

SALT ORIGIN FORENSIC TESTING

October 16, 2026

Remediation Technologies Symposium 2026

BUREAU VERITAS



PRESENTER

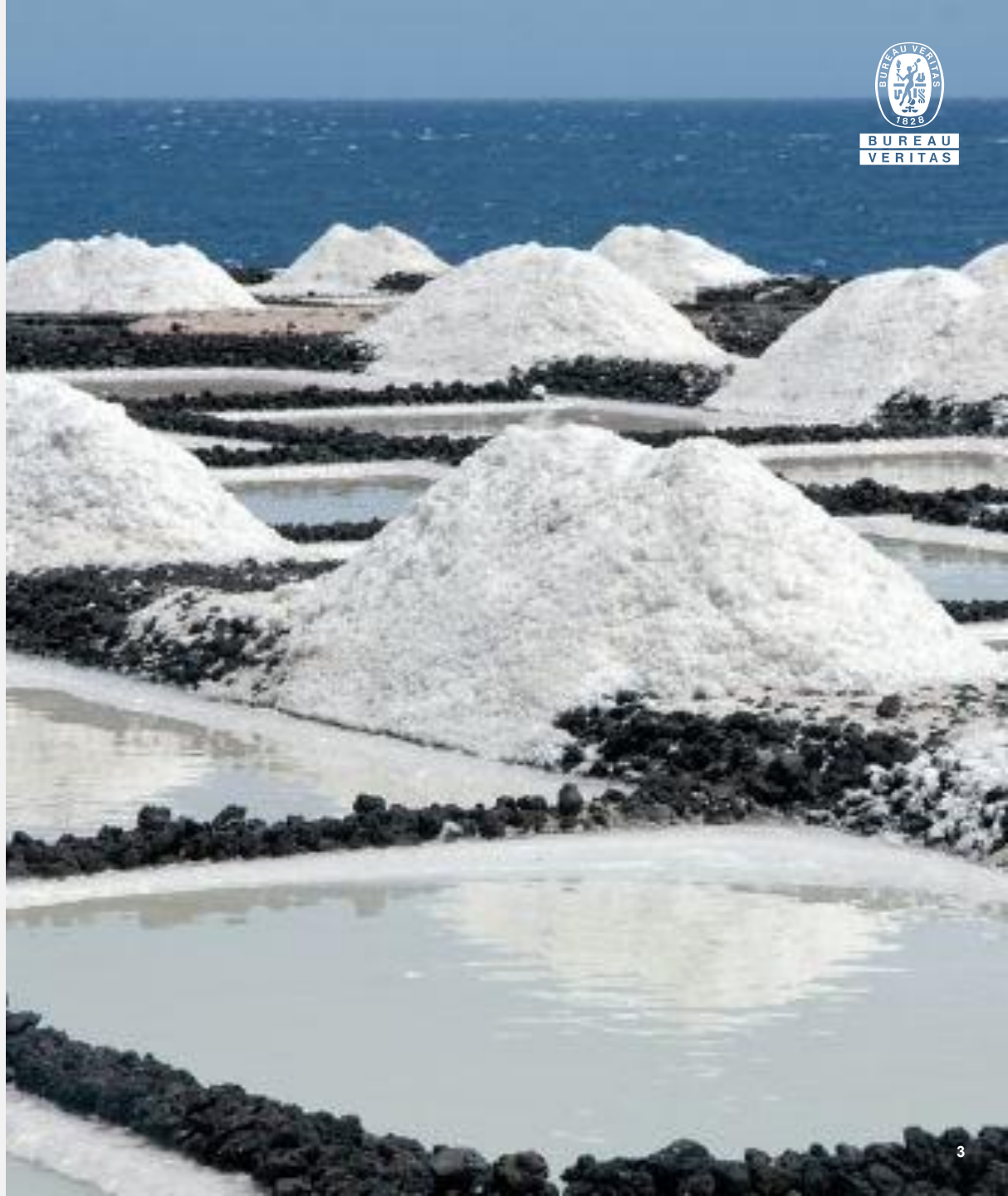
Brody ANDERSEN, B.Sc., B.Sc.

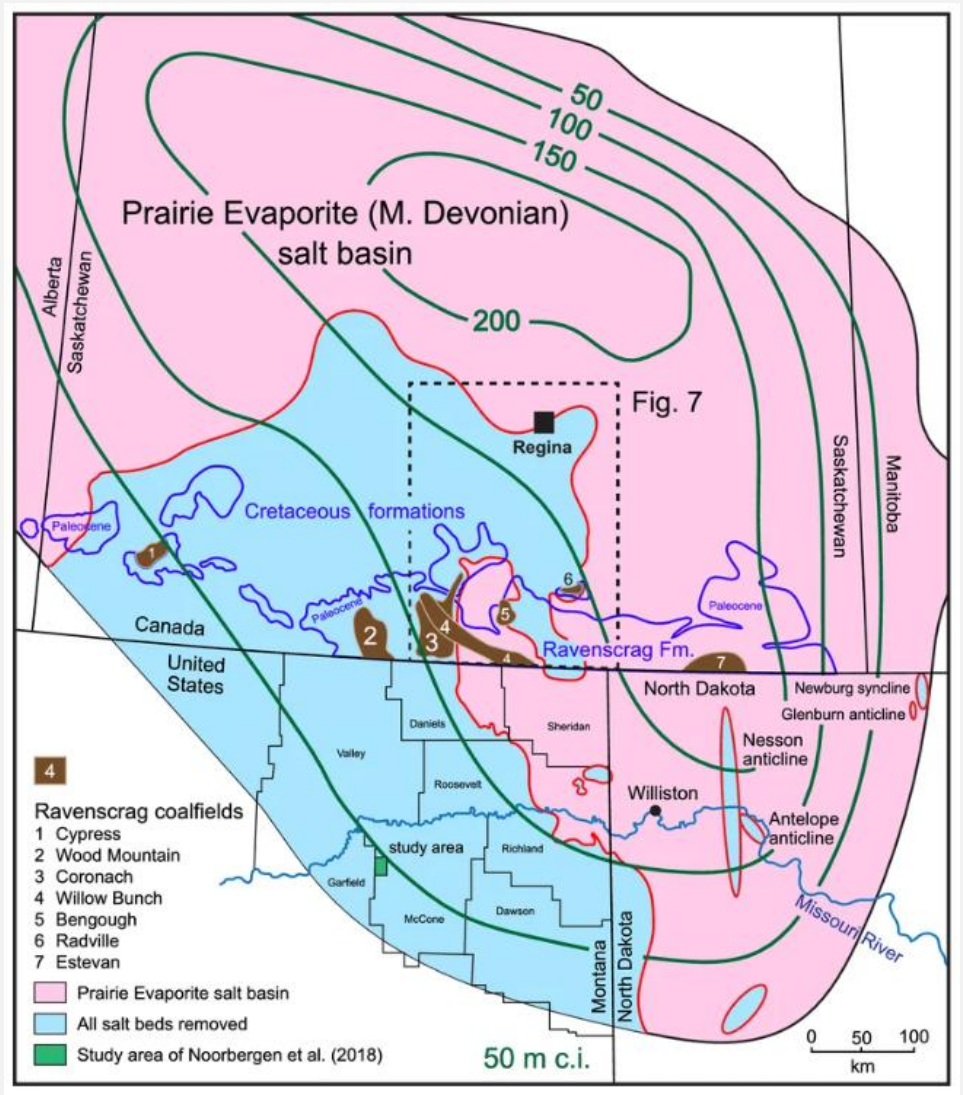
Technical Account Manager

SCAN ME

SOURCES OF SALTS

NATURAL	ANTHROPOGENIC
➢ Geological deposits such as halite and evaporite	➢ Agriculture and soil salinity
➢ Weathering of rocks	➢ Road or de-icing salts
➢ Oceanwater contamination	➢ Produced waters and brines





Broughton, Paul. (2021). Coals peripheral to opening and closure of the northern Western Interior Seaway: depositional signatures recording interplay between Milankovitch orbital forcing and salt dissolution collapse-subsidence structures with responsiveness to craton deformation and eustatic sea-level. Carbonates and Evaporites. 36. 10.1007/s13146-021-00679-9.

