated.		Schulp et al., 2001
1998	Khongil, Mongolia	Unidentified ankylosaur	> 1.0 t (estimated) monolith	Monolith winched onto ZIL flat-decked truck.	No	Suzuki and Watabe, 2000

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weights (t, kg)	Transportation method	Road built?	Citations and Notes
1998	East Coulee, AB	Large conifer tree stump, TMP 1998.114.0001, a.k.a. "3-ton Toby"	2.9 t (TMP collection records)	Much manual dragging effort (4 staff, 5 days); prybars, come-along, "crane and truck" (other details on truck loading phase unknown).	No	Anon, 1999d; Long, uncomplicated downhill grade to bottom
1999/03	Auca Hahueavo, Argentina	Abelisaur dinosaur skeleton, sauropod egg clusters	454 – 907 kg	Honda Passport 4×4 car to move and roll over blocks; crane, cherry-picker crane on flat-deck truck.	No	Chiappe and Dingus, 2001
1999/08/17	Dinosaur Provincial Park, AB	*Gorgosaurus* skeleton; TMP 1999.033.0001	4.0 t	winch truck with cable towing pre-made metal skid; winched onto tilting flat-deck trailer; three ATVs steered the block. **8**	No; 180 m drag thru badland terrain	Anon, 1999b, d; Drohan, 1999a-b; recovery cost CDN$5,000
2000/07/24	Dinosaur Provincial Park, AB	Two *Basilemys* turtles in one large jacket; TMP 2000.052.0001	~227 kg	Block on inverted car hood pulled by at least sixteen people; suburban truck w/winch pulled the last stretch.	No	
2000	Syncrude oilsands mine north of Ft. McMurray, AB	*Athabascasaurus bituminous* ichthyosaur (type); TMP 2000.029.0001	Two multi-tonne blocks; each > 3 m long	Large cherry-picker type crane and flat-deck truck.	No	Anon, 2000; Thomas, 2000
2001 Fall	North of Malta, MT	*Brachylophosaurus* "Leonardo" **9**	7.3 t (McFarlane); 5.9 t (Ivanova); 5.9 t including steel frame (Murphy et al., 2007: 119)	Flipped and dragged by bulldozer then winched onto tilt-bed truck.	Yes	McFarlane, 2001a-b; Ivanova, 2001
2002 Summer	Dinosaur Provincial Park, AB	cf. *Pachyrhinosaurus* skeleton blocks, TMP 2002.076.0001	Largest block ~ 680 kg	Two 4×4 trucks with winches driven into badlands, winched jackets on inverted car hood laterally thru badlands, then winched up to prairie level. > 12 people assisted.	Yes; path was cleared, low spots filled for lateral transfer.	Trucks were positioned side by side to combine winch pulling power.
2002	North of Malta, MT	*Brachylophosaurus* skeleton "Roberta"	2.2 t	Crane and flat-deck truck.		Perez, 2002
c. 2002	Chesapeake Bay, SC	Part of Miocene baleen whale skull	> 136 kg	Block atop unmanned kayak with five people pulling/pushing/steadying while walking in shallow water.	No	Godfrey, 2002
2004	Bighorn Mtns, N-central, WY	*Stegosaurus*, "Sarah"	Main block was > 680 kg	Trackhoe, chains, straps, pickup truck.		Anon, 2005
2004	Near Cerro Cóndor, Argentina	Theropod dinosaur *Asfaltovenator vialidadi* (type)	Single massive block; looks ~ 3.0 t	Self propelled 4-wheel heavy crane with telescopic boom loading heavy truck.	Yes	Puerta and Isasi, 2022, fig. 2.3-4; bulldozer bladed road to site: ibid., fig. 7.2
2004/07	Near Marmarth, ND	Hadrosaur *Edmontosaurus* "Dakota"	3.6 t (body); 907 kg (tail); jacket + welded metal support structure 9. 0 t (Manning, 2008: 156-157)	"Enormous John Deere front-end loader" capable of lifting 27.2 t in its bucket; big truck pulling a low-boy trailer.		Manning, 2008
2006	Fergus Co., MT	*Daspletosaurus* skeleton RMDRC 06-005	~ 3.6 t	Wooden sled built under jacket, winched onto trailer w/ come-alongs.	No	Maltese, 2009
2006	Near Jordan, MT	*Tyrannosaurus* & *Triceratops* "Dueling dinosaurs"	5.4 t	Two tractors dragged/pulled single block from site onto farm truck parked into predug hole. Jacket bent two 10,000 lb rated axles on truck	Yes	C. Phipps, pers. comm., 2022/09/14
2007/06/18	Ammolite mine south of Lethbridge, AB **10**	Elasmosaur plesiosaur *Albertonectes vanderveldei* (type); TMP 2007.011.0001	Block A: 1.6 t. Block B: 1.7 t. Block C: 1.2 kg	Trackhoe and flat-deck trailer	No; existing mine roads	Mitchell, 2013
2007/10/21	Pacific Ocean shoreline, Coos Bay, OR	Miocene-Pliocene baleen whale skull, 2.44 × 1.22 m	"Almost 3 tons,"2.7 t	~30 ton (27.2 t) John Deere 200c trackhoe	No; beach access	Hamner and Chambers, 2007; Fisher, 2014
2008/01/26	Dinosaur Provincial Park, AB	Partial *Corythosaurus* skull, TMP 2007.020.0104	67 kg	Heavy, bad spot to extract by hand; taken to a nearby bluff above river. In winter, when river was frozen, jacket easily sledded out on ice.	No	
2010	Snowmass Village, CO	"Clay mammoth" bonebed jacket	4.5 t	50-ton crane	Yes	Johnson and Miller, 2012: 122
2010	Near Riodeva, Teruel, Spain	Giant sauropod *Turiasaurus riodevensis* (type)	Two pelvic element jackets: 2.5 t and 3.5 t	Heavy truck with built-in crane	No	A. Cuetara, pers. comm., 2022/09/14
2011	Lusk, WY	*Tyrannosaurus* "Lee rex"	11.3 t (jacket + large metal frame)	Large oilfield crane and flatbed truck	No	Anon, 2017a; Cavigelli, pers. comm., 2022/09/14
2012/08/21	Manyberries, AB	Mosasaur TMP 2012.034.0001	2.6 t	Front end loader.	No	
2012	Hand Hills, AB	*Triceratops* post-cranial skeleton; TMP 2012.032.0001	> 2.0 t	Truck winch pulled one end of jacket at a time and "walked" it onto a trailer.	No; found next to gravel road	Anon, 2012b
2012/09/11, 12	Athabasca River, south of Fox Creek, AB	Big Paleocene conifer tree stump; Royal Alberta Museum outdoor display	3.0 t	Custom-made barge with 2 winches, towing jetboat, telescoping crane on a large tilting flat-deck truck.	No	Anonymous, 2015c; Bowerman et al., 2013; Moffat, 2018
c. 2013	Dove Creek, Vancouver Island, BC	Mosasaur skull	Found in unweighed blocks destined for crushing for highway construction; blocks weighed 907 kg – 4.5 t	Unstated; lifted by chains onto 2-ton truck which "groaned and leaned heavily all the way into town."	No	Henderson, 2021

