DIONEX ICS3000 ION CHROMATOGRAPHY SYSTEM INSTALLATION AND INSTRUMENT ASSESSMENT FOR SRNL APPLICATIONS

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NOVEMBER 16, 2009

SRNL

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SAVANNAH RIVER NATIONAL LABORATORY

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LIST OF ACRONYMS

AD – Analytical Development
CRTC – Continuously Regenerating Trap Column
IC – Ion Chromatography
KOH – Potassium Hydroxide
LOD – Limit of Detection
MDL – Method Detection Limit
MSA – Methanesulfonic Acid
RFIC – Reagent Free Ion Chromatography
SRNL – Savannah River National Laboratory
SRNS – Savannah River Nuclear Solutions

1.0 EXECUTIVE SUMMARY

Presented in this report are analytical methods developed on a DIONEX ICS3000 Reagent Free Ion Chromatography (RFIC) system located in the Analytical Development (AD) Directorate at the Savannah River National Laboratory (SRNL). This IC system contains two independent analysis channels comprising of a mobile phase generator, a pump, stationary phase columns, a suppressor and a conductivity detector. One channel is dedicated to anion analysis using Potassium Hydroxide (KOH) as the mobile phase while a second channel is configured for cation analysis using Methanesulfonic Acid (MSA) as the mobile phase. Both channels share an autosampler and the peak analysis software, Chromeleon ® v.6.8. Listed within this report are Dionex ICS3000 parameters and results for the analysis of routine anions and cations. Additional method parameters and discussion are presented on the analysis of Acetate (CH_3COO^-) and Iodate (IO_3^-). This system offers an improved, lower baseline conductivity, elimination of technician time or error in eluent preparation, and analysis of both anion and cation methods.

2.0 INTRODUCTION

Ion Chromatography (IC) is routinely used at the Savannah River National Laboratory (SRNL) for sample analysis and characterization. Results from IC analysis are valued in corrosion control maintenance and measurement programs, remediation waste process control, soil and ground water measurement, nuclear materials processing, and various other research and development programs.

Presented in this report are analytical methods developed on a DIONEX ICS3000 Reagent Free Ion Chromatography (RFIC) system located in AD at SRNL. This IC system contains two independent analysis channels comprising of a mobile phase generator, a pump, stationary phase columns, a suppressor and a conductivity detector. One channel is dedicated to anion analysis using Potassium Hydroxide (KOH) as the mobile phase while a second channel is configured for cation analysis using Methanesulfonic Acid (MSA) as the mobile phase. Both channels share an autosampler and the peak analysis software, Chromeleon ® v.6.8. Instrument configuration is modified from the manufacturer for radiological service. Listed within this report are Dionex ICS3000 parameters and results for the analysis of routine anions and cations. Additional method parameters and discussion are presented on the analysis of Acetate (CH_3COO^-) and Iodate (IO_3^-).

Previous IC analysis instruments at AD have been based upon carbonate/bicarbonate buffer mobile phase chemistry. This report represents a transition to hydroxide as a mobile phase eluent. The hydroxide eluent offers a lower baseline conductivity, which allows for greater sample dilution and/or lower detection limits. Also the hydroxide mobile phase and column set has a significant separation of the phosphate peak from the nitrate and sulfate peaks vs. the carbonate/bicarbonate mobile phase and column set, an advantage for the industrial waste analyzed at SRNL.

3.0 EXPERIMENTAL

3.1 INSTRUMENT CONFIGURATION

The Dionex ICS3000 system was configured to contain two independent analysis channels comprising of a mobile phase generator, a pump, stationary phase columns, a suppressor and a conductivity detector. One channel is dedicated to anion analysis while a second channel is configured for cation analysis. Both channels share an autosampler, the controlling software Chromeleon ® v.6.8, and a Continuously Regenerated Trap Column (CRTC) for carbonate reduction prior to conductivity detection. This system differs from off the shelf products sold by Dionex in that it has been modified for use in Radiological Containment Units for the analysis of radiological samples here at SRNL. Specifically, all of the plumbing that has the potential to be in contact with the injected sample has been isolated for placement within the Radiological Containment Unit, away from non-radiological instrument parts. A remote stand was fabricated to organize and hold the remaining remote components. This includes the injection valves, columns, suppressors, detection cells, trap columns, regeneration loops, capillary lines and connectors, and waste collection. In addition the autosampler is to be located inside of the contamination unit. The flow path and remote components (inside of the red box) are outlined in Figure 1[1]. Figure 2 show images of the remote stand as assembled with two independent flow paths, ready for installation into the Radiological Containment Unit.

Figure 1: Flow path and remote components of ICS3000 ion chromatography system
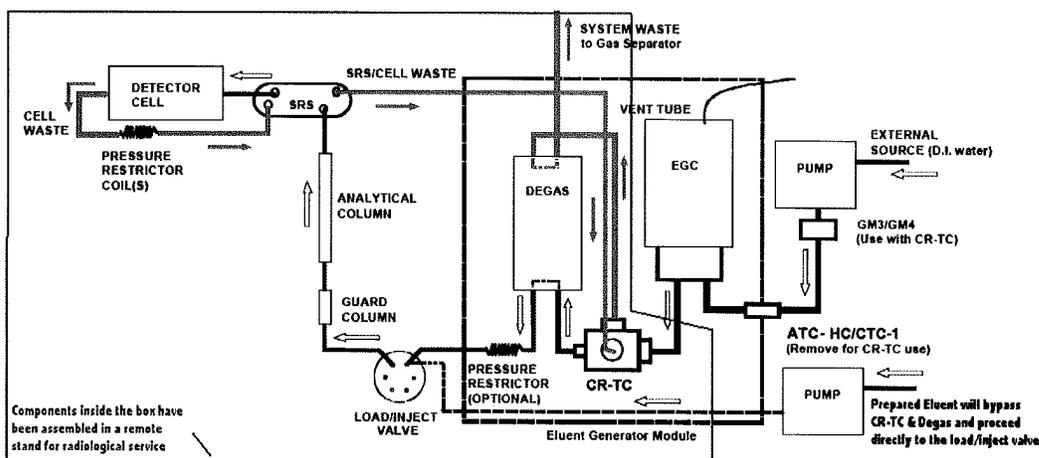
Figure 1
System Flow Diagram for the Eluent Generator with CR-TC

