APPLICATION OF PORTABLE XRF (pXRF) TO MINERAL EXPLORATION

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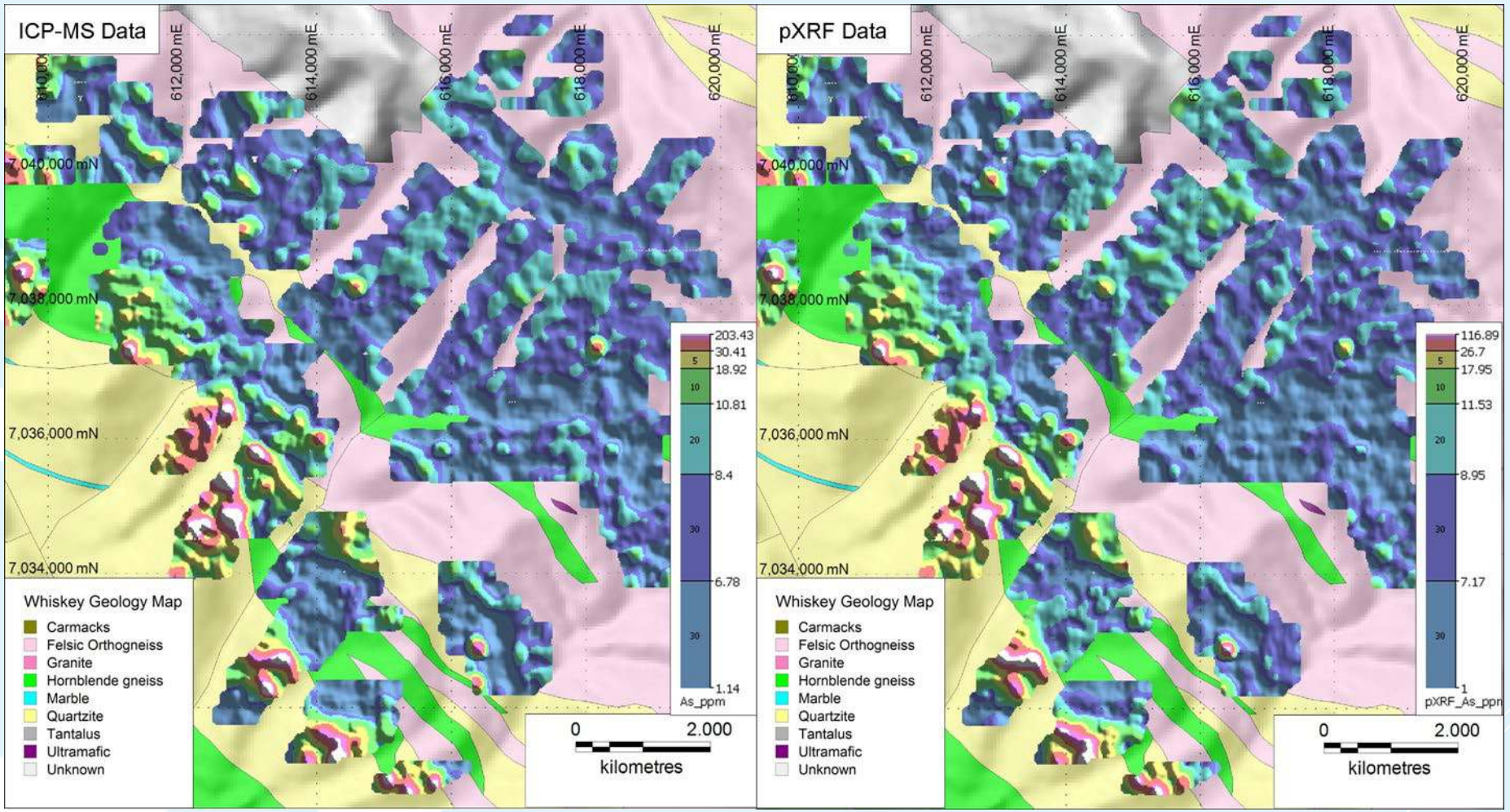
STATEMENT OF PROBLEM

