

PS An Unconventional Discovery from an Unconventional Resource: Recovery of an Early Cretaceous Ankylosaur Fossil from an Oil Sands Mining Operation, Fort McMurray, Alberta, Canada*

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Extended Abstract

On March 21st, 2011, while excavating overburden materials at Suncor Energy Inc.'s oil sand mine, located 50 km north of Fort McMurray, Alberta, Canada; shovel operator Shawn Funk unearthed an unusual piece of siltstone with an odd texture and diamond pattern. The unusual texture and pattern were actually the first pieces discovered of a very rare 110-million-year-old Ankylosaur fossil. This article provides a detailed look at this rare, once-in-a-lifetime find and its complicated recovery from within an active mining area, as well as an introduction to the Canadian oil sands industry and the geology and paleogeography of the Athabasca Oil Sands region during the Early Cretaceous period.

Oil sand consists of unconsolidated, Cretaceous-age, estuarine/tidal-dominated sands and silts combined with water and a viscous form of oil called bitumen. Oil sands are located in three major deposits in northeast Alberta, Canada spanning a total of 140,200 km². Of the total oil sands area, only approximately 10% is close enough to the surface to be mined. Surface mining requires an open-pit mine operation, similar to many coal, iron ore, copper, and diamond mine operations. Oil sands are excavated by large mining shovels and moved by 400-tonne trucks to a cleaning facility where the oil sand is mixed with hot water to separate the recoverable oil from the sand.

Alberta has proven oil reserves of 171.3 billion barrels which make it the third-largest proven crude oil reserve in the world, next to Saudi Arabia and Venezuela. Alberta is the largest supplier of oil to the U.S. sending 1.4 million barrels of oil per day across the Canada/U.S. border.

There have been several large vertebrate fossils found in the Athabasca Oil Sands region. All have been marine reptiles (ichthyosaurs and plesiosaurs), found during open-pit mining operations and located in the marine Clearwater Formation, which immediately overlies the

oil-bearing McMurray Formation. This is the first time that a terrestrial dinosaur has been found in this formation. The reason that dinosaur fossils have not been discovered from this time period in Alberta is that during the Early Cretaceous the majority of Alberta was covered by a broad, inland shallow sea which extended from the Arctic Ocean to New Mexico.

The discovery of the Ankylosaur (an armoured dinosaur with a club tail) at Suncor's Millennium Mine on March 21, 2011, was the result of serendipity and foresight. The serendipity part will be described in more detail later in the article. As for the foresight; it was back in 2007 that Suncor geologists first developed a work practice (MOW0200A Fossil Recovery) that outlines specifically all the steps that must be taken if a fossil were to be unearthed during active mining activities. In the entire 40-year operating history of the Suncor Energy Inc. oil sands operation, there had never been a significant vertebrate fossil discovery. That changed only 4 years later, and the obscure work practice was put into effect.

Once the first pieces were unearthed the shovel operator contacted his supervisor about the find, and the supervisor immediately cordoned off the area and relocated the shovel. Suncor geologists were then called to the site. The geologists examined the pieces, took photographs, and made notes on the geology of the formation within which it was found. While not certain about what exactly it was that was unearthed, they agreed that they had uncovered something unique and following procedure contacted the Royal Tyrrell Museum for assistance in identification. Paleontologists from the Tyrrell were very excited when they viewed the initial photos sent to them, and two days later it was confirmed by the Tyrrell paleontologists that what Shawn Funk had uncovered was indeed a very rare find—a 110-million-year-old Ankylosaur fossil.

As it turns out, the find is significant for many reasons.

