# **Brine Principal Components Analysis Java Applet**

by John R. Victorine

# Introduction

To access Profile go to <u>http://www.kgs.ku.edu/PRS/Ozark/Software/PC/</u>. At the top of the web page there is a menu "Main Page|Applet|Download|Help|Copyright & Disclaimer|". Select the "Applet" menu option a "Warning - Security" Dialog will appear. The program has to be able to read and write to the user's PC and access the Kansas Geological Survey (KGS) Database and File Server, ORACLE requires this dialog.

x Do you want to run this application?						
ſ	4	Name:	Brine Data Principle Components Analysis			
	£	Publisher:	University of Kansas			
		Location:	http://www.kgs.ku.edu			
	This application will run with unrestricted access which may put your computer and personal information at risk. Run this application only if you trust the location and publisher above.					
Do not show this again for apps from the publisher and location above						
Û	More Infor	rmation	Run Cancel			

The program does not save your files to KGS, but allows you to access the KGS for well information that may be missing in your Kansas Data. The program does not use Cookies or any hidden software it only reads the CSV & XML files for the Principal Components Analysis Session and writes a CSV, XML and PNG Files to your PC to save the Brine data imported. The blue shield on the warning dialog is a symbol that the Java web app is created by a trusted source, which is the University of Kansas. Select the "Run" Button, which will show the Brine Data "Enter" Panel illustrated below,



# **Table of Contents**

Loading Brine Data	3
KGS (Database) – Importing Brine Data	3
KGS Icon Button	3
CO2 Icon Button	5
PC - Importing Brine Data	9
Download Well Data to PC	9
Brine XML (Extensible Markup Language) ASCII File	10
Brine Data Extensible Markup Language (XML) Document Type Definition (DTD)	11
Brine CSV (Comma Separated Values) ASCII File	13
Brine Data CSV (Comma Separated Values) File Structure	15
Brine Data Dialog	18
Compute Correlation Matrix Button	19
Save Brine Data as a Comma Separated Values (CSV) ASCII File	22
Save Brine Data as an Extensible Markup Language (XML) ASCII File	24
Save Brine Principal Components Panel as a Portable Network Graphics (PNG) Image File	26
Brine Data - Principal Components Analysis	28
Begin Normalization Process Button	32
Normalization Brine Data to +/- 2% of the Anions/Cations Ratio of 1.0	33
Comparison of the Original Brine Data with the Normalized Brine Data	37

# **Loading Brine Data**

Click the "Brine Data Enter" Icon Button, which will show the "Load Data" Dialog. The dialog below displays an example of the DOE  $CO_2$  2015-10-12 Comma Separated Values (CSV) ASCII File, downloaded using the "PC: Read Brine Data by" panel. The radio buttons & icon buttons in the Data Source Panel assists the user in loading brine data into the Brine Data - Principal Component Applet. The DOE  $CO_2$  2015-10-12 CSV ASCII File can be downloaded from the following URL address,

CSV: <u>http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE\_CO2\_Wells\_2015\_10\_12.csv</u> or ZIP: <u>http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE\_CO2\_Wells\_2015\_10\_12.zip</u>

This file is the output file for an ORACLE PL/SQL stored procedure that accesses the DOE CO2 Project Brine Database Table,

http://chasm.kgs.ku.edu/ords/iqstrat.co2\_brine\_summary\_csv\_pkg.build\_web\_page .

The data displayed is in a CSV format, but it has HTML code embedded, which can be trimmed easily.

💩 Load Data

#### KGS (Database) Panel

#### - KGS Icon

This button allows the user to search the KGS Brine Data Database Table for Brine Data. The Kansas Brine Data Records date back to 1940's and 1950's. - CO2 Icon

This button allows the user to search the CO<sub>2</sub> Brine Data Database Table for Brine Data. This data supports the CO<sub>2</sub> Sequestration Project.

#### PC: Read Brine Data By Panel

This panel allows the user read in brine data by 2 file types

1. Comma Separated Values (CSV) ASCII File

2. Extensible Markup Language (XML) ASCII File

Data Source							
KGS Database							_
Load Brine Data							
PC: Read Brine Data	By						
					Lo	ad PC Data	•
	<ul> <li>XML (Extensible Markup Language) File</li> <li>CSV (Comma Delimited) File</li> </ul>						
id		Leas	e Name		Locatio	n	L
151208055521_0			was KAMAS 6				8 <mark>7.</mark> ▲
151208055521_1			was KAMAS 6				37.
151208055521_2			was Kamas 7 2			-	87. =
151208055521_3			was Kamas 7 2				37.
151208055521_4			was FRANK K				37.
151208055521_5			was FRANK K				37.
151208055521_6			was CURTIS 2				37.
151208055521_7			was W. I. GASH			-	87. 87.
151208055521_8 151208055521_9			was RIDDELL was LUDWIG 2				87. 87.
151208055521_9			was LUDWIG				87.
151208055521_10			was MILLER 1	-		-	87.
151208055521 12			was J. C. FRAM				37.
151208055521 13			was J. C. FRAM			-	37.
151208055521 14			was J. C. FRAM			-	37
151208055521 15			was L C FRAM				7 -
•							•
C	ontinue		Clear		Exit		

#### Brine Data Loaded Table

This identifies the records that have been downloaded to the web app for processing.

#### Load Data Dialog Buttons

Continue – Transfers the Brine Data in the table to the Brine Data Dialog. Clear – Clears the Brine Data Loaded Table. Exit – Exit Dialog.

#### **Data Source Panel**

The Data Source Panel provides two methods of importing data into the Brine Data & Data Entry Web App. The Kansas Geological Survey (KGS) Database and the user's PC. There are 2 icon buttons in the KGS Database panel. The KGS icon button assists the user in locating a set of brine data for selected counties in Kansas. The data are based on archived materials from the Kansas Geological Survey, with measured well data from the 1940's to 1950's. The CO2 icon button allows the user to download the brine data from the CO2 Project Brine Database table by dates measured, analyzed and reported. The "Load PC Data" icon button along with the 2 radio buttons assists the user to load Brine data by 3 possible ASCII File methods,

- 1. Comma Separated Values (CSV).
- 2. Extensible Markup Language (XML) Files.

The CSV (Comma Separated Values) radio button under the "PC: Read Brine Data By" panel are expecting a general type of data presentation. Although the order of the specific data columns is not important, the "Mnemonics" of the data column is. The CSV Search Dialog will use the first two lines of the CSV file to automatically match the file column data mnemonics with the web app curve mnemonics and the units of the brine data, but if the program does not recognize the file data mnemonic then it will leave it blank and expect the user to match the file data mnemonic to the web app curve mnemonics, this will be explained later.

The Extensible Markup Language (XML) radio button under the "PC: Read Brine Data By" panel are expecting a specific Document Type Definition (DTD) to read the file. The DTD is used in retrieve both the data coming from the Kansas Geological Survey Database or as the output from the Brine Data & Data Entry Java Web App. The DTD will be presented later.

#### **Data Loaded Panel**

The Brine Data Loaded Panel provides a visual feedback that the brine data was loaded, by the individual samples listed in the "Brine Data Loaded" table. When the user selects the "Continue" button the data is transferred to the Brine Data dialog, where the Principal Components Process can be performed on the data.

### KGS (Database) - Importing Brine Data – KGS Icon button

The Kansas Geological Survey (KGS) has a good collection of brine data stored in the ORACLE Database. In this example the user will download the well data available from the KGS Brine Database. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the well & brine data that is passed back to the web app making the request.

l	Data Source
	KGS Database
	Load Brine Data
	CO2
	PC: Read Brine Data By
	○ XML (Extensible Markup Language) File
	CSV (Comma Delimited) File

Left Click on the KGS Icon Button in the Data Source Panel of the Load Data Dialog.

Close Dialog				Search for Brine Data in KGS Database
Search for Data in Kans	sas Geological Survey Database:			Search By:
Search By:			_	•Lease Name – The user can search for well data by
Lease Name	Enter Partial Lease Name:			lease partial phrase, i.e. "Marshall", which will look for
0.0.0				📕 🏲 all wells with the phrase "Marshall" in the lease name
Sec. Town. Range	Marshall			Section Township Range – Search for a list of Wells
Counties	l			by a specific area.
	Search			• Counties – Search for a list of Brine Data within counties available in Brine Database Table.
List of Brine Samples:			_	councies available in brine Database rable.
id	Lease Name	Location		
1036136484	MARSHALL E COLE 1	T13S R37E Sec. 13	-	
1034017203	MARSHALL #1	T17N R9E Sec. 31		
1033987835	MARSHALL #1	T33S R3W Sec. 5		
1033987733	MARSHALL #1	T33S R3W Sec. 5		
1033987734	MARSHALL #1	T33S R3W Sec. 5		
1033987735	MARSHALL #1	T33S R3W Sec. 5		List of Brine Data for wells that match the search crite
1033987736	MARSHALL #1	T33S R3W Sec. 5		
1033987737	MARSHALL #1	T33S R3W Sec. 5		
1033987738	MARSHALL #1	T33S R3W Sec. 5		Note: the "List of Brine Samples" Table is set up to ma
1033987739	MARSHALL #1	T33S R3W Sec. 5		multiple selections of data using the "Ctrl" Key on the
1033987740	MARSHALL #1	T33S R3W Sec. 5	=	keyboard with left click of mouse. Sell the highlighted
1033987741	MARSHALL #1	T33S R3W Sec. 5		brine samples for the MARSHALL #1 Well.
1033987742	MARSHALL #1	T33S R3W Sec. 5		
1033987743	MARSHALL #1	T33S R3W Sec. 5		
1033987744	MARSHALL #1	T33S R3W Sec. 5		
1033987745	MARSHALL #1	T33S R3W Sec. 5		
1033987746	MARSHALL #1	T33S R3W Sec. 5		
1033987747	MARSHALL #1	T33S R3W Sec. 5		
1033987748	MARSHALL #1	T33S R3W Sec. 5		
1034046080	MARSHALL E - 1 E - 2	T50N R68W Sec. 32	-	
				Load Data Button – transfers the selected brine data t
	Load Data			the calling web app.

This will display the "Search for KGS Brine Data" Dialog, see above image. This dialog allows the user to search the KGS database for brine data. In this example, the well of interest will be the Marshall #1 this well contains all the brine samples that can be retrieved from the KGS Database.

As the Summary image suggests there are 3 methods for searching for the well data within this dialog,

• By Partial Lease Name – The stored procedure used to retrieve the list of brine samples from the KGS Database allows the user to enter a partial phrase, in this example Marshall. The program places a '%' in front and back of the phrase and sends the request to the Database, i.e. "%Marshall%".

Search for Data in Kansa Search By:	as Geological Survey Database:				
Lease Name	Enter Partial Lease Name:				
<ul> <li>Sec. Town. Range</li> <li>Counties</li> </ul>	Marshall				
Search					

• By Township Range Section – This search is for brine samples in Kansas by, e.g. to look for the Marshall #1 brine samples, enter Section as 5, Township as 33 set the S (South) Radio button and Range as 3 set the W (West) Radio button.

Search for Data in Kans	as Geologic	al Survey Database:				
<ul> <li>Lease Name</li> <li>Sec. Town. Range</li> </ul>	Section:	Township:	Range:			
Counties		5 33 O N	● S 3 ● W ○ E			
	Search					

• By County – This panel allows the user to search for brine samples by counties with brine data in the database table, e.g. select the SUMNER County Button.

Search for Data in Kans Search By:	as Geological Survey Database:					
C Lease Name	SHERMAN	SMITH				
O Sec. Town. Range	STAFFORD	STANTON				
Counties	STEVENS	SUMNER	-			
Search						

The user only needs to enter the above data and select the "Search" Button to display the list of brine data samples in the Kansas Database that match the search criteria. In the image below the Lease Name "Marshall" was entered to search for all brine samples for wells in Kansas with the Phrase Marshall in it. The user searches through the list until they find the well of interest. In this example 6 brine samples are highlighted for the Marshall #1 well.

Close Dialog			
Search for Data in Kans	as Geological Survey Database:		
Search By:			
Lease Name	Enter Partial Lease Name:		7
~			
Sec. Town. Range	Marshall		
Counties			
	Search		
List of Brine Samples:			
id	Lease Name	Location	
1034003719	MARSHALL-FEDERAL 1	T23S R33E Sec. 19	-
1036135172	MARSHALL 1	T23S R33E Sec. 19	
1036135409	MARSHALL B 8	T21S R37E Sec. 27	1
1036136481	MARSHALL E COLE 1	T13S R37E Sec. 13	1
1036136483	MARSHALL E COLE 1	T13S R37E Sec. 13	1
1036136484	MARSHALL E COLE 1	T13S R37E Sec. 13	1
1034017203	MARSHALL #1	T17N R9E Sec. 31	1
1033987835	MARSHALL #1	T33S R3W Sec. 5	
1033987733	MARSHALL #1	T33S R3W Sec. 5	1
1033987734	MARSHALL #1	T33S R3W Sec. 5	
1033987735	MARSHALL #1	T33S R3W Sec. 5	
1033987736	MARSHALL #1	T33S R3W Sec. 5	1=
1033987737	MARSHALL #1	T33S R3W Sec. 5	1
1033987738	MARSHALL #1	T33S R3W Sec. 5	
1033987739	MARSHALL #1	T33S R3W Sec. 5	
1033987740	MARSHALL #1	T33S R3W Sec. 5	1
1033987741	MARSHALL #1	T33S R3W Sec. 5	
1033987742	MARSHALL #1	T33S R3W Sec. 5	
1033987743	MARSHALL #1	T33S R3W Sec. 5	
1033987744	MARSHALL #1	T33S R3W Sec. 5	
1033987745	MARSHALL #1	T33S R3W Sec. 5	
1033987746	MARSHALL #1	T33S R3W Sec. 5	μ
1033987747	MARSHALL #1	T33S R3W Sec. 5	
1033987748	MARSHALL #1	T33S R3W Sec. 5	
1034046080	MARSHALL E - 1 E - 2	T50N R68W Sec. 32	]_
A 1020225			1-

To download the brine data select the "Load Data" Button.

Note: The user needs to hit the "Ctrl" Key on the Keyboard at the same time as they left click with the mouse to select the brine samples for the Marshall #1. In this case there are a number of overlapping samples so only the above samples were selected for viewing. The Brine Data database table is not connected to the Well Headers Table in the Database. For most part the brine data database table holds data from the 1940's and the 1950's. The user will need to search the KGS Master List of Oil and Gas Wells in Kansas web page

(<u>http://www.kgs.ku.edu/Magellan/Qualified/index.html</u>). The brine data samples belong to the Marshall 1 (15-191-00003) Township 33S, Range 3W and Section 5, Sumner County, Kansas.

#### KGS (Database) - Importing Brine Data - CO<sub>2</sub> Icon button

The  $CO_2$  Icon button allows the user to download the well data available from the DOE CO2 Brine Database. The ORACLE Database is accessed by making Stored Procedure PL/SQL calls to the ORACLE Database from which an Extensible Markup Language (XML) data stream is created containing the well & brine data that is passed back to the web app making the request.

Load Brine Data	
PC: Read Brine Data By	
	Load PC Data
XML (Extensible Markup Language) File	A Brine

Left Click on the  $CO_2$  Icon Button in the Data Source Panel of the Load Data Dialog to display the search dialog. There is only one search engine with this dialog the Search By "Dates".

🛓 SELECT		
Search By		Search By
Sa	ampled Date	Wellington
Re	eceived Date	
Re	eported Date	○ Bemis
Total		Description
47	2015-05-21	
5	2015-06-19	
12	2015-07-27	
	Se	lect

Selecting any of the "Search By" buttons will automatically search for data in the Brine Data Database Table based on the type of search. The following buttons will retrieve the available brine data by XML - Extensible Markup Language data streams that are parsed. The XML calls are listed as follows:

Buttons	ORACLE PL/SQL call to retrieve the number of wells and available dates
Sampled Date	http://chasm.kgs.ku.edu/ords/iqstrat.co2_grid_brine_data_pkg.getDateListXML?iDate=0
Received Date	http://chasm.kgs.ku.edu/ords/iqstrat.co2_grid_brine_data_pkg.getDateListXML?iDate=1
Reported Date	http://chasm.kgs.ku.edu/ords/iqstrat.co2_grid_brine_data_pkg.getDateListXML?iDate=2

The Search By "Dates" returns the actual date entered for the brine data group and the total number of wells that have brine data with that date, i.e., select the "Reported Date" Button and the following list will be displayed.

