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Diagenesis of quartz, feldspar, and dolomite in the Montney Formation – implications for particle size analysis and rock properties

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Summary

Most of the Montney Formation is termed a finely laminated to finely interbedded dolomitic siltstone/shale with occasional very fine-grained sandstone as well as limited limestone interbeds. From the perspective of classical sedimentary rock classification, the majority of “silt/mudstone” rocks in the Montney contain particles <63 micrometers. These particles represent individual minerals in contrast to conglomerates or sandstones where rock particles can be present. As particle sizes and sorting is utilized to identify source, origin and transport of material and thus possible depositional conditions and settings, many past studies of the Montney have performed some sort of “particle-size” analysis in order to classify the sediments.

Early work on the Montney Formation observed a relative “homogeneity” in particle sizes across the basin and combined with the apparent “well-sorting”, these sediments were interpretated to reflect an aeolian influence of source and transport (Davies et al., 1997). Subsequent work illustrated an observed trend of particle sizes across the basin from east to west (e.g. Nadaraju and Elliot, 2010) and it was hoped that fracture performance may be quantified based on parameters such as particle sizes. In fact, a recent study in the lower Montney has demonstrated a positive relationship between particle size and porosity/permeability (Zhang, 2015).

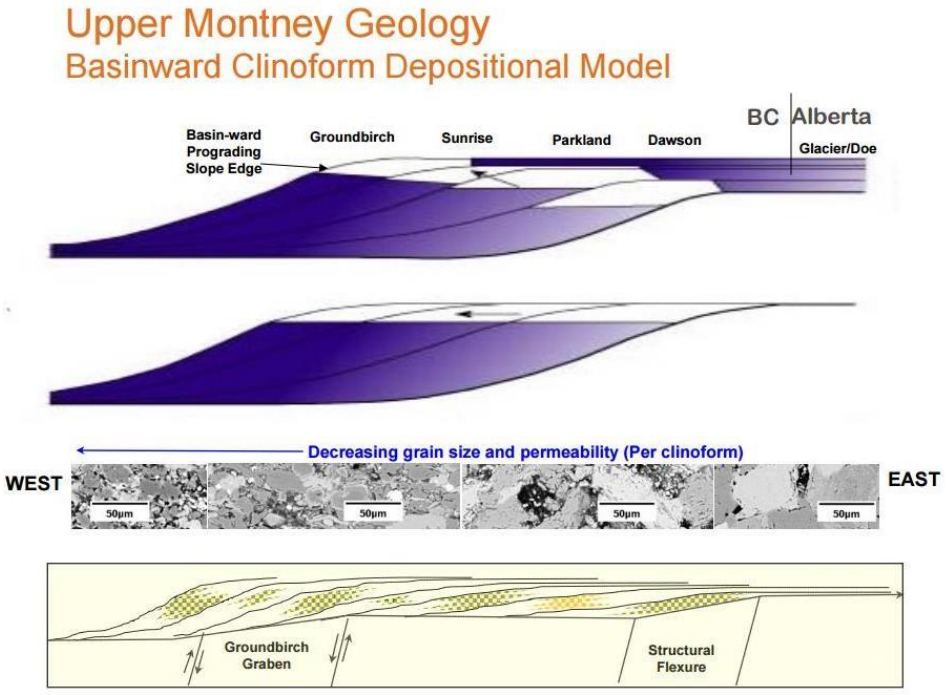

Fig. 1. Montney geological cross section from E-W showing an apparent particle size decrease associated with decreasing permeability. Particle size decrease is assumed to be due to sorting during deposition. Slide 15 from Nadaraju and Elliott (2010).

More recent work pointed out, however, that common minerals present in the Montney Formation have a marked diagenetic overprint (Krause et al., 2012, Wust et al., 2016). These studies illustrate that post-depositional modifications of most minerals took place during burial and changed both shape and morphology of the particles.

Here we present new petrography and scanning electorn microscopy (SEM) data from various wells from the Montney across the WCSB and describe the most common particles of the Montney Formation, namely quartz, feldspar and carbonates. Although some of the particle have a typical detrital character, the majority of the particles show signs of typical diagenetic modifications. Diagenetic changes include dissolution and regrowth, neoformation and mineral overgrowth. Mineral modifications include neoformed quartz grains with inclusions, quartz pseudo-morphs after dolomite, feldspars with various feldspar growths, pseudo-morphs after dolomite, or dolomite with cores of different compositions, pyrite includions, etc. The amount of modified particles can represent up to 60-90% of the sample composition.

The strong modification of particle shape and shape renders particle size analysis from an original transport perspective model unusable. Hence, particle size and composition cannot be used alone for determining a depositional model. In fact, size and morphology needs to be excluded from any interpretations regarding past depositional settings. Zonneveld et al. have drawn a similar conclusion in 2011 that “Montney depositional environments are not easily segregated on the basis of grain size”.

