Objective 1

Geochemistry

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Scope

Objective 1

1. Aims
2. Approach
3. Introduction to mine drainage chemistry
4. Summary of West Coast work
5. Preliminary results from Southland
6. A look forward

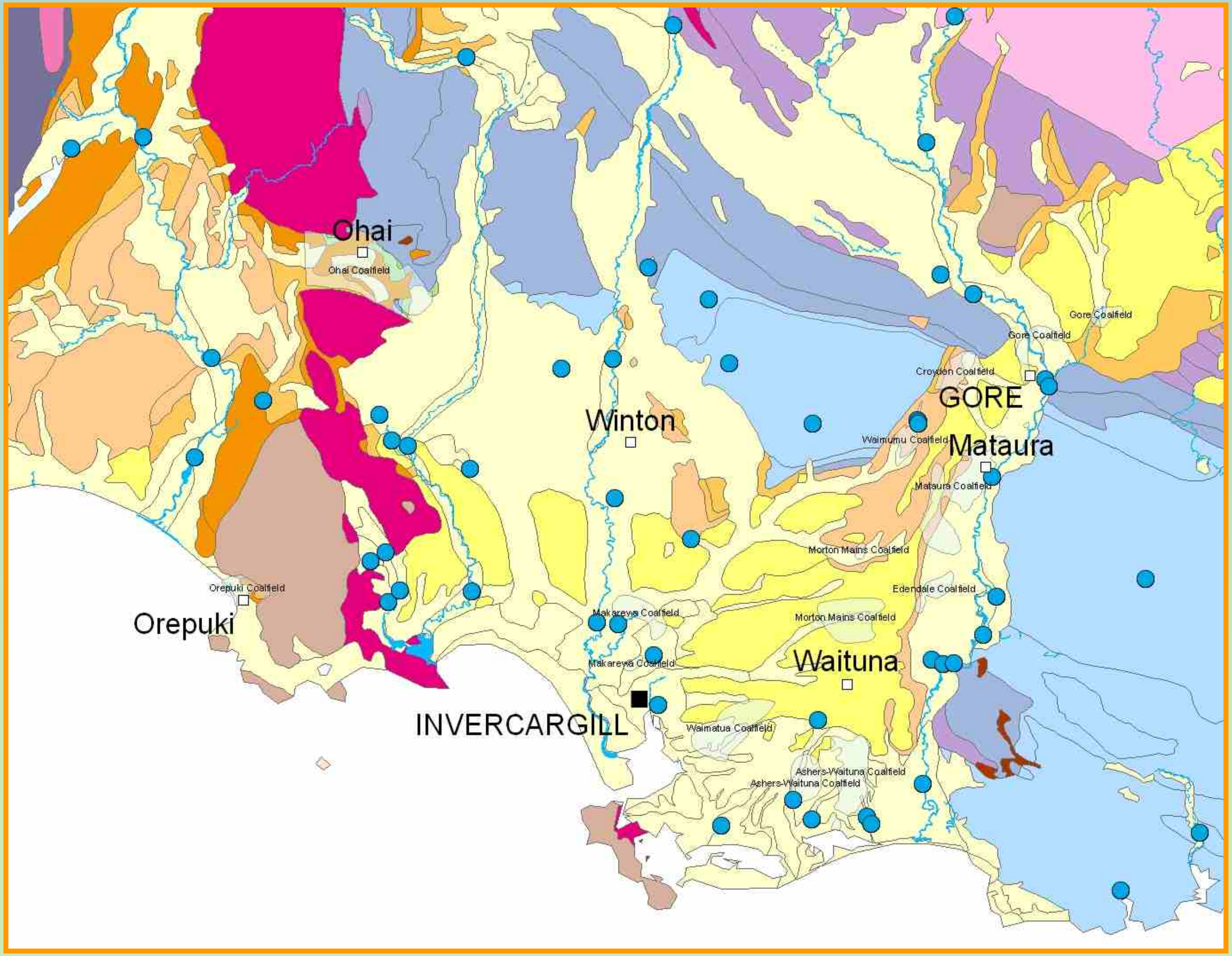
1 Aims

- Identification of the risks to water quality posed by mining in different areas
  - Targeted outcomes
    - Assessment our predictive ability
    - Identification of factors that influence mine drainage chemistry
    - Assessment of geological and other risks
      - Construction of risk module
      - Minimum analytical suite for impact assessment