GROUNDWATER CONTAMINANTS: MAJOR POTENTIAL SOURCES IN BC

GAS STATIONS

How: leaky underground storage tanks.
Contaminants: hydrocarbons.
Importance: the main source of petroleum products contamination in B.C.

MINING

How: Acid Rock Drainage (ARD) from mine waste.
Contaminants: heavy metals, sulphate.
Importance: B.C. is one of the world's major mining regions, and ARD is the most challenging environmental issues faced by this industry.

SEAWATER INTRUSION

How: seawater intrudes aquifers by overpumping, sea level rise, and storm surges.
Contaminants: salts.
Importance: a serious problem for B.C.'s islands with increasing population and limited freshwater availability.



LANDFILLS

How: leachate due to failure of collection systems and faulty operation
Contaminants: highly complex; includes dissolved organic matter, inorganic salts, organic trace impurities, heavy metals.
Importance: landfills are the main source of solid waste disposal. Canada is the country with highest per capita municipal production of solid waste in the world (2013).

SEPTIC TANKS

How: released effluents that are not filtered by the soil and faulty systems.
Contaminants: bacteria, viruses, detergents, and household cleaners.
Importance: ~20% of households in B.C. use septic systems, making this a major source of pollution through the combined effect of widespread septic tanks.

AGRICULTURE

How: mainly excess application of fertilizer on land, but also pesticides, and other chemicals.
Contaminants: nitrate, phosphorus, pesticides, hormones, antibiotics.
Importance: agriculture is the leading cause of groundwater contamination worldwide. Southwest B.C. (Fraser Valley, Metro Vancouver, Sunshine Coast, and Squamish-Lillooet) is most intensively managed agricultural area in Canada.

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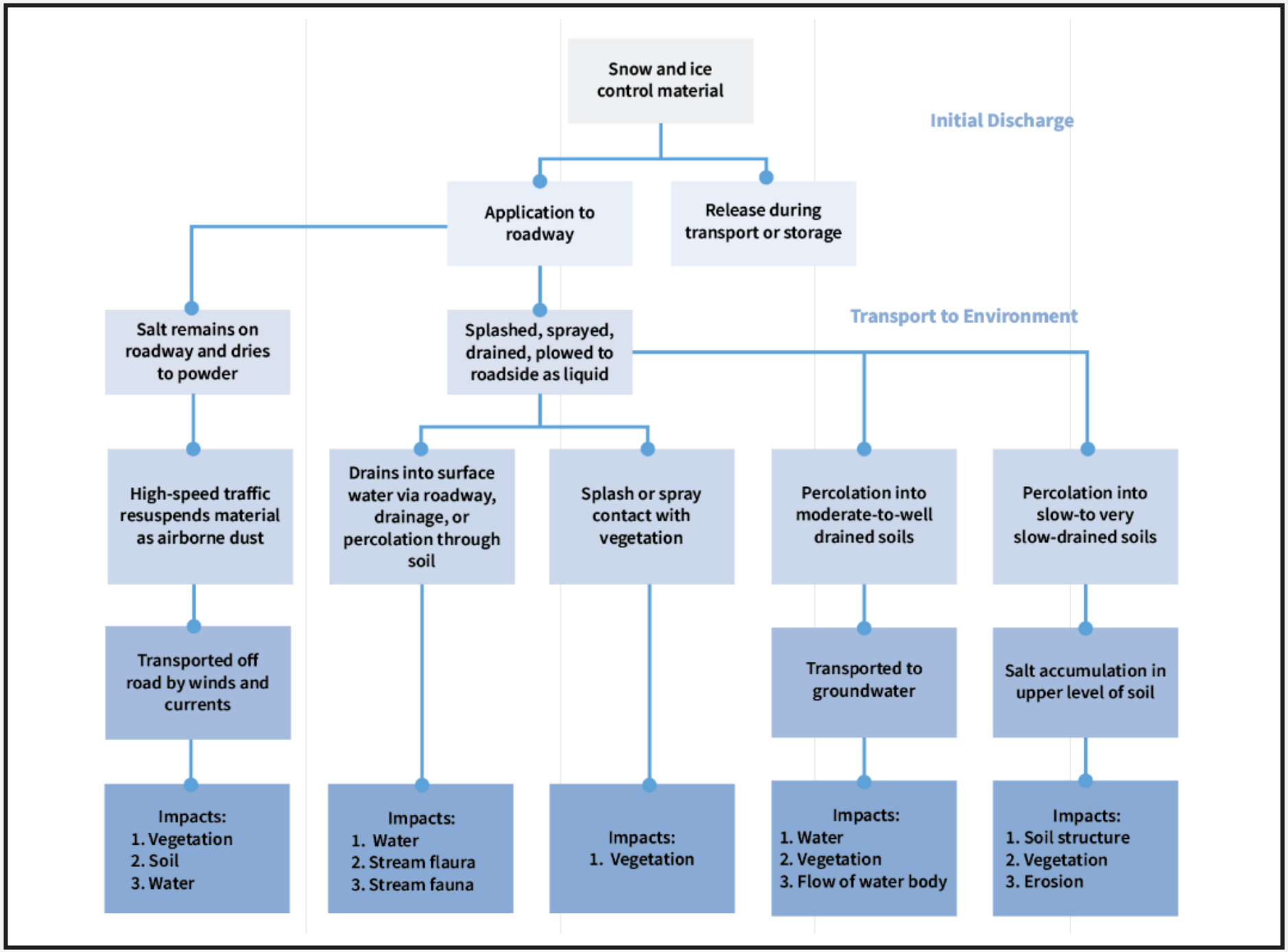
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ROAD SALTS

