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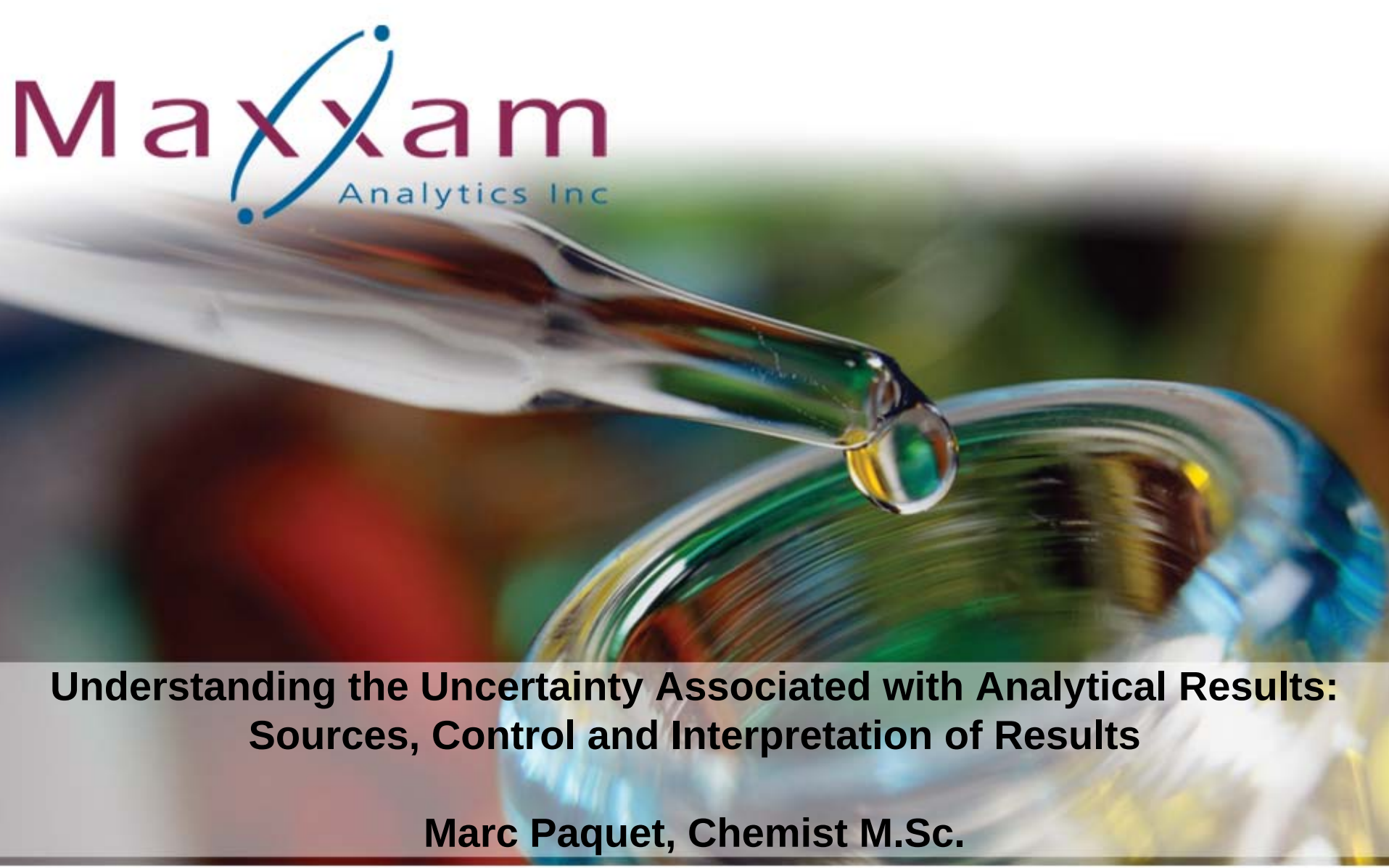

Understanding the Uncertainty Associated with Analytical Results: Sources, Control and Interpretation of Results

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Topics

- Misconceptions;
- Facts;
- FAQs;
- Sources of uncertainty;
- Controlling uncertainty;
- Result interpretation;
- Conclusion.

Misconceptions

- Quality of results is determined primarily by the analytical method chosen;
- Approved analytical methods are exempt of interferences;
- Laboratory accreditation guarantees quality results;
- Quality is only a laboratory concern;
- An analytical result is an exact and absolute value.