- There are two fundamental approaches to the use of portable XRF in mineral exploration:
  - Quantitative analysis (i.e. for public reporting of results).
    - Requires instrument calibration
    - "Fit for Purpose" QA/QC program
    - Thoughtful sampling program to obtain representative analyses
    - Verification using laboratory analyses
  - Qualitative analysis (i.e. for internal use only).
    - Control samples to monitor instrument drift
    - No calibration of instrument
    - Minimal sample preparation (samples must be dry though)
    - Analyses can be done through sample bags

WHISKEY GOLD PROJECT, YUKON, CANADA

- Early stage Au exploration project for Smash Minerals in 2011.
- Intensive grid sampling program in residual soils (unglaciated part of Yukon).
- C-horizon soils used to identify anomalous Au and associated pathfinder elements, as well as to characterise and map bedrock geology.
- 14,651 un-sieved, dry soil samples analysed by benchtop and handheld (in test stand mode) pXRF through Hubco polyester sample bags.
- 1 kg samples also analysed using an aqua regia digestion/ICP-MS analysis of a 30 g, -150 mesh sub-sample.
- Results:
  - Good agreement for As & Cu from both machines for relative trends in ICP data.
  - Pb, Mo & Ni data needed leveling by instrument to give acceptable results.
  - Data for low level pathfinder elements (W, Sb, Ag, Bi, Te) erratic.

COMPARISON OF pXRF AND ICP-MS ARSENIC IN SOILS



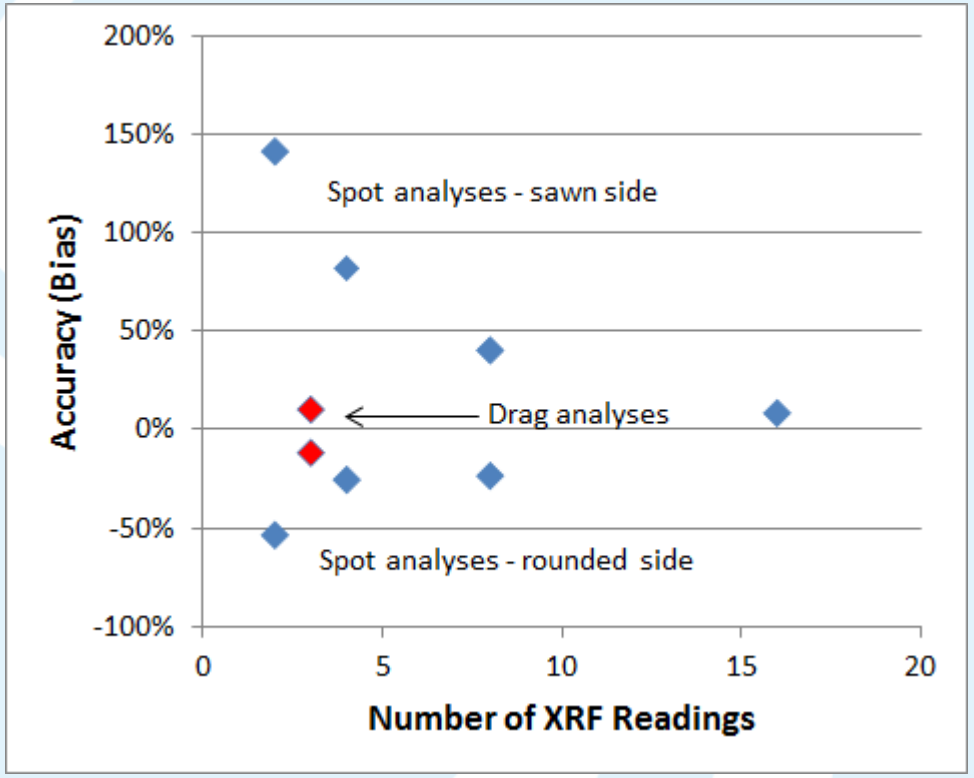
(From Arne et al., 2014)

- Data are plotted as percentile grids to compare relative trends.

