

PiperStiff–An Excel workbook for charting a Piper plot and mapping Stiff diagrams

Piper and Stiff diagrams are plotted and mapped, respectively from water-quality concentrations in milligrams per liter (mg/L). The program converts mg/L to milliequivalents per liter (meq/L). Concentration of major ions are summed for total dissolved solids (TDS) and charge balances are computed. Sites are highlighted if charge balances exceed a user-specified threshold. Constituent concentrations and TDS from a site can be selected and highlighted in the Piper plot (Figure 1). A Stiff diagram is displayed for the selected site.

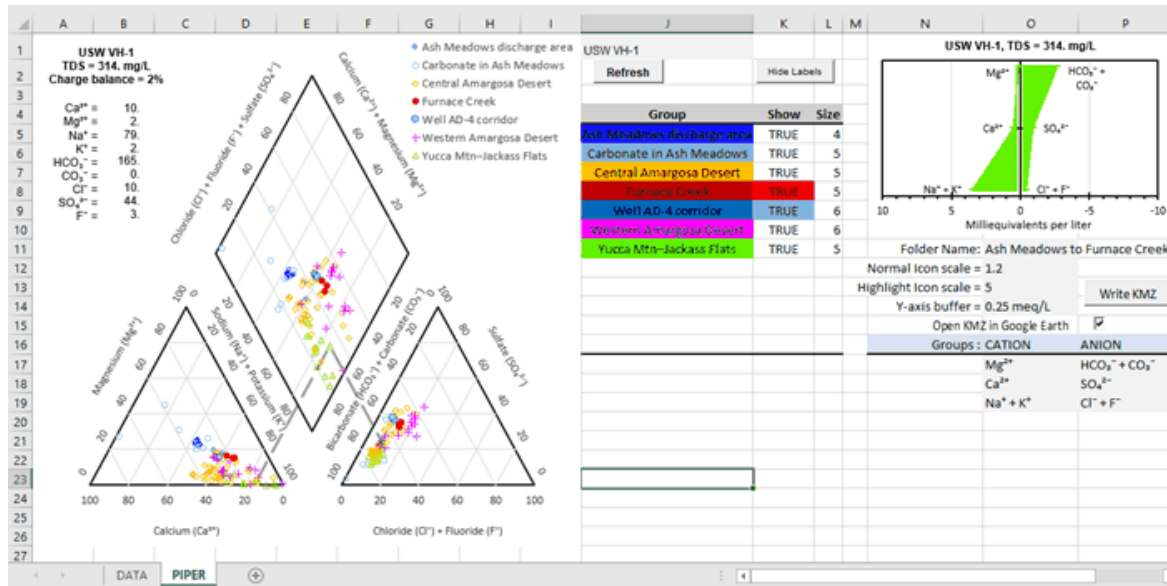


Figure 1.— Piper plot, Stiff diagram, and controls in PiperStiff-QW-2019.xlsm.

Stiff diagrams are written to a KMZ (Google Earth) file where groups of sites can be viewed or hidden (Figure 2). Stiff icon changes to labeled Stiff diagram with site identifier as mouse hovers over an icon. TDS and constituent concentrations in mg/L are displayed as a table after selecting a site. PiperStiff-QW-2019.xlsm and explanatory PDF can be downloaded with the following link.

Macros were developed in Excel 2019 and should work in Excel 2013+. Labels have failed when revised by macros in Excel 2010.