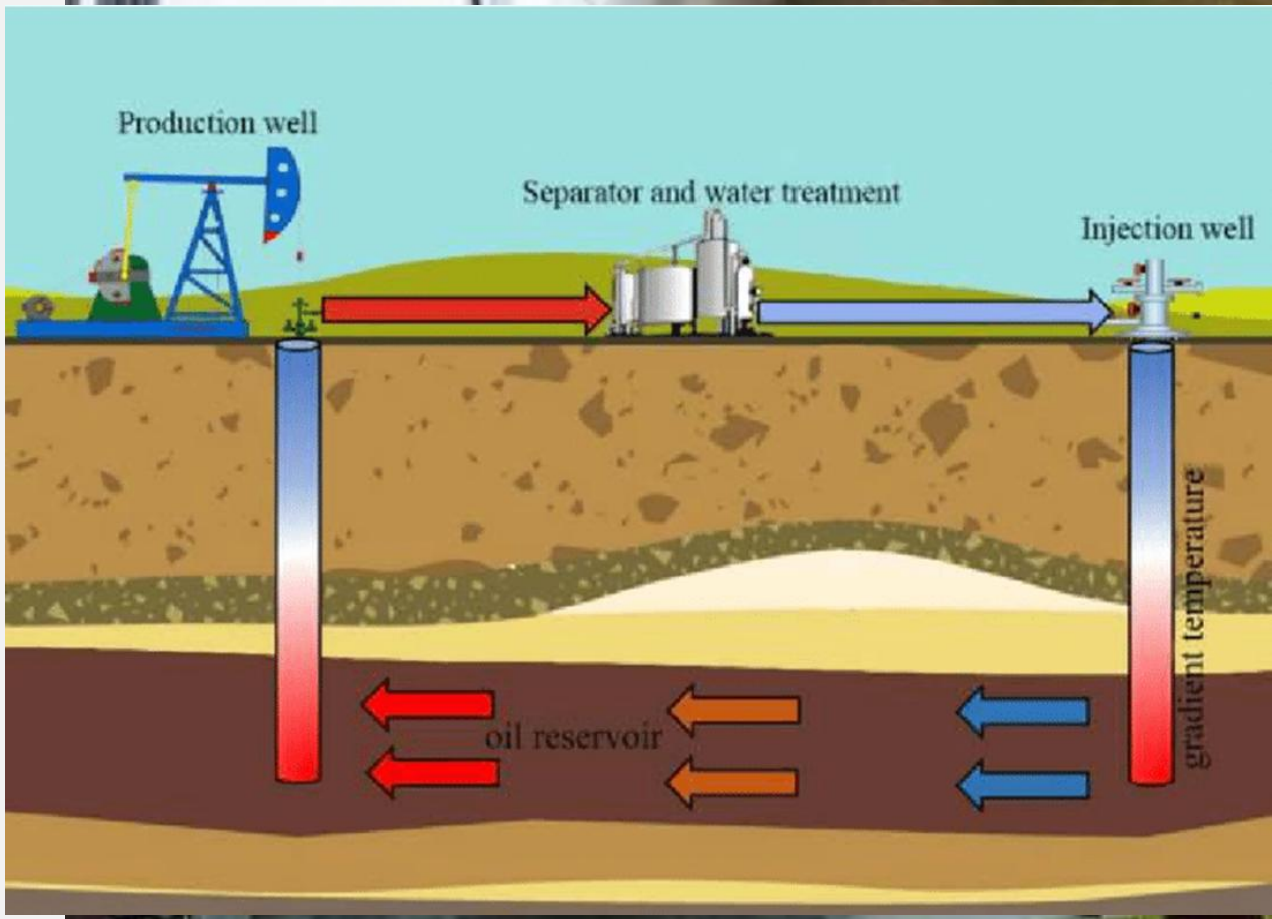
- Many municipalities in Canada use a sodium chloride based salt like rock salt or halite to de-ice roads
- In Canada, more than 5m – 7m tonnes of rock salt are placed onto roads per year
- Sodium and chloride regulated as a result




Snow and ice control material
Initial Discharge
Application to roadway
Release during transport or storage
Salt remains on roadway and dries to powder
Splashed, sprayed, drained, plowed to roadside as liquid
Transport to Environment
High-speed traffic resuspends material as airborne dust
Drains into surface water via roadway, drainage, or percolation through soil
Splash or spray contact with vegetation
Percolation into moderate-to-well drained soils
Percolation into slow-to very slow-drained soils
Transported off road by winds and currents
Transported to groundwater
Salt accumulation in upper level of soil
Impacts:
1. Vegetation
2. Soil
3. Water
Impacts:
1. Water
2. Stream flaura
3. Stream fauna
Impacts:
1. Vegetation
Impacts:
1. Water
2. Vegetation
3. Flow of water body
Impacts:
1. Soil structure
2. Vegetation
3. Erosion

WATER INJECTION

- Injection of water into an oil reservoir allows for oil to be displaced and moved to the production well
- Can increase oil recovery by 30-60%
- Water treated and reused
- Accumulates salts from repeated use
- Scaling common causing corrosion and integrity issues



AGRICULTURAL SALTS

- Potential sources of salt-related compounds in vicinity of testing locations
- Most will have only close-proximity effects due to limited quantities
- Many powdered pesticides have salt component to allow products to be water soluble









