ADVANCES IN RECONNAISSANCE SAMPLING AND GEOCHEMICAL ANALYSIS ARE CREATING NEW EXPLORATION OPPORTUNITIES IN PREVIOUSLY-SAMPLED TERRANES.

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Introduction

This case history uses reconnaissance samples collected in 1969 from near to giant Au and Cu-Au resources in Papua New Guinea, to reveal the significance of the advances in reconnaissance sampling and geochemical analysis. The correct choice of sediment material and the analysis of pathfinder elements to background levels can provide important exploration opportunities in previously-explored terranes. Whilst the use of geochemical orientation to choose the best sample media (Rose, 1979) has been employed for many years, little has been published regarding the sieve-sized fractions optimal for base metal exploration. There is anecdotal evidence to suggest fractions finer than about 100µm in some environments produce better anomaly to background for base-metal deposits than traditional <180µm and similar fractions. However, demonstrating that the use of a finer fraction will make a quantifiable difference to the discovery of a major resource has been difficult.

Background

This case history shows how analysis of the finer fraction of the same stream-sediment samples collected in 1969 (Figure 1) can locate a major Au and a Cu-Au deposit, previously unrecognised in this sampling, at Wafi and Golpu in Papua New Guinea (PNG). The new analysis also includes element concentrations at detection limits commercially unavailable at that time. A number of these previously-unanalysed elements are significantly more effective in creating a unique, anomalous signature for mineralisation than the combination of Cu, Pb or Zn. From this newly-created signature, an obvious new target has also been delineated. There are many mineralised terranes that have been sampled using sediment samples collected using <180µm and similar size fractions (from here on referred to as 'sand sized') and the samples stored. Simple reanalysis of the finer <75µm fraction (from here on referred to as 'silt sized') for a routine, low-level detection suite of elements, with many elements detectable close to background levels, will generate new geochemical targets in terranes previously thought to be well explored.

Methodology

A total of 133 samples from PNG were selected from a region around the Wafi and Golpu (Harmony/Newcrest) resources (Figure 2). The samples had been collected in 1969 during regional reconnaissance exploration of PNG by CRAE Ltd. About 2kg of bulk stream-sediment was collected by helicopter and flown back to a converted tuna-boat called the CRAESTAR. The sand-sized, <180µm material was sieved from the samples on the boat and analysed in the converted fish-hold for Cu, Pb and Zn after an *aqua regia* digest, with atomic absorption spectroscopy determination. The reject sample material was sent to Australia for storage in CRAE's central store in New South Wales. In 2013, the samples were retrieved and a few grams of <75µm silt-sized material was sieved out of the remaining sample and sent for low-level analysis of 35 elements by both four-acid digest (including hydrofluoric acid) and 20 elements (including Au) by an aqua regia digest, using a mixture of inductively-coupled, plasma mass spectrometry (ICP-MS) and inductively-coupled, plasma optical emission spectrometry determinations (ICP-OES) (Figure 3).

For many elements, the differences in concentration between the original, sand-sized and finer, silt-sized fractions are significant. There is five or six times more Cu in the finer fraction (Figure 4). For two of the samples, it was possible to sieve and analyse a few different fractions including the <250µm >75µm; being roughly equivalent to the original, sand-sized fraction. The result of this multi-fraction study shows that the differences in concentration levels were due to the size fraction, not low analysis, as performed in 1969. The silt-sized fraction analysis of Cu is still quite variable (Figure 5) with no distinct anomaly near Wafi/Golpu. The highest concentration of Cu near the Wafi and Golpu resources is only in the top ten Cu values. However, the pathfinder elements of As, Bi, Cu, Mo, Sb (Figure 6), Se, Te and Tl define two distinctly-anomalous samples (Figure 7). One related to the Wafi and Golpu resource area and the other a compelling new target (Figure 8).

A 2.5g aliquot of the silt-sized fraction sample was also analysed for a suite of elements by aqua regia, including Cu, Pb, Zn and Au. A high Au value is associated with the anomalous sample selected near Wafi/Golpu resources (Figure 9) but not with the new target sample. However, Au is spatially associated with drainage catchments located nearby and downstream (Figure 10).