2 Approach

- Data compilation
  - DAME - Database for Assessment of Mine Environments
    - Water quality – many sources, many parameters
    - Rock geochemistry
    - Sediment geochemistry
- GIS Integration
    - Geology
    - Topography – Land use information
    - GERM
- Split into Coal and Gold mine drainage

Water Quality sites in Southland



3 Mine Drainage Chemistry

- Highly variable
  - AMD, NMD, trace element enrichment
- Processes
  - Pyrite oxidation
    - $FeS_2 + 3.75O_2 + 3.5H_2O = 2SO_4^{2-} + 4H^+ + Fe(OH)_3$
    - At Low pH Fe^{3+} is an oxidant
  - Other sulphide oxidation
    - $ZnS + 2O_2 = Zn^{2+} + SO_4^{2-}$
    - $FeAsS + 3.5O_2 + H_2O = Fe^{3+} + HAsO_4^{2-} + SO_4^{2-} + H^+$
  - Biologically catalysed

Mine Drainage Chemistry ctd.

- Reaction between AMD and host rock
  - Neutralisation
    - $MCO_3 + H^+ = M^{2+} + HCO_3^-$ (M = Ca or Mg)
  - Release of other components, Al
    - $KAlSi_3O_8 + 2H^+ + 6H_2O = K^+ + 3H_4SiO_4(aq) + Al^{3+}\ 2OH^-$
- Trace elements usually controlled by sulphide mineral composition
- Acidity related to total sulphide content, rock mineralogy and other factors

West Coast Mine Drainage

Predicting Mine Drainage Chemistry

- First Pass = Acid Base Accounting (ABA)
  - Total acid forming components – Total acid neutralising components
  - Maximum Potential Acidity (MPA)
  - Acid Neutralising Capacity (ANC)
  - Net Acid Production Potential (NAPP)
    - MPA – ANC = NAPP
  - Net Acid Generation (NAG)

Predicting Mine Drainage Chemistry

- Follow Up = Kinetic testing
  - If potentially acid forming rocks are identified
    - How much acid (pH, Fe, Al)
    - How quickly does it form
    - Trace element content
    - Changes in composition with time
  - Variety of leaching tests
  - Variety of scales, lab and field based
  - Trial management and remediation options

Mine Drainage Chemistry Summary

- Highly variable
- Reactions of mined rock with O_2 and H_2O well understood
- Can predict some problems with analysis of rock disturbed by mines
- Environmental conditions make precise prediction of mine drainage chemistry difficult
- Difficult to manage and rehabilitate

4 Summary of West Coast Work

- Results of Data compilation – West Coast
  - Hotspot dataset
  - Can have low pH, Fe and Al rich coal mine drainage
  - Arsenic enrichment down stream of some gold mine sites
- Questions
  - How variable is coalmine drainage on the West Coast?
  - How much As from gold mining vs background?
  - How far downstream does it travel?