Figure 2: Dionex ICS3000RFIC system at SRNL prior to radiological service, & remote components of IC system assembled on stand prior (close-up view)
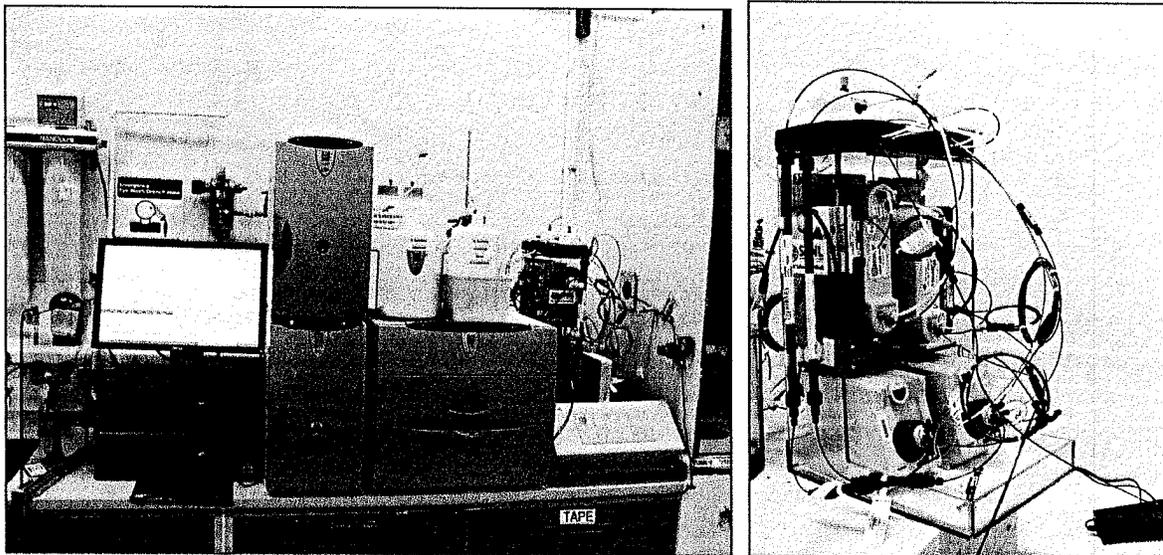
For anion analysis the instrument configuration consisted of: gradient pump, point-of use mobile phase generation (RFIC) of potassium hydroxide, continuously regenerated trap column for carbonate reduction, suppressed conductivity detection, and Dionex AG19(4x50mm)/AS19(4x250mm) column set. The IonPac AS19 is a high-capacity; hydroxide-selective, anion-exchange column and is designed for the analysis of common inorganic anions. The AS19 is composed of alkanol quaternary ammonium ion functional groups on 7.5 μm macroporous resin.[2]

For cation analysis the instrument configuration consisted of: isocratic pump, point-of use mobile phase generation (RFIC) of MSA, continuously regenerated trap column for carbonate reduction, suppressed conductivity detection, and Dionex CG16(5x50mm)/CS16(5x250mm) column set. The IonPac CS16 cation-exchange column is designed for the determination of disparate concentration ratios of sodium and ammonium using an isocratic acid eluent and elevated temperature. The CS16 is composed of grafted carboxylic acid ion functional groups on 5 μm beads.[3]

4.0 RESULTS & DISCUSSION

4.1 INITIAL KOH ANION METHOD DEVELOPMENT & RESULTS

Initial exploration of the DIONEX ICS3000 system for IC analysis focused on development of the anions method. The specific anions commonly analyzed at SRNL are; Fluoride (F^-), Formate ($CHOO^-$), Chloride (Cl^-), Nitrite (NO_2^-), Bromide (Br^-), Nitrate (NO_3^-), Sulfate (SO_4^{2-}), Oxalate ($C_2O_4^{2-}$), Iodide (I^-), and Phosphate (PO_4^{3-}).

Anion retention times in isocratic KOH mobile phase eluent are shown in Figure 3. The molar concentration of KOH was varied from 10 mMol to 45 mMol. Samples that contained 10 mg/L of anion standard were used for the analysis. The final common SRNL analyzed anion to elute from the above instrument configuration and column set is phosphate, and thus is determinate in total run time. A KOH concentration of greater than 25 mMol is required for the phosphate ion to elute from the column in less than 30 minutes total run time.

Figure 3: Retention times of various anions in isocratic KOH mobile phase (chart and graph)

KOH mMol	10	15	17.5	20	25	30	45
Fluoride	5.9	4.6	4.3	4.0	3.7	3.5	3.2
Formate	7.8	5.8	5.2	4.9	4.4	4.0	3.5
Chloride	11.2	7.9	7.0	6.4	5.5	5.0	4.2
Nitrite	14.5	10.0	8.8	7.9	6.7	6.0	4.6
Bromide	19.0	12.2	11.1	10.0	8.3	7.3	4.8
Nitrate	22.1	14.7	12.7	11.3	9.4	7.6	5.4
Sulfate	54.1	27.9	19.8	15.4	10.1	8.1	5.7
Oxalate	71.0	34.7	26.5	20.4	13.2	9.6	6.2
Iodide	97.2	37.8	29.5	25.9	20.8	17.5	7.1
Phosphate	120.0	70.7	64.6	58.5	30.5	18.6	12.4