Total	Description	
47	2015-05-21	
5	2015-06-19	
12	2015-07-27	

At the time of this document there are only 3 possible well groups, "2015-05-21", 2015-06-19" and "2015-07-27". The "2015-05-27" brine data well group has a total of 47 wells out of a possible 52 wells with brine data sampled on this date. The user only needs to highlight the 1<sup>st</sup> row in the list and click on the "Select" button at the bottom of the panel. This action will automatically retrieve the date as the search criteria and make an ORACLE PL/SQL call,

http://chasm.kgs.ku.edu/ords/iqstrat.co2\_grid\_brine\_data\_pkg.getDateXML?iDate=2&sTime=20 15-05-21&field=Wellington

This call will return a XML – Extensible Markup Language data stream with a list of wells and the brine data of each well in the Reported Date Well Brine Data Group.

## Importing PC Data - Download Well Data to PC

Download either the ASCII Text Files directly or the Zip files extracting the contents into a directory. The problem with the ASCII Text Files being downloaded directly from a web page is that the web page will alter the contents so it does not retain the basic structure and add HTML text to the file. The preferred method if you have Zip or WinZip is to download the zip files to your PC and extract.

Well Data:

CSV File contains the all the brine data in the DOE  $CO_2$  Brine Database Table on the date 12 October 2015.

XML File contains the brine data in the DOE  $CO_2$  Brine Database Table for the Reported Date 21 May 2015.

Туре	ASCII Text Files
CSV	http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE_CO2_Wells_2015_10_12.csv
XML	http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE_CO2_Wells_2015_05_21.xml

Туре	Zip Files
CSV	http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE_CO2_Wells_2015_10_12.zip
XML	http://www.kgs.ku.edu/PRS/Ozark/Software/PC/DOE_CO2_Wells_2015_05_21.zip

#### Importing PC Data – Brine XML (Extensible Markup Language) ASCII File.

This web app allows the user to save and read Brine Data as Extensible Markup Language (XML) file. The data that is retrieved from the Kansas Geological Survey database is retrieved as a XML data stream that is parsed and loaded into the Brine Plot & Data Entry web app. This program allows the user to save the data as a XML file, which uses the same Document Type Definition (DTD) to format the data.

Load PC Data
Data

Select the "XML (Extensible Markup Language) ASCII File" radio button and then left click on the "Brine Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select Brine Data Comma Delimited File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Brine XML file DOE\_CO2\_Wells\_2015\_05\_21.xml, highlighted below.

🛓 Select Brine Dat	🛓 Select Brine Data Comma Delimited File from your PC.						
Look in:	👢 WebSite	•	• 🕝 🥬 🖻	۶ ◄			
Name         Recent Places         applet         DOE_CO2_Wells_2015_05_21         DoE_CO2_Wells_2015_05_21         DoE_CO2_Wells_2015_10_12         DOE_CO2_Wells_2015_10_12         DOE_CO2_Wells_2015_10_12				Date modified 12/8/2015 9:27 AM 12/2/2015 12:03 PM 12/2/2015 10:41 AM 12/8/2015 12:09 PM 10/12/2015 9:41 AM 12/8/2015 12:07 PM			
Libraries Computer	Object       Index       Index    <	015_10_12		12/2/2015 12:05 PM 12/2/2015 12:05 PM 12/8/2015 9:29 AM 6/5/2012 11:52 AM 12/3/2015 9:35 AM 12/3/2015 6:22 AM			
Network		III E_CO2_Wells_2015_05_21 Files (*.*)		<ul> <li>Open</li> <li>Cancel</li> </ul>			

# Brine Data Extensible Markup Language (XML) Document Type Definition (DTD).

The Brine Data DTD defines the contents of the XML File. The DTD for the Brine Data is as follows,

<pre><?xml version="1.0"?> <!DOCTYPE fluid_data [ <!ELEMENT fluid_data (columns*, data*)+>     <!--ELEMENT columns (column*)--> <!--ATTLIST columns records CDATA #REQUIRED--> <!--ELEMENT column EMPTY--> <!--ATTLIST column mnemonic CDATA #REQUIRED name CDATA #REQUIRED unit CDATA #REQUIRED type CDATA #REQUIRED--> <!--ELEMENT data (row*)--> <!--ATTLIST data records CDATA #REQUIRED--> <!--ELEMENT row EMPTY--> <!--ATTLIST data records CDATA #REQUIRED--> <!--ELEMENT row EMPTY--> <!--ATTLIST row KEY CDATA #IMPLIED NAME CDATA #IMPLIED NAME CDATA #IMPLIED LOC CDATA #IMPLIED LOC CDATA #IMPLIED LOC CDATA #IMPLIED LOC CDATA #IMPLIED LONG CDATA #IMPLIED LONG CDATA #IMPLIED GL CDATA #IMPLI</th--><th>CationsLiCDATA #IMPLIEDNaCDATA #IMPLIEDKCDATA #IMPLIEDRbCDATA #IMPLIEDRbCDATA #IMPLIEDCsCDATA #IMPLIEDMgCDATA #IMPLIEDMgCDATA #IMPLIEDCaCDATA #IMPLIEDSrCDATA #IMPLIEDBaCDATA #IMPLIEDCrilCDATA #IMPLIEDCrilCDATA #IMPLIEDCrilCDATA #IMPLIEDMnIICDATA #IMPLIEDMnIICDATA #IMPLIEDFeliCDATA #IMPLIEDFeliCDATA #IMPLIEDColiCDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDAuCDATA #IMPLIED<th>AnionsFCDATA #IMPLIEDCICDATA #IMPLIEDBrCDATA #IMPLIEDFCDATA #IMPLIEDICDATA #IMPLIEDOHCDATA #IMPLIEDBO3CDATA #IMPLIEDBO3CDATA #IMPLIEDCO3CDATA #IMPLIEDCI0CDATA #IMPLIEDCI02CDATA #IMPLIEDCI03CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC104CDATA #IMPLIEDNC2CDATA #IMPLIEDNC3CDATA #IMPLIEDNC4CDATA #IMPLIEDNC4CDATA #IMPLIEDPCDATA #IMPLIED</th></th></pre>	CationsLiCDATA #IMPLIEDNaCDATA #IMPLIEDKCDATA #IMPLIEDRbCDATA #IMPLIEDRbCDATA #IMPLIEDCsCDATA #IMPLIEDMgCDATA #IMPLIEDMgCDATA #IMPLIEDCaCDATA #IMPLIEDSrCDATA #IMPLIEDBaCDATA #IMPLIEDCrilCDATA #IMPLIEDCrilCDATA #IMPLIEDCrilCDATA #IMPLIEDMnIICDATA #IMPLIEDMnIICDATA #IMPLIEDFeliCDATA #IMPLIEDFeliCDATA #IMPLIEDColiCDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDNIIICDATA #IMPLIEDAuCDATA #IMPLIED <th>AnionsFCDATA #IMPLIEDCICDATA #IMPLIEDBrCDATA #IMPLIEDFCDATA #IMPLIEDICDATA #IMPLIEDOHCDATA #IMPLIEDBO3CDATA #IMPLIEDBO3CDATA #IMPLIEDCO3CDATA #IMPLIEDCI0CDATA #IMPLIEDCI02CDATA #IMPLIEDCI03CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC104CDATA #IMPLIEDNC2CDATA #IMPLIEDNC3CDATA #IMPLIEDNC4CDATA #IMPLIEDNC4CDATA #IMPLIEDPCDATA #IMPLIED</th>	AnionsFCDATA #IMPLIEDCICDATA #IMPLIEDBrCDATA #IMPLIEDFCDATA #IMPLIEDICDATA #IMPLIEDOHCDATA #IMPLIEDBO3CDATA #IMPLIEDBO3CDATA #IMPLIEDCO3CDATA #IMPLIEDCI0CDATA #IMPLIEDCI02CDATA #IMPLIEDCI03CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDCI04CDATA #IMPLIEDCI05CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC0CDATA #IMPLIEDNC104CDATA #IMPLIEDNC2CDATA #IMPLIEDNC3CDATA #IMPLIEDNC4CDATA #IMPLIEDNC4CDATA #IMPLIEDPCDATA #IMPLIED
Other Measured Data FORM CDATA #IMPLIED AGE CDATA #IMPLIED TOP CDATA #IMPLIED BASE CDATA #IMPLIED SPGR CDATA #IMPLIED SIGMA CDATA #IMPLIED DEG CDATA #IMPLIED OHM CDATA #IMPLIED OHM75 CDATA #IMPLIED	Cd CDATA #IMPLIED Hg CDATA #IMPLIED HgII CDATA #IMPLIED AI CDATA #IMPLIED SbIII CDATA #IMPLIED SbV CDATA #IMPLIED BiV CDATA #IMPLIED BiV CDATA #IMPLIED SnII CDATA #IMPLIED SnIV CDATA #IMPLIED PbII CDATA #IMPLIED PbIV CDATA #IMPLIED NH4 CDATA #IMPLIED	AS CDATA #IMPLIED Se CDATA #IMPLIED S CDATA #IMPLIED HS CDATA #IMPLIED HSO3 CDATA #IMPLIED HSO3 CDATA #IMPLIED S2O3 CDATA #IMPLIED S04 CDATA #IMPLIED HSO4 CDATA #IMPLIED SOLID CDATA #IMPLIED TDS CDATA #IMPLIED>]>

The XML (Extensible Markup Language) ASCII File Read & Parse routines expect the brine data to fit the above DTD (Document Type Definition), otherwise the data will not parse correctly. Select the Open button to load the brine data directly to the "Brine Data Loaded" table.

🛓 Load Data	M. Children		x				
Data Source				-1			
r KGS Database							
	Load Brine Data						
PC: Read Brine Dat	a By						
	-	Load PC D	ata				
• XML (Extensib • CSV (Comma)	le Markup Language) File Delimited) File	Brine Data					
id	Lease Name	Location	L	٦			
151208243626_0	Wellington Unit 128	T32S R1W Sec. 4	37. 4	•			
151208243626_1	Wellington Unit 129	T32S R1W Sec. 4	37.				
151208243626_2	Wellington Unit 123	T32S R1W Sec. 5	37.				
151208243626_3	Wellington Unit 114	T32S R1W Sec. 4	37.	=			
151208243626_4	Wellington Unit 110	T32S R1W Sec. 5	37.				
151208243626_5	Wellington Unit 108	T32S R1W Sec. 4	37.	_			
151208243626_6	Wellington Unit 106	T32S R1W Sec. 4	37.				
151208243626_7	Wellington Unit 107	T32S R1W Sec. 4	37.				
151208243626_8	Wellington Unit 99	T32S R1W Sec. 5	37.				
151208243626_9	Wellington Unit 100	T32S R1W Sec. 5	37.				
151208243626_10	Wellington Unit 102	T32S R1W Sec. 4	37.				
151208243626_11	Wellington Unit 94	T32S R1W Sec. 4	37.				
151208243626_12	WELLINGTON UNIT, was MURPHY 3 82	T31S R1W Sec. 32	37.				
151208243626_13	WELLINGTON UNIT, was ERKER 17 73	T31S R1W Sec. 33	37.				
151208243626_14	WELLINGTON UNIT, was ERKER 10 75	T31S R1W Sec. 33	37.				
151208243626_15	WELLINGTON UNIT, was MURPHY 1 60	T31S R1W Sec. 32	37.				
•							
	Clear	Exit					

The user only needs to click on the "Continue" button to send the brine data to the "Brine Data" dialog.

### Importing PC Data – Brine CSV (Comma Separated Values) ASCII File.

Most of the web apps will use the same input dialogs to import Brine CSV (Comma Separated Values) file. The Load Data Dialog is basically the same for most of the Web Apps, except they only load a subset of the total data types. In this example a Brine CSV file is being imported into the web app.



Select the "CSV (Comma Delimited) ASCII File" radio button and then left click on the "Brine Data" Icon Button in the Data Source Panel of the Load Data Dialog. This will display the "Select Brine Data Comma Delimited File from your PC" Dialog. This dialog allows the user to search their PC for the file of interest. In this example it is the Brine CSV file DOE\_CO2\_Wells\_2015\_10\_12.csv, highlighted below. Select the Open button to display the "Select Brine Data Comma Delimited File from your PC" Dialog.

💩 Select Brine Data Comma Delimited File from your PC.						
Look in:	📜 WebSite 👻 G	) 🏂 📂 🖽 🗸				
Recent Places Desktop Libraries	Name          Images         I	Date modified           12/8/2015 9:27 AM           12/2/2015 12:03 PM           12/2/2015 10:41 AM           12/8/2015 12:09 PM           10/12/2015 9:41 AM           12/8/2015 12:07 PM           12/2/2015 12:05 PM           12/8/2015 12:05 PM           12/8/2015 12:05 PM           12/8/2015 9:29 AM           6/5/2012 11:52 AM           12/3/2015 9:35 AM				
Computer Q Network	PC     III     File name: DOE_CO2_Wells_2015_10_12     Files of type: All Files (*.*)	12/3/2015 6:22 AM				

🍝 Map File Colum	nn Number to I	Brine Data Col	umn		I X		
WELL,API-Number,TF Zone,Sampled,Repor	1st Line of Comma Delimited File: WELL,API-Number,TRS,Iat, Iong, UTM-X, UTM-Y, UTM Zone,Sampled,Reported,Formation,Top,Base,PH,Ca,Mg,Sr,Na,K,Fe,Mn,CI,Br,I,SO4,CO3,HCO3 ,BO3,PO4,TDS,Ratio,LAB,						
<sup>∼</sup> 2nd Line of Comma I NAME,NUMBER,-,deg g/L,mg/L,mg/L,mg/L,r	,deg,DATE,DATE			L,mg/L,mg	)/L,mg/L,m	n	
Brine Data Columns: Start Reading Data at	Brine Data Columns: Start Reading Data at Row 3 Assume Row & Column Count is 1,2,3						
Brine Data Column Na	me		Fi	le Column	Number		
Fluid Primary Key					0		
Formation					8		
Formation Age					0		
Depth Top					12		
Depth Base					13		
Specific Gravity					0		
Specific Conductivit	у				0		
РН					14		
Temperature (F)					5		
Resistivity (Rw)					0		
Resistivity @ 75 deg	J				0		
Estimated Rw					0		
Alkalinity					0		
Turbidity					0		
Lithium ( Li )			● mg/l	🔾 ug/l	0		
Sodium ( Na )			● mg/l	🔾 ug/l	18		
Potassium ( K )			● mg//	🔾 ug/l	19		
Rubidium ( Rb )			● mg/l	🔾 ug/l	0		
Cesium (Cs)			● mg/l	🔾 ug/l	0		
Sodium Potassium	(Na_K)		● mg/l	🔾 ug/l	0		
Beryllium ( Be )			● mg/l	🔾 ug/l	0		
Magnesium ( Mg )			. € mg/	🔾 ug/l	16		
Calcium ( Ca )			● mg/l	🔾 ug/l	15		
Strontium ( Sr )	Strontium ( Sr )						
Barium ( Ba )	Barium (Ba ) 💿 mg/l 🔾 ug/l						
Chromium (II) chro	Chromium (II) chromous ( Crll ) <ul> <li>mg/l</li></ul>						
Charminer (III) about				<u> </u>	0	•	
	Load Data	Cancel	Help				

The "Map File Column Number to Brine Data Column" Dialog allows the user to map the file columns number to the web app brine data structure. In this example the file has the file data columns in line one of the Brine Data CSV File and line two of the Brine Data CSV File has the data units. In this case the chosen file columns match the Brine Mnemonics for the brine data structure for most part. The File Column Number is automatically assigned to the Brine Data Column Names. The user only needs to select the "Load Data" Button to parse the Brine Data into the web app. This dialog has the data units as radio buttons to represent mg/l (milligrams/liter) and ug/l (micrograms/liter). The dialog will convert all data to mg/l.