4 Summary of West Coast Work

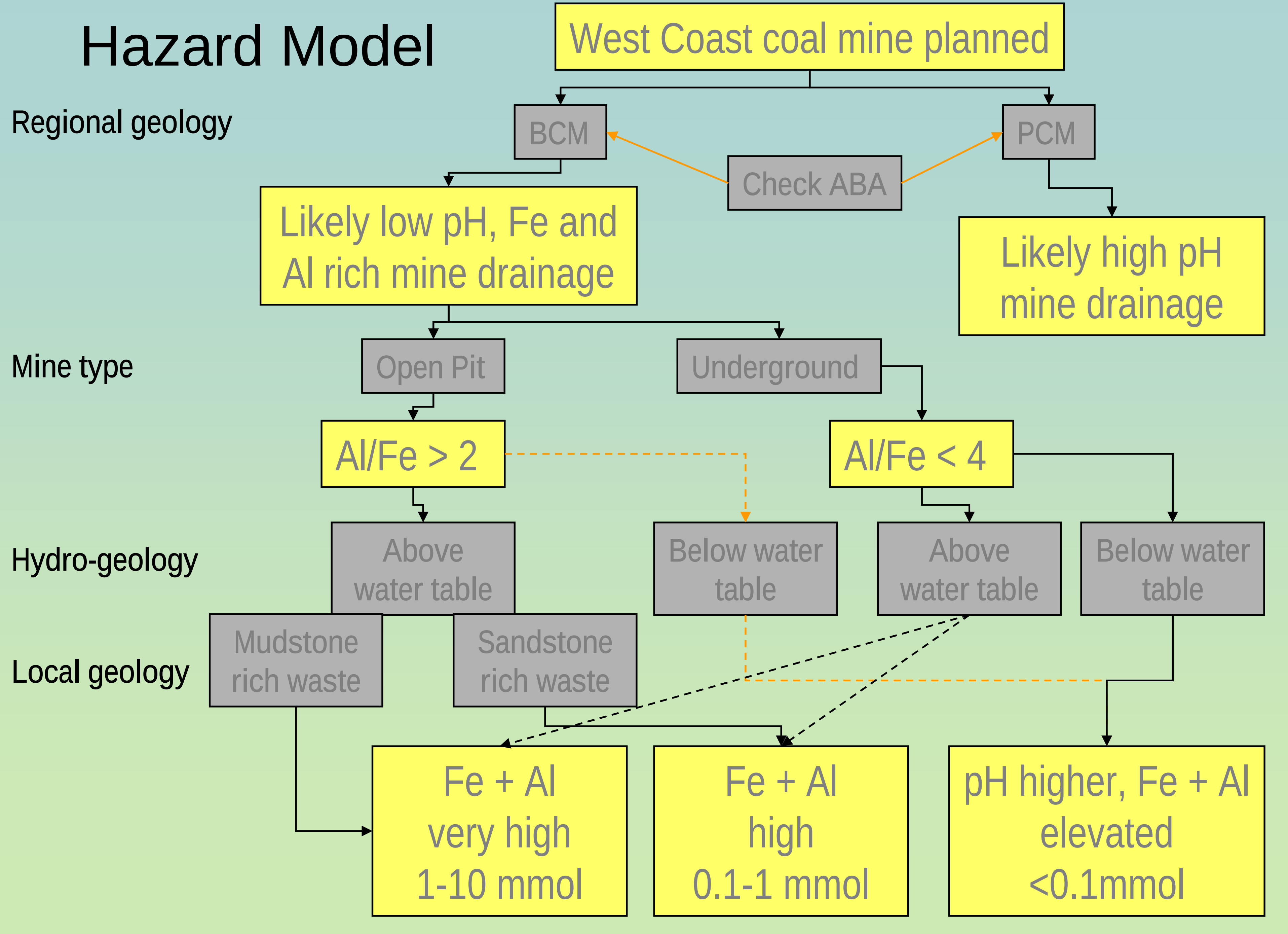
West Coast Coal Mines

- Two very different mine drainage chemistries
  - Regional geology – Paparoa vs Brunner coal measures
- In the Brunner coal measures acid controlled by
  - Mine type
  - Hydrogeology
  - Local geology

