Chemical Analyses of Formation Waters in Northeastern British Columbia

Introduction

The sedimentary succession in northeastern British Columbia is part of the Western Canada Sedimentary Basin (WCSB), which spans the provinces of British Columbia, Alberta, Saskatchewan, and Manitoba and is in a mature stage of petroleum exploration. In British Columbia, 10,744 samples of formation water (Table 1) were analyzed from 4945 wells (see Figure 1 for distribution). The formation water samples were collected mainly by the petroleum industry. The chemical analyses data are submitted in their raw form to the B.C. Ministry of Energy and Mines, and data up to 2002 were electronically entered in two phases into a database by the Alberta Geological Survey of the Alberta Energy and Utilities Board. The first phase included water analyses submitted by the industry approximately until 1993 and in the second phase data were added that were submitted from 1993 to 2002.

Data entry	All chemical analyses	Culled analyses*	Good analyses*
Up to 1998	3546	880	2666
1998 to 2002	7198	1873	5325
Total	10744	2753	7991

Table 1: Number of chemical analyses of formation water submitted to the B.C. Ministry of Energy and Mines until 2002. (* see Table 2 for culling criteria).

The chemistry of formation waters can be used to determine water origin and evolution, and to interpret fluid flow within the sedimentary succession. This can be further applied to the study of mineralization processes, and the prediction of chemical reactions within reservoirs used for the geological sequestration of carbon dioxide, acid gas, and other hazardous wastes.

