

Water Policy Interim Committee

August 16 and 17, 2007
Bozeman, Montana

Learning Session:
Water Chemistry

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Montana Bureau of Mines and Geology



“Common Parameters”

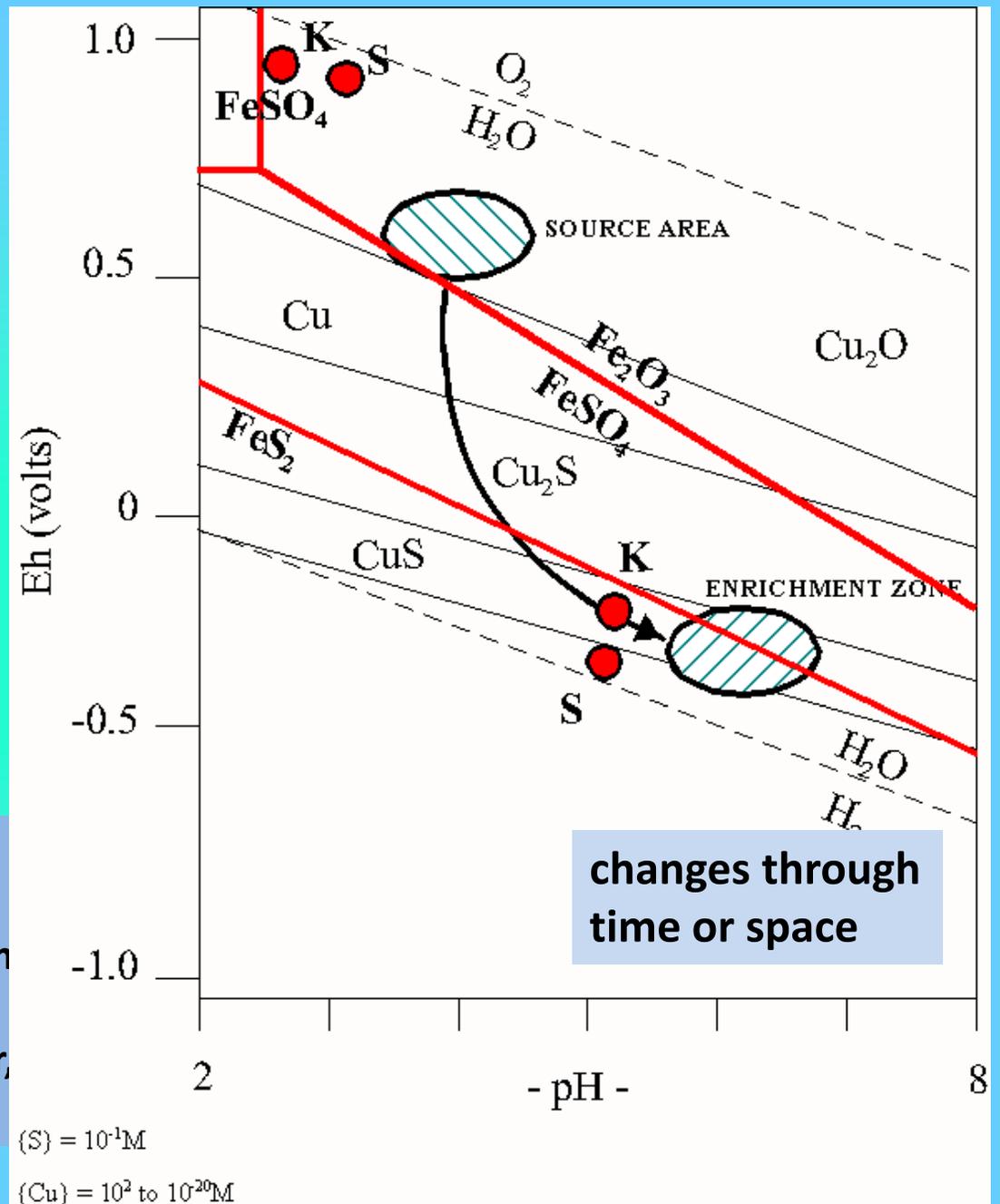
pH (acidic/basic)

cola	2.5
Berkeley Pit	2.5
orange juice	3.5
beer	4.5
soap	10.0
Yankee doodle tailings	12-13
bleach	12.5

Eh (redox)

oxidizing conditions: lakes, stream

reducing conditions: ground water,



Eh / pH in action



Eh / pH in action



Hardness as CaCO₃: ([Ca]+[Mg])*50

0 – 60 soft

61 – 120 moderate

121 – 180 hard

**SAR: tendency of a water to replace
[adsorbed] Ca and Mg with Na**

SC (specific conductance, ~ TDS)

pristine waters (JM)

< 15

Gallatin River near Gateway

107 to 326

Madison Limestone (MT)

300 to 900

Berkeley Pit

8,000

sea water

50,000

saline seep (MT)