West Coast Gold Mines

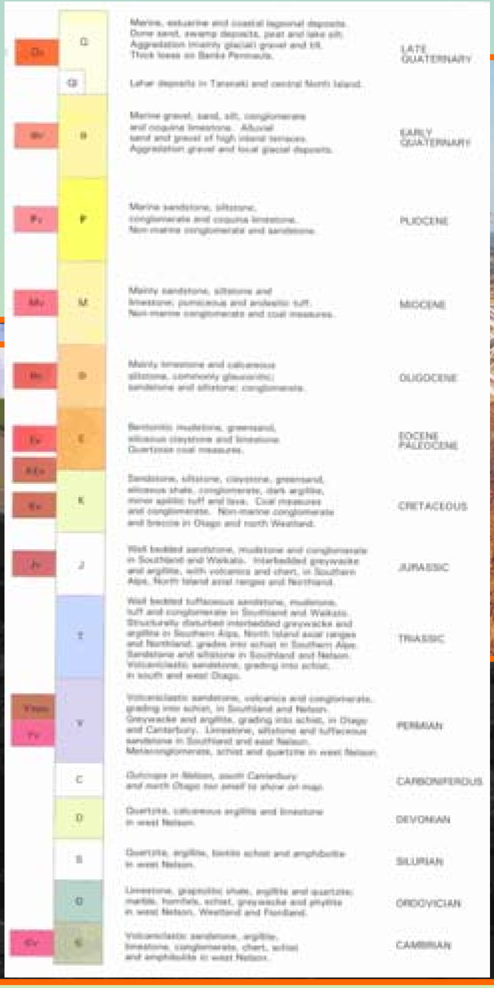
- Mines mostly related to Greenland Group Rocks
- Mine drainage typically near neutral
- Variably As enriched – controlled by
  - Presence of sulphides
  - Ore processing methods
  - Presence of secondary Fe
  - Hydrogeology of waste storage

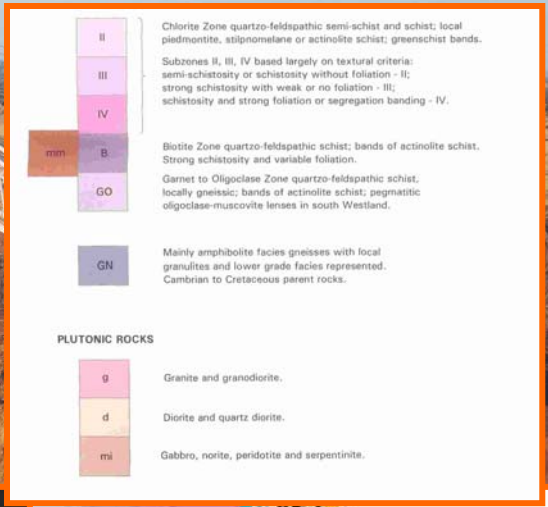
Hazard Model

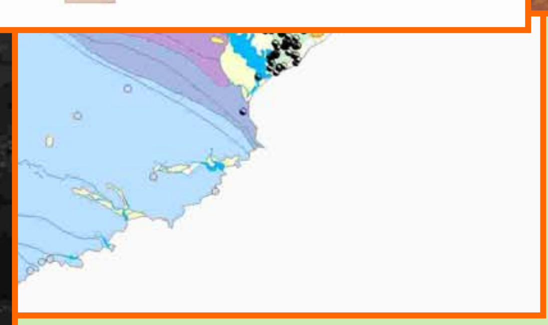


5 Preliminary Results from Southland

- Resources and Mining in Southland
  - Historic mining
  - Future mining
  - Rock types