Time (min)
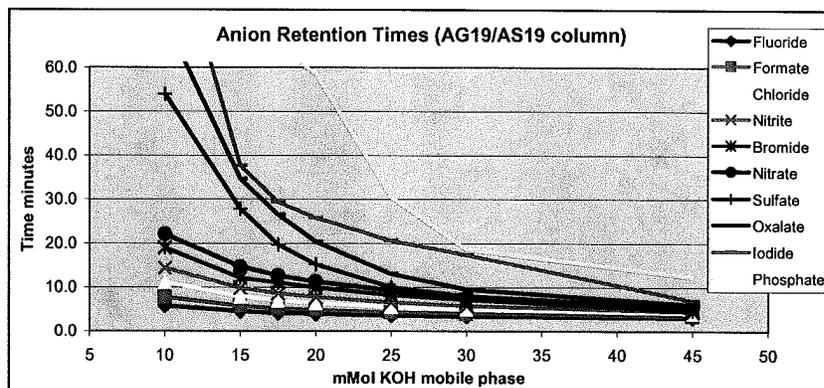
However, molar concentrations of 25 mMol or greater can create ion retention time profiles that have significant peak overlap making peak resolution difficult. Figure 4 shows an expanded view of the first 10 minutes of the isocratic KOH chromatograms. It can be seen that as the molar concentration increases, the retention time decreases, and eventually leads to significant peak overlap. Chromatograms of the 30 and 45mMol KOH show peaks that are not baseline resolved.

Figure 4: Issues of isocratic flow; peak overlap of bromide and nitrate at 20, 25, 30 and 45mMol isocratic KOH concentrations with 10mg/L anion standards.
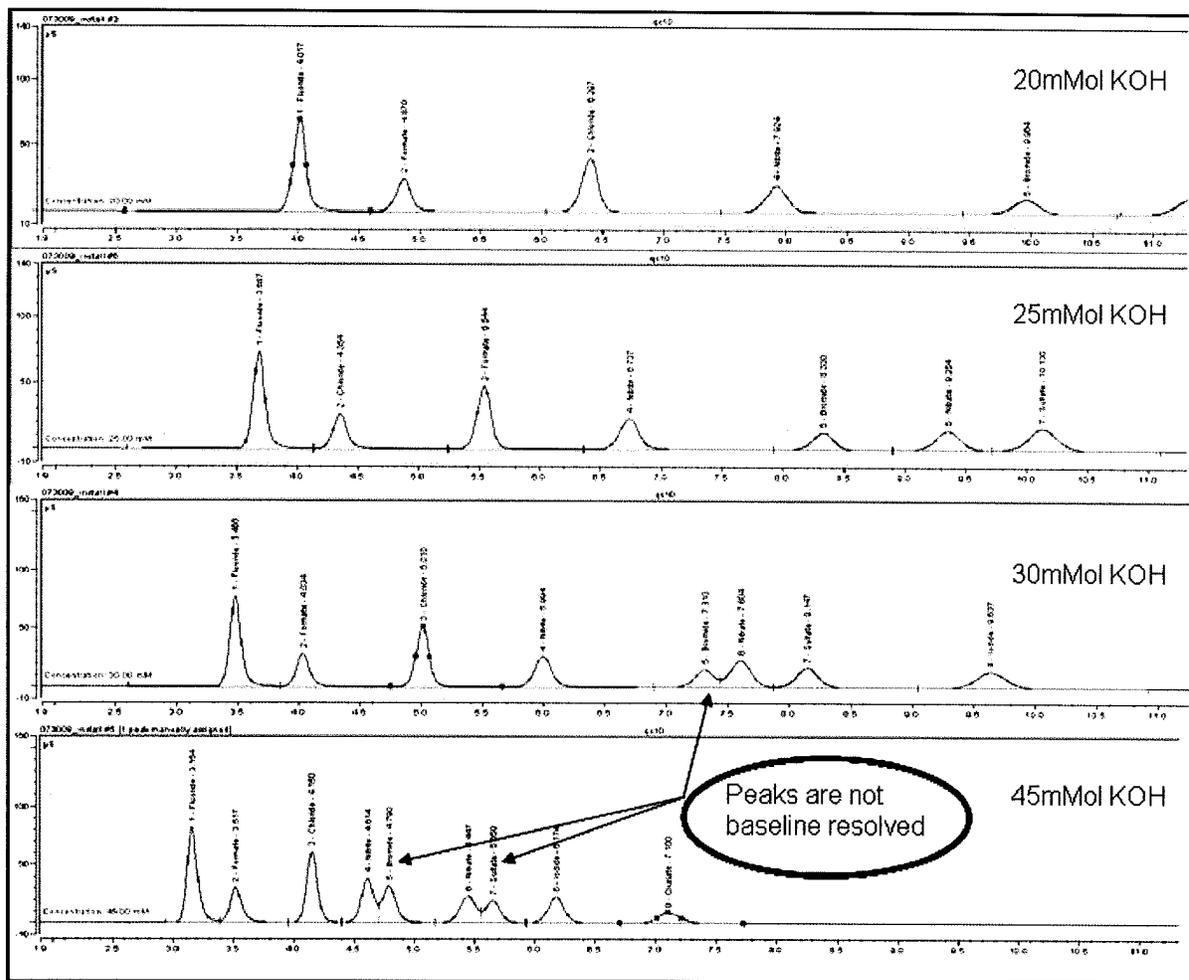
Gradient separations are necessary to maximize peak separation and still create reasonable analysis cycle times. A variety of gradient profiles were attempted to balance baseline effects, cycle times, and peak resolution. Figure 5 shows a selection of the gradient profiles and the expanded view of the effects on the baseline. It can be seen that a rise occurs in the baseline as a result of the increase in KOH concentration. This rise in the baseline occurs during the gradient change and then slowly drops again. Minimizing the difference between the high and low gradient concentrations reduces the effect of the baseline rise. It should be noted that a recovery time is required at the end of the process run to return the baseline to the conductivity of the starting KOH concentration. Typically 5-7 minutes is sufficient. Also noted in the chromatogram is the retention time of carbonate contamination not removed by the continuously regenerated trap column (CRTC), indicated by arrow.

