Geologic Controls on Monach Formation Reservoir Quality

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The gas saturated fluvial sandstones and related overbank sediments of the Monach Formation have been under-represented in the literature despite the potential of the deposit to become an important tight gas resource play in northwest Alberta and northeast British Columbia. Traditionally, the Monach Formation has been relegated to a secondary gas target due to limited reservoir quality (Porosity = 3-9%, Permeability = <0.1-1.0 md), significant drilling costs due to depth (2500-4000 m) and limited exploration success. Recently, improvements in drilling and completions technology (i.e. horizontal drilling and massive hydraulic fracturing), coupled with geological work recognizing the role played by natural fractures in enhancing permeability, have yielded significant increases in production. This study considers basin scale sedimentologic, stratigraphic, paleogeographic, structural and petrographic observations to provide improved context for current drilling and production trends, as well as to enhance ideas and concepts applicable to future exploration.

The lithostratigraphic architecture of the Monach Formation is complicated by the overlying sub-Cadomin angular unconformity causing the formation to thin progressively from >140 m of preserved thickness basinward of the fold and thrust belt to the erosional zero edge in the plains. Utilizing 30 full diameter cores, ~500 wireline logs and outcrop observations, a regional lithostratigraphic framework was developed to better understand sediment distribution and paleogeography. The thickest and most laterally extensive sandstone deposit occurs in the southern portion of the study area (68-13W6 – 62-9W6), which is coincident with the most prolific production of gas (Figure 1). Co-mingling with uphole units complicates our understanding of formation specific production trends but it is likely that the fluvial stratigraphic architecture exerts a significant control on production from the Monach Formation.

A second, perhaps more important control on production from the Monach Formation is the presence of natural fractures, which enhance permeability. Exploration activity and production from the Monach Formation has been concentrated in the structurally deformed foothills belt with associated large scale deformation including filled and un-filled fracture networks. Predictably, zones with higher fracture densities are more productive when hydraulically fractured than zones with lower fracture densities (Figure 2).

Natural fracturing, although far less common, is observable east of the mapped major deformation front, in the deep basin (Figure 3). Identification of areas with increased natural fracturing in these areas, combined with sedimentologic and stratigraphic insight identifying thick, laterally continuous sandstone bodies may be important for future exploration in the Monach Formation.

