# QUEST South: Catchment Basin Analysis and Stream Sediment Exploration

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## Introduction

This project is designed to add value to Regional Geochemistry Survey (RGS) data from the QUEST South project (Figure 1) based on an analysis of catchment size and levelling of the data for dominant catchment bedrock geology. Data levelling will be based on exploratory data analysis (EDA) and ground proofing of the outcomes against known mineral deposits and occurrences using an approach that is both methodologically proven (see reference list) and effective. An expert interpretation of the RGS geochemistry data will generate new exploration targets, and add considerable value to an existing dataset that has cost both the Federal Government and the Province of British Columbia a considerable amount of effort to obtain. In addition, catchment analysis will allow an assessment of the adequacy of the existing RGS data coverage for future in-fill and follow-up surveys.

The two main factors that need to be addressed in the interpretation of stream sediment geochemical data are catchment geology, which controls background geochemistry, and the effect of dilution, which determines whether geochemical anomalies related to mineralization within a particular catchment basin can be detected. The effects of dilution on stream sediment data have long been recognized, and are a described in a mathematical formulation that is sometimes referred to as the productivity of a catchment basin (e.g. Hawkes, 1976). This theoretical calculation involves numerous assumptions, such as equal erosion in all parts of the catchment and *a priori* knowledge of the size and grade of any exposed mineral deposit within the catchment, as well as background values of the elements of interest. As an alternative, we have developed a pragmatic approach for the routine assessment of large, regional stream sediment datasets in a cost-effective manner. This involves the calculation of catchments for individual samples, an evaluation of geochemical controls on the geochemistry with any necessary corrections, and then levelling of the data for the dominant bedrock lithology in each catchment.