30,000

micromhos/cm

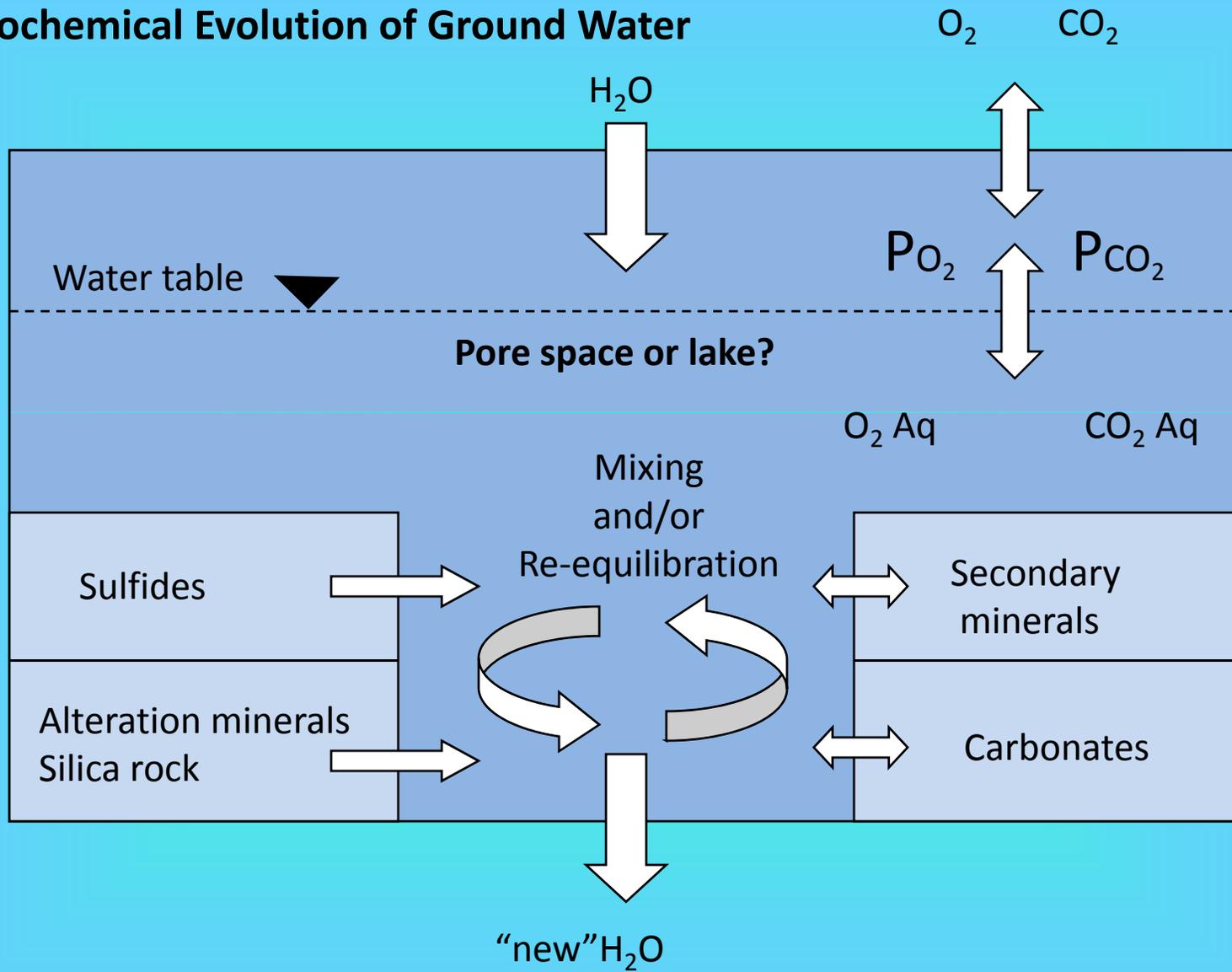
Reported concentrations (a function of technology and toxicology):

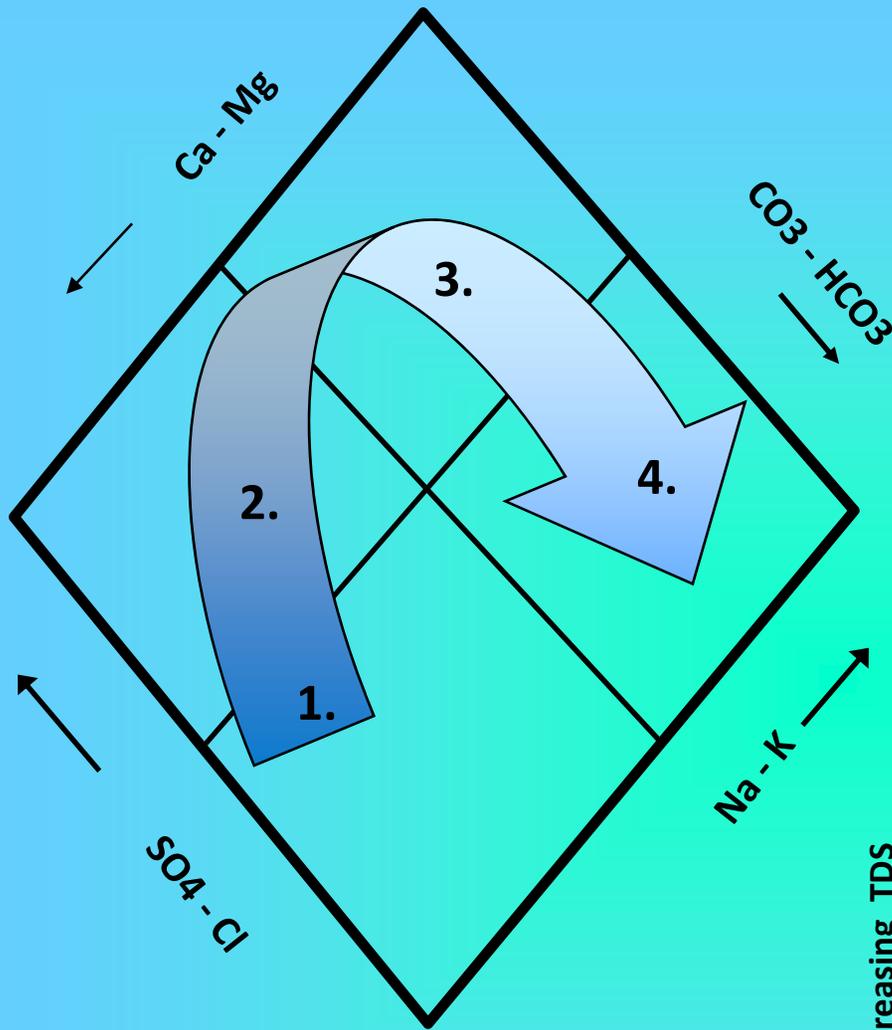
parts per million - ppm (major cations and anions, some metals)

parts per billion - ppb (trace metals, organics)

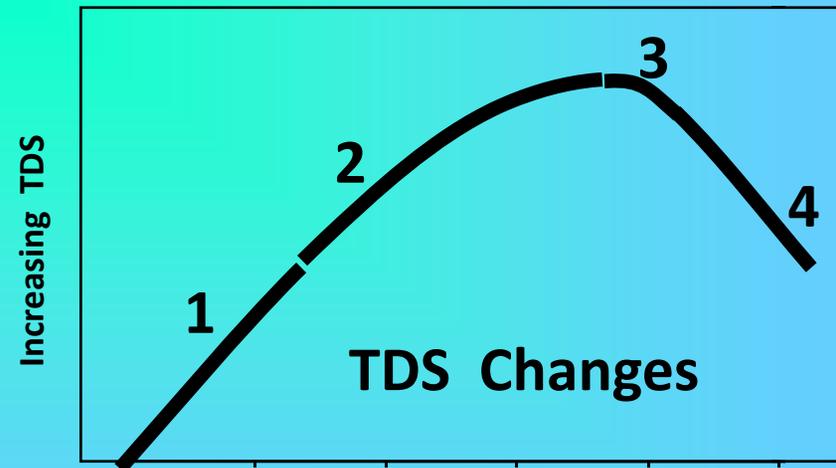
parts per trillion - ppt (pharmaceuticals, PersCareProd, organics)