#### Brine Data CSV (Comma Separated Values) File Structure.

The Brine Data CSV example has two introduction lines, the first line is the file data columns and the second line is the column units for the brine data, illustrated below,

Line 2 Data Column Units Line 3 Data Start	<pre>WELL_API-Number_TRS.lat_long_UTM-X_UTM-Y_UTM_Zone_Sampled_Reported_Formation_Top_Base_PH_Ca_Mg_L_mg/L_mg/L_mg/L_mg/L_mg/L_mg/L_mg/L_m</pre>
	McCord 'A' 20-H,15-051-26218-0100,T11S R17W S26,39.069952,-99.1695539,485332.12,4324344.85,14,11/06/2014 00:00,03/29/2015 00

Figure: Partial Contents of Brine.csv File.

The "Map File Column Number to Brine Data Column" Dialog allows the user to map the data in the Brine Data CSV File to the web app data structure variables. The program first reads the first and second line of the CSV File looking for the data column headers. The lines are each parsed to single out the data column headers and to match those headers to the brine data structure. The program then assigns the column number to the Brine Data Column Name starting at column 1,2,3, … if the file column name used matches the expected brine column name. Next the program then searches both lines for the units and automatically sets the radio button to ug/l if it sees ug/l text for the column otherwise it assumes mg/l. The Column Names matrix used to parse the file column variables are listed below,

	Common Anions				
Formula	Chemical Name	Formula	Chemical Name		
F	Fluoride	NO2	Nitrite		
Cl	Chloride	NO3	Nitrate		
Br	Bromide	CrO4	Chromate		
1	Iodine	Cr207	Dichromate		
OH	Hydroxide	MnO4	Permanganate		
BO3	Borate	Р	Phosphide		
CO3	Carbonate	PO4	Phosphate		
HCO3	Bicarbonate	HPO4	Monohydrogen Phosphate		
CIO	Hypochlorite	H2PO4	Dihydrogen Phosphate		
CIO2	Chlorite	As	Arsenide		
CIO3	Chlorate	Se	Selenide		
CIO4	Per chlorate	S	Sulfide		
CN	Cyanide	HS	Hydrogen Sulfide		
NCO	Cyanate	SO3	Sulphite		
OCN	Isocyanate	HSO3	Hydrogen Sulphite		
SCN	Thicyanite	S2O3	Thiosulphate		
Ν	Nitride	SO4	Sulfate		
N3	Azide	HSO4	Bisulfate		

		Commo	n Cations		
Formula	Chemical Name I	Chemical Name II	Formula	Chemical Name I	Chemical Name II
Alkali Metal			IB		
Li	Lithium		Cu	Copper(I)	cuprous
Na	Sodium		Cull	Copper(II)	cupric
К	Potassium		Ag	Silver	
Rb	Rubidium		Au	Gold	aurous
Cs	Cesium		Aulli	Gold(III)	auric
Na_K	Sodium			IIB	·
	Potassium				
	Alkali Earth I	Metal	Zn	Zinc	
Ве	Beryllium		Cd	Cadmium	
Mg	Magnesium		Hg	Mercury(I)	mercurous
Ca	Calcium		Hgll	Mercury(II)	mercuric
Sr	Strontium		IIIA		
Ва	Barium		Al	Aluminum	
	VIB		IVA		
Crll	Chromium(II)	chromous	Snll	Tin(II)	stannous
CrIII	Chromium(III)	chromic	SnIV	Tin(IV)	stannic
	VIIB		Pbll	Lead(II)	plumbous
Mnll	Manganese(II)	manganous	PbIV	Lead(IV)	plumbic
MnIII	Manganese(III)	manganic		VA	
	VIIIB		SbIII	Antimony(III)	antimonous
Fell	Iron(II)	ferrous	SbV	Antimony(V)	antimonic
Felll	Iron(III)	ferric	Billl	Bismuth(III)	bismuthous
Coll	Cobalt(II)	cobaltous	BiV	Bismuth(V)	bismuthic
Colll	Cobalt(III)	cobaltic	Other		
Nill	Nickel(II)	nickelous	NH4	Ammonium	
Nilli	Nickel(III)	nickelic			

	Other V	ariables					
Mnemonic	Description	Mnemonic	Description				
FORM	Formation	Other Measured Well Data					
AGE	Formation Age	SPGR	Specific Gravity				
	Depth Range of Sample	SIGMA	Specific Conductivity				
ТОР	Depth Top	PH	РН				
BASE	Depth Base	DEG	Temperature (F)				
		ОНМ	Resistivity (Rw)				
		OHM75	Resistivity at 75 deg				
		OHME	Estimated Rw				

	Other Va	ariables II						
Mnemonic	Description	Mnemonic	Description					
	Well ID	Other Well Info						
NAME	Well Name	FIELD	Field					
API	API-Number	Depth Information						
	Location	KB	Kelly Bushing					
COUNTY	County	GL	Ground Level					
STATE	State	DF	Derrick Floor					
LOC	Location	TGT	TGT					
LAT	Latitude	SRC	source					
LONG	Longitude							

When the user selects the "Load Data" Button on the "Map File Column Number to Brine Data Column" Dialog the data is parsed into the Brine Plot & Data Entry web app, where the contents of the Brine Data CSV file name is loaded into the "List of Brine Samples" table.

🛓 Load Data			x
Data Source			
KGS Database			
	Load Brine Data		
	co2		
PC: Read Brine Data	a By		
		Load PC Da	ata
O XML (Extensib	le Markup Language) File		
CSV (Comma I	Delimited) File	Brine Data	
id	Lease Name	Location	L
151208244642_0	WELLINGTON UNIT was KAMAS 6 32		37. 🔺
151208244642_1	WELLINGTON UNIT was KAMAS 6 32		37.
151208244642_2	WELLINGTON UNIT was Kamas 7 25		37. =
151208244642_3	WELLINGTON UNIT was Kamas 7 25		37.
151208244642_4	WELLINGTON UNIT was FRANK KAMAS		37.
151208244642_5	WELLINGTON UNIT was FRANK KAMAS		37.
151208244642_6	WELLINGTON UNIT was CURTIS 2 13		37.
151208244642_7	WELLINGTON UNIT was W. I. GASKILL 2		37.
151208244642_8	WELLINGTON UNIT was RIDDELL 2 16		37.
151208244642_9	WELLINGTON UNIT was LUDWIG 2 11		37.
151208244642_10	WELLINGTON UNIT was LUDWIG 6		37.
151208244642_11 151208244642 12	WELLINGTON UNIT was MILLER 17 WELLINGTON UNIT was J. C. FRANKUM		37.
151208244642_12	WELLINGTON UNIT was J. C. FRANKUM		37.
151208244642_13	WELLINGTON UNIT was J. C. FRANKUM		37.
151208244642_14	WELLINGTON UNIT was J. C. FRANKUM		37
1 101200244042_10			•
	ontinue Clear Exit		

The user only needs to click on the "Continue" button to send the brine data to the "Brine Data" dialog.

# **Brine Data Dialog**

The Brine Data Dialog allows the user to remove unwanted wells with incomplete brine data measurements or data that are outliers that will alias the results of the Principal Components Analysis. The Principal Component Java Functions will not compute the eigenvalues or eigenvector if the column has only zeros. The program will send a warning to the user which columns have zeros and disable functionality of the dialog. To avoid this, the user has the option of deselecting the checkboxes for brine data with excessive zeros before continuing to the next level.

Check boxes at top allow the user to deselect columns with large number of zeros. The Principal Components Matrix functions will not work with a zero column.

		⊮Na ⊮		🖌 Ca 🖌				Br 🔲 BO3		HCO3		SO4 🗹 I			-
API-Number	Na	K	Mg	Ca	Sr	Mnll	Fell	CI	Br	BO3	CO3	HC03	PO4	SO4	PH
5-191-19005	63896.5	358.3	2576.9	12748.4	510.2	1.2	14.3		0.0	42.0	0.0	73.2	0.0	782.0	5.3
5-191-10083-0001	53400.0	478.0	2280.0	10800.0	0.0	0.78	17.4	117000.0	390.0	0.0	0.0	0.0	0.0	682.0	6.31
5-191-43782-0001	62163.4	337.9	2506.6	12624.0	460.8	2.0	43.7		0.0	37.3	0.0	61.0	0.0	1365.0	5.2
5-191-11325	60934.9	354.9	2514.9	12547.9	469.1	0.9	17.0		0.0	40.6	0.0	85.4	0.0	1425.0	5.6
5-191-43814	61737.1	361.8	2526.3	12143.8	474.1	1.2	20.9	116275.0	0.0	39.2	0.0	61.0	0.0	1095.0	5.3
5-191-43814	65736.2	371.0	2589.1	12758.7	497.6	1.2	17.6	122840.0	0.0	43.4	0.0	85.4	0.0	998.0	5.6
5-191-43882	66007.6	357.1	3062.3	12464.6	608.2	0.7	14.5	128012.0	0.0	37.3	0.0	128.1	0.0	1255.0	6.5
5-191-43882	60900.0	380.0	2910.0	12700.0	0.0	0.7	14.0	132000.0	550.0	0.0	0.0	0.0	0.0	570.0	5.75
5-191-11442	61101.6	350.3	2530.4	12109.8	472.5	0.7	12.5	120744.0	0.0	38.3	0.0	115.9	0.0	1475.0	5.6
5-191-11442	56000.0	430.0	2370.0	11800.0	0.0	0.8	15.1	125000.0	480.0	0.0	0.0	0.0	0.0	649.0	5.73
5-191-43889	60895.0	332.5	2551.7	12261.6	454.7	0.8	17.8	113642.0	0.0	38.1	0.0	128.1	0.0	1260.0	5.4
5-191-00395-0001	61475.7	349.1	2518.2	12218.5	468.2	1.0	12.2	109495.0	0.0	39.1	0.0	73.2	0.0	1155.0	5.3
5-191-10083-0002	56748.9	404.4	2449.3	11621.6	432.4	1.9	41.8	107818.0	0.0	44.6	0.0	73.2	0.0	1660.0	5.2
5-191-22590	48600.0	1280.0	1430.0	8820.0	274.0	0.7	0.08	103000.0	198.0	0.0	132.0	0.0	20.0	3140.0	6.56
5-191-22590	38300.0	1080.0	1160.0	7310.0	253.0	2.2	0.2	84400.0	190.0	0.0	0.0	0.0	20.0	346.0	6.66
15-191-22590	54300.0	1430.0	1630.0	10300.0	334.0	0.81	0.09	118000.0	235.0	0.0	74.0	0.0	20.0	336.0	6.46
5-191-22590	48400.0	1280.0	1450.0	8670.0	262.0	0.61	0.16	102000.0	176.0	0.0	134.0	0.0	20.0	3320.0	6.58
5-191-22591	31500.0	834.0	880.0	5030.0	158.0	1.1	0.05	65800.0	120.0	0.0	124.0	0.0	20.0	1060.0	7.02
5-191-22591	17400.0	424.0	460.0	2150.0	71.3	0.59	0.07	32000.0	75.9	0.0	180.0	0.0	5.0	1610.0	7.57
5-191-22591	15900.0	347.0	347.0	1500.0	55.4	1.17	0.09	30500.0	79.7	0.0	192.0	0.0	4.0	873.0	6.75
15-191-22591	58000.0	702.0	1890.0	11300.0	417.0	0.89	0.29	119000.0	464.0	0.0	42.0	0.0	20.0	703.0	5.92
15-191-22770	48400.0	310.0	1990.0	9920.0	0.0	1.2	0.0	109000.0	420.0	0.0	0.0	0.0	0.0	726.0	7.05
5-191-22770	39700.0	270.0	1670.0	8140.0	0.0	1.3	22.0	85000.0	350.0	0.0	0.0	0.0	0.0	761.0	6.86
15-191-22770	0.0	0.0	0.0	0.0	0.0	0.0	10.0	100000.0	0.0	0.0	0.0	0.0	0.0	932.0	5.26
5-191-22770	0.0	0.0	0.0	0.0	0.0	0.0	10.0	100000.0	0.0	0.0	0.0	0.0	0.0	874.0	6.96
JA	2858.2	2.4	1365.0	4159.5	61.4	0.1	0.5	14500.0	0.0	0.0	0.0	0.0	0.0	1080.0	7.0
IA	4720.0	23.6	1510.0	4270.0	0.0	0.126	1.6	18400.0	56.0	0.0	0.0	0.0	0.0	1330.0	7.23
IA	3860.0	21.3	1380.0	3820.0	0.0	0.107	1.54	17200.0	52.0	0.0	0.0	0.0	0.0	1260.0	7.23

**"Delete Well(s)"** button allows the user to highlight problem wells and remove them from list before processing. **"Compute Correlation Matrix"** button performs basic Principal Components and allows the user to display & plot data.

**"Begin Normalization Process"** button with the "% from Anions/Cations equal to 1.0" text field allows the user to normalize the brine data set to a "Good" brine data set that falls between 1.0 +/- X%, where the user defines the limit of the "Good" Brine data.

"Cancel" button closes this dialog and all dialogs that are opened by this dialog.

The Principal Component Analysis is automatic when the "Compute Correlation Matrix" or "Begin Normalization Process" buttons are selected. The dialogs that are displayed will have button panels at the top of the dialog that will allow the user to display the correlation matrix table, eigenvector & eigenvalue table, Anions/Cations Ratio Plot and the Principal Components Scores Plot. The user can save the brine data either as an Extensible Markup Language (XML), Comma Separated Values (CSV) or save the displayed dialogs and plots as Portable Network Graphics (PNG) images with the option of creating a Portable Document Format (PDF) of each plot.

# **Compute Correlation Matrix Button**

Buttons to display dialogs & plots and to save the information generated.

Color Legend for brine data cells that are colored.

Brine Data imported in meq/l units with table cells colored if the data falls outside 1.5 standard deviations.

