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Industrial Stratigraphy in Action: Groundbreaking Geological Discoveries at the Springbank Off-stream Reservoir Project, Alberta

Jon Noad
Stantec Consulting; University of Adelaide

Summary

Geological monitoring of excavations at the Springbank Off-stream Reservoir Project (SR1), Alberta, has revealed structural complexity, a thrust fault zone, and a previously unreported marine incursion. The Entrance Conglomerate separates the two formations and was logged on Highway 22, including the first record of dinosaur bones over this interval. A second, previously unknown conglomerate was also identified deeper in the section. Boulders excavated from the Main Channel feature an unprecedented bed of giant, freshwater oncoids, and these “algal balls” have been demonstrated to have been deposited on the Cretaceous/Palaeogene boundary. Many other significant palaeontological discoveries have been recorded including a new family of fossil plants and a dinosaur bone bed.

Method

The SR1 Project at Springbank will provide flood protection along the Elbow River in Calgary, Alberta and will work in tandem with the Glenmore Reservoir. It is located approximately 15 km west of Calgary and designed to minimize environmental and historical resources. The Project plan is considered to minimize impact on wildlife while maintaining key routes and incorporating existing infrastructure. Extensive Indigenous Engagement was undertaken throughout the process. The Project area covers approximately 3800 acres, and the dry dam will have a storage capacity of 70 million cubic metres of floodwaters.

The Alberta Historical Resources Act provides for the use, designation and protection of historic resources, including palaeontological, archaeological, historic or natural sites. Under this Act, palaeontological monitoring has been undertaken at the SR1 site, beginning in May 2022. This work has led to a series of groundbreaking geological discoveries including structural, stratigraphic, sedimentological and palaeontological findings.

Geology

Ongoing excavations have exposed extended sections through the Brazeau and Coalspur Formations, dating to the uppermost Cretaceous and lowermost Paleocene periods. Existing geological maps indicate that the Brazeau Thrust fault extends through the middle of the Project area. The Cretaceous/Palaeogene sediments are unconformably overlain by glacial deposits including till and glaciolacustrine deposits, some showing evidence of ice push and wedging.

Results, Observations,

More than 500 field visits were made to the site allowing an enormous database to be assembled, covering various aspects of the geology. This included the following datasets.

Structural geology

More than 200 bedding dips and strikes were collected, all georeferenced, as well as fault and fracture data. This allowed the erection of a completely new structural model. The excavation and “hydrovac-ing” of an extraordinary outcrop of horizontal bedrock pavement enabled the development of a new fracture model for the Foothills.

Stratigraphy and Sedimentoloy

Sedimentological sections were measured through almost the entire bedrock stratigraphy. This identified a dominantly clastic succession, deposited in a terrestrial setting. A single, previously unidentified marine incursion, represented by a 2 m thick oyster bed, has tentatively been correlated to the lowermost Bearpaw Shale marine flooding event, immediately overlying the Dinosaur Park Formation.

Other significant beds include the newly identified Springbank Conglomerate, located around 100 m below the Brazeau/Coalspur Formation contact. This contains bones and oyster fragments. The Entrance Conglomerate sits on the boundary between these formations, and is exposed in a roadcut on Highway 22, where new dinosaur bones were found in the conglomerate. This bed was also recognized on site and both conglomerates are interpreted to represent regional lowstands in relative sea level.

Boulders excavated from the Main Channel feature an unprecedented bed of giant, freshwater oncoids, and these “algal balls” have been demonstrated to have been deposited on the Cretaceous/Palaeogene boundary. This has been confirmed by a significant iridium anomaly located 15 cm beneath the Oncoid Bed. This expression of the K/Pg Boundary has only previously been seen in Tremp, in NE Spain.

Palaeontology

An extensive fossil fauna including dinosaurs, reptiles, and molluscs, as well as a diverse fossil flora comprising trees, leaves and seeds, has also been recorded and these fossils have allowed a detailed picture of the depositional setting and climate to be built up. Invertebrates include beds packed with unionid, freshwater bivalves and beds of gastropods interpreted as both lake dwellers and terrestrial species.

A vertically dipping bed of large fossil, coalified logs hosted more than 20 bones thought to be from dinosaurs, as well as a probable therapod tooth. This is interpreted as a major Cretaceous flood deposit. A younger microvertebrate site yielded crocodile teeth, turtle shell fragments and two small dinosaur bones. Another site may display putative dinosaur footprints. Post-glacial sediments contained sub-recent bison as well as trace fossil ground squirrel burrows.

Conclusions

This Project provides an excellent example of the Alberta Historical Resources Act, and associated palaeontological and sedimentary monitoring, in action.

