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Geologic Map, Well and Seismic database Developments for Structural Assessment of the Cordilleran Foreland Belt

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Summary

This paper discusses the progress to date and forward plans for two of the chapters in the Atlas.

1. Chapter 13: Rocky Mountains and Foothills Fold and Thrust Belt (Peter Fermor, Glen Stockmal, Margot McMechan, Bob McMechan, Mark Cooper, Marian Warren, Dinu Pana, Elena Konstantinovskaya, Kevin Root and Eva Enkelmann)
2. Chapter 14: Northern Foreland Fold and Thrust Belt (Karen Fallas, Larry Lane, Glen Stockmal, Peter Fermor and Margot McMechan)

What these two chapters have as a common initial goal is to create a set of consistent structural cross-sections that will allow the illustration of the variation of structural style of the deformed belt from the US border to the Arctic. To do this we have to integrate several datasets including surface geology, existing published cross-sections, well data and seismic data to create the cross-sections. The initial focus of efforts on these Atlas chapter has been on establishing data availability.

Workflow

For surface geology there are provincial and territorial maps available as shapefiles for BC, Alberta, Yukon (Colpron et al. 2016) and NWT (Okulitch & Irwin 2017) plus other maps published by provincial surveys and the GSC. Prior to creating and/or editing existing components of the cross-sections we needed to create a unified surface geology map for the deformed belt, work on which is ongoing. Modifying the component maps of the unified deformed belt map to a consistent colour scheme is a major issue in this work (Fig.1).

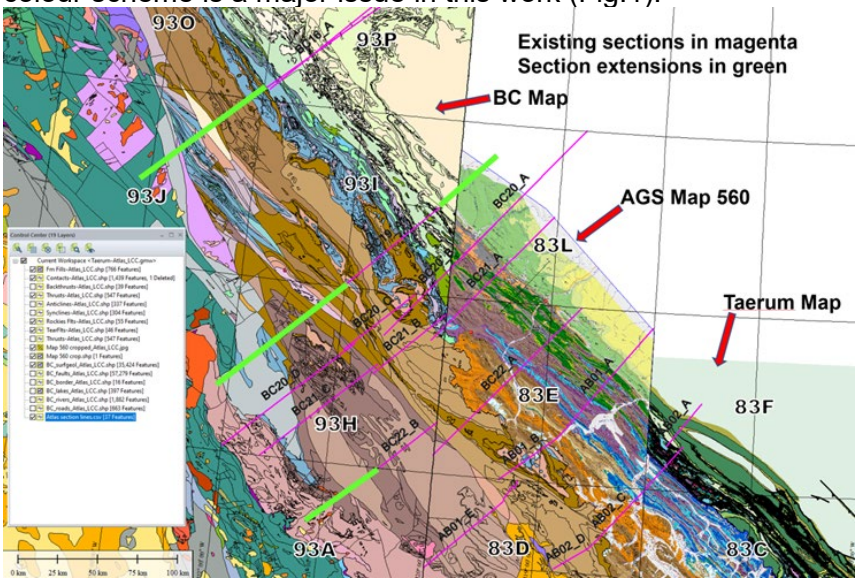

Fig. 1. Differing colour schemes of the BC Provincial Map (Cui et al. 2017), AGS Map 560 (Pana & Elgr, 2013) and the Taerum Map (Taerum, 2011).

There are a large number of sections from maps and papers that are already in the public domain; many of these are quite short which makes them of limited value for our purposes. The main limitation of the longer sections produced in the 1960's and 1970's (and later). is the cautious approach to how structures link or terminate in the subsurface (Fig. 2.).