Geochemical Evolution of Ground Water



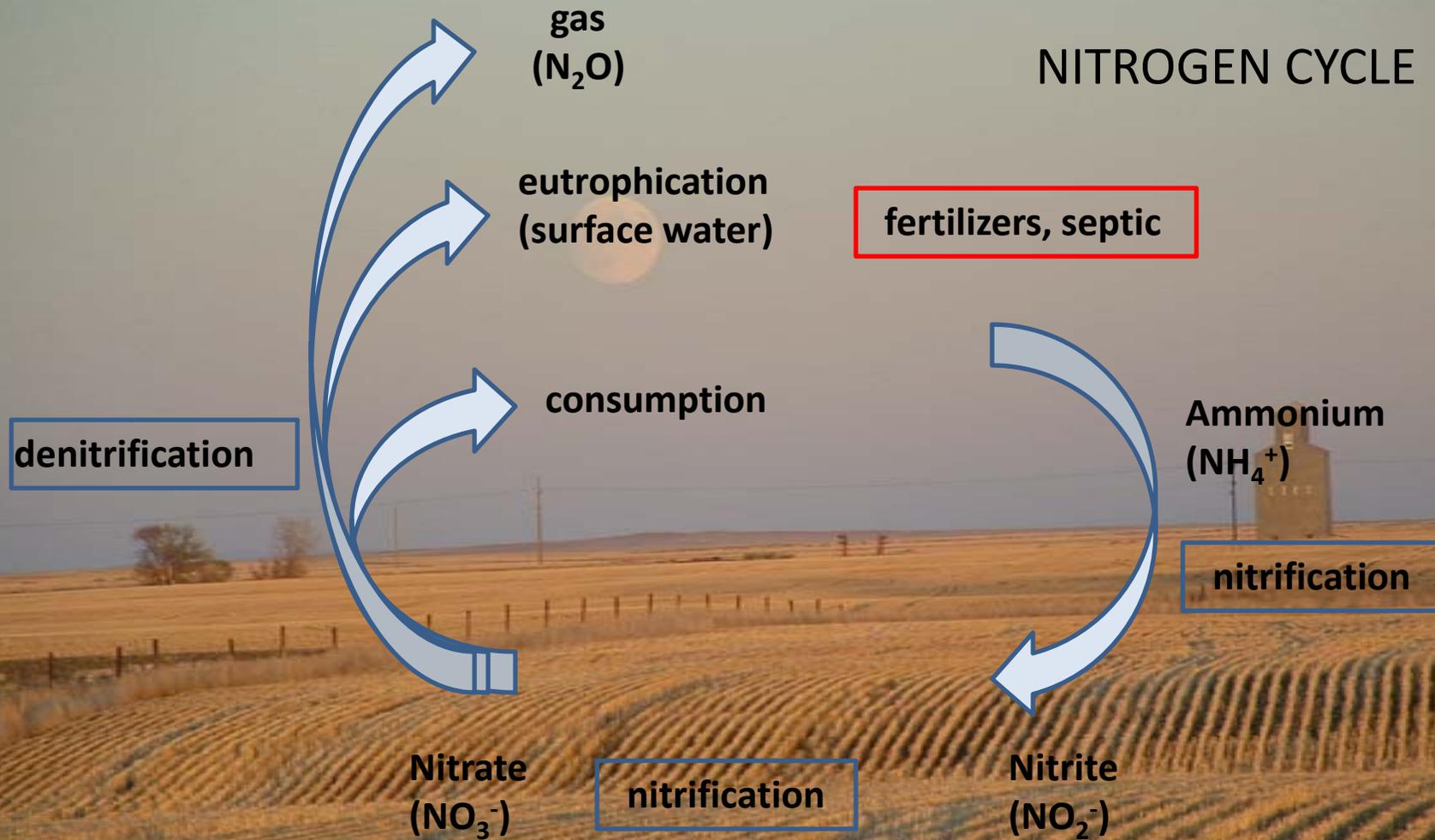


1. Salt Dissolution
2. FeS_2 Oxidation
3. Cation Exchange
4. Sulfate Reduction



Changes in water quality along ground-water flow paths proceed in a predictable fashion, dominated by ions of calcium-bicarbonate near recharge areas and dominated by ions of sodium-bicarbonate in deep aquifers. Total dissolved solids concentrations increase along the flow path until reducing conditions are encountered in deep coal beds (Van Voast and Reiten, 1988).

NITROGEN CYCLE



Also phosphorous, sulfur, iron...

ORGANIC CHEMISTRY

Classification: by their molecular structural arrangement and by what other atoms are present with carbon

