Equilibrium Environmental Inc

# Saturation Percentage and Texture Correlations

and

# SST Technical Manual

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# Acknowledgements


- **Petroleum Technology Alliance of Canada (PTAC)**

- **Technical Champions:**
  - **Linda Eastcott (Imperial Oil)** **Texture Correlations**
  - **Shawn Glessing (Cenovus)** **SST Technical Manual**

- **Other acknowledgements later in presentation…**

# Presentation Overview

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# Saturation Percentage and Texture Correlations

# Overview

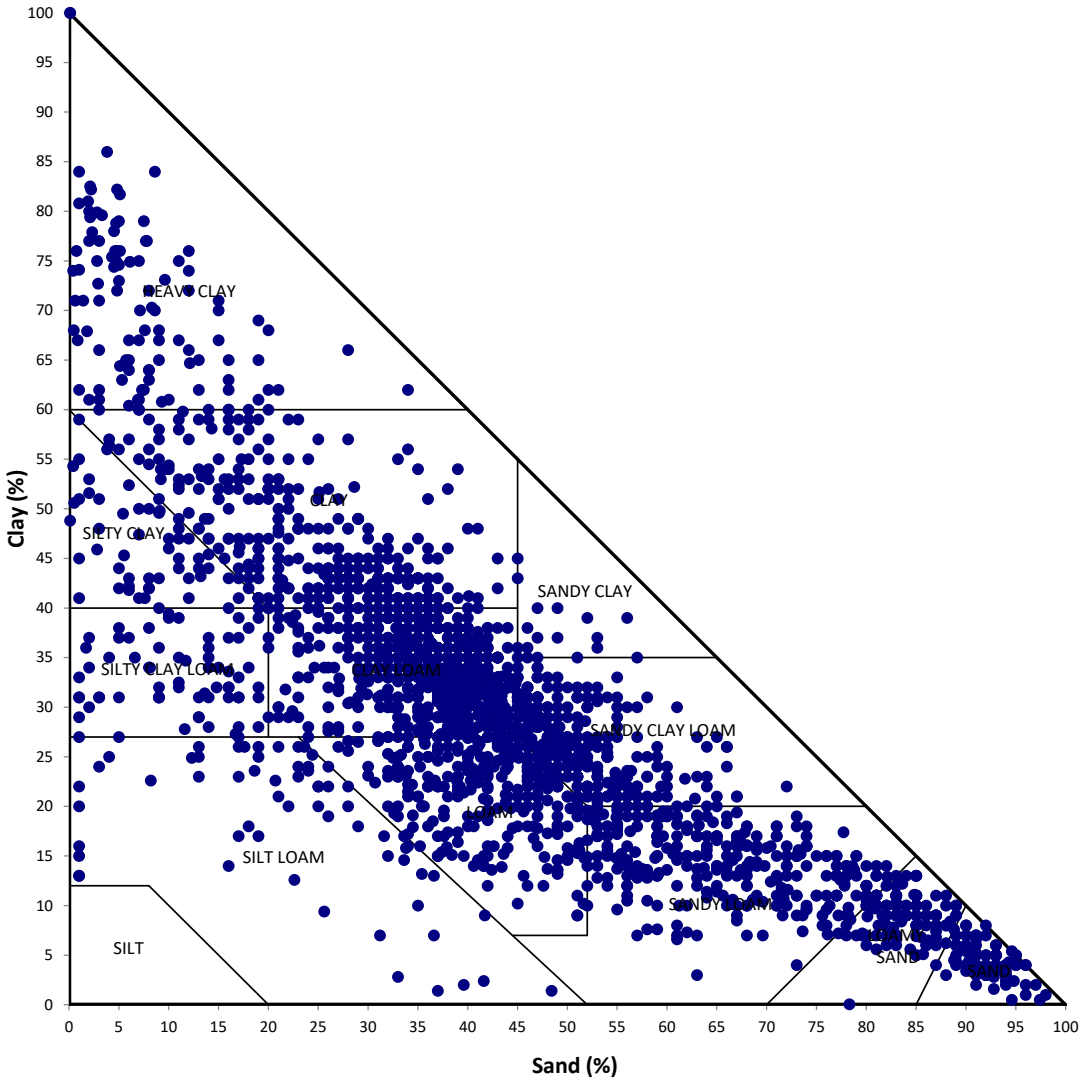
- **Soil texture an extremely important aspect of a Site CSM**
  - **Relevant to both vertical and lateral transport**
- **SST Version 2.5.3 and earlier were primarily based on hydrometer data (% sand, silt, clay) for overall texture**
  - **Clay content compared to 18% for overall texture**
- **Version 3.0 harmonized with Tier 1 guidelines, and defines overall texture via sieve data (% retained on 200 mesh)**
  - **Hydrometer data still required for SAR/sodium assessments**
- **Both types of texture data often have limited datasets**
  - **Useful to supplement via other methods (eg, saturation percentage)**
- **Saturation percentage a useful proxy for soil texture**
  - **Initial correlations with clay content studied in 2014 PTAC project**
  - **Further expanded here, with additional content on sieve data**

# High Level Data Review

- Data reviewed and compiled from >200 sites
  - Primarily Alberta, also Saskatchewan and Manitoba
- Approx 2855 datapoints with both saturation percentage data and either hydrometer or sieve data
  - 2570 datapoints from Alberta
  - 210 datapoints from Saskatchewan
  - 75 datapoints from Manitoba
- In Alberta, broad spatial coverage
  - W4M to W6M and Townships 1-124
- The ~2855 sat % datapoints correspond to:
  - Approx 2000 sieve datapoints
  - Approx 2300 hydrometer datapoints