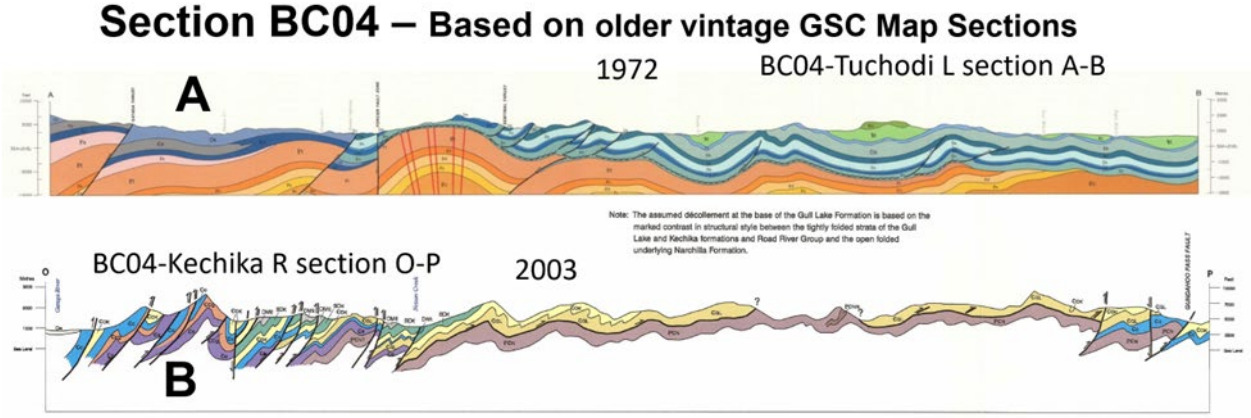

Fig. 2. Typical GSC cross-sections from northern BC, A) Tuchodi Lakes Map section A-B (Taylor, 1972). B) Kechika River section O-P (Gabrielse, 2003).

There are also some published sections which provide the option to extend structural sections further to the west to link with the deformed terranes in BC (Fig. 3.).

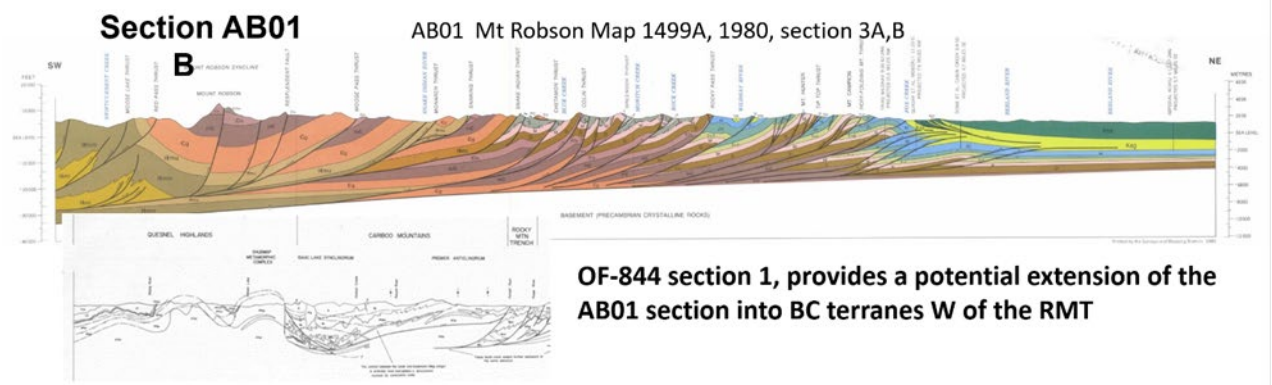

Fig. 3. Upper section, a cross-section from northern Alberta with a more detailed subsurface interpretation on the Mt Robson Map section 3A-B (Mountjoy, 1980. Lower section a possible westward extension of the section from Campbell et al. (1982).

We have created a master map showing sections from various authors, and all located sections are being considered as potential inputs for the section locations yet to be confirmed.

Regarding well data we have access to well logs through Petro Ninja, coverage is good in Alberta, but only more recent wells are available in BC. We have also obtained access to a selection of well logs in SEBC from CNRL and MJ Systems have a comprehensive set of well log data for BC that we have access to. We also have MJ Systems well log data for north of 60 available on the Atlas Google drive. Discussions on accessing dip meter data from Divestco are ongoing. Well tops are available in the tops database built from various data sources for Atlas authors to use and we have also started to build a database of deviation surveys for wells in Alberta and BC.

