RemScan® by Ziltek

Infrared Spectroscopy for In-Field Analysis of TPH in Soil and Beyond

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Ziltek

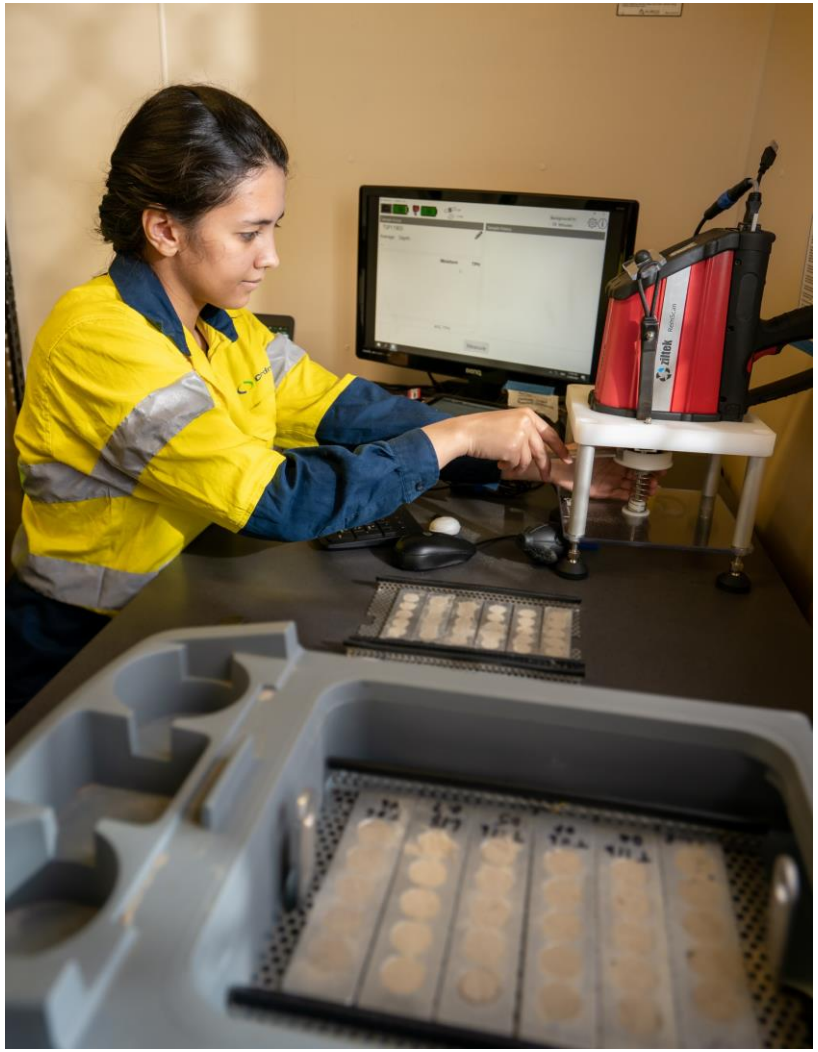
- Ziltek founded in 2008 by Dr. Richard Stewart
- Located in Thebarton, Adelaide
- Ziltek commercialised CSIRO patented technology
- Measurement of total petroleum hydrocarbons (TPH) in soil with mid Infrared spectroscopy
- RemScan was developed
  - Handheld MIR spectrometer (Agilent 4100/4300)
  - Field kit
  - Lab stand
  - Drying box
  - Calibration service
  - Training
  - Support

Benefits of RemScan

- On the spot results in under 20s
  - Make decisions in real time
- Measure multiple parameters at once
  - Spectra are information rich
    - TPH + moisture + soil texture
- Nil incremental cost of measurement
  - Make more measurements → increase confidence
- Non destructive
  - Retain sample for lab analysis / rescan
- Correlated to metadata
  - GPS location
  - Time/date
  - Operator
  - Analysis method
- Secure and auditable
- Indelible record of sample
  - Re-evaluate at any time using latest methods

