

RV INVESTIGATOR

HYDROCHEMISTRY DATA PROCESS REPORT

Voyage:	IN2016_t01
Chief Scientist:	Dr Simon Williams
Voyage title:	Continuity of Australian terranes into Zealandia: towards a geological map of east Gondwana margin
Report compiled by:	Mark Rayner



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1 Itinerary

Mobilise	Date
Fiji	30 June 2016
Depart	Date
Fiji	30 June 2016
Arrive	Date
Hobart	14 July 2016
Demobilise	Date
Hobart	15 July 2016

2 Key personnel list

Name	Role	Organisation	
Mark Rayner	Hydrochemist	CSIRO	

3 Summary

3.1 Hydrochemistry

Analysis	Total
Salinity (Guildline Salinometer)	16
Dissolved Oxygen (automated titration)	16
	113 CTD
	30 UWY
Nutrients (AA3)	240 EXP
	383 TOTAL

3.2 Rosette and CTD

• 13 CTD stations were completed with a 36 bottle rosette (12 L).

3.3 Procedure Summary

The procedure for data processing is outlined in figure 1.



Figure 1: The process above shows the data trail procedure from the initial data generated to output via HyPro for reporting.

4 Salinity Data Processing

4.1 Salinity Parameter Summary

Details				
HyPro Version	4.12			
Instrument	Guildline Autosal Laboratory Salinometer 8400(B) – SN 71613			
Software	Osil Data Logger			
Methods	Hydrochemistry Operations Manual + Quick Reference Manual			
Accuracy	± 0.001 salinity units			
Analyst(s)	Mark Rayner			
Lab Temperature (±0.5°C)	Reasonably constant, 20-22.5°C see lab temperature plot			
Reference Material	Osil IAPSO - Batch P158			
Sampling Container type	200 ml volume OSIL bottles made of type II glass (clear) with disposable plastic insert and plastic screw cap.			
Sample Storage	Samples held in Salt Room for 24 hrs before analysis within ~72 hrs			
Comments	Bath temperature set to 24°C nstrument worked well. Refer to "in2016_t01_HYD_VoyageReport.pdf" for further details. Files are named in2016_v01sal001-02			

4.2 **CTD vs Hydro salinities**



4.3 Missing or Suspect Salinity Data and Actions taken

Data is flagged based on notes from CTD sampling log sheet, observations during analysis, and examination of depth profile and waterfall plots.

CTD	RP	Bottle	Flag	Reason for Flag or Action
11	3	f02	69	Salinity sample suspect

5 Dissolved Oxygen Data Processing

5.1 **Dissolved Oxygen Parameter Summary**

Details			
HyPro Version	4.12		
Instrument	Automated Photometric Oxygen system		
Software	SCRIPPS		
Methods	SCRIPPS		
Accuracy	0.01 ml/L + 0.5%		
Analyst(s)	Mark Rayner		
Lab Temperature (±1°C)	Variable, 20 - 22°C		
Sample Container type	Pre-numbered glass 140 mL glass vial w/stopper.		
Sample Storage	Samples were stored within Hydrochemistry lab under the forward starboard side bench until analysis. All samples were analysed within ~72 hrs.		
Comments	Computer lost communication with the dosimat on 2 occasions, two samples were lost. Files are named in2016_v01oxy001-oxy002		





5.3 **Dissolved Oxygen thiosulphate normality across voyage**

5.4 **Dissolved Oxygen blank concentration across voyage**



5.5 Missing or Suspect Dissolved Oxygen Data and Actions taken

Data is flagged as Good, Suspect or Bad in HyPro based on notes from CTD sampling log sheet, observations during analysis, and examination of depth profile and waterfall plots.

CTD	RP	Bottle	Flag	Reason for Flag or Action
9	1	727	141	Titrator Malfunction
9	3	728	141	Titrator Malfunction

