

IRGF Final Report

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Finding Fault - Implications of Fault-Controlled Eruptive Muds on Animal Communities of the Burgess Shale

1.1 Project Summary

The Burgess Shale of Yoho and Kootenay National Parks hosts spectacularly preserved fossils of marine animals of the Cambrian Period, a time of the initial diversification of animal lineages. My research program focusses on the geologic setting and ancient environments of the Burgess Shale. We hypothesize that hot fluids leaked onto the seafloor and attracted the animals preserved as fossils. Geochemical analyses are used to test this hypothesis.

1.2 Project Outcomes and Impacts

Funding supporting this project for the 2023/03–2024/07 interval resulted in some excellent results. In particular, samples collected in the field in the summer of 2023 were key to the results published with colleagues in our recent paper in *Nature--Earth and Environment* (McCormick et al., 2023). Using radiometric dating, that study showed that the the extensive deposits of the mineral dolomite in geologic strata associated with the Burgess Shale were produced by hot magnesium-rich fluids during the Cambrian Period, not during the much later building of the Rocky Mountains as had been proposed by other researchers. This supported our earlier hypothesis (Johnston et al., 2009; 2017) that magnesium-rich fluids breached the Cambrian seafloor in what is now Yoho and Kootenay National Parks. These fluids promoted localized microbial productivity that in turn attracted the marine animals preserved as fossils in the Burgess Shale. The funding allowed us to use a helicopter in the summer of 2023 to access the top of Wapta Mountain in Yoho National Park (see image) and sample previously unstudied Cambrian strata there. We also sampled rocks from major faults on Mount Field just to the south of the famous quarries in the Burgess Shale on Fossil Ridge. The latter was especially important because we have hypothesized that these faults are Cambrian in age (not associated with the building of the Rocky Mountains) and provided the plumbing for the Mg-rich fluids that leaked onto the seafloor. Students employed as research assistants, and supported by the funding, cut the samples in the lab for geochemical analyses and petrographic thin sections, results of which are pending. Prospecting for additional silicified faunas, as described in Johnston and Streng (2022) did not produce new sites, which highlights the importance of those we have discovered to date, silicification being apparently rare in these deposits.

2.1 Use of Awards Funds

A little more than half of the funds available for this project were paid for helicopter support to access Wapta Mountain (~\$3000). The helicopter was somewhat more expensive that estimated owing to rising fuel cost and a very strong headwind that day. The remainder of the funding was used to support student research assistants who cut the samples in the lab for geochemical analyses and for petrographic thin sections. The students also conducted preliminary graphing of geochemical data.

2.2 Additional Outcomes/Research Issues

N/A

2.3 Dissemination of Project

Two major outcomes of the 2023–2024 IRGF funding are as follows: I was co-author of a conference presentation at the Geological Society of America annual meeting: McCormick, C., Corlett, H., Roberts, N.M.W., Stacey, J., Koeshidayatullah, A., Johnston, P., Collom, C.J. and Hollis, C. (2023). Mg-rich brine seeps in the Burgess Shale lagerstätte constrained by dolomite U-Pb geochronology. Geological Society of America Abstracts with Programs. Vol. 55, No. 6: 238-1. doi: 10.1130/ abs/2023AM-389276 That study was published in 2024: McCormick, C.A., Corlett, H., Roberts, N.M., Johnston, P.A., Collom, C.J., Stacey, J., Koeshidayatullah, A. and Hollis, C., (2024). U-Pb geochronology reveals that hydrothermal dolomitization was coeval to the deposition of the Burgess Shale lagerstätte. Nature— Communications Earth & Environment, 5(1), p. 318.

2.4 Future Research Plans

Research continues on the Burgess Shale. Samples collected from Wapta Mountain and from major faults on Mt Field in Yoho National Park are scheduled for geochemical analyses, pending successful funding from future IRGF applications. Recently, geology major students at MRU have reported finding evidence of hydrothermal dolomite and associated sulfide metal deposits much farther to the east in the vicinity of Castle Mountain. This raises interesting questions as to whether these deposits are part of the same magnesium-rich hydrothermal events that produced the dolomites and sulfide metal deposits near the Burgess Shale. These students are enrolled in 4th year independent research projects to investigate a possible connection. Their studies will also require funding for the necessary geochemical analyses.