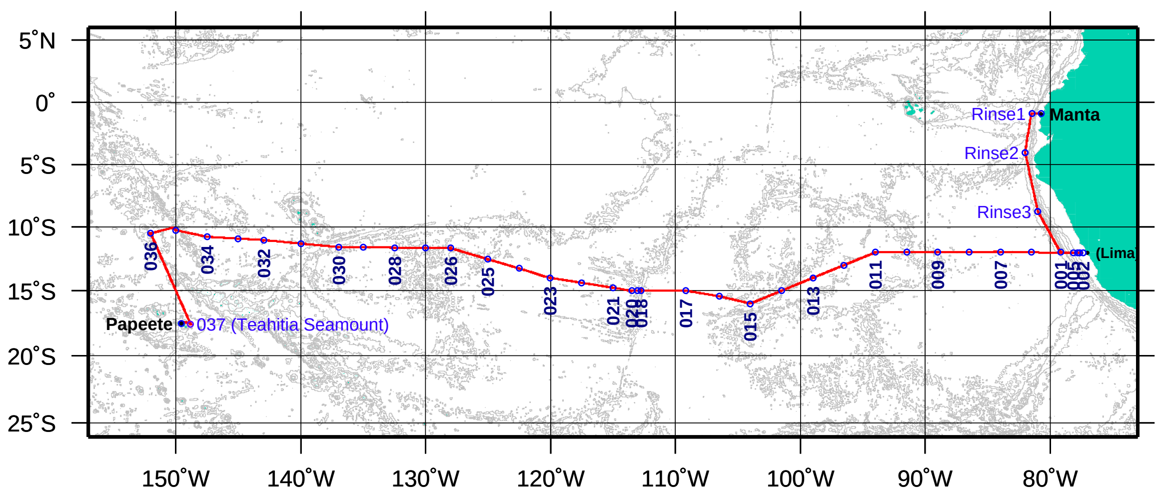
U.S. GEOTRACES EPZT

R/V Thomas G. Thompson (TGT303)
25 October 2013 - 20 December 2013
Manta, Ecuador - Papeete, Tahiti, French Polynesia

Chief Scientist: Dr. James Moffett
University of Southern California

Co-Chief Scientist: Dr. Christopher German
Woods Hole Oceanographic Institution

Co-Chief Scientist: Dr. Gregory Cutter
Old Dominion University



STS Cruise Report
15 August 2014

Principal Programs of U.S. GEOTRACES EPZT

GT-C (ODU/12L GoFlo) CTDO/Rosette + Super-GeoF Depart-Station Samples			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
CTD/Rosette Data NanoMolar Nutrients As Sb Se I †TDS	ODU	Gregory Cutter	gcutter@odu.edu
‡Salinity ‡Nutrients	SIO	James H. Swift	jswift@ucsd.edu
Hg (Total Hg only for Super-GeoF)	WSU WHOI	Chad Hammerschmidt Carl Lamborg	chad.hammerschmidt@wright.edu clamborg@whoi.edu
‡Al ‡Mn †Fe	NOAA	Joseph Resing	Joseph.Resing@noaa.gov
Co Speciation	WHOI	Mak Saito	msaito@whoi.edu
Cu Speciation	SIO	Katherine Barbeau	kbarbeau@ucsd.edu
Fe Speciation	BIOS	Kristen Buck	kristen.buck@bios.edu
Fe	ODU	Peter Sedwick	psedwick@odu.edu
Fe(II) Total Fe, Zn, Cu, Mn	USC	James Moffett	jmoffett@usc.edu
‡Ga Ba V Mo	USM	Alan Shiller	alan.shiller@usm.edu
‡Po ‡Pb (shallow)	UCSC	Russ Flegal	flegal@ucsc.edu
Po Pb (mid/deep)	MIT	Ed Boyle	eaboyle@mit.edu
‡Dissolved Trace Metals: Al Cd Co Cu Ga Fe Pb Mn Ni Sc Ag Ti Zn La Y (filtered and unfiltered for Super-GeoF and mid-GeoF)	UCSC	Ken W. Bruland	bruland@ucsc.edu
Particulate/Cellular Trace Metals: Al P Mn Fe Co Ni Cu Zn Cd †Element Analysis of Phytoplankton	BLOS	Benjamin Twining	btwining@bigelow.org
†Particulate/Labile Trace Metals: Be Mg Al P Ca Ti V Cr Mn Fe Co Ni Cu Zn As Rb Sr Y Zr Mo Ag Cd Sn Sb Ba REE Pb ^{232}Th U	RUTG WHOI	Robert Sherrell Chris German	sherrell@marine.rutgers.edu cgerman@whoi.edu
Dissolved Trace Metals: Fe Cu Zn Cd Mn Fe Colloids	RSMAS	Jingfeng Wu	jwu@rsmas.miami.edu
d ^{56}Fe d ^{66}Zn d ^{114}Cd [Fe] [Zn] [Cd]	SC	Seth John	sjohn@geol.sc.edu

* Affiliation abbreviations are listed on page 7
† Only these samples were not collected by the Surface Fish
‡ These samples were also collected at the mid-GeoF sampling. Bruland and Resing dissolved samples were collected every 2 hours between stations along the track. Unfiltered Bruland samples were collected at every 2-hour position only until station 7; then only at mid-GeoF and super-GeoF positions.

30-ODF (ODF/30L Niskin) CTD/Rosette (Corer samples in a separate table)			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
CTD/Rosette Data diss.O_2 Nutrients Salinity On-Board Data Website Data Management	SIO	James H. Swift	jswift@ucsd.edu
CFCs SF_6	RSMAS	Rana Fine	rfine@rsmas.miami.edu
diss. He Ne Ar Kr Xe $^{3}He/^{4}He$ ^{3}H ^{13}C	WHOI / NOSAMS	William Jenkins	wjenkins@whoi.edu
N_2/Ar d ^{15}N-N_2	UMassD	Mark Altabet	maltabet@umassd.edu
d ^{15}N-N_2O d ^{18}O-N_2O [N_2O] d ^{15}N-NO_2 d ^{18}O-NO_2 [NO_2^-] d ^{15}N-NO_3 d ^{18}O-NO_3	STANF	Karen L. Casciotti	kcasciot@stanford.edu
DIC Total Alkalinity	BIOS	Nick Bates	nick.bates@bios.edu
‡DOC	UCSB	Craig Carlson	carlson@lifesci.ucsb.edu
^{14}C	UW	Paul Quay	pdquay@u.washington.edu
‡Thiols	WHOI WSU	Carl Lamborg Chad Hammerschmidt	clamborg@whoi.edu chad.hammerschmidt@wright.edu
HPLC Pigments	UH	Robert R. Bidigare	bidigare@hawaii.edu
^{234}Th	WHOI	Ken Buesseler	kbuesseler@whoi.edu
^{226}Ra	WHOI SC	Matthew Charette Willard S. Moore	mcharette@whoi.edu moore@geol.sc.edu
Fe(II)	USC	James Moffett	jmoffett@usc.edu
Unfiltered Al Mn Fe	NOAA	Joseph Resing	Joseph.Resing@noaa.gov
Si Isotopes diss. SiO_2	UCSB	Mark A. Brzezinski	mark.brzezinski@lifesci.ucsb.edu
‡ ^{230}Th ‡ ^{232}Th ‡ ^{232}Th Colloids ‡ ^{231}Pa ‡ ^{231}Pa Colloids	LDEO LDEO UMN UMN	Robert F. Anderson Marty Fleisher Larry Edwards Hai Cheng	boba@ldeo.columbia,edu martyq@ldeo.columbia.edu edwar001@umn.edu cheng021@umn.edu
‡Nd ‡REE	LDEO LDEO USC	Leo Pena Steven Goldstein Doug Hammond	leopoldo@ldeo.columbia.edu steveg@ldeo.columbia.edu dhammond@usc.edu
‡ ^{210}Po ‡ ^{210}Pb	WSU QCCUNY	Mark Baskaran Gillian Stewart	Baskaran@wayne.edu gillian.stewart@qc.cuny.edu
‡ ^{239}Pu,‡ ^{240}Pu ‡ ^{237}Np ‡ ^{137}Cs ‡ ^{134}Cs	LDEO	Timothy Kenna	tkenna@ldeo.columbia.edu
‡ ^{90}Sr ‡ ^{129}I ‡ ^{236}U ‡ ^{238}U	LDEO UAB	Timothy Kenna Pere Masqué	tkenna@ldeo.columbia.edu Pere.Masque@uab.cat

* Affiliation abbreviations are listed on page 7

‡ These samples were also collected with Super-GeoF surface fish

30-ODF Rosette Corer samples			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
NIOZ Mono-Corer only:			
^{232}Th ^{230}Th ^{231}Pa ^{234}U ^{238}U	LDEO	Leo Pena	leopoldo@ldeo.columbia.edu
Nd Isotopes	LDEO	Steven Goldstein	steveg@ldeo.columbia.edu
top layer of NIOZ Mono-Corer, and Wax Corer:			
Particulate / Labile Trace Metals:			
Be Mg Al P Ca Ti V Cr Mn Fe	RUTG	Robert Sherrell	sherrell@marine.rutgers.edu
Co Ni Cu Zn As Rb Sr Y Zr Mo	WHOI	Chris German	cgerman@whoi.edu
Ag Cd Sn Sb Ba REE Pb ^{232}Th U			
Wax Corer only:			
	UMN	Brandy Toner	toner@umn.edu
parameters TBA	RUTG	Robert Sherrell	sherrell@marine.rutgers.edu
	WHOI	Chris German	cgerman@whoi.edu

* Affiliation abbreviations are listed on page 7

Aerosols (3 systems) and/or Rainwater			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
Aerosol and Rainwater: Li Na Mg Al P Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga As Se Rb Sr Zr Cd Sn Sb Cs Ba La Ce Nd Pb Th U	UAF SkIO FSU	Ana M. Aguilar-Islas Clifton Buck William Landing	amaguilarislas@alaska.edu clifton.buck@skio.uga.edu wlanding@fsu.edu
Aerosol Cu Ligands	SIO	Katherine Barbeau	kbarbeau@ucsd.edu
Aerosol Fe Ligands	BIOS	Kristen Buck	kristen.buck@bios.edu
Aerosol [Fe] [Zn] [Cd] d ^{56}Fe d ^{66}Zn d ^{114}Cd	SC	Seth John	sjohn@geol.sc.edu
Aerosol ^{210}Po ^{210}Pb	WSU QCCUNY	Mark Baskaran Gillian Stewart	Baskaran@wayne.edu gillian.stewart@qc.cuny.edu
Aerosol and Rainwater: ^{7}Be	RSMAS	David Kadko	dkadko@rsmas.miami.edu
Aerosol and Rainwater: Po Pb stable Isotopes	MIT UCSC	Ed Boyle Russ Flegal	eaboyle@mit.edu flegal@ucsc.edu
Aerosol: ^{232}Th	LDEO LDEO	Robert F. Anderson Marty Fleisher	boba@ldeo.columbia,edu martyq@ldeo.columbia.edu
Aerosol: Nd Isotopes REE	LDEO	Leo Pena	leopoldo@ldeo.columbia.edu
Aerosol and Rainwater: N Isotopes d $^{15}N\text{-}NO_3$ d $^{18}O\text{-}NO_3$ D $^{17}O\text{-}NO_3$ $[NO_3^-]$	Brown	Meredith Hastings	meredith_hastings@brown.edu
Aerosol: DOM (Dissolved Organic Matter)	ODU	Andrew Wozniak	awozniak@odu.edu
Aerosol and Rainwater: Total Hg only	WHOI WSU	Carl Lamborg Chad Hammerschmidt	clamborg@whoi.edu chad.hammerschmidt@wright.edu

