The Lower Triassic Sulphur Mountain Formation, Mount Crum Section, east-central British Columbia: age, tectonic implications and Montney lithofacies comparisons

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Introduction

The Early Triassic Montney Formation is one of the major resource plays in western Canada. Field work conducted during the summer of 2009 on the Lower Sulphur Mountain Formation section at Mount Crum (Fig. 1), Front Ranges, east-central British Columbia is leading to new interpretations of these rocks.

Methodology

Numerous samples were collected for isotopic analyses, thin-section petrography, rock-eval, and conodont biostratigraphy. In addition, gamma-ray values were measured with a hand held scintillometer. Some of the preliminary results are reported below.

Age and structural implication

Conodonts extracted from a sample at the base of the Mount Crum section 0 – 0.15 cm above the top of the Paleozoic (Fig. 2) include *Neospathodus* sp. indet. and reworked fragments, indicating a probable upper Induan (Dienerian) age. Another sample at 54.8 m above the base of the section (Fig. 2) produced *Neospathodus posteroelongatus*, *Paullella meeki, Wapitiella robustus, Novispathodus waageni* sensu lato (including probable *N. eowaageni*), assigned to a lower Olenekian (mid-Smithian) age. Colour alteration index (CAI) of 2.0 indicates that these rocks are mature within the oil preservation window and also corresponds to peak dry gas generation (Utting *et al.*, 1989).

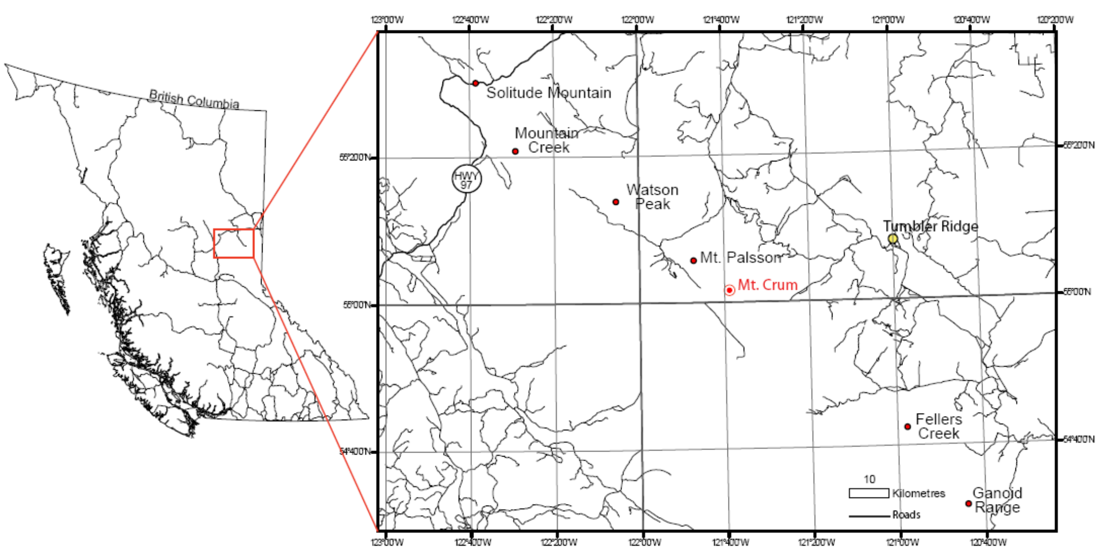

Figure 1. Location of study area in east-central British Columbia. Mount Crum section is depicted in red.