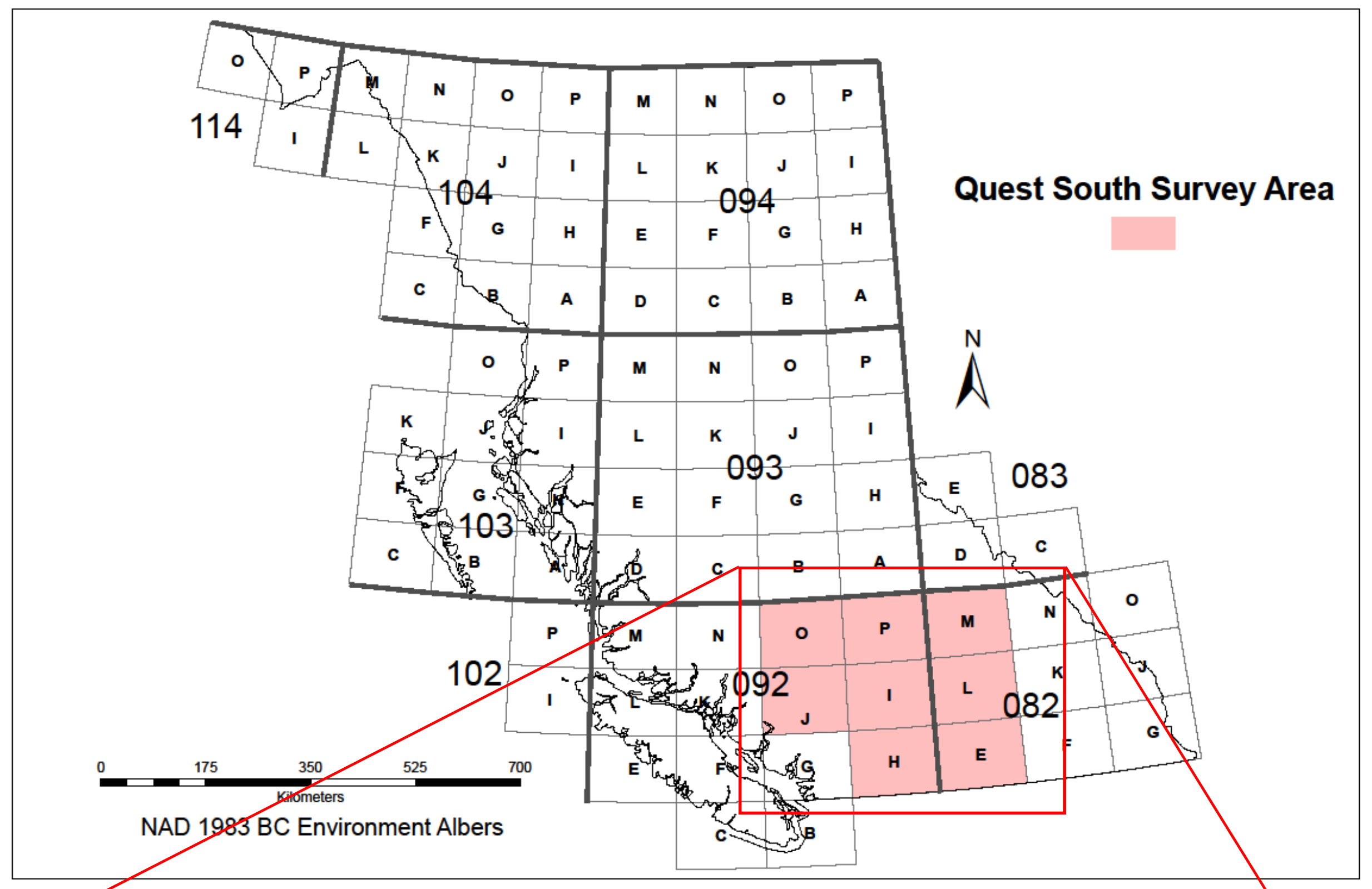


*Figure 1: Location map. Red inset represents the Quest South Survey Area*

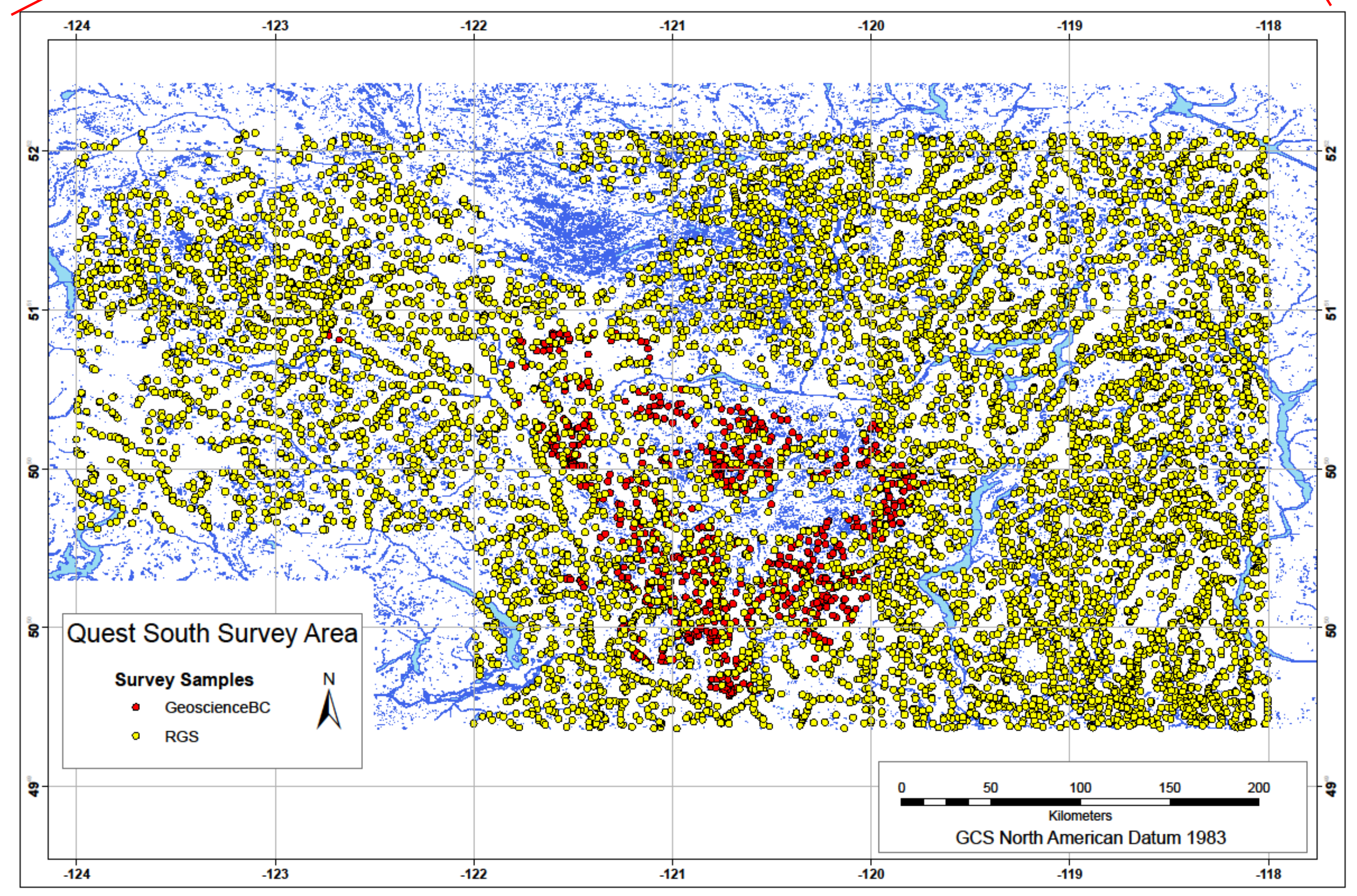


*Figure 2: Stream sediment sample location map*

## Catchment Basin Validation

The use of automated catchment generation for individual stream sediment samples is sensitive to the correct location of the sample site, as illustrated in Figure 9. In the case of the older regional geochemical sample (RGS) data, the sample locations are often in poor agreement with modern topographic and hydrographic data. Thus, individual sample sites must be validated to ensure that the correct catchment has been attributed to the stream sediment sample. Unfortunately, a large number of the RGS sample sites appear to have ambiguities associated with their locations, and these require manual correction and the generation of new catchments before catchment analysis can proceed.