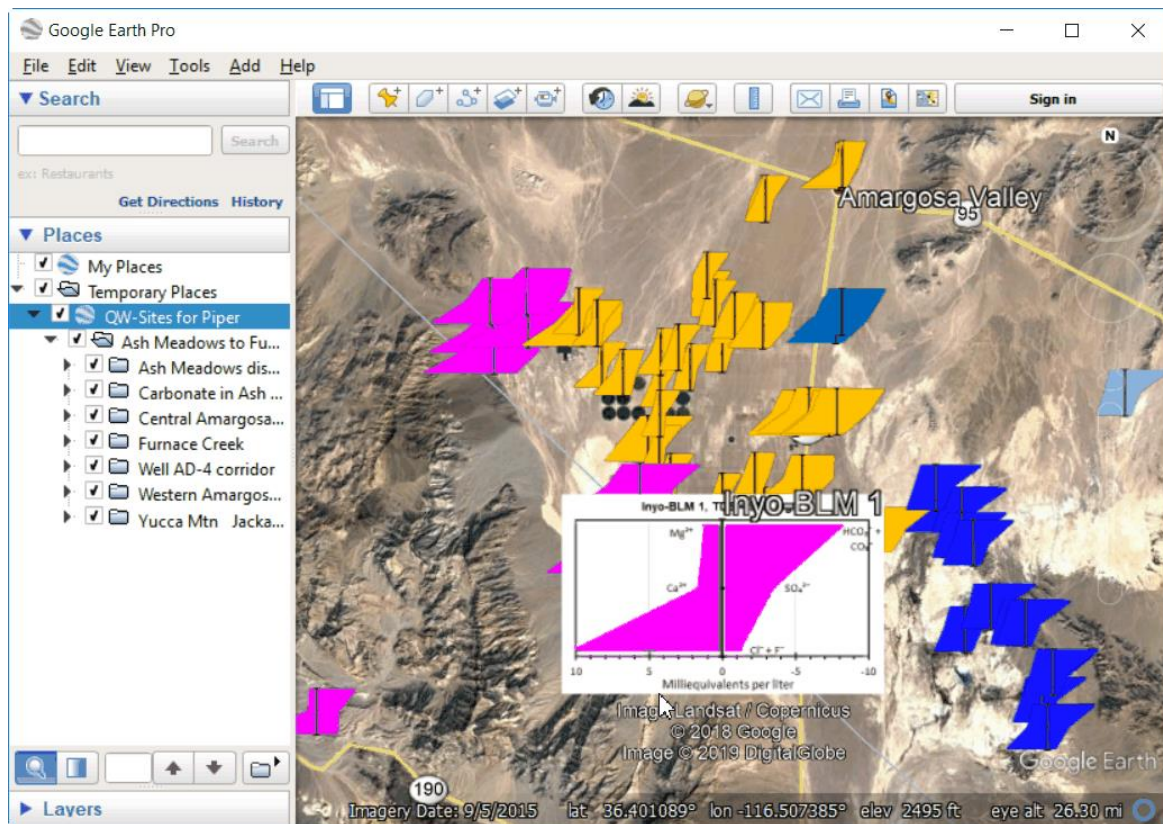


Figure 2.— Stiff diagrams as presented in Google Earth.

PiperStiff-QW-2019.xlsm Workbook

The workbook consists of two visible pages, DATA and PIPER, and one hidden page, CONTROL. The hidden CONTROL page contains code for translating coordinates and users should not need to edit the page. The table for converting mg/L to meq/L is the exception if a constituent exists other than Bicarbonate (HCO_3^-), Calcium (Ca^{2+}), Carbonate (CO_3^{2-}), Chloride (Cl^-), Fluoride (F^-), Magnesium (Mg^{2+}), Potassium (K^+), Sodium (Na^+), and Sulfate (SO_4^{2-}).

DATA page

Longitude, latitude, data group, site name, and chemical concentrations are specified for each site in columns A-N and from row 15 and down (Figure 3). Longitude and latitude are optional, but KMZ file will not be written without a longitude and latitude for all sites. Groups define series in Piper plot (Figure 1) and Stiff icons of similar color in KMZ file (Figure 2). Columns of chemical concentrations can be ordered to suit user's data sets by changing headings in rows 13 and 14 through pull-down menus. Rows of site data are highlighted where charge balance exceeds a user-defined threshold, cell Q12, which is 5 percent in the example (Figure 3).

Figure 3.—DATA page in the PiperStiff-QW-2019 workbook where longitude, latitude, data group, site name, and chemical concentrations are specified for each site.

Clear existing data between columns A and M and from row 15 to the last entry.

	A	B	C	D	K	L	M
12							
13			Count = 0		Bottom	Side	Bottom
14	Longitude	Latitude	Group	Site	Cl ⁻	SO ₄ ²⁻	F ⁻
94							
95							
96							
97							
98							
99							
100							
101							
102							
103							
104							

All data for a site is entered on a single row before pasting into workbook.