Figure 5: Chromatograms of various gradient profiles with 10 mg/L anions standards. Shown is an expanded view of the effects on the baseline. (Carbonate peak indicated by small arrow)
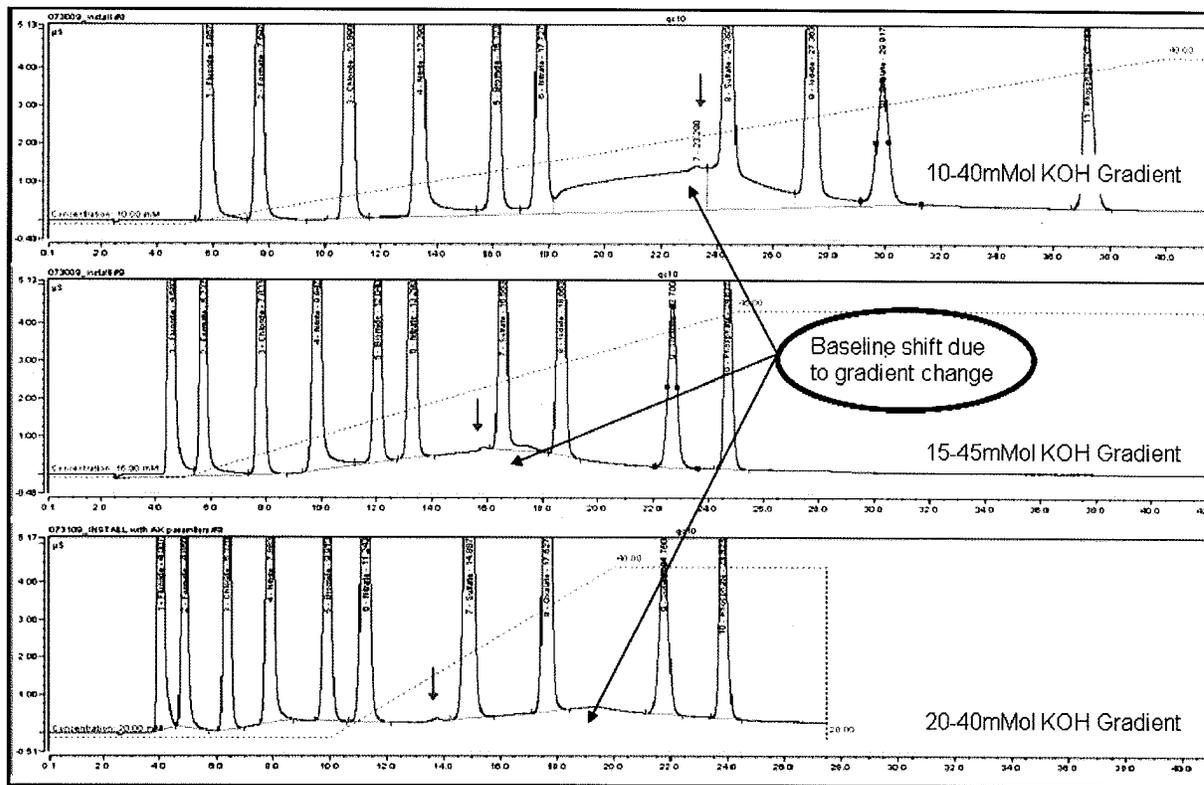
The 20-40 mMol KOH gradient was selected as the sufficiently optimized method conditions. Conditions for the KOH gradient anion method are outlined in Attachment 1. Using these conditions the MDL was calculated. Calibration was established with 4-points at 0.5, 1, 5, and 10 mg/L anion standards, shown in Figure 6a. The MDL was calculated with consecutive runs (11 count) at an anion concentration of 1.0 mg/L (see Equation 1). Using the standard deviation and the one sided students T- distribution (99.5% & n=11 is 3.106) the MDL for the anion method returns results in the range of 55-85 μg/L or ppb. Reporting limits or limits of quantification (LOQ) would be different and would be matrix dependent. Figure 6b shows the results of an unknown challenge for instrument qualification. Results agree well with target values of 2.0 mg/L and 10 mg/L anion standards. Total cycle time with the 20-40 mMol KOH gradient method is 35 minutes including recovery time.

Equation 1 [4] **– MDL = StDev (n runs) * (one side t-dist, 99.5% @ n) * (conc. of standard)**

Figure 6a: Summary of results for Anions MDL.

11 runs of 1 mg/L (0.5 - 10 mg/L calibration), 1.0 ml/min, 20mM-40mM KOH gradient, 35C detector, AG19/AS19 4 mm column, ASRS @ 99mA	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount
	Fluoride	Formate	Chloride	Nitrite	Bromide	Nitrate	Sulfate	Oxalate	Iodide	Phosphate
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	1.039	1.047	0.988	0.987	0.966	0.964	0.963	0.997	1.024	1.019
2	1.038	1.043	0.989	0.984	0.968	0.965	0.966	0.999	n.a.	0.993
3	1.037	1.042	0.987	0.984	0.961	0.961	0.962	0.995	1.032	1.018
4	1.023	1.027	0.975	0.975	0.954	0.955	0.947	0.979	1.021	1.004
5	1.032	1.036	0.982	0.990	0.959	0.959	0.954	0.987	1.014	1.011
6	1.013	1.015	0.964	0.962	0.943	0.946	0.938	0.970	0.994	0.989
7	1.008	1.011	0.968	0.958	0.939	0.943	0.936	0.963	0.983	0.992
8	1.022	1.026	0.971	0.970	0.947	0.947	0.951	0.966	0.999	0.983
9	1.037	1.040	0.984	0.981	0.962	0.959	0.955	0.988	0.993	1.007
10	1.023	1.024	0.973	0.968	0.946	0.948	0.947	0.974	1.030	0.994
11	0.960	0.961	0.914	0.918	0.896	0.898	0.896	0.917	0.947	0.929
Sum:	11.231	11.272	10.695	10.678	10.442	10.444	10.416	10.734	10.036	10.937
Average:	1.021	1.025	0.972	0.971	0.949	0.949	0.947	0.976	1.004	0.994
Std.Dev:	2.256 %	2.420 %	2.116 %	2.050 %	2.013 %	1.884 %	1.953 %	2.333 %	2.619 %	2.477 %
11 runs one sided t-dist. @ 99.5%	3.106									
method detection limit (mg/L)	0.0701	0.0752	0.0657	0.0637	0.0625	0.0585	0.0606	0.0725	0.0814	0.0769
method detection limit (ppb)	70.1	75.2	65.7	63.7	62.5	58.5	60.6	72.5	81.4	76.9

Figure 6b: Summary of qualification unknown results for Anions.