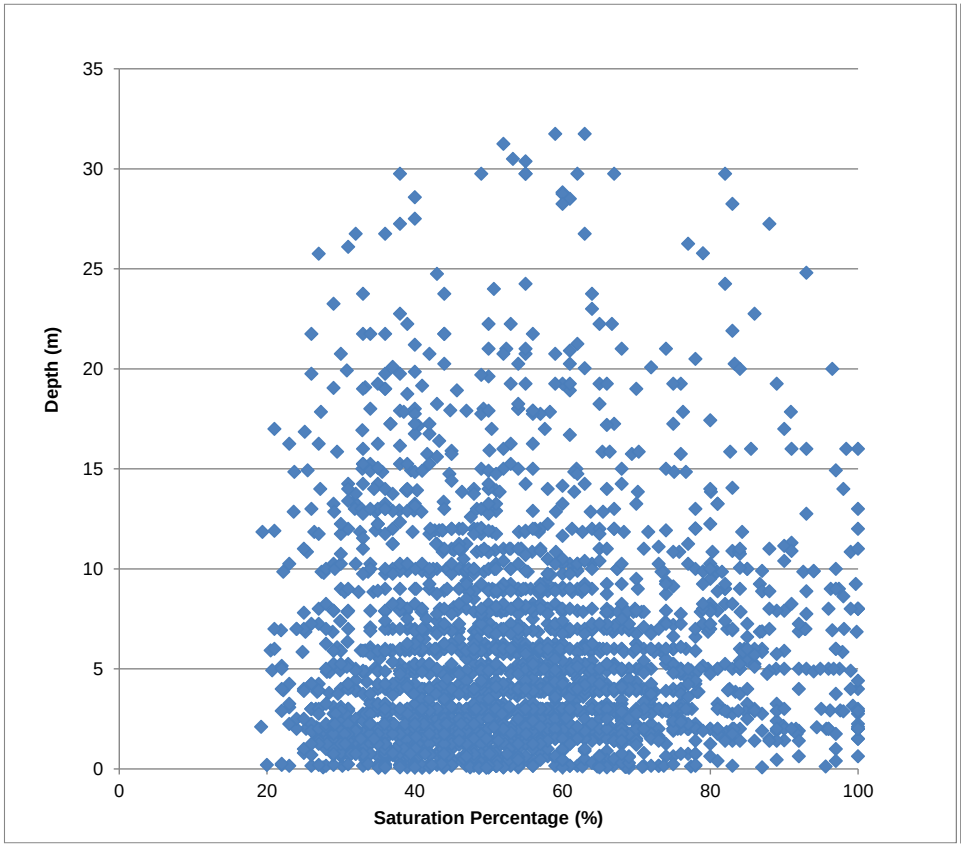
# Range of Hydrometer data

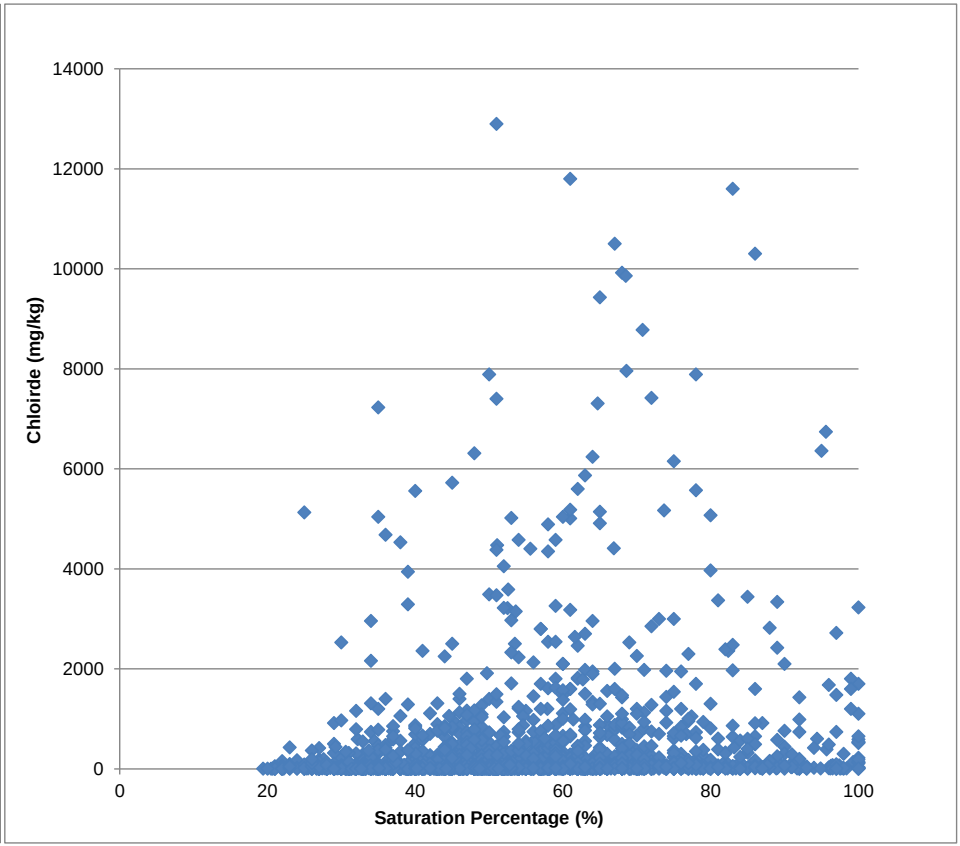
- All soil types represented, with exception of pure silt