Cl -





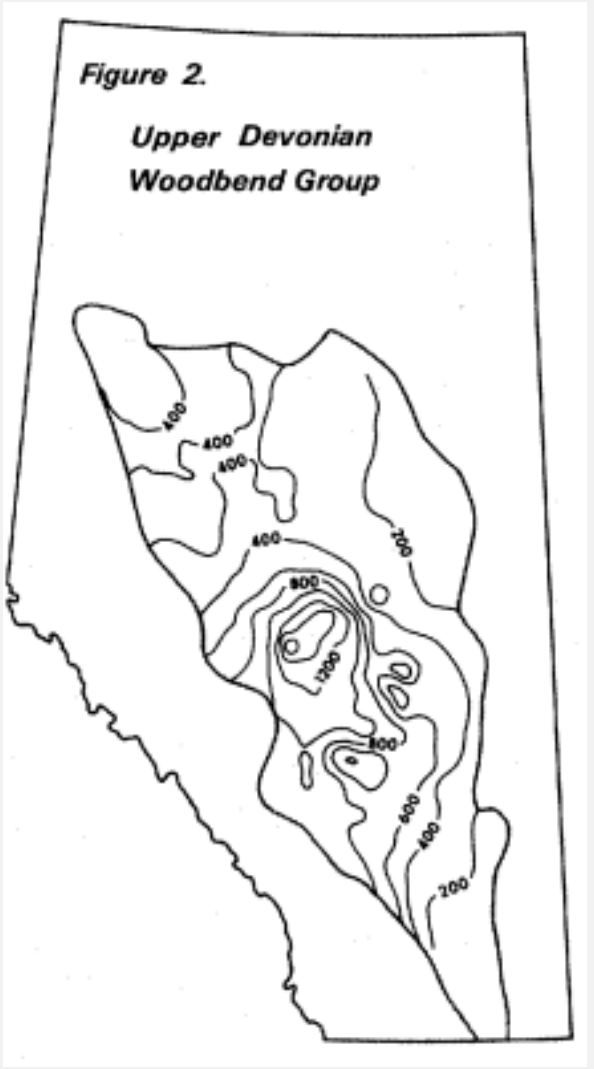


DIFFERENTIATING FACTOR

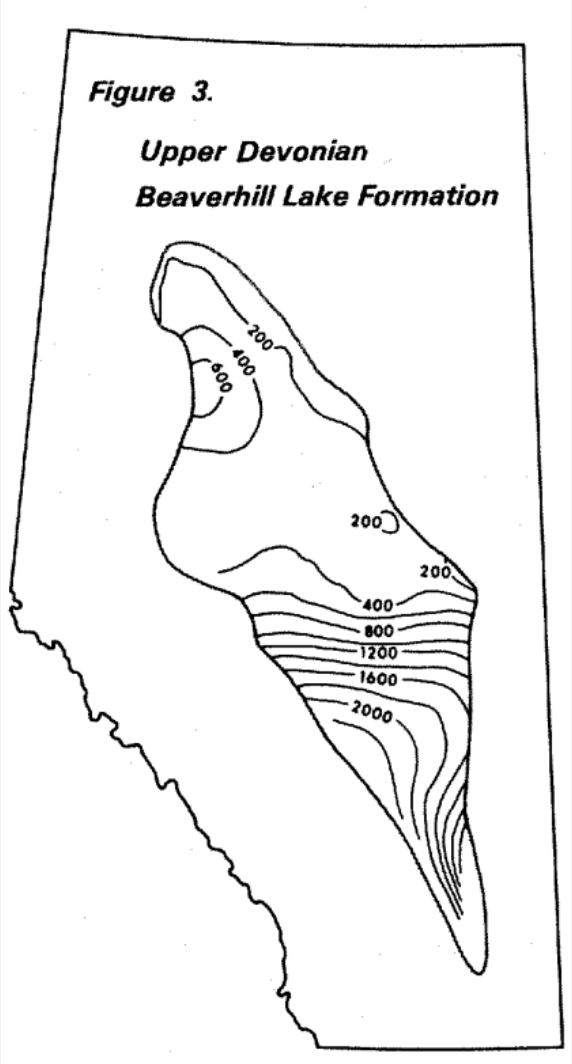
Bromide and Iodide

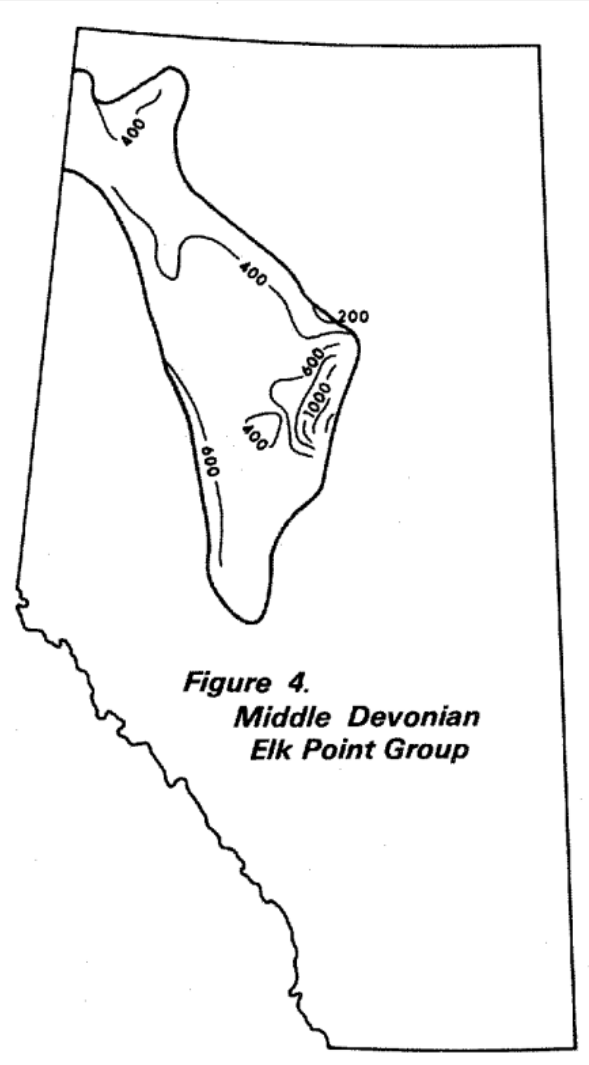
- Chloride is generally 40-8,000 times more abundant in nature than bromide
- Iodide difference is not well studied but presence of any iodide suggests rock salt impact
- Chloride:bromide ratio and, if necessary, chloride:iodide ratio can be used to separate graphically the sources of chloride