The advances in analytical chemistry from the time these samples were collected in 1969 have been remarkable. In 1969, the element Sb had a detection limit of 50ppm in routine, commercially-available analysis, making anomalies <250ppm difficult to resolve. Since 2005, commercial use of Inductively-Coupled Mass spectrometry has become commonplace and with it, the ability to clearly resolve anomalies at the 1ppm Sb level. The resolution of anomalies at this level for Sb and other elements proved to be important in this case history (Figure 6). This clear resolution of anomalous from background values is critical for new discoveries in previously explored terranes, because simply lowering the anomaly-background cut-off level for Cu creates exponentially more (less prospective) targets for follow-up.

Conclusion

Recognising that the silt fraction provides significantly-better exploration results in PNG is an incremental step forward. However, when coupled with the advances in analytical chemistry, it can make the difference between discovery and missing a giant deposit.

Figure 1. A photo of the CRAESTAR vessel with its associated helicopter taking off to collect stream sediment samples in Bangula Bay, New Britain, 1965. In 1969, samples were collected in a similar manner around the then-unknown Wafi and Golpu resources. The bulk sediment samples were brought back, sieved on board and analysed in the converted fish-hold.

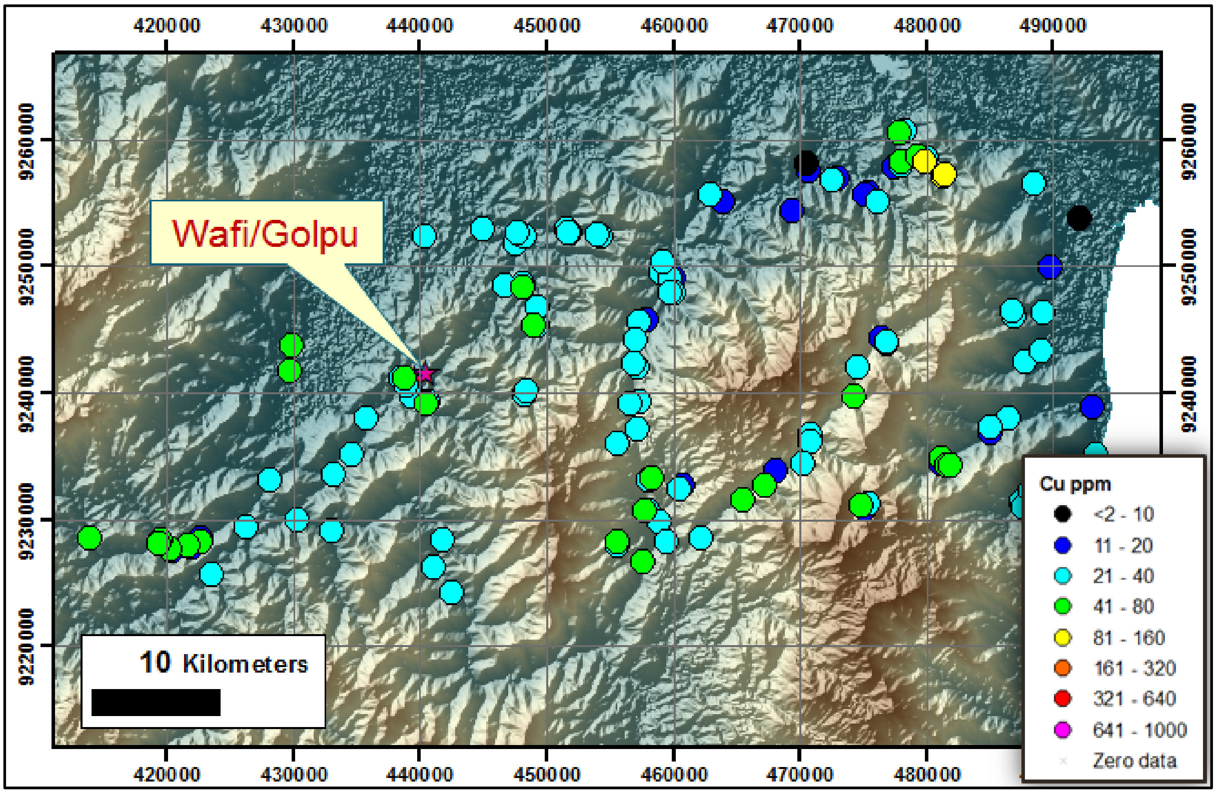

Figure 2. This map shows the sample locations as dots coloured by Cu concentration of <180µm fraction stream sediment sample Cu on a background depicting the elevation based on SRTM. This Cu analysis was from samples analysed in 1969. The Cu concentrations have no focus at the Wafi/Golpu resources. The high Cu values in this survey were followed-up, with no significant discoveries.