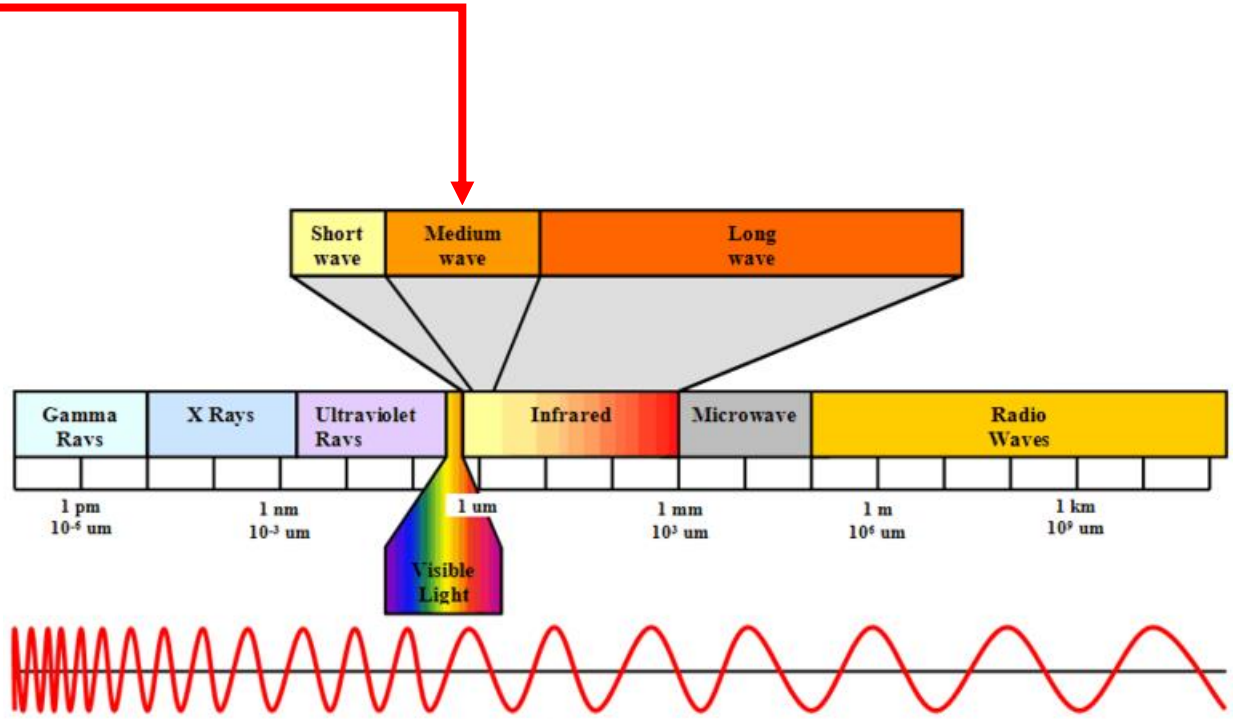
Ziltek

- Process control tool for TPH remediation
- Compliments laboratory analysis
- Many Customers
  - Oil companies: Chevron, Shell, Total, Sinopec
  - Analytical Labs: ALS Malaysia
  - Mining: FMG, Alcoa, Roy Hill
  - Environmental/Waste: Cardno, Envisol, Suez, SAES, PolyEco, AECOM, DEME
  - Universities: RMIT, Melbourne Uni, Concawe, Jan Evangelista Purkyně University
  - Government: UN Italy, UN Congo, Indonesian Government
- RemScan has been use to remediate soils/sites from all over the world