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weights (t, kg)	Transportation method	Road built?	Citations and Notes
2013/03	Near Okotoks, AB	Paleocene garfish mass mortality sandstone boulder; TMP 2013.009.0001	2.7 t [11]	27.5 ton Freightliner flat-deck truck w/ twin rear axles & attached telescoping crane.	No	Anon, 2013a; Hale, 2015; Eberth, 2017
2013/07/20	Stratford Hall, VA	15 million-year-old baleen whale skull	~ 450 kg	~ 12 people hoisted jacket into boat, then at boat launch a mid-sized John Deere tractor with forks loaded block into pickup truck.	No	Weil and Fard, 2013
2013/11	Near Spirit River, AB	Subadult hadrosaur, TMP 2013.043.0001, in 24.5 t sandstone concretion	Blocks up to 4.5 t	33 ton John Deere 290G trackhoe. [12]	Yes; part of active pipeline project	Brumfield, 2013; Tanke, 2016c
2013 – 2019	Newcastle, WY	*Triceratops*, "Darnell bonebed"	Large blocks, ~ 700 – 900 kg	John Deere 310SJ loader backhoe (larger loads) + New Holland LS170 skid-steer loader.	Yes	Emaus, 2022; D. Bastiaans, pers. comm., 2022/10/16
2013, Late fall	Leduc, AB	*Hypacrosaurus* hadrosaur skeleton, TMP 2013.025.0001	Blocks up to 1.0 t	76 ton John Deere 650D trackhoe for lifting blocks.	No; part of sewer pipeline construction	Tanke, pers. obs., 2013.
2011 – 2013	Rio Colorado Potassium Mine, near Mendoza province, Argentina	Unstated large sauropod	Blocks up to 10.9 t	80 ton-rated 4-wheeled crane with telescoping boom.	No; mine site so easy access	Riga et al., 2022: 138, fig. 2.2
2014	North of Havre, MT	*Zuul crurivastator* skeleton, ROM 75860	16.8 t main block (RCI, 2022); Torso block > 15.0 t (Arbour and Evans, 2017)	Unstated heavy equipment (in field); heavy crane and flatdeck truck (at storage building).	No	Arbour and Evans, 2017; Anon., 2016c; RCI, 2022
2014	Stikes Quarry, near Moab, UT	*Utahraptor* and iguanodont "megablock"	8.2 t	Trackhoe dragging a massive prebuilt wooden sled.	Yes	Anon, 2013, 2015a; De Blieux, 2015; Kirkland et al., 2016; Johnson, 2021
2014	Mygatt-Moore quarry, near Fruita, CO	*Apatosaurus* femur 1.9 m long	1.3 t	Backhoe and flatdeck trailer.	No	J. McHugh, pers. comm., 2022/09/14
2014/11/26	Near Spirit River, AB	Hadrosaur tail in sandstone block, TMP 2014.037.0001	1.3 t	Mid-size John Deere 624 front end loader with forks lifting pallet; Ford F350 flatdeck truck.	No	Gas/oil drilling rig worksite construction
2015	Near Buffalo, ND	*Triceratops* partial skeleton	~ 1.0 t (pelvis block)	John Deere farm tractor w/ front end loader.	No; drove on prairie grass to site	MacDonald and Morrison, 2016; L. Tanke, pers. comm., 2022/09/28
2016	Northern MT	*Tyrannosaurus* skull block	1.4 t	John Deere farm tractor w/ front end loader. At museum a Gehl telehandler, aka "zoom boom" moved block.		Burke Museum, 2016
2016/10/04	Head-Smashed-In Buffalo Jump Provincial Park, AB	Archaeological feature: large 1,600 year-old *in situ* roasting pit with animal skeletal contents	1.3 t	Heavy flat-deck truck (3 rear axles) with articulating and telescoping crane.	No; drove on prairie grass to site	Anon, 2016a-b; Gilmar, 2016; Hallson et al., 2017; Tanke et al., 2017; author led trenching and jacketing
2017	Montbrook site, Levy Co., FL	Miocene–Pliocene elephant bones in large jacket	> 1.4 t?	26 ton Komatsu PC 200LC trackhoe.	No?	Narducci, 2017
2017	Near Jordan, MT	*Triceratops* skull and partial skeleton "Luke"	15.9 – 18.1 t	One huge jacket. Custom welded support frame/skid made on site. Terex S11 earth mover dragged sled to transport truck.	Yes	C. Phipps, pers. comm., 2022/09/14
2019, Summer	Undisclosed site, ND	*Triceratops* partial skull "Alice"	Unstated but > 450 kg	Bobcat E35 backhoe, Bobcat skid-steer.	No?	Anon, 2019b
2019, Fall	Undisclosed site, southern UT	*Brachiosaurus* humerus FHPR 17108	~ 450 kg	Two Clydesdale horses pulled a wheeled cart.	No	Kessler, 2020; Salleh, 2020
2019/10/19	North Saskatchewan River, Edmonton, AB	Late Cretaceous tree stump	363 kg	Winched and dragged with nylon slings by hand onto industrial boat with outward folding transom forming a ramp.	No	Kraus, 2019; Anonymous, 2020a; Fournier, 2020
2021/08 – 09	Rutland Water Nature Reserve, Rutland, England	Rutland ichthyosaur; cf. *Temnodontosaurus trigonodon*	Skull alone: 907 kg (Mendoza); skull + jacket just under 1 t; main body block ~ 1.5 t (Ashworth)	Lifted by boom forklift/telehandler, aka a "Zoom Boom."	No	Ashworth, 2022; Lomax, 2022; Mendoza, 2022
2022, Summer	Ammolite mine near Lethbridge, AB	Big mosasaur, *Prognathodon*; TMP 2022.043.0097	> 2.5 t (main body block)	~ 30 ton trackhoe.	No; in a mine setting	Opinko, 2022
2022/10/05	Horseshoe Canyon, AB	Partial hadrosaur skeleton	Jackets 136 – 181 kg	Bobcat 5600 Toolcat with small front-end loader, via rough path/narrow gravel road and grassy field.	No	Tanke, pers. obs., 2022.
2022/12 – ? (work in progress)	Cerro Condor, Chubut, Argentina	Jurassic sauropod skeleton	Gigantic jacket, ~ 3.66 m in diameter and thick	Welded metal frame and more plastering needed; looks > 6.35 t; big crane lift planned.	Yes; road access required for crane + truck	J. Kaluza, pers. comm., 2023