- It is the oldest known, complete dinosaur from Alberta.
- It is the first Ankylosaur from the Early Cretaceous of Alberta in contrast to the more typical Late Cretaceous forms from the south of the province.
- It is the first dinosaur from the marine Clearwater Formation (better known for its ichthyosaurs and plesiosaurs), and represents a terrestrial animal that became entombed in a seafloor approximately 200km from the nearest known palaeo-shoreline.
- It experienced no post-mortem disruption, with all the bones, including fingers and toes, in three-dimensional articulation. All the armour appears to be undisturbed and present. There are large areas with impressions of scales of alternating diamond and hexagon shapes in close association with the armour plates.
- There are skin impressions and a large cluster of unusual, pisolith-like bodies (up to 2cm in diameter) in the gut region, and these may represent stomach contents.

This is where serendipity enters the story. The Ankylosaur was a terrestrial dinosaur, and yet its remains were found in a marine formation. It is postulated that 110 million years ago this animal was entrapped by a flowing river, drowned and washed out to sea. Its bloated carcass floated out 200 km from shore before it finally “popped,” and the body sunk to the sea floor in an inverted position.

Impact marks show how it collided with the soft muddy bottom and the disturbed sediments settled overtop the animal, and the fossilization process began almost immediately. Where the fossil was finally unearthed 110 million years later was within 50 metres of Suncor's Millennium Mine final pit wall. This means that, if the animal had floated only another 50 metres to the east, it would never have been discovered! Coincidentally, the shovel operator had visited the Royal Tyrell Museum with his family just the weekend prior to making the discovery.

While being extremely rare and scientifically significant there remained one very large issue; the find was located in the heart of a busy industrial complex and open-pit mining operation. Suncor's oil sands operation moves 1.2 million tonnes of material and produces 300,000 bbls of synthetic crude oil (SCO) per day, 365 days a year. The challenge became how to properly excavate and document the find safely, while at the same time minimizing the impact to the ongoing mining operations. What transpired over the following four weeks was a great example of how industry and government came together to preserve a significant piece of Alberta's history, without compromising production from one of the world's most significant oil reserves.

Within seven (7) days of the discovery, Suncor had assembled a dedicated Fossil Recovery Team of scientists, geologists, videographers, project coordinators, trainers, and administrators. The project team developed a detailed work scope and achieved a series of targeted milestones before finally extracting the fossil from the earth. Safety was at the forefront of every activity, and the scientists and videographers received proper training and all the tools and supplies necessary to work safely on site.

First, the entire project area was secured by creating a berm and establishing 24/7 security guard to monitor access to the location. A backhoe then carefully lifted sections of rocky rubble at the bottom of the wall and laid it in rows so scientists could sift through for smaller fossil pieces. Every effort was made to collect all the dinosaur material, no matter how small. Every piece was carefully packaged, documented by the Tyrell Museum scientists and stored temporarily in the fire hall on site.

Once the area surrounding the fossil had been cleared, the team relied on the in-house expertise of the Operations and Mine Equipment Maintenance departments to design a method to extract the fossil from the mine. One of the benefits of the discovery being made in a large mining operation is the opportunity to make use of the vast mining expertise and large equipment. If the fossil had been discovered in similar circumstances anywhere else in the province (10 metres below surface and in a remote location) it would likely never have been recovered as the logistics would have been insurmountable.

First a ramp of material was put in place up to the elevation of the fossil in the mining face to allow access for the large mining equipment to be used in the fossil extraction. An excavator was then used to remove the overlying material from above and all around the fossil. The final detailed excavation work was completed by hand.

The exposed fossil pieces were plaster cast (with the aid of many willing volunteers) to ensure their stability during extraction and

eventual transport. Once the large samples were cast in plaster they were carefully lifted out of the high wall with the excavator arm and transported to the Royal Tyrrell Museum in Drumheller, Alberta via an enclosed flat deck transport.

The fossil is currently the top priority project at the Tyrrell Museum and is being actively worked on by the museum's technicians. The bone of the fossil is much softer than the rock containing the specimen, and careful and responsible preparation will take several years to complete.

The entire Fossil Recovery Project is an excellent example of how various departments and disciplines within both academia and industry can come together in a very short time frame to work together to accomplish a unique project efficiently and safely. The project contributed to the preservation of natural history for the Province of Alberta and was a highlight in the careers of many of the Suncor personnel and contractors involved.