Paste your data to cell to A15 or C15 if longitude and latitude are not included.

<p>Change headings with the pull-down menus in row 14 to match chemical constituent in columns of user's data.</p>	
<p>Change headings with the pull-down menus in row 13 to match sides of ternary plots of cations and anions.</p>	
<p>Bottom, side, and diamond are defined relative to ternary plots.</p>	
<p>Criteria for excessive charge imbalance is specified with a pull-down menu in cell Q12.</p>	

PIPER page—Piper plot

Piper plot and plotting controls are displayed on the PIPER page (Figure 4). A unique list of groups is created and corresponding series in the Piper plot are formatted with the refresh button (cell J2). Symbol colors are assigned by fill colors in column J and are filled with colors in column K if colored. Groups are displayed or hidden by toggling cells TRUE or FALSE in column K. Specific sites are identified by pull-down menu in cell J1.

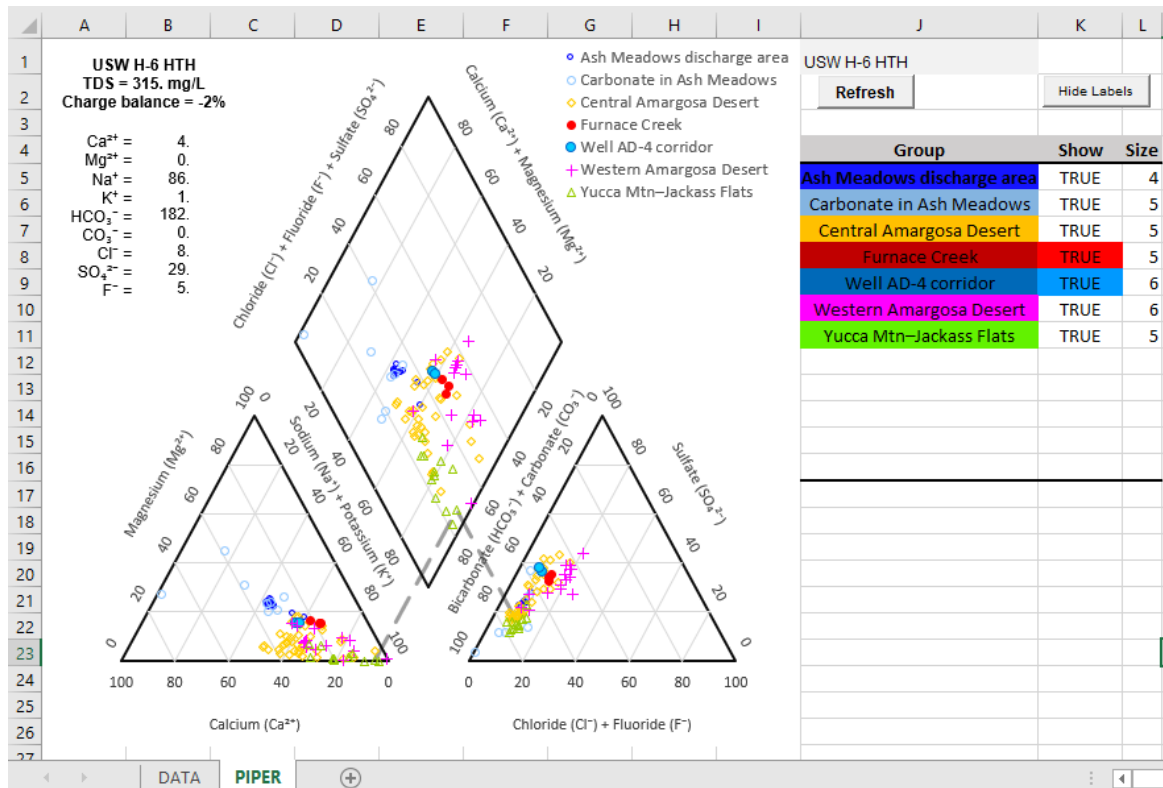


Figure 4.—User controls for Piper plot in the PiperStiff-QW-2019 workbook.

Piper Plot

Refresh button in cell J2.

- Creates a list of unique group names in column J.
- Maps cell colors in columns J and K to series in Piper plot.
- Sizes symbols as specified in column L.