No.	Name	Fluoride	Formate	Chloride	Nitrite	Bromide	Nitrate	Sulfate	Oxalate	Iodide	Phosphate
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3	HIGH ANIONS Unknown	9.440	9.295	9.785	9.785	9.849	10.078	9.735	9.678	n.a.	9.669
4	HIGH ANIONS Unknown	9.458	9.312	9.792	9.807	9.851	10.091	9.731	9.675	n.a.	9.622
5	HIGH ANIONS Unknown	9.459	9.314	9.798	9.806	9.863	10.093	9.730	9.680	n.a.	9.624
6	LOW ANIONS Unknown	2.111	1.990	1.950	1.881	1.794	1.843	1.836	1.917	n.a.	1.825
7	LOW ANIONS Unknown	2.082	1.967	1.913	1.853	1.777	1.831	1.817	1.894	n.a.	1.797
8	LOW ANIONS Unknown	2.082	1.961	1.927	1.864	1.769	1.826	1.808	1.906	n.a.	1.802

Target 10.0 mg/L										
Ave High	9.5	9.3	9.8	9.8	9.9	10.1	9.7	9.7	n.a.	9.6
Stdev (%)	0.12%	0.11%	0.06%	0.13%	0.08%	0.08%	0.03%	0.02%	n.a.	0.28%

Target 2.0 mg/L										
Ave Low	2.1	2.0	1.9	1.9	1.8	1.8	1.8	1.9	n.a.	1.8
Stdev (%)	0.80%	0.77%	0.97%	0.74%	0.74%	0.48%	0.78%	0.62%	n.a.	0.82%

4.2 ACETATE, IODATE KOH METHOD RESULTS

Scoping tests using the 20-40 mMol KOH gradient anion method for other anions not routinely reported at SRNL was also accomplished. Acetate, a small molecular weight organic anion, was injected unto the column at 10 mg/L along with a routine Anion standard mix, shown here in Figure 7. It can be seen that the retention time for Acetate is 4.3 minutes and can be resolved from the closely eluting peaks of Fluoride and Formate. The MDL was calculated with consecutive runs (12 count) at an anion concentration of 1.0 mg/L (see Equation 1). Using the standard deviation and the one sided students T- distribution (99.5% & n=12 is 3.055) the MDL for the anion method for Acetate returns results in the range of 70 µg/L or ppb. See figure 8 for Acetate MDL and calibration data. Reporting limits or LOQ would be different and would be matrix dependent.

Iodate, an inorganic anion, is shown in Figure 9. It can be seen that Iodate, co-elutes with Fluoride. A variety of KOH concentrations (1-20 mMol KOH) were attempted using the AG19/AS19 column set. All attempts at separating the Iodate peak from the Fluoride peak were unsuccessful. Further work would be required if Iodate and Fluoride were to be analyzed in the same sample using this instrument setup.

Figure 7: Acetate at 10 mg/L using the 20-40 mMol KOH gradient method with 10 mg/L of anion standards.

Figure 8: Summary of results for Acetate MDL, and calibration data.

12 runs of 1 mg/L (0.5 - 10 mg/L calibration), 1.0 ml/min, 20mM-40mM KOH gradient, 35C detector, AG19/AS19 4 mm column, ASRS @ 99mA	
	Amount
	Acetate
	mg/L
1	1.107
2	1.136
3	1.093
4	1.081
5	1.083
6	1.077
7	1.076
8	1.068
9	1.064
10	1.062
11	1.060
12	1.057
Sum:	12.962
Average:	1.080
Std.Dev:	2.285 %
12 runs one sided t-dist. @ 99.5%	3.055
method detection limit (mg/L)	0.0698
method detection limit (ppb)	69.8

No.	Time min	Peak Name	Cal.Type	#Points	Offset	Slope	Curve	Corr.Coeff. %
1	4.173	Acetate	XLOff	4	0.038	0.153	0.000	99.889

Figure 9: Co-elution of Iodate (13 mg/L) with Fluoride (10 mg/L) using the 20-40 mMol KOH gradient method.

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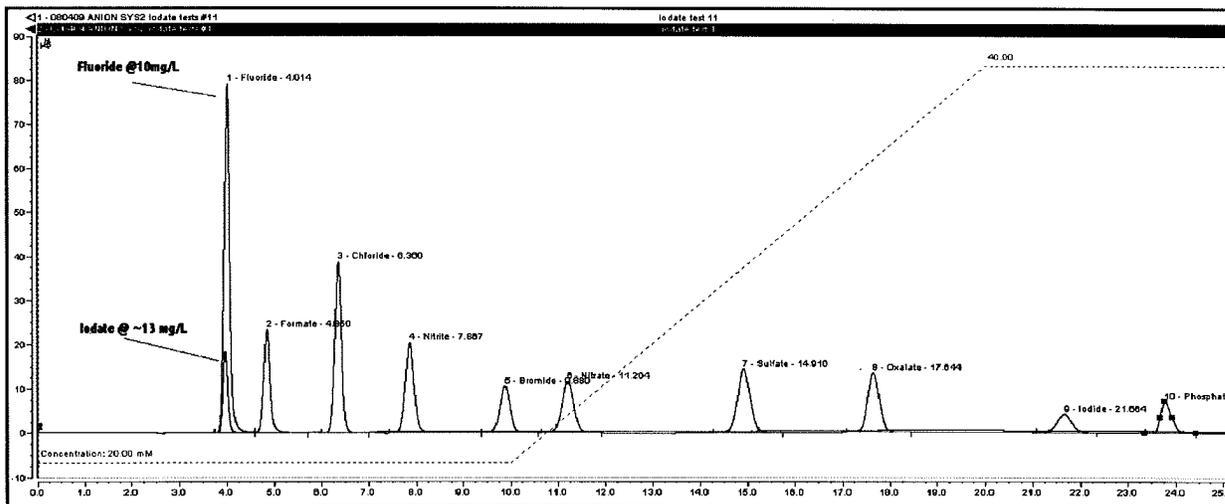
4.3 INITIAL MSA CATION METHOD DEVELOPMENT & RESULTS