🥖 👫 Σν	20										
Sign	a * -3.0	-2.5	-2.4 -2.	.3 -2.2	-2.1	-2.0	1.9 -1.	8 -1.7	-1.6	-1.5	
	1.5 1.6	1.7	1.8	1.9 2	.0 2.1	2.2	2.3	2.4 2	.5 3.6		
API-Number	Na	К	Mg	Ca	Sr	Moll	Fell	CI	BO3	SO4	PH
5-191-10045	2717.24	8.8	212.61	617.85	10.93	0.04	0.73	3321.15	1.97	26.23	5.2
5-191-10045	2414.09	11.2	204.11	573.85	0.0	0.03	0.47	3497.88	0.0	14.03	5.74
5-191-10054	2788.36	8.56	206.51	627.67	10.3	0.03	0.51	3379.35	1.93	25.6	5.3
5-191-10054	2422.79	10.2	187.65	578.84	0.0	0.03	0.38	3526.09	0.0	13.13	5.94
5-191-10055	3036.56	7.16	310.94	560.79	34.29	0.02	0.45	3739.6	1.77	8.47	5.6
5-191-10055	2757.72	9.3	276.54	533.93	0.0	0.02	0.51	4090.26	0.0	6.97	5.83
5-191-10049	2620.88	9.42	204.74	626.08	10.32	0.05	1.38	3192.75	2.16	24.46	5.2
5-191-10061	2626.65	9.11	205.53	610.7	12.87	0.04	0.67	3162.08	2.12	30.7	5.4
5-191-10059	2394.91	9.86	178.59	559.08	9.44	0.04	0.58	2818.82	2.19	31.85	5.3
5-191-10074	2560.04	8.75	199.59	602.55	10.06	0.04	0.44	3068.57	1.97	32.89	5.6
5-191-10066	2514.43	8.44	189.36	586.46	10.16	0.04	1.09	3030.77	2.03	23.83	5.4
5-191-10067	2547.32	8.93	201.7	596.74	12.6	0.04	0.7	3046.43	2.07	27.17	4.9
5-191-10078	2506.24	8.67	179.09	557.13	9.15	0.02	0.75	3238.53	0.0	22.17	6.26
5-191-10078	2520.36	10.5	205.18	590.15	10.09	0.06	1.88	3039.26	2.31	29.77	5.2
5-191-10078	2496.73	11.89	213.99	578.84	0.0	0.04	0.94	3300.42	0.0	14.4	5.98
5-191-10077	2700.01	9.25	202.95	615.79	10.66	0.07	1.23	3253.9	1.91	28.73	5.6
5-191-10076	2817.72	9.58	214.08	637.74	11.51	0.03	0.72	3402.82	2.21	17.23	5.3
5-191-10076	2701.17	9.97	200.0	608.78	0.0	0.03	0.78	3497.88	0.0	13.47	5.88
5-191-10093	2617.27	10.06	206.74	611.07	10.47	0.02	0.52	3128.18	1.97	33.31	5.3
5-191-10096	2565.14	11.1	198.32	610.84	10.34	0.03	0.26	3165.69	1.97	24.46	5.6
5-191-10092	2694.05	12.97	199.81	638.33	10.57	0.06	3.33	3301.6	2.42	20.73	5.2
5-191-10087	2814.38	10.01	210.33	625.69	12.54	0.03	0.84	3352.77	2.1	17.65	5.2
5-191-10087	2561.98	12.22	198.35	578.84	0.0	0.03	0.86	3526.09	0.0	13.2	5.87
5-191-10104	2694.82	8.67	213.91	614.78	9.77	0.03	0.71	3327.27	1.99	28.52	4.9
5-191-10100	2771.76	8.76	214.55	630.16	11.05	0.03	0.56	3537.26	1.9	27.79	5.2
5-191-10119	2646.31	8.64	210.05	596.98	10.83	0.02	0.33	3351.05	1.95	31.33	5.3
5-191-10126	2698.62	8.6	210.43	611.65	10.55	0.03	0.77	3447.44	1.96	37.47	5.4
5-191-10107	3074.65	7.49	316.7	586.96	26.59	0.03	1.58	3936.5	1.82	14.67	5.4
5-191-10112	2675.51	9.2	216.51	611.2	11.3	0.02	0.45	3465.98	2.1	29.87	5.3
5-191-10136	2729.22	9.06	214.23	618.41	10.87	0.03	0.46	3291.22	1.99	22.69	6.1
5-191-10136	2418.44	10.79	193.41	558.88	0.0	0.03	0.39	3582.51	0.0	13.17	5.8
5-191-10134	2691.93	9.24	209.56	624.63	11.01	0.03	0.5	3279.49	1.99	25.6	5.2
5-191-10134	2453.24	11.09	195.06	573.85	0.0	0.02	0.59	3554.3	0.0	13.47	5.81
5-191-10131	2638.29	8.79	213.7	615.84	10.8	0.05	1.43	3273.76	1.96	28.0	5.2
5-191-10271	2567.06	9.39	205.86	606.92	10.02	0.03	0.74	3345.33	2.25	33.52	5.8
5-191-10255	2703.57	9.45	214.23	621.45	11.0	0.13	3.68	3412.01	1.95	33.0	5.2
5-191-10270	2584.61	9.63	205.57	607.43	10.14	0.09	5.43	3340.87	2.3	34.97	5.0
5-191-10262	2603.41	9.37	198.64	605.4	10.25	0.02	0.55	3333.48	2.02	29.35	5.2
5-191-10257	2615.45	8.99	210.71	619.58	10.49	0.02	0.86	3346.17	2.09	31.33	5.2
5-191-10259	2714.2	9.48	215.81	629.83	10.83	0.02	0.63	3383.66	1.98	26.44	5.3
5-191-10261	2958.42	8.15	274.69	656.47	12.35	0.02	0.74	3759.54	1.83	16.86	5.3
5-191-10290	2608.45	9.48	197.42	607.64	10.2	0.02	0.42	3306.93	1.93	26.54	5.8
5-191-10281	2637.43	9.68	200.52	616.87	10.5	0.02	0.6	3230.23	1.98	28.73	5.3
5-191-10295	2650.11	9.67	206.4	619.66	10.69	0.03	0.73	3413.51	1.87	29.25	4.9
5-191-10294	2694.51	10.1	204.65	626.21	10.48	0.03	0.46	3352.77	1.86	24.98	6.5
5-191-20789	2677.05	8.08	206.11	643.67	9.97	0.06	1.79	3195.37	1.9	24.67	5.3
5-191-21000	2752.68	8.1	211.61	649.3	10.16	0.03	0.71	3343.18	1.88	29.98	5.2
5-191-21179	2695.07	8.23	208.85	635.46	10.32	0.08	1.99	3294.18	1.94	23.83	5.4
	No	K	Ha	00	Sr	Moll	Fell	CI	BO3	S04	PH
	Na	K	Mg	Ca							
lean ioma	2,576.914	10.962				0.036	0.817				

Table showing the Mean and Standard Deviation of the wells that are displayed.



Close this dialog and all dialogs opened by this dialog.

Display the Covariance Matrix Table.

 $\sum_{v}$  Display the Eigenvector Matrix & Eigenvalues Tables.

Display the Brine Data Anions/Cations Ratio Plot.

- Display the Principal Components Scores Plot.
- 14

Save Brine Data Displayed as a Comma Separated Values (CSV) ASCII File.





Save Brine Data Displayed as a Extensible Markup Language (XML) ASCII File.

Save dialog or plot as a Portable Network Graphics (PNG) file with the option of creating a Portable Document Format (PDF) file.



📑 Display the Covariance Matrix Table Dialog.

🍝 Brin	e Data Cov	variance N	latrix										
	Na	K	Mg	Ca	Ba	Mnll	Felli	CI	Br	S04	PH		
Na	0.999	0.537	0.83	0.786	0.337	-0.122	0.028	0.902	0.768	-0.676	-0.719		
К	0.537	1.0	0.262	0.56	-0.214	-0.182	-0.009	0.435	0.08	-0.064	-0.529		
Mg	0.83	0.262	0.999	0.6	0.62	0.112	0.235	0.881	0.938	-0.788	-0.679		
Ca	0.786	0.56	0.6	1.0	-0.192	0.267	0.379	0.753	0.47	-0.175	-0.846		
Ba	0.337	-0.214	0.62	-0.192	1.0	-0.148	-0.109	0.44	0.711	-0.859	-0.048		
Mnll	-0.122	-0.182	0.112	0.267	-0.148	1.0	0.948	0.067	-0.022	0.346	-0.335		
Felli	0.028	-0.009	0.235	0.379	-0.109	0.948	0.999	0.164	0.05	0.25	-0.502		
CI	0.902	0.435	0.881	0.753	0.44	0.067	0.164	1.0	0.857	-0.719	-0.784		
Br	0.768	0.08	0.938	0.47	0.711	-0.022	0.05	0.857	0.999	-0.875	-0.578		
SO4	-0.676	-0.064	-0.788	-0.175	-0.859	0.346	0.25	-0.719	-0.875	1.0	0.324		
PH	-0.719	-0.529	-0.679	-0.846	-0.048	-0.335	-0.502	-0.784	-0.578	0.324	1.0		

#### **Covariance Matrix Table Dialog Buttons**

Close this dialog.

PDF

Save covariance matrix table as a Portable Network Graphics (PNG) file with the option of creating a Portable Document Format (PDF) file.

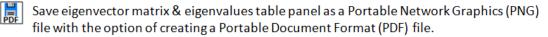


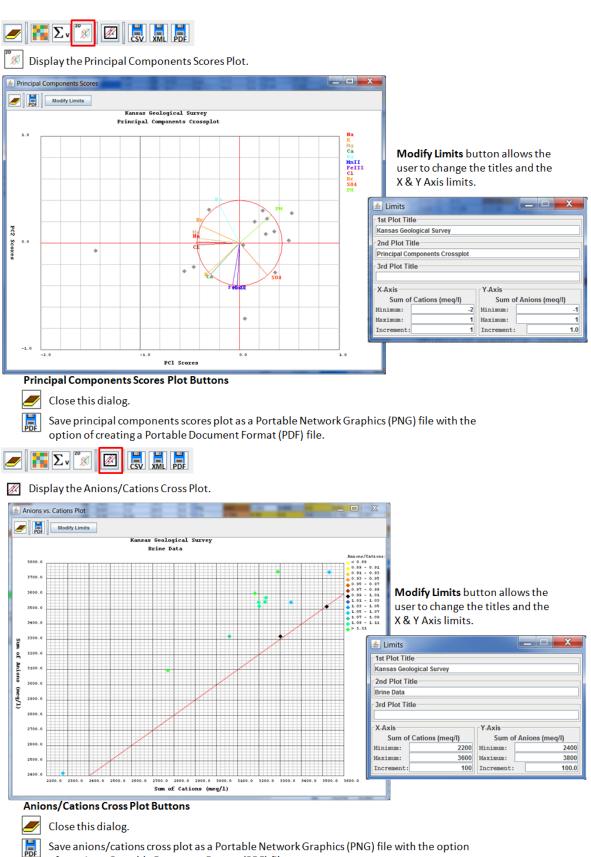
 $|\Sigma_v|$  Display the Eigenvector Matrix & Eigenvalues Table Dialog.

🛓 Brine	Data Eiger	nvector M	atrix								X
	DF	-									
	1	2	3	4	5	6	7	8	9	10	11
Na	-0.19	0.03	-0.309	0.404	0.59	0.007	-0.377	-0.143	-0.203	0.011	-0.386
К	0.131	-0.17	-0.066	0.039	-0.227	-0.03	-0.135	0.711	-0.558	-0.165	-0.175
Mg	-0.152	0.511	-0.029	-0.277	-0.249	-0.577	-0.242	0.04	0.146	0.045	-0.396
Ca	0.512	-0.089	0.478	-0.18	0.044	0.008	-0.198	-0.415	-0.229	-0.327	-0.305
Ba	0.243	0.151	0.507	0.295	0.178	0.152	-0.064	0.412	0.382	0.39	-0.21
Mnll	0.378	0.166	-0.43	0.19	-0.214	0.265	-0.218	0.07	0.465	-0.47	-0.023
Felli	-0.35	-0.418	0.194	-0.254	0.32	-0.15	-0.037	0.264	0.398	-0.487	-0.082
CI	-0.47	0.1	0.118	-0.167	-0.295	0.684	-0.02	-0.069	-0.037	-0.016	-0.403
Br	-0.025	-0.578	-0.057	0.391	-0.439	-0.241	0.108	-0.202	0.182	0.167	-0.376
SO4	-0.33	0.231	0.412	0.57	-0.221	-0.127	-0.141	-0.072	-0.108	-0.37	0.318
PH	-0.052	-0.276	0.03	-0.173	-0.157	0.068	-0.809	-0.039	0.07	0.294	0.334
	1	2	3	4	5	6	7	8	9	10	11
Eigen	0.004	0.007	0.009	0.027	0.085	0.096	0.161	0.403	1.721	2.715	5.772
%	0	0	0	0.2	0.7	0.8	1.4	3.6	15.6	24.6	52.4

#### Eigenvector Matrix & Eigenvalues Table Dialog Buttons

Close this dialog.





Save anions/cations cross plot as a Portable Network Graphics (PNG) file with the option of creating a Portable Document Format (PDF) file.

# Save Brine Data as a Comma Separated Values (CSV) ASCII File



Click on the CSV Icon Button at the top of the "Brine Principal Components" dialog to open the "Select a Different Directory Path" Dialog.

	Select a Different Directory Path		
Г	Save Files To: C:\Users\jvictor	Search	Select the "Search" Button in the "Select a Different Directory Path" Dialog to search
	Image Filename: Filename: Filename:	brine .csv	your PC for the correct directory path.
	Continue Cancel		

A Salact

Highlight the Directory you wish to place the CSV File

Select the "Select" Button.

Look In: 📑	HELP 🔽 🖬 🖨 🗖 🐯 🗄
CSV	
Doveton	elp
T XML	-12
Folder <u>n</u> ame:	C:\Users\jvictor\Documents\dummy\Earthquakes\PC\HELP\CSV
Folder <u>n</u> ame: Files of <u>T</u> ype:	C:\Users\jvictor\Documents\dummy\Earthquakes\PC\HELP\CSV All Files
_	

Select a Different Directory Path	<sup>7</sup> The Directory path is transferred to the "Save Files To:" text field.
Save Files To: C:\Users\jvictor\Documents\dummy\Earthquakes\PC\HELP\CSV Search Image Filename:	"brine" is the default filename, you can alter the name to any name you wish. The "File save as:" text field will show what the file
brine.csv brine.csv	name will be saved as.
Continue Cancel	Select the "Continue" Button to save file.

X

	Home		Page Layout	Formulas	Data	Review Vie		General		•			g™ Insert ~ g₩ Delete ~	Σ Z	e - ∝×	
Pa	ste 🛷 🖪		💷 - 🍮 -	A • E		i 🗊 🔜 Mei	rge & Center		, ta a	Conditio Formattin		s Cell Styles *	Cells	Sort 8	k Find & * Select *	
ciipi	A1	- (			,	againen		- 140			Styles		Cella	Luiu	¥	
	A	В	С	D	E	F	G	Н	1	J	К	L	M	N	0	
1	NAME	API	FIELD	COUNTY	STATE	LOC	LAT	LONG	KB	GL	DF	TGT	SRC	DATE	TOP	
2							deg	deg	ft	ft	ft	ft			ft	
3	WELLINGT	15-191-10	WELLING	SUMNER	Kansas		37.31881				1246	i		06/24/20		
4			WELLING			T315 R1W	37.32062	-97.4313			1258			06/24/20		
5			WELLING				37.32069				1264			06/24/20		
6			WELLING					-97.4428			1255			06/17/20		
7			WELLING					-97.4405			1264			06/18/20		
8			WELLING					-97.4428			1258			06/18/20		
9			WELLING					-97.4381			1262			06/25/20		
			WELLING					-97.4381			1262			06/23/20		
			WELLING					-97.4427			1259	•		06/17/20	): 3650	
			UNKNOW				37.3041				-					_ 0
			1 WELLING				37.30955	-								
			WELLING				37.31053		)(=)-	« dumm	ny 🕨 Earth	quakes 🕨	PC + HELP	<ul> <li>CSV</li> </ul>	- + <del>,</del>	Searc
			WELLING				37.31053			-						
	Wellingtor	15-191-22	WELLING	SUMNER	Kansas	T315 R1W	37.31053	-97 C	rganize 🔻	AL OP	en 🔻	Share wit	h 👻 🛛 Print	t »	- II •	- 1
17											A					
18								1	👆 Favorite	s	Do	cumer	nts librar	У	Arrange by:	Folder
19									📃 Deskto	p	CSV				Analige by.	, older
	→ > bri	ne 🖉							b Downl	oads	-					
Rea	dy	_		_	_	_					= Salt	orine				
_									S Recent							
То	view t	ne CSV	File cre	ated ju	st go to	o the dir	rectory		📗 My Do	cuments						

you saved the CSV file. To open the file you can open the file in a notepad text editor or you can double click on the file and a Microsoft Excel Application will launch and display the contents of the file.

Crganize      Generative     Crganize      Crganize      Desktop     Downloads     Recent Places	-
Organize • Share with • Print » IF • Open • Share with • Print » IF • • • • • • • • • • • • • • • • • •	
★ Favorites Documents library CSV Arrange by: Folder ▼ CSV Solution	
Desktop     CSV     Arrange by: Folder	(
<sup>15</sup> al brine	
My Documents	
🚝 Libraries	
Documents	
🕹 Music	
lictures 💌	
brine Microsoft Office Excel Comma Separated Values File	

# Save Brine Data as an Extensible Markup Language (XML) ASCII File



Click on the XML Icon Button XML at the top of the "Brine Principal Components" dialog to open the "Select a Different Directory Path" Dialog.

🛓 Select a Different Directory Path	
Save Files To: C:\Users\jvictor Search	Select the "Search" Button in the "Select a Different Directory Path" Dialog to search your PC for the correct directory path.
Filename:	your reformed uncered ypach
Continue Cancel	

Highlight the Directory you wish to place the XML I

Select the "Select" Button.

🛓 Select	
· Look In: 📑 I	HELP 🔽 🗟 🛱 🛱 🔀 🕃
Doveton	
Doveton-h	
Folder <u>n</u> ame:	C:\Users\jvictor\Documents\dummy\Earthquakes\PC\HELP\XML
Files of <u>Type</u> :	All Files
	Select Cancel

🗟 Select a Different Directory Path	The Directory path is transferred to the "Save Files To:" text field.
Save Files To:	
C:\Users\jvictor\Documents\dummy\Earthquakes\PC\HELP\XML	"brine" is the default filename, you can alter
Image Filename: Filename:	the name to any name you wish. The "File save as:" text field will show what the file
brine.xml brine	name will be saved as.
Continue Cancel	Select the "Continue" Button to save file.