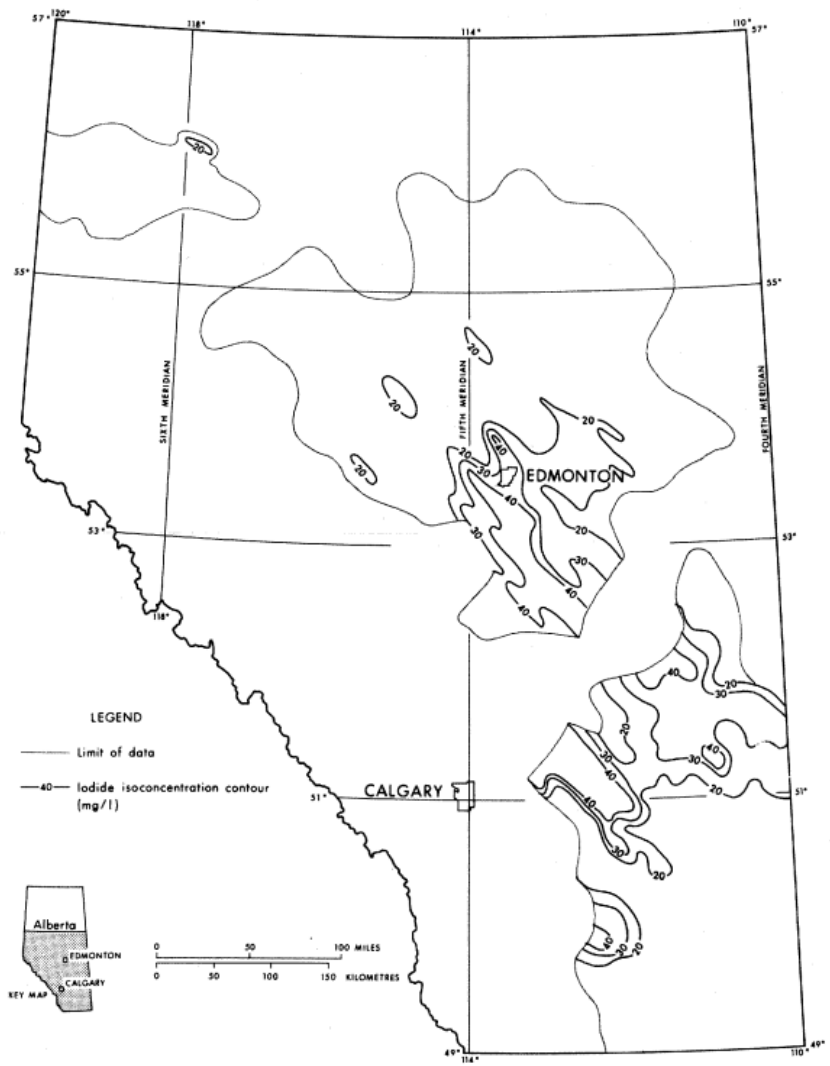


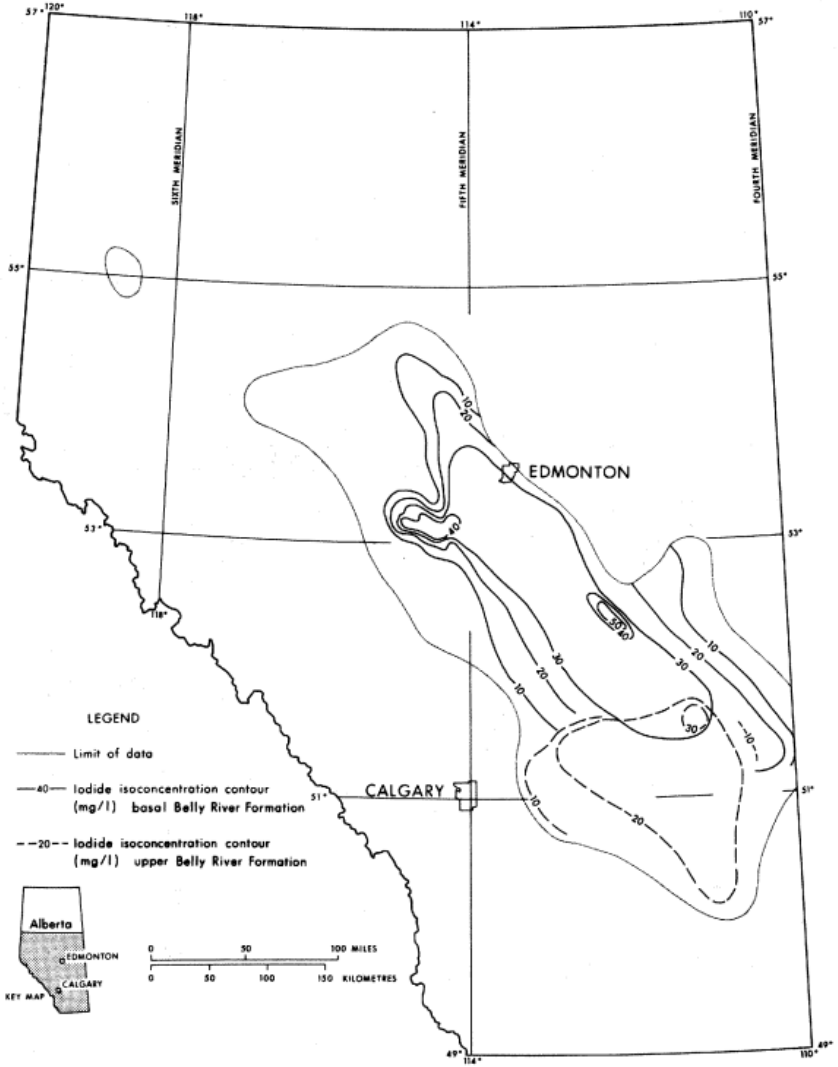
Levinson, A. A., et al. "Bromide, Iodide, and Boron in Alberta Formation Waters." Economic Geology Report 5, Association of Professional Engineers and Geoscientists of Alberta, https://static.ags.aer.ca/files/document/ECO/ECO_5.pdf.





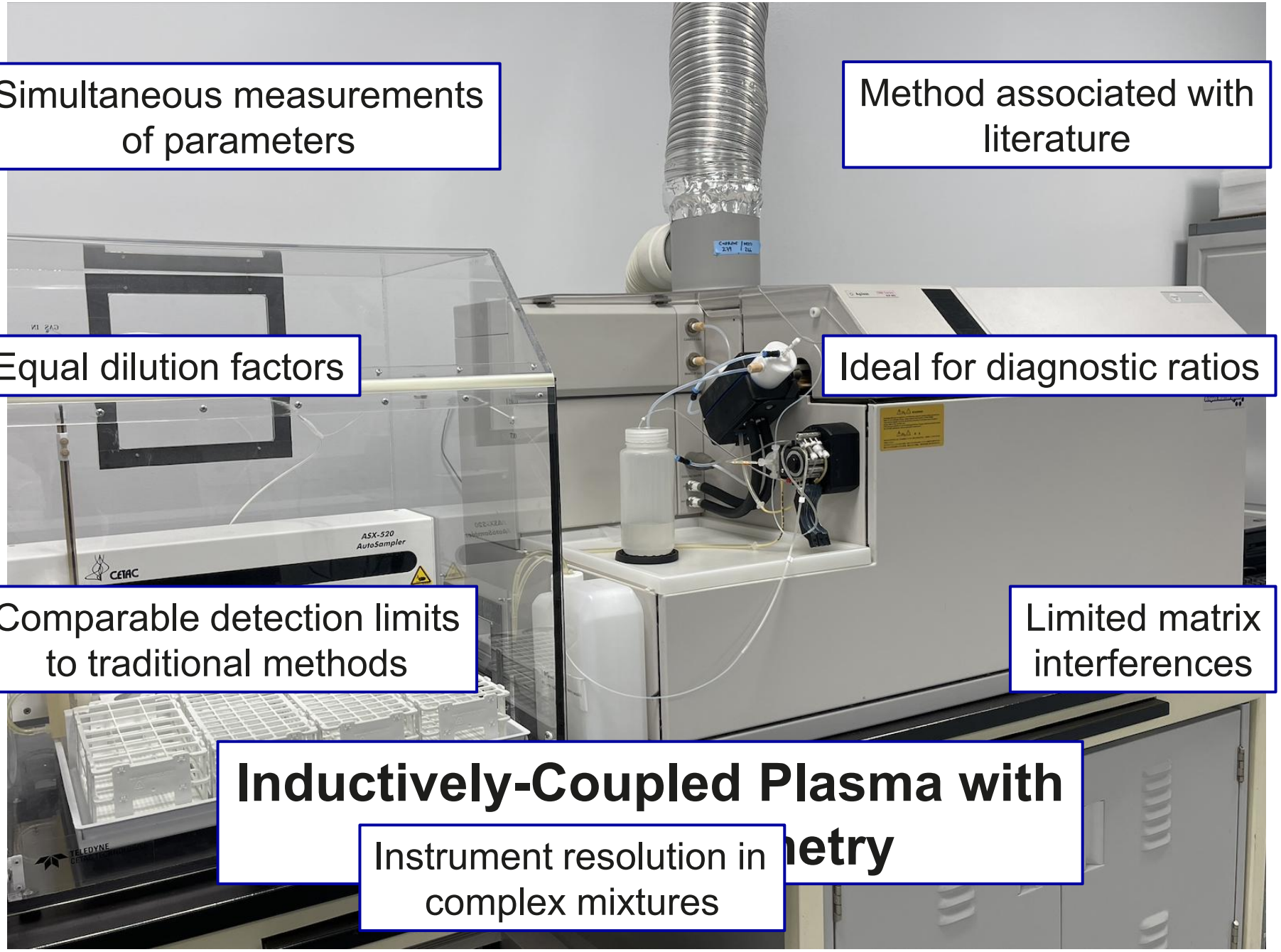
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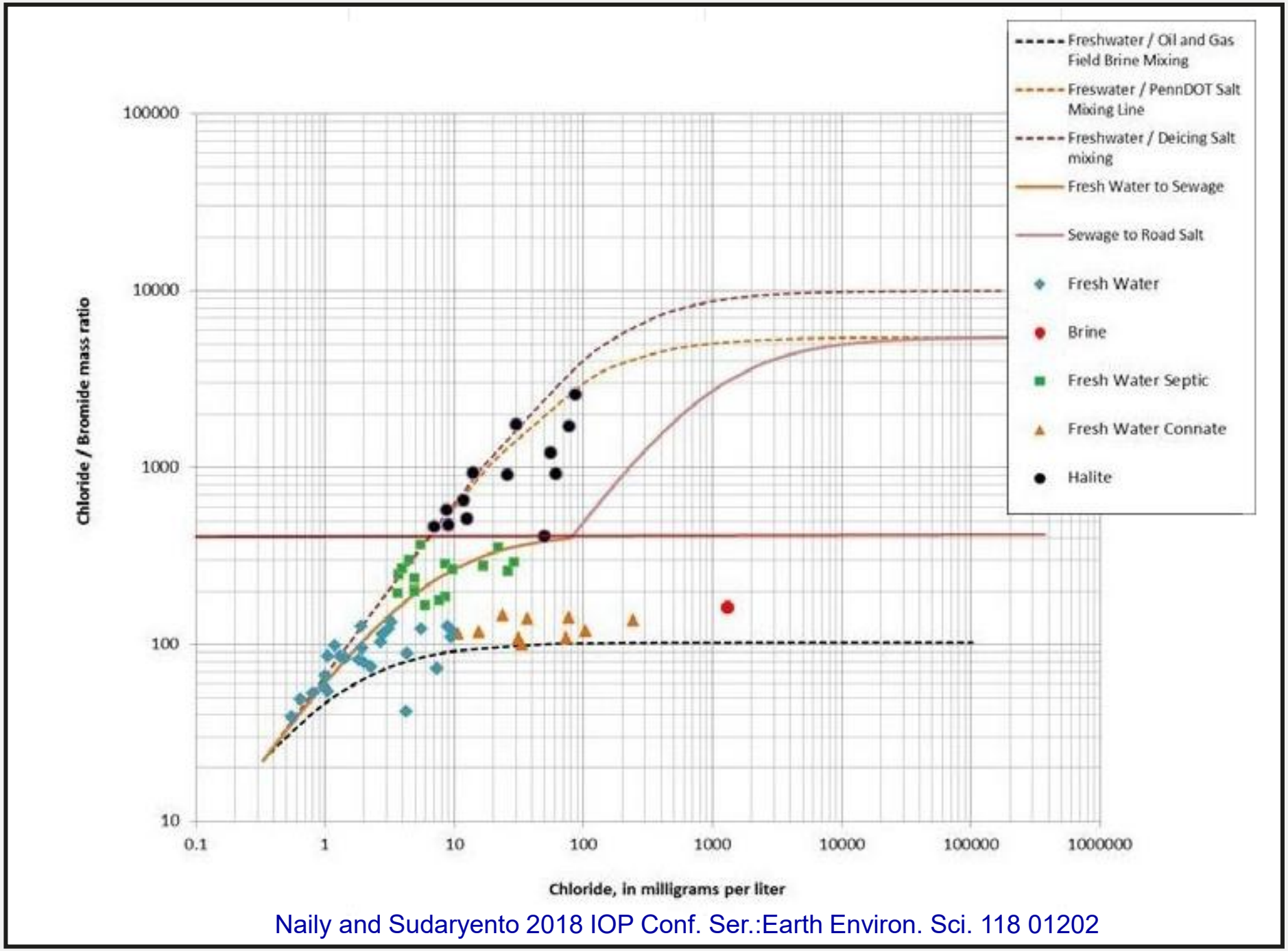