6 Nutrient Data Processing

6.1 Nutrient Parameter Summary

Details							
HyPro Version	4.12, re-processed onshore with 4.16						
Instrument	AA3	AA3					
Software	Seal AACE 6.1	10					
Methods	AA3 Analysis	Methods interna	il manual				
Nutrients anaylsed	⊠ Silicate ⊠ Phosphate ⊠ Nitrate + ⊠ Nitrite ⊠ Ammoni Nitrite						
Concentration range	112 µmol/L	3 μmol/L	36.4 µmol/L	1.4 µmol/L	2 μmol/L		
Method Detection Limit (MDL)	0.2 μmol/L	0.02 μmol/L	0.02 μmol/L	0.02 μmol/L	0.02 μmol/L		
Matrix Corrections	Ν	Ν	Ν	Ν	Ν		
Analyst(s)	Mark Rayner						
Lab Temperature (±1°C)	Reasonably c	onstant, 20-22°C	see lab tempera	ature plot			
Reference Material	RMNS – CA						
Sampling Container type	10mL polypro	opylene sample t	ubes				
Sample Storage	< 2 hrs at roo	om temperature o	or < 24hrs @ 4°C				
Pre-processing of Samples	None						
Comments	Cleaned AA3	daily with 10% H	ypochlorite and	10% HCL.			
	Non-CTD rela and exp.	ited samples wer	e analysed and p	processed with t	ne prefix-uwy		
	Files are nam	ed in2016_t01n	ut001 – nut013				

6.2 Nutrient calibration and data parameter summary

During the course of the voyage all run information was logged - LNSW batch, new cadmium column, new stock standard, daily standard information, fresh reagent information, instrumentation settings, pump tube changes and pump tube hours, this information is contained in the voyage documentation and is available upon request. All analysis runs have a corresponding AA3_Run_Analysis_sheet and AA3_Processing_Worksheet file to assist in characterizing data and note questionable peaks, this information is also available upon request.

Additional information is contained in the following folder;

http://www.cmar.csiro.au/datacentre/process/data_files/Investigator_NF/in2016_t01/data/in2016_ v04_Hydro_Additional_Calibration_info.zip

The link is available through Marlin, within the folder there are 2 more folders "Calibration_Plots" and "Calibration_Summary" contain information regarding the calibrations, drift, baseline and MDL.

The raw data is imported into HyPro for peak determination. For each analysis run (indicated by a NUT###), HyPro fits the best calibration curve to the standards by performing several passes over each standard point. If the measured value is different from the calculated value it will allocate less weighting to the point in the calibration curve. HyPro will mark these points as suspect or bad within the calibration curve. Following standard procedures, the operator may choose to remove bad calibration points by placing a # in front of the peak start column within the data file (see section 6.6 for edited data). Below are the standard corrections and settings that HyPro applies to the raw data. Once data processing is completed the output files (CSV and NetCDF) are run through the HydroNcChecker programme to ensure all correct data has entered into these files.

Result Details	Silicate	Phosphate	Nitrate + Nitrite	Nitrite	Ammonia
Data Reported as	µmol l ⁻¹	µmol l⁻¹	µmol l⁻¹	µmol l⁻¹	µmol l⁻¹
Calibration Curve degree	Linear	Linear	Quadratic	Quadratic	Quadratic
Forced through zero?	N	N	N	N	N
# of points in Calibration	6	6	6	6	6
Matrix Correction	N	N	N	N	N
Blank Correction	N	Ν	Ν	Ν	Ν
Carryover Correction (HyPro)	N	N	N	N	N
Baseline Correction (HyPro)	Y	Y	Y	Y	Y
Drift Correction (HyPro)	Y	Y	Y	Y	Y
Data Adj for RMNS	N	Ν	Ν	Ν	Ν
Window Defined*	HyPro	HyPro	HyPro	НуРго	HyPro
Medium of Standards	LNSW (bulk on deck of Investigator) collected 17/5/2015 off shore from Brisbane (-27.1S, 155.2E) using the clean instrument seawater supply inlet. Twenty five carboys were filtered through 1µM by Stephen Tibben and				

Result Details	Silicate	Phosphate	Nitrate + Nitrite	Nitrite	Ammonia		
	Kendall Sherri stored in the h	Kendall Sherrin on the 21 st and 22 nd of April 2016. Four containers were stored in the hydrochemistry laboratory at 21°C.					
Medium of Baseline	18.2 Ω MQ						
Proportion of samples in duplicate?	1 duplicate for each CTD from NISKIN bottle 1						
Comments Calibration and QC data that was edited or removed is located in the in section 6.6. The reported data is not corrected to the RMNS. Per u RMNS data can be found in Appendix 7.4.				ed in the table NS. Per run			

6.3 Accuracy - Reference Material for Nutrient in Seawater (RMNS) Plots

The certified reference materials (CRM) for silicate, phosphate, nitrate and nitrite in seawater produced by KANSO – Japan was used in each nutrient analysis to ensure the accuracy of results. The RMNS was run 4 times after the calibration standards. QC data is not supplied for the experimental ammonium samples as there is not a CRM. Accuracy is determined by comparing the new standard batch with the old and tracking to ensure the concentration is within 1% accuracy between batches.