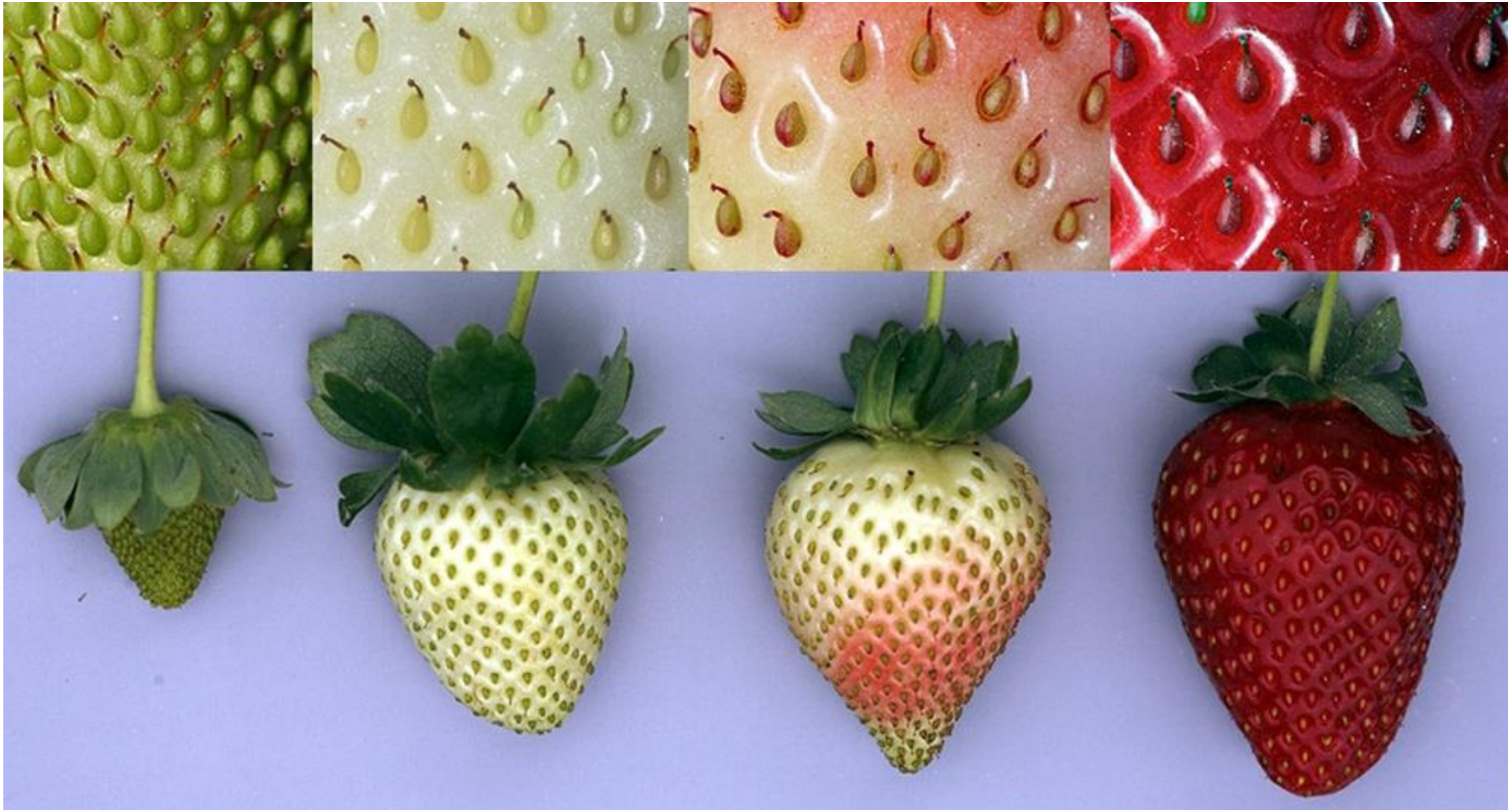
MIR Spectroscopy

- Mid infrared light = long wavelength light, 2-20 μm
- Causes molecular bonds to vibrate
- Reflected light from samples is missing certain colours
- Record of the reflected colours is a spectrum
- Spectra tell us what substances are in a sample
- Spectra + lab measurements can be turned into calibrations