Facts

- Decisions made based on the interpretation of results may have important financial impacts;
- Generally, interpretation of results is limited to comparison to regulatory norms or criteria;
- Interpretation of results is usually performed by :
  - Different people;
  - Different qualifications (engineers, chemists, geologists, other);
  - Different professional experience.
- Assessment of the quality of results is limited to laboratory interpretation.

FAQs

- What impact will an erroneous result, a poor interpretation, and the uncertainty of a result have on decisions taken?
- How do I know if a result is accurate or not?
- What is the % uncertainty linked to a result (% error)?
- What factors can influence the quality of a result?
- What tools can I use to validate a result?

Sources of uncertainty

- **Environmental characterization program;**
- **All steps between sampling and reporting of results by the laboratory carry an uncertainty and may impact the quality of a result;**
- **The uncertainty associated with an analytical result corresponds to the sum of the uncertainties of all steps between sampling and reporting of results;**
- **An uncertainty can be present when interpreting results with the project history**

Sources of uncertainty

- Sampling method;
- Sample conservation (integrity);
- Sample homogeneity;
- Complex sample matrix (ex.: multiple phases);
- Pretreatment of water and soil samples;
- Sample contamination during sampling and transport;
- Laboratory analytical methods.

Sources of uncertainty

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Sampling

70 %

Sub-sampling

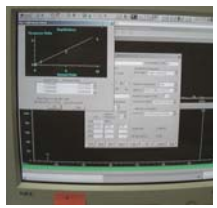
20 %

Calibration

5%

Instrument

4%



Interpretation

1%

Variance

Sources of uncertainty

Sources of uncertainty

Petroleum hydrocarbon analysis

Field : contaminated soil pile to be characterized = 20 metric tons

Field : soil sample for laboratory analysis = 500 grams

Laboratory : sub-sample = 10 grams

Extraction with 20 mL of solvent

Analysis : injection of 1 uL of extract in GC

In other words:
1 uL of extract represents 20 metric tons of soil

Controlling uncertainty

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During sampling :

- **Blanks (field, transport, etc.) :**
  - **Verification of risks of contamination attributable to each step of the sampling and transportation processes.**
- **Field duplicate :**
  - **Sampling reproducibility;**
  - **Degree of homogeneity of samples;**
- **Blind samples :**
  - **Homogenous samples of known concentrations submitted unknowingly to the laboratory. Permits the verification of laboratory bias.**

Controlling uncertainty

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Laboratory analysis :

- **Laboratory blank :**
  - **Verification of risk of contamination during each step of analytical method.**

- **Control sample / reference material :**
  - **Sample generally prepared by the laboratory and analyzed to verify the accuracy of the analytical method as well as the percent recovery.**

- **Certified reference material :**
  - **Sample prepared by a recognized external laboratory or organization and analyzed to verify the accuracy of the analytical method as well as the percent recovery.**

Controlling uncertainty

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Laboratory analyses :

- **Laboratory duplicate :**
  - **Verification of precision of analytical method and degree of homogeneity of a sample.**
- **Spike :**
  - **Verification of matrix effects and percent recovery of the analytical method. Addition of a known quantity of a specific compound to a sample that has already been analyzed.**
- **Surrogate :**
  - **Verification of percent recovery (organic analysis). Addition of a known quantity of surrogates (deuterium or carbon 13 labelled compounds) to each sample.**
  - **Ex. : benzene-d6, pentachlorophenol-13C6.**

Result interpretation

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Verification of quality control :

- **Knowledge of laboratory acceptability criteria;**
- **Verification of laboratory quality control results (blanks controls, duplicates, etc.);**
- **Verification of the laboratory MDL, MQL, and RDL;**
- **Verification of field blanks and duplicates;**
- **Verification of surrogates recovery.**

Result interpretation

Do the results make sense? :

- **Site environmental history;**
- **Sampling method;**
- **Nature of sample;**
- **Pretreatment of samples;**
- **Conservation of samples;**
- **Observed evidence of contamination during sampling.**

Result interpretation

Do the results make sense? :

- **Results are representative of potential sources of contamination on the site;**
- **Relationship between different parameters :**
  - **Petroleum hydrocarbons-PAH-BTEX;**
  - **COD-BOD-TSS;**
  - **Phenols 4-AAP - Phenols by GC-MS;**
- **Interpretation and comparison of results with quality control data;**
- **Interpretation of chromatograms (petroleum hydrocarbons).**

Conclusion

It is the project manager's responsability to determine the acceptability of the analytical data.