Table 1 Notes

1. Their first tripod broke under the heavy weight.
2. This was hoped to be a helicopter lift project (Phillips, 1979), but plans fell through and winter was coming, so it was collected the hard way (DeWolf, 1979). The MOR museum director who helped collect it, Mike Hager, recalled: "I've never seen a truck bend like that. As we came up that last hill to the road, the wheels were bent in four

different directions and the front of the truck was twisted a different direction from the back."

3. This amount is overestimated. McInnes (1981, August 17), who ran the quarry, gives varying weight estimates for the largest block, stating "4+", "9.25", and "more like 5-6" tons. The crane, despite its ample rating, was denied its full lifting capability due to the distance from prairie edge to the quarry. It could not actually lift the large block and had to drag it uphill, which tore the jacket open and exposed bones, the latter fortunately undamaged. McInnes (1981, August 18) says the crane was "strained to the limit." The author recalls the biggest block weighing about 4.5 t.
4. The overstrained crane was damaged during the otherwise successful lift. A hydraulic piston ruptured and its mounting infrastructure was badly twisted. The owner, a local farmer, figured the repairs would cost about what he had charged us, so he broke even.
5. The machine's track marks in sandstone eroded away within a year. Those deeply bitten into the flat bench bentonite "popcorn" clay lasted much longer and were finally reclaimed by nature thirteen years later.
6. The tow truck began to tip over to one side on uneven park grass while proceeding downhill. The rear wheels began to rise on one side. Unprompted and quick-thinking nearby public observers, jumped onto the uphill side of the truck, acting as counterweight and saved the day.
7. The Foremost Commander is a large, unusual appearing driveable oilfield machine with oversized balloon tires inflated to a low pressure resulting in low ground pressure (Foremost, 2022). In 1998 it drove through the DPP badlands and left virtually no ruts. In valley bottoms with ex situ soft sand in major drainage channels, it did leave some ruts in a couple places, but within a year, and after several major rains, all traces of its passage had vanished. One Commander model (the "Commander C") is articulated, allowing it into tight places.
8. These were single-seat ATVs which were of little, if any, use due to their light weight, the heavy block, and heavy block friction.
9. Was originally planned as a U.S. Armed Forces Boeing CH-47 Chinook helicopter lift, but the lift was cancelled after the terrorist attacks on September 11, 2001.
10. Since 2007 trackhoe operators and ground crew at these mines have regularly located skeletons of mosasaurs, plesiosaurs and dinosaurs (likely carcasses washed out to sea). Jackets are made oversize to expedite work. Beginning in 2007, at the author's initiative, trackhoes are routinely used to remove overburden, trench, flip jackets, lift them out and away from the mine's active work area, and load them onto trucks. These jackets are routinely in excess of 1 t in weight. See Tanke, 2014, 2016.
11. The crane on the truck, while more than able to do so, could not lift the rock at first. A small area, a little less that 1 m^2 on the bottom was lightly frozen to the ground. Once this broke away, the lift went smoothly.
12. The machine really struggled with heavier blocks and quite literally loudly "moaned" during the heavy lifting work.