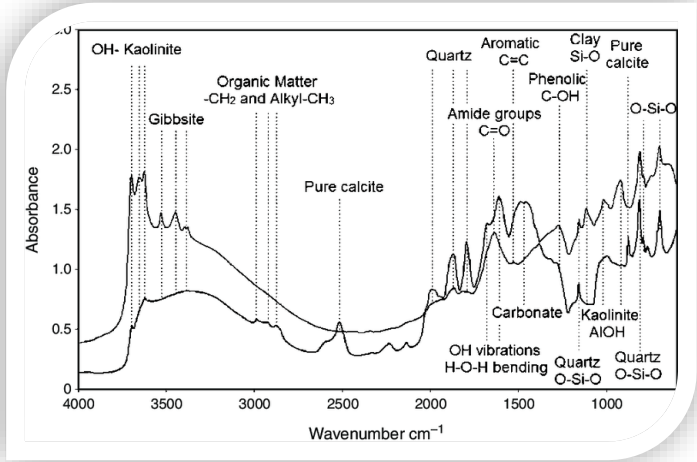
RemScan®

RemScan®



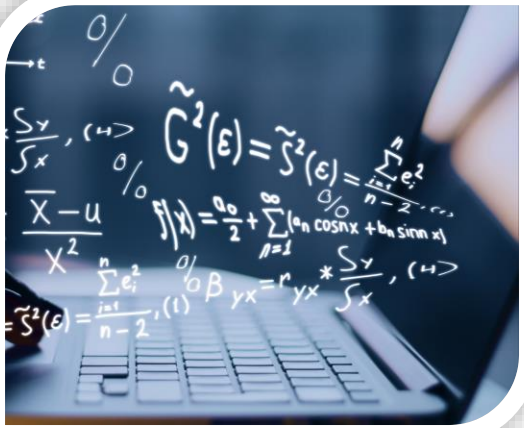
MIR Scanning

Identification

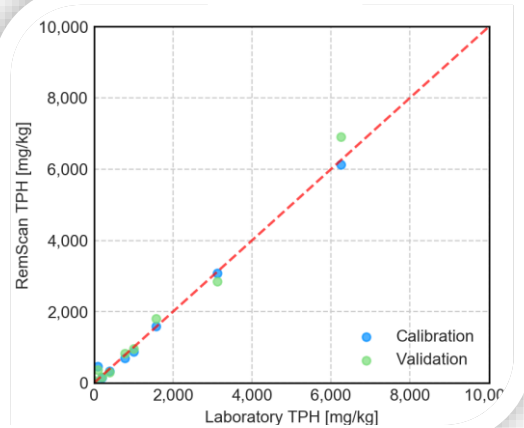


Laboratory Assay

Mathematics



Calibration



Site Specific Calibrations

- Prior to use RemScan must be calibrated
- Site specific calibrations provide the greatest accuracy
  - LOD as low as 50 mg/kg
  - Dependant on soil type, heterogeneity, interfering species (SOC, carbonate)
  - May require ongoing monitoring
- Collaborative process between customer and Ziltek

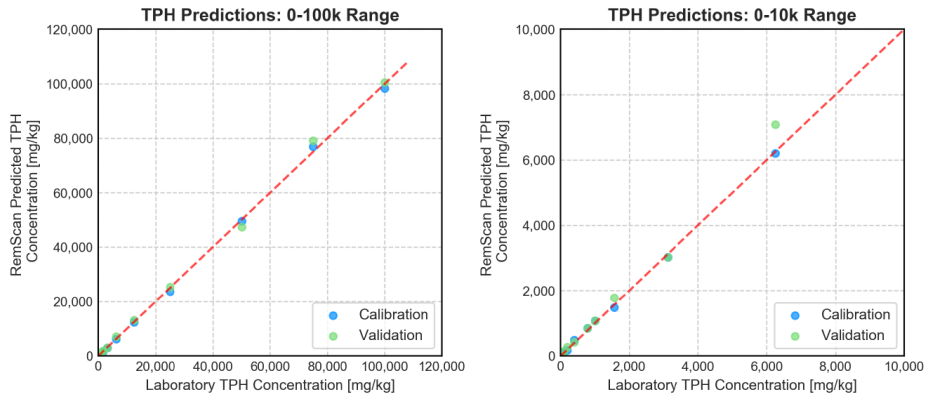
Site Specific Calibrations

- Customer
  - **Sampling** – guided by Ziltek staff
  - **Spiking** – Ziltek procedure
  - **Scanning** – with RemScan
  - **Send** – data to Ziltek
- Ziltek
  - **Analysis** – Determine the number of calibrations required
  - **Calibration** – Optimised cascaded PLS
  - **Report** – Regression statistics
  - **Monitoring** – Ongoing support to ensure the calibrations remain relevant

Calibration Report for Light Clay

Sub-Model	Model Cutoff	Samples	Spectra	PLS Factors	RMSECV (mg/kg)	r^2_{CV}	RMSEP (mg/kg)	r^2_P
1	100,000	14	115	2	802	0.999	1,224	0.999
2	50,000	12	105	2	384	0.999	895	0.998
3	20,000	11	100	2	553	0.995	576	0.99
4	12,000	10	95	2	82	1.0	286	0.99
5	6,000	9	85	2	50	0.999	160	0.998
6	3,000	8	75	2	68	0.997	139	0.99