Changing all group entries on the DATA page to same label will define a single big group.

Groups are limited to twelve or less.

Toggle visibility of series with TRUE/FALSE pull-down menus in column K.

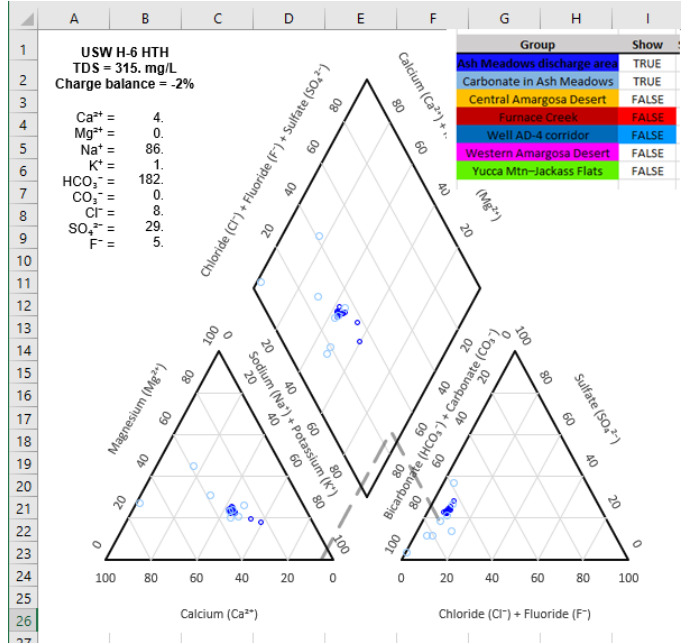
G	H	I	J	K	L
			USW VH-1		
			Refresh	Hide Labels	
			Group	Show	Size
			Ash Meadows discharge area	TRUE	4
			Carbonate in Ash Meadows	TRUE	5
			Central Amargosa Desert	TRUE	5
			Furnace Creek	TRUE	5
			Well AD-4 corridor	TRUE	6
			Western Amargosa Desert	TRUE	6
			Yucca Mtn-Jackass Flats	TRUE	5

New list of 1 group after revising groups on DATA

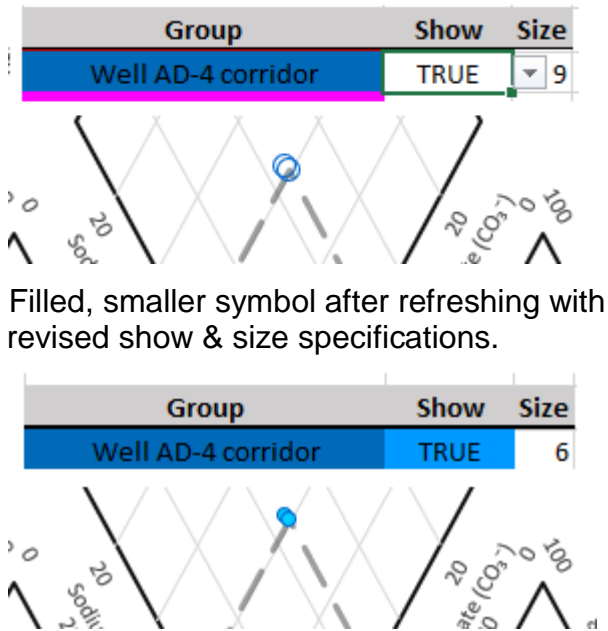
G	H	I	J	K	L
			WW-C-1		
			Refresh	Hide Labels	
			Group	Show	Size
			One big group	TRUE	4
					5
					5
					5
					6
					6
					5

J	K	L
Group	Show	Size
Ash Meadows discharge area	TRUE	4
Carbonate in	TRUE	5
Central Amargosa Desert	TRUE	5