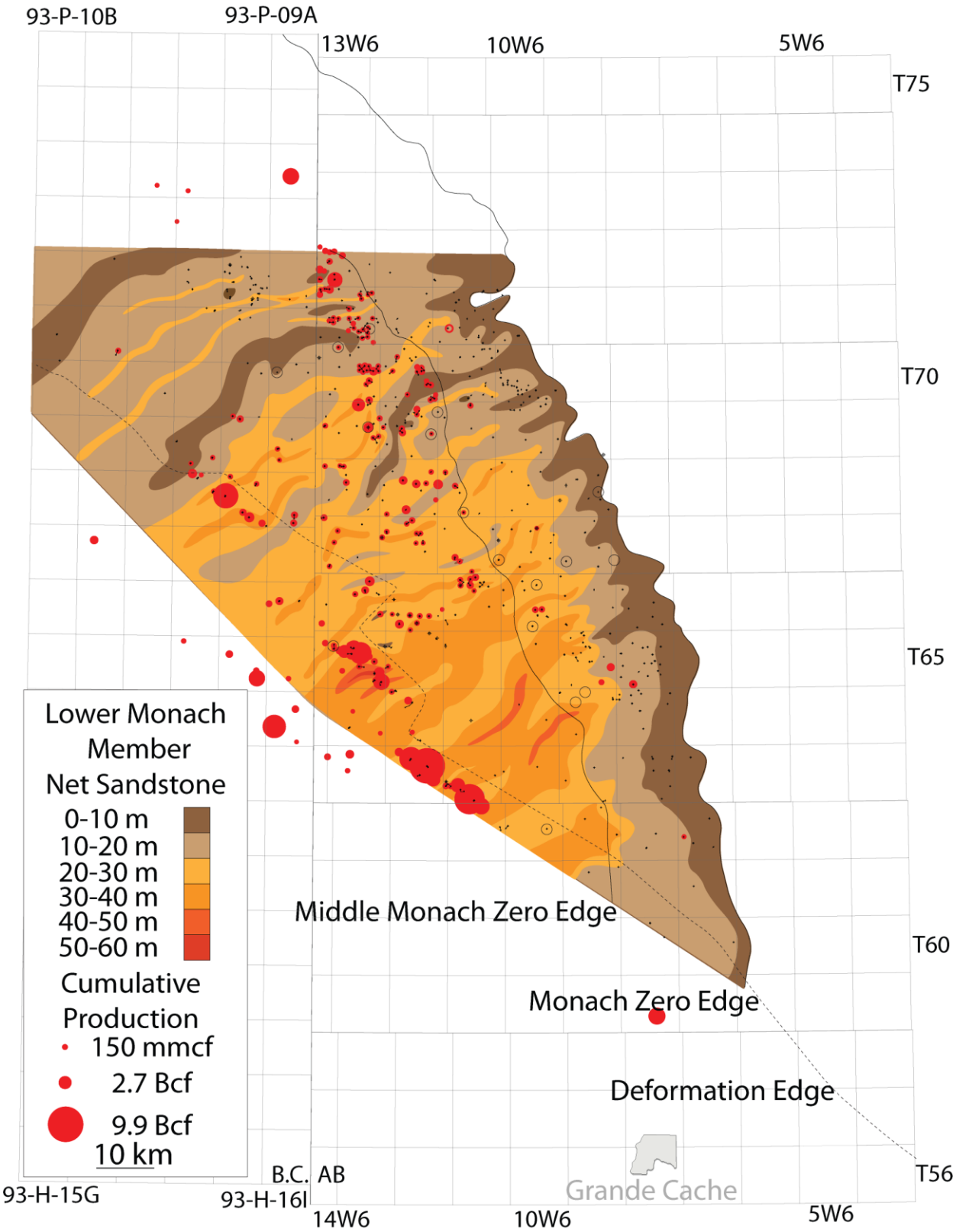

Figure 1: Description of chart, graphic, equation, etc.

Figure 1. Lower Monach net sandstone map with cumulative comingled production shown. Isolated production information from the Monach Formation is poorly documented.