# Correlation Examples

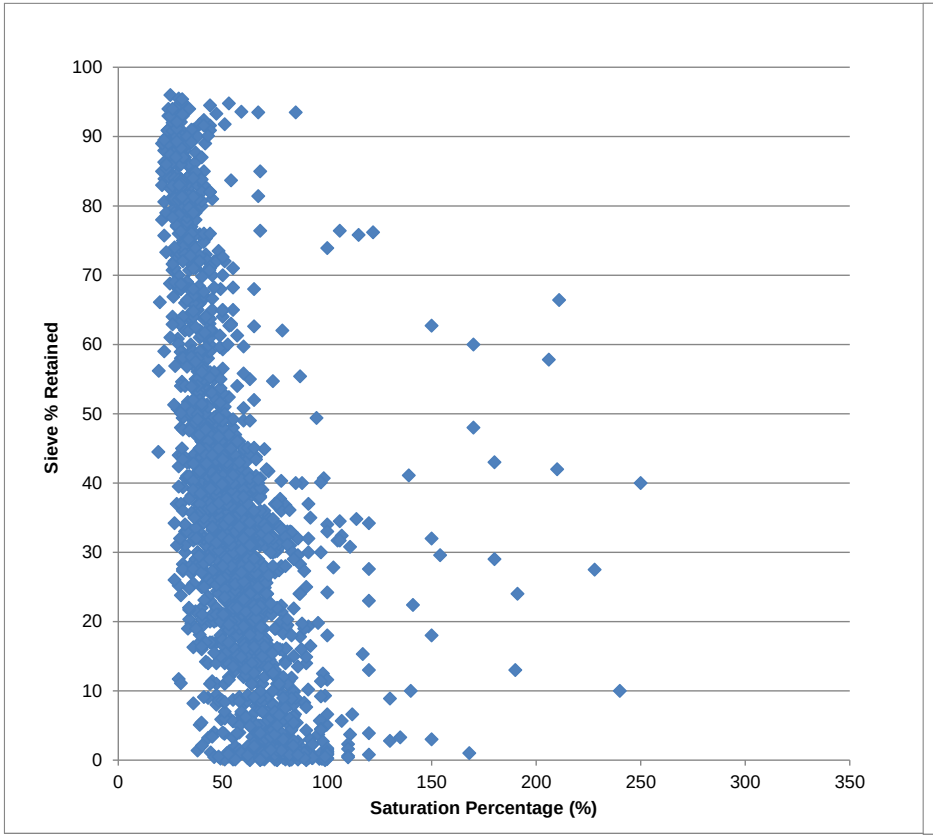
- **Depth and salinity effects**
- **Data uniformly distributed by depth, no clear influence**
- **Data uniformly distributed by chloride, no clear influence**
  - **Also no clear trend with SAR**
  - **Indicates no need to filter by depth or impact status**