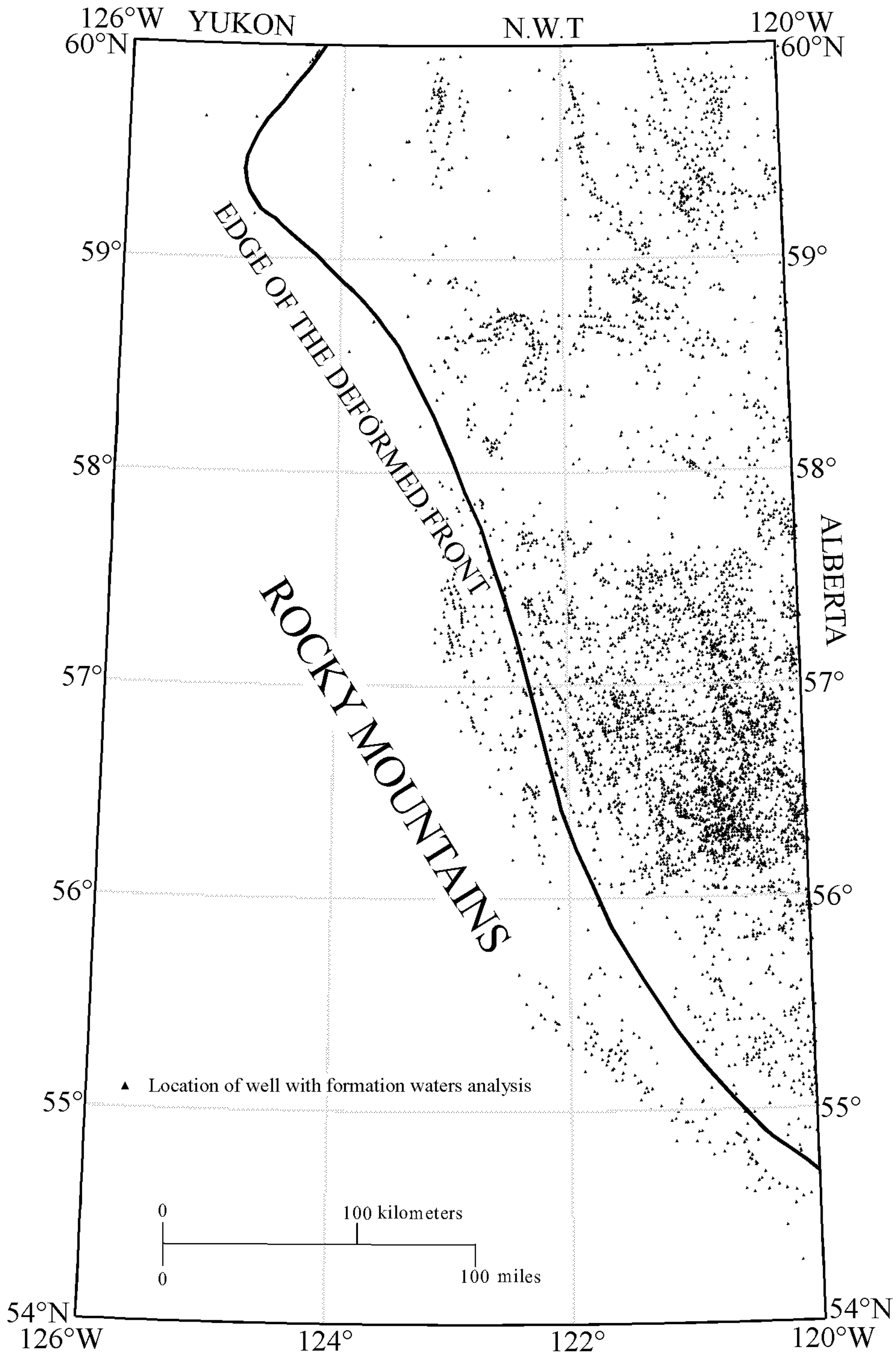

Figure 1: Location of wells with chemical analyses of formation waters in northeast British Columbia.

Data quality

The database of formation water chemistries contains analyses of varying quality, including incomplete analyses and analyses from samples contaminated with drilling mud. The quality of chemical analyses should be evaluated before using the data in any hydrogeological investigation, because it is important to use good-quality and uncontaminated analyses. For example, by using a sequential mechanical culling procedure as described by Hitchon & Brulotte (1994) (Table 2), initially only 7991 analyses out 10,744 pass as "good analyses".

Flag #	Culling Criteria
1	Any of Ca, Mg, Cl, HCO_3 (or alkalinity), or SO4 missing
2	Mg-concentration > Ca-concentration
3	10.0 < pH < 5.0
4	OH reported
5	CO_3 reported
6	Calculated Na-concentration < 0
7	Density < 1000 kg/m^3
8	([cation] - [anion]) / ([cation] + [anion]) > 0.15
9	No sample depth interval reported
10	Method of production from excluded class
11	Sampling point from excluded category
12	Fe > 100 mg/l in separator or treator
13	Analysis from multiple drillstem tests

Table 2: Culling criteria for formation water analyses used in the automatic culling procedure (from Hitchon & Brulotte 1994).

The rejection criteria act on the data set in successive order of their individual importance. Herein, incomplete analyses for example are considered of the highest culling priority, because important ion concentrations are missing and these analyses cannot be hydrochemically balanced. This will affect mainly analyses where only one component (most often chloride) is reported. Drilling and production methods are considered of a lesser priority, because they might suggest a high possibility of sample contamination due to their technical nature, but the quantitative influence on the analysis cannot be defined. Additional data culling by a geochemist is necessary, taking in account the specific chemical characteristics of formation water in various aquifer units, regional geology and flow of formation water.

Allocation of chemical analyses of formation waters

The sedimentary succession in northeastern B.C. overlies the crystalline Precambrian basement and consists of Cambrian to Lower Jurassic, dominantly marine sediments (carbonates, shales, evaporites), and Upper Jurassic to Cretaceous, foreland basin siliciclastics (sandstones, siltstones, shales). Based on the general lithology distribution, the entire succession can be subdivided into various regional aquifer (carbonates, sandstones) and aquitard (shales, evaporites) units (see Figure 2). The number of chemical analyses in various hydrostratigraphic units is related to the occurrence of hydrocarbon reservoirs. Therefore, the main hydrocarbon-producing intervals, i.e., Lower Mannville, Triassic, Mississippian, and Devonian, have the largest number of formation water analyses (Figure 2).

Reference:

Hitchon, B., and Brulotte, M. (1994): Culling Criteria for “Standard” Formation Water Analyses. Applied Geochemistry, v. 9, 637-645.