Organize • Share w	rith • Burn New folder	11 · 🗋 🔮
Favorites	Documents library	Arrange by: Folder +
Downloads     Secent Places     My Documents	E 2 brine	
📜 Libraries	1	
Documents		
Jusic Sectors		
Pictures Videos		

To view the XML File created just go to the directory you saved the XML file and double click and a web page will display the brine data XML File.

	K
C:\Users\jvictor\Documents\dummy\E: Q ~ C Brine Dat C:\Users\jvictor\Documents\dummy\E: Q ~ C	¢
<column mnemonic="H2PO4" name="Dihydrogen Phosphate" type="COMP" unit="mg/l"></column> <column mnemonic="As" name="Arsinide" type="COMP" unit="mg/l"></column> <column mnemonic="Se" name="Selenide" type="COMP" unit="mg/l"></column> <column mnemonic="H5" name="Hydrogen Sulfide" type="COMP" unit="mg/l"></column> <column mnemonic="HS3" name="Hydrogen Sulfide" type="COMP" unit="mg/l"></column> <column mnemonic="SO3" name="Sulfide" type="COMP" unit="mg/l"></column> <column mnemonic="HS3" name="Thiosulphate" type="COMP" unit="mg/l"></column> <column mnemonic="HS3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="HS3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="SO3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="SO3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="SO3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="SO3" name='Thiosulphate"' type="COMP" unit="mg/l"></column> <column mnemonic="SO1D" name="Total" solids"="" type="DATA" unit="mg/l"></column> <column computed"="" mnemonic="TDS" name="Total Solids" type="DATA" unit="mg/l"></column> <column mnemonic="SO1D" name="Total Solids" type="DATA" unit="mg/l"></column> <column mnemonic="TDS" name="Total Solids" type="DATA" unit="mg/l"></column> <column mnemonic="TDS" name="Total Solids" type="DATA" unit="mg/l"></column>	~
<pre></pre>	
FIELD = "WELLINGTON" NAME="WELLINGTON UNIT was Kamas 7 25" API="15-191- 10054"/> <row <br="" br="650.0" ci="145000.0" so4="335.0" solid="223838.5" tds="223838.5">FeIII=14.3" MnII="0.64" Ba="14.6" Ca="10700.0" Mg="3360.0" K="364.0" Na="63400.0" NTU=1.95" ALKNTY=116.95" PH=-5.83" SIGMA=192.73" TOP="3670.0" FORM="Mississippian" DATE="06/24/2015 00:00" DF="1264.0" LONG="&gt;&gt;97.4346848" LAT="37.3206017" STATE="Kansas" CONTY="SUMMER" LOC="T31S RIW Sec. 28" FIELD="WELLINGTON" NAME="WELLINGTON UNIT, was FRANK KAMAS 9 24" API="15- 191-10055"/&gt;</row>	
<pre>IDJ1-10035 /&gt; </pre> <pre>(row TDS="190255.3" SOLID="190255.3" SO4="692.0" Br="470.0" Cl="117000.0" FellI="26.5" MnII="1.2" Ba="0.61" Ca="11600.0" Mg="2600.0" K="465.0" Ma="57400.0" NTU="2.68" ALKNTY="319.9" PH="5.89" SIGMA="169.7" TOP="3657.0" FORM="Mississippian" DATE="06/17/2015 00:00" DF="1255.0" LONG="97.4427614" LAT="37.3113174" STATE="Kansas" CONTY="SUMNER" LOC="T31S RIW Sec. 32" FIELD="WELLINGTON" NAME="WELLINGTON UNIT, was JLC. FRANKUM S53" API="15- 191-10078"&gt;</pre> <pre> crow TDS="202250.5" SOLID="202250.5" SO4="647.0" Br="460.0" Cl="124000.0" FOIL="2.60" ALKNTY="150.0" PH="5.88" SIGMA="170" Br="460.0" Cl="124000.0" FOIL="2.60" ALKNTY="150.0" PH="5.88" SIGMA="171.0" TOP="3660.0" NTU="4.65" ALKNTY="150.0" PH="5.88" SIGMA="171.0" TOP="3660.0" FORM="Mississippian" DATE="06/18/2015 00:00" DF="1254.0" LONG="-97.4405029" LAT="37.3095366" STATE="Kansas" CONTY="SUMNER" LOC="T31S RIW Sec. 32" FIELD="WELLINGTON" NAME="WELLINGTON UNIT, was MURPHY 162" API="15-191- </pre>	

# Save Brine Principal Components Panel as a Portable Network Graphics (PNG) Image File



Click on the PDF Icon Button **PDF** at the top of the "Brine Principal Components" Dialog to open the "Select a Different Directory Path" Dialog.

l	🛓 Select a Different Directory Path	
	Save Files To:	Select the "Search" Button in the "Select a
i	C:\Users\jvictor Search	Different Directory Path" Dialog to search your PC for the correct directory path.
	Image Filename:	
	brine.png brine	
	Continue Cancel	

Highlight the Directory you wish to place the PNG File

Select the "Select" Button.

Look In:	HELP	▼ 🖬 🔂 🗂 🔡
CSV Doveton		
Doveton-h	eln	
PDF _	eith	
T XML		
Folder <u>n</u> ame:	C:\Users\jvictor\Documen	nts\dummy\Earthquakes\PC\HELP\PDF
	All Files	
Files of Type:		

Select a Different Directory Path	The Directory path is transferred to the "Save Files To:" text field.
Save Files To: C:\Users\\victor\Documents\dummy\Earthquakes\PC\HELP\PDF Search Image Filename: brine.png brine.png	"brine" is the default filename, you can alter the name to any name you wish. The "File save as:" text field will show what the file name will be saved as.
	Select the "Continue" Button to save file.

The PNG Image File is created along with a HTML file to display the PNG image. At the top of the HTML File is a link that allows the user to create a PDF document of the PNG Image File.

$\leftrightarrow \Rightarrow \mathbf{C}$ $\square$ file:///C:/Users/jvictor/Documents/dummy/Earthquakes/PC/HELP/PDF/brine_brine.html $\therefore$ =													
Create a PDF Doc											)		
Sigma	-3.0	-2.5	2.4 -2.	.3 -2.2	-2.1	-2.0 -	1.9 -1.	8 -1.7	-1.6	-1.5			
	1.5 1.6	1.7	1.8	1.9 2.	.0 2.1	2.2	2.3	2.4 2.	5 3.0				
API-Number	Na	К	Mg	Ca	Ba	Mnll	Felll	CI	Br	SO4	PH		
15-191-10045	2414.09	11.2	204.11	573.85	0.0	0.03	0.71	3497.88	5.88	14.03	5.74		
15-191-10054	2422.79	10.2	187.65	578.84	0.0	0.03	0.57	3526.09	5.63	13.13	5.94		
15-191-10055	2757.72	9.3	276.54	533.93	0.21	0.02	0.76	4090.26	8.13	6.97	5.83		
15-191-10078	2496.73	11.89	213.99	578.84	0.0	0.04	1.42	3300.42	5.88	14.4	5.98		
15-191-10076	2701.17	9.97	200.0	608.78	0.0	0.03	1.18	3497.88	5.75	13.47	5.88		
15-191-10087	2561.98	12.22	198.35	578.84	0.01	0.03	1.29	3526.09	5.63	13.2	5.87		
15-191-10136	2418.44	10.79	193.41	558.88	0.0	0.03	0.59	3582.51	6.0	13.17	5.8		
15-191-10134	2453.24	11.09	195.06	573.85	0.01	0.02	0.89	3554.3	5.88	13.47	5.81		
15-191-10083	2322.74	12.22	187.65	538.92	0.0	0.02	0.93	3300.42	4.88	14.19	6.31		
15-191-43882	2648.97	9.71	239.5	633.73	0.0	0.02	0.75	3723.55	6.88	11.86	5.75		
15-191-11442	2435.84	10.99	195.06	588.82	0.0	0.02	0.81	3526.09	6.0	13.51	5.73		
15-191-22770	1726.83	6.9	137.44	406.18	0.01	0.04	1.18	2397.74	4.38	15.84	6.86		
15-191-22770	2409.74	9.71	227.16	638.72	0.0	0.17	5.8	3723.55	6.13	15.15	5.25		
15-191-22770	2105.26	7.92	163.78	495.0	0.01	0.04	0.0	3074.75	5.25	15.11	7.05		
	Na	К	Mg	Ca	Ba	Mnll	Felll	CI	Br	SO4	PH		
Mean	2,419.681	10.294	201.407	563.37	0.018	0.039	1.206	3,451.538	5.879	13.393	5.986		
Sigma	257.517	1.546	32.778	58.928	0.055	0.039	1.37	382.579	0.875	2.11	0.467		

If the Covariance Matrix Dialog, Principal Components Scores Plot, etc. are displayed then the PNG button automatically retrieves the image from those dialogs and creates a PNG image of each and displays it at the same time the Brine Principal Components PNG Image is displayed.

It the default name "brine" for the Brine Principal Components PNG Image is used then the each of the other images will append a distinct phrase to distinguish it from the main dialog PNG Image plot, i.e.

- Covariance Matrix Panel PNG File will have the name brine\_cov.png
- Eigenvectors & eigenvalues Panel PNG File will have the name brine\_eign.png
- Principal Components Scores Plot PNG File will have the name brine\_Xplot.png
- Anions/Cations Plot PNG File will have the name brine\_plot.png

# **Brine Data - Principal Components Analysis**

	Sigma	-3.0	-2.5	2.4 -2.	.3 -2.2	-2.1	-2.0 -	1.9 -1.	8 -1.7	-1.6	-1.5	
	1	.5 1.6	1.7	1.8	1.9 2	.0 2.1	2.2	2.3	2.4 2.	5 3.0		
	API-Number	Na	К	Mg	Ca	Ba	Mnll	Fell	CI	Br	SO4	PH
1	15-191-10045	2414.09	11.2	204.11	573.85	0.0	0.03	0.71	3497.88	5.88	14.03	5.74
2	15-191-10054	2422.79	10.2	187.65	578.84	0.0	0.03	0.57	3526.09	5.63	13.13	5.94
3	15-191-10055	2757.72	9.3	276.54	533.93	0.21	0.02	0.76	4090.26	8.13	6.97	5.83
	15-191-10078	2496.73	11.89	213.99	578.84	0.0	0.04	1.42	3300.42	5.88	14.4	5.98
	15-191-10076	2701.17	9.97	200.0	608.78	0.0	0.03	1.18	3497.88	5.75	13.47	5.88
	15-191-10087	2561.98	12.22	198.35	578.84	0.01	0.03	1.29	3526.09	5.63	13.2	5.87
-	15-191-10136	2418.44	10.79	193.41	558.88	0.0	0.03	0.59	3582.51	6.0	13.17	5.8
•	15-191-10134	2453.24	11.09	195.06	573.85	0.01	0.02	0.89	3554.3	5.88	13.47	5.81
•	15-191-10083	2322.74	12.22	187.65	538.92	0.0	0.02	0.93	3300.42	4.88	14.19	6.31
	15-191-43882	2648.97	9.71	239.5	633.73	0.0	0.02	0.75	3723.55	6.88	11.86	5.75
	15-191-11442	2435.84	10.99	195.06	588.82	0.0	0.02	0.81	3526.09	6.0	13.51	5.73
	15-191-22770	1726.83	6.9	137.44	406.18	0.01	0.04	1.18	2397.74	4.38	15.84	6.86
	15-191-22770	2409.74	9.71	227.16	638.72	0.0	0.17	5.8	3723.55	6.13	15.15	5.25
N	15-191-22770	2105.26	7.92	163.78	495.0	0.01	0.04	0.0	3074.75	5.25	15.11	7.05
	-	Na	К	Mg	Ca	Ba	Mnll	Felli	CI	Br	SO4	PH
	Mean	2,419.681	10.294	201.407	563.37	0.018	0.039	1.206	3,451.538	5.879	13.393	5.9
	Sigma	257.517	1.546	32.778	58.928	0.055	0.039	1.37	382.579	0.875	2.11	0.4

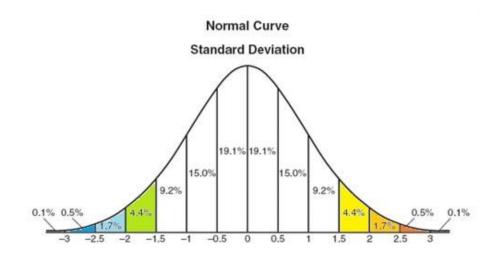
The original Brine data set are converted from mg/l units to meq/l units.

_		
Mean X <sub>k</sub> is the	average value	of each column k

$$\overline{X}_{k} = \frac{\sum_{i=1}^{N} X_{i}}{N}$$
$$\sigma_{k} = \left[\frac{\sum_{i=1}^{N} (X_{ik} - \overline{X}_{k})^{2}}{(N-1)}\right]$$

1⁄2

Sigma (Standard Deviation)  $\sigma_k$  is a measure of how spread out the k<sup>th</sup> data column is.



The brine data cells are colored to illustrate how spread out the data is with respect to the standard deviation, i.e. green and blues from  $-1.5\sigma$  to less than  $-3\sigma$  and yellows and oranges from  $1.5\sigma$  to above  $3\sigma$ .

	Na	K	Mg	Ca	Ba	Mnll	Felll	CI	Br	S04	PH
1	2414.09	11.2	204.11	573.85	0.0	0.03	0.71	3497.88	5.88	14.03	5.74
2	2422.79	10.2	187.65	578.84	0.0	0.03	0.57	3526.09	5.63	13.13	5.94
3	2757.72	9.3	276.54	533.93	0.21	0.02	0.76	4090.26	8.13	6.97	5.83
	2496.73	11.89	213.99	578.84	0.0	0.04	1.42	3300.42	5.88	14.4	5.98
	2701.17	9.97	200.0	608.78	0.0	0.03	1.18	3497.88	5.75	13.47	5.88
	2561.98	12.22	198.35	578.84	0.01	0.03	1.29	3526.09	5.63	13.2	5.87
•	2418.44	10.79	193.41	558.88	0.0	0.03	0.59	3582.51	6.0	13.17	5.8
•	2453.24	11.09	195.06	573.85	0.01	0.02	0.89	3554.3	5.88	13.47	5.81
•	2322.74	12.22	187.65	538.92	0.0	0.02	0.93	3300.42	4.88	14.19	6.31
	2648.97	9.71	239.5	633.73	0.0	0.02	0.75	3723.55	6.88	11.86	5.75
	2435.84	10.99	195.06	588.82	0.0	0.02	0.81	3526.09	6.0	13.51	5.73
	1726.83	6.9	137.44	406.18	0.01	0.04	1.18	2397.74	4.38	15.84	6.86
	2409.74	9.71	227.16	638.72	0.0	0.17	5.8	3723.55	6.13	15.15	5.25
N	2105.26	7.92	163.78	495.0	0.01	0.04	0.0	3074.75	5.25	15.11	7.05
	k = 1	2	3			1993					м

Normalize each column to its standard deviation. Unless the data is normalized, a variable with a large variance will dominate,  $x_{ik} = X_{ik}/\sigma_k$ , where i is the row, k is column.