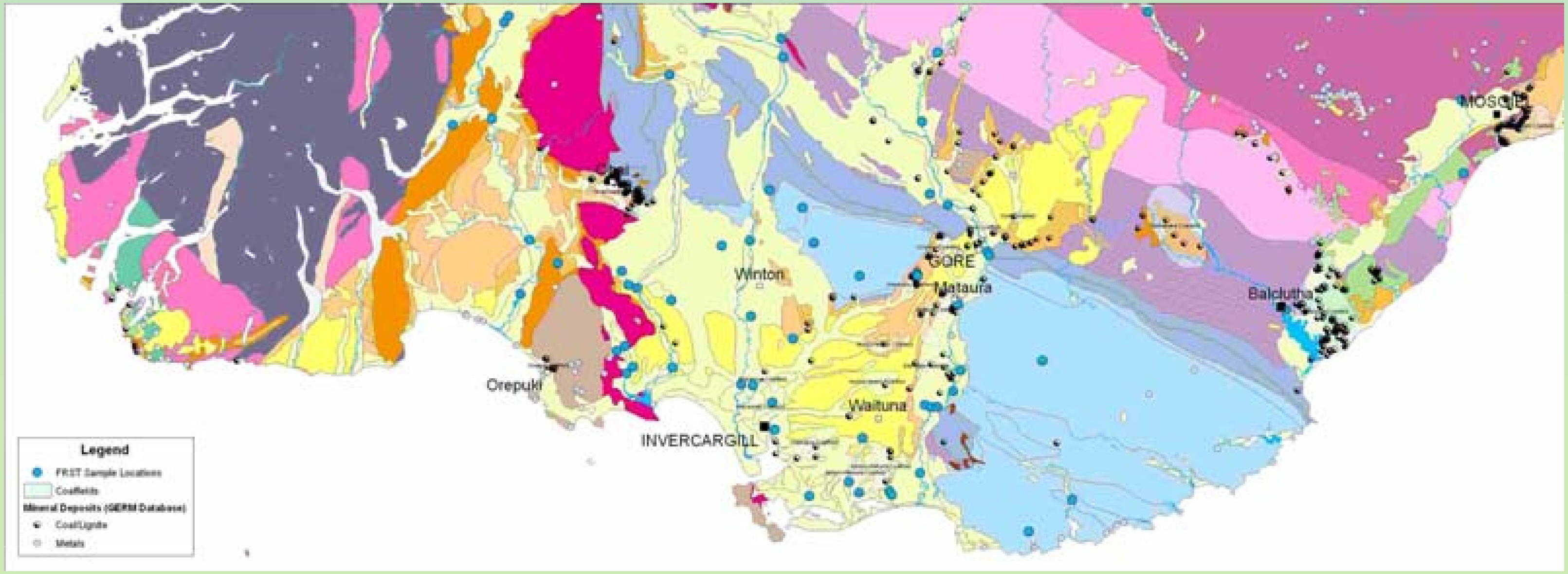






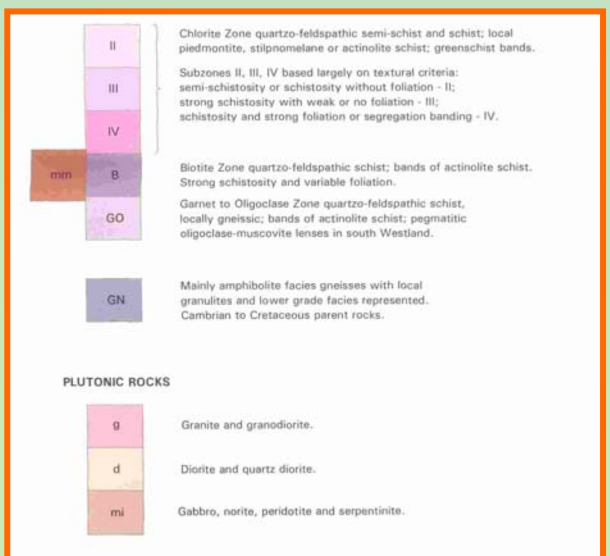
Data Compilation – Southland

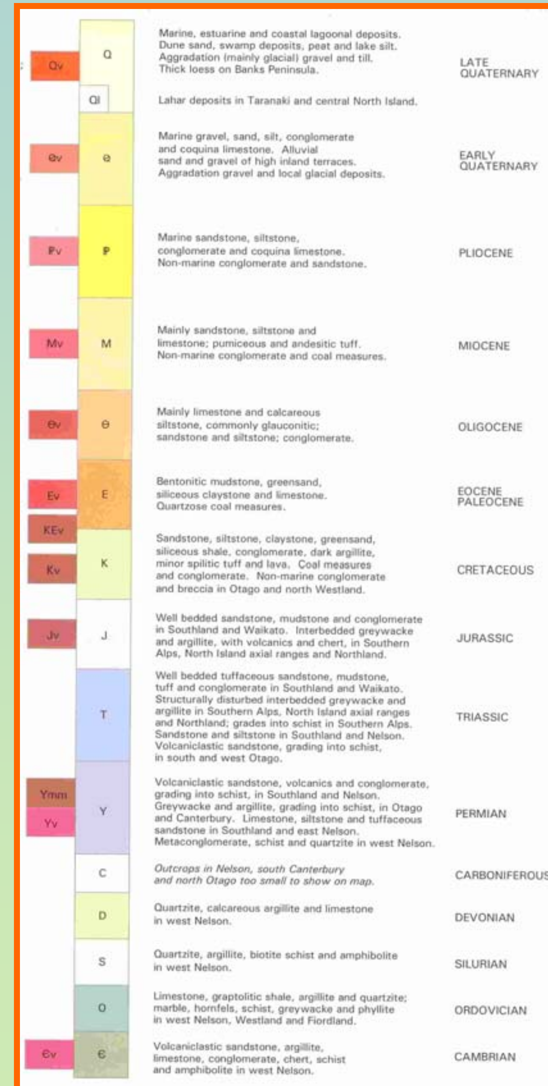
- Water chemistry
  - Mostly focused on agriculture
    - ES
    - NIWA
    - Theses
    - Publications
    - This programme
  - Any additional data that you are aware of??