The RMNS Lot CA (produced 22/02/2013) was measured 4 times in every CTD analysis. The RMNS Lot CD (produced 08/04/2015) was analysed twice with the CA. RMNS results were converted from μ mol/kg to μ mol l⁻¹ at 21°C in the following table.

RMNS	NO ₃	NOx	NO ₂	PO ₄	SiO ₄
CA	20.13	20.20	0.065	1.44	37.46
CD	5.63	5.65	0.018	0.457	14.26

Table 1: RMNS CA, BV and BW concentrations (µM) at 21°C

The submitted nutrient results do <u>NOT</u> have RMNS corrections applied.

The following equation can be used to correct the data for each nutrient analysis using the CA RMNS.

RMNS Correction
% error = (RMNS measured – RMNS Published)/RMNS Published
Corrected Nutrient Concentration = Nutrient measured – (nutrient measured x error)

Note: NOx data should be corrected as NO_3 and NO_2 .

The following plots show RMNS values within 1% (green lines), 2% (pink lines) and 3% (red lines) of the published RMNS value except for nitrite. The nitrite limit is set to $\pm 0.020 \ \mu$ M (MDL) as 1% is

below the method MDL. The GO-SHIP criteria (Hyde *et al.*, 2010), reference section 7.3, specifies using 1-3 % of full scale (depending on the nutrient) as acceptable limits of accuracy. The measured RMNS values per CTD are reported in the table in Appendix 7.4. The CD RMNS Plots are under review as 1% of the published RMNS value is below the detection limit for SiO₄, PO₄ and NO₂. The lines are to be changed to the MDL value.



In2016_t01_hyd_processreport_v2.docx



6.3.2 Phosphate RMNS Plot



6.3.3 Nitrate + Nitrite (NOx) RMNS Plot



6.3.4 Nitrite RMNS Plot

6.4 Analytical Precision

The CSIRO Hydrochemistry method measurement uncertainty (MU) has been calculated for each nutrient based on variation in the calibration curve, calibration standards, pipette and glassware calibration, and precision of the CRM over time (Armishaw, 2003).

	Silicate	Phosphate	Nitrate + Nitrite (NOx)	Nitrite	Ammonium
Calculated MU* @ 1 µmol l ⁻¹	±0.017	±0.020	±0.017	±0.108	±0.066 [¥]

*The reported uncertainty is an expanded uncertainty using a coverage factor of 2 giving a 95% level of confidence.

^{*}The ammonia MU precision component does not include data on the CRM.

Method detection limits (MDL) achieved during the voyage were much lower than the nominal detection limits, indicating high analytical precision at lower concentrations. Results are μ mol l⁻¹. The precision of the RMNS is also reported in the following table.

MDL	Silicate	Phosphate	Nitrate + Nitrite (NOx)	Nitrite	Ammonium
Nominal MDL*	0.20	0.02	0.02	0.020	0.02
Min	0.016	0.001	0.004	0.001	0.001
Max	0.223	0.014	0.018	0.016	0.013
Mean	0.084	0.006	0.010	0.004	0.006
Median	0.075	0.006	0.009	0.003	0.005
Precision of MDL (stdev)	0.060	0.003	0.004	0.004	0.003

*MDL is based on 3 times the standard deviation of Low Nutrient Seawater (LNSW) analysed in each nutrient run.

Published RMNS (μ mol l ⁻¹)	37.46	1.441	20.20	0.065	-
w/uncertainty	± 0.22	± 0.014	± 0.16	± 0.010	-
RMNS Min	37.34	1.390	19.92	0.063	-
RMNS Max	38.35	1.432	20.38	0.073	-
RMNS Mean	37.86	1.411	20.19	0.069	-
RMNS Median	37.81	1.410	20.15	0.070	-
RMNS Std Dev	0.30	0.015	0.14	0.004	-

6.5 Sampling Precision

Duplicates samples were collected from NISKIN bottle 1 to measure the precision of nutrient sampling (this is not a measurement of analytical precision). The duplicate measurements are reported in the data as an average when the duplicates are flagged GOOD. The sampling precision is deemed good if difference between duplicate concentrations is below the MDL for silicate, phosphate, NOx¹ and nitrite. Duplicate samples that were greater than the MDL are noted in section 6.7 Investigation of Missing or Flagged Nutrient Data and Actions taken.