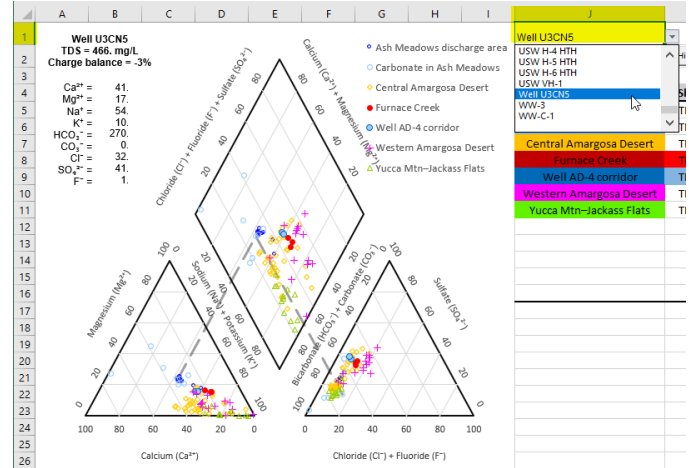
Plot limited to two groups where TRUE specified only in cells K5:K6.



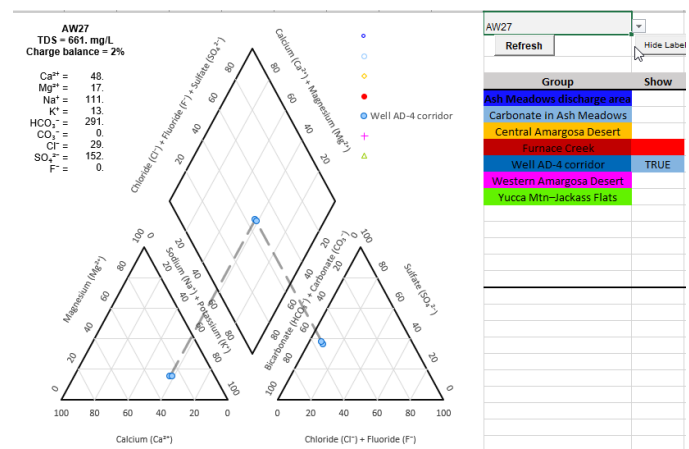
Effect of cell colors in columns J and K and size specification in column L on series symbols in Piper plot.



Select TDS, charge balance, and concentrations at a site with site selector in cell J1.



Available sites in site selector limited to sites in visible series.



For example, wells AW27 and AW28 are the only sites in the Well AD-4 corridor and site selection is limited to these two sites.

	J	K
1	AW27	
2	AW27	
3	AW28	Hide Label
4	Group	Show
5	Ash Meadows discharge area	
6	Carbonate in Ash Meadows	
7	Central Amargosa Desert	
8	Furnace Creek	
9	Well AD-4 corridor	TRUE
10	Western Amargosa Desert	
11	Yucca Mtn-Jackass Flats	
12		

Button in cell K2 toggles labels on

Show Labels

Hide Labels

and off

Site selector also is cleared so that TDS, charge balance, and table of concentrations do not appear.

Group	Show	Size
Ash Meadows discharge area	TRUE	4
Carbonate in Ash Meadows	TRUE	5
Central Amargosa Desert	TRUE	5
Furnace Creek	TRUE	5
Well AD-4 corridor	TRUE	6
Western Amargosa Desert	TRUE	6
Yucca Mtn-Jackass Flats	TRUE	5

Stiff diagrams and KMZ file

Stiff diagrams are created primarily for display in a KMZ file. Icon sizes are user defined and Stiff diagrams are colored by cell colors in column J (Figure 5).

