

Revised Frasnian and youngest Givetian Stratigraphic Framework, Alberta Outcrops and Subsurface

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Abstract

Latest Givetian and Frasnian strata (Upper Devonian) of Alberta are widespread, over 400 metres thick and consist of shallow water carbonates (reefs, reef complexes and ramps), basin-filling carbonates and shales derived mainly from easterly sources, and platform top evaporites. These strata have a classic transgressive to regressive stacking of facies with a widespread organic-rich marine shale in the mid portion of this package and are bounded by regionally recognizable unconformities mantled by fine siliciclastics (Graminia and Gilwood Formations respectively). These strata were deposited in about 11 million years and represent a second-order depositional sequence. This 2nd order sequence has all the attributes of a world class petroleum province (source, seal, reservoir, favorable timing and migration pathways) and indeed has been extremely important in the oil and gas story of Western Canada since the Leduc discovery in 1947. Discovered hydrocarbon reserves in conventional and unconventional plays are on the order of 20 billion barrels or more of oil equivalent barrels, with more than 400 billion barrels of bitumen trapped in the Grosmont carbonate trend in Alberta (Potma et al 2001). Many of these large carbonate complexes are being examined for carbon sequestration as well as being targets for extraction of critical minerals.

Wong et al (2016) showed this 2nd order sequence (informally termed the Graminia to Gilwood sequence) is comprised of ten smaller order (3rd order) depositional sequences which can be correlated across the Alberta basin. 3rd order sequences are typically 50 to 75 metres thick and contain a series of recognizable linked contemporaneous depositional systems, or systems tracts. The youngest eight of the 3rd order sequences, and their bounding surfaces, were defined in Alberta Rocky Mountain outcrops, were traced into the subsurface via regional well log correlation and core description and are supported by conodont biostratigraphy. The two oldest 3rd order sequences are not present by onlap in the outcrop study area.

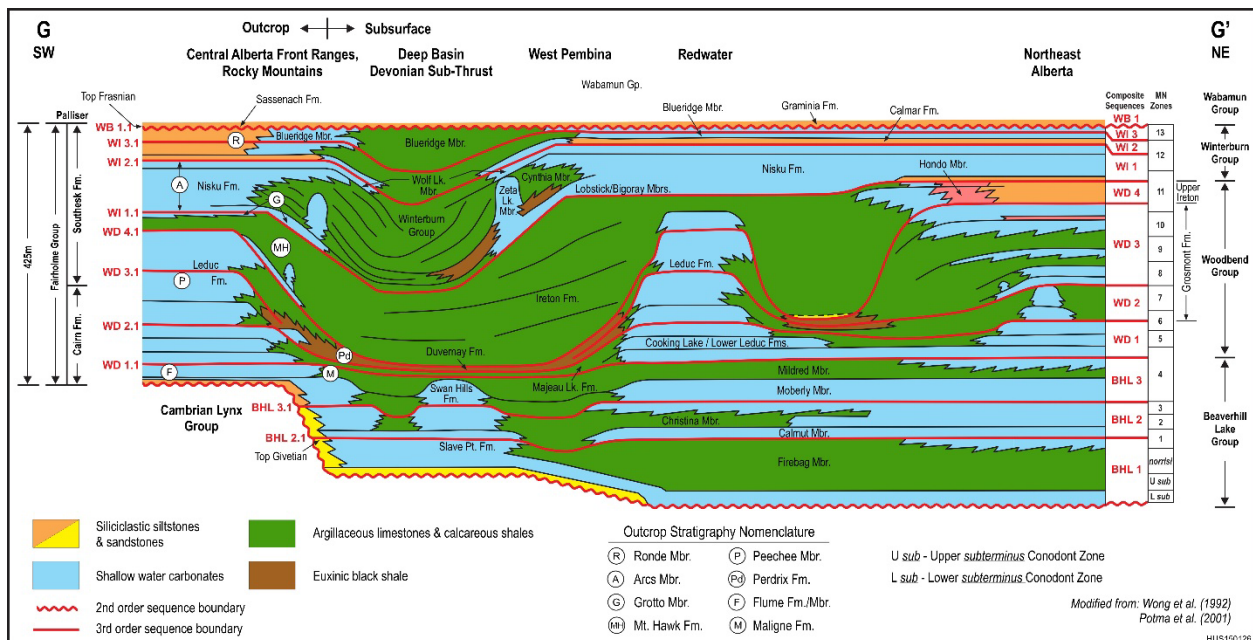
3rd order sequences which compose the 2nd order sequence often are of the same scale and comprise lithologies recognizable in established lithostratigraphic Group names. That is, the oldest Beaverhill Lake sequences (BHL 1.1, 2.1 and 3.1 from oldest to youngest) include Beaverhill Lake Group strata, the overlying four Woodbend 3rd order sequences (WD 1.1, 2.1, 3.1 and 4.1) include Woodbend Group strata, and similarly the youngest Winterburn 3rd order sequences (WI 1.1, 1.2, and 1.3) contain Winterburn Group strata. Well known Formations included within the 2nd order sequence may be wholly contained within a single 3rd order sequence (Cooking Lake for example) or may be represented within several 3rd order sequences (Swan Hills, Leduc, Duvernay for example). Subsurface rather than outcrop nomenclature has stratigraphic precedence in this portion of the Upper Devonian.