Limit of detection: 46



RMSECV: Root mean square error for Cross-Validation
RMSEP: Root mean square error for Prediction

$$RMSE = \sqrt{\frac{\sum(x_i - \hat{x}_i)^2}{N-1}}$$

Light Clay Demo, Friday 27th August, 2021

Universal Calibration

- Small spills don’t justify calibration setup time/cost (2-3 days)
- Need an “out of the box” calibration solution
- We developed a Universal calibration marketed as “Spill Response”
- Short setup time (<1 hour)
  - Representative clean soils are scanned to establish a site baseline
  - Site details are saved in software
  - Return visits require no further setup
- Fast results → Fast decisions

Regional soil sampling guided by CSIRO

- >200 samples
- Sourced primarily from Victoria
- Some South Australian samples

Customer Site Specific Data

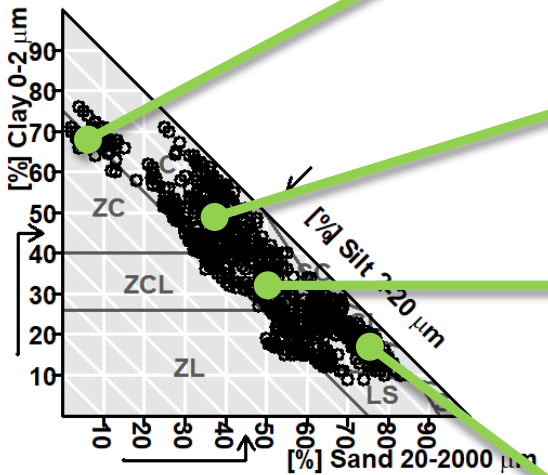
- International soils
- Screened for quality and suitability

In-house generated data

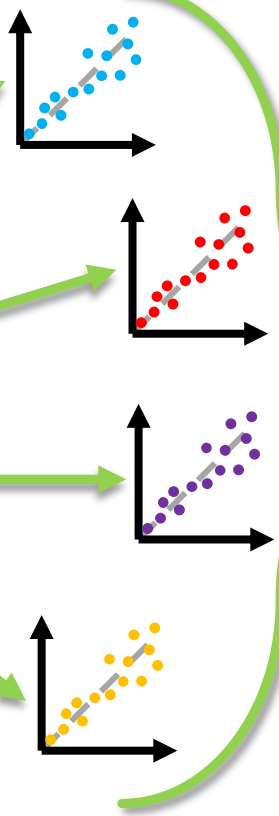
- Soil collection campaign
- Several soils added per month
- Looking to increase rate