References

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Introduction

On March 21, 2011, while excavating overburden materials at Suncor Energy Inc.'s oil sand mine located 50 km north of Fort McMurray, Alberta, Canada; shovel operator Shawn Funk unearthed an unusual piece of siltstone with an odd texture and diamond pattern. The unusual texture and pattern were actually the first pieces discovered of a very rare 110-million-year-old Ankylosaur fossil.

This following text and photographs provide a rare insight into this unique discovery and its complicated recovery from within an active mining area. In addition, a brief introduction to the Canadian oil sands industry and the geology and paleogeography of the Athabasca Oil Sands is provided.

What are Oil Sands?

Oil sand consists of unconsolidated, Cretaceous age estuarine-fluvial dominated sands and silts combined with water and a viscous form of oil called bitumen (Figure 1).

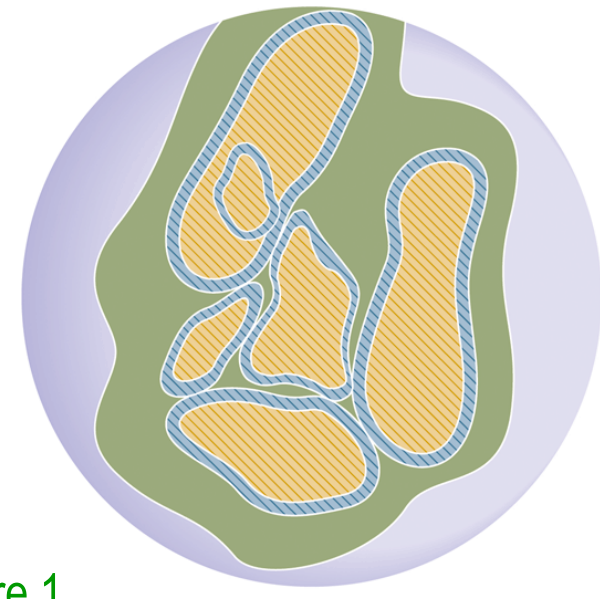


Figure 1

Composition of Oil Sands
Each grain of sand is surrounded by a layer of water and a film of bitumen.
Source: Canadian Centre for Energy Information



Figure 2

Oil sands are located in three (3) major deposits in northeast Alberta, Canada spanning a total area of 142,200 km² (Figure 2).
Of the total oil sands area only approximately 10% is near to surface, allowing for the extraction of the oil sands by surface mining methods, similar to many coal, iron ore, copper and diamond mine operations. Oil sands are mined by large mining shovels and moved by 400-tonne trucks to a cleaning facility where the oil sand is mixed with hot water to separate the recoverable oil from the sand (Figure 3).