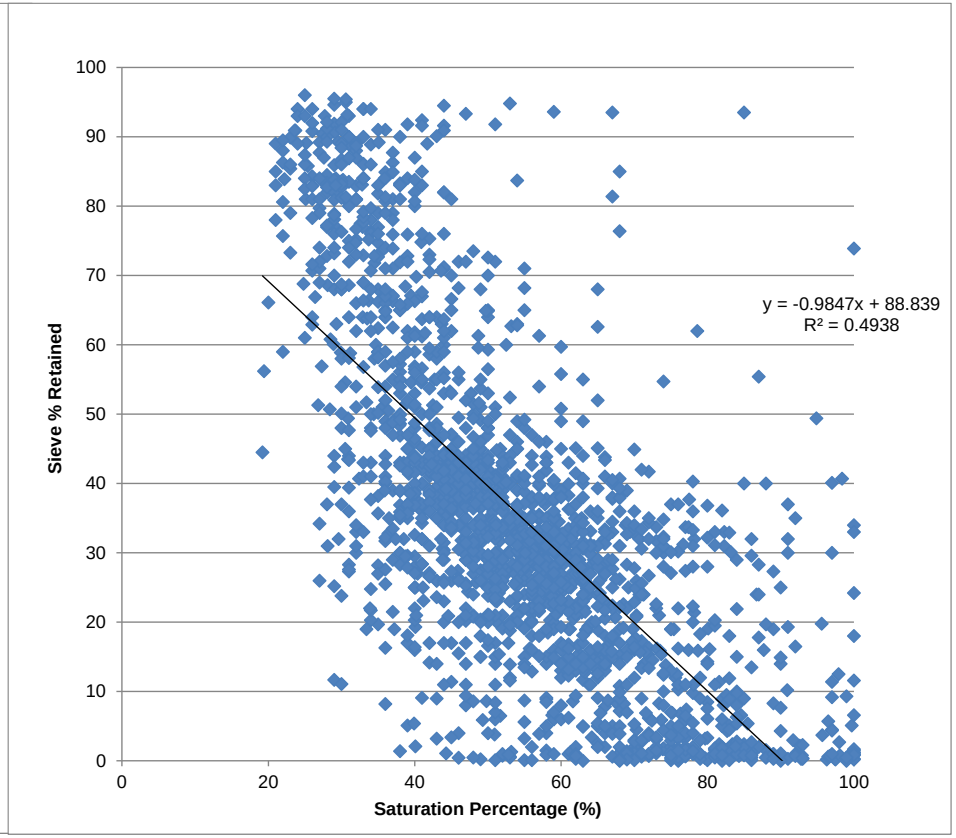


# Correlation Examples

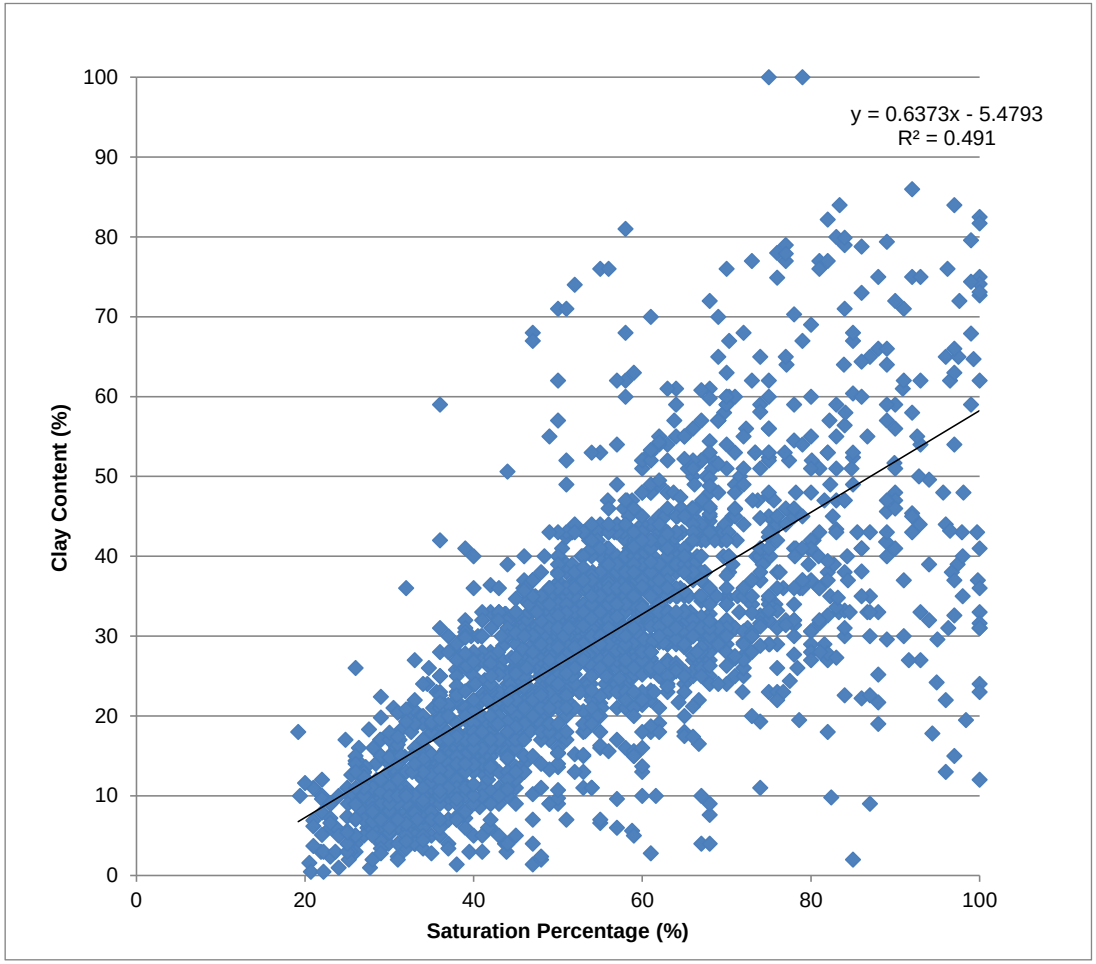
- **Sieve data (% retained) vs Saturation percentage**
  - Sat% >100% frequently indicate organic soils, poor correlation with texture data
  - Sat % values >100% excluded in graph on right
- **Definite trend of higher % retained with lower sat %**
  - Indicates coarser soils
  - $R^2$ value approx 0.49



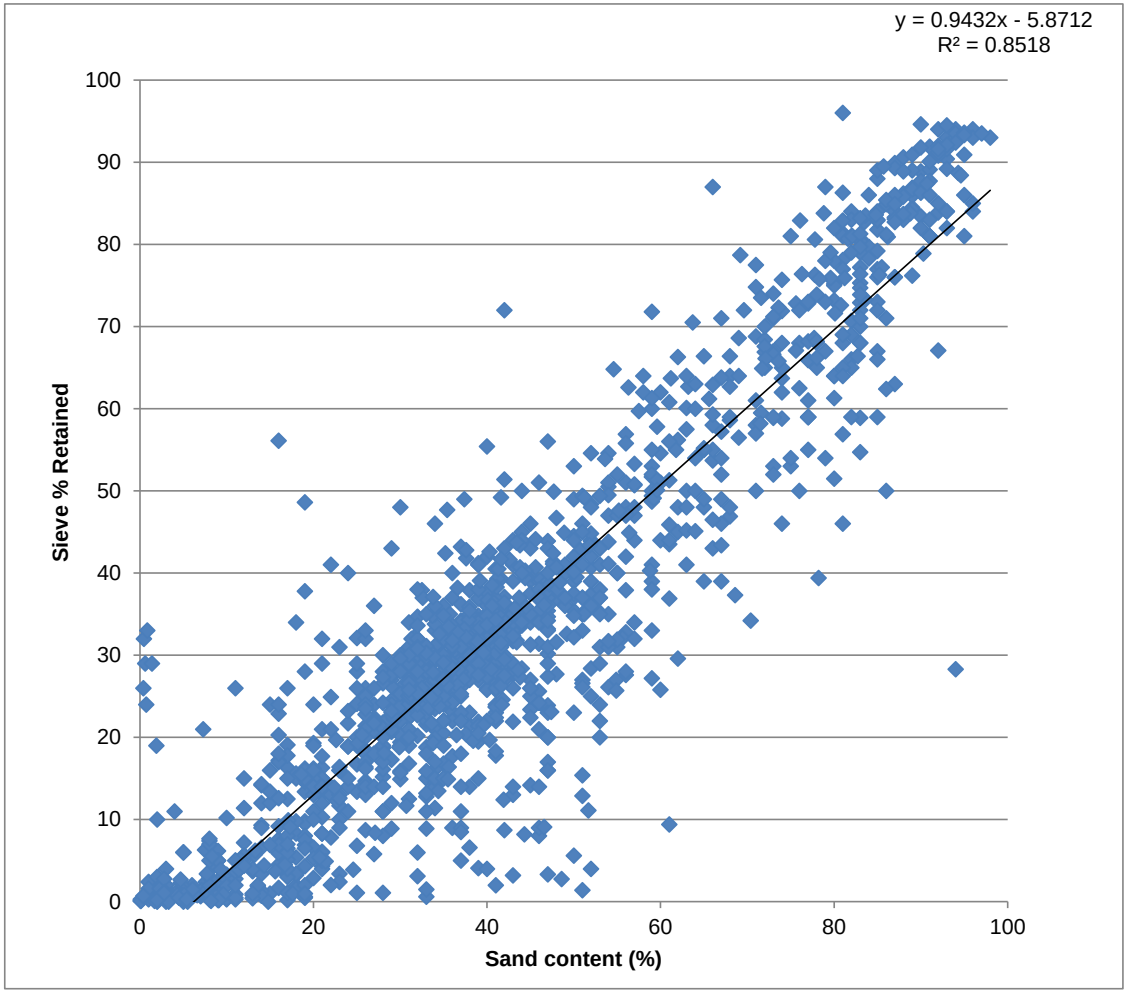
# Correlation Examples

- **Clay content vs Saturation percentage**
- **Trend of higher saturation percentage with higher clay content**
  - **Excludes sat % values >100%, similar $R^2$ value as for sieve data**
  - **Similar shape to regression from 2014, but with larger dataset**