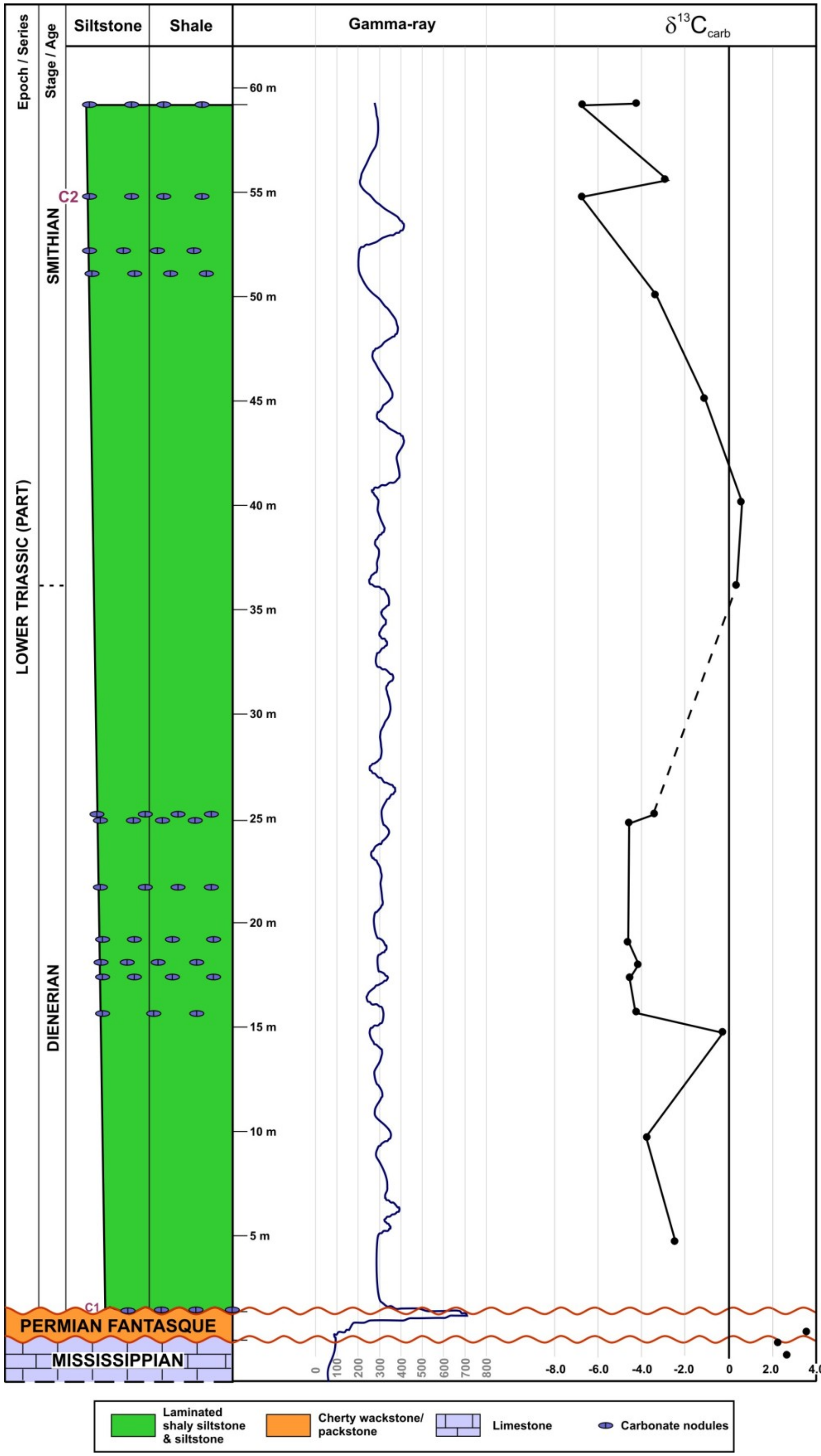

Figure 2. Lithology of the Mount Crum section with age based on conodont biostratigraphy. Gamma readings and $\delta^{13}C_{carb}$ values are shown. Position of both conodont samples are indicated as C1 and C2.