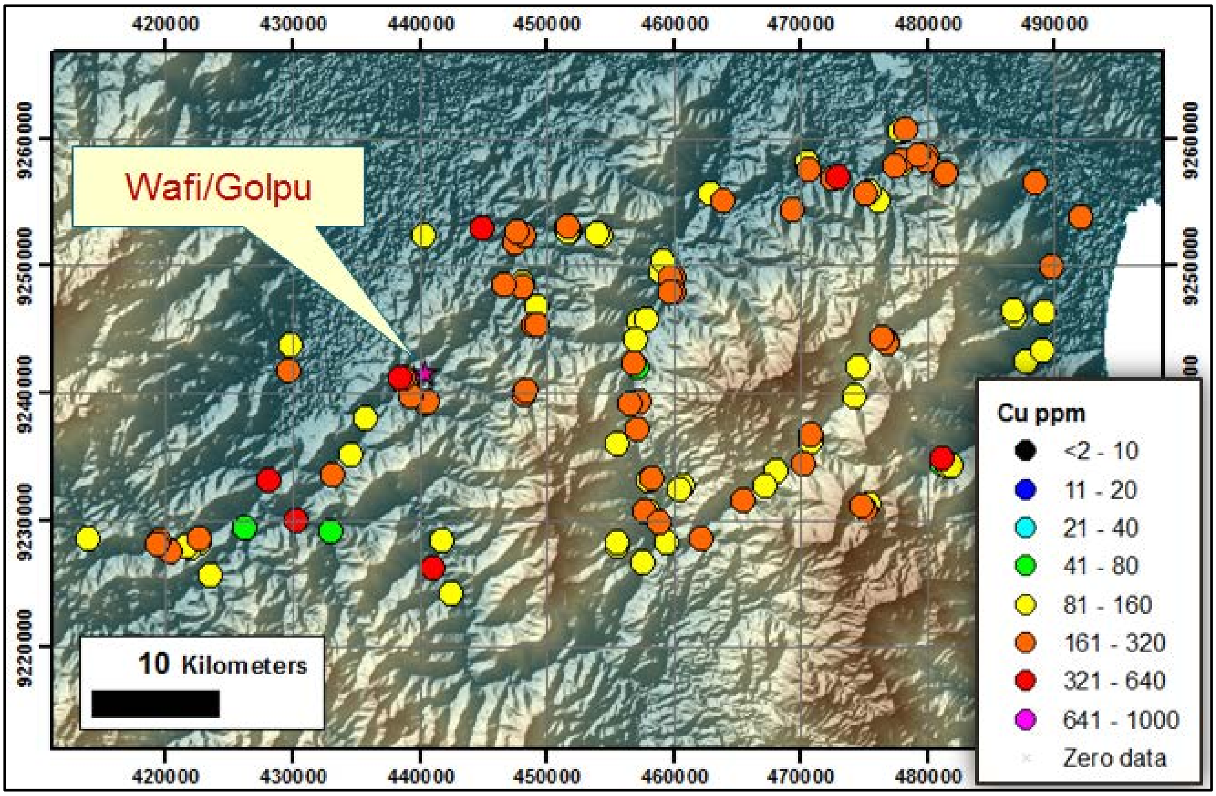

Figure 3. This map shows the sample locations as dots coloured by Cu concentration of <75µm fraction stream-sediment samples Cu on a background depicting the elevation based on SRTM. This Cu analysis completed in 2013 shows much higher levels of Cu than the <180µm fraction (Figure 2). However, we have still not identified a definitive Cu anomaly near the Wafi/Golpu resources.

