Catchment Analysis Applied to the Interpretation of New Stream Sediment Data from Northern Vancouver Island (NTS 102L and 92L), British Columbia, Canada

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Introduction

Geoscience BC has been engaged for many years in the re-analysis of archived samples from the Regional Geochemistry Survey (RGS) program in BC, as well as, the collection of in-fill samples to cover areas where historical coverage was not considered to be adequate. A number of Geoscience BC–sponsored projects in the past have examined ways to add value to these new regional geochemistry data sets, including the use of catchment analysis (eg. Arne and Bluemel, 2011). Such approaches identify 2nd– and 3rd-order geochemical anomalies by accounting for the effects of metal scavenging onto secondary Fe and Mn oxides, as well as for variable background levels for important pathfinder elements due to exposure of different lithologies in catchment basins. Such approaches also allow the effectiveness of sample coverage to be assessed.

Location

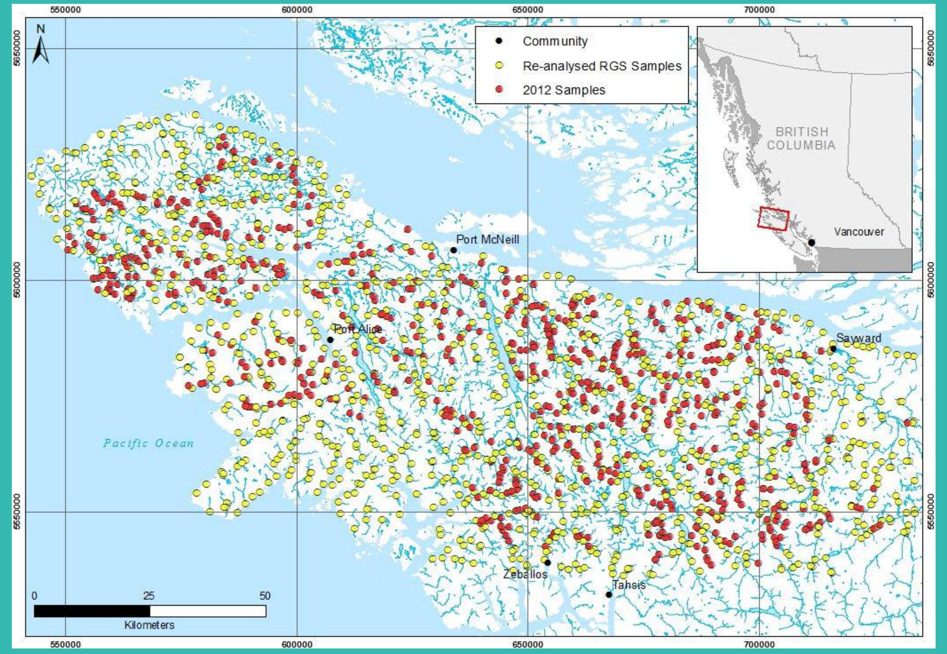


Figure 1: Location of study area showing sample locations.