The carbon isotopic composition ($\delta^{13}C_{carb}$) of the Mount Crum section shows a negative carbon isotopic excursion with a range of values between 0.5‰ to -6.8‰ that correlates with a similar trend as seen in the Early to Middle Triassic $\delta^{13}C_{carb}$ profile of Payne *et al.,* (2004). However, the $\delta\ ^{13}C_{carb}$ values of this section are significantly more negative (-6.8‰) than those measured by Payne *et al.,* (2004); their most negative values are in the -2.0 to -3.0‰ range. The peak of a positive excursion is correlated with the Dienerian-Smithian boundary based on comparison with the profile from Payne *et al.,* (2004).

The implications of these age assignments and tectonostratigraphy in the Mount Crum section are that the Griesbachian is not present, and thus the Mount Crum area was structurally high until about early Dienerian time. The 54.8 m sample is the same age as the base of the Meosin Mountain Member, a newly-proposed name for the turbidite section to the south in the lower part of the Sulphur Mountain Formation (Orchard and Zonneveld, 2009), including at the Ganoid Range. The turbidites are not present to in the Mount Crum section; their absence plus the increased carbonate content is indicative of relatively slow (condensed) siliciclastic sedimentation away from a major direct clastic source. Furthermore, the turbidite succession of west-central Alberta subsurface is older than the Meosin Mountain Member (Kendall, 1999; Orchard and Zonneveld, 2009) indicating variation in timing of turbidite deposition across the region. The Montney in the subsurface of NE BC also shows increased carbonate content in deeper, condensed settings (G. R. Davies, pers. comm., 2010).

An explanation for a structurally high position for the Mount Crum section and variation in timing of turbidite deposition is that the Sukunka Uplift, a major NNW-SSE structural element that influenced sedimentation from Mississippian to at least the Permian (Richards, 1989), was still intermittently active during the Early Triassic.

Field lithofacies and Montney comparison

The dominant lithofacies of the Sulphur Mountain Formation at Mount Crum is a laminated to very thin-bedded fine to medium siltstone that shows an indistinct coarsening-up profile over the first 60 m of section (Fig. 2) that is confirmed in the gamma-ray that shows an indistinct “cleaning-up” or slightly upward-decreasing trend. The lower Montney in the subsurface also is dominantly siltstone, with a similar irregular, but overall ‘cleaning-up’ gamma log profile (G.R. Davies, pers. comm., 2010). Compositionally, the Mount Crum siltstone succession is very dolomitic and feldspathic, with high detrital muscovite mica, authigenic framboidal pyrite, and black, organic intergranular matrix. In all of these components, the Mount Crum siltstone is identical to the subsurface lower Montney, although grain size is slightly finer.

The other prominent lithologic component of the Mount Crum section are large limestone or calcareous nodules that show differential compaction of siltstones around them indicating early diagenetic emplacement of the calcite cement (similar to Montney calcite nodules). Internally, the nodules preserve abundant calcispheres, some with high concentrations of bivalve fragments. Calcispheres may record the occurrence of algal blooms associated with coastal upwelling.

Conclusions

Turbidite successions in east-central British Columbia are variable in deposition and age. At the Mount Crum area, turbidites are not present. The area was structurally high during earliest Triassic time due to continued or renewed influence of the Sukunka Uplift. Correlation of conodont biostratigrapy with $\delta^{13}C_{carb}$ values adds further insights into the paleostructural, age interpretation and facies relationships of the lowermost Triassic. A sharp positive excursion of $\delta^{13}C_{carb}$ value denotes the late Dienerian and a negative excursion represents the Smithian as determined by conodont biostratigraphy.

Lithofacies of the Mount Crum section show striking similarities with the Montney. Laminated siltstone is the dominant lithofacies of the Mount Crum section; it is dolomitic and feldspathic, with abundant muscovite and framboidal pyrite, with variable clay content similar to the Montney Formation. Calcite nodules, probably formed early and before significant compaction, contain bivalves and abundant calcispheres, which record algal blooms in the Lower Triassic; these bioclasts also occur throughout the Montney and Doig formations.

Data collected in the east-central British Columbia region will provide a coherent framework that enhances our understanding of the Lower Triassic Montney successions. This will help lead to a better exploration strategy of the Montney tight gas play in the region.

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