2018 ATLAS SYMPOSIUM UNDERGRADUATE POSTER SESSION

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A Geochonologic study of the basement of the Canadian Shield near Nonacho Lake, NWT

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Much less is known about the geology of the western Rae craton than the adjoining Slave craton. This is particularly true of the crystalline basement rocks. Limited previous work on the basement rocks suggests a variety of rock types and of formation ages including a hint of some ages as old as 3.99 Ga[1]. The present study aims to provide more detailed information on the basement rocks in the southwestern Rae craton and use this information to better understand the tectonic history of the area.

Our work focuses on a spectacular outcrop of basement rocks on an island ('Udder Island') in Nonacho Lake which is 260 km southeast of Yellowknife. The outcrop was investigated as part of a mapping project that covered both the basement rocks and the unconformably overlying supracrustal rocks of the Nonacho group. The outcrop consists of porphyroclastic granite, gneiss, gray tonalite, and amphibolite, all of which exhibit very high degrees of strain and have been interlayered on the centimeter to meter scale.

Thin sections were prepared of all the major rock types for petrographic analysis and U-Pb dating. These were then examined with the optical microscope and the electron probe microanalyzer (EPMA) to find zircons suitable for U-Pb isotropic work analysis. Zircons were identified in all the major rock types present. Prior to isotopic analysis, the EPMA was used to obtain backscatter electron images to determine their internal structure and assess the radiation damage. Work is currently underway to obtain U-Pb isotope analysis via laser-ablation ICP-MS.

1. van Breemen, O., Kjarsgaard, B.A., Tella, S., Lemkow, D., and Aspler, L., 2013. U-Pb detrital zircon geochronology of clastic sedimentary rocks of the Paleoproterozoic Nonacho and East Arm basins, Thaidene Nene MERA study area, Chapter 4 *in* Mineral and Energy Resource Assessment for the Proposed Thaidene Nene National Park Reserve in the Area of the East Arm of Great Slave Lake, Northwest Territories, (eds.) D.F. Wright, E.J. Ambrose, D. Lemkow, and G.F. Bonham-Carter; Geological Survey of Canada, Open File 7196, p. 119-142.

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Characterization of porosity in black shales using nitrogen adsorption experiments and scanning electron microscopy: an example from the Middle to Late Devonian Horn River Group, Central Mackenzie Valley, Northwest Territories

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Recently, organic-rich shales have become important unconventional reservoirs due to advances in technology that make it possible to exploit hydrocarbons trapped in the pores of these successions. In order to achieve an accurate assessment of the quality of the reservoir, understanding the porosity in these intervals is essential, however, as pores observed in black shales are microscopic, micro-imaging techniques are required to determine pore size, shape, distribution, and total pore volume.

This study focuses on the Middle to late Devonian Canol and Hare Indian formations, black shales of the Horn River Group located in Central Mackenzie Valley, Northwest Territories that have been identified as prospective unconventional resource candidates. Due to the remote location of these intervals, there is relatively few data gathered from the formations in the Horn River Group, and a detailed assessment of porosity has not yet been conducted.

For this project, scanning electron microscopy (SEM) and nitrogen adsorption-desorption experiments are used to characterize pores and determine pore volume. The dataset consists of four samples taken from the Husky Little Bear N-09 well: two from the Canol Formation at depths of 1727.05m and 1718.95m and two from the Hare Indian Formation at depths of 1810.0m and 1825.0m. Using the Barrett-Joyner-Halenda (BJH) model, nitrogen adsorption-desorption experiments suggests that the pore sizes in these samples ranged from 10nm to 100nm. The adsorption-desorption isotherms gathered from the same analysis also indicate that the pores are slit-shaped. The images from the SEM analysis indicate that the pores in these samples can be found in several sites including pyrite framboids, grain boundaries, microfractures, inside grains and in organic matter.

The results of this study contribute to our knowledge of the hydrocarbon storage capacity of the Hare Indian and Canol formations and increases our understanding of their potential as shale reservoirs.

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Volcanic provenance of Holocene ash deposits in SW Alaska: a case study from Eklutna Lake

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Throughout the Holocene, the Cook Inlet has been impacted by ash produced by Aleutian Arc volcanos. Many of these volcanos are still active and pose an environmental hazard to present Alaskans living around the Cook Inlet. Thus, understanding how often ash clouds have impacted this area throughout the Holocene is important for understanding the risk of future eruptions faced by today's Cook Inlet inhabitants. To strengthen the existing chronologic framework of eastern Aleutian eruptions, major oxide data for Eklutna Lake tephras were compared with geochemical reference data for several of the most important active eastern Aleutian volcanos to construct the first tephrochronology of Eklutna Lake. This record demonstrates that Mount Redoubt was highly active throughout the Late Holocene. Late Holocene activity from Katmai, Augustine, and Hayes were also identified.