Data compilation – Southland

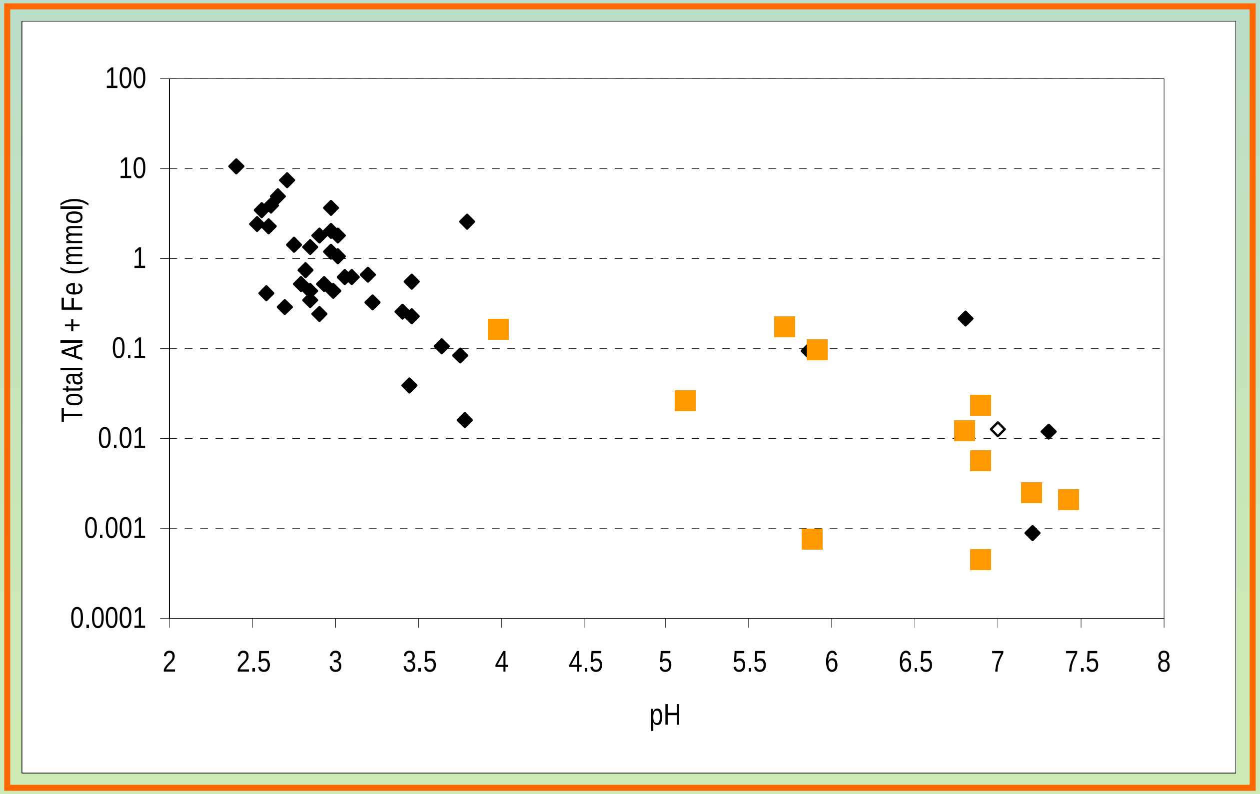
- Rock Geochemistry
  - Acid base accounting data from Ohai (small dataset ~12)
  - Sulphides observed in gravels