Obtaining access to seismic data has been more complex. Through summer and fall Ben Mackenzie, Peter Fermor and Denis McGrath have been leading work on getting access to seismic data for Atlas authors from Pulse Seismic and Explor Data (Fig. 4 and we hope to have an agreement on access to data quite soon. This is particularly important for the Foothills and Rockies and Mackenzie Mountains groups to help select which structural cross sections to focus on. There are two outstanding tasks; getting the contract in place and determining the protocol for QCing and transferring the seismic data likely as images or SEGY data. We need to develop an efficient process that minimizes staff time commitment for Pulse and Explor. Once we have data availability and transfer issues resolved, we hope that all Atlas chapters will have an opportunity to also access seismic data.

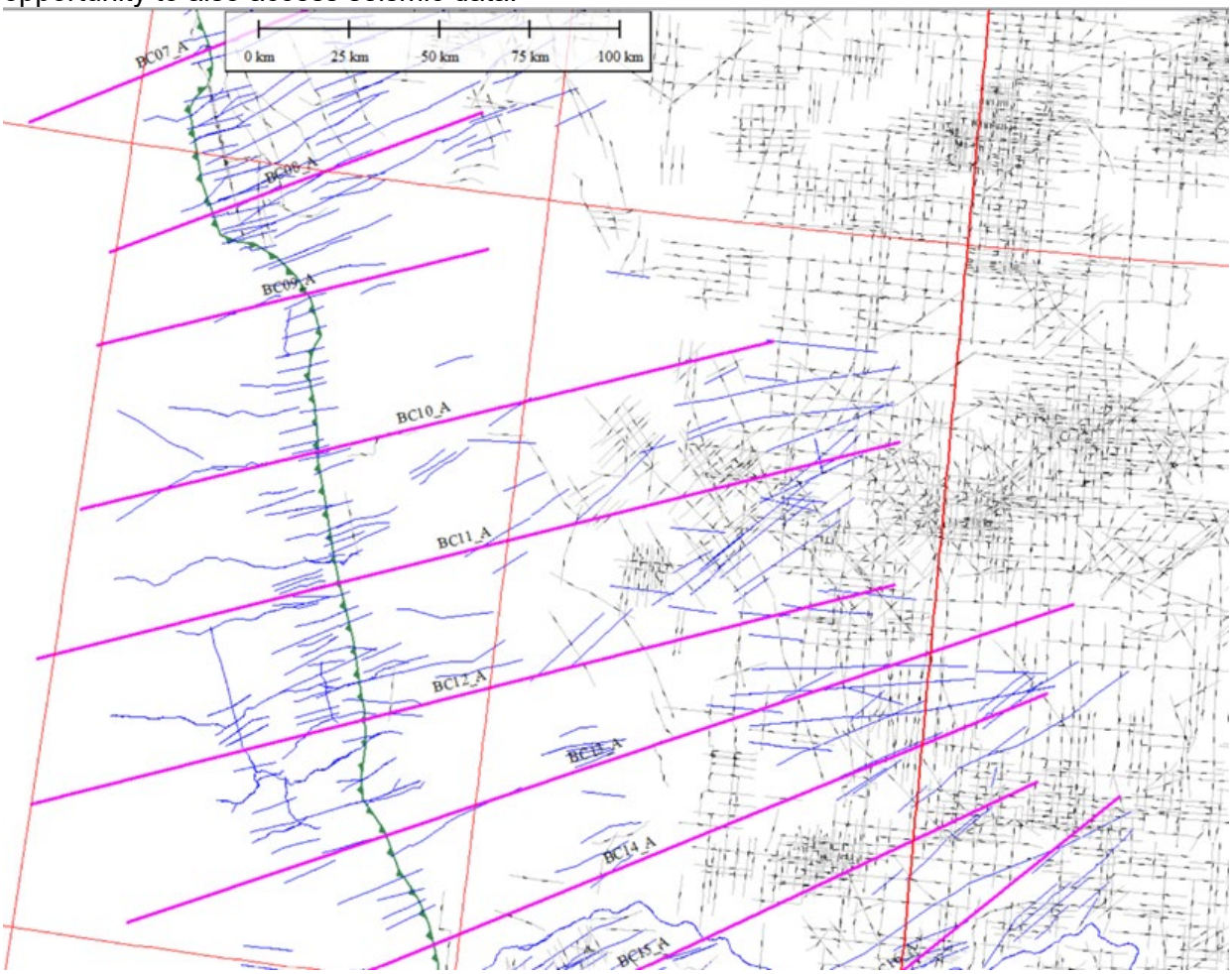

Fig. 4. Part of the BC foothills showing seismic lines (blue) in the Pulse database and potential cross-section lines (magenta). Seismic lines not of interest are greyed out.

Current Status of Section Selections

Seismic and well coverage north of 60 is quite sparse with few published structural sections in the NWT the majority of which come from first-generation sections published with GSC A-series maps. There are only two palinspastic restorations of sections that have been published for the Mackenzie Mountains both of which have some challenges. Areas outlined in green show areas

targeted for possible cross-sections (Fig. 5.). These would cover the northern Liard Basin east to the Bovie Fault (1), Mackenzie and Franklin mountains (2, 3, and 4), the Colville Hills (5, could connect to 4), and Eagle Plain + Richardson Mountains (6).