The hadrosaur block could potentially be removed from the site directly by a large flat-decked truck. The RTMP has a large truck with removable swaploader flatdeck **(Figure 7)**, whose hoisting and carrying specifications indicate that it alone could load and haul the Kaskie hadrosaur jacket from the site to Drumheller. Alternatively, the block could be towed on skids, or a custom-made wood/metal wheeled cart with a strong winch and cable by a vehicle positioned on the bus tour road. If the jacket has a large flat side, rounded fence posts could be used underneath as effective rollers: this was done in 1994 to good effect on a partial DPP *Centrosaurus* skull (TMP 1994.164.0001). It only requires several people to grab the rollers as they emerge from the rear and replace them at the front. A towing cable can be disconnected and the towing vehicle moved to a different vantage point on the road to make any turns necessary; three or four are anticipated. One small bentonite outcrop may have to be removed—a one hour job. The towing truck might need to be anchored during the towing phase.

The author is exploring various options for an overland extraction where workers, specimen and grassland habitat are all safe. Considering the latter, work could be done in the winter when above ground foliage has died off and the ground is frozen and firm, thus protecting deeply positioned root stock, be more supportive to any vehicular traffic and less inclined to develop ruts. The pediment would likely be indented by tire tracks but as it is loose and in a drainage area, such ruts could quickly be filled in manually and after a season of rains any ruts would no longer be visible. There is plenty of relatively flat terrain (50 × 20 m) immediately adjacent to the north of the hadrosaur quarry where any vehicle, even of a large size, could repeatedly maneuver and turn itself around if required.

Conducting this work in winter would reduce impacts on local wildlife. In the late fall/winter seasonal birds have migrated south and other avian species from more northerly locations have migrated on through. The breeding season for deer, other ungulates and other Park denizens has passed. Other species such as bats, snakes and amphibians are hibernating. Insects and scorpions are safe deep underground below the frostline. Doing the jacket recovery work at this time of year is a more logical choice when wildlife and ecosystem protection is a major consideration.

Another mitigation process is the use of "oilfield mats," also known as rig, ground protection, environmental, or swamp mats. They can be rented. Stacked on a trailer, they are easily transported. These rectangular-shaped mats, made of sturdy wood and steel or rubber from recycled car tires can be laid end to end (and side by side if needed) atop the ground creating a temporary road and support heavy equipment and stop or minimize damage to the ground underneath.

A machine like a trackhoe can place a mat on the ground and drive onto it, then the operator can rotate the cab and boom backwards, pick up another mat, rotate forward, then place the second mat in front of the first. The operator then drives onto the second mat, rotates the cab and boom backward and picks up the first mat, rotates again and places it in front of the second (see Anonymous, 2020b making a double wide road and Kozdrowski, 2015 using steel mats in muskeg). By repeating this process, the matting quickly advances in a stepwise fashion to the destination, using a small number of mats over and over again. Or they can be laid end to end and "locked" together with built-in pegs to create a continuous road. Corners can easily be made with the mats, turning the second leg of the "road" 90° to the first leg. A trackhoe could set up a continuous rig mat road to the site, in winter, carry the block out, load it onto a heavy transport truck and then return and dismantle the rig mat road. Rig mats come in various sizes, but a standard one is 13 cm thick, 2.4 m wide and 4.3 m long.

A serious uncertainty is whether or not heavy and—in particular—long vehicles can maneuver on the bus tour road. The road was designed for smaller vehicles like cars, trucks and up to 24 passenger tour buses about 8.2 m long. There are some tight, right-angle curves in the road. Large coach passenger buses of the Greyhound-type have negotiated the Park's bus tour road with some difficulty—the driver needing others to disembark and act as spotters on some particularly tight curves. In the summer of 2016 the author helped guide a large crane truck and its multi-ton towed trailer load deep into the Park on the bus tour road in the restricted area (Tanke, 2016b, p. 95). The truck required spotters in a couple places on especially tight corners. Such a crane could lift and load the Kaskie hadrosaur block.

Other technical considerations include crossing Little Sandhill Creek and a bridge with limited weight bearing capabilities. Here rig mats could be stacked atop the completely frozen creek and heavy equipment driven across or by other means like a second temporary bridge. Other technical aspects include unloading the block at the museum (with the RTMP forklift, rated at 4.5 t), weight-bearing cart(s) under the block, getting it through the loading bay door (2.13 m) maximum width; shunting the block through corridors and two co-joined workshops by forklift; possible use of an overhead crane in the RTMP fossil preparation lab (rated at 2.7 t maximum); and floor weight loading.

Figure 8. Intraformational erosion surface (marked by arrows) with pale, finer grained, horizontally bedded sandstone above; coarser, low-angle crossbedded sandstone below. The Kaskie hadrosaur is preserved in the lower sandstone unit and may be compromised by erosional action that preceded deposition of the upper unit. Width of view approximately 45 cm. Photo by the author.