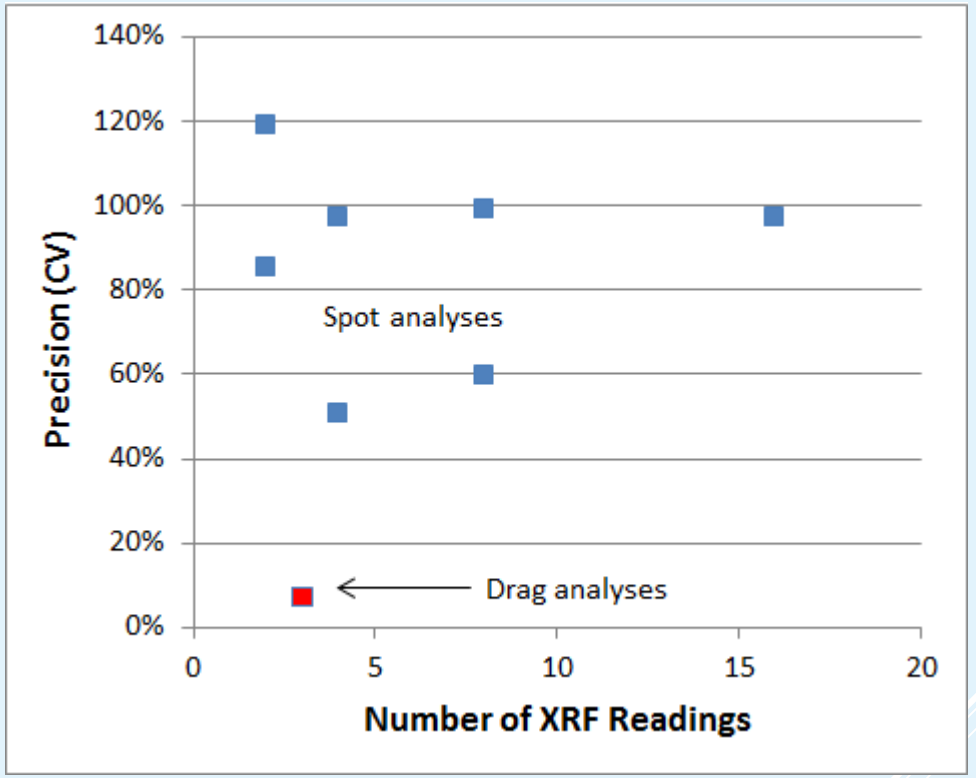
SCANNING DIAMOND DRILL CORE

- Direct scanning by dragging the pXRF detector over the core may produce acceptable results.
- Ensure that only one beam set to the element (s) of interest is active during the analysis.
- Need a constant rate of scanning; lay out intervals in angle iron for analysis – can now be done robotically.
- Need close contact with the surface of the core.
- Results:
  - Spot sampling struggles to give good data if there are large particles in the core (i.e. nugget effect); the time required becomes impractical.
  - Multiple scans along different surfaces give more repeatable results (better precision) compared to a single scan.
  - Some orientations of mineralisation in drill core cannot be adequately sampled using pXRF of the surface of drill core (i.e. high-angle veins)

FINELY DISSEMINATED CHALCOPYRITE IN DRILL CORE



Increasing accuracy



Increasing precision

(Modified from Arne 2018)

- Performance of pXRF spot versus 3x drag analyses has been evaluated by comparing pXRF grade estimates following calibration to laboratory assays; precision has been estimated using the coefficient of variation (CV).

CONCLUSIONS

- Decide whether you want quantitative or qualitative data from your pXRF and devise your program accordingly.
- Qualitative pXRF data are sufficient for obtaining data quickly in the field and modifying exploration programs “on the fly”.
- Quantitative pXRF data must be obtained for public reporting purposes – this is no trivial matter.
- In some circumstances it may not be possible to obtain representative compositional data from outcrop or drill core using pXRF due to an unfavourable distribution of commodity minerals and/or a nugget effect.

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