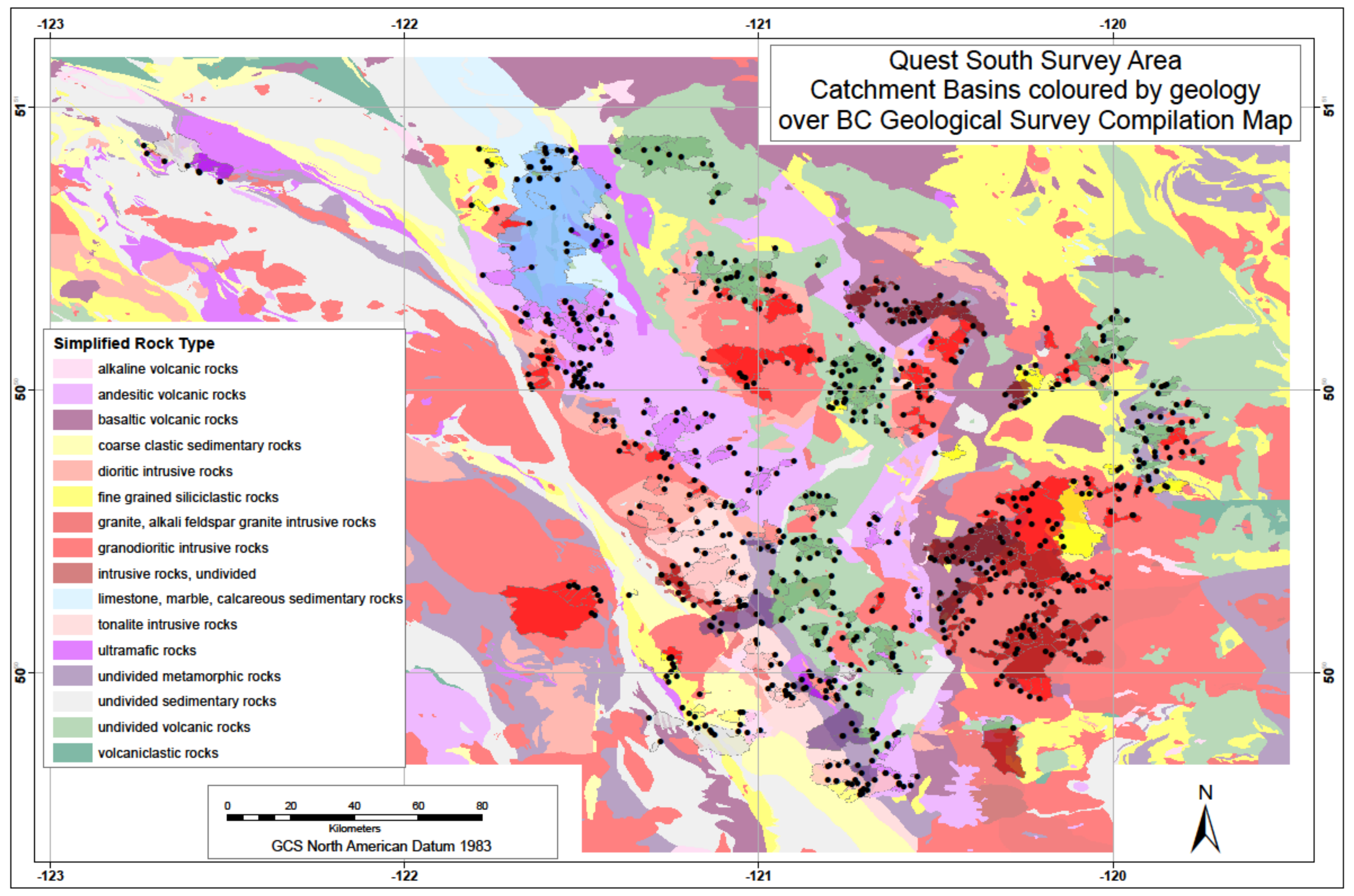


*Figure 3: Geological Compilation map of BC with Quest South Catchment areas coloured by dominant lithology*

## Exploratory Data Analysis and Levelling

Exploratory data analysis (EDA) indicates that the values of key commodity and pathfinder elements are in part related to the levels of Al, Fe and Mn in the samples, reflecting adsorption of trace metals onto clay minerals and secondary Fe and Mn oxides. Therefore, the trace element data have been regressed against the Al content of the samples and residuals calculated for each sample. In some cases, residuals may be more appropriate to use than raw data values for levelling purposes. An efficient way to correct for the effects of variable bedrock lithology, and thus variable geochemical background, is to level the data by the dominant bedrock unit in each catchment. In the example shown below, rock types have been grouped by type to form classes with at least 10 catchments having the same dominant lithology. The raw Cu data show varying levels consistent with the dominant rock type in the catchment (e.g. high Cu associated with basalt). Log transformation and Z-score levelling ((value – mean)/standard deviation) brings the median values into alignment with no loss of outliers. Three gridded images are compared with known mineral occurrences in Figures 6 to 8 (raw Cu, Z-score levelled Cu, Cu residuals from regression against Al, Z-score levelled Cu residuals). Although the highest Cu values in the study area are preserved in all cases, the analysis highlights 2nd order features that are worthy of further investigation. The lower order anomalies unrelated to known Cu mineralization could reflect problems with the levelling process (i.e., incorrect bedrock geology or the presence of a minor, yet geochemically significant unit, such as basalt) or they may represent mineral deposits. In either case, the catchment areas warrant follow-up investigation.