* Affiliation abbreviations are listed on page 7

McL-Prof (McLane Pump) Profiles (*in situ* pump filters or piggyback 30L Niskins)			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
SBE19*plus* (SeaCAT) CTD Data	WHOI	Phoebe J. Lam	pjlam@whoi.edu
Niskin Bottles			
^{234}Th	WHOI	Ken Buesseler	kbuesseler@whoi.edu
^{226}Ra	WHOI SC	Matthew Charette Willard S. Moore	mcharette@whoi.edu moore@geol.sc.edu
Organic and Inorganic Hg Thiols	WSU WHOI	Chad Hammerschmidt Carl Lamborg	chad.hammerschmidt@wright.edu clamborg@whoi.edu
Nutrients Salinity	SIO	James H. Swift	jswift@ucsd.edu
***In situ* pump MnO_2-coated cartridges**			
Dissolved Radium Isotopes	WHOI SC	Matthew Charette Willard S. Moore	mcharette@whoi.edu moore@geol.sc.edu
Dissolved ^{227}Ac	USC	Doug Hammond	dhammond@usc.edu
Dissolved ^{228}Th	WHOI WHOI SC	Ken Buesseler Matthew Charette Willard S. Moore	kbuesseler@whoi.edu mcharette@whoi.edu moore@geol.sc.edu
***In situ* pump filters: QMA side**			
d ^{15}N-PN	STANF	Karen L. Casciotti	kcasciot@stanford.edu
Particulate Organic and Inorganic Hg Thiols	WSU WHOI	Chad Hammerschmidt Carl Lamborg	chad.hammerschmidt@wright.edu clamborg@whoi.edu
Particulate ^{234}Th and ^{228}Th	WHOI WHOI SC	Ken Buesseler Matthew Charette Willard S. Moore	kbuesseler@whoi.edu mcharette@whoi.edu moore@geol.sc.edu
Particulate Organic and Inorganic Carbon	WHOI	Phoebe J. Lam	pjlam@whoi.edu
Proteins	WHOI	Mak Saito	mak@whoi.edu
Particulate ^{210}Po ^{210}Pb (Super Stations Only)	WSU QCCUNY	Mark Baskaran Gillian Stewart	Baskaran@wayne.edu Gillian.Stewart@qc.cuny.edu
Particulate Anthropogenic Radionuclides: ^{239}Pu, ^{240}Pu ^{237}Np ^{137}Cs ^{134}Cs ^{90}Sr (Super Stations Only)	LDEO UAB	Timothy Kenna Pere Masqué	tkenna@ldeo.columbia.edu Pere.Masque@uab.cat
^{7}Be (4 stations only, 3 depths in upper 200m)	RSMAS	David Kadko	dkadko@rsmas.miami.edu
McL-Prof table continued on next page			

* Affiliation abbreviations are listed on page 7

McL-Prof (McLane Pump) Profiles (*in situ* pump filters or piggyback 30L Niskins) - cont'd			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
***In situ* pump filters: Supor side** (142mm paired 0.8µm Supor filters and 51µm polyester prefilter)			
Particulate ^{232}Th ^{230}Th ^{231}Pa	LDEO LDEO UMN UMN	Robert F. Anderson Marty Fleisher Larry Edwards Hai Cheng	boba@ldeo.columbia,edu martyq@ldeo.columbia.edu edwar001@umn.edu cheng021@umn.edu
Particulate/Cellular Trace Metals: Al P Mn Fe Co Ni Cu Zn Cd	BLOS	Benjamin Twining	btwining@bigelow.org
Particulate Trace Metals and Major Particle Composition: Fe Al Mn Cd Cu Co Ti Ba P POC $CaCO_3$ bSi (biogenic Silica) Lithogenic Particles Fe oxyhydroxides Mn oxyhydroxides Suspended Particulate Mass	WHOI	Phoebe J. Lam	pjlam@whoi.edu
Particulate ^{210}Po ^{210}Pb	WSU QCCUNY	Mark Baskaran Gillian Stewart	Baskaran@wayne.edu gillian.stewart@qc.cuny.edu
Particulate AVS Elemental Se	ODU	Gregory Cutter	gcutter@odu.edu
Particulate Nd Isotopes and REE	LDEO LDEO USC	Leo Pena Steven Goldstein Doug Hammond	leopoldo@ldeo.columbia.edu steveg@ldeo.columbia.edu dhammond@usc.edu
Particulate Fe Speciation (XANES)	UMN WHOI	Brandy Toner Phoebe J. Lam	toner@umn.edu pjlam@whoi.edu
Particulate Fe Isotopes	SC	Seth John	sjohn@geol.sc.edu

Other Sampling			
Program / Parameters Measured	Affiliation*	Princ. Investigator	Email
Beryllium Pump Profiles: Total Dissolved ^{7}Be	RSMAS	David Kadko	dkadko@rsmas.miami.edu
Towed Surface Fish, Filtered and Unfiltered: Al Cd Co Cu Ga Fe Pb Mn Ni Sc Ag Ti Zn La Y (extra sampling between stations and mid-GeoF samples)	UCSC	Ken W. Bruland	bruland@ucsc.edu
Towed Surface Fish Only, Trace Metals: Li Na Mg Al P Sc Ti V Cr Mn Fe Co Ni Cu Zn Ga As Se Rb Sr Zr Cd Sn Sb Cs Ba La Ce Nd Pb Th U (Super-GeoF and mid-GeoF only)	UAF	Ana M. Aguilar-Islas	amaguilarislas@alaska.edu
Co storage test (stas 8/1 and 34/5 only)	WHOI UCSC	Nick Hawco Claire Parker	nickhawco@gmail.com ceparker@ucsc.edu
Ship's Underway Sensors	UW	Thompson SSSG Technicians	sssg@thompson.washington.edu

* Affiliation abbreviations are listed on page 7

Shipboard Personnel on U.S. GEOTRACES EPZT

Name	Affiliation	Shipboard Duties	Shore Email
James Moffett	USC	Chief Scientist Fe(II) Analysis	jmoffett@usc.edu
Christopher German	WHOI	Co-Chief Scientist ODF Console Ops	cgerman@whoi.edu
Gregory Cutter	ODU	Co-Chief Scientist GoFlo Winch Ops	gcutter@odu.edu
Patrick A'Hearn	UW/SSSG	Thompson Science Support	pahearn@uw.edu
Susan Becker	SIO/STS	Nutrients / Deck	sbecker@ucsd.edu
Erin Black	WHOI	Th / Ra Sampling	eblack@whoi.edu
Katlin Bowman	WSU	Organic Hg	bowman.49@wright.edu
Clifton Buck	SkIO	Aerosol / Fish Sampling	cliftonsbuck@gmail.com
Marty Fleisher	LDEO	30-ODF Supertech	martyq@ldeo.columbia.edu
Carlos Alberto Martinez Gamboa	IMARPE	Pigments / Observer	cmartinez@imarpe.gob.pe
Jim Happell	RSMAS	CFCs / DIC Sampling	jhappell@rsmas.miami.edu
Nick Hawco	WHOI	Co Analysis	nickhawco@gmail.com
Stephen Jalickee	UW/SSSG	Thompson Science Support	jalickee@uw.edu
Mary Carol Johnson	SIO/STS	Data Manager ODF Data Processing	mcj@ucsd.edu
Brett Longworth	WHOI	3He / 3H / DIC / 13C Sampling	blongworth@whoi.edu
Melissa T. Miller	SIO/STS	Oxygen / Deck	melissa-miller@ucsd.edu
Sarah Nicholas	UMN	McLane Pumps	nich0160@umn.edu
Maria Nielsdottir	ODU	Iodide / Iodate / As	maria.nielsdottir@gmail.com
Daniel Ohnemus	WHOI	McLane Pumps SeaCAT CTD Data	dohnemus@gmail.com
Robert Palomares III	SIO/STS	ET / Salinity / Deck	rpalomares@ucsd.edu
Claire Parker	UCSC	GoFlo Sampling	ceparker@ucsc.edu
Leopoldo Pena	LDEO	30-ODF Supertech	leopoldo@ldeo.columbia.edu
Brian Peters	STANF	N and O isotopes	bpeters1@stanford.edu
Steven Pike	WHOI	McLane Pumps	spike@whoi.edu
Sara Rauschenberg	BLOS	Phytoplankton Elements Particulate TM	srauschenberg@bigelow.org
Joseph Resing	UW	Al / Mn / Fe	Joseph.Resing@noaa.gov
Laura Richards	ODU	GoFlo Sampling	lcrichar@odu.edu
Saeed Roshan	RSMAS	Colloids	sroshan@rsmas.miami.edu
Gugu Rutherford	ODU	Nanonutrients / As	grutherf@odu.edu
Virginie Sanial	WHOI	McLane Pumps / Ra	virginie.sanial@legos.obs-mip.fr
Rob Sherrell	RUTG	GoFlo Sampling	sherrell@marine.rutgers.edu
Geoffrey J. Smith	UCSC	Underway Towed Fish	geosmit@ucsc.edu
Bettina Sohst	ODU	Fe Analysis	bsohst@odu.edu
Mark Stephens	RSMAS	Be-7	mstephens@rsmas.miami.edu
Gretchen Swarr	WHOI	Inorganic Hg	gswarr@whoi.edu
Cheryl Zurbrick	UCSC	GoFlo Sampling	czurbric@ucsc.edu

* Affiliation abbreviations are listed on page 7

KEY to Affiliation Abbreviations	
BIOS	Bermuda Institute of Ocean Sciences
BLOS	Bigelow Laboratory for Ocean Sciences
Brown	Brown University
FSU	Florida State University
IMARPE	Instituto del Mar del Perú
LDEO	Lamont-Doherty Earth Observatory
MIT	Massachusetts Institute of Technology
NOAA	National Oceanic and Atmospheric Administration
NOSAMS	National Ocean Science AMS Facility (WHOI)
ODU	Old Dominion University
QCCUNY	Queens College, The City University of New York
RSMAS	Rosenstiel School of Marine and Atmospheric Science (University of Miami)
RUTG	Rutgers University
SC	University of South Carolina
SIO	Scripps Institution of Oceanography (UCSD)
SkIO	Skidaway Institute of Oceanography (Univ. of GA)
SSSG	Shipboard Scientific Services Group (UW)
STS	Shipboard Technical Support (UCSD/SIO)
ODF	Oceanographic Data Facility (sub-group of STS)
STANF	Stanford University
UAB	Universitat Autònoma de Barcelona
UAF	University of Alaska, Fairbanks
UCSB	University of California, Santa Barbara
UCSC	University of California, Santa Cruz
UCSD	University of California, San Diego
UH	University of Hawaii
UMassD	University of Massachusetts, Dartmouth
UMN	University of Minnesota
USC	University of Southern California
USM	University of Southern Mississippi
UW	University of Washington
WHOI	Woods Hole Oceanographic Institution
WSU	Wayne State University

Summary

The U.S. GEOTRACES East Pacific Zonal Transect (EPZT) was occupied from 25 October 2013 - 20 December 2013 aboard R/V Thomas G. Thompson for a survey consisting of rosette/CTD casts, McLane *in situ* pump and ^{7}Be pump casts, and a variety of underway measurements. The ship departed Manta, Ecuador on 25 October 2013 and arrived in Papeete, Tahiti on 20 December 2013 (UTC dates).

A sea-going science team gathered from 15 oceanographic institutions participated on the cruise. The programs and PIs, and the shipboard science team and their responsibilities, are listed in the "Principal Programs" and "Shipboard Personnel" sections above.

Two types of rosette/SBE9*plus* CTD casts (ODF/30L-Niskin and GT-C/12L-GoFlo) were made at 36 station locations during U.S. GEOTRACES EPZT. Deep ODF/30L-Niskin casts included a device suspended 20 meters below the rosette, designed either to take a core sample or pick up particulates from the sea floor. Shallow and deep McLane pump profiles were done at all Full stations, with an additional mid-water profile at Super Stations. An SBE19*plus* CTD was attached to the end of the McLane wire on all but seven deep pump casts, when it was attached to the ODF rosette instead. Water was pumped and filtered for Beryllium-7 analysis on some stations. Underway samples were also collected for multiple programs, and 5 ARGO floats were deployed during the eastern half of the cruise for the University of Washington.

Samples analyzed on board or stored for shore analysis are tabulated in the "Bottle Sampling" section later in the documentation. 10 test/rinse cast(s) and 9 aborted/canceled cast(s) (total for all cast types) were not reported.

U.S. GEOTRACES EPZT Station/Cast Summary

Station Type	Station Numbers	Total Casts	Cast Types
All	All but 19	1	1 Underway Surface Sample (GeoFish + "Bubble" Lab)
Super	1, 11, 18, 26, 36	15-16	1 Shallow / 1 Mid / 1-2 Deep GT-C/12L GoFlo 1 Shallow / 1 Mid / 1 Deep ODF/30L Niskin 1 Shallow / 1 Mid / 1 Deep McLane Pump 1 Pigments-Th-Ra ODF/30L Niskin 2 Shallow / 2 Deep Pb,Po-Pu-129I ODF/30L Niskin 1 Be-7 pump
Shelf	2, 3, 4, 5	4-6	1-2 GT-C/12L GoFlo 1-2 ODF/30L Niskin 1 Pigments-Th-Ra ODF/30L Niskin 1 McLane Pump
Demi	6, 8, 10, 12, 14, 16, 22, 24, 27, 29, 31, 33, 35	2	1 GT-C/12L GoFlo (~1000m depth) 1 ODF/30L Niskin (~1000m depth)
Full	7, 9, 13, 15, 17, 20, 21, 23, 25, 28, 30, 32	9-11	1 Shallow / 1 Mid / 1 Deep GT-C/12L GoFlo 1 Shallow / 1 Mid / 1 Deep ODF/30L Niskin 1 Shallow / 1 Deep McLane Pump 1 Pigments-Th-Ra ODF/30L Niskin (extra Ra cast sta 7) 1 Be-7 pump (stas 7,9,13,15,23,30,32 only)
Volcano	19	1	1 Deep ODF/30L Niskin
Hemi	34	6	1 Shallow / 1 Deep GT-C/12L GoFlo 1 Shallow / 1 Deep ODF/30L Niskin 1 McLane Pump 1 Be-7 pump
Teahitia Seamount	37	4	3 Multibeam Surveys 1 ODF/30L Niskin (no bottle samples, just automated/default CTDO processing)

Description of Measurement Techniques

1. SIO/ODF CTD/Hydrographic Data: CTD, Salinity, Nutrients and Oxygen

Oceanographic Data Facility and Research Technicians
Shipboard Technical Support
Scripps Institution of Oceanography
UC San Diego
La Jolla, CA 92093-0214

Hydrographic measurements consisted of salinity and nutrient water samples taken from each CTD/rosette cast, plus dissolved oxygen from each ODF rosette cast. In addition, salinity and nutrient samples were taken from the surface fish and from Niskins attached to the wire at each Deep and Mid McLane pump cast.