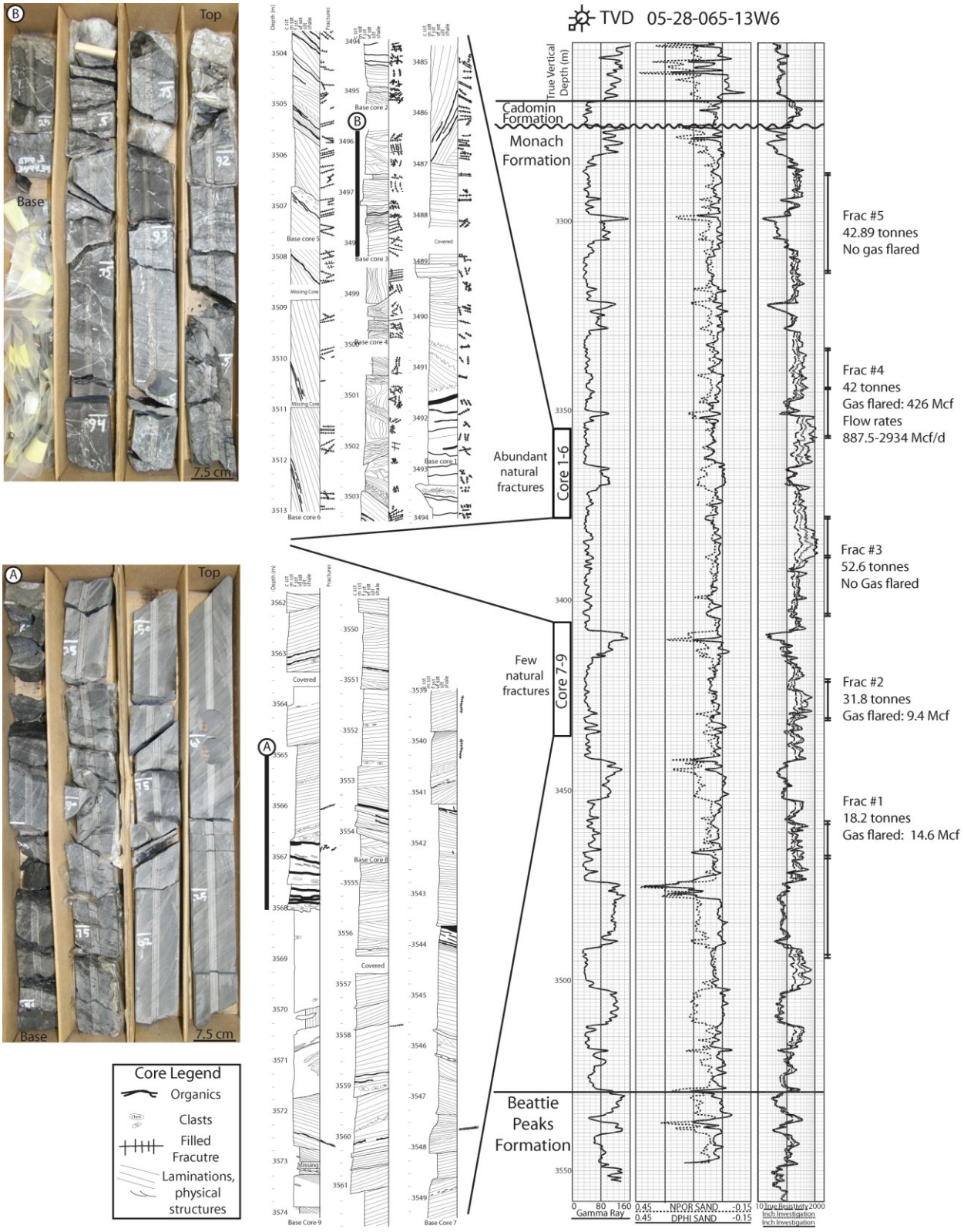

Figure 2. Wireline logs, cores, hydraulic fracture stimulation position, and representative photographs of the cored intervals from 05-28-065-13W6. Five separate hydraulic fracture stimulations were applied to the Monach Formation, with the amount of gas flared during flow test recorded. Hydraulic fracture stimulation #4 returned the largest amount of gas with measurable flow rates of 887.5 to 2934 Mcf/d. This interval is partially cored and shows a higher density of natural fractures than a cored interval that did not produce gas (see stimulation #2). This demonstrates that the presence of natural fractures has a significant influence on the producibility of the Monach Formation.

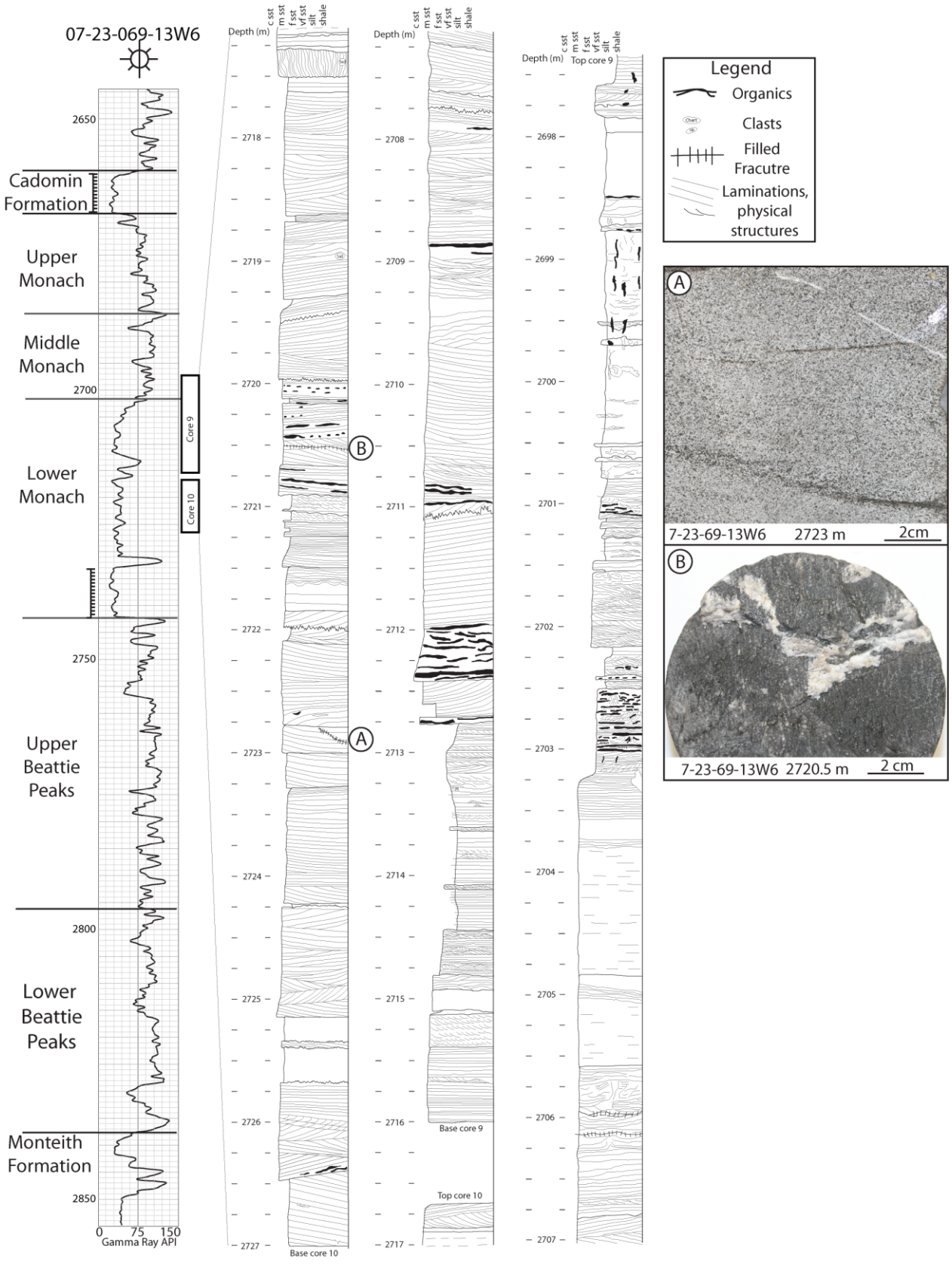

Figure 3. Gamma radiation log, core description, and photographs from 7-23-69-13W6. This core taken ~20km from the foothills belt demonstrates the presence of filled fractures (~2-3 mm) in the deep basin, which could provide enhanced permeability and gas production as it does in the foothills (Figure 2).