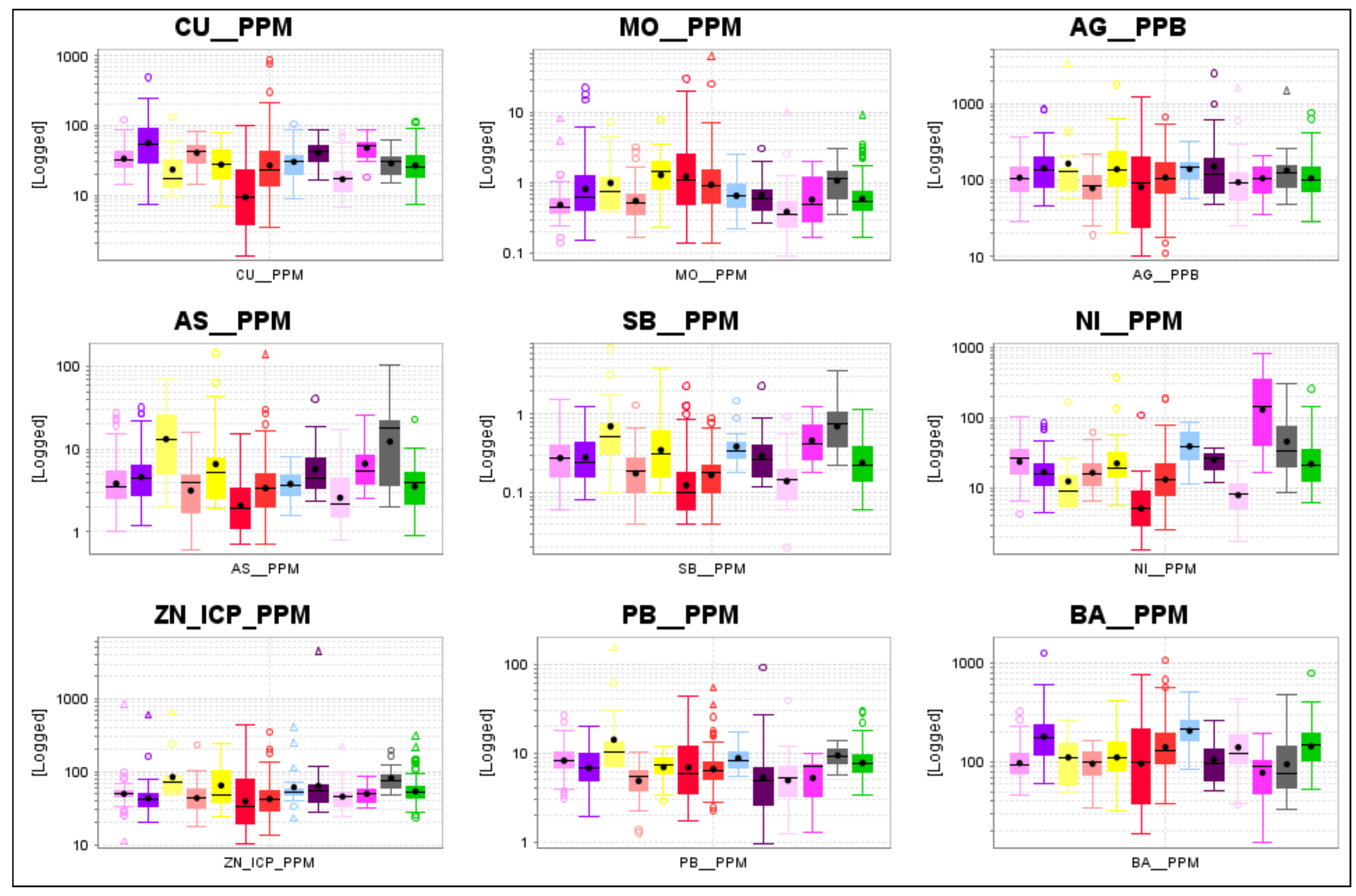


*Figure 4: Box and Whisker plots of analytical data coloured by dominant catchment lithology*