All these recovery and transport issues hinge on whether the specimen is complete. It is hoped that the entire skeleton is covered in a three-dimensional ironstone skin. However, during his work on site, the author noted that the grey, low-angle crossbedded sandstone in which the skeleton lies is erosionally truncated by a distinctive white horizontal sandstone bed **(Figure 8)**. The Cretaceous erosional scouring could potentially have compromised the neck and head area: possibly the entire animal was buried, then the river shifted its course and eroded previously deposited sand and part of the Kaskie hadrosaur. We will learn what is there in the summer of 2023 and excavation, jacketing and recovering strategies will be conducted accordingly. As can be seen, the Kaskie hadrosaur has and will challenge us with a variety of new technical issues regarding uncovering, jacketing, extraction/recovery, transport and preparation.

Table 2 (Following pages). Select examples of heavy helicopter lifts at mostly North American palaeontological sites with further information. **Bold numbers** refer to notes at end of table, Page 35.

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weights (t, kg)	Helicopter type	Citations and Notes
1967/09/19	Dry Island Buffalo Jump Provincial Park, AB	Ornithomimid skeleton [1]	816 kg	Canadian Army CH-113A Voyageur	Anon, 1967 a-c; Tanke and Walker, 2011
1977/12	San Pedro, CA	Partial whale skeleton in rock	581 kg	Bell helicopter (unstated model) + dump truck	Anon, 1977
1981, Summer	Near Buffalo, Harding Co., SD	*Triceratops* skull and lower jaws	680 kg (Anon); 1.8 t (Hill Smith)	Unstated (military)	Anon, 1981 a; Hill Smith, 1983: 27.
1981	Wawmda, Morocco	Cetiosaur sauropod pelvis and limb bone jackets	500 kg	Moroccan police Eurocopter AS 332 Super Puma	Taquet, 1999:109
1982	Near Choteau, MT	*Maiasaura* egg clutch	771 kg	Unstated	J. Horner, pers. comm., 2022/08/04
1983/12/19	Badlands near Three Hills, AB	*Albertosaurus* partial skeleton	91 – 680 kg [2]	Two Aérospatiale Gazelle (British Army)	Anon, 1983 a-b
1985/06/06	Painted Desert, AZ	*Chindesaurus* partial skeleton, "Gertie"	1.8 t	Sikorsky S-58T (N1168U) with a bin net; jacket then reloaded internally and flown to UC Berkely	Anon, 1985 a-b; Coates, 1985; Hodge, 1985; Greenwald, 1989
1985/08/03	Dinosaur Cove, Australia	368 bags of bonebed matrix	7 t total	Unstated NCSA [3] helicopter [4] and Victoria Police Eurocopter AS365 Dauphin	Munday, 1985; taken out in multiple loads
1986/10/01	Near Cutbank, MT	Two ceratopsian skulls	454 kg each	Unstated	Anon, 1986
1990/08/10	Meeteetse, WY	Hadrosaur skeleton [5]	~ 544 kg	Unstated	Anon, 1990
1992/08/14	Near Cañon City, CO	*Stegosaurus* skeleton missing skull, neck armor and tail	"5.0 t", "5.9 t" [6] / 6.3 t	Boeing CH-47 Chinook (military)	Anon, 1992a; Anon, 1998; Anon, 1992b
1993/09, middle	Near Vernal, UT	Large theropod dinosaur skeleton	2.7 t	Unstated helicopter, but given the weight would have to be a CH-47 Chinook	Anon, 1993
1994/08/16 [7]	Weed Creek, near Calmar, AB	*Amblydactylus* (hadrosaur) ichnites slab; TMP 1994.158.0001	800 kg; TMP records say 1134 kg [8]	Eurocopter AS350 B	Thomas, 1994
1998/06	Langebaan Lagoon, South Africa	117,000 yr old human footprints	Large slab, weight unstated	Bell helicopter (unknown model)	Harris, 1998
1998/09	Dinosaur National Monument, UT	*Allosaurus jimmadsenii* (type) UT DINO 11541	2.5 t	Boeing Vertol (= civilian verson of Chinook)	Repanshek, 2020
1998/09/11	Bisti De-Na-Zin Wilderness Area, near Farmington, NM	Half an *Albertosaurus* (now *Bistahieversor sealeyi* "Bisti Beast") skeleton + nearly complete *Pentaceratops* skull	~ 454 kg	UH-60A Blackhawk (military)	Taugher, 1998; Roberts, 1998
1999/07/09	Dry Island Buffalo Jump Provincial Park, AB	Partial *Hypacrosaurus* sacrum (specimen jettisoned during inflight emergency) [9]	315 kg	Aérospatiale Gazelle (British Army)	Anon, 1999a; Hickie, 1999
1999/10/18	Taimyr Peninsula, Russia	Woolly mammoth ("Jarkov mammoth") in permafrost block	20.0 t (Stone); 20.9 t (Anon); 22.7 t (Croft) [10]	Mil Mi-26T (civilian)	Stone, 1999, 2001; Anon, 2022g; Croft, 2006
1999	Undisclosed site, MT	2.7 m long "Torosaurus" skull			J. Horner, pers. comm., 2022/08/04
1999	Pink Mountain, BC	Ichthyosaur, *Shonisaurus sikanniensis* TMP1994.378.0002	4.1 t (partial skull alone) [11]	Sikorsky S-61N (civilian)	Wilson, 2022
c. 2001	Undisclosed site, MT	"C-rex" (MOR 1126)	Up to 1.1 t	Bell 405	J. Horner, pers. comm., 2022/08/04.
2001/05/07	Big Bend National Park, TX	*Alamosaurus* cervical series	Largest block was > 454 kg	Unstated	Chapman, 2001
2001/07/27 (2001/07/21 according to Olson, 2011: 32).	Winnett, MT	*Torosaurus* skull	1.6 t (Anon, 2001 says 2 blocks, 1.6 t total). Olson (2011: 31) says 907 kg each. Marquez Estrada (2003) implies single block at 2.3 kg	UH-60 Blackhawk (US military)	Downey, 2001; Kidston, 2001a-b; Marques Estrada, 2003; Olson, 2011
2002/06/28	Cutaway Creek, AK	Ichthyosaur skeleton in rock slab	680 kg	Boeing CH-47D Chinook (US military)	Chinook Helicopter, 2021 a-b
2002 or 2003	North Slope, AK	*Pachyrhinosaurus* bonebed material in one large block	907 kg (McGee); 454 kg (Gangloff)	Boeing CH-47D Chinook (US military)	McGee, 2003; Gangloff, 2012: 76.
2003	Undisclosed site, MT	*Tyrannosaurus*, "B-rex"	Up to 1.1 t	Bell 405	J. Horner, pers. comm., 2022/08/04.
2004/09/29	Grand Staircase-Escalante National Monument, UT	*Gryposaurus* body block	~ 500 kg	Eurocopter AS350 B2	Sampson, 2009: 233-237
2008/11/21	Aliso Creek, Lake Forest, CA	Right whale skull and other vertebrate fossils	~ 1.8 t [12]	Bell 204C	Brennan, 2008; G. Smith, pers. comm., 2022/10/03