 1 The value of 0.02 μM for NOx is under review and may be changed to 0.05 μM within HyPro.

6.5.1 Redfield Ratio Plot (14.0)

Plots consists of phosphate versus NOx, best fit ratio = 14.18.





6.6 Calibration and QC edited data

During this voyage a number of NH₄ analysis had contamination in the MQ Baseline water The baseline positions were shifted down to the NULL positions by adjusting the peak start time within the slk file ,the runs were ; nut002, nut004, nut005, nut010 and nut12. Analysis run nut009 peak time slippage occurred in the NH₄ channel, the timing was adjusted within the peak start column of the slk file to ensure the peak plateau occurred within the correct position. All data is good within these adjusted files.

CTD, exp, uwy	Peak	Run #	Analysis	Action
02, uwy1-2, exp1-3	Cal 5	Nut001	NOx	2 nd marked suspect – peak shape.
02, uwy1-2, exp1-3	Calibration Curve	Nut001	SiO4, NH4	<70% of Cals used in calibration curves. Calibration GOOD from HyPro fit.
03, uwy3-4, exp4-21	Cal 5	Nut002	NOx	1 st marked suspect – peak shape.
03, uwy3-4, exp4-21	Calibration Curves	Nut002	SiO4, NH4	<70% of Cals used in calibration curves. Calibration GOOD from HyPro fit.
04, uwy5-7, exp22-42	Cal 5	Nut003	NOx	1 st marked suspect – peak shape.
04, uwy5-7, exp22-42	Calibration Curves	Nut003	SiO ₄	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.
05, uwy8-9, exp43-69	Cal 1 & 4	Nut004	NOx	2 nd marked as bad – peak shape.
05, uwy8-9, exp43-69	Calibration Curve	Nut004	SiO ₄	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.
06, uwy010- 011, exp70- 81	Calibration Curve	Nut005	NH4	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.
07, uwy012- 016, exp82- 102	Calibration Curve	Nut007	NH4	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.
08, 09, exp103-120	Calibration Curve	Nut008	SiO4	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.
10, uwy19- 22, exp121- 146	Cal 5	Nut009	NOx	2 nd marked suspect – peak shape.

CTD, exp, uwy	Peak	Run #	Analysis	Action
10, uwy19- 22, exp121- 146	Cal 2	Nut009	NH4	Both marked bad – peak shape.
10, uwy19- 22, exp121- 146	Calibration Curve	Nut009	SiO4, NH4	<70% of Cals used in calibration curves. Calibration GOOD from HyPro fit.
12, uwy25- 27, exp187- 207	Cal 4	Nut011	NOx	1 st marked bad – peak shape.
12, uwy25- 27, exp187- 207	Cal 5	Nut011	NOx	1 st marked suspect – peak shape.
12, uwy25- 27, exp187- 207	RMNS	Nut011	SiO ₄	3 rd RMNS marked bad – spike in plateau.
13, uwy28- 30, exp205- 222	Cal 4	Nut012	NOx	2 nd marked bad – peak shape.
exp223-240	Cal 5	Nut013	NOx	1 st marked suspect – peak shape.
exp223-240	Calibration Curve	Nut013	\mathbf{NH}_4	<70% of Cals used in calibration curve. Calibration GOOD from HyPro fit.

The table below identifies all flagged data and data that was repeated. Data that falls below the detection limit, Flag 63, is not captured in this table. All GOOD data is flagged 0 in the .csv and .netcdf files. Refer to Appendix 7.2 for flag explanations.