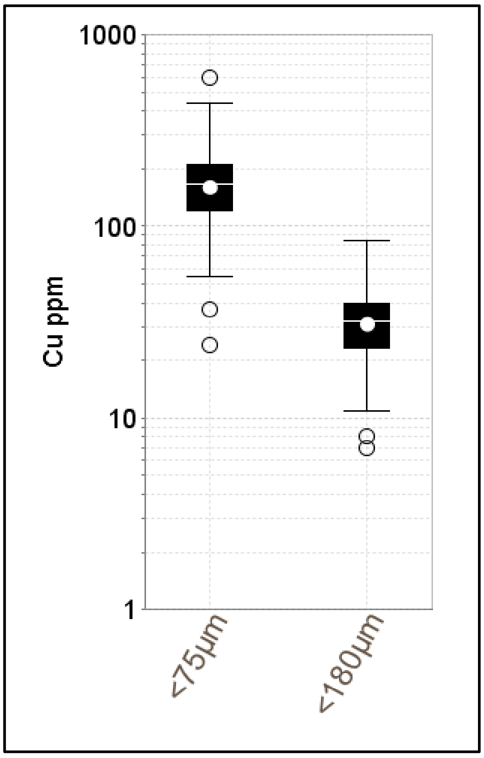

Figure 4. This Tukey boxplot shows there is five or six times the amount of Cu in the <75µm fraction stream sediment material, compared to the<180µm fraction.

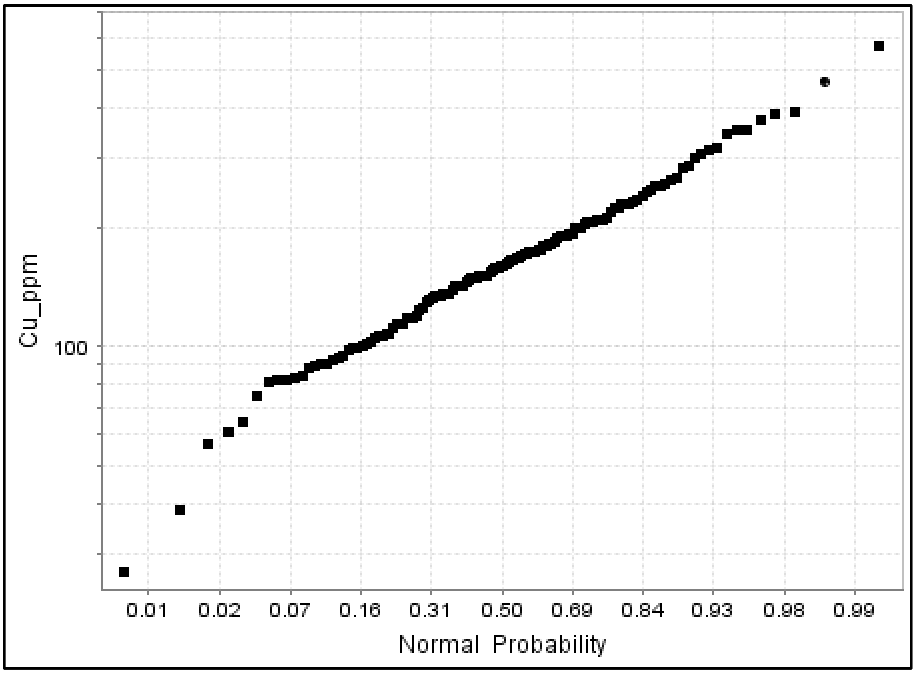

Figure 5. A log Cu log-probability plot of the Cu assays for the <75µm fraction stream sediment material show the Cu assays plotting on a straight line and from this plot, appear to be all part of one population (Sinclair, 1976). Anomalous samples will plot significantly off the straight line of samples representing the main population of values.