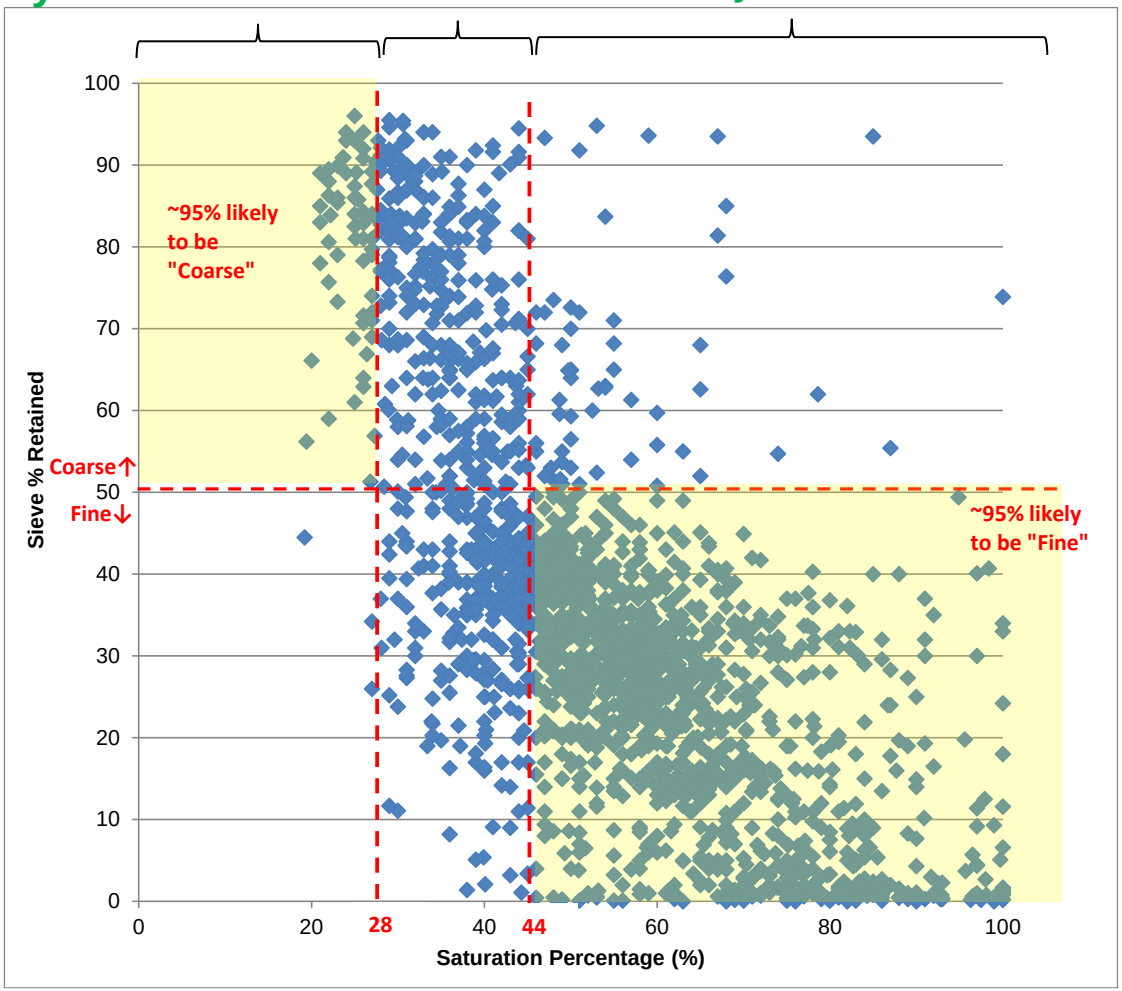
# Correlation Examples

- **Sieve data (% retained) vs Sand content**
- **"Sand" by hydrometer is >50 um, whereas % retained (sieve) is >75 um**
- **Strong correlation between the two ($R^2$=0.85) despite the different size**



# Statistical Relationships

- **Sieve data (% retained) vs Saturation Percentage**
- **Based on preliminary analysis, can assign ranges for saturation percentage values where 95% likely to be "Coarse" or "Fine" by sieve**