CTD, exp, uwy	RP	Run	Analysis	Fla	g Reason for Flag or Action
6	1	Nut006	NOx, NH_4	69	Data good, difference between duplicates > 0.02µM (MDL).
8	1	Nut008	NH_4	69	Data good, difference between duplicates > 0.02µM (MDL).
9	1	Nut008	NH_4	69	Data good, difference between duplicates > 0.02μM (MDL).
10	1	Nut009	NOx	69	Data good, difference between duplicates > 0.02μM (MDL).
12	1	Nut011	NH_4	69	Data good, difference between duplicates > 0.02μM (MDL).
exp 4, 5, 7, 10	-	Nut002	PO ₄	129	Over A/D range, could not be processed in HyPro only within AACE.
exp 25	-	Nut003	NH_4	129	Over A/D range, no result as not repeated.
exp 71-81	-	Nut005	NOx	129	Over A/D range, ran out of NEDD Colour reagent, samples repeated in Nut006 values were calculated in AACE not HyPro.
exp 77-81	-	Nut005	NO ₂	69	Suspect - baseline shifted.
09	21	Nut008	NOx	133	Bad – spike in Plateau, no result as not repeated no result in csv file.
exp 118	-	Nut008	NOx	65	Suspect - peak shape.
exp 211	-	Nut012	NOx	65	Suspect - peak shape.
exp 205-207	-	Nut011 & Nut012	All	-	Suspect. Samples were given to Hydrochemist to be analysed with sample numbers 205-207 on the 11/7/2016 as well as the 12/7/2016. Probable incorrect labelling on 12/7/2016, possibly should have been labelled 208 etc. See in2016_t01_Hydro_EXP.csv.

7 Appendix

7.1 Salinity Reference Material

Osil IAPSO Standard Seawater					
Batch	P158				
Use by date	25/03/2018				
K ₁₅	0.99940				

7.2 HyPro Flag Key for CSV & NetCDF file

Flag	Meaning
0	Data is GOOD - nothing detected.
192	Data not processed.
63	Below nominal detection limit.
69	Data flagged suspect by operator. Set suspect by software if Calibration or Duplicate data is outside of set limits but not so far out as to be flagged bad.
65	Peak shape is suspect.
133	Error flagged by operator. Data is bad - operator identified by # in slk file or by clicking on point.
129	Peak exceeds maximum A/D value. Data is bad.
134	Error flagged by software. Peak shape is bad - Median Absolute Deviation (MAD) analysis used. Standards, MDL's and Duplicates deviate from the median, Calibration data falls outside set limits.
141	Missing data, no result for sample ID. Used in netcdf file as an array compiles results. Not used in csv file.
79	Method Detection Limit (MDL) during run was equal to or greater than nominal MDL. Data flagged as suspect.

7.3 GO-SHIP Specifications

Salinity Accuracy of 0.001 is possible with Autosal[™] salinometers and concomitant attention to methodology, e.g., monitoring Standard Sea Water. Accuracy with respect to one particular batch of Standard Sea Water can be achieved at better than 0.001 PSS-78. Autosal precision is better than 0.001 PSS-78. High precision of approximately 0.0002 PSS-78 is possible following the methods of Kawano (this manual) with great care and experience. Air temperature

stability of ± 1°C is very important and should be recorded.1

- O₂ Target accuracy is that 2 sigma should be less than 0.5% of the highest concentration found in the ocean. Precision or reproducibility (2 sigma) is 0.08% of the highest concentration found in the ocean.
- SiO₂ Approximately 1-3% accuracy⁺, 2 and 0.2% precision, full-scale.
- PO₄ Approximately 1-2% accuracy⁺, 2 and 0.4% precision, full scale.
- NO₃ Approximately 1% accuracy[†], 2 and 0.2% precision, full scale.
- Notes: + If no absolute standards are available for a measurement then *accuracy* should be taken to mean the *reproducibility* presently obtainable in the better laboratories.

1 Keeping constant temperature in the room where salinities are determined greatly increases their quality. Also, room temperature during the salinity measurement should be noted for later interpretation, if queries occur. Additionally, monitoring and recording the bath temperature is also recommended. The frequent use of IAPSO Standard Seawater is endorsed. To avoid the changes that occur in Standard Seawater, the use of the most recent batches is recommended. The bottles should also be used in an interleaving fashion as a consistency check within a batch and between batches.

2 Developments of reference materials for nutrients are underway that will enable improvements in the relative accuracy of measurements and clearer definition of the performance of laboratories when used appropriately and the results are reported with the appropriate meta data.