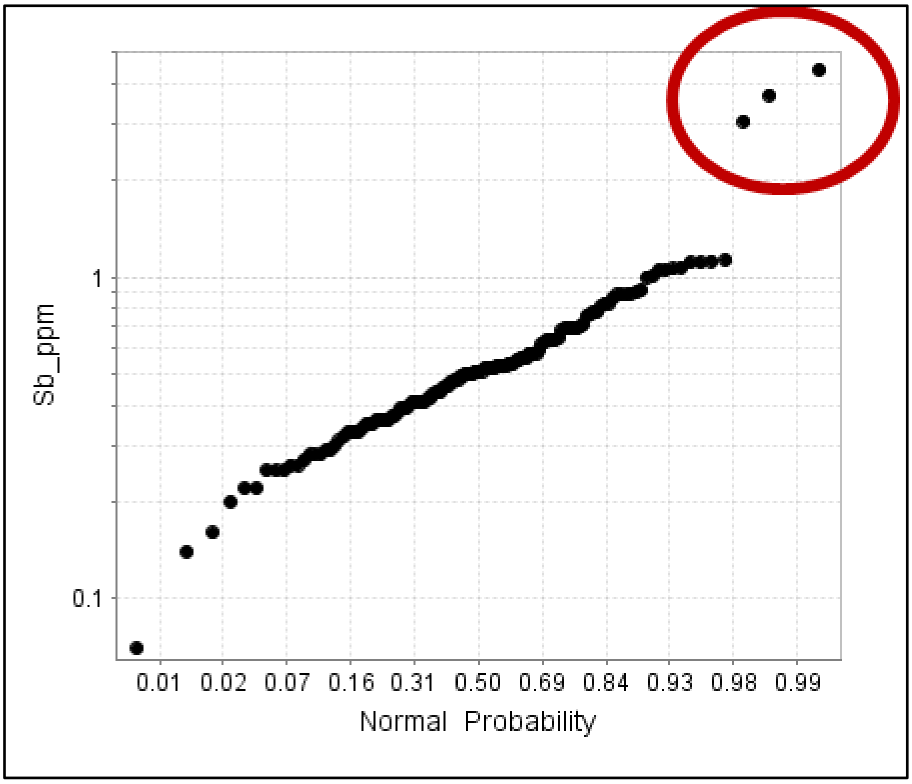

Figure 6. A log probability plot of the Sb assays for the <75µm fraction stream sediment material show clearly-anomalous samples, as do As, Bi, Mo, Sb, Se, Te and Tl.