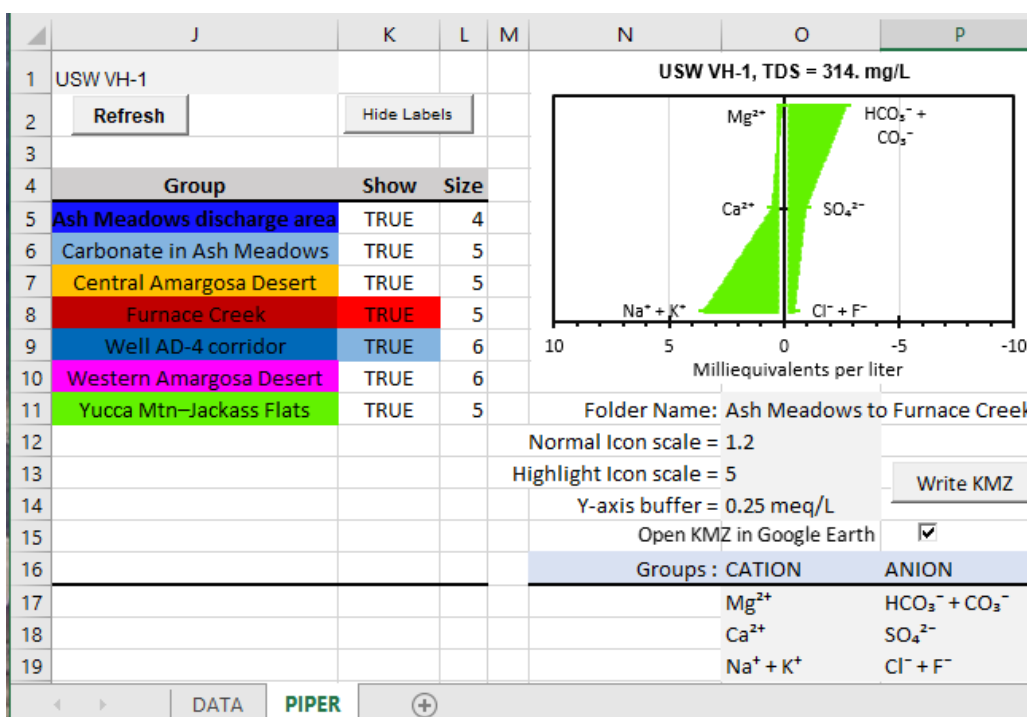
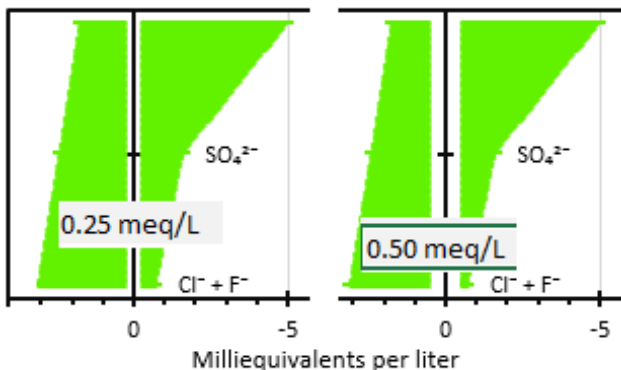


Figure 5.—User controls for Stiff diagrams in the PiperStiff-QW-2019 workbook.