Date (YYYY/MM/DD)	Locality	Specimen	Field jacket weights (t, kg)	Helicopter type	Citations and Notes
2012/12/14	Asturias, Spain	Large ornithopod dinosaur	2.6 t	Boeing CH-47 Chinook (Spanish Army)	A. Cuetara, pers. comm., 2022/09/03; Anon, 2012a
2013/08	Near Tumbler Ridge, BC	Hadrosaur skeleton	2.0 t	Kamov KA-32	Anon, 2013c
2014/10/30	Castle River, AB	Hadrosaur skeleton in boulder in river TMP 2014.022.0027	1.3 t	Unstated	Graveland, 2014
2015/08	Augusta Mountain, NV	Ichthyosaur, *Cymbospondylus youngorum* skull and anterior postcrania	Unstated but heavy; possibly taken out in separate jackets; skull divided up into three sections	Unstated	
2015/10/29	Bisti/De-na-zin Wilderness Area, NM	Juvenile *Pentaceratops* skeleton	2.0 t	UH-60 Blackhawk (US military)	Anon, 2015b; Doo, 2015; Wenz, 2015
2015/10/29	Ah-shi-sle-pah, NM	Adult *Pentaceratops* skull	2.5 t	UH-60 Blackhawk (US military)	Doo, 2015; Wenz, 2015
2015	Near Dinosaur Provincial Park, AB	*Styracosaurus* skull	2.5 t	Unstated	Anon, 2019a
2016/07/13	Oldman River, AB	Torso, neck and skull of an adult hadrosaur in thick slab of hard rock; TMP 2016.022.0124	1.1 t [13]	Eurocopter AS350 [14]	
2017/09/26	Hilda, AB badlands	*Chasmosaurus* skull; TMP 2016.034.0012	907 kg	Eurocopter AS350	Anon, 2017b
2017/10/15	Grand Staircase, UT	*Teratophoneus* tyrannosaur skeleton		Unstated	Anon, 2017c
2021/09/02	Red Willow River, AB	Partial ceratopsian skull	567 kg [15]	Eurocopter AS 350 B2 (C-GIDB)	Carter, 2021
2021/09/16	Hinsdale, MT	*Daspletosaurus* skeleton	4.1 t rock + 450 kg steel (4.5 t total)	Boeing CH-47D Chinook (civilian)	Hamby, 2021a-b; D. Fowler, pers. comm., 2022/09/03.