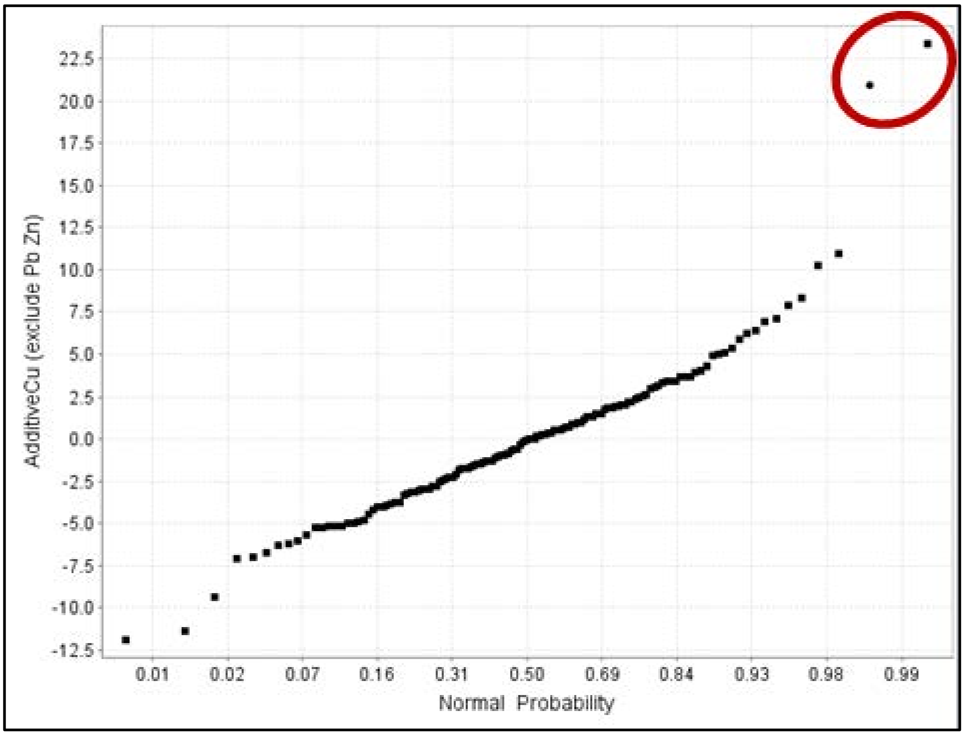

Figure 7. A probability plot of an additive index of Cu, As, Bi, Cu, Mo, Sb, Se, Te and Tl for the <75µm fraction stream sediment material shows two clearly-anomalous samples.

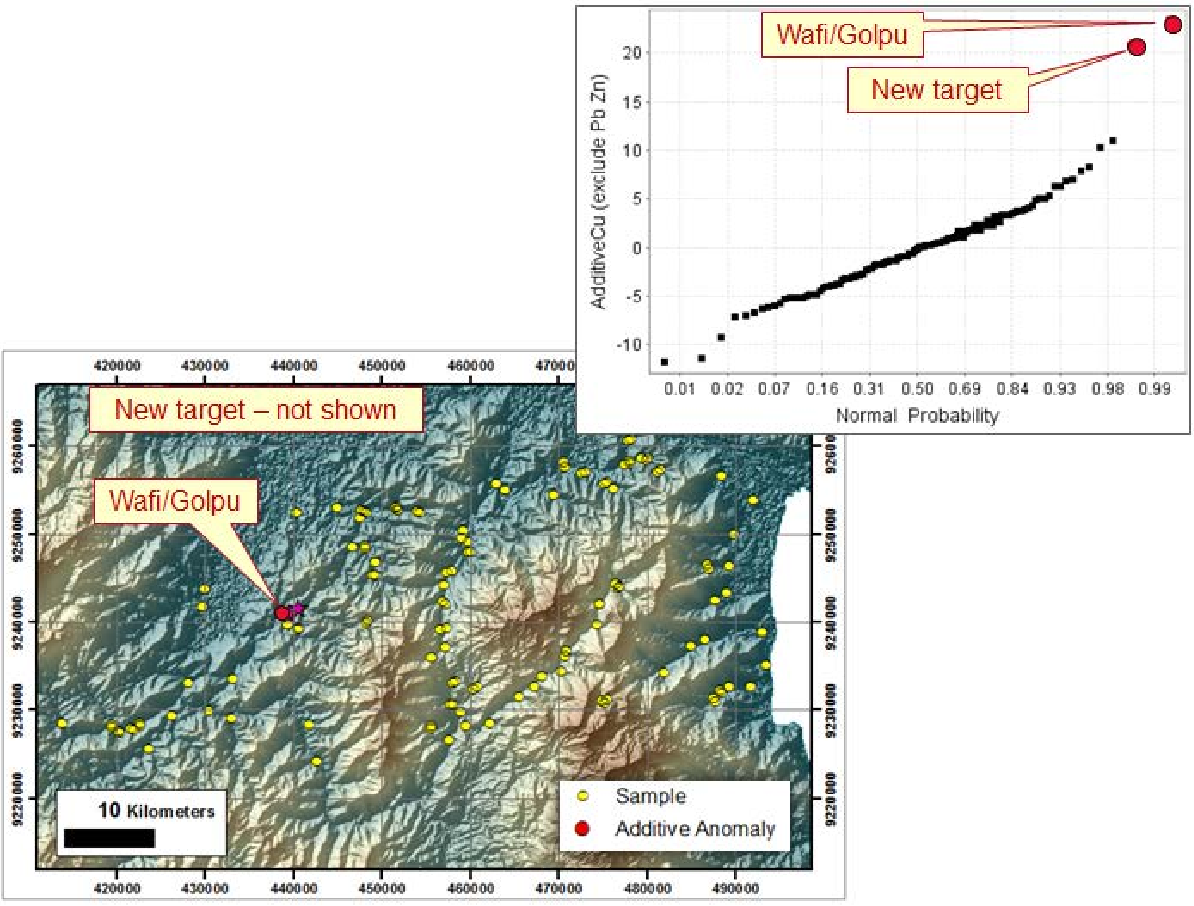

Figure 8. A log probability plot of an additive index of Cu, As, Bi, Cu, Mo, Sb, Se, Te and Tl for the <75μm fraction stream sediment samples and a map showing the sample locations as dots with one sample picked by the additive Index as anomalous on a background depicting the elevation. The second anomalous sample location is not shown as its location is commercially sensitive but it is >15km from the Wafi/Golpu area.