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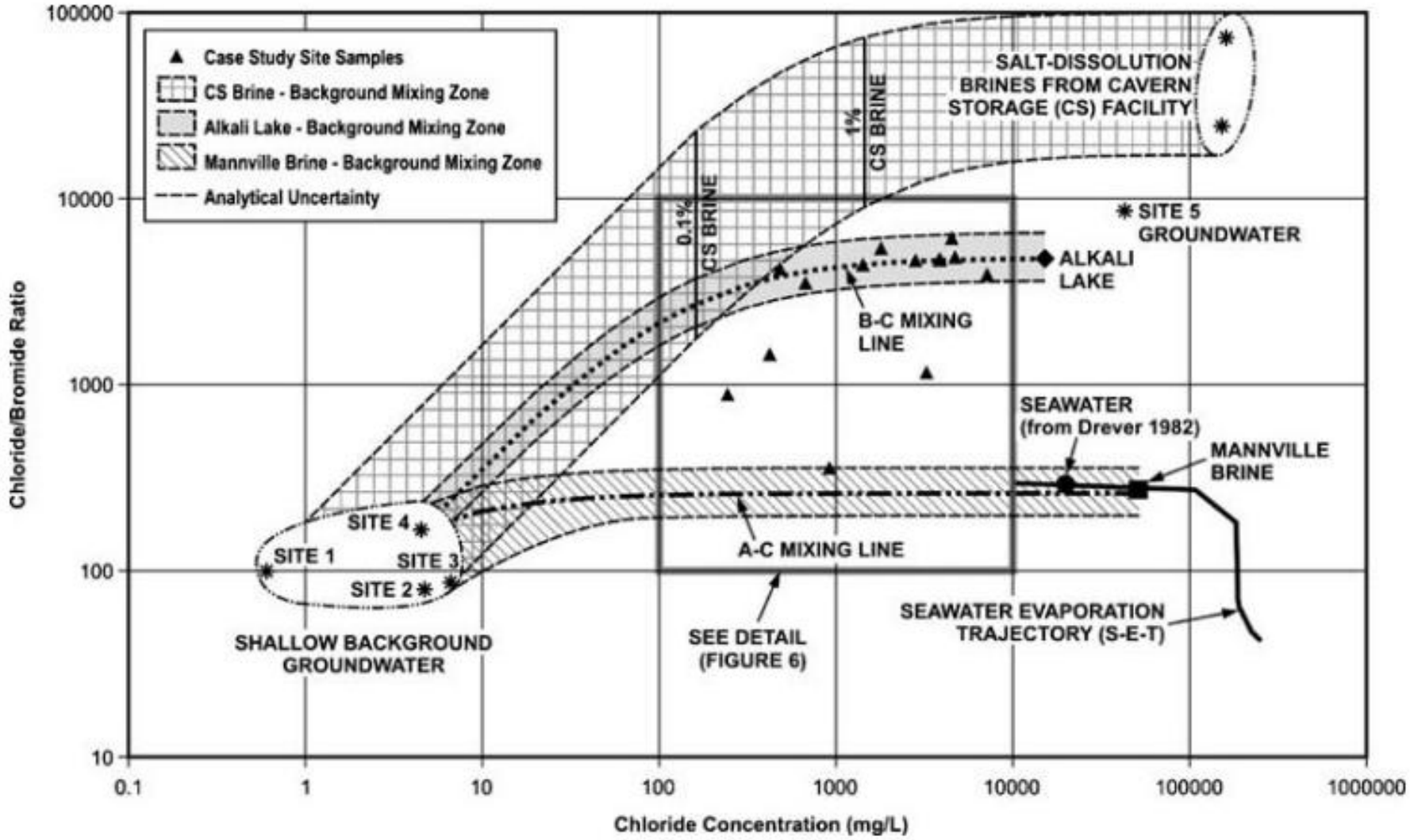
PARAMETERS	ROAD SALT ("BLUE SALT")	ROAD SALT (GENERIC)	COMMERCIAL SEA SALT	COMMERCIAL TABLE SALT	HIMALAYAN ROCK SALT (PINK)	COMMERCIAL COARSE SALT
Iodide	ND	0.3	30	70	ND	ND
Bromide	1,200	1,600	50	310	60	48
Chloride	510,000	470,000	260,000	540,000	520,000	490,000
Cl^-/Br^-	430	290	5,200	1,700	8,700	10,000
Cl^-/I^-	5.1×10^8	$>1.6 \times 10^6$	8,700	7,700	5.2×10^8	4.9×10^8


