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Not in the shadow of the Escarpment—Deposition of the middle Cambrian Burgess Shale and Monarch Formation adjacent to the Cathedral carbonate platform reconsidered

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The famous middle Cambrian Burgess Shale was deposited abutting an alleged, near vertical, seafloor carbonate cliff known as the Cathedral Escarpment. The Escarpment is thought to have formed from massive failure of the Cathedral carbonate platform margin resulting in a slide surface with a sub-vertical headwall up to 200 m high. Subsequent retrograde spalling of the headwall has been proposed to explain large carbonate bodies (olistoliths) hosted in adjacent basinal deposits. Field and petrographic observations reveal difficulties with the olistolith/escarpment model: 1) the 'olistoliths' shows lithologies unlike those of Cathedral platform carbonates—textures common in the platform margin such as microbially-lined herringbone-calcite-filled cavities being absent; 2) 'olistoliths' commonly show "gum drop" morphology (planar bottoms, rounded tops), which make little sense as spalled blocks, and which we interpret as carbonate mounds that grew on the basin floor; in some instances these slid down paleoslope encurring fragmentation and goughing semi-brittle underlying beds; 3) an oft cited, large, bedded, carbonate block hosted in the Burgess Shale on the NW face of Mt Stephen (Yoho National Park) appears to be surrounded by talus, not bedrock, and cannot be accepted as a *bona fide* olistolith; it was likely derived from the cliffs of the Eldon Formation above, rather than from the Cathedral Formation.

If the escarpment represents a standing sea-floor cliff as traditionally interpreted, then its face must have been essentially a subvertical hardground exposed to seawater during >2 trilobite subzones, probably about 2-4 million years, until the basin filled. However, the escarpment face lacks evidence for long exposure such as: 1) manganese staining, glauconite, and hard-ground derived clasts in adjacent basinal sediments; and 2) paleontological features typical of hardgrounds including bored irregular surfaces, encrusting organisms, and holdfasts of sessile fauna. Late dolomitization cannot be evoked as a means to efface hardground features on the escarpment face because

recent studies by independent research groups have shown that dolomitization of the platform margin was earlier than, or syndepositional with, deposition of the Burgess Shale.

We conclude that the contact of platformal carbonates and the Burgess Shale, at least at Fossil Ridge, resulted from movement of a middle Cambrian transpressional growth fault, which underwent oblique reverse slip. While substantial thickening of the Stephen Fm/Burgess Shale from the platform to the basin indicates a significant break in slope, it is unlikely that a standing seafloor carbonate escarpment was developed. Faults at the junction of the Burgess Shale and platform carbonates, including Fossil Gully Fault, are locally filled with clinochlore, a Mg-rich mineral associated with serpentinization initiated in the mid-crust (300-550ºC). The faults served as conduits for clinochlore mud that erupted onto the Cambrian seafloor via mud volcanism at several localities, including the Trilobite Beds and Fossil Ridge. Brine seeps, commonly associated with mud volcanism, likely fueled microbial productivity locally, which in turn promoted localized concentrations of animals.

Figure 1. Carbonate features, middle Cambrian, Yoho National Park, British Columbia, Canada. **A)** Helicopter view of alleged carbonate olistoliths (arrows) in the Monarch Fm, Mt Field. Fir trees at left for scale. **B)** Carbonate mounds (arrows) hosted on Yoho River Limestone Member of Burgess Shale, Mt Stephen. Person circled for scale. **C)** Clinochlore dike in Fossil Gully Fault (*FGf*) cross-cutting Burgess Shale, Mt Stephen, Trilobite Beds. **D)** Prominent "olistolith" on NW face of Mt Stephen, reinterpreted as fallen block from overlying Eldon Fm cliffs and secured in Pleistocene—Holocene talus.