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Isotopic analysis of fugitive gas from oil and gas wells in Alberta.

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Migration of gas from oil and gas wells is a common and highly problematic occurrence, migrated fugitive gases contaminate nearby aquifers, soils, and they accumulate in the atmosphere. The petroleum industry is the primary anthropogenic source of Canada's methane emissions and Alberta alone is responsible for about 40% of these emissions. Dr. Karlis Muehlenbachs has established an extensive database containing the isotope composition of approximately 10 000 gas samples from various sources such as production, well, soil, and river gases from across Alberta. The obtained methane isotope signature of production gases ranges from -73.39 to -44.08 $\delta^{13}CH_4$ ‰. With a focus on methane and carbon dioxide the database is being analyzed and used to formulate a concrete isotope signature of Alberta's fugitive gases and to draw conclusions on the relationship between geographical location and well emissions.

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Using 3D Printed Models of Atrypide Brachiopods to Access the Effects of Shape on Feeding

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Brachiopods of the order Atrypida, some of the most common and diverse Siluro-Devonian organisms, are known to have morphologies associated with environmental gradients. Globose, biconvex morphologies have been associated with higher-energy and cleaner carbonate systems, while more shield-shaped, plano-convex morphologies have been associated with low-energy, muddy systems. This study observed the effects of these two shapes on passive flow of water through the brachiopods. Passive flow is used as a proxy for the most energetically efficient system for moving water through the mantle cavity to capture food particles.

Using 3D scanning and printing, we constructed two highly accurate gaping models of both end-member brachiopod shapes. A recirculating flume tank and dye streams were used to visualize passive flow through the models in multiple orientations relative to flow direction. The plano-convex shape outperformed the biconvex shape in all experimental orientations, demonstrating more efficient flow of dye across the lophophore, and a steady medial exhalent current above the model, similar to a chimney. These results suggest that the plano-convex morphology was more capable of using passive flow, while the biconvex morphology may have been forced to rely more on active pumping. This is consistent with observed morphological distributions along environmental gradients, where quiet water taxa such as plano-convex atrypides rely on body shapes that maximize passive flow/food capture.

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Damage to gastropod shells during experimental sediment compaction

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Palaeoecologic interpretations drawn from the fossil record could be biased by taphonomic processes. Post-depositional compaction of gastropod shells may alter perceived predation intensities by fragmentation. For example, predatory drill holes may reduce shell strength, and be preferentially lost during compaction; thus observed drilling frequencies may be lower than their original frequencies. To test this hypothesis, 280 *Olivella biplicata* shells (248 undrilled and 32 successfully drilled) were subjected to compaction (4000 psi) in a coarse-grained sand matrix. For each trial, multiple shells were tested simultaneously, but were spaced so that no shells were in contact. Shell strength was categorized at three increasingly severe thresholds: damaged (fractured and or fragmented), fragmented, and obliterated (< 50% intact). This equated to both conservative (any damage) and practical (potentially removed from the fossil record) testing of compactional strength. The difference in compactional strength between drilled and undrilled shells at each damage threshold was determined utilizing Fisher's exact tests. A total of 88%, 44%, and 16% of drilled shells were damaged, fractured, and obliterated, respectively. The likelihood of drilled shells to exceed any of these thresholds did not significantly differ from that of undrilled shells. Therefore, drilled gastropod shells are inferred to not be selectively damaged by compaction, and studies utilizing drill hole data need not worry about bias from compaction.

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Geologic Context of Candidate Source Craters for Martian Meteorites

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Martian meteorites are currently the only known samples from Mars and thus provide the best clues and information about the geologic history and evolution of the planet. The meteorites are all derived from unknown locations on Mars through impact, sometime within the past 20 Ma (based on ejection age from cosmic ray exposure). This study involves using results from modeling of the impact delivery process applied to four Martian meteorites (Zagami, Tissint, Chassigny, NWA 8159) with known crystallization age, ejection age, petrology, and geochemical make-up to narrow down the potential source craters from a database of over 200. Implementation of this approach has resulted in eight craters which could be the sources of these four meteorites.

Potential source craters are typically observed to overlie or crosscut lava flows from various volcanoes across the Martian surface. These flows can potentially be traced back to specific volcanoes or secondary vents and fractures using a combination of MOLA data, CTX imagery, and USGS mapping of the surface. Additionally, the presence of rays as observed by THEMIS imagery indicates high-velocity impacts which suggests that the craters presenting this feature are the more probable source of Martian meteorites. Degree of preservation, volcanic context, and rays combined with USGS surface maps and individual crater observation and analysis provide an overview of the local and regional geologic context of craters for further analysis as candidate source craters of Martian meteorites.