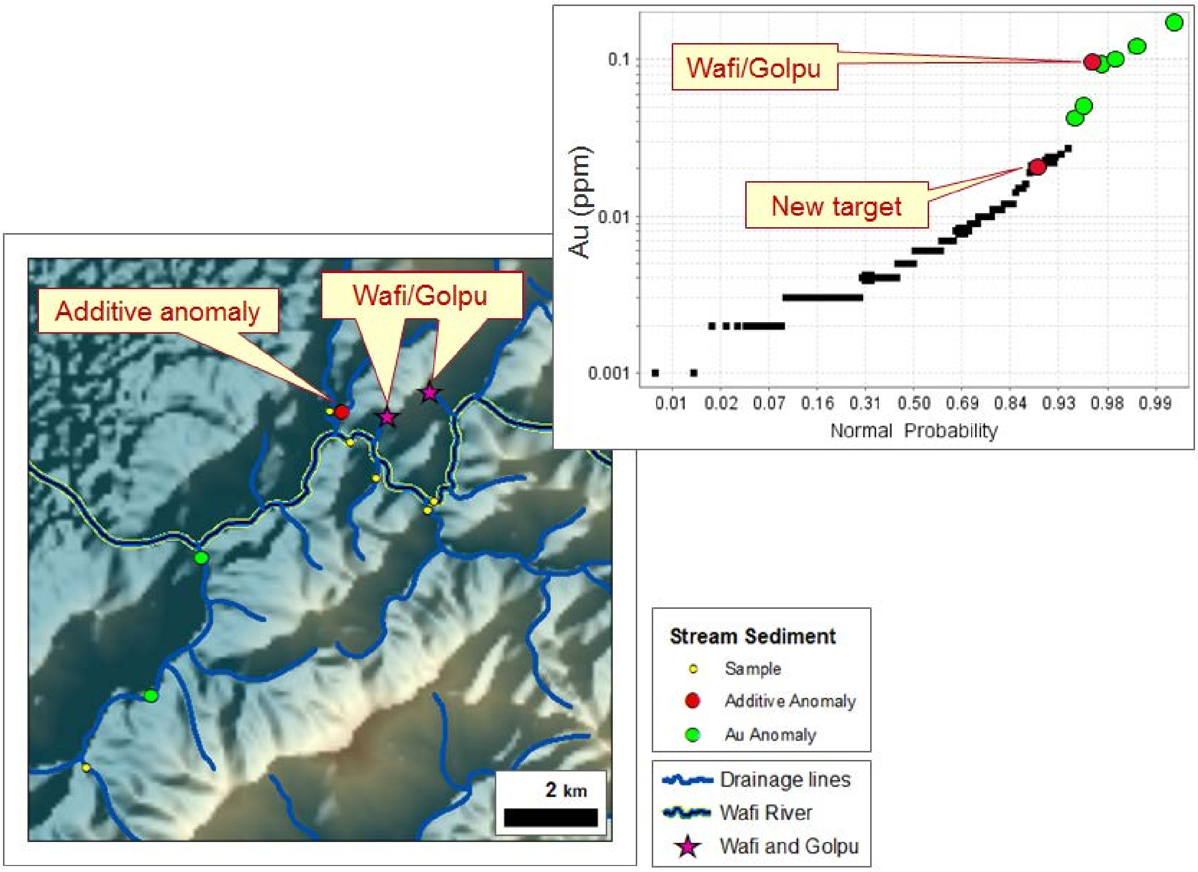

Figure 9. A log probability plot of Au and a schematic location map showing the area around Wafi and Golpu resources. Although the sample depicted in red at Wafi/Golpu as the 'additive anomaly' does have anomalous Au associated with it, the other samples with high Au are in a second drainage unrelated to the Wafi and Golpu resources.