Continuing exploration of the DIONEX ICS3000 system for IC analysis focused on development of the cations method. The specific cation commonly analyzed at SRNL is; Ammonium (NH_4^+). Additional ions, for example, Potassium, Lithium, Magnesium, Sodium, and Calcium could also be analyzed by this method, but are not covered in this report.

Development for the cation method was minimal. The conditions were more closely copied from the existing SRNL IC cation method. Conditions for the MSA isocratic cation method are outlined in Attachment 2. Using these conditions the MDL was calculated. Calibration was established with 4-points at 0.5, 1, 5, and 10 mg/L cation standards, shown in Figure 10a. The MDL was calculated with consecutive runs (12 count) at a cation concentration of 1.0 mg/L (see Equation 1). Using the standard deviation and the one sided students T-distribution (99.5% & n=12 is 3.055) the MDL for the cation method returns results in the range of 40 µg/L or ppb. Results agree well with target values of 2.0 mg/L and 10 mg/L cation standards. Reporting limits or LOQ would be different and would be matrix dependent. Total cycle time with MSA isocratic method is 22.5 minutes.
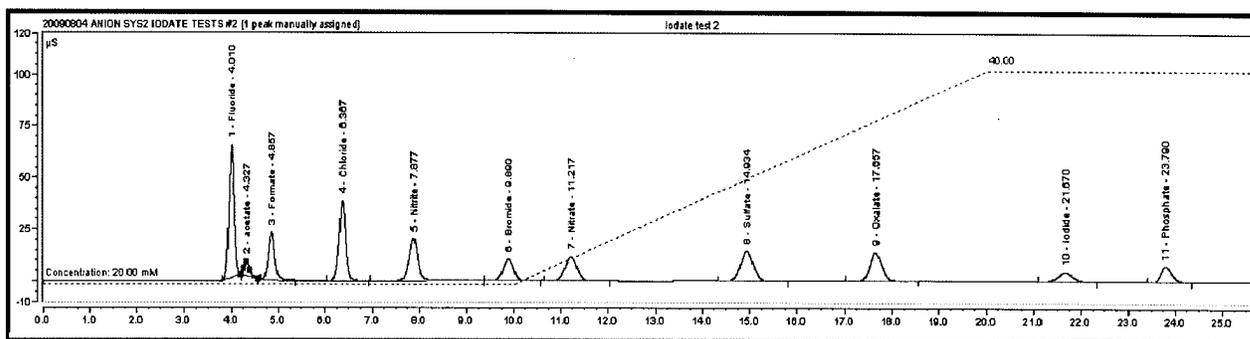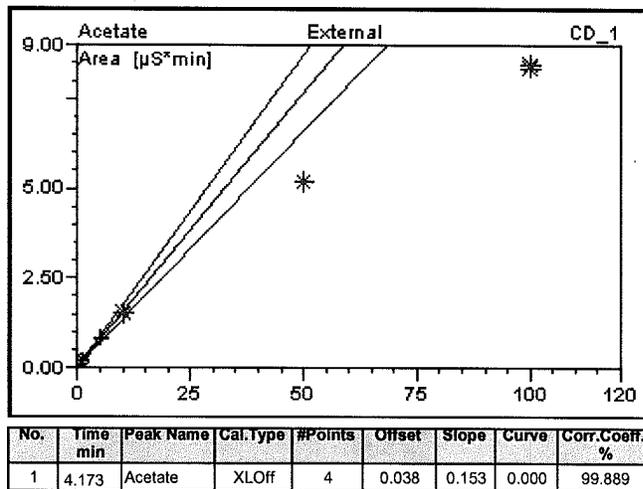
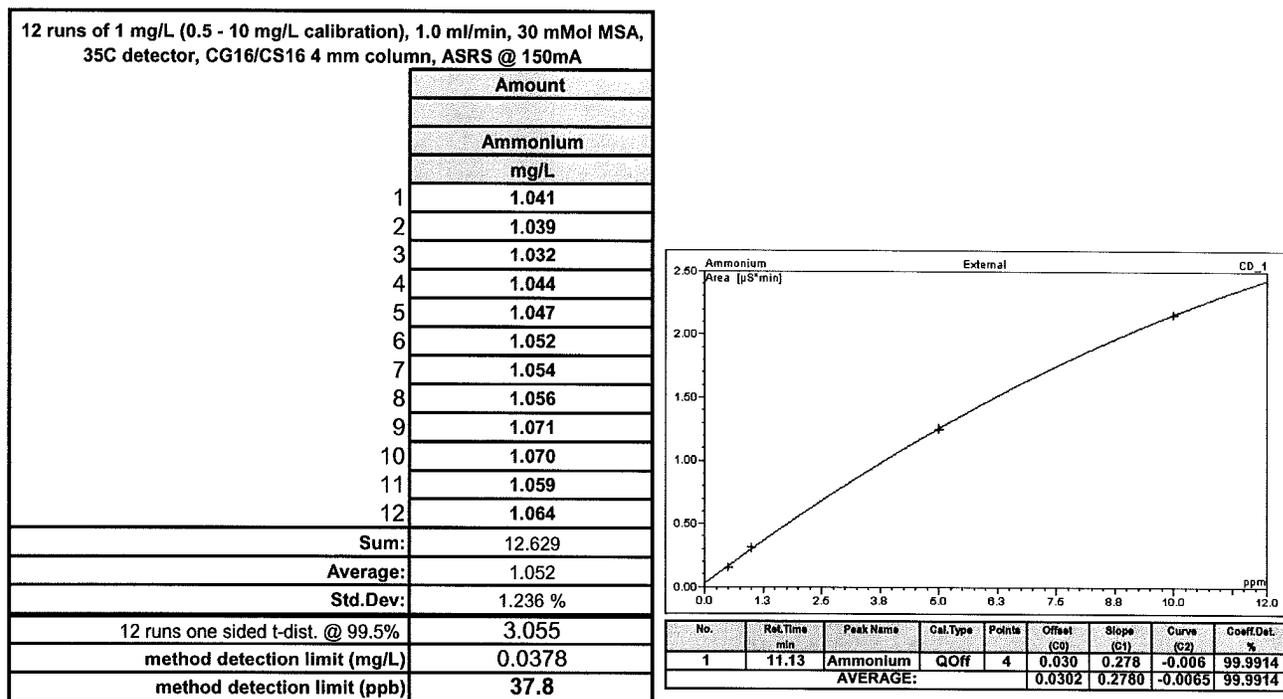**Figure 10a:** Summary of results for Cations MDL, and calibration data.