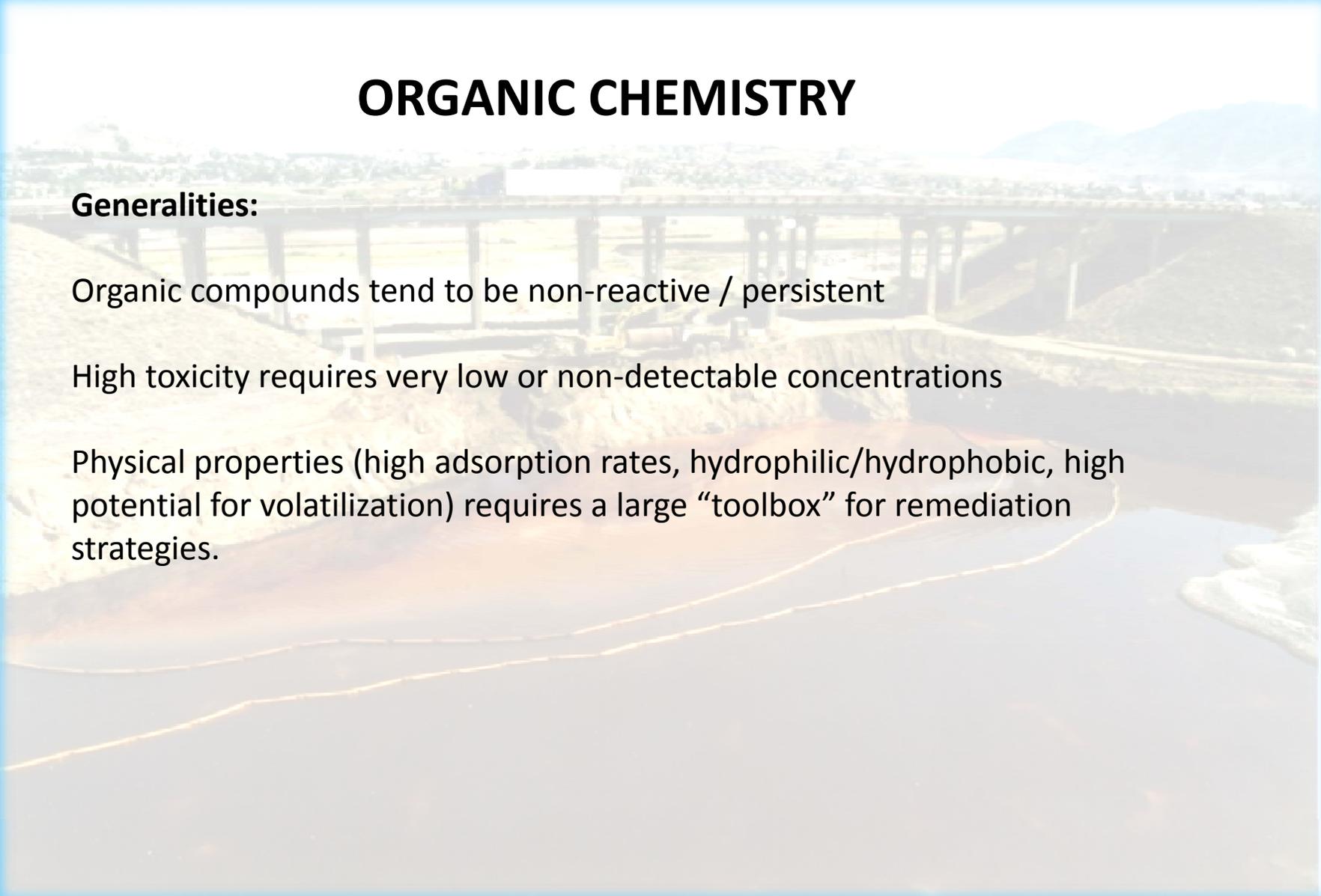
Hydrocarbons : oils, petroleum or synthetic

Aliphatic compounds: alkanes, alkenes, and alkynes

Polymers: individual molecules of which are capable of forming a chain or a network.

Biomolecules: proteins, DNA, pharmaceuticals

ORGANIC CHEMISTRY

The background of the slide is a faded photograph of a large concrete dam with multiple pillars, situated in a valley. A river flows through the valley below the dam. The scene is captured from an elevated perspective, showing the surrounding landscape and distant hills under a clear sky.

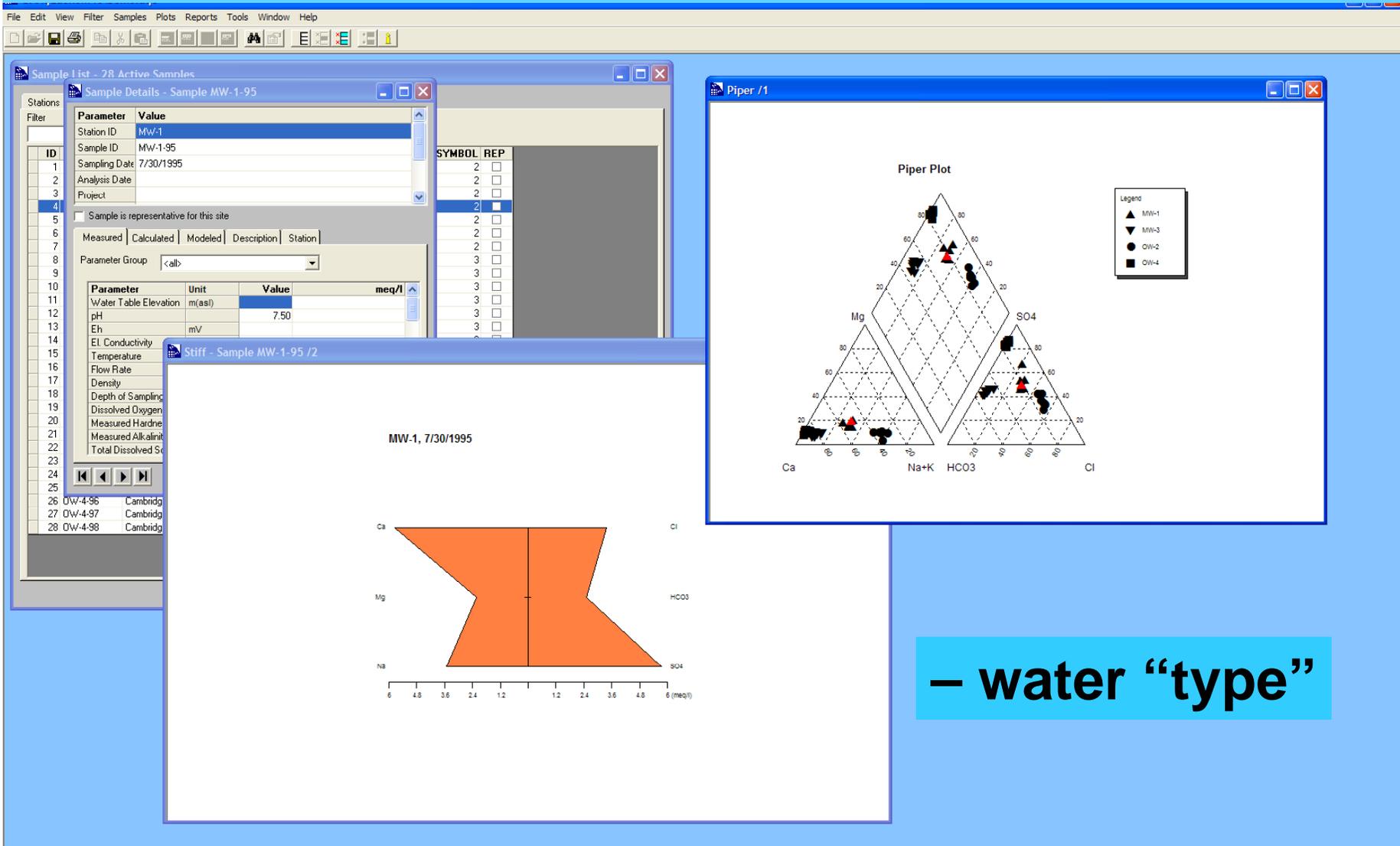
Generalities:

Organic compounds tend to be non-reactive / persistent

High toxicity requires very low or non-detectable concentrations

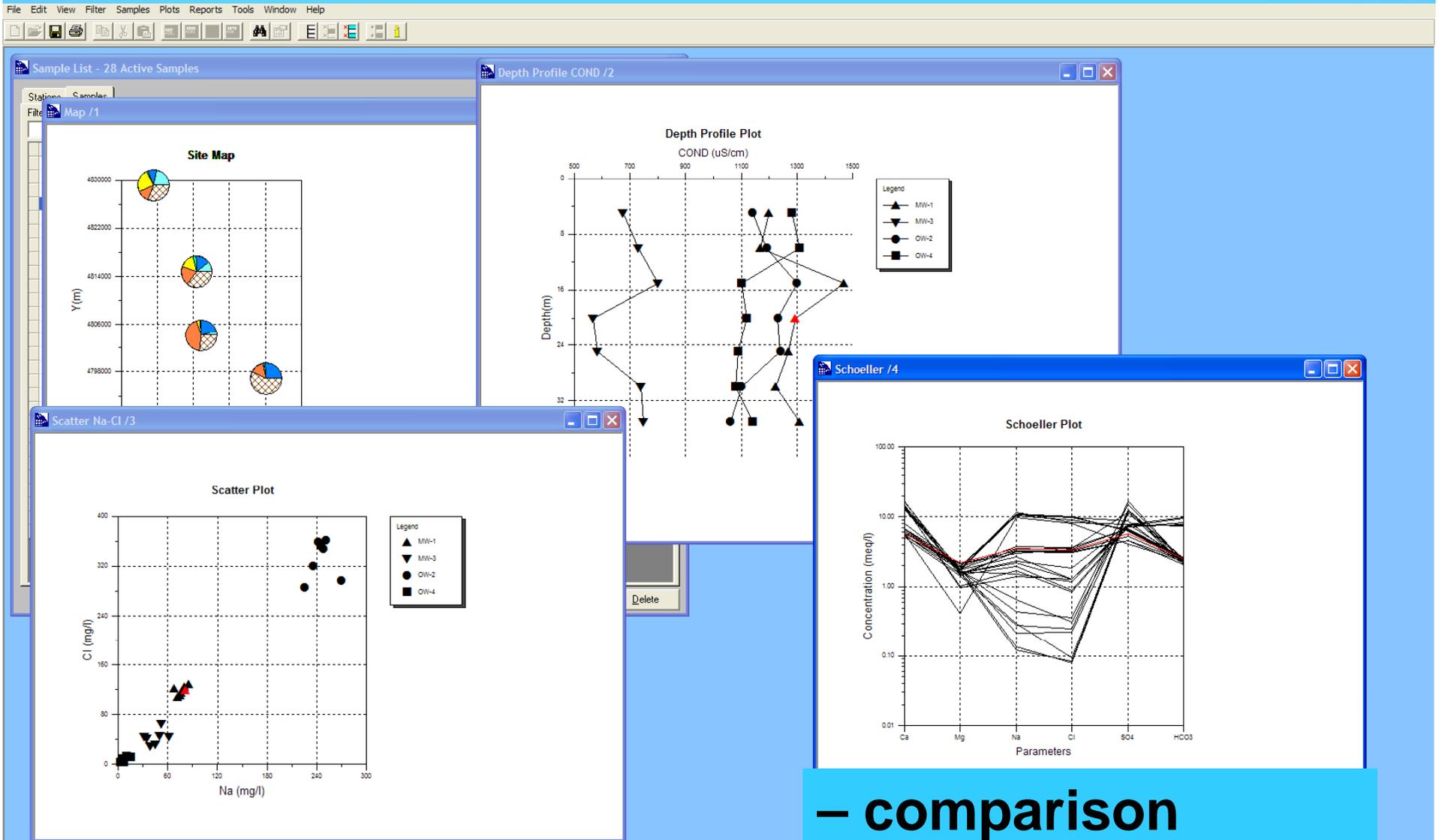
Physical properties (high adsorption rates, hydrophilic/hydrophobic, high potential for volatilization) requires a large “toolbox” for remediation strategies.

Data Synthesis



– water “type”

Data Synthesis



– comparison
where in the cycle..?

Data Synthesis

Modeling

Single phase (inorganic)

particle trace (adsorption)

reaction path (kinetics)

Two-phase flow and transport (organic)

“oil” or LNAPL

dissolved

Data requirements:

based on ground water flow model

(aquifer parameters, water levels,...)

nature of source, “inventory of reaction”

detailed concentration (time and space)

Output:

detailed concentration through time and space

outside the data

Modeling

Geochemical equilibrium (inorganic and limited organic)

mineral – water interaction

mixing of two waters

dissolution/precipitation under range of conditions (Eh/pH)