	Na	K	Mg	Ca	Ba	Mnll	Felli	CI	Br	SO4	PH
Na	0.999	0.537	0.83	0.786	0.337	-0.122	0.028	0.902	0.768	-0.676	-0.719
К	0.537	1.0	0.262	0.56	-0.214	-0.182	-0.009	0.435	0.08	-0.064	-0.529
Mg	0.83	0.262	0.999	0.6	0.62	0.112	0.235	0.881	0.938	-0.788	-0.679
Са	0.786	0.56	0.6	1.0	-0.192	0.267	0.379	0.753	0.47	-0.175	-0.846
Ва	0.337	-0.214	0.62	-0.192	1.0	-0.148	-0.109	0.44	0.711	-0.859	-0.048
Mnll	-0.122	-0.182	0.112	0.267	-0.148	1.0	0.948	0.067	-0.022	0.346	-0.335
Felli	0.028	-0.009	0.235	0.379	-0.109	0.948	0.999	0.164	0.05	0.25	-0.502
CI	0.902	0.435	0.881	0.753	0.44	0.067	0.164	1.0	0.857	-0.719	-0.784
Br	0.768	0.08	0.938	0.47	0.711	-0.022	0.05	0.857	0.999	-0.875	-0.578
SO4	-0.676	-0.064	-0.788	-0.175	-0.859	0.346	0.25	-0.719	-0.875	1.0	0.324
PH	-0.719	-0.529	-0.679	-0.846	-0.048	-0.335	-0.502	-0.784	-0.578	0.324	1.0

# The web app performs all the processing in the background. The process begins by constructing the Covariance matrix for the brine data set. Covariance [cov(x,y)] is a measure how much each data column vary from the mean with respect to each other.

$$\operatorname{cov}(\mathbf{x},\mathbf{y}) = \frac{\sum_{i=1}^{N} (\mathbf{x}_{i} - \overline{\mathbf{x}}) (\mathbf{y}_{i} - \overline{\mathbf{y}})}{(N-1)}$$

where x is the mean of brine data column k divided by  $\sigma_k$  where  $x_i$  is the individual brine data divided by  $\sigma_k$ , subscript i represents the well, subscript k represents the brine data column, e.g. cov (Na, Ca) is sum over the Na (Sodium cation) and Ca (Calcium cation) columns of the normalized data set.

To compute the Eigenvectors and Eigenvalues this web app uses JAMA a Java Matrix Package (<u>http://math.nist.gov/javanumerics/jama/</u>).

"JAMA is a basic linear algebra package for Java. It provides user-level classes for constructing and manipulating real, dense matrices. It is meant to provide sufficient functionality for routine problems, packaged in a way that is natural and understandable to non-experts. It is intended to serve as the standard matrix class for Java." JAMA Java Functions:

C represents the symbol for the Covariance Matrix

The eigenvalues & eigenvectors JAMA functions are listed as follows

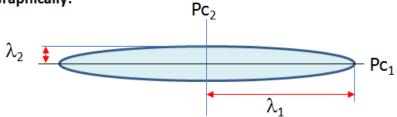
 $E_v = C.eig()$ , where the eig() function computes the eigenvalues & eigenvectors of the covariance matrix C.

The eigenvalues can be retrieved as follows, Eigenvalues  $= E_v.getRealEigenvalues()$  and the eigenvectors can then be retrieve as follows, Eigenvectors  $= E_v.getV()$ .

					1 <sup>st</sup> tv	wo prii	ncipal c	ompo	nent ve	ectors:	Pc <sub>2</sub>	Pc <sub>1</sub>
		1	2	3	4	5	6	7	8	9	10	11
1	Na	-0.19	0.03	-0.309	0.404	0.59	0.007	-0.377	-0.143	-0.203	0.011	-0.386
	K	0.131	-0.17	-0.066	0.039	-0.227	-0.03	-0.135	0.711	-0.558	-0.165	-0.175
	Mg	-0.152	0.511	-0.029	-0.277	-0.249	-0.577	-0.242	0.04	0.146	0.045	-0.396
	Са	0.512	-0.089	0.478	-0.18	0.044	0.008	-0.198	-0.415	-0.229	-0.327	-0.305
	Ba	0.243	0.151	0.507	0.295	0.178	0.152	-0.064	0.412	0.382	0.39	-0.21
Eigenvectors	Mnll	0.378	0.166	-0.43	0.19	-0.214	0.265	-0.218	0.07	0.465	-0.47	-0.023
	Felli	-0.35	-0.418	0.194	-0.254	0.32	-0.15	-0.037	0.264	0.398	-0.487	-0.082
	CI	-0.47	0.1	0.118	-0.167	-0.295	0.684	-0.02	-0.069	-0.037	-0.016	-0.403
	Br	-0.025	-0.578	-0.057	0.391	-0.439	-0.241	0.108	-0.202	0.182	0.167	-0.376
	SO4	-0.33	0.231	0.412	0.57	-0.221	-0.127	-0.141	-0.072	-0.108	-0.37	0.318
l	PH	-0.052	-0.276	0.03	-0.173	-0.157	0.068	-0.809	-0.039	0.07	0.294	0.334
				1	<sup>st</sup> two p	princip	al comp	ponent	t eigen	values	: λ <sub>2</sub>	λ1
		1	2	3	4	5	6	7	8	9	10	11
Eigenvalues 🛶	Eigen	0.004	0.007	0.009	0.027	0.085	0.096	0.161	0.403	1.721	2.715	5.772
-	%	0	0	0	0.2	0.7	0.8	1.4	3.6	15.6	24.6	52.4

The principal components is less than or equal to the number of original variables. The first principal component  $Pc_1$  has the largest possible variance i.e., it accounts for as much of the variability in the data as possible and the next principal component  $Pc_2$  has the highest variance possible under the constraint that it is orthogonal to the preceding component. The principal components are orthogonal because they are the eigenvectors of the covariance matrix, which is symmetric.





Construct a Feature Vector from the 1<sup>st</sup> two principal components, e.g. columns 10 and ll.

	Pc <sub>1</sub>	Pc <sub>2</sub>	
	-0.386	0.011	Na
	-0.175	-0.165	К
	-0.396	0.045	Mg
	-0.305	-0.327	Ca
	-0.21	0.39	Ba
Feature Vector [V] =	-0.023	-0.47	Mnll
	-0.082	-0.487	Felli
	-0.403	-0.016	CI
	-0.376	0.167	Br
	0.318	-0.37	SO4
	0.334	0.294	PH

Then construct an Adjusted Data Matrix from the Brine Data Matrix by subtracting the mean of each column and then dividing the standard deviation of the each column.

Adjusted Data Matrix [Am] = [  $(X_{ik} - \overline{X}_k) / \sigma_k$ ]

where  $\overline{X}_k$  is the mean of brine data column k

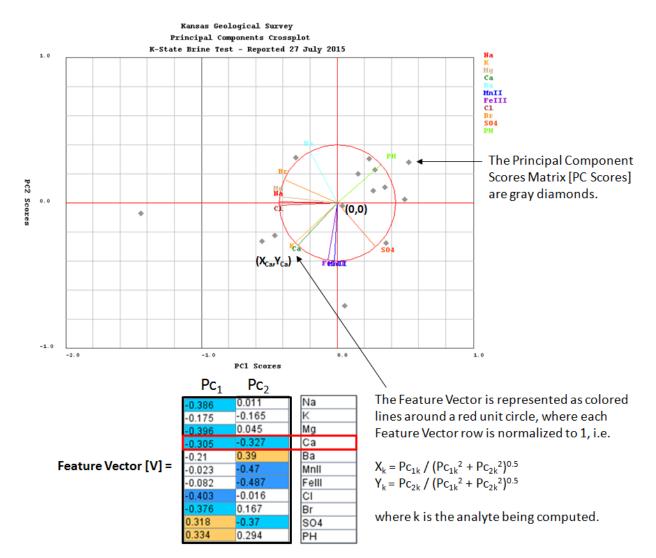
X<sub>ik</sub> is the individual brine data; i=well, k=brine data

 $\sigma_k$  is the standard deviation of the brine data column

Compute the Principal Components Scores [PC Scores] matrix as the Adjusted Data matrix times the Feature Vector.

[PC Scores] = [Am] X [V]

The Principal Components Scores [PC Scores] matrix converts the multi dimensional matrix into a 2 dimensional matrix.



## **Begin Normalization Process Button**

Buttons to display dialogs & plots and to save the information generated.

Color Legend for brine data cells that are colored.

Brine Data imported in meq/l units with table cells colored if the data falls outside 1.5 standard deviations.

Brine Data show	×ing data g			<ul> <li>Original</li> </ul>		iood Data	<ul> <li>Data Bel</li> </ul>	ow 1 🔾 [	Data Above	1 O Norma
Sigma *	-3.0	2.5 -2.	4 -2.3	-2.2	-2.1 -	2.0 -1.	9 -1.8	-1.7	-1.6 -	1.5
1.5	1.6	1.7	1.8 1.	9 2.0	2.1	2.2	2.3 2.	4 2.5	3.0	1
API-Number	Na	К	Mg	Ca	Sr	Mnll	Fell	CI	SO4	PH
-191-10078	2506.24	8.67	179.09	557.13	9.15	0.02	0.75	3238.53	22.17	6.26
-191-10078	2496.73	11.89	213.99	578.84			0.94	3300.42	14.4	5.98
-191-10076	2701.17	9.97	200.0	608.78			0.78	3497.88	13.47	5.88
-191-10100	2771.76	8.76	214.55	630.16			0.56	3537.26	27.79	5.2
-191-10126	2698.62	8.6	210.43	611.65			0.77	3447.44	37.47	5.4
-191-10107	3074.65	7.49	316.7	586.96			1.58	3936.5	14.67	5.4
-191-10112 -191-10271	2675.51 2567.06	9.2	216.51 205.86	611.2 606.92			0.45	3465.98 3345.33	29.87 33.52	5.3 5.8
-191-10270	2584.61	9.39	205.86	606.92	10.02	0.03		3345.33 3340.87	33.52	5.8
-191-10270	2584.01	9.03	205.57	605.4			0.55	3333.48	29.35	5.2
-191-10202	2650.11	9.67	206.4	619.66			0.73	3413.51	29.35	4.9
-191-11442	2657.74	8.95	208.26	604.28			0.44	3406.03	30.7	5.6
191-10045	2717.24	8.8	212.61	617.85			0.73	3321.15	26.23	5.2
191-10054	2788.36	8.56	206.51	627.67	10.3		0.51	3379.35	25.6	5.3
191-10055	3036.56	7.16	310.94	560.79			0.45	3739.6	8.47	5.6
191-10049	2620.88	9.42	204.74	626.08	10.32	0.05	1.38	3192.75	24.46	5.2
191-10061	2626.65	9.11	205.53	610.7	12.87		0.67	3162.08	30.7	5.4
-191-10059	2394.91	9.86	178.59	559.08	9.44	0.04	0.58	2818.82	31.85	5.3
-191-10074	2560.04	8.75	199.59	602.55			0.44	3068.57	32.89	5.6
-191-10066	2514.43	8.44	189.36	586.46			1.09	3030.77	23.83	5.4
191-10067	2547.32	8.93	201.7	596.74	12.6		0.7	3046.43	27.17	4.9
191-10078	2520.36	10.5	205.18	590.15	10.09		1.88	3039.26	29.77	5.2
191-10077	2700.01	9.25	202.95	615.79	10.66		1.23	3253.9	28.73	5.6
-191-10076	2817.72	9.58	214.08	637.74			0.72	3402.82	17.23	5.3
-191-10093	2617.27	10.06	206.74	611.07			0.52	3128.18	33.31	5.3
-191-10096	2565.14	11.1	198.32	610.84			0.26	3165.69	24.46	5.6
-191-10092 -191-10087	2694.05 2814.38	12.97	199.81 210.33	638.33 625.69	10.57	0.06	3.33 0.84	3301.6 3352.77	20.73	5.2 5.2
-191-10087	2694.82	8.67	210.33	614.78	9.77		0.84	3352.77	28.52	5.2 4.9
-191-10104 -191-10119	2694.82	8.64	213.91 210.05	596.98			0.71	3327.27	31.33	5.3
-191-10136	2729.22	9.06	210.05	618.41			0.33	3291.22	22.69	6.1
-191-10134	2691.93	9.00	209.56	624.63			0.46	3291.22	25.6	5.2
191-10131	2638.29	8.79	213.7	615.84			1.43	3273.76	28.0	5.2
191-10255	2703.57	9.45	214.23	621.45	11.0	0.13	3.68	3412.01	33.0	5.2
191-10257	2615.45	8.99	210.71	619.58	10.49	0.02	0.86	3346.17	31.33	5.2
191-10259	2714.2	9.48	215.81	629.83	10.83		0.63	3383.66	26.44	5.3
191-10261	2958.42	8.15	274.69	656.47			0.74	3759.54	16.86	5.3
191-10290	2608.45	9.48	197.42	607.64	10.2	0.02	0.42	3306.93	26.54	5.8
191-10281	2637.43	9.68	200.52	616.87	10.5	0.02	0.6	3230.23	28.73	5.3
-191-10294	2694.51	10.1	204.65	626.21			0.46	3352.77	24.98	6.5
-191-20789	2677.05	8.08	206.11	643.67			1.79	3195.37	24.67	5.3
191-21000	2752.68	8.1	211.61	649.3			0.71	3343.18	29.98	5.2
191-21179	2695.07	8.23	208.85	635.46			1.99	3294.18	23.83	5.4
191-21180	2660.72	8.41	211.72	624.35			0.9	3180.08	33.52	5.2
191-21608	2485.49	9.57	186.38	582.51			0.4	2956.16	25.92	4.9
-191-19005	2662.57	9.09	209.08	606.36			0.44	3263.1	23.94	5.0
-191-19005	2779.31	9.16	212.09	636.14			0.51	3393.11	16.28	5.3
-191-43782-0001	2703.93	8.64	206.3	629.94	10.51		1.56	3154.86	28.41	5.2
-191-11325	2650.49	9.07	206.98	626.14	10.7	0.03	0.6	3155.62	29.66	5.6
	Na	K	Mg	Ca	Sr	Mnll	Fell	CI	SO4	PH
an	2,576.914	10.962	201.759	587.802	8.985	0.036	0.817	3,279.356	24.518	5.595
oma	274.521	5.672	37.364	67.51	5.631	0.02	0.841	320.572	10.584	0.525

Table showing the Mean and Standard Deviation of the wells that are displayed.

👫 Σν 🥙 🖉 📕 📕 

- Close this dialog and all dialogs opened by this dialog.
- Display the Covariance Matrix Table.
- **//** Σν <sup>2</sup>% Display the Eigenvector Matrix & Eigenvalues Tables.
  - Display the Principal Components Scores Plot.
- // Display the Brine Data Anions/Cations Ratio Plot.
- Esv Save Brine Data Displayed as a Comma Separated Values (CSV) ASCII File.
- XML Save Brine Data Displayed as a Extensible Markup Language (XML) ASCII File.

PDF Save dialog or plot as a Portable Network Graphics (PNG) file with the option of creating a Portable Document Format (PDF) file.

#### **Radio Buttons:**

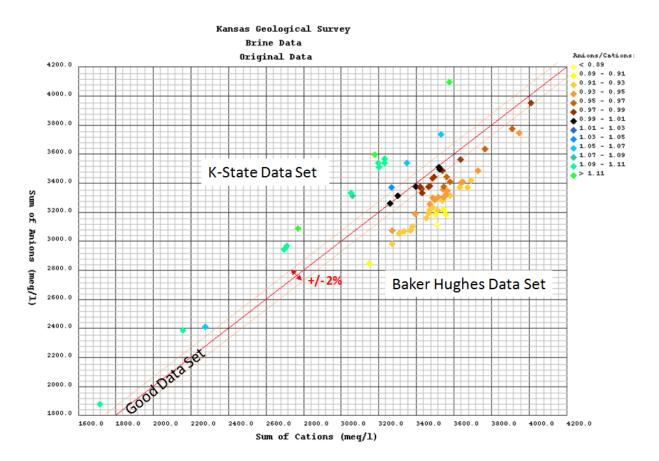
• Original Data - Displays all the imported brine data ordered by "Good" brine data set, Brine Data Anions/Cations Ratio below 1.0, Brine Data Anions/Cations Ration above 1.0.

- Good Data Displays the "Good" brine data set.
- Data Below 1 Displays the Brine Data Anions/Cations Ratio below 1.0.
- Data Above 1 Displays the Brine Data Anions/Cations Ration above 1.0.

• Normalized - Displays all the brine data normalized to the "Good" brine data set ordered by "Good" brine data set, Brine Data Anions/Cations Ratio below 1.0, Brine Data Anions/Cations Ration above 1.0.

### Normalization Brine Data to +/- 2% of the Anions/Cations Ratio of 1.0

The "Begin Normalization Process" Button on the "Brine Data" Dialog allows the user to force the brine data set to a "Corrected" Value. The default "% from Anions/Cations equal to 1.0" text field is 2.0, which implies the "Good" data set will fall between 1.02 and 0.98 inclusive. The web app separates the brine data above 1.02 and labels it as "Data Above 1" and brine data below 0.98 as "Data Below 1". In this specific example the data above 1.0 is K-State measured data and the data below is Baker Hughes measured data. The "Good" data set has at least 2 measurements of K-State in the data set with the rest being from the Baker Hughes data set.