Simultaneous measurements of parameters
Method associated with literature
Equal dilution factors
Ideal for diagnostic ratios
Comparable detection limits to traditional methods
Limited matrix interferences
Inductively-Coupled Plasma with
netry
Instrument resolution in complex mixtures
CETAC
ASX-520
AutoSampler
TELEDYNE

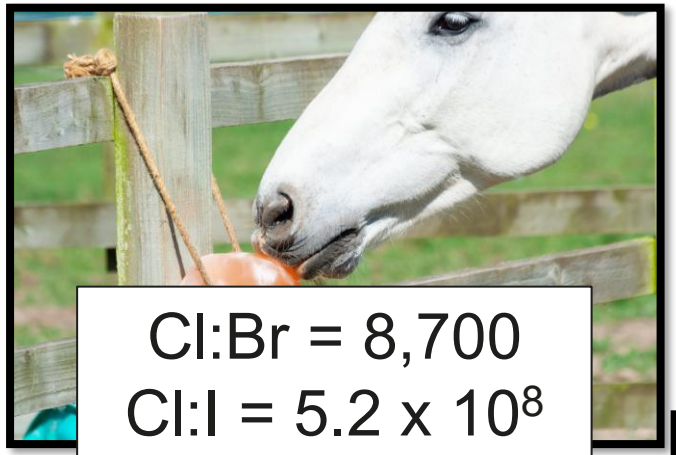
Parameter	Ion Chromatography	Automated Colourimetry	Neutron Activation	Inductively-Coupled Plasma
Chloride	1 mg/L 10 mg/kg	1 mg/L 20 mg/kg	10 ppb 10 ppb	5 mg/L 100 mg/kg
Bromide	0.01 mg/L 2 mg/kg	N/A	5 ppb 5 ppb	0.01 mg/L 1 mg/kg
Iodide	0.1 mg/L 1 mg/kg	N/A	2 ppb 2 ppb	0.002 mg/L 0.1 mg/kg



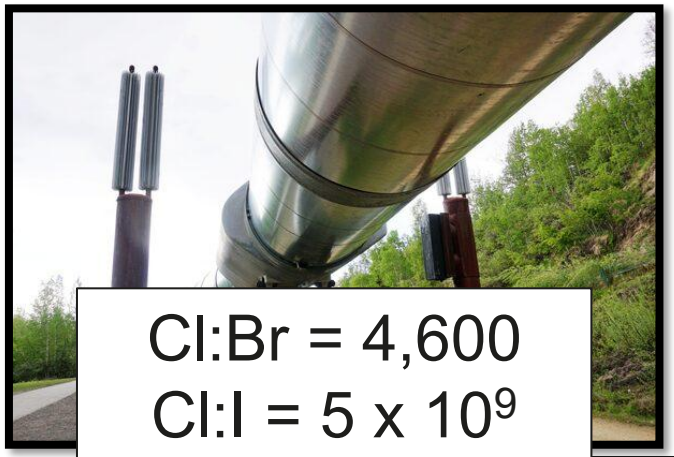
Naily and Sudaryento 2018 IOP Conf. Ser.:Earth Environ. Sci. 118 01202



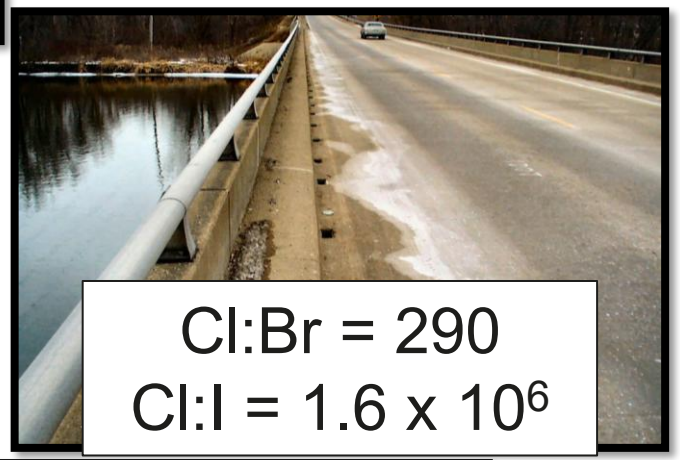
Freeman, J. T. (2007). The use of bromide and chloride mass ratios to differentiate salt-dissolution and formation brines in shallow groundwaters of the Western Canadian Sedimentary Basin. *Hydrogeology Journal*, 15, 1377–1385.