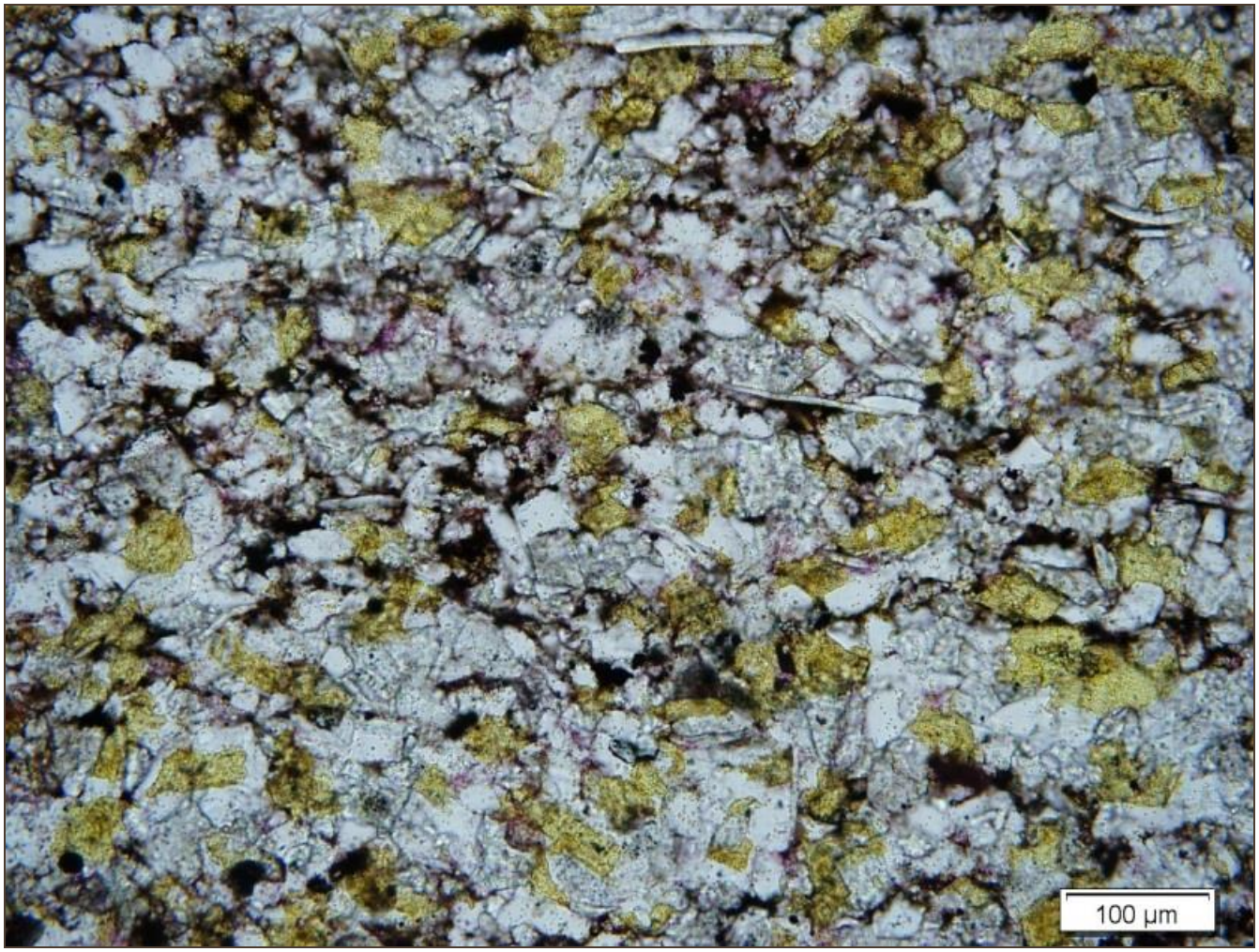

Fig. 2. Petrographic photomicrograph of a Montney sample from the Elm area showing abundant quartz (bright white), dolomite (light grey) and K-feldspars (yellow stained).