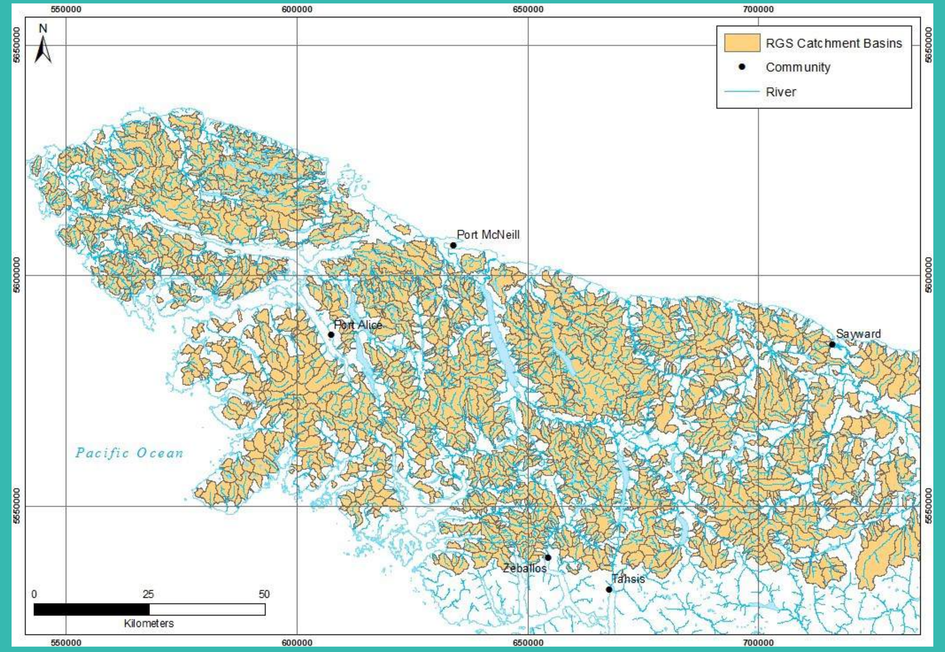
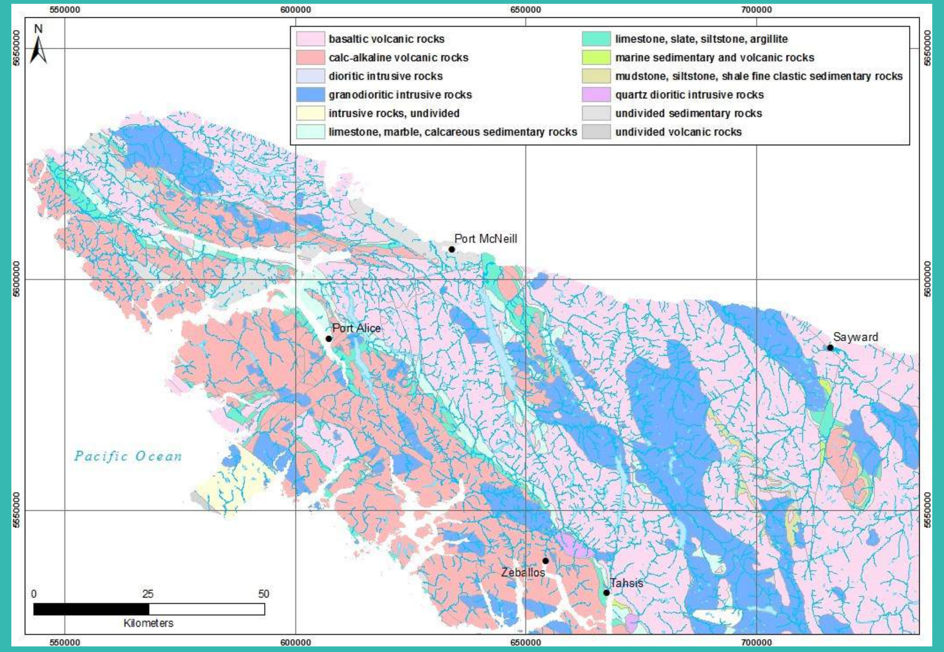


Figure 2: Delineated catchment basins for all samples.