Dilution series produced from samples

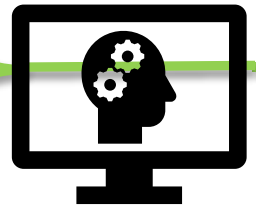
- Scanned on RemScan
- >10,000 spectra



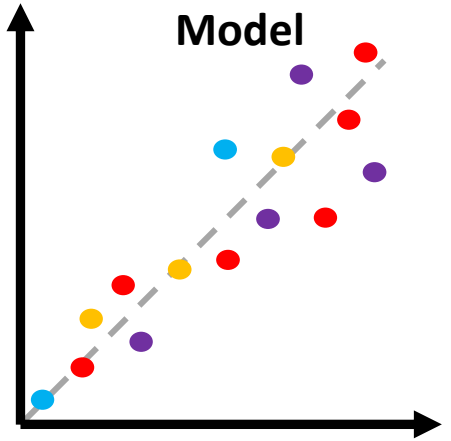
Broad variety of soil lithologies



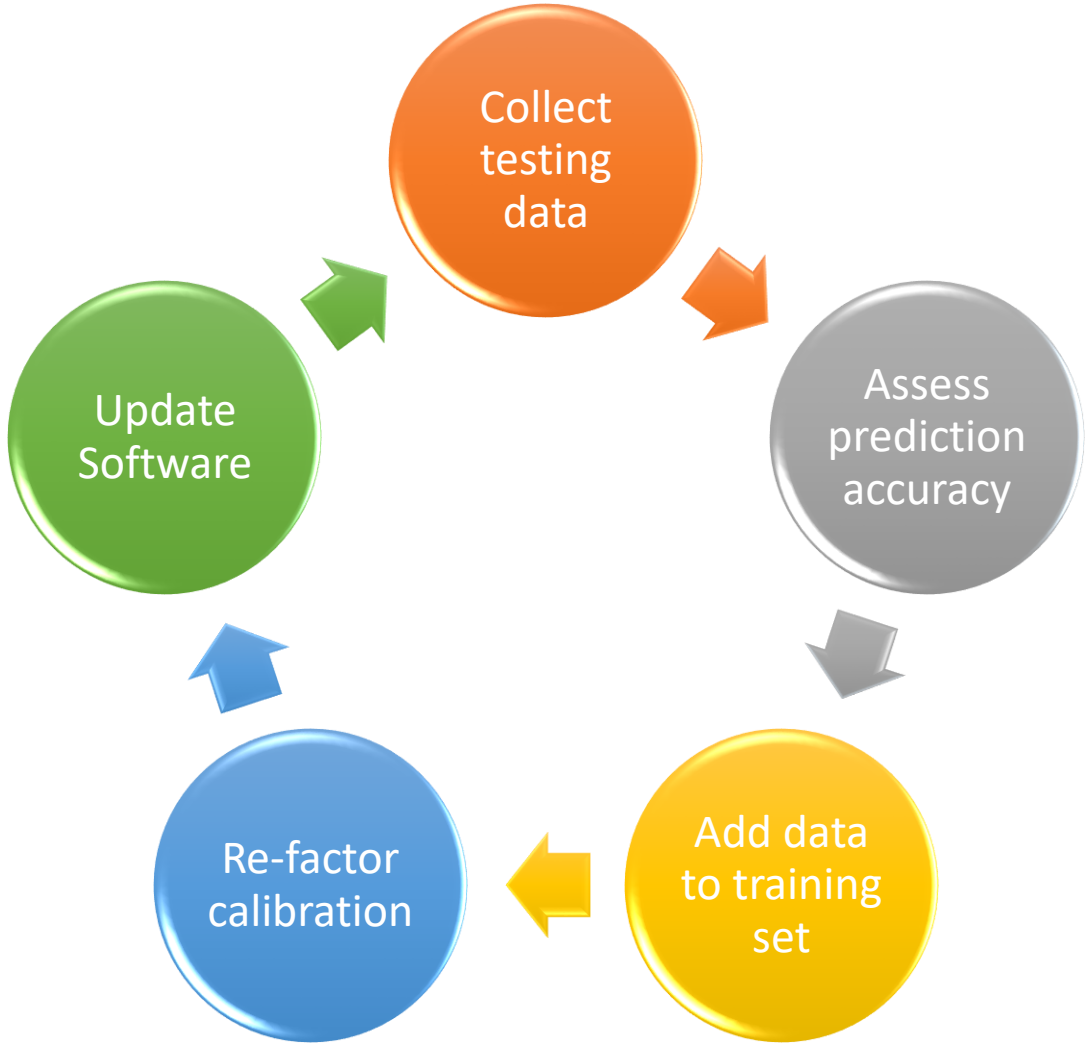
Machine Learning applied to dataset



Universal Calibration Model



Continual Improvement



Spill Response – Trial

- Suspected leaky pipe between waste oil hopper and storage tank
- Area was a steep, clayey slope with a small amount of vegetation and damp from rain
- Site baselining ≈10 min
- Samples collected
  - Jar samples for later lab analysis
  - Scanning samples
    - Dried on sample slides ≈30 min
- Dried samples scanned
  - Contamination results obtained
- Entire job completed in ≈3 hours
- Lab assay turn around ≈3 days
- Lab and RemScan results in agreement!

Where to now?

- Ziltek are leaders in in-field TPH measurement of soil
- Looking to expand the capabilities of RemScan / enter new markets
- Precision agriculture and soil carbon sequestration show potential
  - Scientific literature
  - Climate change
  - Food security
  - Water usage