Table 2 Notes

1. First helicopter lift of a dinosaur skeleton anywhere; see Tanke and Walker, 2011.
2. The heavier weight given is curious as this type of helicopter cannot lift a heavy load: 227 kg maximum, according to several pilots. Possibly the combined weight of several jackets lifted separately? The work was done under extremely cold conditions: –30° C.
3. NSCA (National Safety Council of Australia).
4. The NSCA operated two MBB Bo 105 and four Bell 412 helicopters at this time (helis.com, 2022). One of these machines must have done the lift.
5. The first lift, the day before, failed. It was too hot, late morning when the attempt was made. The next day, at 6:00 A.M. when the air was cooler and denser, the helicopter had more lifting ability and performed without issue.
6. Weights differ in various publications. Plaster jacketed specimens will weigh more if the jacket is fresh and excess water has not had time to evaporate away.
7. Author was involved in the project and/or lifting and hauling work.
8. The helicopter had difficulty with the lift. It had to fly away for about 45 minutes to burn off some fuel to reduce weight and try again, this time with success. The heavier weight given here may include a heavy, rolling metal frame and wooden crate: after collection the specimen was mounted and sent to Japan for a temporary exhibit.
9. This was an unfortunate incident, the fossil a total loss. Anonymous (1999b) quotes the pilot as saying his engine was not at full power owing to low fuel and (correctly) the load was heavier than he had been led to believe. It was also a hot and muggy day, poor conditions for any helicopter lift. RTMP field staff seriously underestimated the actual weight of the jacket, thinking it was below 227 kg, the maximum lifting ability of the helicopter. In fact, it weighed about 315 kg and when the helicopter gained altitude and began moving forward, the load began to pendulum back and forth in ever increasing arcs, leading to an emergency situation where the pilot had to jettison the load or be yanked out of the sky. After the incident the RTMP bought a good and portable electronic scale. We began weighing some of our well-dried, unopened field jackets and guessed their weight. It was quickly learned that all staff were consistently underestimating field jacket weights by up to 50%. Now that the scale is used regularly, better-experienced staff deliberately overestimate block weights by 10%, preventing surprises for the helicopter pilot or transport trucker. The lost Hypacrosaurus sacrum (about 35% of a whole specimen) was part of the specimen haul from the Albertosaurus-dominated bonebed.
10. This is undoubtedly the heaviest fossil ever lifted by a helicopter. Croft (2006) states the helicopter may have been overstressed during this massive lift and ". . . had to be returned to the factory immediately after the lift to check for structural excesses that could have warped the airframe and rotors." Unverified internet helicopter chat group comments (Reddit, 2022) suggest the helicopter was too damaged to be returned to service and had to be scrapped; if so, a very expensive loss, especially so as the specimen did not live up to its expectations with respect to completeness.
11. Helicopter was at its limit of lifting capability.
12. Had to abandon the first attempt as the load was heavier than expected. A second try the next day worked after removing extra gear, one passenger (lift engineer) and carrying a reduced fuel load. It is quite possible the block weight was underestimated, a common mistake.
13. This weight is approximate and likely slightly underestimated. The main block with torso and large wood pallet, and a separate full skull on wood pallet were weighed with a scale-equipped pallet jack. Known weight of the pallets was then subtracted. Saved waste matrix in buckets was weighed and weight of empty buckets subtracted. An unknown, but low weight of matrix had been discarded at the beginning of the project, plus small rock chips lost on the floor and dust collected by a dust extractor are unknowns. The main block also retained moisture and damp soil/moss on collection. Actual weight at time of helicopter lift is probably close to our estimate or slightly under.
14. A particularly difficult lift. Specimen was found on a riverbank. It took three tries to do the lift, dragging it through the adjacent river twice.
15. According to Carter (2021) an attempted lift by the helicopter the day before failed and the ground crew were obliged to remove even more rock from an already trimmed-down specimen to achieve the lift.

Aerial extraction?

Another option to remove the Kaskie hadrosaur is a large helicopter. Alberta has a long history of using helicopters to lift fossil specimens—in fact the first ever occurred in Dry Island Buffalo Jump Provincial Park in 1967, with a Canadian Army twin-rotor Voyageur lifting an ornithomimid skeleton (Anonymous, 1967; Tanke and Walker, 2011; see Canadian Army Aviation, 2022 for video of the lift). The RTMP has used helicopters well over 100 times for specimen extraction, reconnaissance and field crew and equipment insertion and extraction, the latter two especially in mountainous British Columbia (Tanke, 2009, 2012, in prep.).

If the skeleton is complete, the rock, heavy FGR, other materials and any retained moisture combined could result in a block weighing upwards of 4.5 t. Using a weighed 5 cm^3 cube of Kaskie hadrosaur sandstone matrix for reference, a skeletal drawing of AMNH 5340 in its "death pose" as a hypothetical model, and a lot of geometry, a calculated weight of a 0.5 m-thick jacket—a "worst case" scenario—was just over 4.5 t. Of course the head and neck, forelimbs, and tail portions need not be this thick, but there has to be enough thickness to capture the hoped-for skin impressions.

Megalifts of fossil specimens by helicopter have been done in the past. The heaviest lift was done by the world's largest helicopter, a Russian Mil M-26T lifting the "Jarkov Mammoth" (Anonymous, 2022g) weighing a variably reported 20 – 22.7 t, though the machine may have been overstressed and irreparably damaged in the effort. In the recent past, such a helicopter would be used in Alberta once a year to do heavy lifting jobs, though its availability and cost are now unknown given Russia's recent invasion of Ukraine. The next-best heavy lift helicopters, the Boeing CH-47 "Chinook," are based in western British Columbia where they are used for heli-logging, or in southern Montana. It is uncertain if they are authorized to fly over the Rocky Mountains or enter Canada to do work here. They have been utilized successfully on a number of American super-heavy fossil lifts.

Some heavy-lift helicopter models and their lifting capabilities (which can vary depending on factors like temperature, elevation, humidity and wind) are:

- Mil M-26T: 20.0 t.
- Sikorsky S-61N: ~ 4.5 t.
- Boeing CH-47 Chinook (military): ~ 9.0 t.
- Boeing 234 (civilian version of CH-47): 11.8 – 12.2 t.
- Boeing-Vertol CH-46 (107-II): 9.0 t.
- British Army Westland Lynx (occasionally stationed at nearby Suffield military base): 1.3 t.
- Kaman K-1200: 2.7 t.

If the specimen is incomplete, removing it by helicopter may be less of an issue. Once it is known what is there, and if incomplete, the field jacket can be made thinner and more time dedicated to the removal of excess rock on the underside of the flipped block. Weight would still be high but within the capacity of larger single-rotor craft.