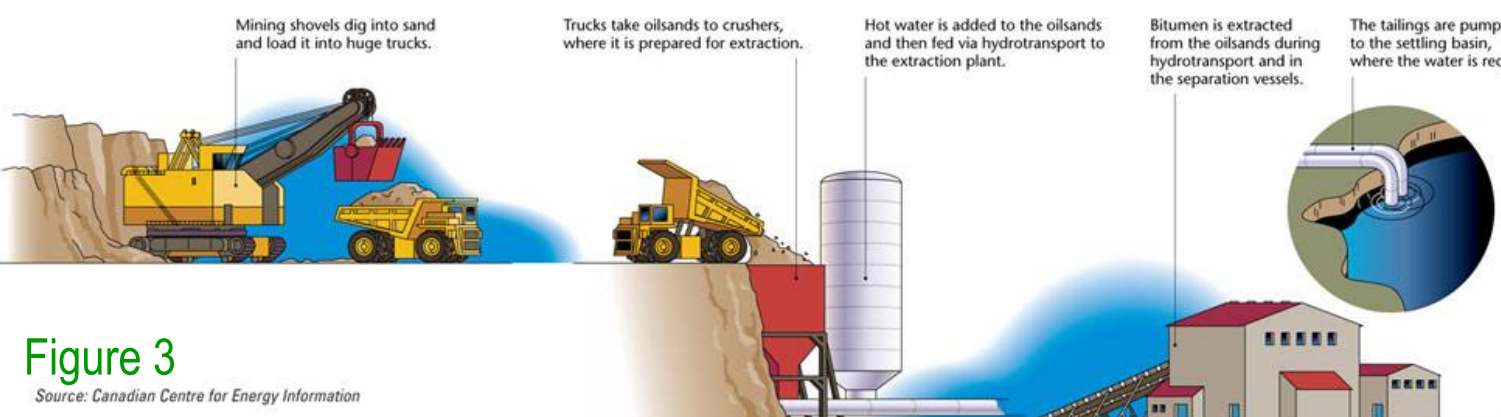


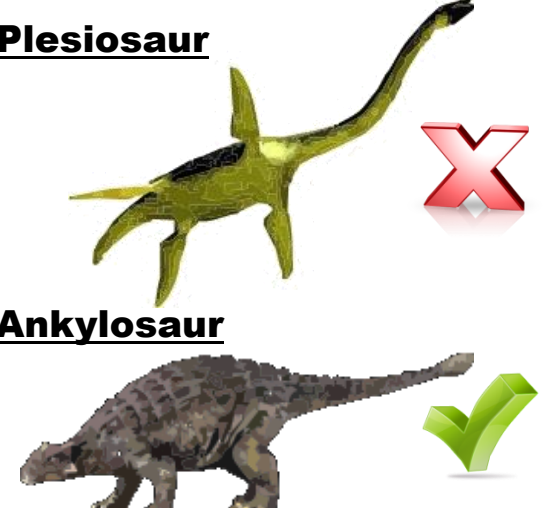
Figure 3
Source: Canadian Centre for Energy Information

Importance of the Resource

The Province of Alberta has proven oil reserves of 171.3 billion barrels which makes it the third-largest proven crude oil reserve in the world, next to Saudi Arabia and Venezuela. Alberta is the largest supplier of oil to the US, sending 1.4 million barrels of oil per day across the Canada-US border.

Something Quite Extraordinary is Discovered

Lying above the Aptian-age McMurray Fm. oil sands, Albian-age Clearwater Fm. marine shales were being mined as overburden when something odd tumbled out of the mining face.



It quickly became apparent that this was a find of great scientific importance. The next issue: how to successfully extricate the remaining bulk of the fossil currently residing 7 metres high in the mine face.



When Did It Live?

SERIES	STAGE	STRATIGRAPHY
LOWER CARBONIFEROUS	ALBIAN	COLOMADO GROUP
		WIKING FORMATION
		JOLI FOLI FORMATION
		GRAND RAPIDS FORMATION
		UPPER Mbr
		LOWER Mbr
		MANVILLE GROUP
		CLEARWATER FORMATION
		WABIKAW Mbr
		McMURRAY FORMATION
112.2 MA	APTIAN	
DEVONIAN		BEAVERHILL LAKE GROUP