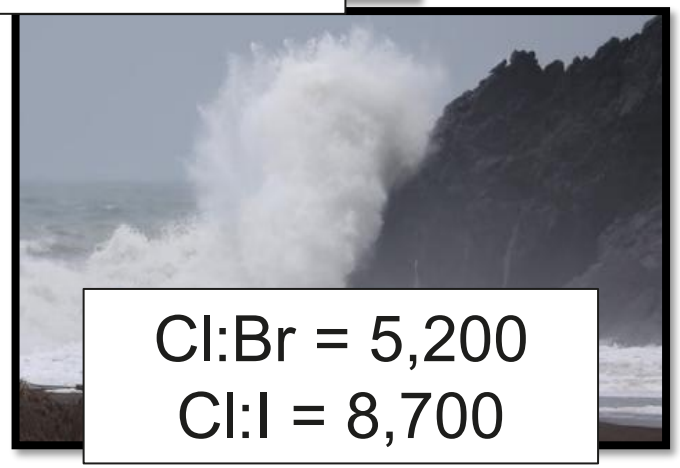
Cl:Br = 8,700
Cl:I = 5.2×10^8



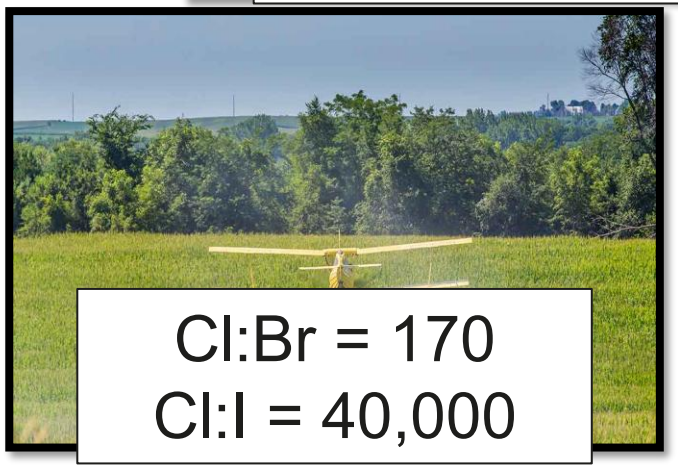
Cl:Br = 4,600
Cl:I = 5×10^9



Cl:Br = 290
Cl:I = 1.6×10^6

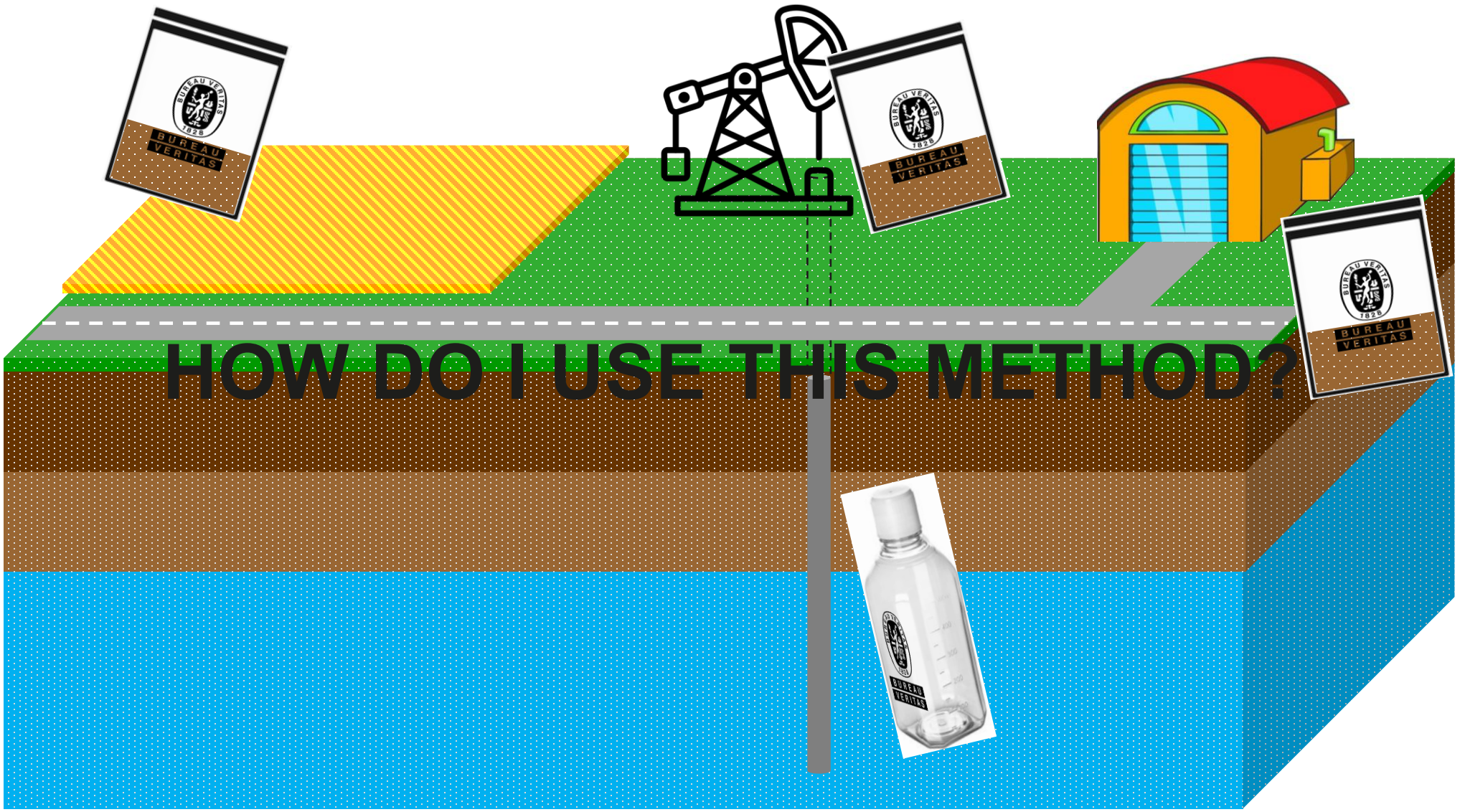


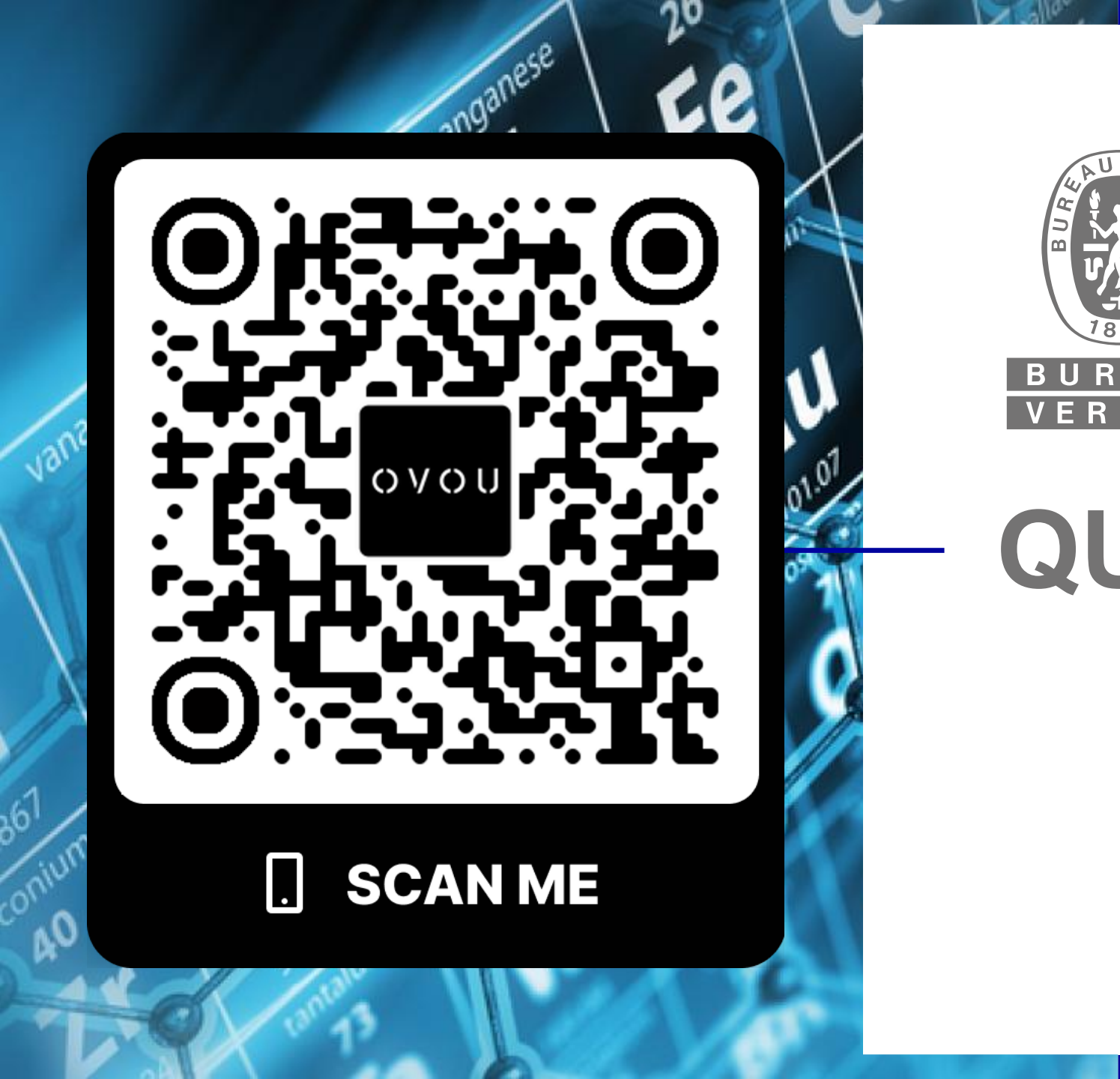
Cl:Br = 5,200
Cl:I = 8,700



Cl:Br = 170
Cl:I = 40,000

HOW DO I USE THIS METHOD?





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QUESTIONS?



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Shaping a World of Trust