Data requirements:

based on equilibrium reactions

mineralogy, background chemistry

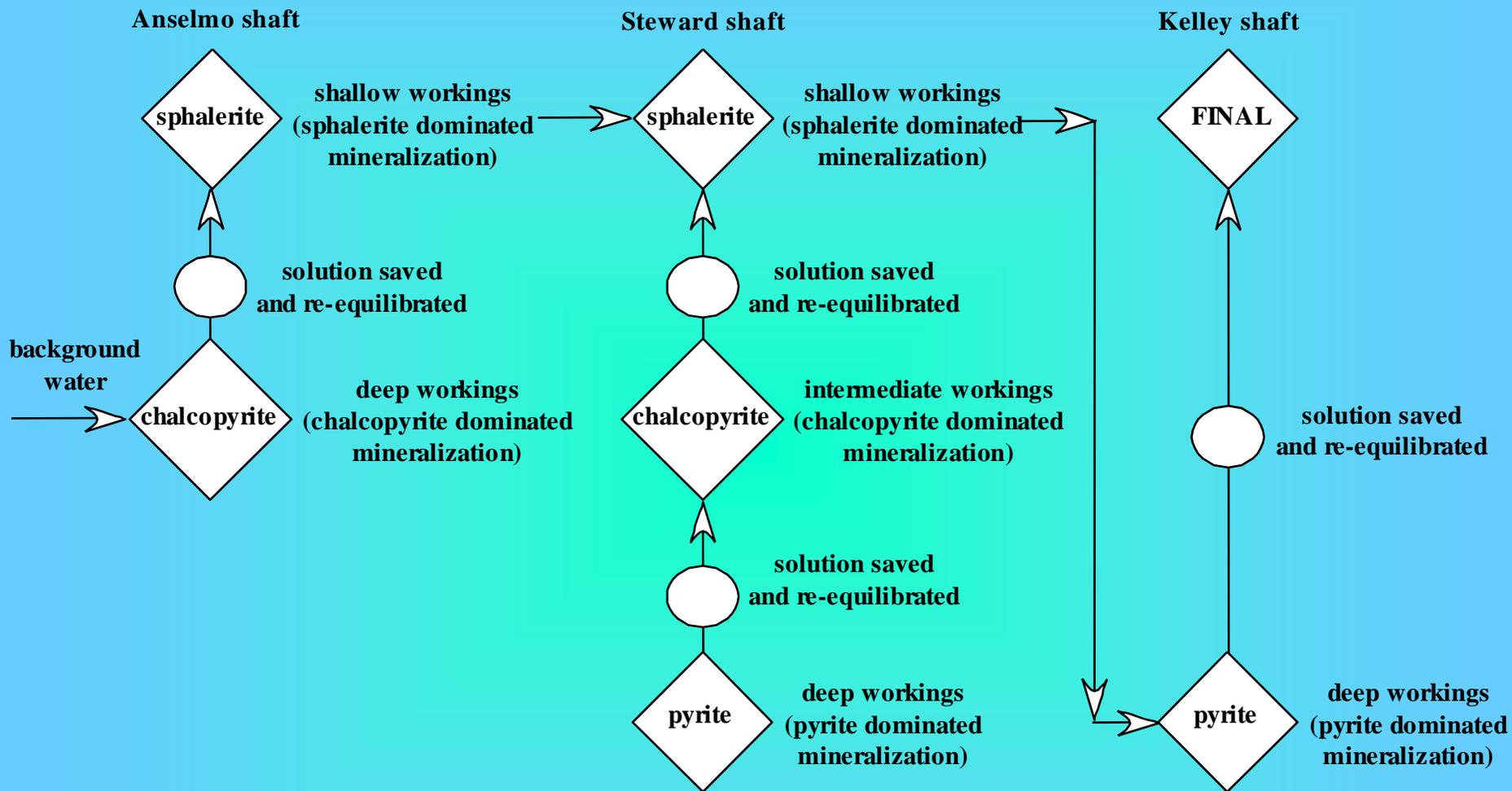
detailed concentration (time and space)

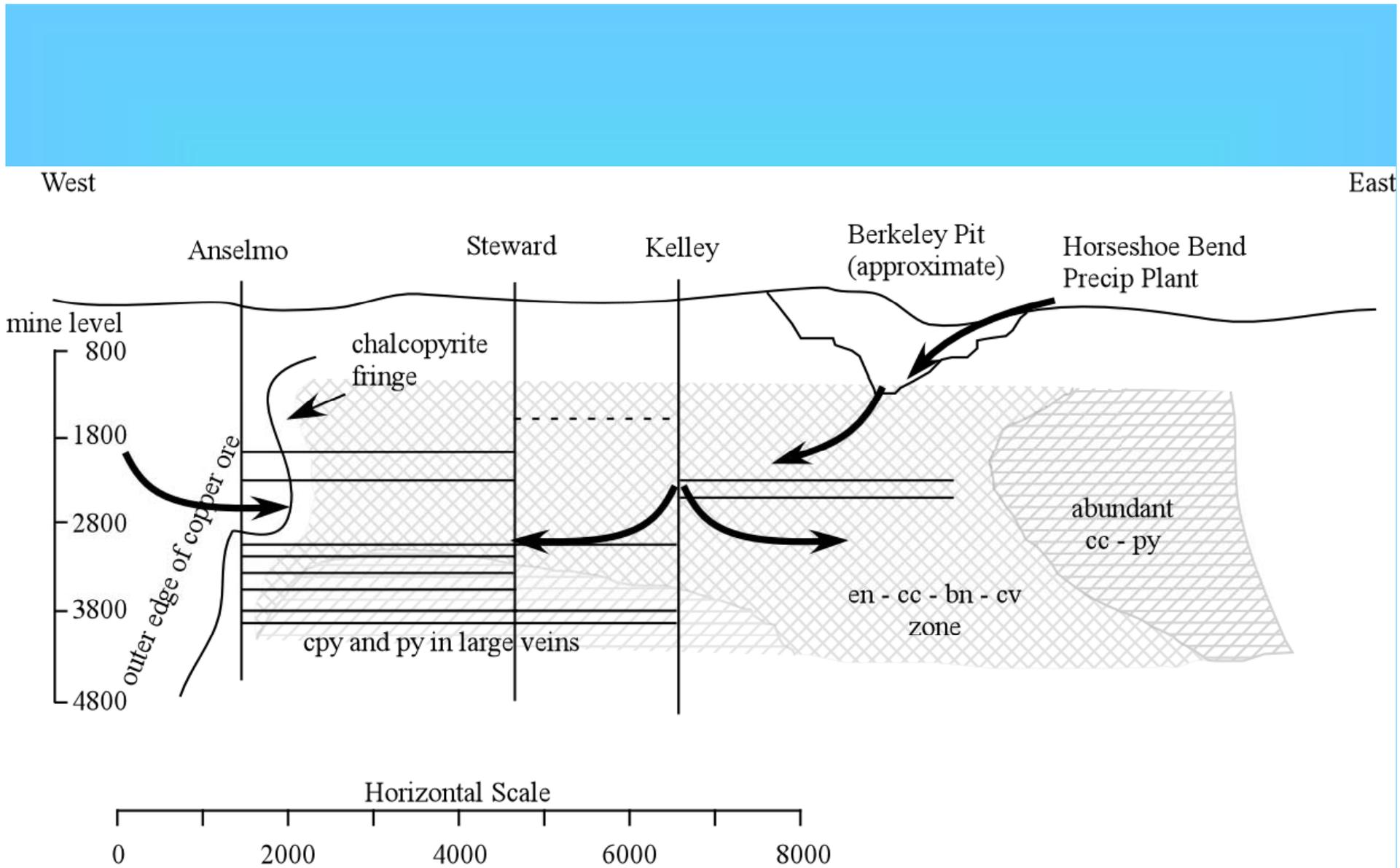
Output:

detailed concentration

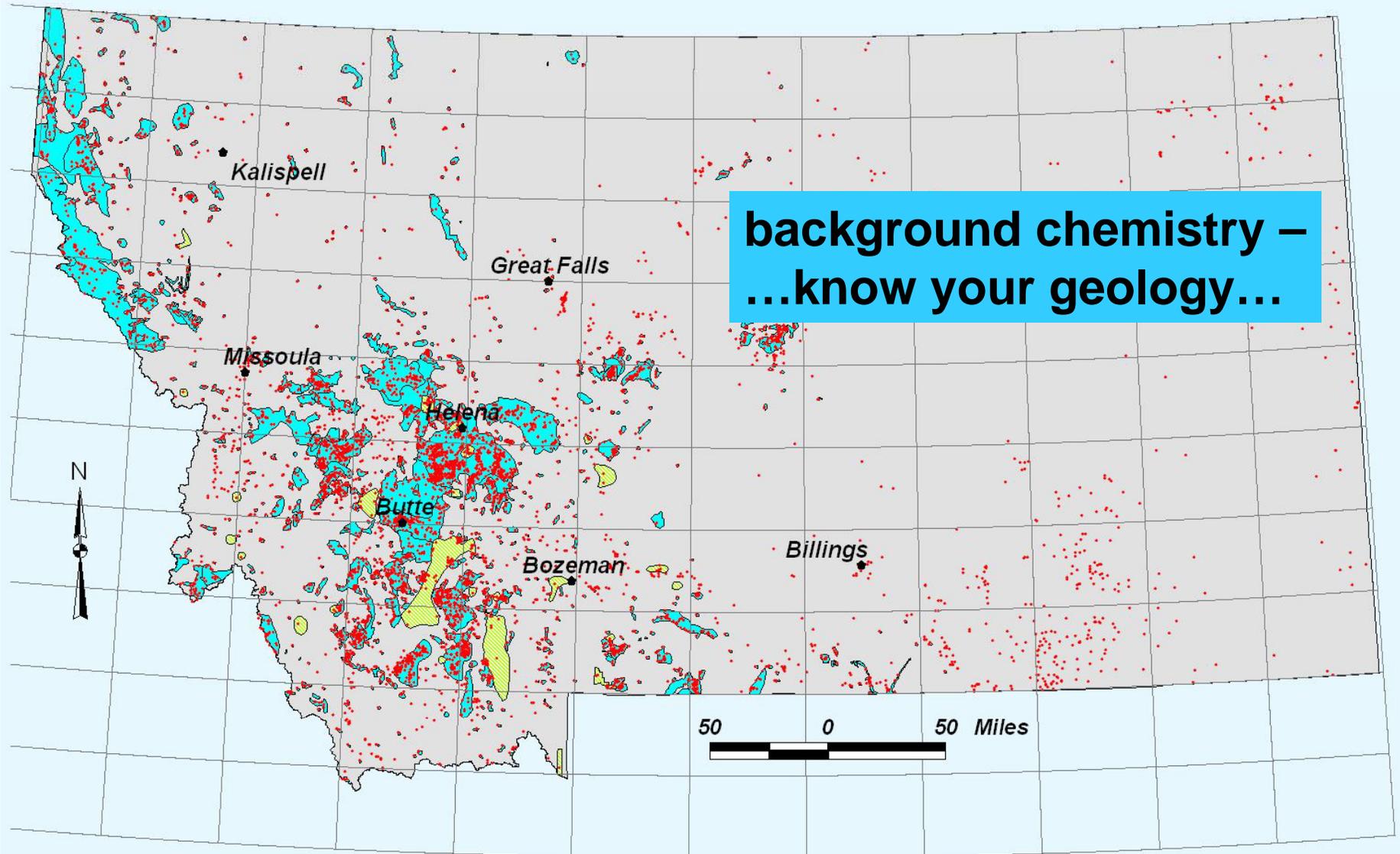
dissolution and/or precipitation of solids

reaction, mixing, re-equilibration...





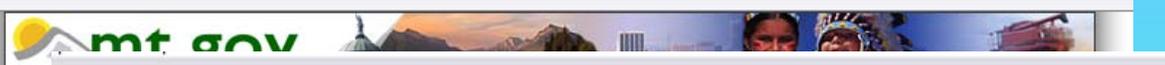
Locatable Mineral Potential & Historic Mines



**background chemistry –
...know your geology...**

- Historic Mine Locations
- Geothermal Areas
- Locatable Mineral Potential

USGS Water Resources
 PLANNED
 About STORET
 Data Owner's
 Updates/Down
 Obtaining Wat
 Quality Data
 Real-ti
 Useful Internet
 Commonly Ask
 Questions
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- What
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- Appli

mt.gov
 Montana's Official State Website
 DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
 About Us | Divisions | Field Operations | Forestry | Grants & Loans | Land Management | Oil & Gas | Public Interest | Water
 SEARCH DNRC Submit
 NEWS News Releases
 Director Mary Sexton

Montana's Ground-Water Information Center 2007 - Mozilla Firefox
 http://mbmgwic.mtech.edu/
 7/17/2007

Hot Topics

Western Wildland Interface Grant P
 Fire Season Infor
 - Are you prepar
 season?
 - Current Fire Re
 - Outdoor Safety

Fidelity Exploratio
 (pdf)

Register your Wa
 (pdf)

Update your Wat
 Information

Residential Lease
 DNRC Job Opport

Contact The

GWIC
 Ground-Water Information Center
 Montana Bureau of Mines and Geology
 Montana Tech of The University of Montana
 1300 West Park Street - Main Hall 314
 Butte Montana 59701-8997

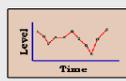
Drought Reports [more reports](#)

Download an Adobe Acrobat file that discusses how aquifers respond to climatic conditions. The document also includes statistics about how wells in Montana's statewide monitoring network are responding to the current drought. **Updated to June 2006 (3.8 MB).**



Statewide Monitoring Network

GWIC features current hydrographs for wells that are being measured regularly by MBMG and its cooperators. Click the picture to the left to view data collected by the Statewide Monitoring Program. Data from other MBMG projects are available through the **SWL Menu** after you sign in.