Geology



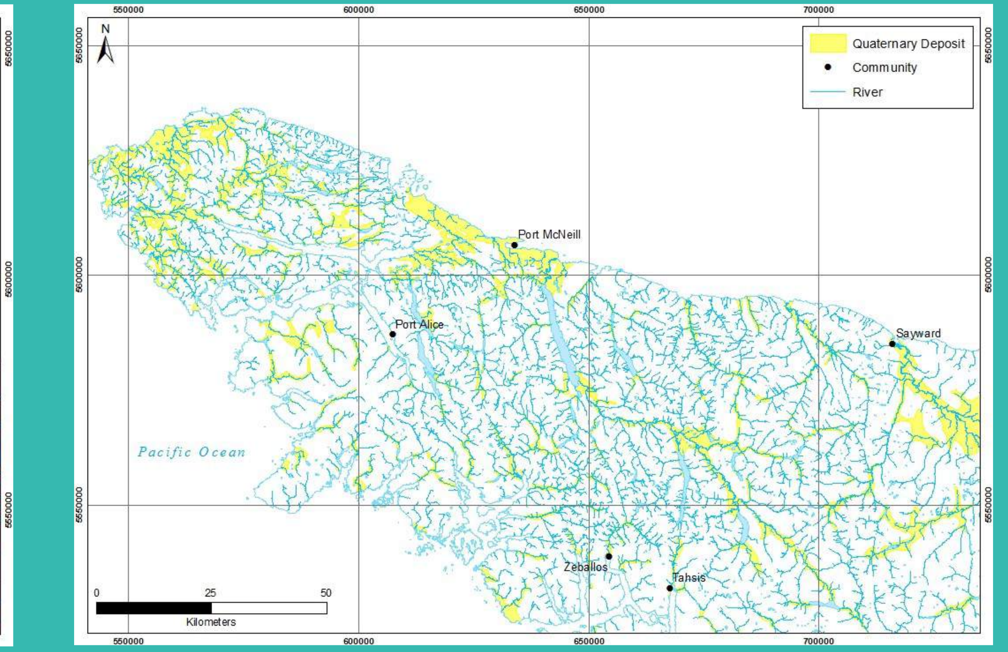


Figure 3: The bedrock geology of the study area is dominated by Mesozoic basalts of the Karmutsen Formation and calc-alkaline volcanic rocks of the Bonanza Group. Quaternary deposits are extensive is some areas but undefined.

Methodology

A total of 1,735 moss mat sample locations from northern Vancouver Island (NVI; Figure 1) were compared to TRIM drainage data and adjusted where necessary to ensure every sample location intersected a drainage line. The adjusted locations were validated against the original NTS map sheets upon which the sample locations were marked. Catchment basins were then delineated using an automated routine developed at the British Columbia Geological Survey based on digital elevation data (Cui *et al.*, 2009; Figure 2). The derived catchment basins were used to query the bedrock geology (Figure 3) and the Quaternary cover map (Figure 4) to estimate the percentage of each bedrock unit, as well as the percentage of Quaternary material in the catchments. A dominant catchment lithology was chosen using this information and the presence of >5% basalt in each catchment noted. Catchment area was also derived for each of the NVI samples.

The attributed data underwent exploratory data analysis (EDA) using ioGAS software and the results compared to known mineral occurrences on NVI. Copper is one of the main commodities of interest on NVI but its response in the RGS data set is known to be dominated by elevated Cu in the Karmutsen Formation (Sibbick, 1994). EDA confirms elevated Cu present in catchments dominated by the Karmutsen Formation, as well as in the Daonella Beds of the Vancouver Group that contain mafic sills of the Mount Hall Gabbro (Figure 5 & 6). Z-score levelling of the data for the dominant lithology in the catchment following a Log_{10} data transformation shows how the effects of variable background can be removed to reveal anomalous Cu associated with mineralization (Figure 7 & 8). A similar result is obtained through levelling the Cu data for the presence or absence of basalt in the catchment and for robust Z-scores using the weighted background values from the catchments.