The web app performs all the processing in the background, the user can only change the "% from Anions/Cations equal to 1.0" text field. The process begins by constructing the Covariance matrix for the "Good" data set, since this will be used in correcting the above and below data sets. Covariance [cov(x,y)] matrix is a measure how much each data column vary from the mean with respect to each other.

$$\operatorname{cov}(\mathbf{x},\mathbf{y}) = \frac{\sum_{i=1}^{N} (\mathbf{x}_{i} - \overline{\mathbf{x}}) (\mathbf{y}_{i} - \overline{\mathbf{y}})}{(N-1)}$$

where x is the mean of brine data column k divided by  $\sigma_k$  where  $x_i$  is the individual brine data divided by  $\sigma_k$ , subscript i represents the well, subscript k represents the brine data column, e.g. cov (Na, Ca) is sum over the Na (Sodium cation) and Ca (Calcium cation) columns of the normalized data set.

# Covariance Matrix – Good Data Set

		Na	K	Mg	Са	Sr	Mnll	Fell	CI	S04	PH
v	Na	1.0	-0.672	0.88	0.218	0.754	-0.135	-0.033	0.988	-0.262	-0.327
·	K	-0.672	1.0	-0.457	-0.065	-0.831	0.253	0.048	-0.584	-0.224	0.216
	Mg	0.88	-0.457	1.0	-0.049	0.761	0.001	0.09	0.921	-0.366	-0.208
ŧ	Са	0.218	-0.065	-0.049	0.999	0.01	0.093	-0.009	0.165	0.496	-0.729
	Sr	0.754	-0.831	0.761	0.01	0.999	-0.077	0.11	0.713	0.128	-0.397
	Mnll	-0.135	0.253	0.001	0.093	-0.077	0.999	0.958	-0.11	0.186	-0.326
	Fell	-0.033	0.048	0.09	-0.009	0.11	0.958	0.999	-0.023	0.191	-0.337
	CI	0.988	-0.584	0.921	0.165	0.713	-0.11	-0.023	1.0	-0.353	-0.265
	SO4	-0.262	-0.224	-0.366	0.496	0.128	0.186	0.191	-0.353	1.0	-0.505
	PH	-0.327	0.216	-0.208	-0.729	-0.397	-0.326	-0.337	-0.265	-0.505	0.999

X→

**Covariance Matrix** 

	cov( Na, Na ) cov( K, Na ) cov( Mg, Na )	cov ( Na, K ) cov ( K, K ) cov ( Mg, K )	cov ( Na, Mg ) cov ( K, Mg ) cov ( Mg, Mg )	  $cov(Na, SO_4) cov(Na, PH)$ $cov(K, SO_4) cov(K, PH)$ $cov(Mg, SO_4) cov(Mg, PH)$
C =		•		
	cov (SO <sub>4</sub> , Na )	cov (SO <sub>4</sub> , K )	cov (SO <sub>4</sub> , Mg )	 $cov(SO_4, SO_4) cov(SO_4, PH)$
	cov ( PH, Na )	cov ( PH, K )	cov ( PH, Mg )	 cov (SO <sub>4</sub> , SO <sub>4</sub> ) cov (SO <sub>4</sub> , PH ) cov ( PH, SO <sub>4</sub> ) cov ( PH, PH )

To compute the Eigenvectors and Eigenvalues this web app uses JAMA a Java Matrix Package (<u>http://math.nist.gov/javanumerics/jama/</u>).

"JAMA is a basic linear algebra package for Java. It provides user-level classes for constructing and manipulating real, dense matrices. It is meant to provide sufficient functionality for routine problems, packaged in a way that is natural and understandable to non-experts. It is intended to serve as the standard matrix class for Java."

JAMA Java Functions:

C represents the symbol for the Covariance Matrix

The eigenvalues & eigenvectors JAMA functions are listed as follows

 $E_v = C.eig()$ , where the eig() function computes the eigenvalues & eigenvectors of the covariance matrix C.

The eigenvalues can be retrieved as follows, Eigenvalues  $= E_v.getRealEigenvalues()$  and the eigenvectors can then be retrieve as follows, Eigenvectors  $= E_v.getV()$ .

	0.511	-0.528	-0.12	0.353	0.033	-0.246	-0.177	0.024	-0.062	-0.47	Na
	0.476	0.04	0.088	-0.011	-0.296	0.482	-0.513	0.204	0.006	0.37	K
	-0.544	-0.27	0.129	0.04	-0.473	0.343	-0.125	0.241	-0.094	-0.432	Mg
	-0.082	-0.103	0.12	-0.495	-0.17	-0.339	-0.502	-0.417	0.376	-0.094	Ca
Eigenvector [V] =	0.377	0.06	-0.1	-0.606	0.0	0.373	0.381	-0.02	0.047	-0.434	Sr
0	-0.072	0.049	-0.687	-0.061	-0.14	-0.173	-0.02	0.502	0.459	0.049	Mnll
	0.095	-0.062	0.671	-0.031	0.13	-0.17	0.163	0.517	0.44	-0.016	Fell
	0.101	0.785	0.078	0.183	-0.114	-0.185	-0.237	0.092	-0.093	-0.459	CI
	0.14	0.069	0.049	0.384	-0.553	0.061	0.395	-0.399	0.443	0.05	SO4
	0.147	-0.05	0.064	-0.27	-0.549	-0.486	0.225	0.19	-0.482	0.202	PH

Construct an Adjusted Data Matrix from the Brine Data Matrix by subtracting the mean of each column.

Adjusted Data Matrix [Am] =  $[(X_{ik} - \overline{X}_k)]$ 

where  $\overline{X}_k$  is the mean of brine data column k

 $X_{ik}$  is the individual brine data; i=well, k=brine data

Compute the Final Data [F] matrix as the Eigenvector [V] times the transpose of the Adjusted Data [Am]<sup>T</sup> matrix,

 $[F] = [V] X [Am]^{T}$ 

The Original Data [B] matrix can be found by multiplying the transpose of the Feature Vector  $[V]^T$  times the Fine Data [F] matrix plus the Original Mean  $[X_o]$  of the "Good" data set,

 $[B] = [V]^T X [F] + [X_o].$ 

The above equation also works even if a feature vector is constructed from the eigenvectors where not all the eigenvectors are included. If the eigenvector is used on the Adjusted Data Matrix and the Original Mean is added back then the original Brine data matrix should be reproduced. This is the basis of the correction of the above and below data sets.

Good	Na	К	Mg	Ca	Sr	Mnll	Fell	CI	S04	PH
Mean	2,665.634	9.299	214.667	602.367	10.043	0.033	1.143	3,438.603	26.469	5.493
Sigma	152.374	1.045	33.629	19.478	6.607	0.019	1.383	178.909	8.326	0.416
Below 1	Na	к	Mg	Ca	Sr	Mnll	Fell	CI	S04	PH
Mean	2,677.727	9.214	211.104	615.492	11.342	0.039	0.918	3,263.849	25.996	5.372
Sigma	122.8	0.936	21.36	20.935	3.693	0.021	0.724	183.52	5.352	0.339
Above 1	Na	к	Mg	Са	Sr	Mnll	Fell	CI	SO4	PH
Mean	2,259.291	16.556	169.01	507.481	2.278	0.03	0.332	3,206.169	19.403	6.229
Sigma	372.107	9.807	52.16	98.683	3.367	0.015	0.308	565.91	18.376	0.482

The mean values for the Below & Above data sets are compared with the "Good" data set. The means for the Chlorides are lower for the Below & Above data sets. The Above data set is also mixed for the other analytes.

The normalization process assumes that the "Good" Data set is correct and that for some reason the measurements Below and Above the 2% of the Anions/Cations ratio of 1.0 have below average values of Chlorides, because these water samples have a very high concentration of Chlorides which could have saturated the measurements results. This analysis is not suggesting that the data is in error only that the Brine data for Below and Above data sets will be modified to fit the "Good" Data set mean value.

The "Good" Data eigenvectors and Means will be used to correct the Brine data for the Below and Above data sets. In the same manner as the "Good" brine data set, the Adjusted Data Matrix will be constructed for the Below and Above data sets using their respective means. Then the "Good" eigenvectors and "Good" means will be used to compute the "original" data sets as if the above and below were measured as the original good data, the final equation is used to compute the corrected data sets,

 $[B] = [Vg]^T X [ [Vg] X [Am_R]^T] + [Xg].$ 

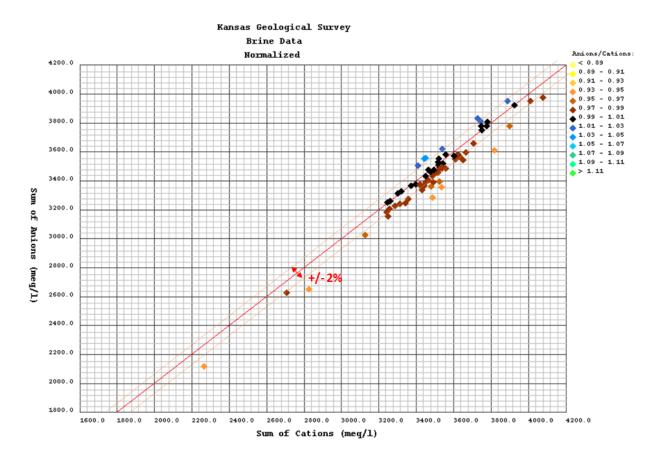
where [Vg] is the eigenvector of the "Good" data set

[Xg] is the "Good" mean matrix

[Am<sub>R</sub>] is the Adjusted Data Matrix for either the Below or Above data sets.

[B] is the "new Original" data set of the Below or Above Brine data.

Using the above equation on the Above & Below data sets the data is corrected to the 2% range limit as illustrated below,



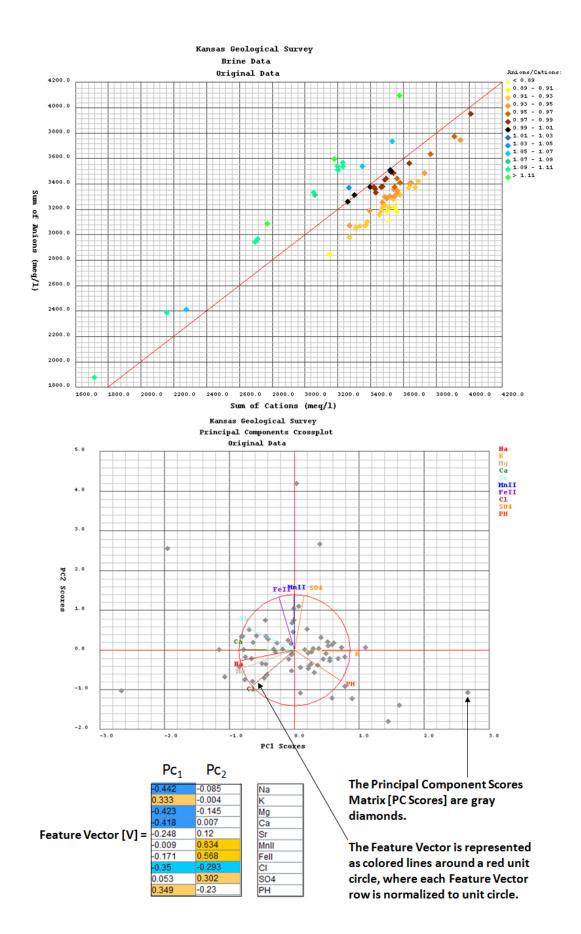
# Comparison of the Original Brine Data with the Normalized Brine Data

riginal Data Cat	API-Number	Na	K	Mg	Ca	Sr	Mnli	Fell	CI	\$04	PH	
riginal Data Set 🛛 🔒	15-191-10078	2506.24 2496.73	8.67	179.09	557.13 578.84	9.15	0.02	0.75	3238.53 3300.42	22.17	6.26 5.98	
•	15-191-10078	2496.73 2701.17	9.97	213.99	578.84 608.78	0.0	0.04	0.94	3300.42	14.4	5.98	
and the second	15-191-10100	2771.76	8.76	214.55	630.16	11.05	0.03	0.56	3537.26	27.79	5.2	
ood Brine Data"	15-191-10126	2698.62	8.6	210.43	611.65	10.55	0.03	0.77	3447.44	37.47	5.4	
	15-191-10107	3074.65	7.49	316.7	586.96	26.59	0.03	1.58	3936.5	14.67	5.4	
8 > Cations/Anions < 1.02	15-191-10112	2675.51	9.2	216.51	611.2	11.3	0.02	0.45	3465.98	29.87	5.3	
	15-191-10271	2567.06	9.39	205.86	606.92	10.02	0.03	0.74	3345.33	33.52	5.8	4.1.10
	15-191-10270 15-191-10262	2584.61 2603.41	9.63	205.57	607.43 605.4	10.14	0.09	0.55	3340.87 3333.48	34.97 29.35	5.0 5.2	1.
	15-191-10295	2650.11	9.67	206.4	619.66	10.69	0.02	0.73	3413.51	29.25	4.9	in
*	15-191-11442	2657.74	8.95	208.26	604.28	10.78	0.02	0.44	3406.03	30.7	5.6	
· · · · · · · · · · · · · · · · · · ·	15-191-10045	2717.24	8.8	212.61	617.85	10.93	0.04	0.73	3321.15	26.23	5.2	
	15-191-10054	2788.36	8.56	206.51	627.67	10.3	0.03	0.51	3379.35	25.6	5.3	PA .
	15-191-10055	3036.56	7.16	310.94	560.79	34,29	0.02	0.45	3739.6	8.47	5.6	9
	15-191-10049 15-191-10061	2620.88 2626.65	9.42	204.74 205.53	626.08 610.7	10.32	0.05	1.38	3192.75 3162.08	24.46 30.7	5.2 5.4	
	15-191-10059	2394.91	9.86	178.59	559.08	9.44	0.04	0.58	2818.82	31.85	5.3	
	15-191-10074	2560.04	8.75	199.59	602.55	10.06	0.04	0.44	3068.57	32.89	5.6	14
	15-191-10066	2514.43	8.44	189.36	586.46	10.16	0.04	1.09	3030.77	23.83	5.4	1
	15-191-10067	2547.32	8.93	201.7	596.74	12.6	0.04	0.7	3046.43	27.17	4.9	
	15-191-10078	2520.36	10.5	205.18	590.15	10.09	0.06	1.88	3039.26	29.77	5.2	
	15-191-10077	2700.01	9.25	202.95	615.79 637.74	10.66	0.07	1.23	3253.9 3402.82	28.73	5.6	14
	15-191-10076 15-191-10093	2817.72 2617.27	9.58	214.08 206.74	611.07	11.51	0.03	0.72	3402.82	33.31	5.3	
	15-191-10095	2565.14	11.1	198.32	610.84	10.34	0.02	0.26	3165.69	24.46	5.6	00
	15-191-10092	2694.05	12.97	199.81	638.33	10.57	0.06	3 33	3301.6	20.73	5.2	
	15-191-10087	2814.38	10.01	210.33	625.69	12.54	0.03	0.84	3352.77	17.65	5.2	
	15-191-10104	2694.82	8.67	213.91	614.78	9.77	0.03	0.71	3327.27	28.52	4.9	14
	15-191-10119	2646.31	8.64	210.05	596.98	10.83	0.02	0.33	3351.05	31.33	5.3	LD .
Second and the second second second second	15-191-10136 15-191-10134	2729.22 2691.93	9.06	214.23 209.56	618.41 624.63	10.87	0.03	0.46	3291.22 3279.49	22.69	6.1 5.2	
"Baker Hughes Data"	15-191-10131	2638.29	8.79	213.7	615.84	10.8	0.05	1.43	3273.76	28.0	5.2	
0	15-191-10255	2703.57	9.45	214.23	621.45	11.0	0.13	0.58	3412.01	33.0	5.2	N
Cations/Anions<0.98	15-191-10257	2615.45	8.99	210.71	619.58	10.49	0.02	0.86	3346.17	31.33	5.2	0
cutions/rinons (0.50	15-191-10259	2714.2	9.48	215.81	629.83	10.83	0.02	0.63	3383.66	26.44	5.3	
	15-191-10261	2958.42	8.15	274.69	656.47	12.35	0.02	0.74	3759.54	16.86	5.3	
	15-191-10290 15-191-10281	2608.45 2637.43	9.48	197.42 200.52	607.64 616.87	10.2	0.02	0.42	3306.93 3230.23	26.54 28.73	5.8 5.3	N
	15-191-10294	2694.51	10.1	204.65	626.21	10.48	0.03	0.46	3352.77	24.98	6.5	· · ·
	15-191-20789	2677.05	8.08	206.11	643.67	9.97	0.06	1.79	3195.37	24.67	5.3	
	15-191-21000	2752.68	8.1	211.61	649.3	10.16	0.03	0.71	3343.18	29.98	5.2	
	15-191-21179	2695.07	8.23	208.85	635.46	10.32	0.08	1.99	3294,18	23.83	5.4	N
	15-191-21180 15-191-21608	2660.72 2485.49	8.41	211.72 186.38	624.35 582.51	9.95	0.04	0.9	3180.08 2956.16	33.52	5.2	Na.
	15-191-19005	2662.57	9.09	209.08	606.36	11.02	0.03	0.44	3263.1	23.94	5.0	
	15-191-19005	2779.31	9.16	212.09	636.14	11.64	0.04	0.51	3393.11	16.28	5.3	
	15-191-43782-0001	2703.93	8.64	206.3	629.94	10.51	0.07	1.56	3154.86	28.41	5.2	ENV.
	15-191-11325	2650.49	9.07	206.98	626.14	10.7	0.03	0.6	3155.62	29.66	5.6	in the
	15-191-43814	2685.38	9.25	207.92	605.97	10.82	0.04	0.74	3279.97	22.79	5.3	
	15-191-43814 15-191-43882	2859.33 2871.14	9.48 9.13	213.09 252.04	636.66 621.98	11.35	0.04	0.63	3465.16 3611.05	20.77 26.12	5.6 6.5	
	15-191-43889	2648.76	8.5	210.01	611.85	10.37	0.02	0.51	3205.69	26.23	5.4	IN N
	15-191-00395-0001	2674.01	8.92	207.25	609.7	10.68	0.03	0.43	3088.71	24.04	5.3	
<b>*</b>	15-191-10083-0002	2468.41	10.34	201.58	579.92	9.86	0.06	1.49	3041.41	34.56	5.2	
<b>*</b>	15-191-10045	2414.09	11.2	204.11	573.85	0.0	0.03	0.47	3497.88	14.03	5.74	
	15-191-10054	2422.79	10.2	187.65	578.84	0.0	0.03	0.38	3526.09	13.13	5.94	
	15-191-10055 15-191-10087	2757.72 2561.98	9.3	276.54	533.93 578.84	0.0	0.02	0.51	4090.26 3526.09	6.97 13.2	5.83 5.87	
	15-191-10136	2418.44	10.79	198.30	558.88	0.0	0.03	0.39	3582.51	13.17	5.8	a
	15-191-10134	2453.24	11.09	195.06	573.85	0.0	0.02	0.59	3554.3	13.47	5.81	
	15-191-10083-0001	2322.74	12.22	187.65	538.92	0.0	0.02	0.62	3300.42	14.19	6.31	
"K-State Data"	15-191-43882	2648.97	9.71	239.5	633.73	0.0	0.02	0.5	3723.55	11.86	5.75	100
N-State Data	15-191-11442	2435.84	10.99	195.06	588.82	0.0	0.02	0.54	3526.09	13.51	5.73	10
Cations/Anions>1.02	15-191-22590 15-191-22590	2113.96	27.63	117.69	440.11	6.25 5.77	0.02	0.0	2905.5	7.2	6.56 6.66	
Cations/Amons / 1.02	15-191-22590	2361.89	36.67	134.15	513.97	7.62	0.08	0.0	3328.63	7.2	6.46	
	15-191-22590	2105.26	32.73	119.34	432.63	5.98	0.02	0.0	2877.29	69.12	6.58	
	15-191-22591	1370.16	21.32	72.42	250.99	3.6	0.04	0.0	1856.13	22.06	7.02	
	15-191-22591	2522.83	17.95	155.55	563.87	9.51	0.03	0.01	3356.84	14.63	5.92	
	15-191-22770		7.92	163.78	495.0	0.0	0.04	0.0	3074.75	15.11	7.05	