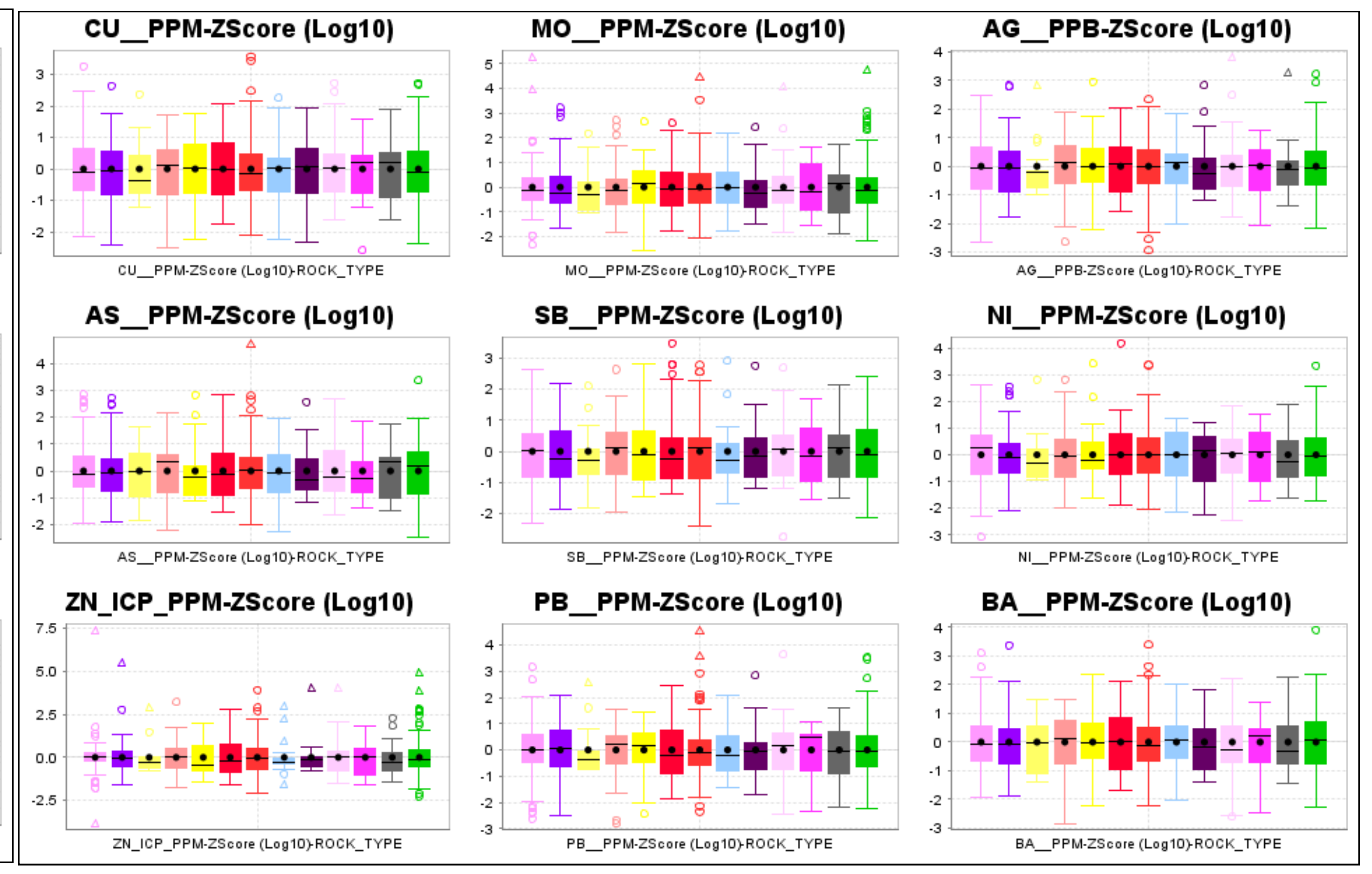


*Figure 5: Box and Whisker plots of the data coloured and levelled by dominant catchment lithology*