[View a list](#) of statewide monitoring network wells. The listing is by number of wells per county.

County-wide Statistics [more reports](#)

View statistical overviews of the well data in individual counties. Select the county name from the drop-down box to the right and click the **Go!** button.

BEAVERHEAD
 Go!

Sign In Status: Signed Out

Enter your User Id and Proposed Data Use. Click **Sign In** to access GWIC's online services.

If you do not have a User Id, click [create one here](#).

User Id:
 Data Use:
 Sign In

Coaled Methane GW Monitoring Network



MBMG operates the Montana Powder River Regional Coaled methane ground-water monitoring network of springs and wells. Data for this program plus site specific research such as coaled methane infiltration pond studies can be viewed online, or downloaded from GWIC. Click on the picture to access the MBMG coaled methane project data.

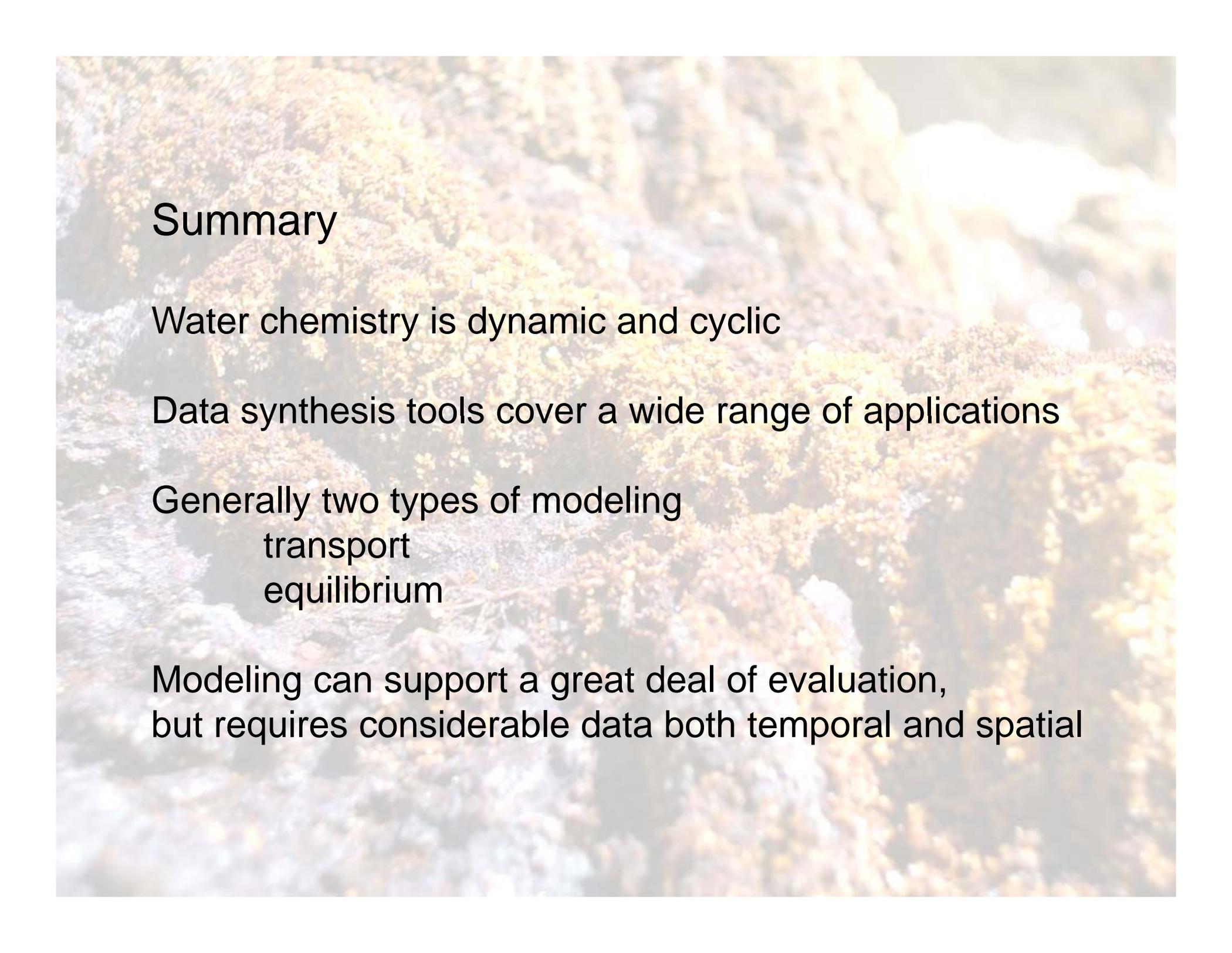
A little about us

The Ground-Water Information Center (GWIC) at the Montana Bureau of Mines and Geology (MBMG) is the central repository for information on the ground-water resources of Montana. The data include well-completion reports from drillers, measurements of well performance and water quality based on site visits, water-level measurements at various wells for periods of up to 60 years, and water-quality reports for thousands of samples. The databases at GWIC are continually updated with new data from driller's logs, MBMG research projects, and research projects from other agencies.

Other sites of interest

- DNRC - Department of Natural Resources and Conservation
- NRSIS - Natural Resource Information System (Montana State Library)

Ground-Water Information Center Online 1998 - 2007
[Staff](#) | [Privacy Statement](#)



Summary

Water chemistry is dynamic and cyclic

Data synthesis tools cover a wide range of applications

Generally two types of modeling
transport
equilibrium

Modeling can support a great deal of evaluation,
but requires considerable data both temporal and spatial