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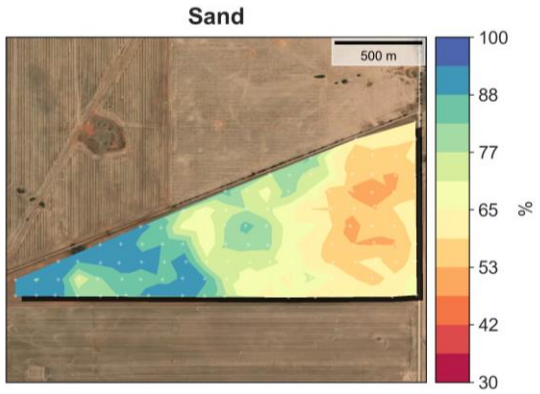
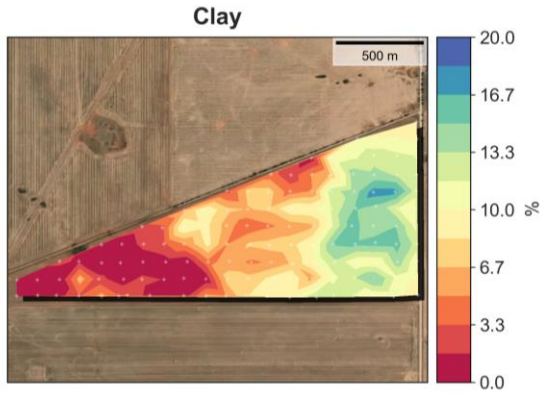
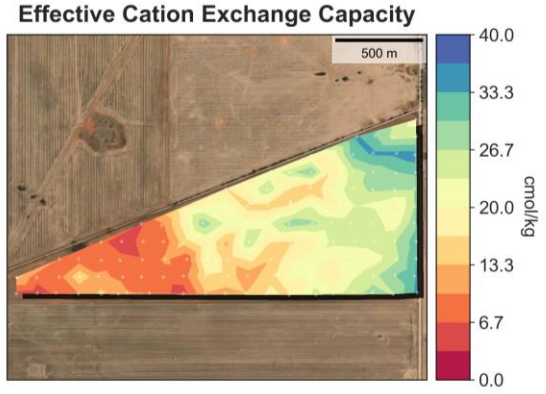
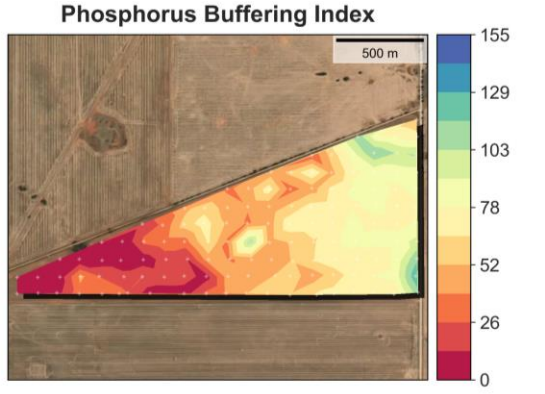
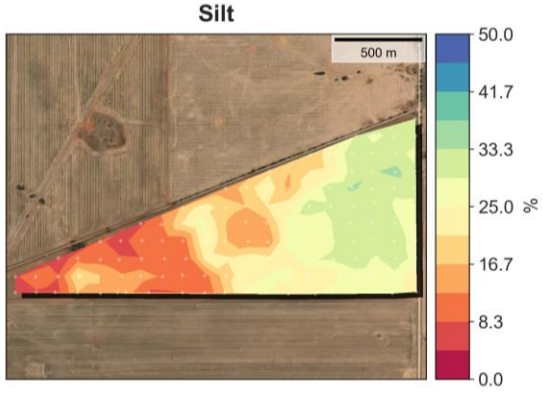
Agricultural Field Trial Results