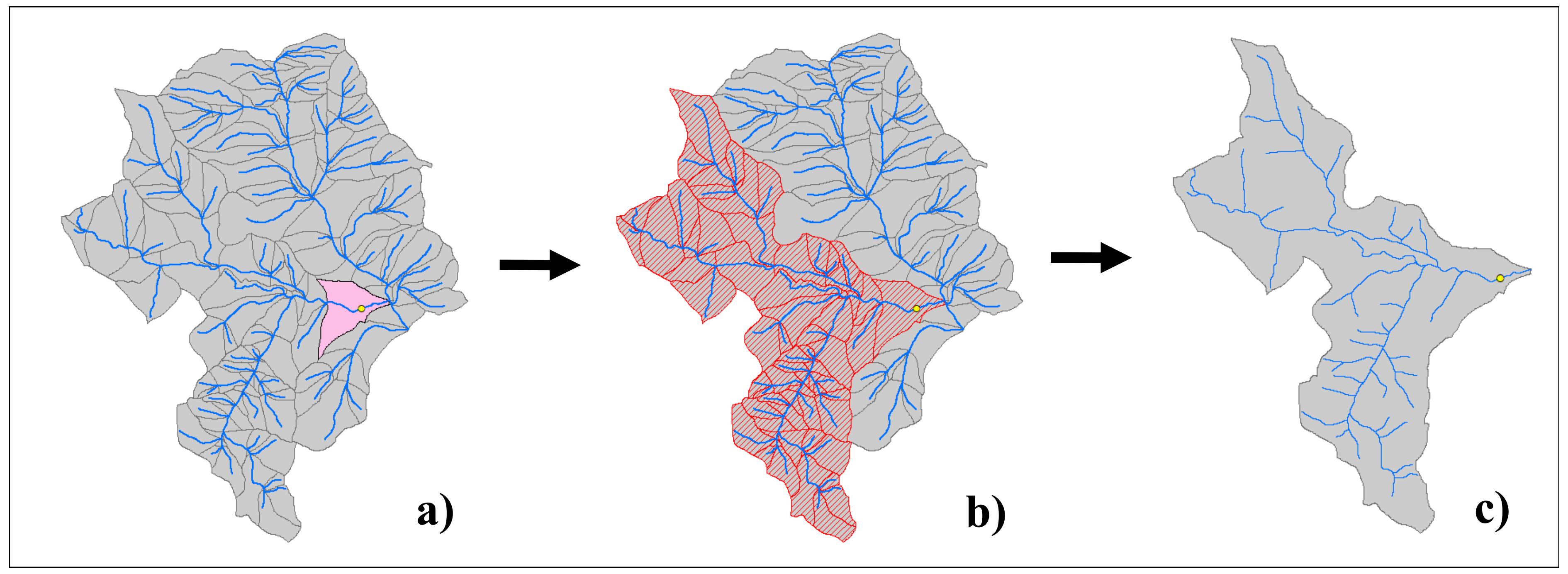


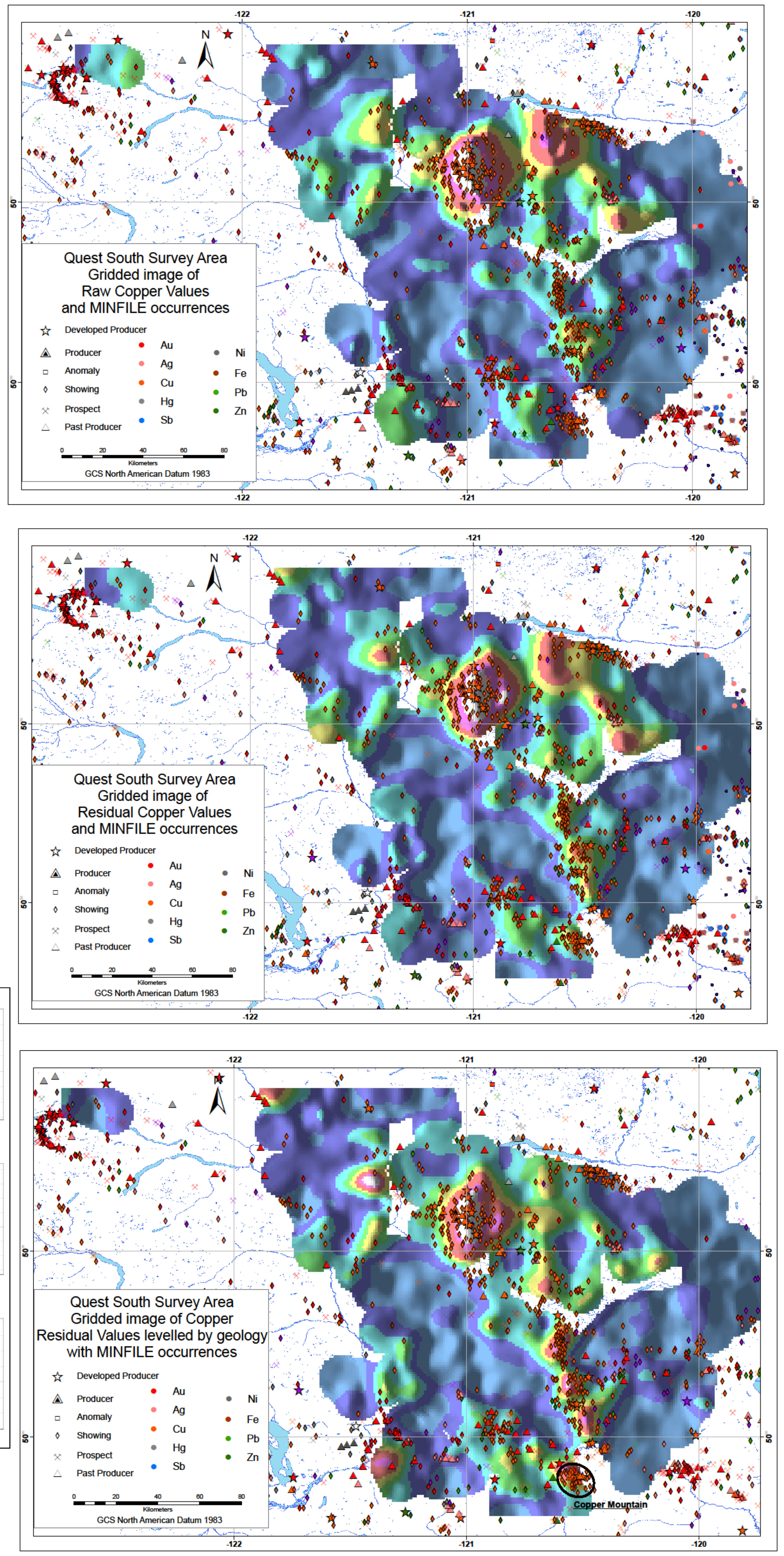
*Figure 9 (left): Stepwise delineation of catchment basins using upstream queries.*

*A) Multiple watersheds need to be combined to make a representative catchment. Here only one watershed (pink) is selected by the sample location*
*B) All appropriate watersheds are selected by SQL query*
*C) The watersheds are merged into a validated catchment basin*

## Catchment Basins

As a demonstration of the approach, catchments have been determined for the 785 new stream sediment samples collected by Geoscience BC for the QUEST South project area in 2009. These catchments were captured using an automated process developed by the British Columbia Geological Survey (Cui *et al.*, 2009) based on the 1:20,000 BC Provincial Terrain Resource Information Management (TRIM I) streams and heights of land.

Catchment basins for individual stream sediment samples are also illustrated in Figure 3. Analysis of the Cu data suggests that the maximum catchment area for sampling should be no more than 25 km$^2$, at which point geochemical anomalies become diluted.



*Figures 6, 7, 8 (above)*
*Gridded images of raw Cu, Cu residuals after regression against Al, and Cu residuals levelled by dominant catchment with BCGS MINFILE data, symbolized by prospect type and coloured by commodity*

## References

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