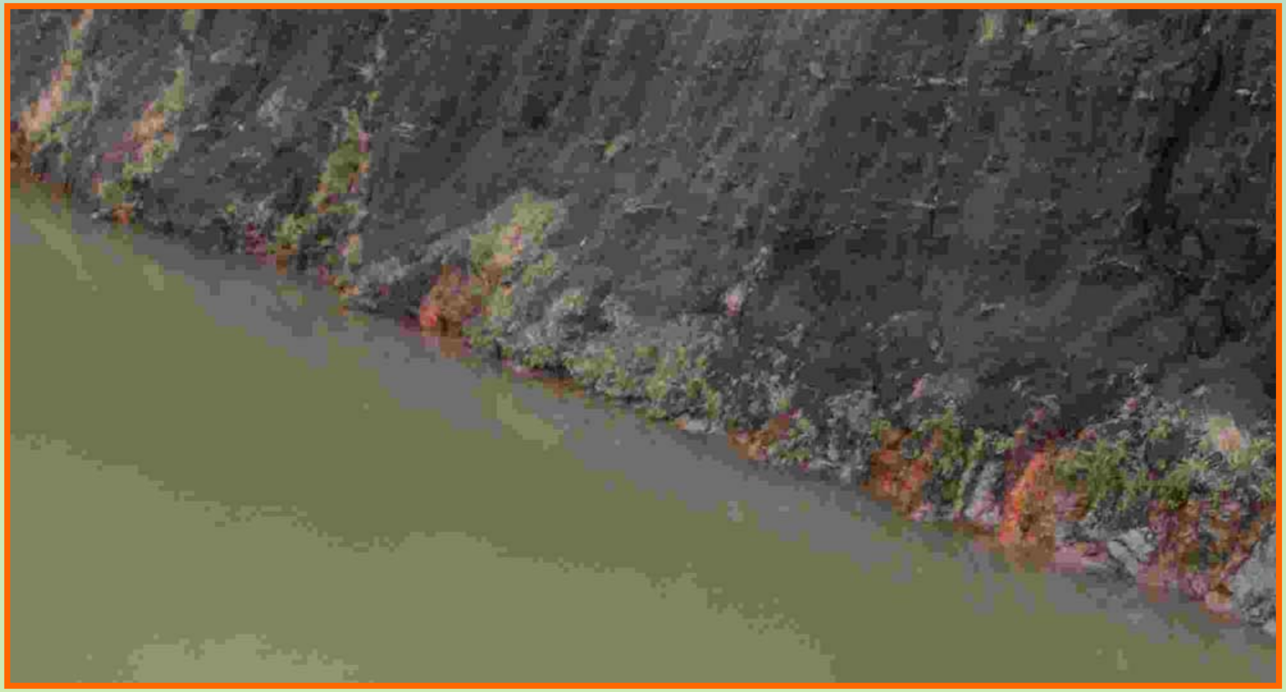
Results - Mine Drainage Chemistry

- Nine pits/mine drainage streams – additional data from Newvale
- Preliminary data relating turbidity to geology (Tim Mulliner MSc)



Results – Rock Geochemistry

- ABA preliminary dataset collected at Newvale (Tim Mulliner MSc)
  - Non acid producing