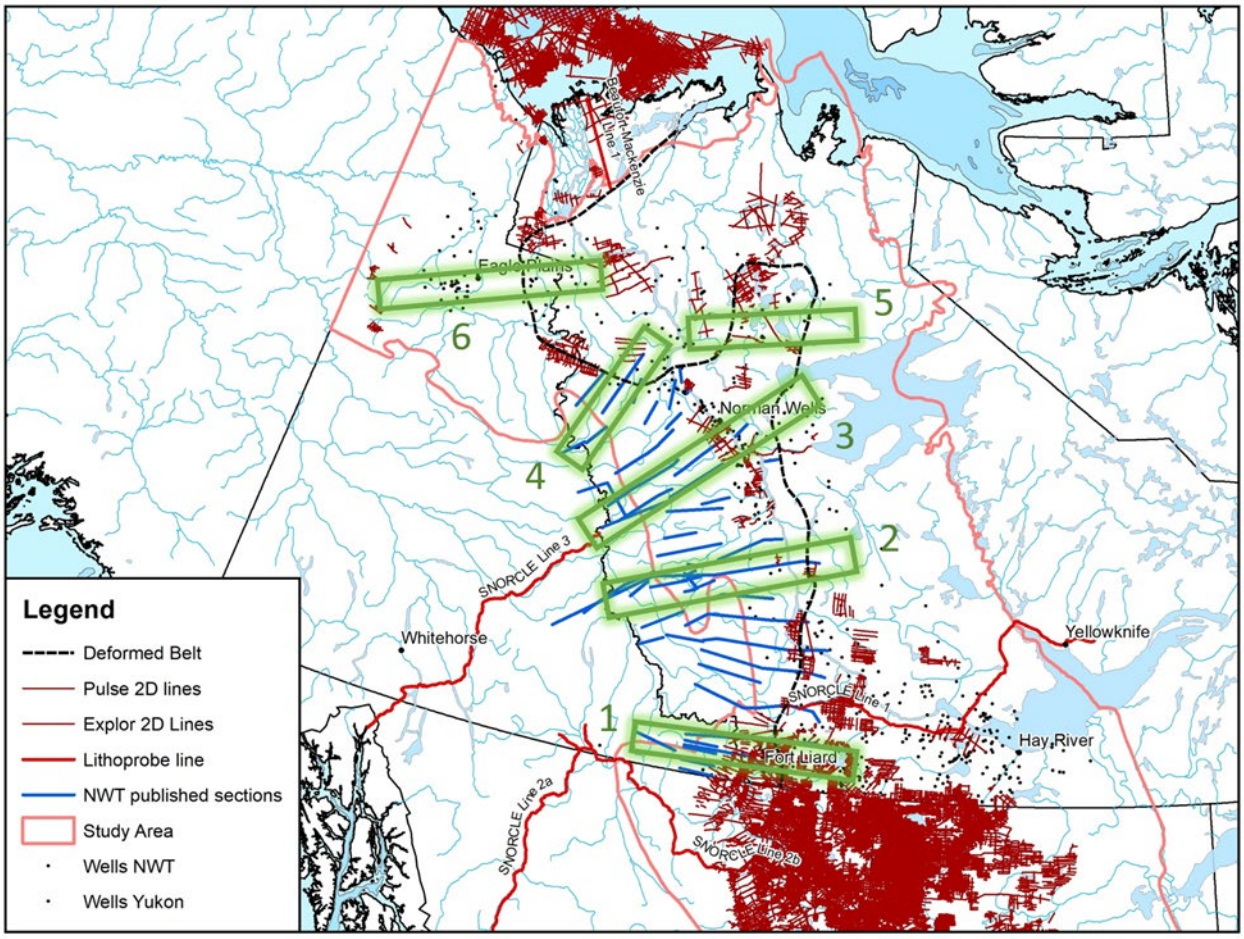

Fig.5. Map for north of 60 showing published sections, wells and seismic lines owned by Pulse and Explor.

In BC there are a number of published cross-sections with good coverage except in the northern area. The example section shown in Fig.6 is part of a series of 7 cross-sections of the BC Foothills created using extensive well data and some seismic data as part of a project to assess water disposal well potential for the Montney Play (Hayes et al, 2021). These