12 runs of 1 mg/L (0.5 - 10 mg/L calibration), 1.0 ml/min, 30 mMol MSA, 35C detector, CG16/CS16 4 mm column, ASRS @ 150mA	Amount
	Ammonium
	mg/L
1	1.041
2	1.039
3	1.032
4	1.044
5	1.047
6	1.052
7	1.054
8	1.056
9	1.071
10	1.070
11	1.059
12	1.064
Sum:	12.629
Average:	1.052
Std.Dev:	1.236 %
12 runs one sided t-dist. @ 99.5%	3.055
method detection limit (mg/L)	0.0378
method detection limit (ppb)	37.8

No.	Ret.Time min	Peak Name	Cal.Type	Points	Offset (C0)	Slope (C1)	Curve (C2)	Coeff.Det. %
1	11.13	Ammonium	QOff	4	0.030	0.278	-0.006	99.9914
		AVERAGE:			0.0302	0.2780	-0.0065	99.9914

Figure 10b: Summary of qualification unknown results for Cations.

No.	Name	Fluoride
		mg/L
3	TLW Cation High	10.03
4	TLW Cation Low	2.120
5	TLW Cation High	10.33
6	TLW Cation Low	2.181
7	TLW Cation High	10.35
8	TLW Cation Low	2.188

Target 10.0 mg/L

Ave High	10.2
Stdev (%)	1.77%

Target 2.0 mg/L

Ave Low	2.2
Stdev (%)	1.73%

The CS16 Cation exchange column is promoted as a column set that has ample peak separation between Na^+ ions and NH_4^+ ions. Resolution of disparate concentration ratios of sodium and ammonium (up to 10,000:1) are reported [4]. This concentration ratio was tested and can be seen in a chromatogram overlay in Figure 11. Sodium concentrations up to 10,000 mg/L were contrasted against a 10 mg/L ammonium standard. It was observed that the peak analysis software was clearly able to resolve ratios of Na/NH_4 up to 1000:1, however, at the 1000:1 ratio integration of the NH_4^+ was under reported ~ 20%.

Figure 11: Chromatogram overlay of Na^+ (10,000, 1000, 100, & 10 mg/L) and NH_4^+ (10 mg/L present in each sample)