Pressure, temperature, conductivity/salinity, dissolved oxygen, transmissometer, fluorometer, turbidity/LSS, and oxidation-reduction potention (ORP) data were recorded during all CTD/rosette profiles. Only raw voltages are reported for transmissometer, fluorometer, turbidity and ORP sensors. A Rinko optical oxygen sensor was also part of the ODF rosette, for evaluation purposes only; these data were recorded, but not processed or reported.

The distribution of samples is shown in figures 1.0 and 1.1.

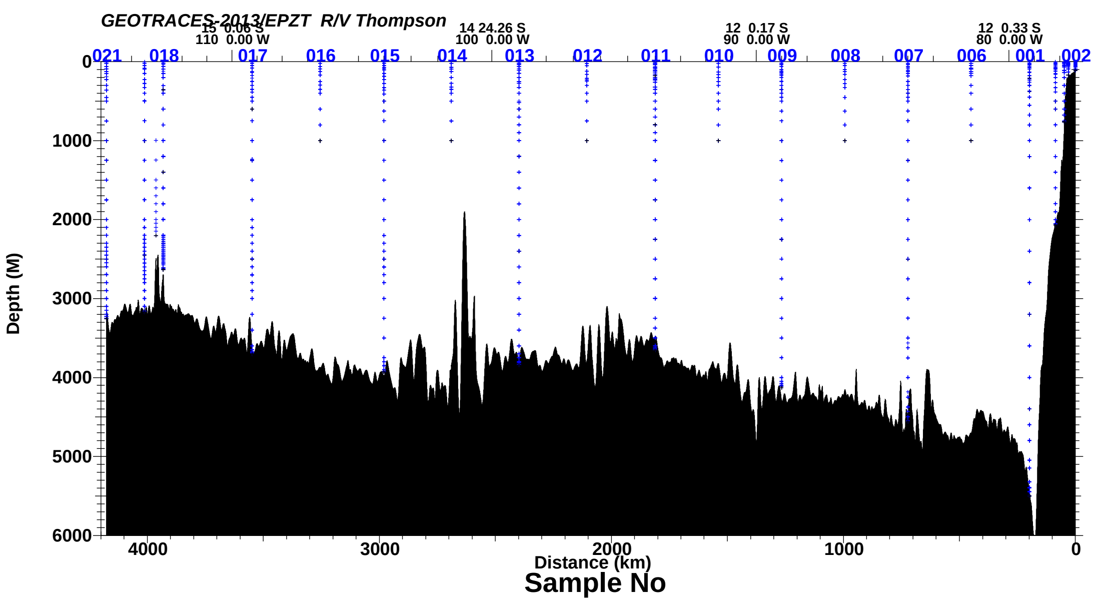


Figure 1.0 U.S. GEOTRACES EPZT Sample distribution: stations 1-21.

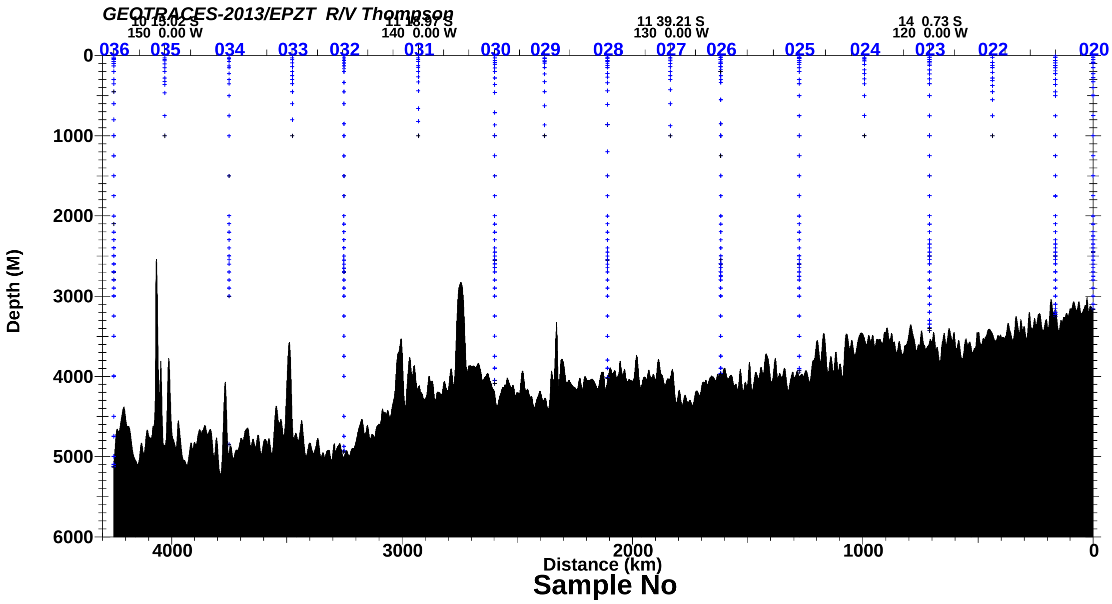


Figure 1.1 U.S. GEOTRACES EPZT Sample distribution: stations 20-36.

1.1. ODF/30L-Niskin Water Sampling Package

ODF/30L-Niskin Rosette/CTD casts were performed with a package consisting of a 12-bottle rosette frame (SIO/STS), a 12- or 24-place carousel (SBE32) and 12 ea. 30L General Oceanics Niskin-style bottles with an absolute volume of 30L each. A 12-place carousel was used on station 1, but had repeated trip-confirmation failures during stations 2 and 3. It was replaced with an older 24-place carousel mid-station 3, which resolved the trip-confirmation issues. Prior to station 4, the carousel head was replaced by one with titanium instead of stainless steel latches in order to resolve mechanical tripping issues. This "hybrid" carousel was used successfully for the remainder of the cruise.

Underwater electronic components consisted of a Sea-Bird Electronics CTD (SBE9*plus*) with dual pumps (SBE5), dual temperature (SBE3*plus*), reference temperature (SBE35RT), dual conductivity (SBE4C), dissolved oxygen (SBE43), transmissometer (WET Labs C-Star), fluorometer (Seapoint SCF), Oxidation-Reduction Potention (ORP) sensor (NOAA), turbidity meter (Seapoint STM11) and altimeter (Simrad 807). A second dissolved oxygen + oxygen temperature sensor (JFE Advantech RINKO-III) was incorporated into the data stream for future sensor evaluation; it was not processed for this cruise.

Additionally, an SBE19*plus* CTD was mounted on the rosette during deep ODF casts for full and super stations beginning with station 25, since it could no longer be deployed on deep McLane pump casts after their wire was damaged.

Routine CTD maintenance included soaking the conductivity and oxygen sensors in fresh water between casts to maintain sensor stability, and syringing distilled water through the conductivity sensors to eliminate any accumulating bio-films. Rosette maintenance was performed on a regular basis. Bottle valves and O-rings were inspected for leaks. The rosette, CTD and carousel were rinsed with fresh water as part of the routine maintenance.

The sensors and instruments used during U.S. GEOTRACES EPZT, along with pre-cruise laboratory calibration information, are listed below in Table 1.1.0. Copies of the pre-cruise calibration sheets for various sensors are included in Appendix D.

Table 1.1.0 U.S. GEOTRACES EPZT Rosette Underwater Electronics.

Instrument/Sensor	Mfr./Model*	Serial Number	CTD Channel	Stations Used (R=Rinse)	Pre-Cruise_Calibration Date	Facility*
Carousel Water Sampler	SBE32 (12-Pl.) SBE32 (24-Pl.)**	3231807-0456 32xxxxx-0030	n/a n/a	R2-3/3 3/5-36		
Reference Temperature	SBE35RT	3528706-0034 3516590-0011	n/a n/a	R2-3/5 3/6-36	18-Jun-2013 18-Jun-2013	SIO/STS SIO/STS
CTD	SBE9*plus*	09P21561-0569	n/a	R2-36		
Pressure	Paroscientific Digiquartz 401K-105	569-75672	Freq.2	R2-36	29-Jul-2013	SIO/STS
Primary						
Temperature (T1)	SBE3*plus*	03P-2333	Freq.0	R2-36	20-Aug-2013	SIO/STS
Conductivity (C1)	SBE4C	04-2659	Freq.1	R2-36	28-Aug-2013	SBE
Dissolved Oxygen	SBE43	43-0875	Aux2/V2	R2-36	13-Sep-2013	SBE
Pump	SBE5T	05-4890	n/a	R2-36		
Secondary						
Temperature (T2)	SBE3*plus*	03P-2202	Freq.3	R2-36	20-Aug-2013	SIO/STS
Conductivity (C2)	SBE4C	04-3399	Freq.4	R2-36	27-Aug-2013	SBE
Pump	SBE5T	05-1409	n/a	R2-36		
Altimeter§	Simrad 807 Tritech LRPA200	9711091 244480	Aux1/V0	R2, 1-36 R3 only	n/a n/a	n/a n/a
Chlorophyll Fluorometer§	Seapoint 6km	SCF2775	Aux1/V1	R2-36	17-Dec-2009	Seapoint
Oxidation-Reduction Potention Sensor	NOAA	ORP4†	Aux2/V3	1-36	n/a	n/a
Transmissometer	WET Labs C-Star	CST-491DR CST-400DR+	Aux3/V4	R2 only R3-36	25-Nov-2008 13-Sep-2013§	WET Labs WET Labs
Turbidity Meter (LSS)§	Seapoint 6km	STM11-14059‡	Aux3/V5	1-36	n/a	n/a
Diss. Oxygen Optode/Temp. (Experimental)	RINKO-III ARO-CAV	105	Aux4/ V6+V7	R2-36	7-Aug-2012	JFE Advantech
SeaCAT CTD	SBE19*plus*	19P-5236‡	(internally recorded)	25-36 "Deep" casts only	unknown	unknown
Deck Unit (in lab)	SBE11*plus* V2	11P21561-0518	n/a	R2-36		

All listed sensors / instruments belong to SIO/STS, unless otherwise noted.
+ Owned by UW † Owned by NOAA-PMEL ‡ Owned by WHOI
* SBE = Sea-Bird Electronics SIO/STS = Scripps' Shipbd. Tech. Support Calibration Facility
** older-style SBE32 for 3/5-3/7; then older base with titanium head from newer-style SBE32 for stations 4-36.
§ Altimeters: Simrad 807 has a 500m range, Tritech LRPA200 has a 200m range.
Transmissometers: several shipboard "deck" calibrations also occurred during EPZT
Fluorometer used 10x cable. Turbidity meter used 5x standard gain, MCBH6M connector.

The SBE9*plus* CTD was mounted horizontally in an SBE CTD cage attached to and centered on the bottom of the rosette frame, allowing free flow of water to the temperature sensor. The SBE3*plus* temperature, SBE4C conductivity and SBE43 dissolved oxygen sensors and their respective pumps and tubing were mounted horizontally in the CTD cage. The transmissometer was mounted horizontally, and the fluorometer was mounted vertically near the bottom of the rosette frame. The Rinko DO sensor was mounted horizontally to the SBE9 body, and the altimeter was mounted on the inside of the bottom frame ring. The ORP was mounted vertically, adjacent to the altimeter, with the sensor end looking downward into clean water during the down-cast. The turbidity sensor was mounted to the underside of a frame support arm at approxiately a 30 degree angle looking inward toward the transmissometer. Table 1.1.1 shows height of the sensors referenced to the bottom of the frame.