If a helicopter lift extraction is chosen, the best time to do this would be in the fall or winter when the weather is not too cold. There are several advantages to doing the lift at this time. It is traditionally "off season" for helicopters, which are often engaged in fire-fighting work during the non-winter period. Off season there are usually more choices of helicopter types and hiring rates are sometimes reduced during this time because of less demand. The colder air is more dense, allowing the helicopter's blades more "bite" and increased lifting capability. Warming "Chinook winds" and cold front winds excluded, the air and weather are typically more benign this time of year: no thermals, forest fire smoke, unexpected thunderstorms, or humidity changes. As noted earlier, any impacts on Park biota would also be greatly reduced.

Dinosaur and other large fossil skeleton collecting in the province is usually a straightforward process, relatively unchanged after some 140 years of fieldwork. However, the Kaskie hadrosaur has and will continue to challenge our imagination and stimulate our technical creativity regarding its safe collection, extraction, and ultimately its preparation and long-term conservation for research and display.

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❑

APS Revenue & Expenses for 2022 For January 1, 2022 to December 31, 2022

Revenues		**Expenses**	
US$ Exchange	4.98	Bulletin Printing	106.25
2022 Single + Family Memberships	1580.00	Bulletin Postage	63.40
2023 Single + Family Memberships	355.00	Meeting Speaker expenses	178.12
Bank interest + GICs cashed	16485.50	Membership expenses	45.28
T-shirts (member + non-member)	30.00	Field Trip Expenses	52.75
Book: Common Vert Fossils (mem+non)	1115.00	Symposium Workshop	0.00
Book: Hope Johnson (mem + non)	35.00	Symposium Speaker	143.32
Handling fees: Book Common Vert Fossil	255.21	Symposium Abstract Printing	0.00
Handling fees: Book Hope Johnson	0.00	Book: Common Vert Fossils	1515.05
APS Guides (field trip + old abstracts)	0.00	Book: Hope Johnson print	0.00
Other books (China-Canada)	0.00	Postage: Common Vert Fossils	217.90
APS pins	3.00		
Refreshment donations	3.50	Postage: Hope Johnson	0.00
Field trip fees	860.00	Website domain and hosting fees	0.00
Donations (General to APS)	70.00	Refreshments	13.37
Symposium 2022 Abstract sales	0.00	Bank Charges+GIC purchase	16407.00
Symposium Donations	0.00	Postbox rental	185.85
Symposium workshop fees	0.00	Insurance	0.97
Library income	0.00	Hope Johnson award	0.00
Public Outreach income	0.00	Public Outreach expenses	72.00
Hope Johnson award income	0.00	Library expenses	0.00
Subtotal Revenues	**20797.19**	**Subtotal Expenses**	**19001.26**
Plus Revenue Received in 2021 for 2022		**Plus Expenses paid in 2021 for 2022**	
2022 Membership Fees	650.00	2022 Insurance	1675.97
Savings for 2022 Symposium	2734.00	Website for 2022	224.68
Savings for Library	725.25	**Minus Expenses paid for 2023**	
Savings for Public Outreach	706.23	Website for 2023	0.00
Savings for Hope Johnson award	1605.23	2023 Insurance	0.97
Savings for Insurance	5801.37		
Savings for T-shirt purchase	573.05		
Subtract Revenue Received in 2022 for 2023			
2023 Memberships Fees	355.00		
Savings for 2023 Symposium	2590.00		
2023 Symposium Workshop Fees	0.00		
Savings for 2023 Library	725.25		
Savings for 2023 Public Outreach	634.23		
Savings for 2023 Hope Johnson Award	1605.23		
Savings for Liability Insurance	5801.37		
Savings for future T-shirts	573.05		
Total Revenues	**21308.19**	**Total Expenses**	**20900.94**
Excess of Revenues over Expenses	**407.25**	**GICs**	**16,400.00**
Inventory Cost	**$1,855.34**	**Dec. 31, 2022 Bank Account:**	**16,994.07**
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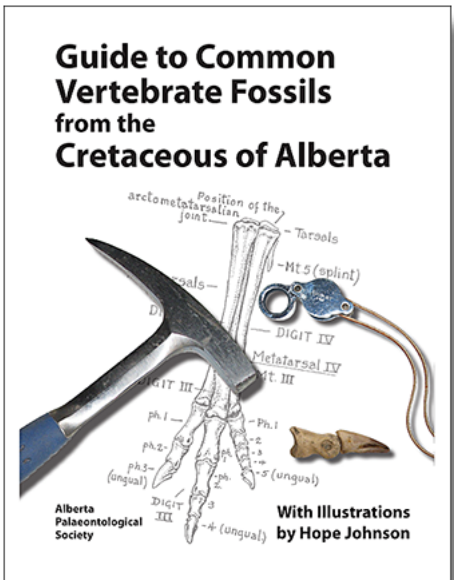

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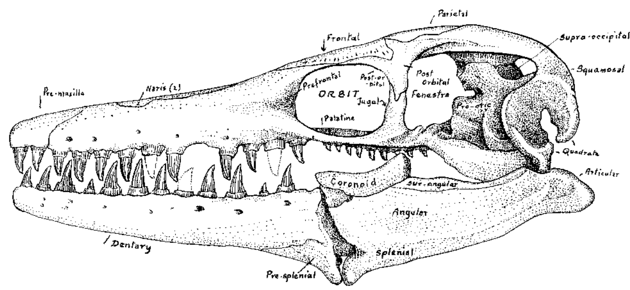

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