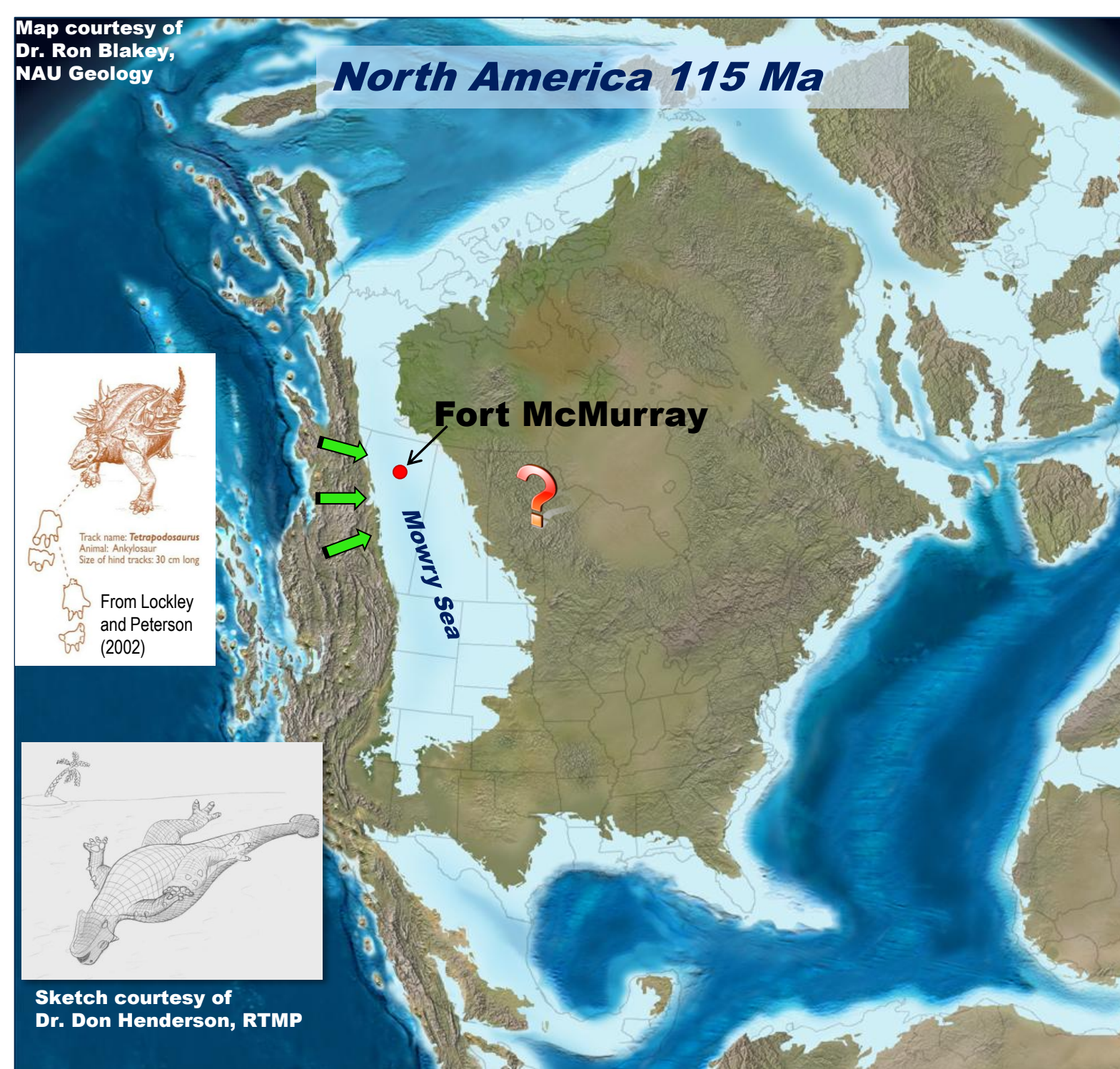
Figure 4



Figure 5

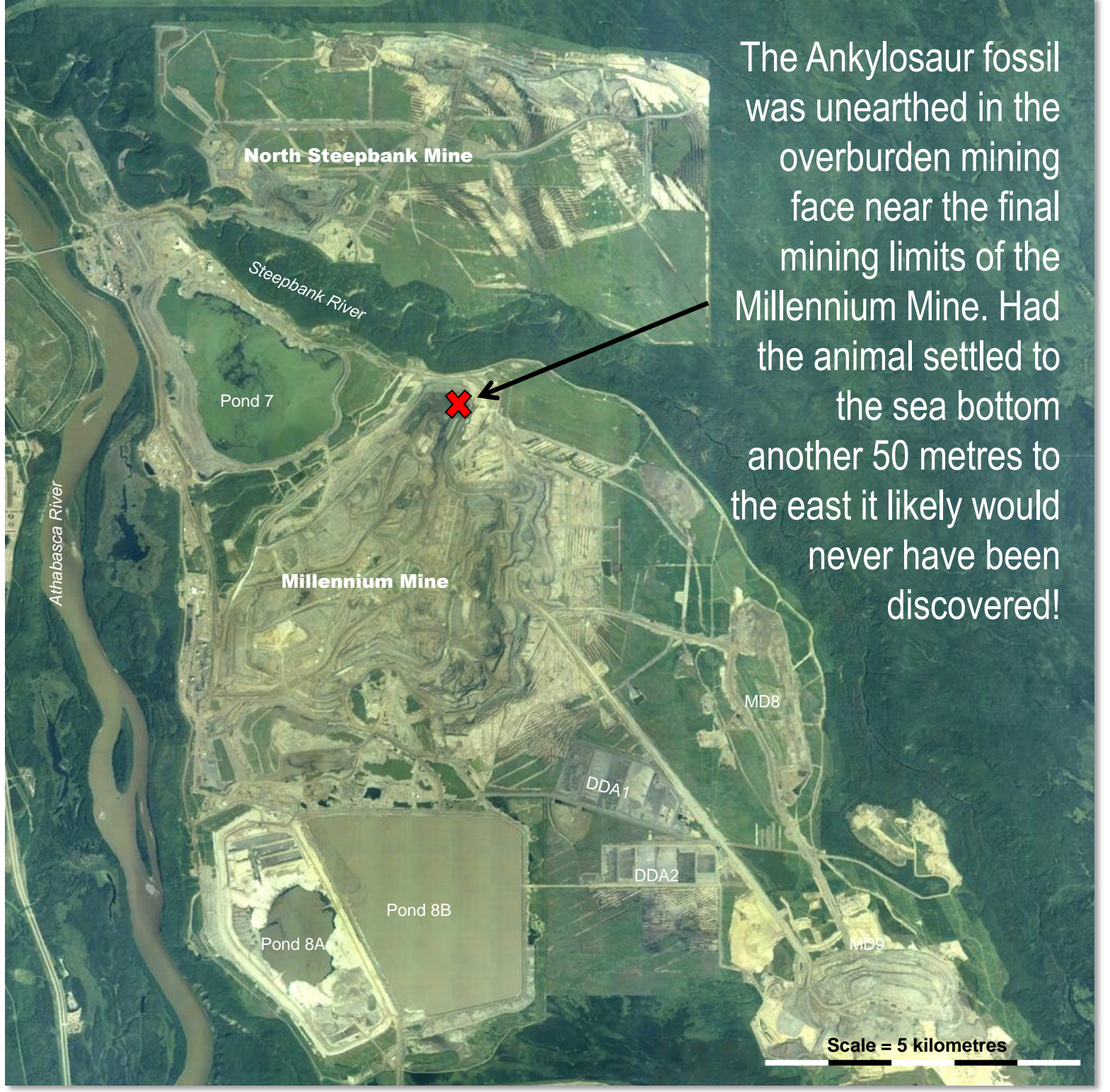
A formation table for the northeast region of Alberta is shown in Figure 4. The fossil, lying inverted with its head pointing into the formation, was encased within a siltstone concretion (outlined in green) in the lower part of the glauconitic shales of the Wabiskaw member of the Clearwater Fm. (Figure 5). Its position immediately above the Aptian age McMurray Fm. places its age at approximately 110 million years. Several marine reptile fossils have previously been found in this formation in this region; however, this is the first ever dinosaur fossil from this formation!

Where Did It Come From?



The Ankylosaur may have originated up to 200 km to the west (where fossil track ways have been found) and was washed out to sea by a large river. The bloated carcass floated for several days before finally "popping" and sinking to the sea floor.