19
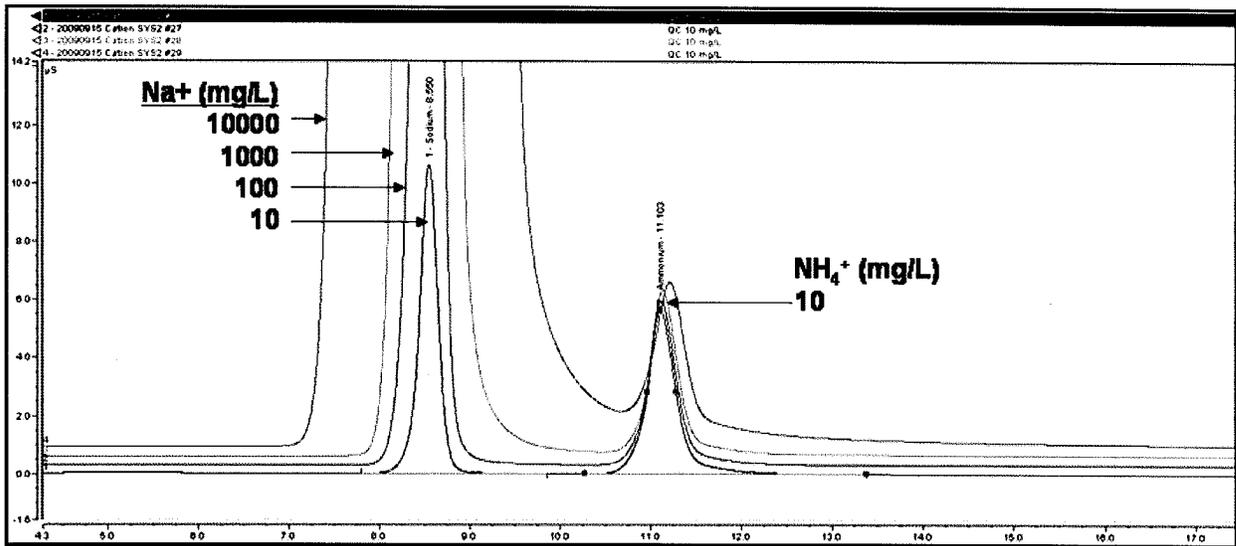
5.0 CONCLUSIONS

Presented in this report are analytical methods developed on a DIONEX ICS3000 Reagent Free Ion Chromatography (RFIC) system located in the Analytical Development Directorate at SRNL. One channel dedicated to anion analysis using Potassium Hydroxide (KOH) as the mobile phase was qualified and a method detection limit was calculated at 55-85 μg/L (ppb) for the anions Fluoride (F$^-$), Formate (CHOO$^-$), Chloride (Cl$^-$), Nitrite (NO$_2^-$), Bromide (Br$^-$), Nitrate (NO$_3^-$), Sulfate (SO$_4^{2-}$), Oxalate (C$_2$O$_4^{2-}$), Iodide (I$^-$), and Phosphate (PO$_4^{3-}$), and Acetate (CH$_3$COO$^-$). Interferences between Fluoride and Iodate (IO$_3^-$) prevent Iodate quantification using this method unless Fluoride amounts are determined with an alternative method. Method time was 35 minutes. A second channel configured for cation analysis using MSA as the mobile phase was qualified and a method detection limit was calculated at 40 μg/L (ppb) for the Cation Ammonium (NH$_4^+$). Interferences with Sodium (Na$^+$) are present with this method if disparate concentration ratios of sodium and ammonium exceed 1,000:1. Method time was 22.5 minutes. Reporting limits or limits of quantification (LOQ) based upon these methods would be different and would be matrix dependent.

Figure 12: Conclusion table of methods

	Eluent Conc.	Method time (min)	MDL	Calibtration curve			LOQ	Ion(s)
KOH	20-40 mMol	35.0	55-85 μg/L	4 point	0.5 - 10 mg/L	$r^2 > 99.5\%$	Matrix dep.	Anions listed above
MSA	30mMol	22.5	40 μg/L	4 point	0.5 - 10 mg/L	$r^2 > 99.5\%$	Matrix dep.	NH$_4^+$

REFERENCES

[1]   Dionex ICS3000 RFIC Ion Chromatography system maintenance manual (http://www1.dionex.com/en-us/webdocs/48428_Man-IC-ICS-3000-System-Operators-2008-01-065031-04.pdf)

[2]   IonPac AS-19 Anion Exchange Column Web Document: (http://www.dionex.com/en-us/webdocs/7088_AS19.pdf)

[3]   IonPac CS-16 Cation Exchange Column Web Document: (http://www.dionex.com/en-us/webdocs/4237_CS16_DataSheet_V30_released103006.pdf)

[4]   Wisconsin Department of Natural Resources, "ANALYTICAL DETECTION LIMIT GUIDANCE & Laboratory Guide for Determining Method Detection Limits", PUBL-TS-056-96, 1996

Attachment 1: Method conditions for Dionex ICS3000 KOH gradient Anions.

DIONEX ICS3000 - KOH 20-40mMol Gradient Anion Method	
Injection	50 µL
Flow rate	1.0 mL/min
Stop Time	27.5 min
Recovery time	7.5 min
Guard Column	IonPac AG-19 4x50 mm
Analytical Column	IonPac AS-19 4x250 mm
Suppressor	Self-Regenerating Suppressor (ASRS) 300 @ 99mA
RFIC KOH (instrument generated)	0.0 - 10.0 Minutes 20 mMol KOH
	10.0 - 20.0 Minutes ramp 20-40mMol KOH
	20.0 - 27.0 Minutes 40 mMol KOH
	27.0 - 27.5 Minutes 20 mMol KOH
Calibration Curve	4 point - (0.5 mg/L to 10 mg/L) $r^2 < 0.995$
Baseline conductivity (20 mMol KOH)	~0.3 µS
DI Water (Treatment)	start > 18MΩ (CRTC -carbonate control)
Peak Analysis	Chromeleon 6.8
Autosampler	DIONEX AS40 (or equivalent)

Anion	Retention time in (Min)
Fluoride	3.97
Formate	4.82
Chloride	6.34
Nitrite	7.86
Bromide	9.90
Nitrate	11.25
Sulfate	14.87
Oxalate	17.63
Iodide	21.79
Phosphate	23.89

Integration parameters		
0.0	Inhibit Integration	On All Channels
0.0	Minimum Area	0.1 All Channels
2.8	Inhibit Integration	Off All Channels
2.8	Valley to Valley	On All Channels
5.5	Tailing Sensitivity Factor	5.0 All Channels
7.2	Fronting Sensitivity Factor	2.0 All Channels
10.5	Tailing Sensitivity Factor	Off All Channels
10.5	Fronting Sensitivity Factor	Off All Channels

Attachment 2: Method conditions for Dionex ICS3000 MSA Isocratic Cations.

DIONEX ICS3000 - MSA Isocratic Cation Method	
Injection	25 μL
Flow rate	1.0 mL/min
Stop Time	22.5 min
Recovery time	n/a
Guard Column	IonPac CG-16 5x50 mm
Analytical Column	IonPac CS-16 5x250 mm
Suppressor	Self-Regenerating Suppressor (CSRS) 300 @ 150mA
RFIC MSA (instrument generated)	30 mMol MethaneSulfonic Acid (MSA)
Calibration Curve	4 point - (5 mg/L to 100 mg/L) $r^2 < 0.995$
Baseline conductivity (20 mMol KOH)	~0.5 μS
DI Water (Treatment)	start > 18MΩ (CRTC -carbonate control)
Peak Analysis	Chromeleon 6.8
Autosampler	DIONEX AS40 (or equivalent)

Anion	Retention time in (Min)
Sodium	8.3
Ammonium	11.1
Potassium	19.2

Integration parameters		
0.0	Inhibit Integration	On All Channels
0.0	Minimum Area	0.1 All Channels
2.8	Inhibit Integration	Off All Channels
2.8	Valley to Valley	On All Channels