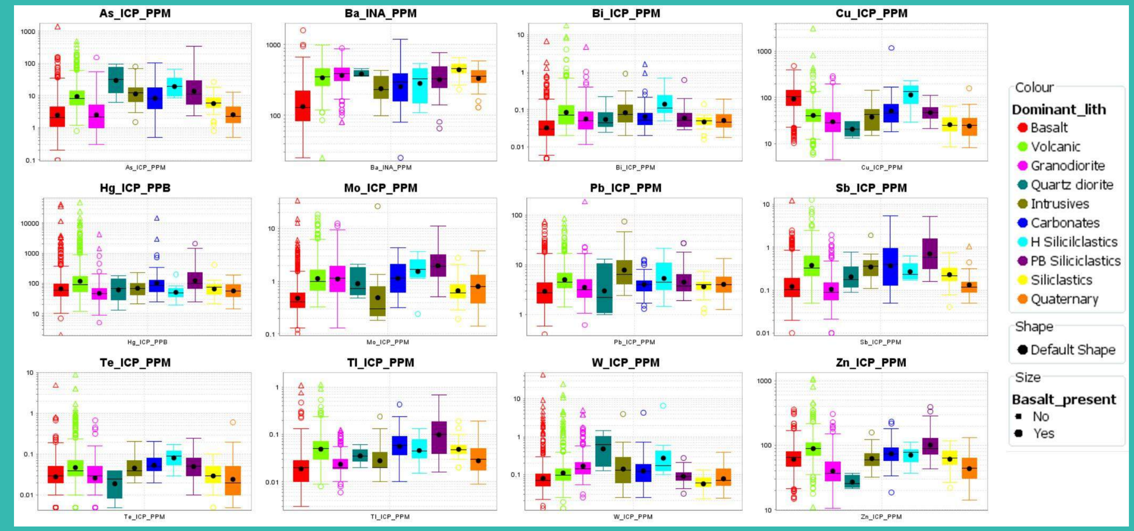


Figure 5: Box and whisker plots showing the distribution of selected elements for RGS samples based on the dominant lithology in the catchment.

Figure 7: Raw data Z-score levelled following a $\log_{10}$ data transformation to remove the effects of the dominant lithological unit in the catchments.

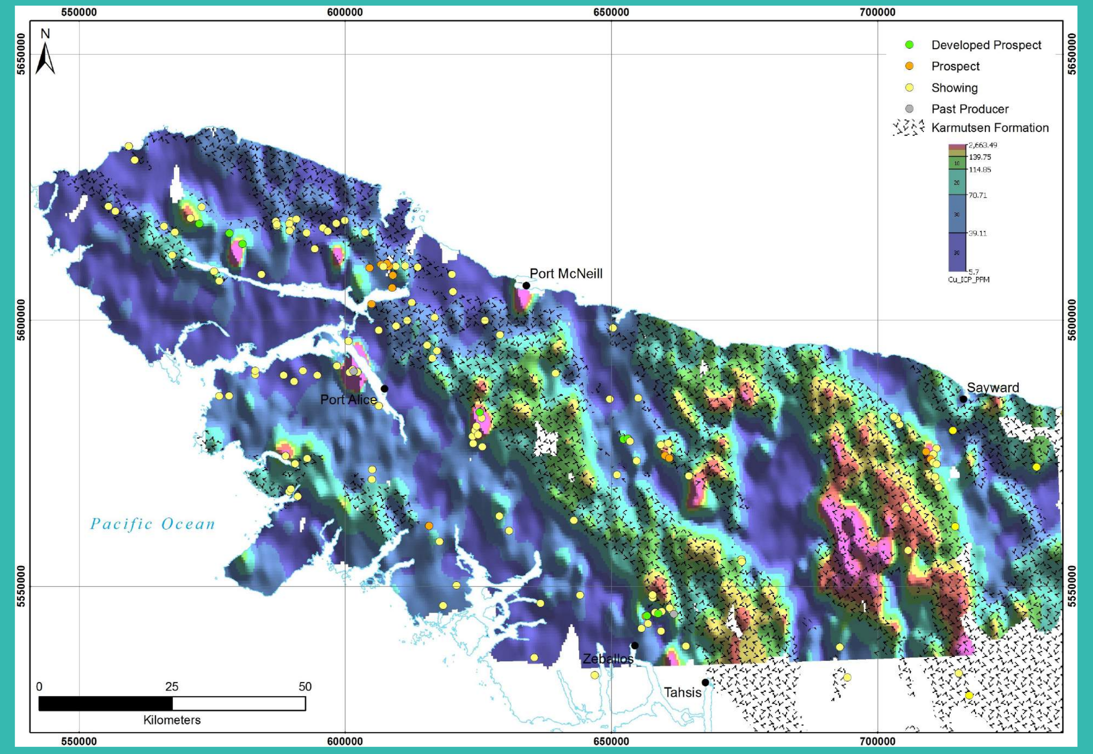


Figure 6: Gridded percentile image of raw Cu data overlaid by the distribution of the Karmutsen Formation and known Cu occurrences.