sections need minimal modification but require some extension to the SW (Fig. 6.).

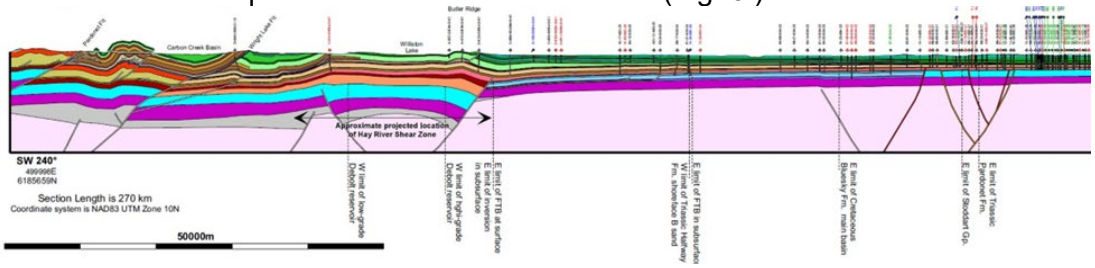

Fig. 6. Portion of the Carbon Cross-section from Hayes et al. (2021).

In Alberta there are a large number of structural cross-sections to choose from that come from the GSC, AGS publications, PhD and MSc theses and published papers (Fig.7.). Work is underway to high grade the sections to be selected as the basis for the cross-sections to be used as the basis for the Atlas sections.