Table 1.1.1 Heights (in cm) referenced to bottom of rosette frame

Instrument/Sensor	Height in cm
Pressure Sensor (inlet to capillary tube)	27
Temperature (probe tip at TC duct inlet)	15
SBE35RT (centered between T1/T2 on same plane)	15
Altimeter	2
Fluorometer	12
ORP	10
Transmissometer	12
Turbidity (LSS)	50
Rinko DO	28
SeaCAT CTD (stations 25,26,28,30,32,34,36 deep casts only)	15
30L-Niskin centerline	124
Reference (Surface Zero tape on wire)	280

The ODF rosette system was suspended from a UNOLS-standard three-conductor 0.322" electro-mechanical sea cable attached to the R/V Thomas G. Thompson’s Markey DESH-5 (50hp) winch. One conductor in the sea cable was used for power and signal; the sea cable armor was used for ground. The ship’s poured termination, done several months prior to the cruise and only used for 5 casts before EPZT, was used through the first ODF cast of station 26.

Shortly after the 10m equilibration "soak" at the start of station 26 cast 4, the ODF rosette was accidentally brought up into the overbearing block by the winch driver. Tensions exceeded 8500 lbs. for over 30 seconds. Thanks to an alert scientist sampling on deck, the rosette was safely returned to the deck. As a precautionary measure, 50m of wire was removed, and a new, standard SIO/STS full (electrical and mechanical) cable grip termination was applied prior to the next ODF cast.

1.2. Navigation and Bathymetry Data Acquisition

Navigation data were acquired at 1-second intervals from the ship’s C&C Technologies C-Nav DGPS receiver by a Linux system starting before ship departed Manta, Ecuador until after it docked in Papeete, Tahiti.

Center-beam bathymetric and hull-depth correction data from the Kongsberg-Simrad EM 302 Multibeam Echosounder system were acquired by the ship, and fed into the ODF Linux systems through a serial data feed. The EM 122 format in the SIO/ODF software was the same as the EM 302, and was used to acquire the depth and correct for the hull depth. Sound velocity values were intermittently adjusted by the SSSG Technicians using ODF CTD data as the cruise progressed.

Bathymetry and navigation data were merged and stored on the ODF systems, and data were made available as displays on the ODF acquisition system during casts. Bottom depths associated with rosette casts were recorded on the Console Logs during deployments. However, the automatically recorded Multibeam depths were extracted from the stored navigation data and used for cast event depths in the Exchange format files.

1.3. SIO/ODF CTD Data Acquisition and Rosette Operation

The SIO/ODF CTD data acquisition system consisted of an SBE-11*plus* (V2) deck unit and two networked generic PC workstations running CentOS-5.9 Linux. Each PC workstation was configured with a color graphics display, keyboard, trackball and DVD+RW drive. Both systems had a Comtrol Rocketport PCI multiple port serial controller, each providing 8 additional RS-232 ports. The systems were interconnected through the ship's network. These systems were available for real-time operational and CTD data displays, and provided for CTD and hydrographic data management.

One of the workstations was designated the SIO/ODF CTD console and was connected to the CTD deck unit via two RS-232 cables, one for the CTD signal feed and the other as a modem for carousel communication. The CTD console provided an interface and operational displays for controlling and monitoring a CTD deployment and closing bottles on the rosette. The other workstation was designated as the website and database server, and maintained the hydrographic database for GEOTRACES EPZT. Redundant backups during casts were managed automatically. Both PCs were synced with the ship's timeserver on a regular basis to keep accurate UTC time.

The SBE9*plus* CTD supplied a standard SBE-format data stream at a data rate of 24 Hz (frames/second). The CTD was connected to an SBE32 12- or 24-place carousel, providing for sea cable operation. Power to the SBE9*plus* CTD and sensors, SBE32 carousel and Simrad altimeter was provided through the sea cable from an SIO/STS SBE11*plus* deck unit in the computer lab.

An SBE35RT reference temperature sensor was connected to the SBE32 carousel and recorded a temperature for each bottle closure. These temperatures were used as additional CTD calibration checks. The SBE35RT was utilized using Sea-Bird Electronics' recommendations (*http://www.seabird.com*).

Details about the sensors and instruments used during EPZT are listed above in table 1.1.0.

SIO/ODF CTD deployments were initiated by the console operator after the ship stopped on station. The acquisition program was started and the deck unit turned on at least 2 minutes prior to package deployment. The watch maintained a console operations log containing hand-entered metadata for each deployment, a record of every attempt to close a bottle and any relevant comments. The deployment and acquisition software presented a short dialog instructing the operator to turn on the deck unit, to examine the on-screen CTD data displays and to notify the deck watch that this had been accomplished.

The deck watch prepared the rosette 5-15 minutes prior to each cast. The bottles were cocked and all valves, vents and lanyards were checked for proper orientation. Once stopped on station, the rosette was moved out from the hangar to the deployment location under the squirt boom using a pallet jack. The CTD was powered up and the data acquisition system started from the computer lab. Tag lines were threaded through the rosette frame and syringes were removed from CTD intake ports. The rosette was unstrapped from the pallet. The winch operator was directed by the deck watch leader to raise the package. The squirt boom was extended outboard and the rosette package was quickly lowered into the water.

On the last/deep cast of each Shelf, Hemi, Full and Super station from station 4 onward, a mono-corer was suspended below the rosette on a 20 meter braided line. An "umbrella" of plastic corrugated sheeting was placed on the line above the corer to shield it from the altimeter. This setup was hooked to the rosette before deployment, then an outrigger plank was used to push the line away from the ship. On station 18, over the East Pacific Rise, it was speculated that there would not be enough sediment depth to deploy this corer without damage, so a "wax corer" (steel ball coated with soft wax) was utilized instead on two deep casts. The SIO/ODF "Deep" cast was always the last event of the station to preclude extruded mud or sediment exiting the core on the up-cast from contaminating other samples in the water column.

Rosette tag lines were removed and the package was lowered to 10 meters, or deeper in heavier seas. The CTD sensor pumps were configured with a 5-second start-up delay after detecting seawater conductivities. The console operator checked the CTD data for proper sensor operation and waited for sensors to stabilize. Then the winch operator was directed to bring the package back to the surface, re-zero the wire-out and start the descent to a specified target depth (wire-out), based on CTD depth shown on the console display.

The CTD profiling rate was at most 30m/min to 100m and up to 60m/min deeper than 100m, depending on sea cable tension and sea state. As the package descended toward the target depth, the rate was reduced to 30m/min at 100m from the bottom. Casts were lowered to pre-determined target depths, depending on the type of sampling being done. Most deep rosette casts were lowered to within 5-10 meters of the bottom, using the altimeter, winch wire-out, CTD depth and echosounder depth to determine the distance of the package from the bottom for a safe approach.

For each up-cast, the winch operator was directed to stop the winch at up to 12 pre-determined sampling depths, chosen by the GEOTRACES program participants during the first cast at each station. Bottles were closed on the up-cast by operating an on-screen control, nominally 30-40 seconds after the package stopped to allow the rosette wake to dissipate and the bottles to flush. The winch operator was instructed to proceed to the next bottle stop at least 10 seconds after closing bottles to ensure that stable CTD data were associated with the trip, and to allow the SBE35RT temperature sensor to measure bottle trip temperature.

The progress of the deployment and CTD data quality were monitored through interactive graphics and operational displays. Bottle trip locations were transcribed onto the console and sample logs. The sample log was used later as an inventory of samples drawn from the bottles. Bottle sampling for specific programs was outlined on sample log sheets prior to cast recovery or at the time of collection.

The deck watch leader directed the package to the surface after the last bottle trip. Recovering the package at the end of the deployment was essentially the reverse of launching, with the additional use of poles and snap-hooks to attach tag lines to the rosette. Recovery of the corer was made easier with a block rigged to the aft neck of the boom, to assist in keeping the line away from the ship as well as easing the hauling-in process. The rosette was secured on the pallet and moved into the hangar for sampling. The bottles and rosette were examined before samples were taken, and anything unusual was noted on the sample log.

The console operator terminated the data acquisition, waited for the SBE35RT data to auto-upload through the deck unit modem channel, then turned off the deck unit and assisted with rosette sampling.

1.4. ODF CTD Data Processing

Shipboard CTD data processing was performed automatically at the end of each deployment using SIO/STS CTD processing software v.5.1.6-1. Raw GT-C CTD data and bottle trip files, acquired by SBE Seasave V 7.17a on a Windows XP workstation, were also imported into the Linux processing system, providing a backup of the raw data.

Pre-cruise laboratory calibrations were applied, then CTD data were processed into a 0.5-second time series, bottle trips were extracted, and a 1-decibar down-cast pressure series of the data was created. The pressure-series data were used by the web service for interactive plots, sections and CTD data distribution. Time-series data, and eventually basic up-cast pressure-series data, were also available for distribution through the website.

SIO/ODF CTD data were examined at the completion of each deployment for clean, corrected sensor response and any calibration shifts. As bottle salinity and oxygen results became available, they were used to refine shipboard conductivity and oxygen sensor calibrations.

Theta-S and theta-O_2 comparisons were made between down- and up-casts as well as between groups of adjacent deployments. Vertical sections of measured and derived properties from sensor data were checked for consistency.

After final processing, corrected CTDO trip data were updated into the bottle database using SIO/STS-processed data for the ODF/30L casts. Shipboard Seasave-processed CTDO values were used for the GT-C/12L casts' trip data. Only the SIO/STS processing details are documented here.

1.5. SIO/ODF CTD Acquisition and Data Processing Details

Adjustments to the conductivity "advance" time (default: 0.073 seconds) were examined by re-averaging data from the stored 24 Hz data at various time intervals, then evaluating down- and up-cast salinity spiking and noise levels in sharp gradients and in deep water for multiple casts from stations 1 and 7. An additional 0.06-second "advance" was applied to the primary conductivity sensor, and a 0.04-second "advance" was used for the secondary. The new "advance" times were applied by re-averaging all casts from stations 1-7, and applied through real-time software starting with station 8.

The same primary and secondary sensor pairs were used through-out the cruise. Primary T/C sensors were used for all casts of reported ODF-30L CTD data: the background salinity noise level was lower than the secondary pair, and deep Theta-Salinity overlays appeared to be a bit more consistent from cast to cast.

The following table identifies problems or comments noted during specific SIO/ODF casts
(NOTE: mwo = meters of wire out on winch):

Sta/Cast	Comment
Start	New, baked Viton O-rings installed on all bottles before first Rinse cast. Used Markey DESH-5 winch for ODF 30L rosette casts; used Thompson’s existing termination from 2 months prior to start of EPZT. Start with Simrad altimeter (500m range).
999/05	Rinse 2 30-ODF Test cast; 0.01 mS/cm offset between C1 and C2. 12 bottles full range to calibrate O2 and check which C sensor is offset. NIOZ corer interferes with altimeter readings: 24.4m the entire cast, even though cast never went within 2000m of the sea floor. Many bottles leaked due to new O-rings settling into caps: adjusted O-rings/caps; also adjusted spigots on two bottles due to leaks.
Transit	On-deck tensiometer test done to adjust slope/offset on winch readings. During transit between Rinse 2 and Rinse 3, 7 transmissometers were collected and lab-tested for start-of-cruise characterization. Installed transmissometer 400DR (UW) to replace 491DR (SIO): had more recent factory calibration (2013 vs 2008).
998/03	Deck/air calibration done on transmissometer 400DR just prior cast. Rinse 3 30-ODF Test cast; 0.01 mS/cm offset between C1 and C2 remains. Using 200m altimeter to check interference of NIOZ corer on backup altimeter: same 24.4m readings through-out cast. Only one bottle had top-cap leak on recovery, fixed.
Stas 1-37	Back to using Simrad altimeter; added NOAA ORP and Seapoint Turbidity Meter from station 1 onward. No conductivity sensor changes: check-salts were an even split between the 2 C sensors. In addition to 0.073-second TC advance applied by Deck Unit, used additional lags through ODF software to match T/C with minimal salinity spiking: 0.06-second (primary T/C), 0.04-second (secondary T/C). Re-averaged stations 1-7 with new lags, applied realtime for station 8 onward.
002/02	Surface soak done mid-thermocline, never went back up to surface mixed layer. Using down-cast, with a few despiked O2 levels, to get near-surface O2 and T/C, almost back to mixed layer.
002/04	SBE35RT-0034 changed from 1 to 4 readings per trip prior to this cast. Cast NOT REPORTED: NIS-1, NIS-2 did not close: NO-confirms on carousel. Re-cocked rosette without sampling, and re-did as cast 5.
002/05	Bottles 1-4 did not close: 3 NO-confirms at each, with carousel repositioned between each attempt. Bottles 5-12 all got good confirms.
003/02	Cast ABORTED: NIS-1 did not fire. no SBE35RT data (intentionally). 5-10 minutes post-cast before deck unit turned off.
003/03	Fixed/switched cable prior to cast: no SBE35RT data (intentionally). Direct cable between carousel and SBE9 without SBE35RT (not a wye). Cast ABORTED: NIS-1 did not fire. 12-place carousel acting up; after this cast, changed out carousel for a UW 24-place SBE carousel (S/N 0030, an early SBE version with stainless steel latches).