Where Was It Found?



The Ankylosaur fossil was unearthed in the overburden mining face near the final mining limits of the Millennium Mine. Had the animal settled to the sea bottom another 50 metres to the east it likely would never have been discovered!

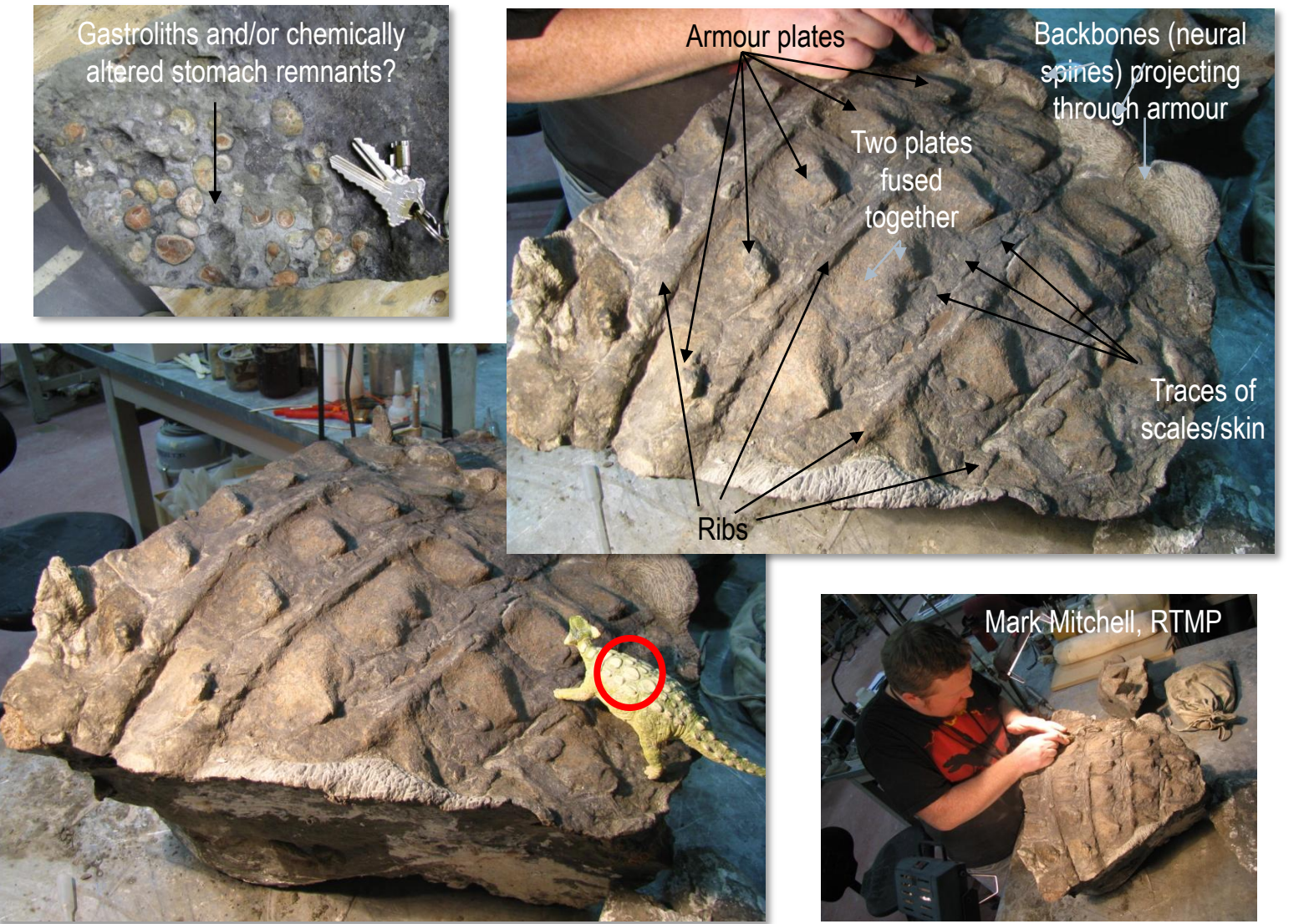
How Was It Recovered?