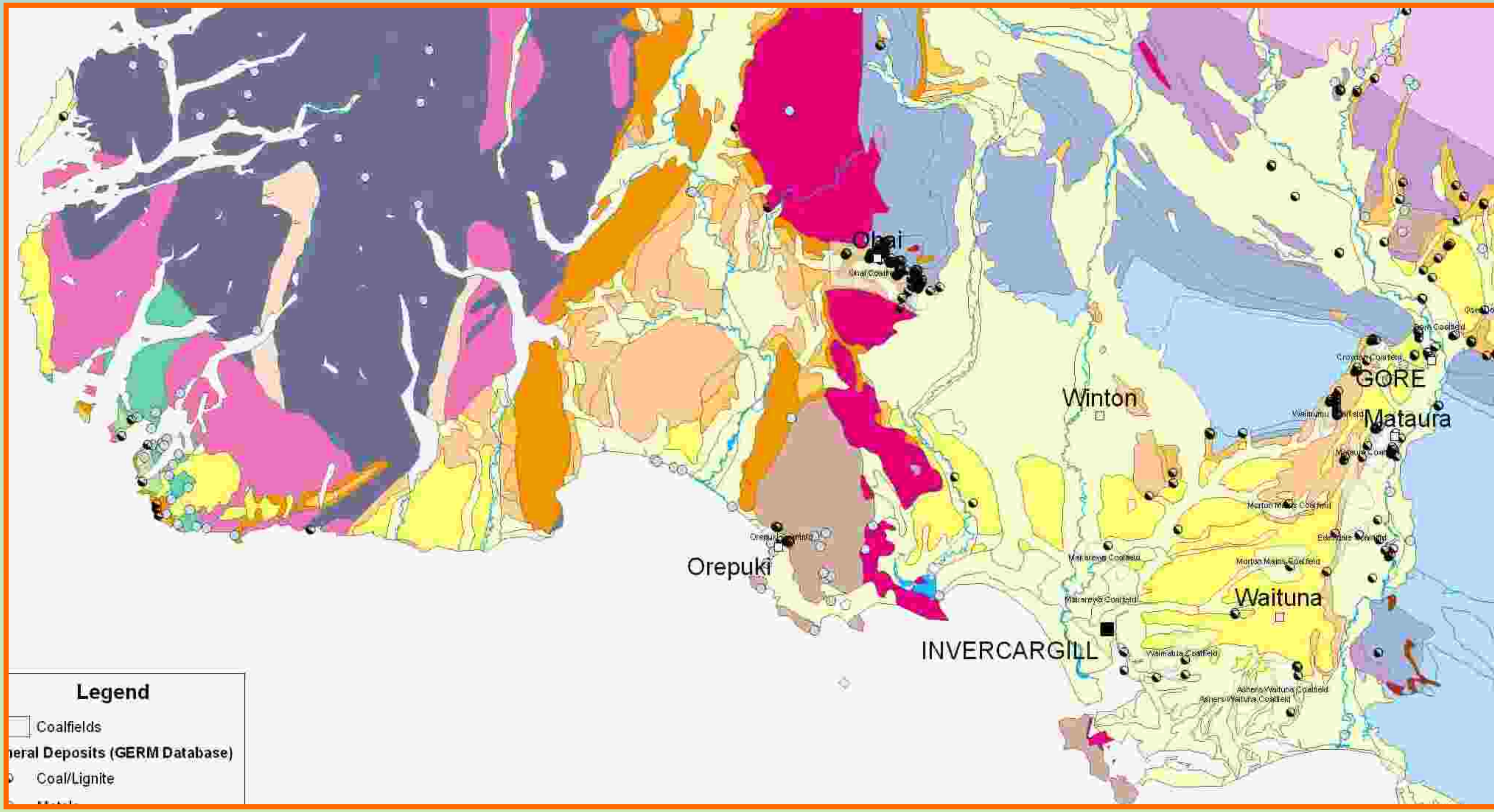
Gaps in Dataset

- Water chemistry issues
  - Belle-Brook AMD – extent of sulphides in gravels
  - Slight trace element enrichments As, Zn & B
  - Turbidity
- Additional mine drainage analyses
- ABA from remainder of rocks that could be disturbed by mining in Southland
  - Relate to stratigraphy
- Mining related turbidity

6 A Look Forward

- ABA (acid base accounting) data for rocks disturbed by lignite mining

Other areas in Southland



Summary

- Objective 1
  - Use mine drainage chemistry and rock geochemistry from current and historic mines to predict risk associated with future mines
- Predictive ability assessed – hazard models constructed for West Coast
- Few current/historic mine drainage chemistry problems in Southland
- Gaps identified
  - ABA data
  - Mine drainage chemistry and turbidity

Conclusion

A rare chance in Southland to be proactive with respect to environmental issues around mining