Sta/Cast	Comment
003/05	24-place carousel installed prior to cast: still trip confirm problems. NO-confirm on NIS-4, repositioned twice and tried a total of 3 times. All bottles except NIS-4 and NIS-12 closed.
003/06	Switch SBE35RT from 35-0034 to 35-0011 prior to cast: still confirm problems. Cast NOT REPORTED: Bottles 1-10 did not confirm, bottles 11-12 confirmed but came up open. Only NIS-1 and NIS-6 closed. No SBE35RT data came through.
003/07	All bottles confirmed; only NIS-4, NIS-10 and NIS-12 did not close. All failures to close were mechanical issues (with carousel), not electronic communication issues.
004/02	Prior to station 4, carousel head changed out for the one on spare UW rosette (with titanium latches). No routine tripping issues from station 4 onward.
004/04	A cone-shaped cloaking device ("umbrella"), fashioned from corrugated plastic sheeting formerly used as box-spacers, was placed on wire between NIOZ corer and altimeter to mask the corer from the altimeter. It was acoustically nearly opaque, the altimeter readings were "normal", and the first core was successfully retrieved. Awkward for deployment and recovery, but it works.
005/06	"Inelegant core recovery": lost core, apparently dumped out during up-cast/recovery. Deployment/recovery procedure for corer refined/streamlined throughout the cruise.
007/02	Changed SBE35RT-0011 to use 4 readings vs. 1 before station 7/2.
007/10	Added this cast to collect Radium missed from deep pump cast 3.
007/12	NIS-12 failed to close on this cast. After station 7 complete: change configuration to use trip position 22 for NIS-12.
011/04	Exceptional ship-roll noise vs any other cast - not sure why.
012/02	Deck/air calibration done on transmissometer 400DR prior to cast, in transit to station 12.
018/16	Cast ABORTED and brought back to surface: Deck Unit turned off at 772dbar down, apparently came unplugged. Shifted power cord to UPS for Linux PCs before station 21.
018/17	New cast 17 started in-water immediately following cast 16. Apparently came out for a moment, due to big spike in density at surface. First use of Rob’s wax corer: a steel fishing weight coated with wax to collect sediment from the fresh lava flow that would likely break the mono-corer.
020/02	Deck/air calibration done on transmissometer 400DR prior to this cast.
021/04	Extra trigger (op.error) after last bottle fired; removed from data files.
021/06	Winch started down from 10dbar soak without returning to surface; came back up from 30dbar, then down.
022/02	Recovered rosette pre-deployment, in water 3 minutes later.
025/09	Lam SeaCAT CTD strapped onto ODF rosette in addition to the corer. Forgot yoyo back to surface after cast start, yet console op noticed the salts did not match top 15m. No good data for top 12dbar (secondary) or 15dbar (primary); using the primary, since there’s a big mixed layer and up-casts are too noisy. Surprisingly, oxygen came in very fast compared to salinity. Winch overshot 3801dbar trip by 11m, back down; after trip, cons. op. noticed winch went down, not up, for about 1 minute (45m total) to 3847dbar.

Sta/Cast	Comment
026/04	Cast ABORTED: rosette package hit the winch block on "return to surface" after soak - winch went wrong way. Scientist sampling on deck heard/saw/reported the incident promptly to winch and console ops. Over 8000lbs of pressure on the wire for more than 25 seconds at initial "two-block". Wire looked ok at 10m, but recovered to check.
026/05	Cast CANCELED: this cast was started on the console, but never went in the water: decided to re-terminate due to calculated stress on the wire from the "two-blocking". Wire reterminated with the standard SIO/STS method, after removing 50m of wire.
026/15	Winch only yoyo'd back to 11dbar after soaking at 19dbar; probably forgot to rezero the wire-out. Pressure-sequenced using the first-down (pre-soak) from 7dbar to recover some of the lost surface data.
028/02	Deck/air calibration done on transmissometer 400DR prior to cast, in transit to station 28.
030/11	T/C not stable before yoyo back to surface: noisy at start, despiking fixed most of it.
032/06	Multibeam off for about an hour starting mid-up-cast; no end reading.
035/02	CTDO O2 seems low relative to nearby casts in this minimum area (107-150 dbar); no bottles to compare with, and only a single cast on this station.
036/02	Shift in transmissometer (4.623 to 4.615) at 2400m on up-cast - ectoplasm on window? Offset persisted to 180m and surface ocean particle max.
036/15	At altim=50: slow to 20m/min, at altim=30: slow to 10m/min; bottom approach "soft and soupy". Deck/air calibration done on transmissometer 400DR 17 hrs after cast, in transit to Teahitia survey area. Later during transit, various transmissometers were collected and lab-tested for end-of-cruise characterization.
037/01	Extra station at Teahitia Seamount - not part of EPZT, "exploratory" cast only. No bottle O2 data, used CTDO corrections from cast 036/11, which gave best down/up overlay. However, CTDO looks nothing at all like station 36, or its own SBE43 or Rinko O2 unprocessed voltages. Coded CTDO2 data from this entire cast as questionable.

1.6. SIO/ODF CTD Sensor Laboratory Calibrations

Laboratory calibrations of the SIO/ODF CTD Pressure, Temperature, Conductivity and Dissolved Oxygen sensors, as well as the Reference Temperature sensors, were performed prior to U.S. GEOTRACES EPZT. The sensors and calibration dates are listed in Table 1.1.0. Copies of these calibration sheets, as well as manufacturer and deck calibration data for the UW Transmissometer, are in Appendix D at the end of this SIO/ODF report.

1.7. ODF/30L CTD Shipboard Calibration Procedures

A single SBE9*plus* CTD (S/N 09P21561-0569) was used for all ODF/30L rosette/CTD casts during EPZT. The CTD was deployed vertically, due to space limitations in the 12-place rosette, with all sensors and pumps aligned horizontally as recommended by SBE.

An SBE35RT Digital Reversing Thermometer served as an independent calibration check for T1 and T2 sensors. *In situ* salinity and dissolved O_2 check samples collected during each cast were used to calibrate the conductivity and dissolved O_2 sensors.

1.7.1. CTD Pressure

The Paroscientific Digiquartz pressure transducer (S/N 569-75672) was calibrated in July 2013 at the SIO/STS Calibration Facility. The calibration coefficients provided on the report were used to convert frequencies to pressure. The SIO/STS pressure calibration coefficients already incorporate the slope and offset term usually provided by Paroscientific.

During EPZT, the initial deck readings for pressure indicated a -0.5 decibar pressure offset was needed, typically because CTDs are calibrated horizontally but deployed vertically. This settled down to merely -0.2 decibars within a few stations. An offset of -0.2 decibars was applied to all casts by re-averaging stations 1-7, and using this offset during acquisition from station 8 onward.

Residual pressure offsets (the difference between the first and last submerged pressures, after the offset corrections) varied from -0.1 to +1.0 decibars. Pre- and post-cast on-deck/out-of-water pressure offsets varied from -0.1 to +0.5 decibars before the casts, and -0.7 to +0.1 decibars after the casts; only 2 casts were below -0.5 decibars post-cast. Most of the +0.4- and +0.5-decibar start-cast offsets were from casts where the CTD was powered on less than 4 minutes before the rosette entered the water.

1.7.2. CTD Temperature

The same SBE3*plus* primary (T1: 03P-2333) and secondary (T2: 03P-2202) temperature sensors were used during U.S. GEOTRACES EPZT. Calibration coefficients derived from the pre-cruise calibrations were applied to raw primary and secondary sensor frequencies during each cast. Corrections for both temperature sensors were determined near the end of the cruise.

Two different SBE35RT sensors (S/N 3528706-0034 for Rinse2 through station 3/5, S/N 3516590-0011 for stations 3/6 through 37) were used as a tertiary temperature check. The sensor was located equidistant between T1 and T2 with the sensing element aligned in a plane with the T1 and T2 sensing elements. SBE35RT Digital Reversing Thermometers are internally-recording temperature sensors that operate independently of the CTD. According to the manufacturer's specifications, the typical stability for an SBE35RT sensor is 0.001°C/year.

The SBE35RT is triggered by the SBE32 carousel in response to a bottle closure. The SBE35RT sensors on EPZT were initially set to take a single reading, but after a few casts, each sensor was re-set to internally average over a more typical 4 sampling cycles (a total of 4.4 seconds).

Two independent metrics of calibration accuracy were examined. At each bottle closure, the primary and secondary temperature were compared with each other and with the SBE35RT temperature.

Both temperature sensors were first examined for drift with time, using the more stable SBE35RT as a reference. Bottles at all depths were used, but only for casts deeper than 2000 decibars. Using these casts avoided skewing the fit to the more numerous and less stable shallower bottle differences. A filter was also applied to omit high-gradient trip data by using only the T1-T2 differences within ±0.005°C.

T1 needed a first-order fit vs time; T2 required a second-order fit over time, as the differences changed most rapidly at the start of the cruise. The total offset drift over the whole cruise for either sensor was less than 0.001°C.

In order to better align deeper and shallower data, a pressure correction was applied to each temperature sensor. The polynomial fits were examined using low-gradient bottles only (T1-T2 within ±0.005°C) for all stations, and for stations deeper than 2000 decibars only.

T1 required a simple slope vs pressure, using all stations. T2 required a second-order correction vs pressure, using only stations deeper than 2000 decibars in order to pull the deepest data in-line with the shallow and intermediate-depth data.

Neither of the temperature sensors exhibited a temperature-dependent slope, or required any further adjustment vs pressure or time.

The final corrections for T1 temperature data reported on EPZT are summarized in Appendix A. Corrections to the temperature sensors had the form:

$$T1_{ITS90} = T1 + tp1 * P + t0$$

$$T2_{ITS90} = T2 + tp2 * P^2 + tp1 * P + t0$$

Residual temperature differences after correction are shown in figures 1.7.2.0 through 1.7.2.8.

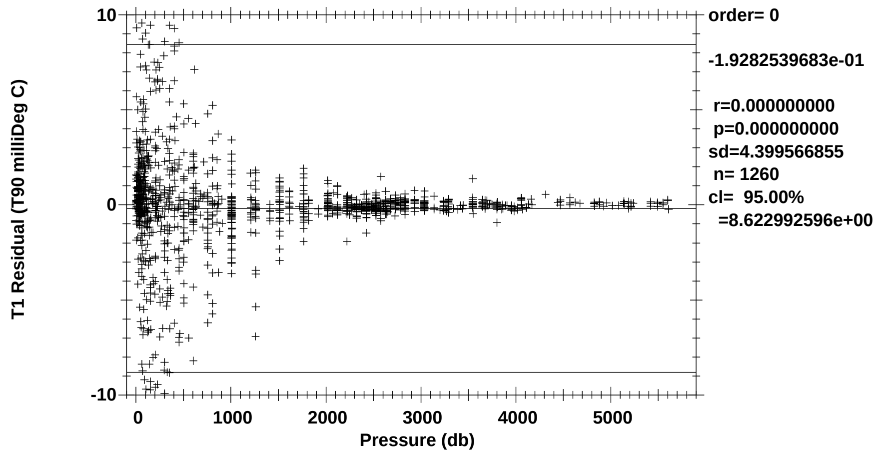


Figure 1.7.2.0 EPZT SBE35RT-T1 by pressure (-0.01°C ≤T1 – T2≤0.01°C).

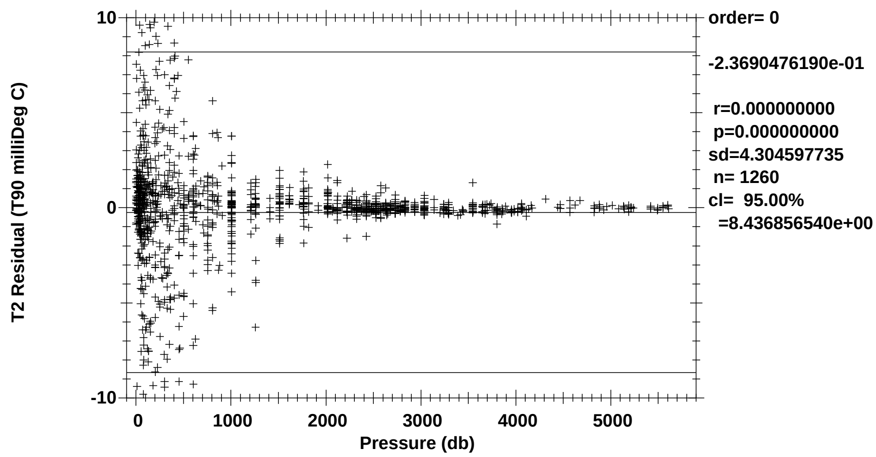


Figure 1.7.2.1 EPZT SBE35RT-T2 by pressure (-0.01°C ≤T1 – T2≤0.01°C).