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Rethinking Zoning: An Alternative to Rigid and Complex Land Use Bylaws

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Zoning is one of the most fundamental and widespread tools available to urban planners. It involves the division of urban areas into zones in which only specified uses can occur, and the prescription of regulations and guidelines for the buildings and land within those zones. Throughout much of the 20th century, zoning emphasized a stringent separation of uses. In recent decades, planners have sought to promote a greater mix of land uses in order to create more livable and sustainable communities. In this study, I investigate key principles underlying both traditional and contemporary zoning bylaws, and suggest an updated approach that is more accessible to the public and more closely aligns with contemporary planning objectives.

The research involved a three-part methodology. First, I explored the historical and contemporary contexts of land use regulation. Second, I developed a local contextual understanding by reviewing the costs and benefits of Edmonton's current zoning bylaw and conducting key informant interviews with practicing planners. Third, I created an alternative zoning bylaw based on this context and the degree of political will for change.

This alternative bylaw seeks to address several shortcomings of traditional zoning, including overly complex regulations, limited flexibility, and a lack of design-based elements. As a mock-up, it is intended to influence Edmonton's Zoning Bylaw Renewal project taking place over the next three years. Ultimately, my research aims to improve the practical outcomes of zoning, and enable clear two-way communication between planners and citizens regarding the future form and design of Edmonton's communities.

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An Ichnological and Geochemical Analysis of the Middle and Upper Montney Formation

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Environmental reconstruction is one of the most important and most difficult problems sedimentary geologists and paleontologists must tackle. In the past, both process ichnological and geochemical methods have proven to be effective when making inferences about the presence of physiochemical stresses and other paleoenvironmental parameters. Nevertheless, these two methods are not often used in conjunction with one another. In this study, process ichnological and geochemical datasets from the Montney Formation are integrated in order to determine the degree to which the two methods correspond with each other. Three cores from the Middle to Upper Montney/Basal Doig Siltstone are analyzed every 10 centimeters for facies identification, process ichnological features (*i.e.* burrow size, diversity and distribution) and X-ray Flourescence (XRF) geochemical profiles. The detailed ichnological dataset is integrated with trace element geochemistry to construct a framework to understand how the interpretations of the two datasets compare. The combination of using these two approaches can enhance interpretations of physiochemical stresses and paleoenvironmental conditions within the Montney Formation and other fine-grained formations around the world.

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Juvenile naticid drill hole stereotypy within a predator-prey system of small bivalves from the St. Marys Formation of Maryland

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Naticid drilling predation is one of the most well-studied predator-prey interactions within palaeontology. Naticids are known to show stereotypy in drill hole placement on their prey, which can provide information on ecological trends and behavioural patterns. Drill holes in the fossil record can provide information on predation frequency, success rate, and prey selection, as well as serve as a proxy for predator size. The interactions between naticids and their prey have been well-studied; however, more information is needed on systems in which both the predator and prey are small, as these may exhibit different dynamics. This study examines drilling predation by ontogenetically young *Euspira* naticids on small (< 15 mm) bivalves from the Little Cove Point Member of the St. Marys Formation (Miocene, Maryland). All the specimens examined bear small drill holes less than 2 mm in diameter; these holes are attributed to small, young naticids, as *Euspira* is the only naticid in the unit. *Spisula subcuneata* is the most abundant bivalve in this size range, as well as the most common prey item for the young naticids.

Geometric Morphometrics (Bookstein Shape Coordinates) and a 9-sector grid system were used to analyze drill hole stereotypy. The results were compared to previous research on large naticids preying on larger prey species from the same unit. Juvenile naticids demonstrated drill hole stereotypy like that of adult naticids; this was demonstrated by (1) the presence of strong prey-size selectivity and (2) strong drill hole location stereotypy at the umbo of *S. subcuneata*. Therefore, naticids show stereotyped behavior, even early in their ontogeny.

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Refining the radiocarbon chronologies of past glacier fluctuations in the Canadian Rocky Mountains

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Glacier fluctuations during the Little Ice Age, a period of expanded glacier cover over the last millennium, have been well documented in the Canadian Rocky Mountains over the last ~50 years. However, periods of glacier advance prior to the Little Ice Age are only broadly understood. To better understand the pre-Little Ice Age history of glaciers in the region, we radiocarbon-dated subfossil wood exposed by recent retreat of Peyto Glacier. We also compiled and critically reanalyzed radiocarbon data from the literature on Holocene glacier fluctuations in the Canadian Rocky Mountains. The field data and radiocarbon results indicate that Peyto Glacier advanced and overrode a mature forest near its present terminus 2900-3000 ^{14}C yr BP (2950-3350 cal yr BP). The new radiocarbon dates from Peyto Glacier are similar to previously published dates from Brian Luckman's pioneering research found along the 1984 ice margin, indicating very rapid glacier advance ~3300 years ago from an ice margin upvalley of the present terminus. The regional compilation of calibrated radiocarbon dates pertaining to Holocene glaciation highlights the need to consider geomorphic and stratigraphic contexts when evaluating such compilations, with the potential to achieve additional insight into timing of glacial activity with Bayesian radiocarbon calibration.