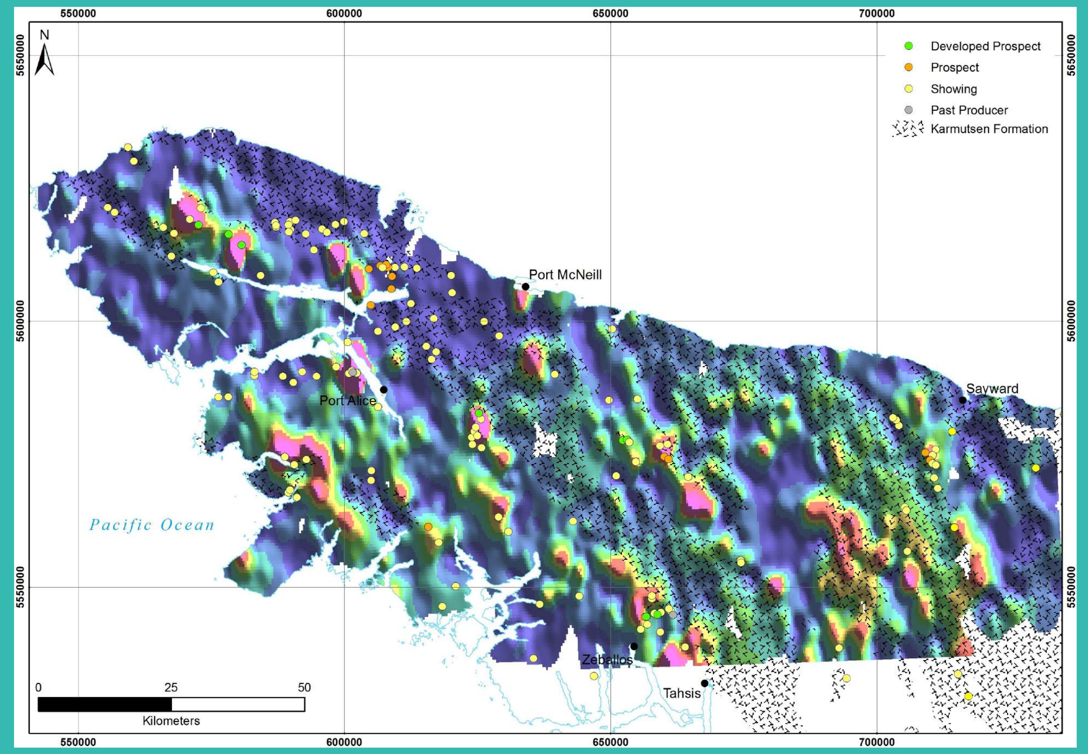
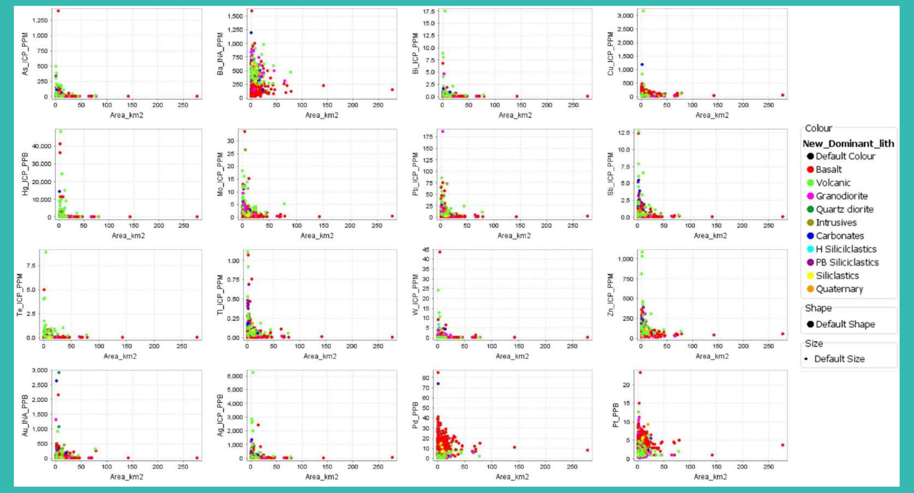


Figure 8: Robust Z-score Cu levelled for dominant bedrock lithology. The influence of the Karmutsen Formation is suppressed.