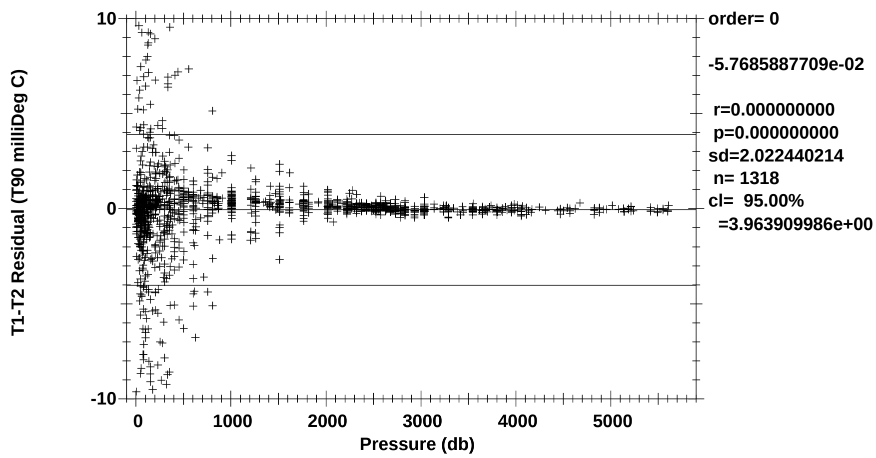


Figure 1.7.2.2 EPZT T1-T2 by pressure (-0.01°C ≤T1 – T2≤0.01°C).

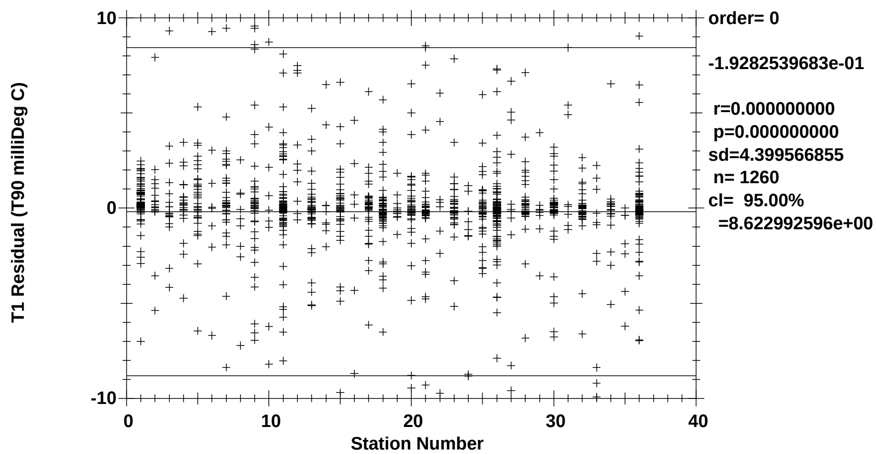


Figure 1.7.2.3 EPZT SBE35RT-T1 by station (-0.01°C ≤T1 – T2≤0.01°C).

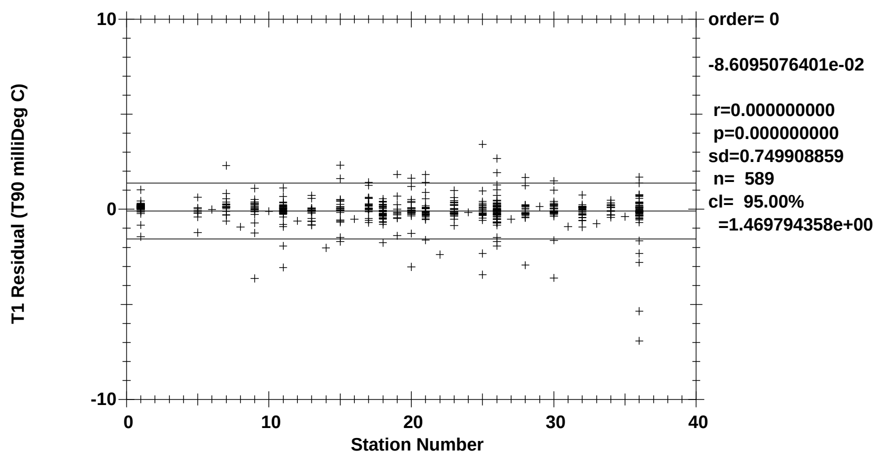


Figure 1.7.2.4 EPZT Deep SBE35RT-T1 by station (Pressure >= 1000 dbars).

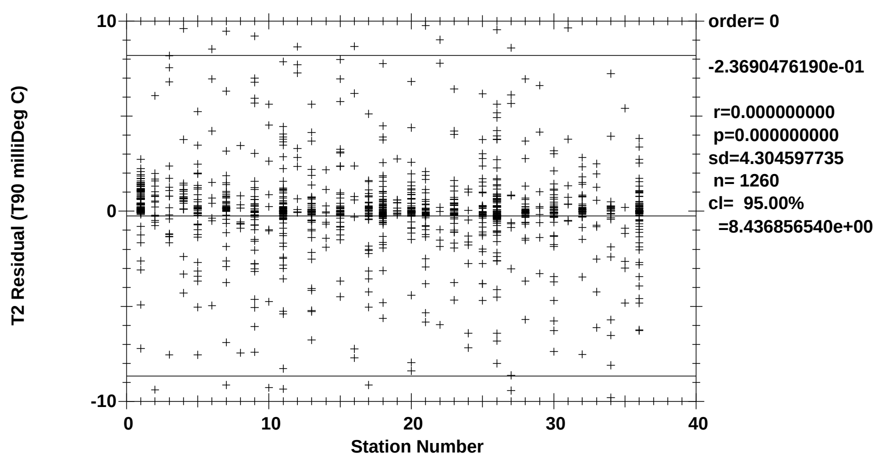


Figure 1.7.2.5 EPZT SBE35RT-T2 by station (-0.01°C ≤T1 – T2≤0.01°C).

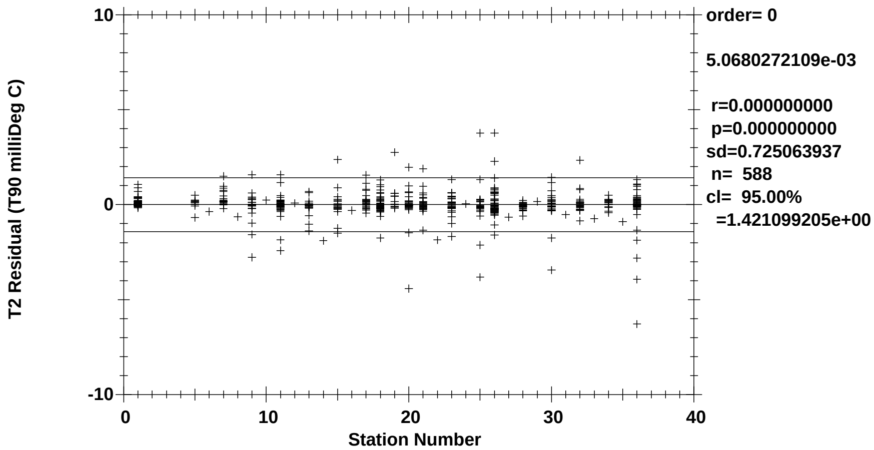


Figure 1.7.2.6 EPZT Deep SBE35RT-T2 by station (Pressure >= 1000 dbars).

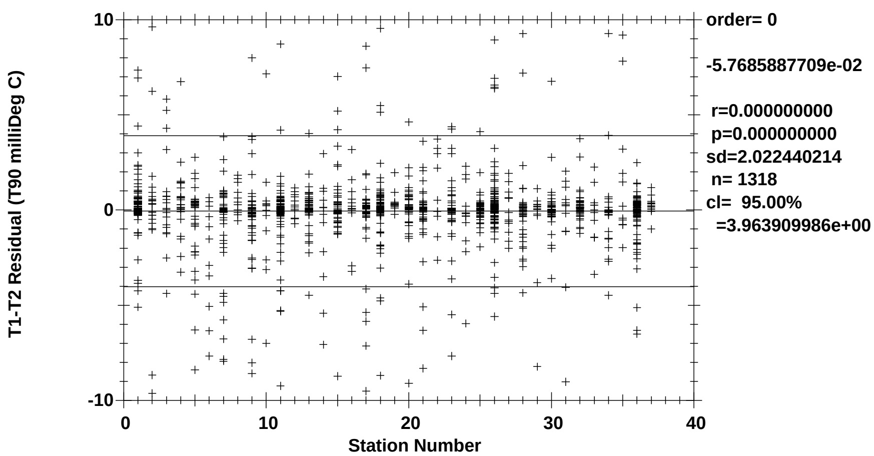


Figure 1.7.2.7 EPZT T1-T2 by station (-0.01°C ≤T1 – T2≤0.01°C).

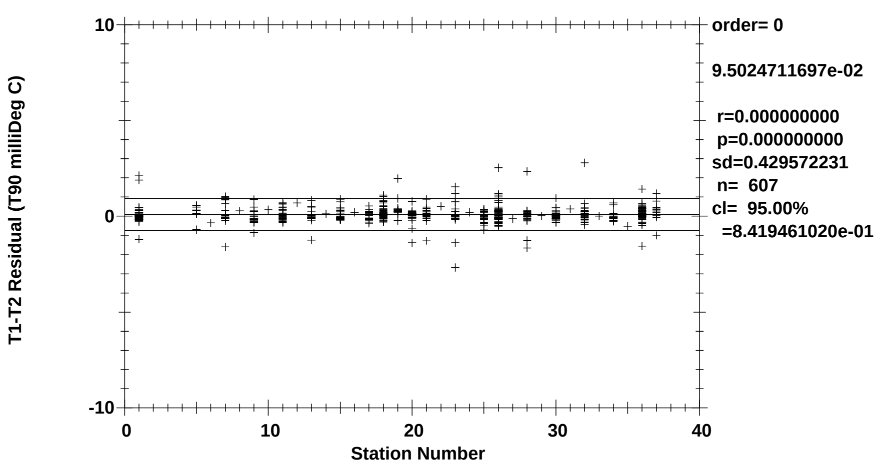


Figure 1.7.2.8 EPZT Deep T1-T2 by station (Pressure >= 1000 dbars).

The 95% confidence limits for the EPZT mean low-gradient differences are ±0.00862°C for SBE35RT – T1 and ±0.00396°C for T1 – T2. The 95% confidence limit for deep temperature residuals (where pressure > 1000 dbars) is ±0.00147°C for SBE35RT – T1 and ±0.00084°C for T1 – T2.

1.7.3. CTD Conductivity

The same SBE4C primary (C1: 04-2659) and secondary (C2: 04-3399) conductivity sensors were used for all of EPZT. Primary T/C sensor data were used to report final CTD data for all casts.

Calibration coefficients derived from the pre-cruise calibrations were applied to convert raw frequencies to conductivity. Adjustments to the default conductivity "advance" time (0.073 seconds, through the deck unit) were made while processing SBE asciihex files to half-second time-series data. An additional 0.06 seconds was used for T1/C1, and 0.04 seconds for T2/C2 data, determined from tests and plots using deep casts from stations 1 and 7.

Shipboard conductivity corrections were applied to primary and secondary conductivity data for each cast at the end of the cruise. Corrections for both CTD temperature sensors were finalized before analyzing conductivity differences.

Two independent metrics of calibration accuracy were examined. At each bottle closure, the primary and secondary conductivity were compared with each other. Each sensor was also compared to conductivity calculated from check sample salinities using CTD pressure and temperature.

Theta-Salinity comparisons showed that cast-to-cast deep CTD data were well-aligned before applying any offsets. Differences from all stations were included in the fits for conductivity corrections.

The differences between primary and secondary temperature sensors were used as filtering criteria for conductivity fits to reduce the contamination of conductivity comparisons by package wake. The coherence of this relationship is shown in figure 1.7.3.0.