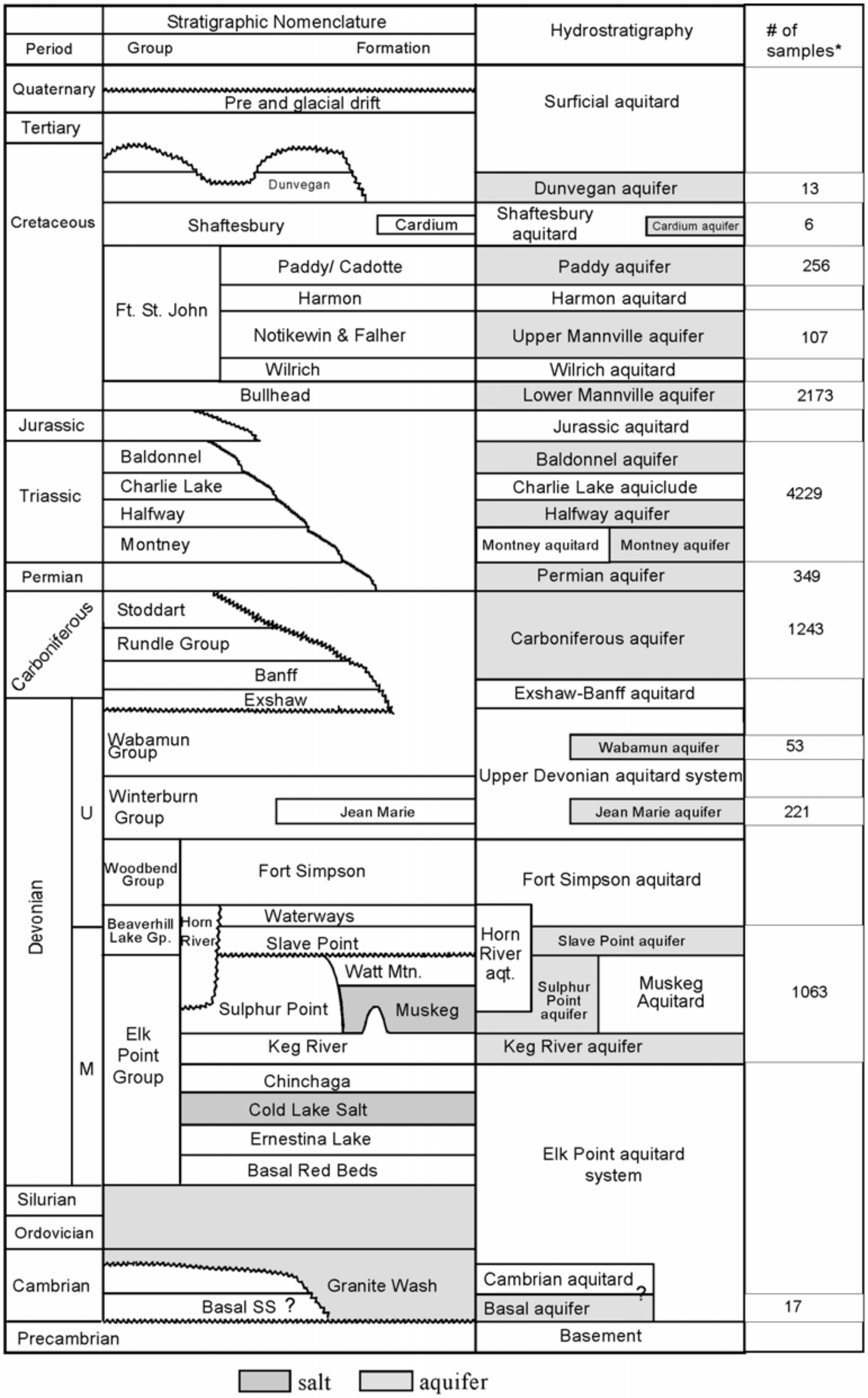

Figure 2: Stratigraphic and hydrostratigraphic nomenclature of the sedimentary successsion, northeastern British Columbia. (*) Number of samples is based on the formation names in the chemistry report (where given), and represents a bulk estimate for the various hydrostratigraphic units.