Fortunately for a paleontologist, a mining operation has access to an extensive variety of large excavating equipment. What might have normally taken several field seasons to excavate was unearthed efficiently and safely in only three weeks with teamwork, ingenuity and an army of willing volunteers.



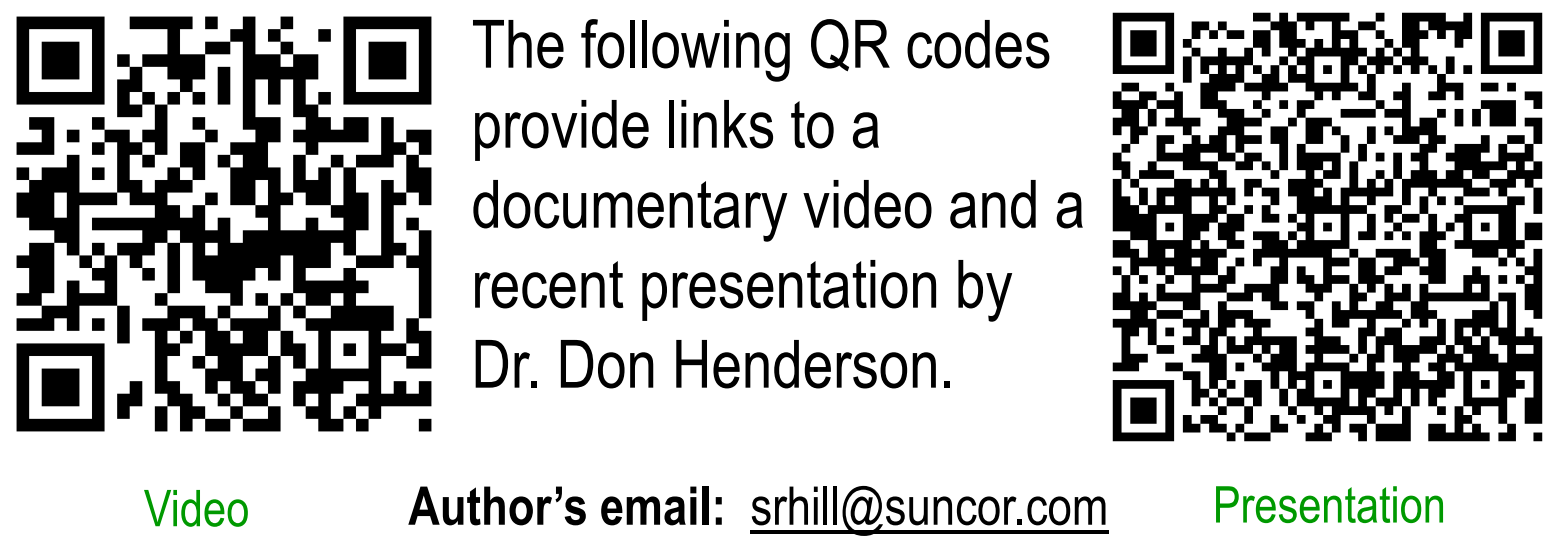
How Rare Is It?

- This is the first ever dinosaur discovered in the province from this time period (110 Ma).
- It is almost entirely complete (less the tail), fully articulated and is preserved in three dimensions with no flattening.
- It has skin impressions and carbon residue presumed to be from the actual dinosaur skin.
- Stomach contents may be preserved within oolitic structures.



The current preparation of this rare Ankylosaur specimen is complicated by the fact that the bone material is much softer than the surrounding matrix. Final preparation will take several years.

Additional Information



Acknowledgements

Doug Lacey¹, Hans Heltke², Ryan MacPherson² and the staff at Suncor Energy.
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