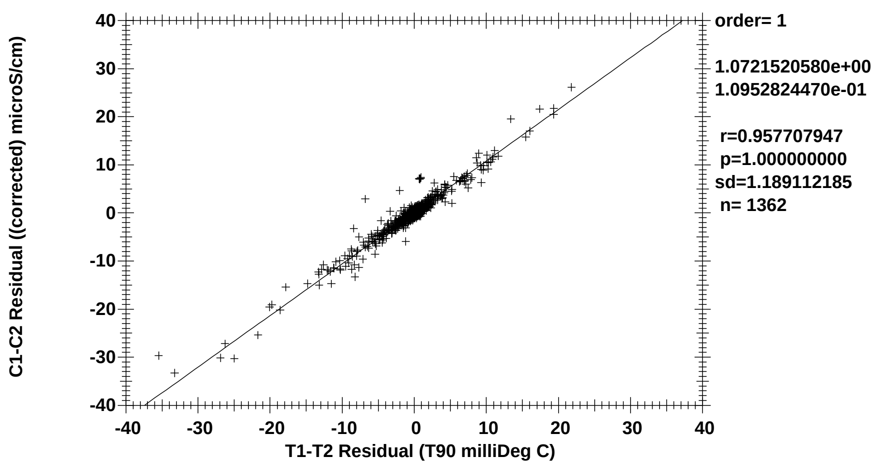


Figure 1.7.3.0 EPZT Coherence of conductivity differences as a function of temperature differences.

Uncorrected conductivity comparisons are shown in figures 1.7.3.1 through 1.7.3.3.

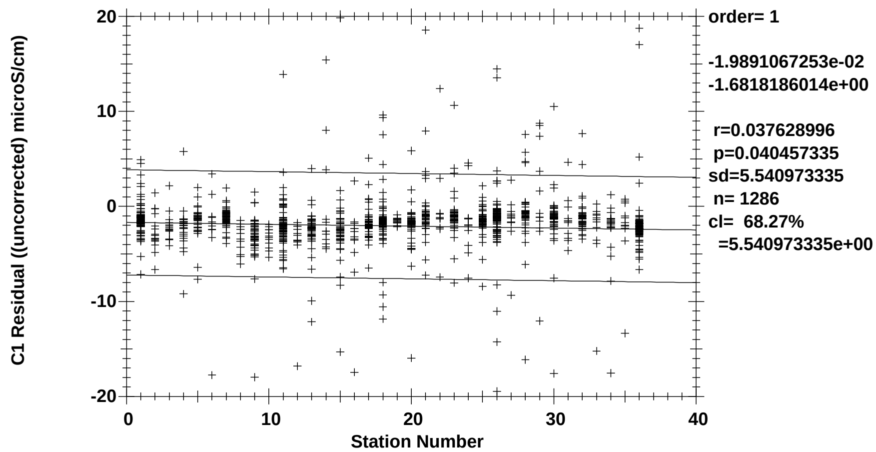


Figure 1.7.3.1 EPZT Uncorrected $C_{Bottle} - C1$ by station (-0.01°C ≤T1 – T2≤0.01°C).

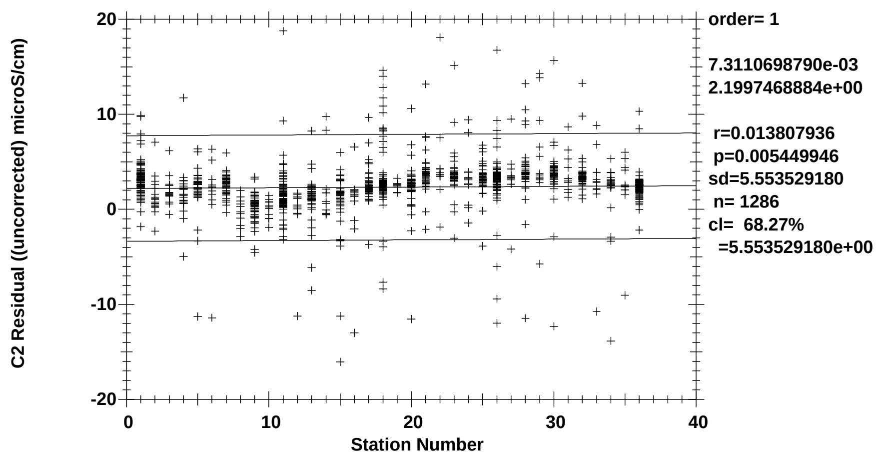


Figure 1.7.3.2 EPZT Uncorrected $C_{Bottle} - C2$ by station (-0.01°C ≤T1 – T2≤0.01°C).

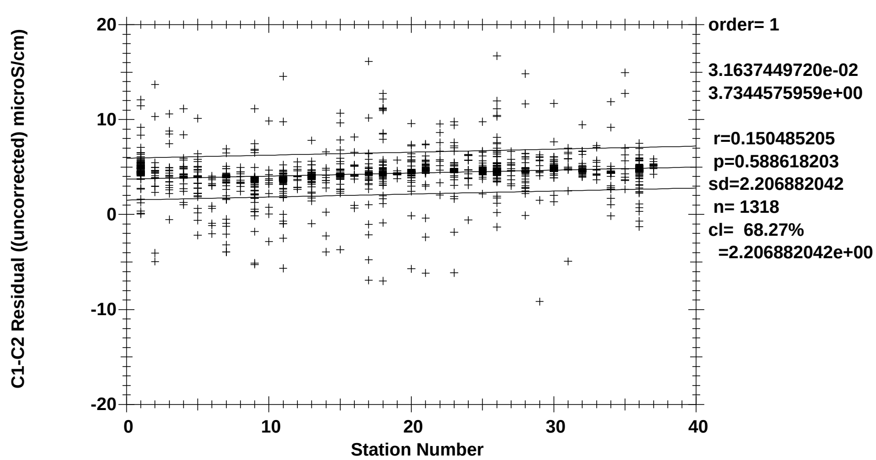


Figure 1.7.3.3 EPZT Uncorrected C1 – C2 by station (-0.01°C ≤T1 – T2≤0.01°C).

The C1 – C2 differences were fairly tight throughout the cruise, but with a definite "split" at mid-range pressures. Offsets for both C sensors were evaluated for drift with time, as well as for dependencies on pressure or conductivity, using $C_{Bottle} - C_{CTD}$ differences. The most clearly defined dependence for both sensors was conductivity, which typically shifts between pre- and post-cruise SBE laboratory calibrations.

Parabolic fits of $C_{Bottle} - C_{CTD}$ values for all trip data were applied to each conductivity sensor.

Time and pressure dependencies for C1 and C2 were then re-examined. C1 needed only a linear correction, and C2 required a parabolic correction as a function of pressure. A second-order fit was applied to C2 in order to pull in deep data without shifting the near-0 surface differences.

Both $C_{Bottle} - C1$ and $C_{Bottle} - C2$ differences shifted abruptly down, approximately -0.0015 for C1 and -0.002 for C2, between stations 7 and 8. The $C_{Bottle} - C_{CTD}$ differences drifted slowly back up over the next 3 weeks. The C1 – C2 differences were fairly stable over the entire cruise. The Theta-S comparisons of adjacent (deep) CTD casts indicated no need for adjustment to S1.

All of these factors indicated the bottle salinity data likely shifted, not the CTD data. Statistics from the salinity runs showed a fairly steady, very small (typical) drift in the standard dial over the course of the cruise. The shift between any 2 runs would result in less than a 0.0005 change in salinity. There were no notes regarding any Autosal maintenance done between stations 7/8, and the lab temperature was fairly stable through-out the cruise. The ultimate cause of the shift could not be determined.

The residual conductivity differences after correction are shown in figures 1.7.3.4 through 1.7.3.15.

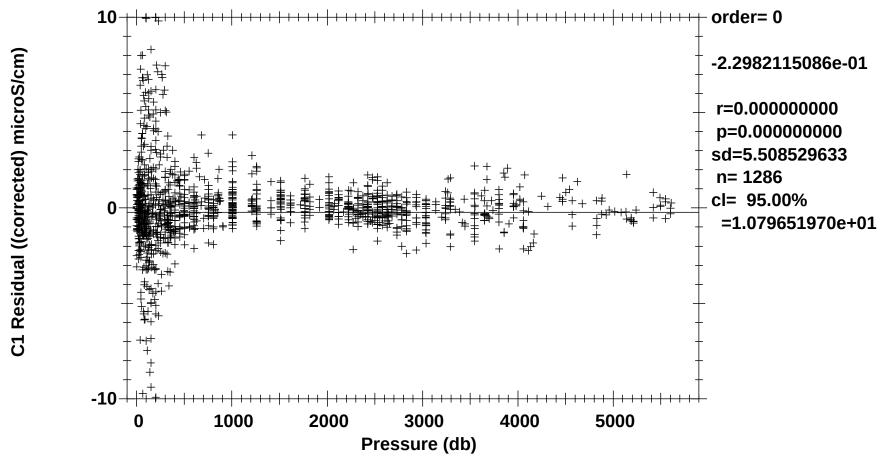


Figure 1.7.3.4 EPZT Corrected $C_{Bottle} - C1$ by pressure (-0.01°C ≤T1 – T2≤0.01°C).

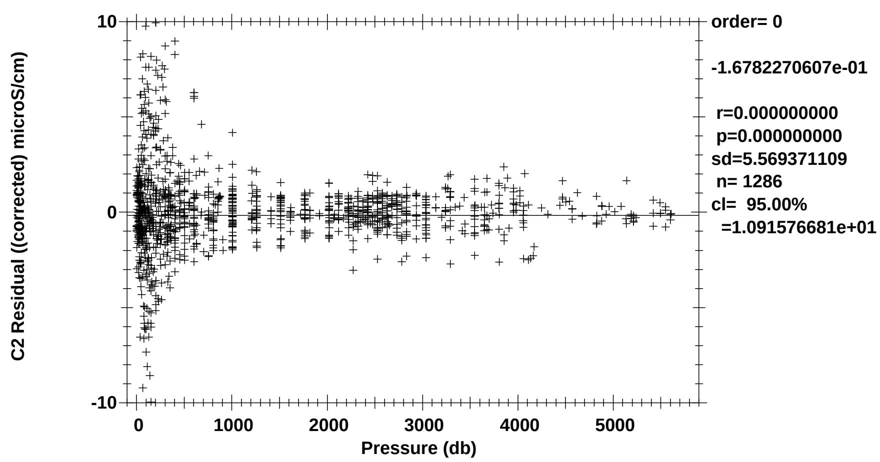


Figure 1.7.3.5 EPZT Corrected $C_{Bottle} - C2$ by pressure (-0.01°C ≤T1 – T2≤0.01°C).

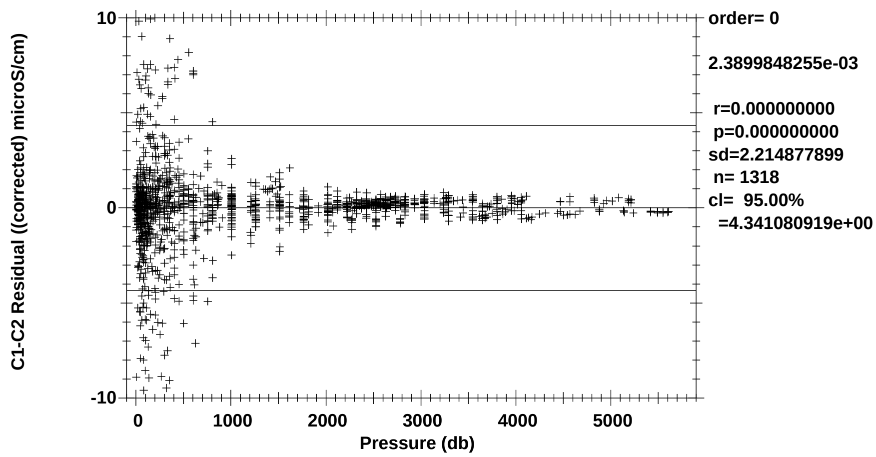


Figure 1.7.3.6 EPZT Corrected C1 – C2 by pressure (-0.01°C ≤T1 – T2≤0.01°C).

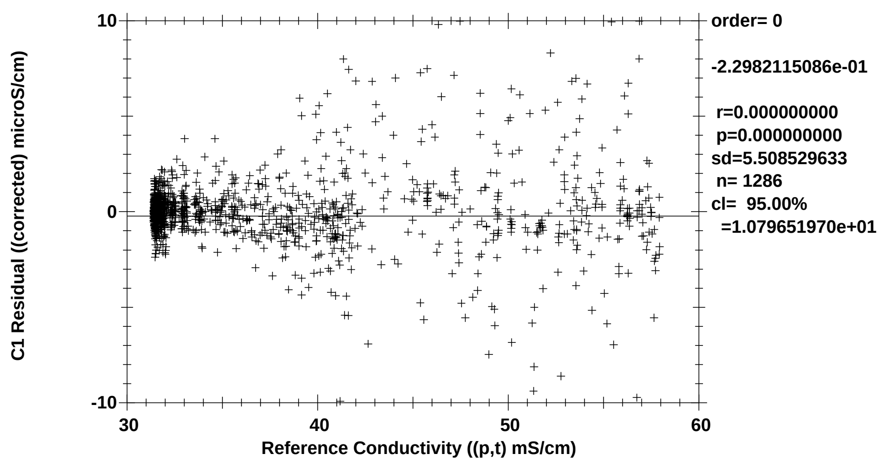


Figure 1.7.3.7 EPZT Corrected C_{Bottle} – C1 by conductivity (-0.01°C ≤T1 – T2≤0.01°C).