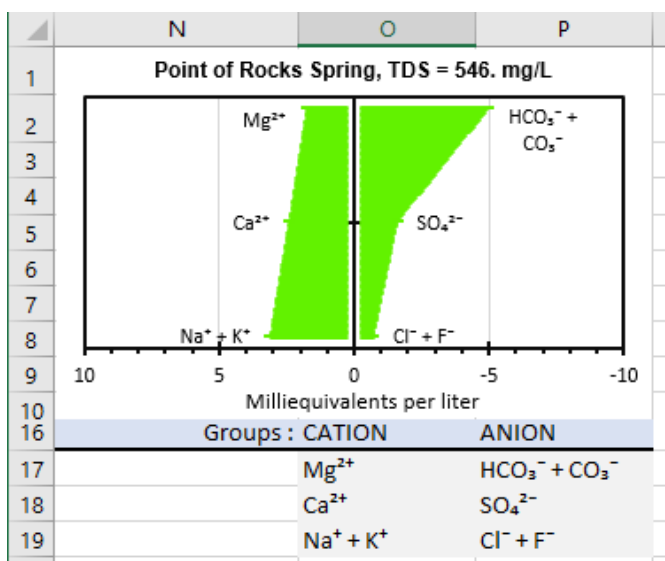
Stiff diagrams and KMZ

Folder name specifies name of KMZ file that is written in the directory that contains the workbook.	<table><tr><th></th><th>N</th><th>O</th><th>P</th></tr><tr><td>11</td><td>Folder Name:</td><td>Ash Meadows to Furnace Creek</td><td></td></tr><tr><td>12</td><td>Normal Icon scale =</td><td>1.2</td><td></td></tr><tr><td>13</td><td>Highlight Icon scale =</td><td>5</td><td>Write KMZ</td></tr><tr><td>14</td><td>Y-axis buffer =</td><td>0.25 meq/L</td><td></td></tr><tr><td>15</td><td>Open KMZ in Google Earth</td><td></td><td><input checked="" type="checkbox"/></td></tr></table>		N	O	P	11	Folder Name:	Ash Meadows to Furnace Creek		12	Normal Icon scale =	1.2		13	Highlight Icon scale =	5	Write KMZ	14	Y-axis buffer =	0.25 meq/L		15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>
	N	O	P																						
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15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>																						
Icon scales are multipliers that scale placemark icons in Google Earth. Normal defines unselected icon scale and highlight defines icon scale as mouse hovers and on selection.	<table><tr><th></th><th>N</th><th>O</th><th>P</th></tr><tr><td>11</td><td>Folder Name:</td><td>Ash Meadows to Furnace Creek</td><td></td></tr><tr><td>12</td><td>Normal Icon scale =</td><td>1.2</td><td></td></tr><tr><td>13</td><td>Highlight Icon scale =</td><td>5</td><td>Write KMZ</td></tr><tr><td>14</td><td>Y-axis buffer =</td><td>0.25 meq/L</td><td></td></tr><tr><td>15</td><td>Open KMZ in Google Earth</td><td></td><td><input checked="" type="checkbox"/></td></tr></table>		N	O	P	11	Folder Name:	Ash Meadows to Furnace Creek		12	Normal Icon scale =	1.2		13	Highlight Icon scale =	5	Write KMZ	14	Y-axis buffer =	0.25 meq/L		15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>
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Y-axis buffer creates a gap in the Stiff diagram so that the Y-axis remains visible.	<table><tr><th></th><th>N</th><th>O</th><th>P</th></tr><tr><td>11</td><td>Folder Name:</td><td>Ash Meadows to Furnace Creek</td><td></td></tr><tr><td>12</td><td>Normal Icon scale =</td><td>1.2</td><td></td></tr><tr><td>13</td><td>Highlight Icon scale =</td><td>5</td><td>Write KMZ</td></tr><tr><td>14</td><td>Y-axis buffer =</td><td>0.25 meq/L</td><td></td></tr><tr><td>15</td><td>Open KMZ in Google Earth</td><td></td><td><input checked="" type="checkbox"/></td></tr></table> 		N	O	P	11	Folder Name:	Ash Meadows to Furnace Creek		12	Normal Icon scale =	1.2		13	Highlight Icon scale =	5	Write KMZ	14	Y-axis buffer =	0.25 meq/L		15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>
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15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>																						
Press Write KMZ to create icon images, kml file, and zip output to a KMZ file. KMZ file will be opened automatically if box in cell P15 is checked.	<table><tr><th></th><th>N</th><th>O</th><th>P</th></tr><tr><td>11</td><td>Folder Name:</td><td>Ash Meadows to Furnace Creek</td><td></td></tr><tr><td>12</td><td>Normal Icon scale =</td><td>1.2</td><td></td></tr><tr><td>13</td><td>Highlight Icon scale =</td><td>5</td><td>Write KMZ</td></tr><tr><td>14</td><td>Y-axis buffer =</td><td>0.25 meq/L</td><td></td></tr><tr><td>15</td><td>Open KMZ in Google Earth</td><td></td><td><input checked="" type="checkbox"/></td></tr></table>		N	O	P	11	Folder Name:	Ash Meadows to Furnace Creek		12	Normal Icon scale =	1.2		13	Highlight Icon scale =	5	Write KMZ	14	Y-axis buffer =	0.25 meq/L		15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>
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15	Open KMZ in Google Earth		<input checked="" type="checkbox"/>																						

Vertical order of cations and anions in Stiff diagram are user defined through pull-down menus.

	N	O	P
16	Groups : CATION		ANION
17		Mg ²⁺	O ₃ ⁻ + CO ₃ ⁻
18		Ca ²⁺	SO ₄ ²⁻
19		Na ⁺ + K ⁺	Cl ⁻ + F ⁻

Example alternative Stiff diagrams where vertical order of cations and anions differed in cells O17:P18.



Stiff pattern changed by user-ordered ions.