Run #	Samples	SiO ₄	SiO ₄	PO ₄	PO ₄	NO ₂	NO ₂	NOx	NOx
		measured	expected	measured	expected	measured	expected	measured	expected
1	ctd2, uwy1-2, exp1-3	37.3	37.5	1.43	1.44	0.070	0.065	20.12	20.20
2	ctd3, uwy3-4, exp4-21	37.5	37.5	1.42	1.44	0.068	0.065	20.15	20.20
3	ctd4, uwy5-7, exp22-42	37.8	37.5	1.43	1.44	0.073	0.065	20.14	20.20
4	ctd5, uwy8-9, exp43-69	37.8	37.5	1.43	1.44	0.064	0.065	20.10	20.20
5	ctd6, uwy10-11, exp70-81	37.9	37.5	1.40	1.44	0.072	0.065	20.10	20.20
7	ctd7, uwy12-16, exp82-102	37.9	37.5	1.41	1.44	0.073	0.065	20.14	20.20
8	ctd8 & 9, exp103-120	38.4	37.5	1.42	1.44	0.070	0.065	19.92	20.20
9	ctd10, uwy19- 22, exp121-147	38.2	37.5	1.41	1.44	0.067	0.065	20.24	20.20
10	ctd11, uwy23- 24, exp148-186	37.8	37.5	1.39	1.44	0.072	0.065	20.30	20.20
11	ctd12, uwy25- 27, exp187-207	38.2	37.5	1.39	1.44	0.064	0.065	20.37	20.20
12	ctd13, uwy28- 30, exp205-222	37.8	37.5	1.39	1.44	0.063	0.065	20.39	20.20
13	exp223-240	37.8	37.5	1.41	1.44	0.071	0.065	20.35	20.20

7.4 RMNS Values for each Analytical Run

7.5 Nutrient Methods

CSIRO Oceans and Atmosphere Hydrochemistry nutrient analysis is performed with a segmented flow auto-analyser – Seal AA3 – to measure silicate, phosphate, nitrite, nitrate plus nitrite, and ammonia.

Table 2: Calibration range and detection limits of nutrient analysis.

Details									
Instrument	AA3	AA3							
Software	Seal AACE 6.1	Seal AACE 6.10							
Methods	AA3 Analysis	AA3 Analysis Methods internal manual							
Nutrient	Silicate	Phosphate	Nitrate + Nitrite	Nitrite	Ammonia				
Concentration range	140 µmol l ⁻¹	140 μmol l ⁻¹ 3 μmol l ⁻¹ 42 μmol l ⁻¹ 1.4 μmol l ⁻¹ 2.0 μmol l ⁻¹							
Method Detection Limit (MDL)	0.2 μmol l ⁻¹	0.02 µmol l ⁻¹	0.02 μmol l ⁻¹	0.02 µmol l⁻¹	0.02 µmol l⁻¹				

Silicate analysis is based on a modified Armstrong et al. (1967) method. Silicate in seawater reacts with acidified ammonium molybdate to produce silicomolybdic acid. This solution will also react with phosphate producing a phosphomolybdic acid. Tartaric acid is introduced to remove this interference. Finally, Stannous Chloride (Tin II Chloride) is added to reduce silicomolybdic acid to the blue compound silicomolybdous acid which can be detected at 660 nm or 820 nm.

Phosphate measurement is based on the original Murphy and Riley (1962) method with some modifications developed at the NIOZ-SGNOS Practical Workshop 2012 optimizing antimony catalyst/phosphate ratio and reduction of silicate interferences by pH. Phosphate in seawater forms a phosphomolybdenum blue complex with acidified ammonium molybdate reduced by ascorbic acid which can be detected at 880 nm.

Nitrate is determined by first reducing to nitrite via a basic buffered copperized cadmium column before the colour reaction (Wood et al., 1967). Nitrite in seawater will react with sulphanilamide under acidic conditions to form a diazo compound. This compound couples with 1-N-naphthly-ethylenediamine di-hydrochloride to produce a reddish purple azo complex which can be detected at 520 nm.

The ammonia method, developed by Roger Kérouel and Alain Aminot, IFREMER (1997 Mar.Chem.57), is based on the reaction of ammonium with orthophtaldialdehyde and sulfite at a pH of 9.0-9.5 producing an intensely fluorescent product; excitation 370 nm, emission 460 nm.

Detailed SOPs can be obtained from the CSIRO Oceans and Atmosphere Hydrochemistry Group on request.

8 References

Armishaw, Paul, "Estimating measurement uncertainty in an afternoon. A case study in the practical application of measurement uncertainty." Accred Qual Assur, 8, pp. 218-224 (2003).

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