	Na	К	Mg	Ca	Sr	Mnll	Fell	CI	SO4	PH
Mean	2,576.914	10.962	201.759	587.802	8.985	0.036	0.817	3,279.356	24.518	5.595
Sigma	274.521	5.672	37.364	67.51	5.631	0.02	0.841	320.572	10.584	0.525

# Covariance Matrix – Original Data Set

	Na	K	Mg	Ca	Sr	Mnll	Fell	CI	SO4	PH
Na	1.0	-0.559	0.875	0.895	0.559	-0.092	0.232	0.796	-0.059	-0.653
K	-0.559	1.0	-0.671	-0.635	-0.222	-0.05	-0.25	-0.368	0.226	0.522
Mg	0.875	-0.671	0.999	0.708	0.508	-0.114	0.227	0.801	-0.233	-0.527
Ca	0.895	-0.635	0.708	0.999	0.335	0.005	0.297	0.661	-0.007	-0.728
Sr	0.559	-0.222	0.508	0.335	1.0	0.053	0.158	0.167	0.174	-0.436
Mnll	-0.092	-0.05	-0.114	0.005	0.053	1.0	0.724	-0.253	0.062	-0.175
Fell	0.232	-0.25	0.227	0.297	0.158	0.724	1.0	0.113	0.103	-0.393
CI	0.796	-0.368	0.801	0.661	0.167	-0.253	0.113	1.0	-0.291	-0.328
SO4	-0.059	0.226	-0.233	-0.007	0.174	0.062	0.103	-0.291	1.0	-0.141
PH	-0.653	0.522	-0.527	-0.728	-0.436	-0.175	-0.393	-0.328	-0.141	1.0



	API-Number	Na	ĸ	Mg	Ca	Sř	Mnll	Fell	CI	\$04	PH	
ormalized Data Set	15-191-10078	2506.23	8.66	179.09	557.13	9.14	0.01	0.75	3238.53	22.17	6.26	
	15-191-10078 15-191-10076	2496.73 2701.17	11.88	213.99	578.84 608.78	0.0	0.03	0.94	3300.42 3497.88	14.39	5.97 5.88	
	15-191-10100	2771.76	8.76	214.54	630.16	11.05	0.03	0.55	3537.26	27.79	5.2	
Good Brine Data"	15-191-10126	2698.62	8.6	210.42	611.65	10.55	0.02	0.76	3447.44	37.47	5.4	
00 0 1 10 1 0 0	15-191-10107	3074.65	7.49	216.69	586.95	26.59	0.03	1.57	3936.5	14.67	5.39	
$0.98 \ge Cations/Anions \le 1.02$	15-191-10112 15-191-10271	2675.51 2567.06	9.2 9.38	216.51 205.86	611.2 606.91	11.3 10.01	0.02	0.44	3465.98 3345.33	29.87	5.29 5.79	
	15-191-10270	2584.61	9.62	205.57	607.42	10.13	0.08	5.43	3340.87	34.97	4.99	[ ba
	15-191-10262	2603.41	9.36	198.64	605.4	10.24	0.01	0.55	3333.48	29.35	5.19	(n
+	15-191-10295 15-191-11442	2650.11 2657.74	9.66 8.94	206.4 208.26	619.66 604.28	10.68	0.02	0.73	3413.51 3406.03	29.25 30.7	4.89	91
	15-191-10045	2705.14	8.88	206.20	604.72	9.63	0.03	0.95	3495.9	26.7	5.32	
	15-191-10054	2776.26	8.64	210.07	614.54	9.0	0.02	0.73	3554.1	26.07	5.42	<b>I</b>
	15-191-10055	3024.46	7.24	314.5	547.66	32.99	0.01	0.67	3914.35	8.94	5.72	6
	15-191-10049 15-191-10061	2608.78 2614.55	9.5	208.3	612.95 597.57	9.02	0.04	1.6	3367.5 3336.83	24.93	5.32 5.52	
	15-191-10059	2382.81	9.94	182.15	545.95	8.14	0.03	0.8	2993.57	32.32	5.42	
	15-191-10074	2547.94	8.83	203.15	589.42	8.76	0.03	0.66	3243.32	33.36	5.72	14
	15-191-10066	2502.33	8.52	192.92	573.33	8.86	0.03	1.31	3205.52	24.3	5.52	-1
	15-191-10067 15-191-10078	2535.22 2508.26	9.01	205.26 208.74	583.61	11.3	0.03	0.92	3221.18	27.64	5.02 5.32	
	15-191-10077	2687.91	9.33	206.51	602.66	9.36	0.06	1.45	3428.65	29.2	5.72	
	15-191-10076	2805.62	9.66	217.64	624.61	10.21	0.02	0.94	3577.57	17.7	5.42	1 th
	15-191-10093 15-191-10096	2605.17 2553.04	10.14	210.3 201.88	597.94 597.71	9.17	0.01	0.74	3302.93 3340.44	33.78 24.93	5.42	00
	15-191-10095	2553.04 2681.95	11.18	201.88	625.2	9.04	0.02	3.55	3340.44	24.93	5.72	
	15-191-10087	2802.28	10.09	213.89	612.56	11.24	0.02	1.06	3527.52	18.12	5.32	
	15-191-10104	2682.72	8.75	217.47	601.65	8.47	0.02	0.93	3502.02	28.99	5.02	1
	15-191-10119 15-191-10136	2634.21 2717.12	8.72 9.14	213.61 217.79	583.85 605.28	9.53	0.01	0.55	3525.8 3465.97	31.8	5.42	6
	15-191-10134	2679.83	9.32	213.12	611.5	9.71	0.02	0.08	3454.24	26.07	5.32	
"Baker Hughes Data"	15-191-10131	2626.19	8.87	217.26	602.71	9.5	0.04	1.65	3448.51	28.47	5.32	N
0	15-191-10255	2691.47	9.53	217.79	608.32	9.7	0.12	3.9	3586.76	33.47	5.32	<b>B</b>
Cations/Anions < 0.98	15-191-10257 15-191-10259	2603.35 2702.1	9.07	214.27 219.37	606.45 616.7	9.19	0.01	1.08	3520.92	31.8 26.91	5.32 5.42	0
	15-191-10261	2946.32	8.23	278.25	643.34	11.05	0.01	0.95	3934.29	17.33	5.42	
	15-191-10290	2596.35	9.56	200.98	594.51	8.9	0.01	0.64	3481.68	27.01	5.92	N
	15-191-10281 15-191-10294	2625.33 2682.41	9.76	204.08 208.21	603.74 613.08	9.2	0.01	0.82	3404.98	29.2	5.42	
	15-191-20789	2664.95	8.16	208.21	630.54	8.67	0.02	2.01	3370.12	25.45	6.62 5.42	
	15-191-21000	2740.58	8.18	215.17	636.17	8.86	0.02	0.93	3517.93	30.45	5.32	
	15-191-21179	2682.97	8.31	212.41	622.33	9.02	0.07	2.21	3468.93	24.3	5.52	N
	15-191-21180 15-191-21608	2648.62 2473.39	8.49	215.28	611.22 569.38	8.65	0.03	1.12	3354.83 3130.91	33.99 26.39	5.32 5.02	N
	15-191-19005	2650.47	9.17	212.64	593.23	9.72	0.02	0.66	3437.85	24.41	5.12	
	15-191-19005	2767.21	9.24	215.65	623.01	10.34	0.03	0.73	3567.85	16.75	5.42	
	15-191-43782-0001	2691.83	8.72	209.86	616.81	9.21	0.06	1.78	3329.61	28.88	5.32	N
	15-191-11325 15-191-43814	2638.39 2673.28	9.15	210.54 211.48	613.01 592.84	9.4	0.02	0.82	3330.37 3454.72	30.13	5.72	ίω –
	15-191-43814	2847.23	9.56	216.65	623.53	10.05	0.03	0.85	3639.91	21.24	5.72	
	15-191-43882	2859.04	9.21	255.6	608.85	12.58	0.01	0.73	3785.8	26.59	6.62	
	15-191-43889 15-191-00395-0001	2636.66	8.58	213.57 210.81	598.72 596.57	9.07	0.01	0.85	3380.44 3263.46	26.7 24.51	5.52 5.42	
•	15-191-10083-0001	2456.31	10.42	210.81	566.79	9.38	0.02	1.71	3263.46	35.03	5.42	4. L
<b>`</b>	15-191-10045	2820.43	3.94	249.76	668.73	7.76	0.03	1.28	3730.31	21.09	5.0	
T	15-191-10054	2829.13	2.94	233.3	673.72	7.76	0.03	1,19	3758.52	20.19	5.2	
	15-191-10055 15-191-10087	3164.06 2968.32	2.04	244.0	628.81 673.72	7.76	0.02	1.32	3758.52	14.03 20.26	5.09 5.13	
	15-191-10136	2824.78	3.53	239.06	653.76	7.76	0.03	1.2	3814.94	20.23	5.06	
	15-191-10134	2859.58	3.83	240.71	668.73	7.76	0.02	1.4	3786.73	20.53	5.07	
	15-191-10083-0001	2729.08	4.96	233.3	633.8	7.76	0.02	1.43	3532.85	21.25	5.57	
"K-State Data"	15-191-43882 15-191-11442	2842.18	2.45	285.15	728.61 683.7	7.76	0.02	1.31	3955.98	18.92 20.57	5.01	
and the second	15-191-22590	2520.3	25.47	163.34	534.99	14.01	0.02	0.81	3137.93	72.43	5.82	
Cations/Anions > 1.02	15-191-22590	2072.28	20.36	141.12	459.65	13.53	0.08	0.81	2613.24	14.26	5.92	
	15-191-22590	2768.23	29.31	179.8	608.85 527.51	15.38	0.02	0.81	3561.06	14.05	5.72	
	15-191-22590 15-191-22591	2511.6	14.06	164.99	345.87	13.74	0.02	0.81	3109.72	29.12	5.84 6.28	
	15-191-22591	2929.17	10.69	201.2	658.75	17.27	0.03	0.82	3589.27	21.69	5.18	3
•	15-191-22770	2511.6	0.66	209.43	589.88	7.76	0.04	0.81	3307.18	22.17	6.31	
	15-191-22770	2133 17	-0.35	183.09	501.06	7.76	0.04	1.59	2630.17	22.9	6.12	

	Na	K	Mg	Ca	Sr	Mnll	Fell	CI	SO4	PH
Mean	2,665.629	9.295	214.663	602.363	10.04	0.029	1.139	3,438.599	26.466	5.491
Sigma	209.095	4.729	32.53	50.126	4.169	0.019	0.792	311.532	10.187	0.384

# Covariance Matrix – Normalized Data Set

	Na	К	Mg	Ca	Sr	Mnll	Fell	CI	S04	PH
Na	1.0	-0.317	0.841	0.818	0.224	-0.255	0.034	0.969	-0.319	-0.383
K	-0.317	1.0	-0.551	-0.431	0.236	0.051	-0.092	-0.368	0.468	0.243
Mg	0.841	-0.551	0.999	0.594	0.285	-0.207	0.08	0.865	-0.437	-0.311
Са	0.818	-0.431	0.594	1.0	-0.208	-0.156	0.128	0.818	-0.261	-0.499
Sr	0.224	0.236	0.285	-0.208	1.0	-0.081	-0.069	0.137	-0.006	0.04
Mnll	-0.255	0.051	-0.207	-0.156	-0.081	1.0	0.729	-0.247	0.004	-0.073
Fell	0.034	-0.092	0.08	0.128	-0.069	0.729	0.999	0.057	0.016	-0.266
CI	0.969	-0.368	0.865	0.818	0.137	-0.247	0.057	1.0	-0.351	-0.363
SO4	-0.319	0.468	-0.437	-0.261	-0.006	0.004	0.016	-0.351	0.999	0.057
PH	-0.383	0.243	-0.311	-0.499	0.04	-0.073	-0.266	-0.363	0.057	0.999