Novel/Additive Information

The major findings include:

- Re-interpretation of the existing structural geological model, including an interpretation of an unprecedented bedrock pavement exposing 160 m of fracture data
- The identification of four major stratigraphic horizons, three previously unreported, including an Oncoid Bed overlying the K/Pg Boundary
- Fossil discoveries including a leaf bed with exceptional preservation; a completely new family of fossil plant; several in situ fossil trees; a dinosaur bone bed; a microvertebrate site hosted in mudstone beds; and numerous other invertebrate fossils and beds

Most of these are, literally and figuratively, groundbreaking geological discoveries.

Acknowledgements

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References

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To be added later

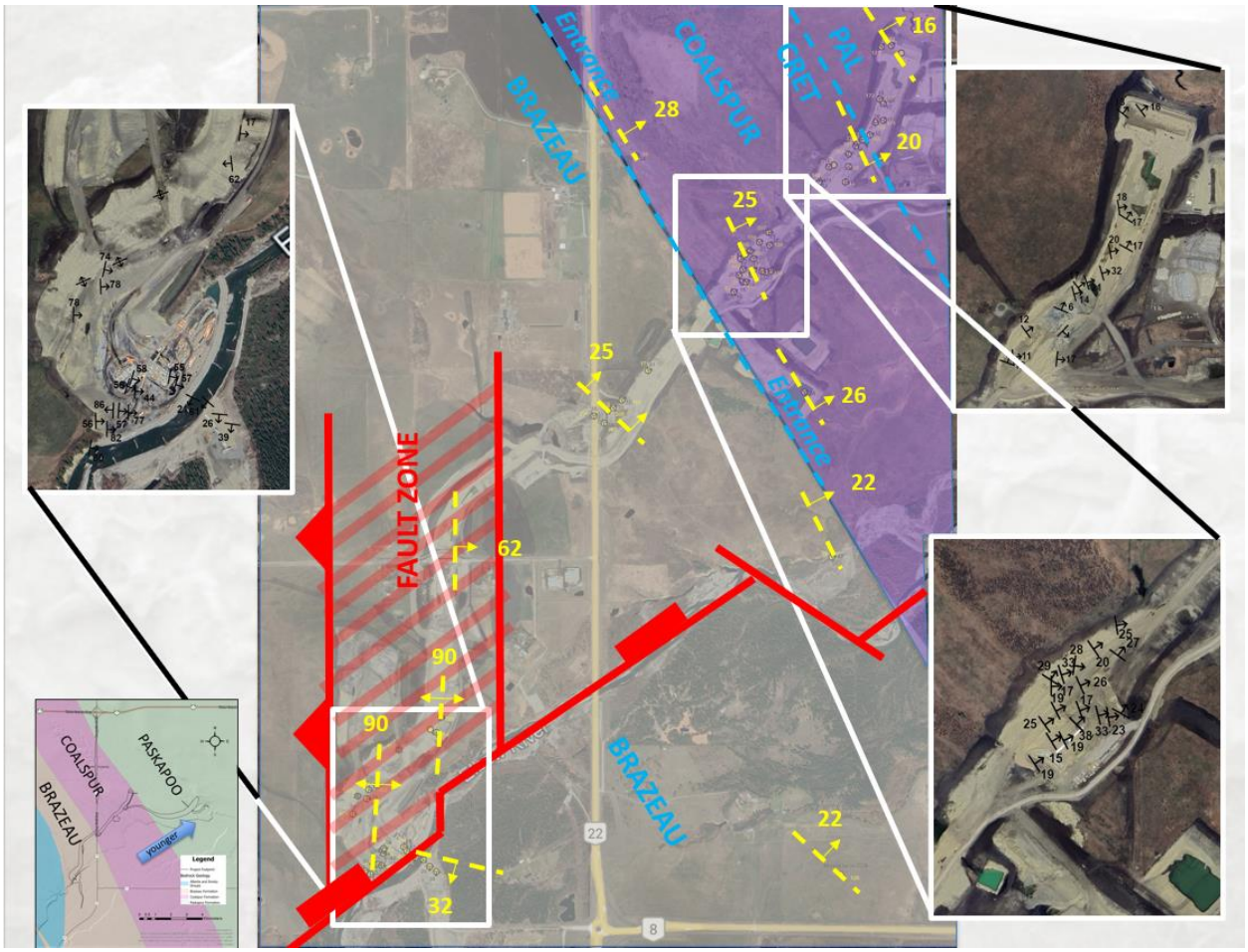

Figure 1. Summary structural map of the SR1 Project area

Figure 2. to follow – stratigraphy of the Project site