

Geochemical Characterization of Fine-grained Carboniferous Strata of the Maritimes Basin Complex of New Brunswick

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Introduction

The Late Devonian to Early Permian stratified rocks of the Maritimes Basin Complex plays host to the only onshore petroleum system in the Maritime Provinces (Wilson and White, 2006; Keighley, 2008). The stratigraphic succession is divisible into six disconformity-unconformity-bounded groups; in ascending order they are the Horton, Sussex, Windsor, Mabou, Cumberland, and Pictou groups.

Precise stratigraphic relationships are still incompletely understood due to a combination of several factors including:

- 1) Limited outcrop exposure.
- 2) Many of the units have undergone several episodes of deformation, juxtaposing units in faulted contact.
- 3) Several stratigraphically distinct red and grey-bed units cannot be easily distinguished lithologically, particularly since they contain little material of biostratigraphic use or radiometrically datable materials.
- 4) The biostratigraphic subdivision is often complicated by the reworking of Devonian-Carboniferous microfossils within the succession.
- 5) There has been inconsistent and cross-usage of stratigraphic terms, particularly with respect to what is now accepted as a valid lithostratigraphic, biostratigraphic, or chronostratigraphic units of the North American Commission on Stratigraphic Nomenclature (1983), as well as imprecisely defined lithostratigraphic units.

A Solution to these Obstacles

Recent studies of stratigraphic successions with similar complications have used chemostratigraphic approaches to aid in the differentiation of specific geologic units. One such method is the comparison of bulk inorganic elemental geochemistry determined using ICP-MS or XRF analyses (Pearce et al., 1999, 2005; Ratcliffe et al., 2010). At present, little such geochemical data currently exists for the Carboniferous of New Brunswick. Accordingly, 139 samples have been collected from

fine-grained strata in both outcrop and borehole from each of the Carboniferous groups throughout the province of New Brunswick. For each sample; and additionally for reference standards, 55 elements were analyzed by Inductively-coupled-plasma and mass spectrometry (ICP-MS). Following data transformation of Aitchison (1986), the geochemical data was then statistically analysed to determine if unique major, minor, or trace elemental composition might characterize any or each of the stratigraphic units.

Examples

Broadly, the samples taken from all groups (25 from each, with the exception of 14 samples from the Windsor Group) are quite similar. However, some distinct relationships can be recognised.

A noticeable difference exists in the relationship of Rubidium (Rb) and Zirconium (Zr) in the Pictou Group in comparison to any other group in the Carboniferous succession. The coefficient of determination (R^2) of the Pictou Group samples is 0.7525, whereas all other groups throughout the succession do not exceed an R^2 value of 0.1146 (Fig. 1). The Pictou Group's tight distribution to the regression line in comparison to that of the other groups (Sussex used as an example below) indicates that sediment of the Pictou Group originated most likely from a relatively homogeneous source, whereas the sediment deposited of the other groups originated from a more mixed heterogeneous source.

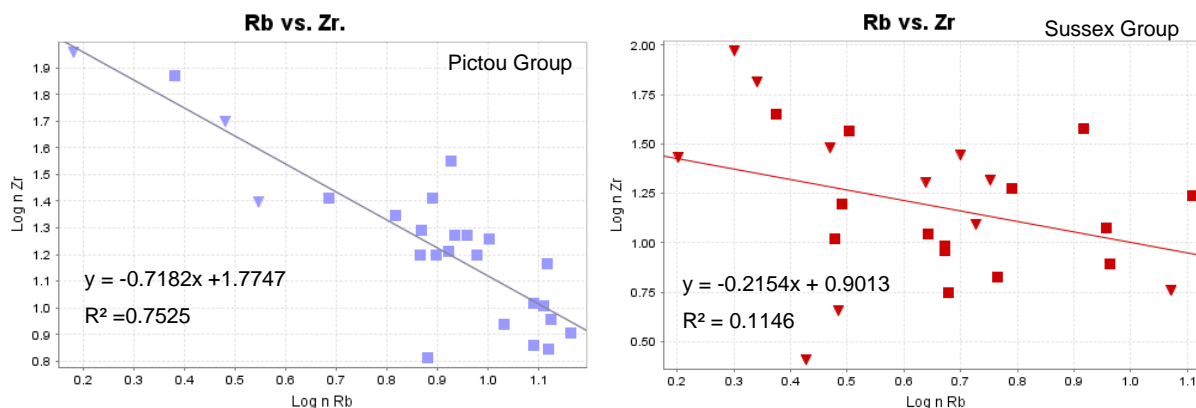


Figure 1 – Cross plots of Rubidium (Rb) and Zirconium (Zr) of the (Left) Pictou Group and (Right) Sussex Group. The \square represents samples taken from core, whereas Δ represents outcrop samples.

Box and whisker plots (Fig. 2) show a separation in the means of the three lower groups (Horton, Sussex and Windsor); that possess a higher LOI ratio, with respect to the three upper groups of the succession (Mabou, Cumberland and Pictou). Furthermore, even though the mean of the Pictou Group is similar to the Mabou and the Cumberland groups, it has a much lower variance (0.033163) than the rest of the groups throughout the succession. This distinction in the Pictou highlights that there were less organics driven off during geochemical analysis.

Group	Mean Value	Variance
Pictou	6.774455	0.033163
Cumberland	6.884682	0.181715
Mabou	6.840606	0.124345
Windsor	7.175484	0.696448
Sussex	7.366069	0.312996
Horton	7.430945	0.262922

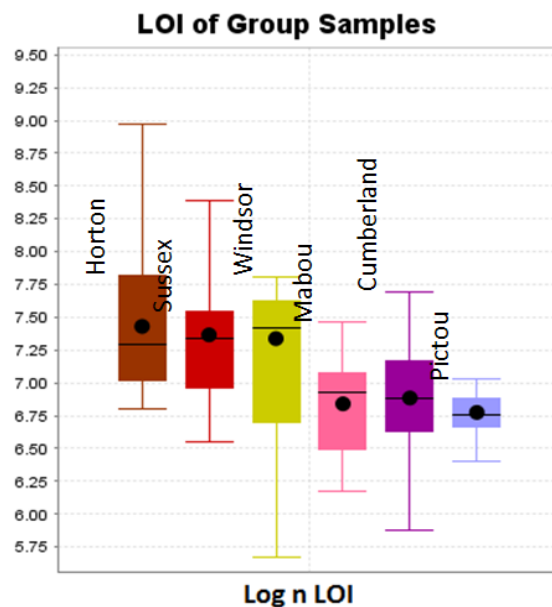


Figure 2 - (Left) Table including the mean and variance values of LOI throughout the succession. (Right) Box and whisker plot of LOI throughout the Carboniferous stratigraphy.

Conclusions

Within a series of associated sedimentary basins such as those comprising the Maritimes Basin Complex, it would be expected that provenance and diagenesis would not vary greatly and hence that the component stratigraphic units would not show major geochemical variation. However, preliminary investigations have indicated that statistically significant trends are still present. Through further investigation and future statistical analyses (such as Principal Component Analyses and Q-R clusters) of the data, possible chemostratigraphic characterization of the Maritimes Basin succession may be achieved.

References

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