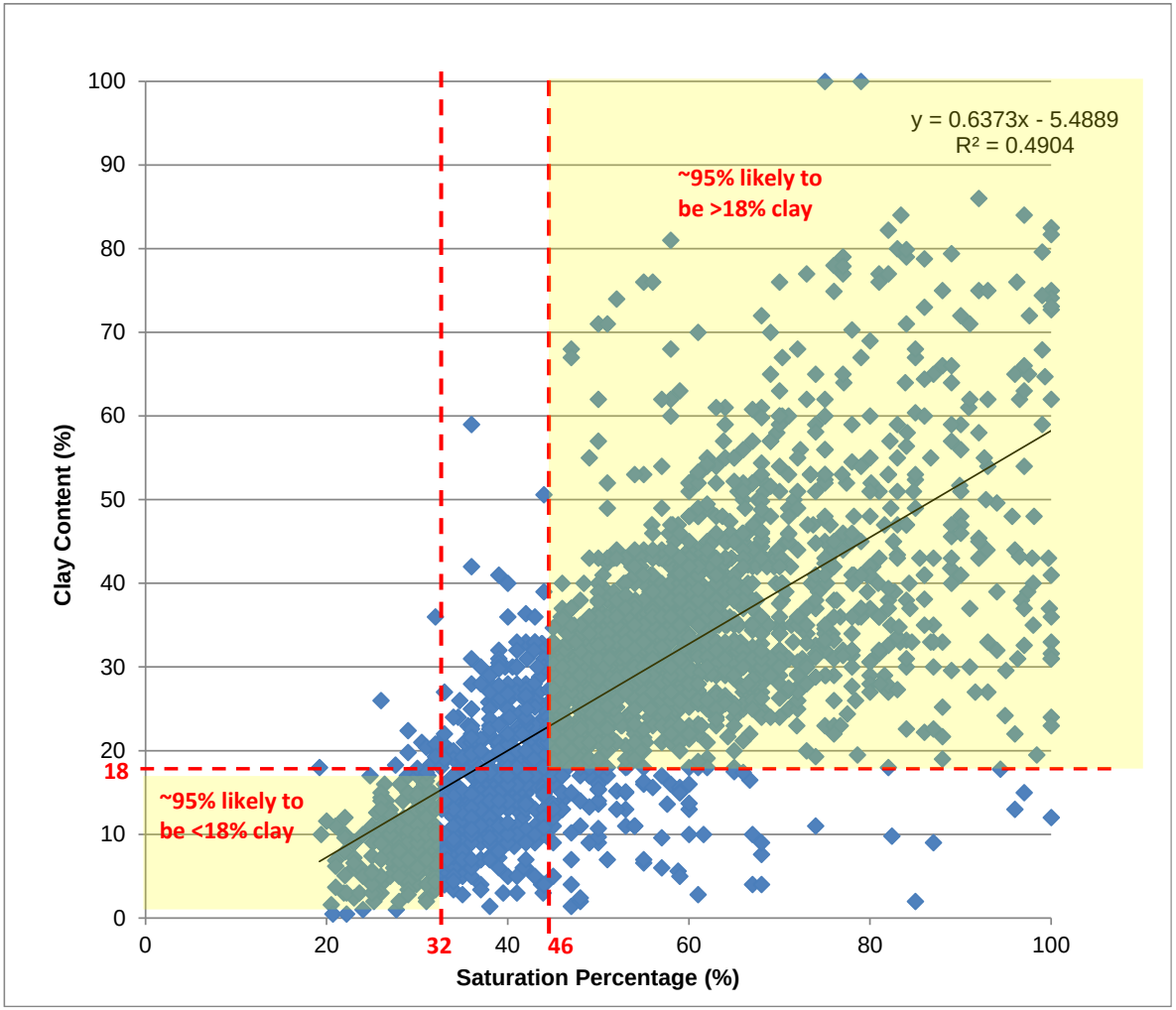
# Statistical Relationships

- <u>Clay content vs Saturation Percentage</u>
- Can also assign updated ranges for sat percent values where 95% likely to be <18% Clay (“Low”) or >18% clay (“Medium” or “High”)

<32% for ‘low clay’

>46% for ‘medium’ or ‘high clay’

- Relevant to SAR/sodium in SST Ver 3.0
- Fairly similar ranges to previous dataset from 2014



# Database Power-up!!!

**Ref:** ***The Mighty Hercules*, 1963**

# Expanded Database

- **Larger industry-sourced database from different PTAC project was provided for further evaluation of saturation percentage and texture trends**

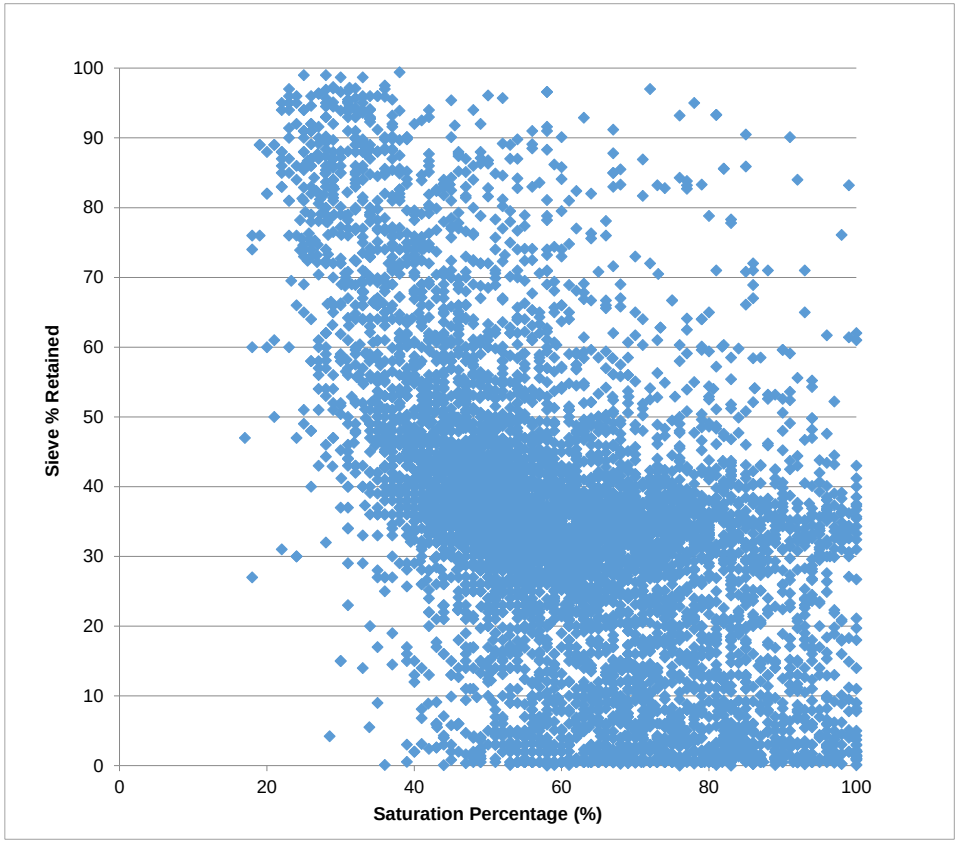

- **Acknowledgements:**
  - **Tyler Prediger (Matrix Solutions)**
  - **BP**
  - **Cardinal Energy Ltd.**
  - **Cenovus Energy Inc.**
  - **CNRL**
  - **Crescent Point Energy**
  - **Murphy Oil Corp.**
  - **Orphan Well Association**
  - **Whitecap Resources Inc.**