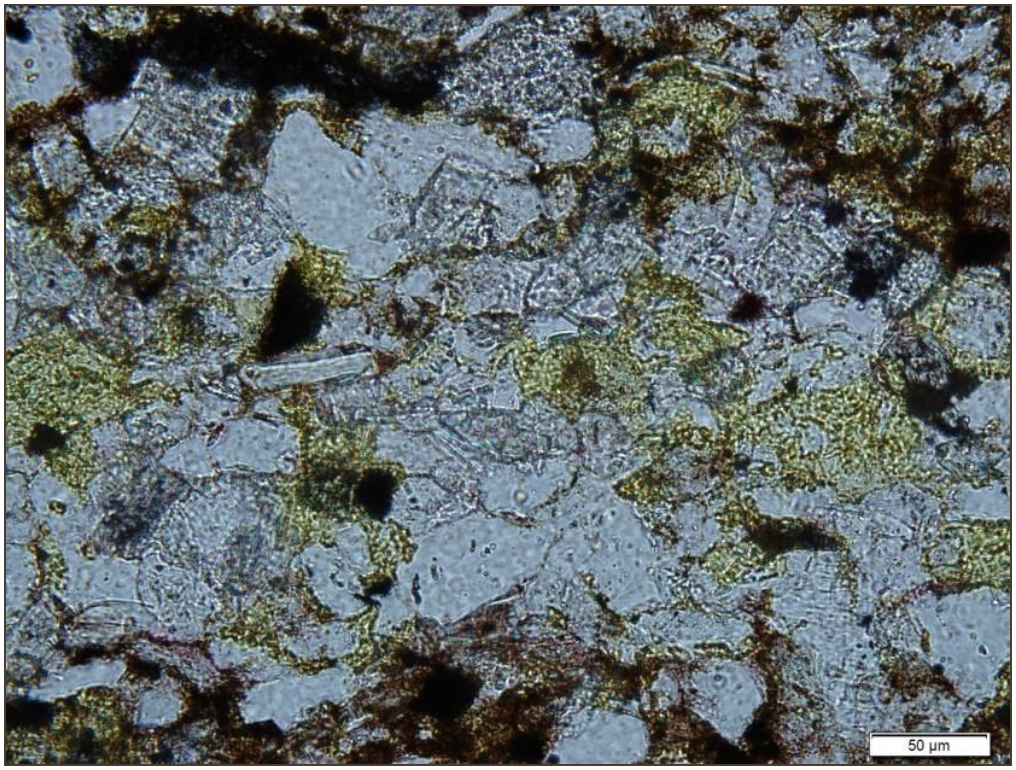

Fig. 3. Petrographic photomicrograph of a Montney sample from the Elm area showing post-burial modified grains of quartz (bright white), dolomite (light grey) and K-feldspars (yellow stained). Modification include amorphous shapes, inclusions, dissolution features, overgrowth, etc.

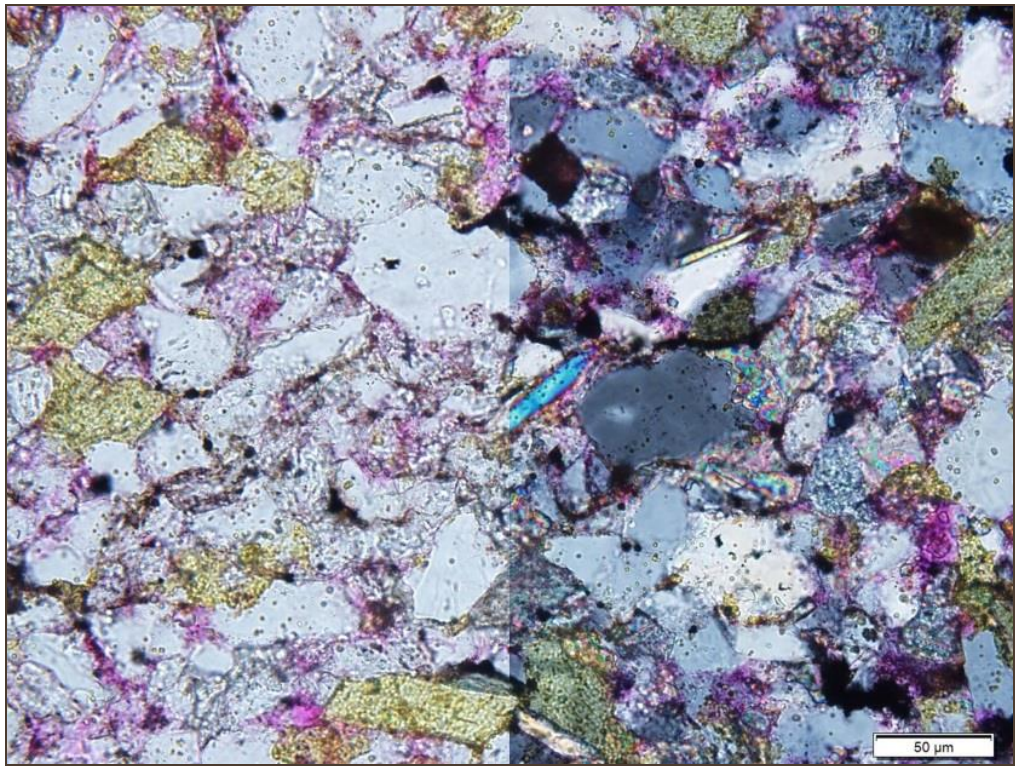

Fig. 4. Petrographic overexposed photomicrograph (left: plain light, right x-pol ligth) of a Montney sample from the Elm area showing most minerals (quartz, dolomite, feldspar) contain other mineral inclusions illustrating a post-depositional modification.

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