This talk will present an overview of the results, techniques and application of the findings of Wong et al (2016), The subsequent two talks will present outcrop studies (Cline Channel and Nikanassin Range) which were found to be critical with respect to understand geometries of carbonate platform and adjacent basinal strata at various scales. These geometries can be applied and tested in subsurface data sets to construct realistic subsurface paleogeographic reconstructions. These Authors and others are applying the same techniques along with modifications of previous work for incorporation within the CEGA Atlas 2027 Update.

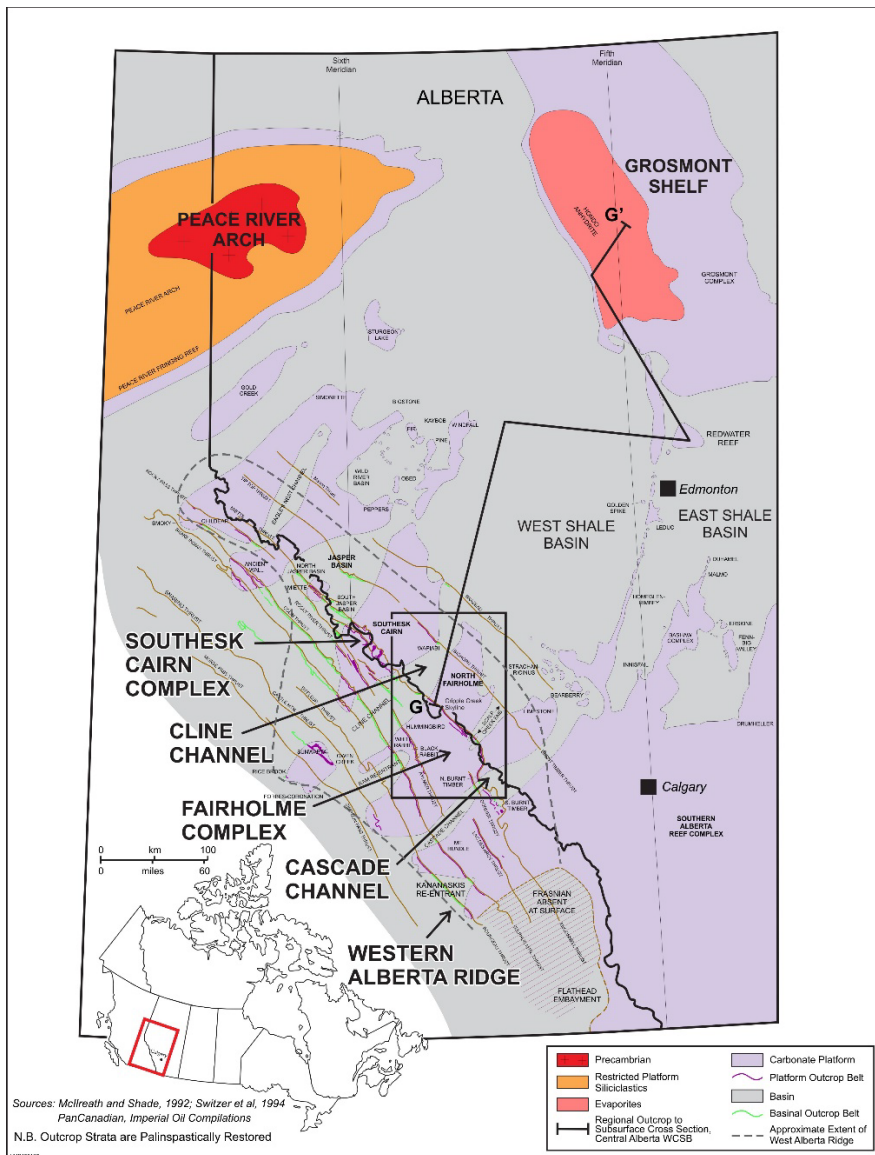
References

Potma K, Weissenberger JA, Wong PK, Gilhooly MG, 2001, Toward a sequence stratigraphic framework for the Frasnian of the Western Canadian Basin. Bulletin of Canadian Petroleum Geology, vol 49, No 1 (March 2001), P 37-85

Wong PK, Weissenberger JA, Gilhooly MG, 2016, Revised Regional Frasnian Sequence Stratigraphic Framework, Alberta Outcrop and Subsurface, In Playton TE, Kerans C, Weissenberger JA (Editors). New Advances in Devonian Carbonates: Outcrop Analogs, Reservoirs, and Chemostratigraphy, Special Publication 107: SEPM (Society for Sedimentary Geology), Tulsa Oklahoma DOI: 10.2110/sepmsp. 107.05



The figure is a summary cross section which runs from Rocky Mountain outcrops in the southwest and into the adjacent subsurface, and towards Northeast Alberta (section line in next figure). Carbonate platforms, reefs and ramps are shown in blue, basin-fill in green (oxic) and brown (dyoxic), evaporites in orange and siliciclastics in yellow. The section shows the 2nd order Graminia to Gilwood sequence, with basal and top sequence boundaries, ten 2nd order depositional sequences, conodont zones, and lithostratigraphic Group names.



The figure shows the distribution of shallow water carbonate platforms and reefs (purple) during deposition of youngest I Leduc Formation and adjacent basinal-off reef areas (grey). Also shown are the emergent Peace River Arch, major carbonate paleogeographic features such as the Southern Alberta Shelf, Grosmont Shelf and major carbonate complexes of the Rocky Mountains. The dashed area within the outcrop belt refers to the approximate extent of the West Alberta Ridge, onto which most of Beaverhill Lake 3rd order sequences were overlapped. Outcrops have been palinspastically restored.