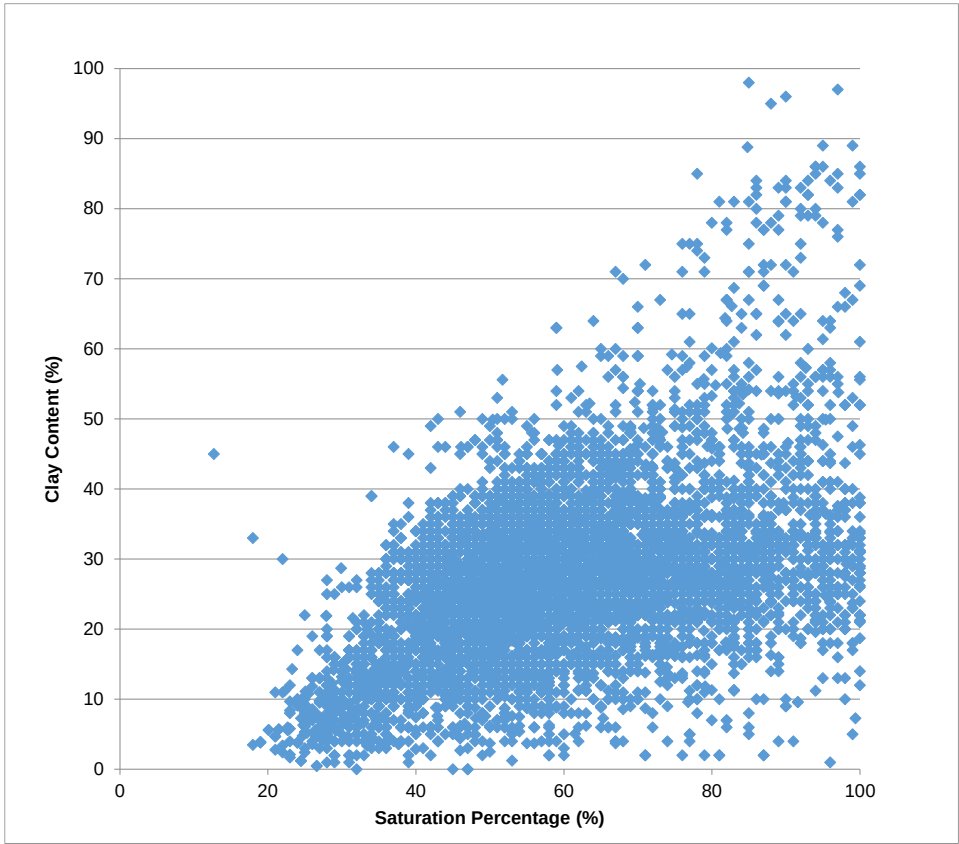
# Expanded Database

- Additional data reviewed and compiled from ~980 sites
  - Alberta and Saskatchewan
- Approx 10,200 datapoints with both saturation percentage data and either hydrometer or sieve data
  - Approx 8,020 sieve datapoints
  - Approx 7,800 hydrometer datapoints
- So approximately 3.5 to 4-fold larger than original dataset

# Correlation Examples

- Similar trends between original database and expanded database
  - Lower % retained with higher sat %
  - Higher % clay with higher sat
- Somewhat more scatter in expanded dataset than original dataset
  - Potentially due to broader geographical, lab, and date ranges



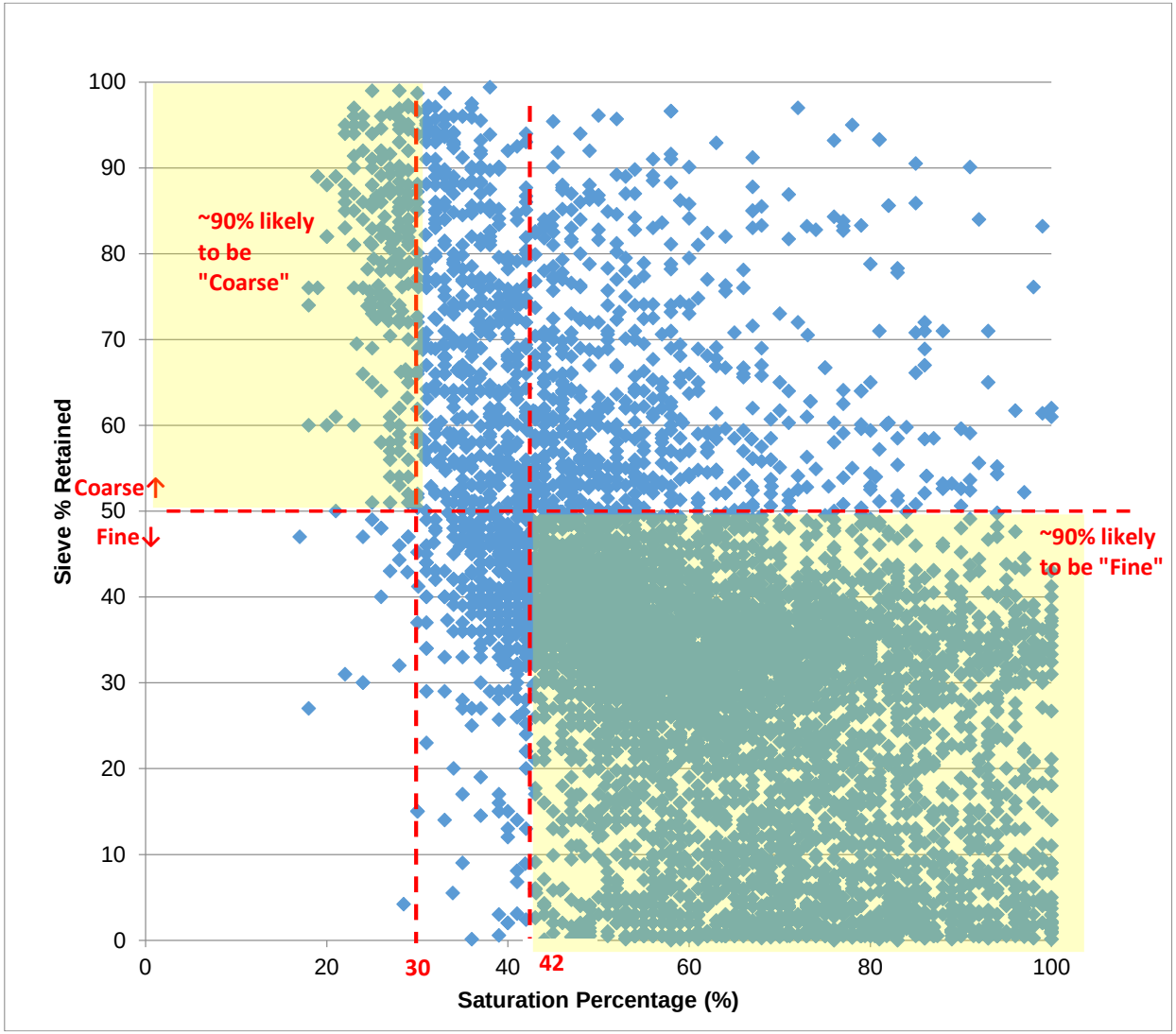



# Results and Conclusions

- Generally similar results with expanded database

- Seems more practical to target 90% confidence for sieve data, compared to 95% confidence for hydrometer data