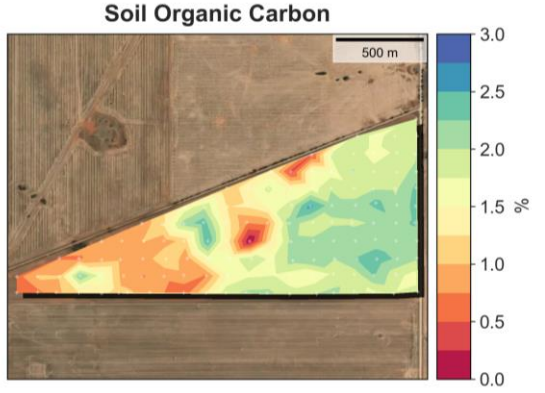


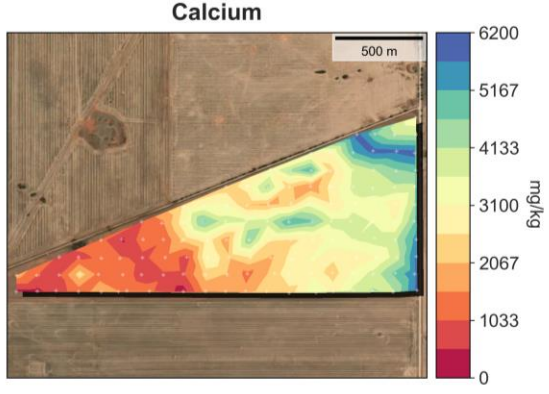


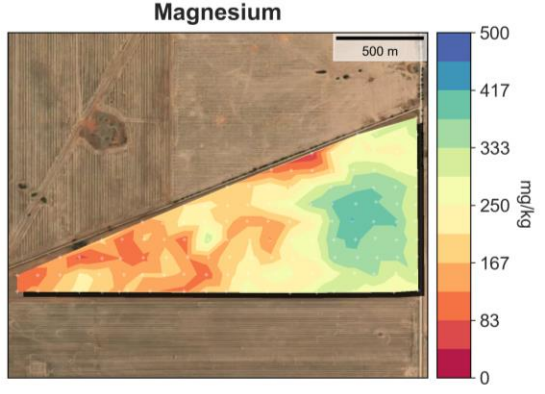


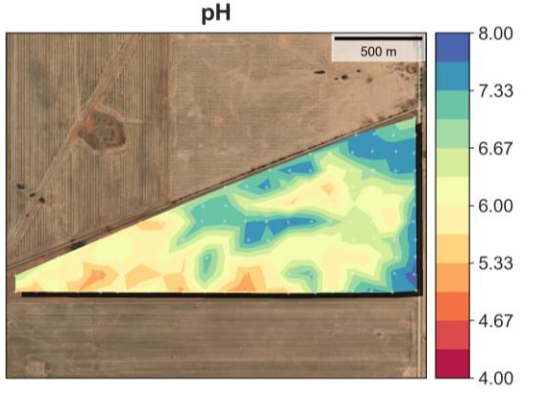


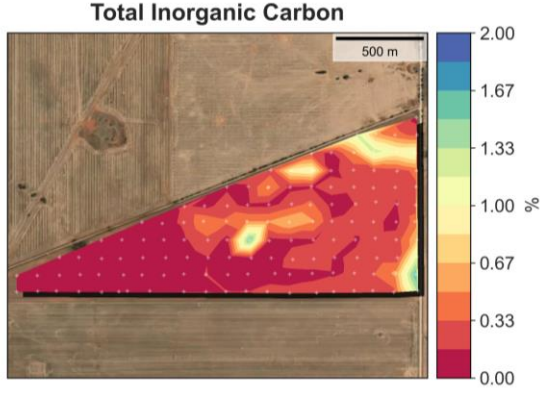


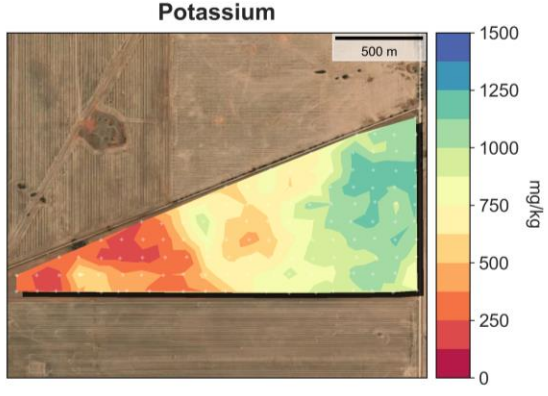


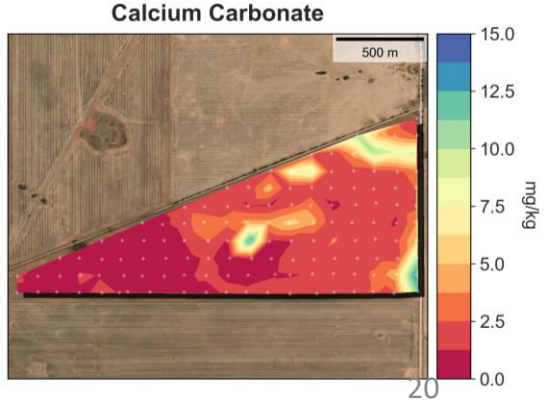












Thanks for listening

Questions welcome

Contact→