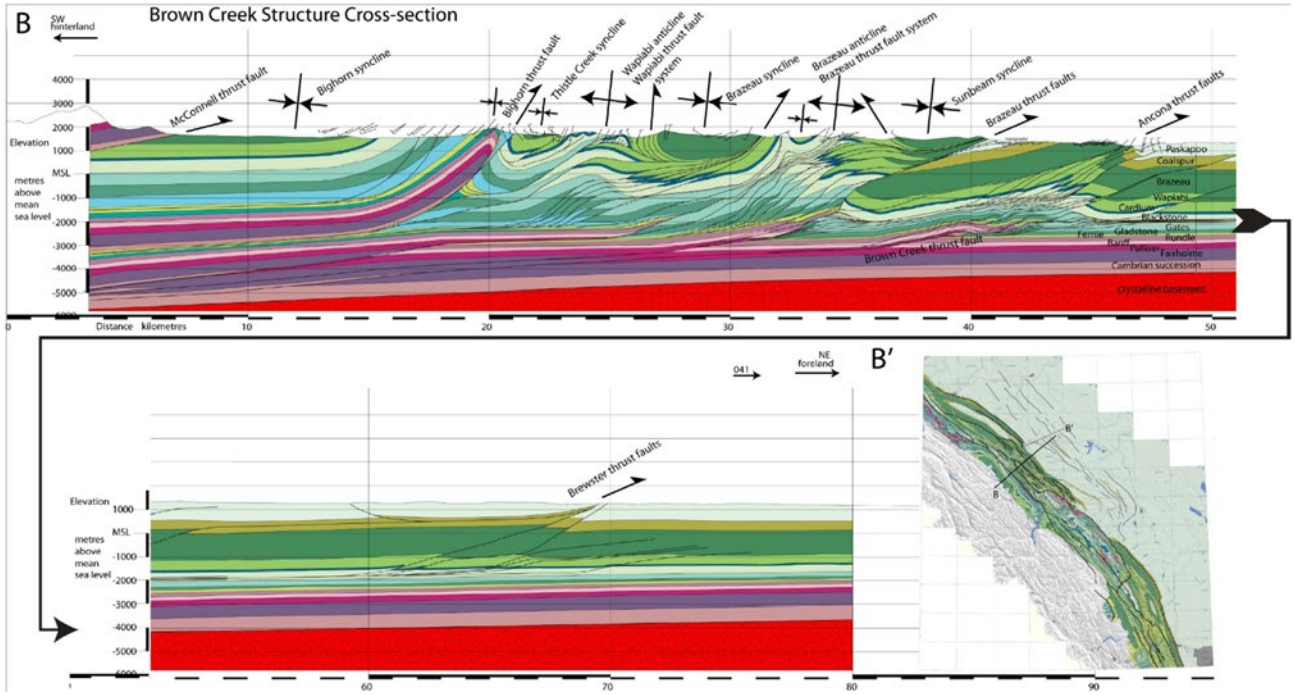

Fig. 7. Brown Creek cross-section encompasses the width of the Foothills and a portion of the deformed Plains, Taerum (2011).

Conclusions

The forward plans for 2023 are outlined below and will be updated in the presentation.

Once seismic data access is resolved Atlas section line locations will be finalised. Each Atlas section will have a designated author that would have responsibility for modifying and updating the section. In many cases this will ideally be the original creator of the cross-section.

The plan is ambitious with a section spacing of about 50km; we need enough sections to portray the variations in structural style from the US border up into the NWT. However, we will start with a wider spacing and then infill as time and resources permit.

There are areas where alternative models are possible, e.g. detachment depths, thin vs thick skinned deformation. Subsurface control is equivocal so alternative models should be carried.

Some selected sections will be extended out into the foreland basin to illustrate the linkage between deformation in the Rocky Mountains and Foothills with the expression of deformation in the foreland basin. There is also a desire to extend sections to the west across the RMT to link deformation back into the Cordillera in BC. The goal is to provide a holistic view of deformation of the North American Margin

Workflows for how to compile data into the sections are under development with the aim of being able to provide the section authors with a complete template that contains all available data so that the author effort can be focussed on section interpretation and construction.

We are also trying to source suitable section construction software for the section authors to use although we wish to provide flexibility so that authors can use their preferred methodology which could include drafting packages. We anticipate that the section interpretation will be well underway during 2023.

Once the work on the cross-sections is completed the team will then be able to create a synthesis of the deformation history of the FTB through the Mesozoic and Cenozoic and to consider the relationship between deformation and the stratigraphic history of the basin including palinspastic restorations of selected units.

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