- Overall, sat % data allows very useful inferences about texture, both by sieve and hydrometer



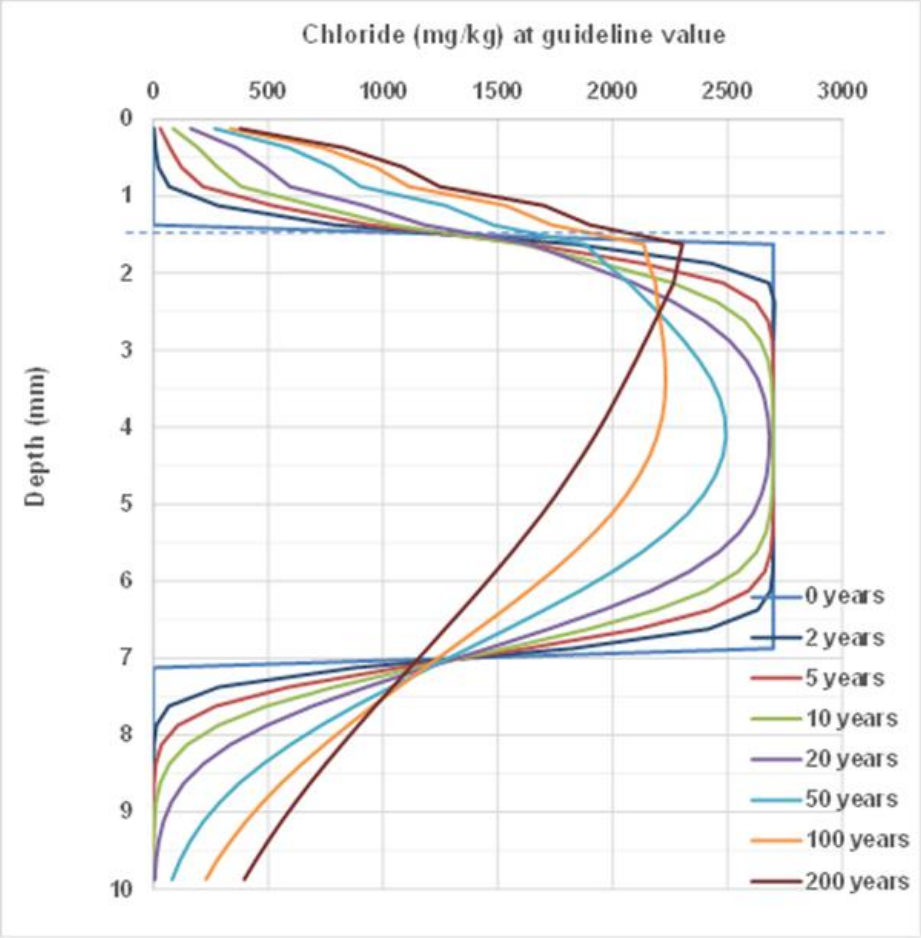
# SST Technical Manual

# Overview

- Subsoil Salinity Tool (SST) Ver 3.0 was released with the Version 3.0 "User Manual", which represents an update from the "Help File" from Ver 2.5.3 and prior
- Due to the increasing amount of information, certain supporting technical details were excluded from the "User Manual" to be included in the "Technical Manual"
- Will include additional details and topics such as:
  - Climate and evapotranspiration
  - Moisture balance, drainage rates
  - Chloride modeling assumptions and techniques
  - Water table modeling and effect on vertical transport
  - Sodium modeling assumptions and techniques
  - Effects of SAR on hydraulic conductivity

# Example Topic: Chloride Transport Progression

- **Discussion provided of the internal modeling of chloride**
  - **Progression of depth profiles, starting from a square wave**
  - **Example of 1.5-7 m impact depth shown below over 200 years**



# Example Topic: Sodium Transport

- Additional modeling was performed for Version 3.0 using LeachC for sodium transport and influence on SAR
- Also considered transport and background concentrations of other relevant cations (calcium, magnesium)
  - All cations play an important role in SAR effects and sodium transport
- Discusses algorithm to estimate Ca+Mg based on EC, SAR, and saturation percentage
  - Used extensively in the sodium transport modeling
- Discusses correlations between factors such as transport distance and soil texture (based on clay content for cation exchange) to predict sodium transport from chloride data

# Example Topic:
# Water Table Depth vs Upward Transport

- **Additional modeling performed in Ver 3.0 with deeper water table to evaluate upward chloride migration**
  - **Deeper water tables have reduced risk of upward salt transport**
  - **Based on reduced diffusion through unsaturated soils (increased tortuosity), can be modelled with analyzed in LeachM**
  - **Implemented in Version 3.0, results in more lenient root-zone guidelines with deeper water tables, particularly when in recharge conditions and coarse soils**

# SST Course and FAQ

**3.5-Day Full Certification Course [ON-LINE]**

**Fall 2023** **(recently completed)**

**Spring 2024** **(**April, dates TBD**)**

**SST Frequently Asked Questions (FAQ)**

**Location where common SST technical questions will be answered, in some cases after vetting by AER/AEP**

**For further information:**

**Visit our webpage at www.eqm.ca**

**Or contact SSTinfo@eqm.ca**

**Or visit our LinkedIn page**

# Thank you!

**SSTinfo@eqm.ca**