Sampling Effectiveness

Another advantage to using catchments to interpret stream sediment data is that the effects of dilution can be taken into account. A simple plot of metal value using either raw or levelled data plotted against catchment area typically shows a decrease in metal content as a function of dilution. This relationship can be used to determine the maximum catchment area that can be effectively sampled. The plot also serves to display those catchments that contain elevated metal contents greater than expected for the catchment area (Figure 9). The catchment polygons can then be colour coded based on whether they have been effectively sampled or not (Figure 10). Areas thought to have been effectively sampled by historical RGS programs may have been under-sampled in some regions, providing new opportunities for exploration where the potential had been down graded based on ineffective regional sampling programs.



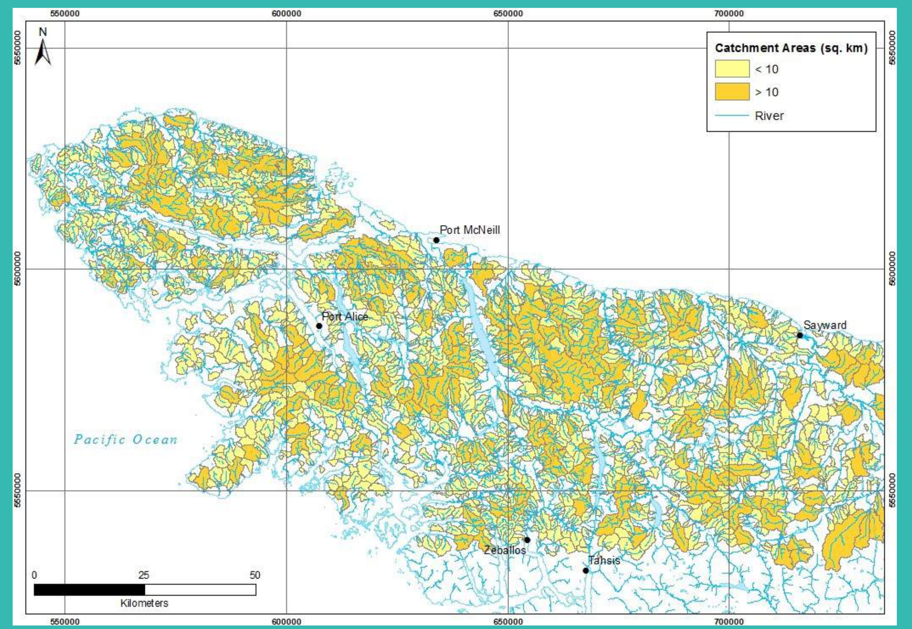


Figure 9: Plot of metal values against catchment area demonstrating the dilution of metals in catchments >10 km^2.

Figure 10 (right): Thematic map showing those catchments that have been effectively sampled and those that have been under-sampled.

Conclusions

A catchment analysis approach adds value to the interpretation of stream sediment geochemical data by moderating the effects of variable bedrock geology on the background values of particular commodity and pathfinder elements. This has the effect of elevating 2^{nd} and 3^{rd} order geochemical anomalies that may have been overlooked if only the raw geochemical data are assessed. Suppressing the effects of high background Cu from the Karmutsen Formation highlights known Cu occurrences as well as new prospective areas. In addition, the effects of dilution on geochemical data from catchments having a variety of different areas can be empirically assessed to determine how effective historical stream sediments have been in their coverage. In spite of in-fill sampling carried out by Geoscience BC on NVI, there are still large areas where sampling is insufficient.

Acknowledgements

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References

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