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Testing ecological niche modeling using paleoclimatic data: Implications for modern conservation

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Ecological niche models (ENMs), which model a species' niche based on their distributions and associated environmental parameters, are a widely used method within conservation for predicting how a species' distribution will shift due to climate change. However, the results of these models are predictions which require the passage of time to empirically test. This passage of time puts at risk the species that the predictions are trying to protect. The paleontological record allows us to test the accuracy of ENMs empirically by testing the niches of species before, during, and after distribution shifts. This study investigates the predictive capabilities of the ENM MaxEnt by modelling the ecological niche space for multiple modern Caribbean and Pacific coral and mollusc species using sea-surface temperate and bathymetry as the environment data, and projecting them into the Pliocene (~3 Mya) to predict their Pliocene niches. Those predicted niches were then compared to the known Pliocene occurrences. As an additional test, we reversed the model and projected the Pliocene niches, based on the Pliocene occurrences, into the modern. The predicted distributions were consistent with the actual distributions in both the modern and Pliocene. The same was true when the modelled niches of the Pliocene fauna were projected into the present day. The striking similarity between the modeled distributions and known occurrence data suggests that ENMs can accurately predict faunal movement in response to climate change, and that the paleontological record is useful for providing relevant information for modern conservation efforts.

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Ichnological Analyses of Cambrian aged Strata in the Colville, North West Territories Area

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Ichnology or the study of trace fossils is a paleontological discipline that uses the fossil burrows and tracks of animals to better understand environmental conditions in paleo sedimentary environments. Parameters such as burrow size, type, and diversity coupled with observations of burrow distribution and bioturbation intensity can be used to proxy environmental parameters such as sedimentation rate, environmental hydraulic energy, salinity, and oxygenation. Interestingly bioturbation distributions have changed from the end of the Ediacaran to today.

In an attempt to understand evolutionary aspects of bioturbation, some research has stated that in Cambrian-Ordovician rocks bioturbation depth remained very shallow compared to later sedimentary environments. Some have claimed this limitation was imposed by morphological and behavioral constraints assigned as evolutionary in nature. Their work occurred in shelf settings, however, this study sets out to test their hypotheses in shallow-water marine settings such as proximal offshore and lower shoreface deposits.

We have found that in different environmental setting than previous research we have deeper bioturbation. Specifically, in sedimentary environments such as fairweather proximal lower shoreface, middle – distal lower shoreface, and lower shoreface settings showing modal bioturbation depths of 3.0, 3.3, and 3.4 centimeters respectively. Compared to previous research with values of 0.2, and 1 centimeters from lower-middle Cambrian and Cambro-Ordovician shelf settings.

This suggests that physical chemical conditions in shallower water promoted the deeper bioturbation of sedimentary surfaces compared to the shelf settings outlined in previous research. We take this to show that limitations of burrowing animals in the offshore were not evolutionary limitations, but physio chemical limitations imposed by stress, (most likely related to lowered dissolved oxygen levels).

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Biogenic Porosity and Permeability in the Cardium Formation, Ferrier Field, Alberta

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Fine-grained unconventional lithosomes of the Cardium Formation are increasingly being exploited by the petroleum industry; the reason for increased economic interest is due to the high hydrocarbon storage potential of such rocks. Importantly, bioturbate textures can enhance or reduce permeabilities and porosities of fine-grained sedimentary rocks by changing grain and pore space distribution. Accordingly, understanding and identifying biogenic permeability in siltstone may help assess the bulk permeability, which indicates the rock's ability to conduit flow of hydrocarbon and water.

This study characterizes the sedimentology and Ichnology of CNRL Ferrier 7-3-39-7- w5m drill core (NW Alberta), which contains Cardium Formation siltstones. The siltstone facies are classified based on the fabric generated by bioturbation and some inferred characteristics pertaining to reservoir quality.

Micro-CT and thin section data are used in this research to image the internal structure of ichnofossils, which are characteristically filled by very fine sand to fine sand in the studied core. As such the trace fossil infill contrasts with siltstone host rock. Additionally, Micro-CT provides three-dimensional visualizations of the ichnological fabrics in small diameter core. The resulting isotropic flow fabrics stand to improve fracture-matrix interactions, improving potential well performance. In short, bioturbated zones stand to provide preferred horizontal drilling zones in Cardium Formation unconventionals

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