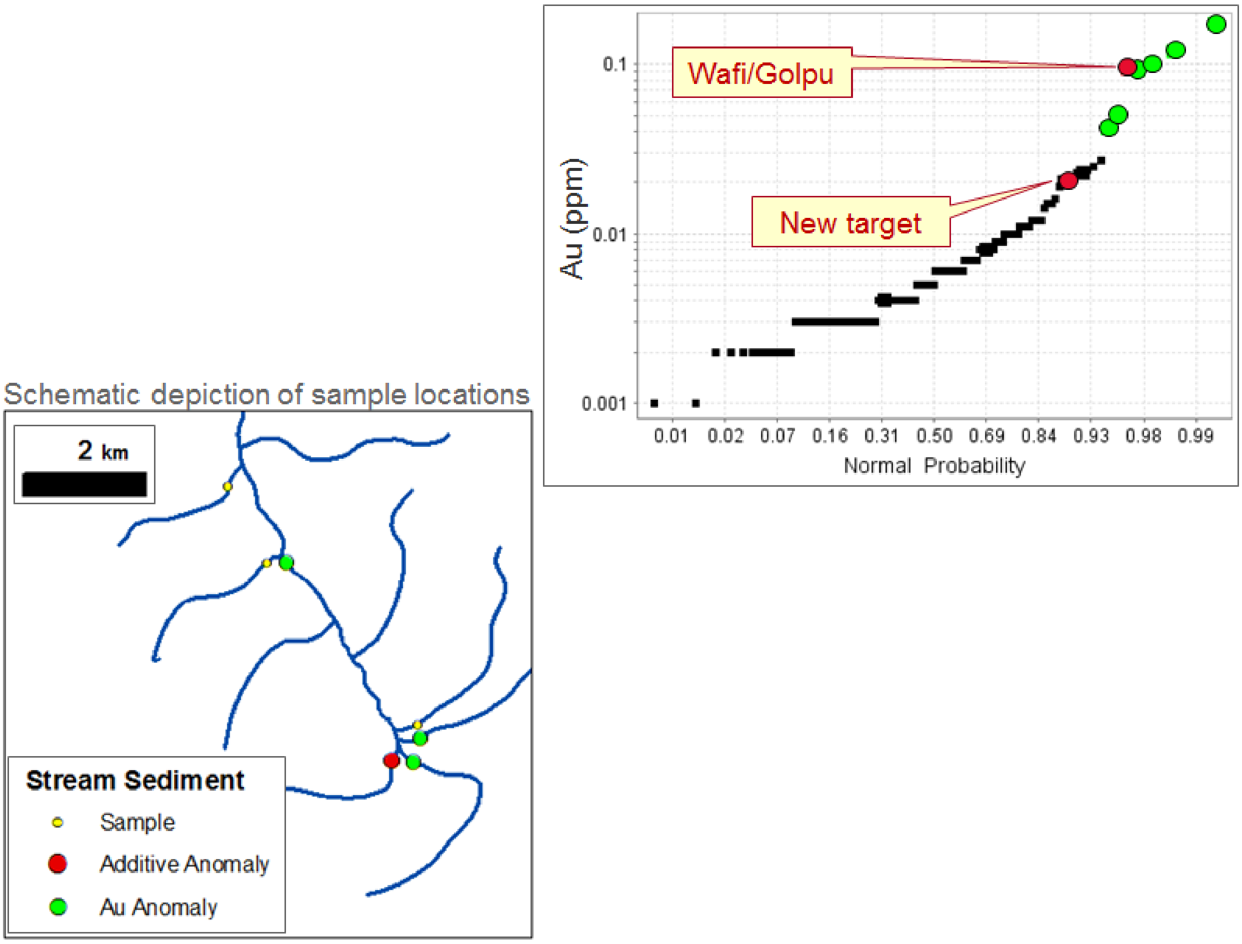

Figure 10. A log probability plot of Au and a schematic location map showing the area around the new target. Although the sample depicted in red as the 'additive anomaly' does not have anomalous Au associated with it, the drainages around it and downstream are anomalous in Au.

References

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