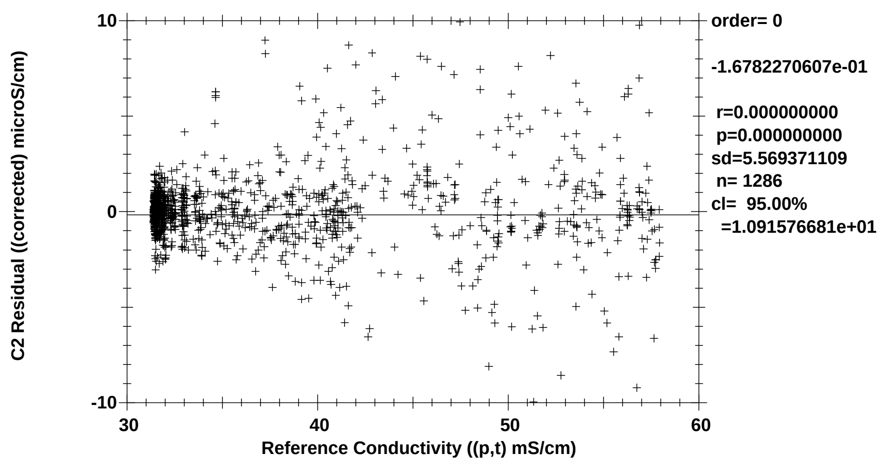


Figure 1.7.3.8 EPZT Corrected C_{Bottle} – C2 by conductivity (-0.01°C ≤T1 – T2≤0.01°C).

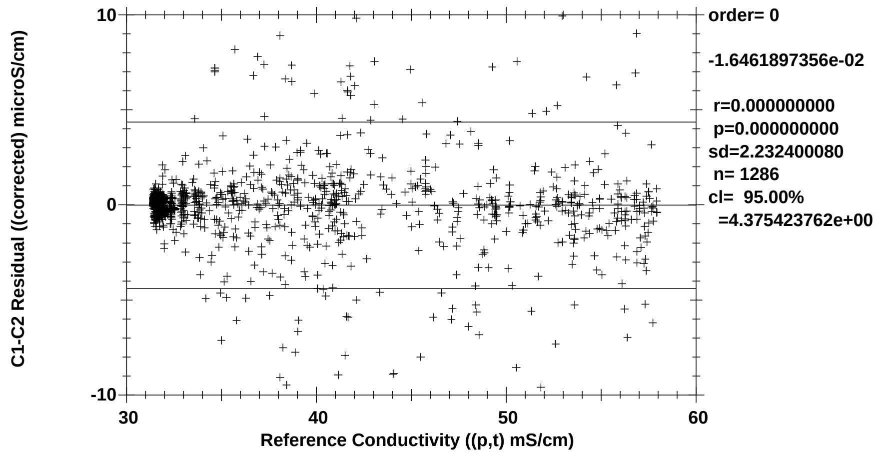


Figure 1.7.3.9 EPZT Corrected C1 – C2 by conductivity (-0.01°C ≤T1 – T2≤0.01°C).

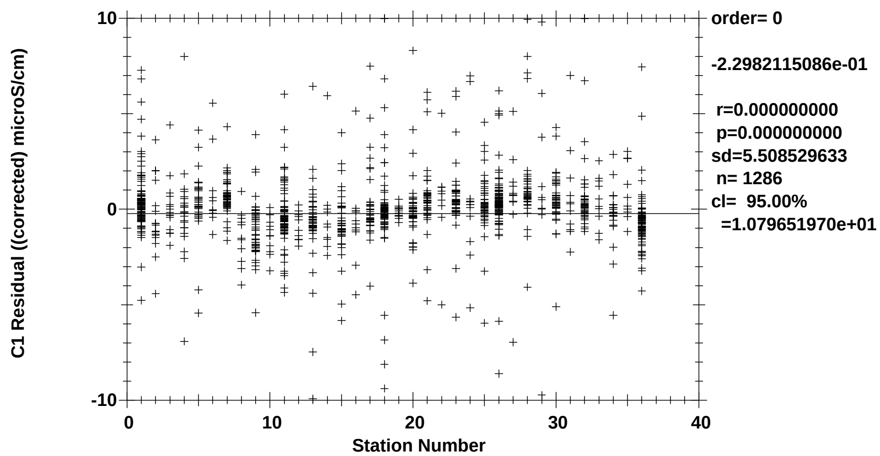


Figure 1.7.3.10 EPZT Corrected C_{Bottle} – C1 by station (-0.01°C ≤T1 – T2≤0.01°C).

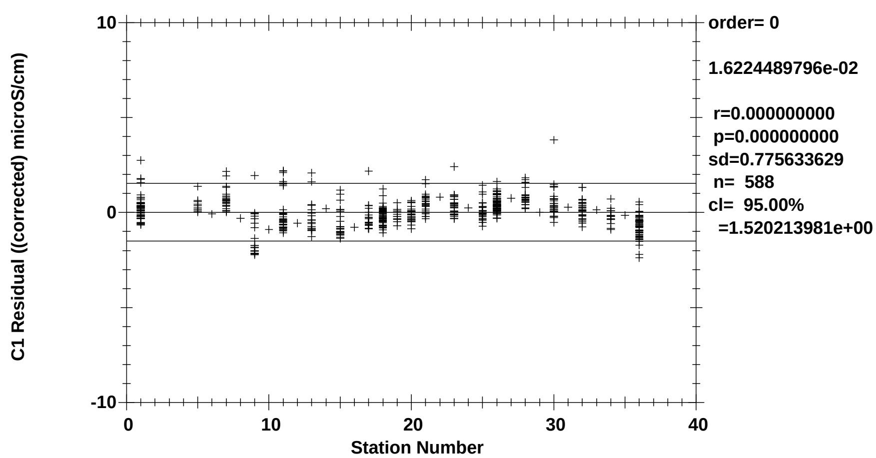


Figure 1.7.3.11 EPZT Deep Corrected C_{Bottle} – C1 by station (Pressure >= 1000 dbars).

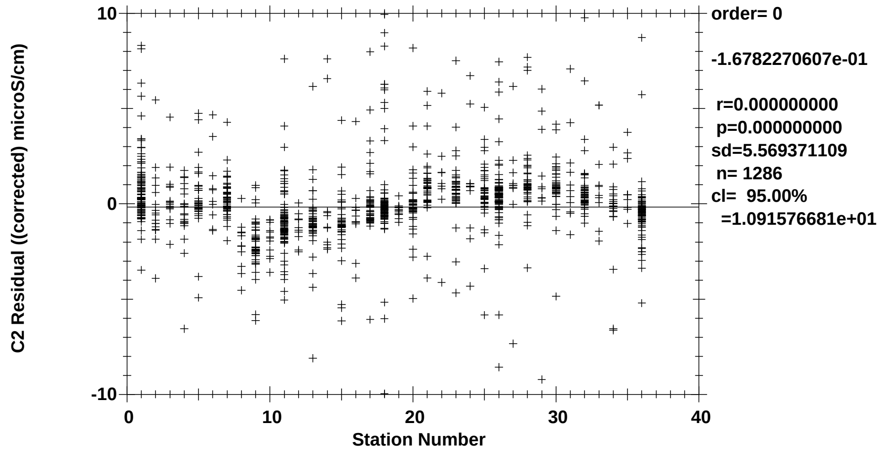


Figure 1.7.3.12 EPZT Corrected $C_{Bottle} - C2$ by station (-0.01°C ≤T1 – T2≤0.01°C).

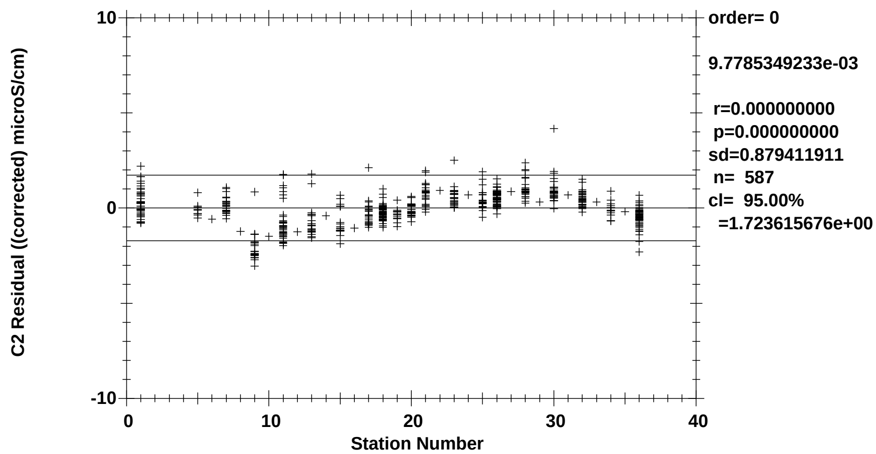


Figure 1.7.3.13 EPZT Deep Corrected $C_{Bottle} - C2$ by station (Pressure >= 1000 dbars).

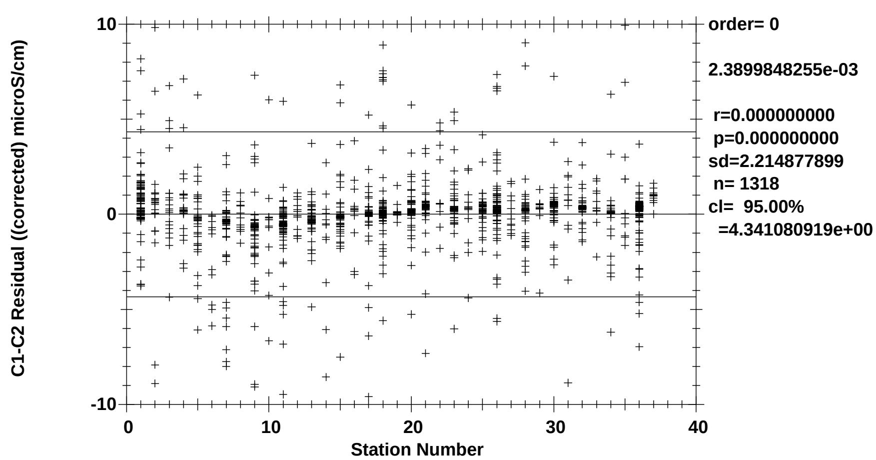


Figure 1.7.3.14 EPZT Corrected C1 – C2 by station (-0.01°C ≤T1 – T2≤0.01°C).

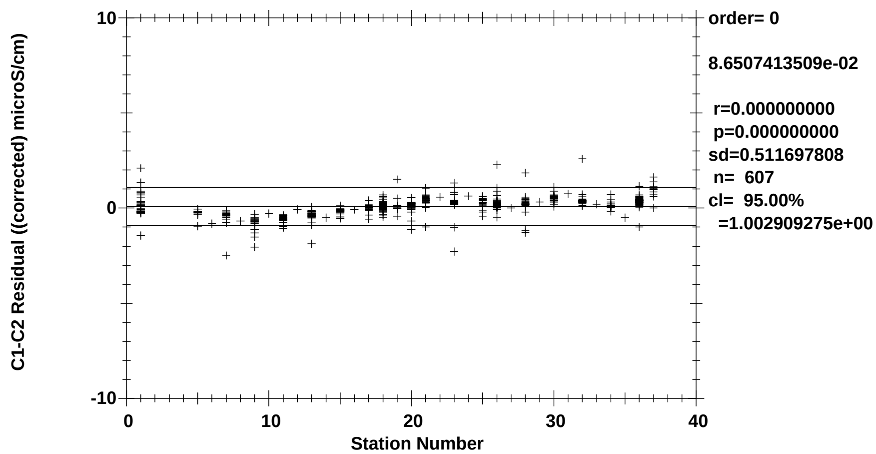


Figure 1.7.3.15 EPZT Deep Corrected C1 – C2 by station (Pressure >= 1000 dbars).

The final corrections for the sensors used on EPZT are summarized in Appendix A. Corrections made to the conductivity sensors had the form:

$$C1_{cor} = C1 + cp1 * P + c2 * C1^2 + c1 * C1 + c0$$

$$C2_{cor} = C2 + cp2 * P^2 + cp1 * P + c2 * C2^2 + c1 * C2 + c0$$

Salinity residuals after applying shipboard P/T/C corrections are summarized in figures 1.7.3.16 through 1.7.3.18. Only CTD and bottle salinity data with "acceptable" quality codes are included in the differences.

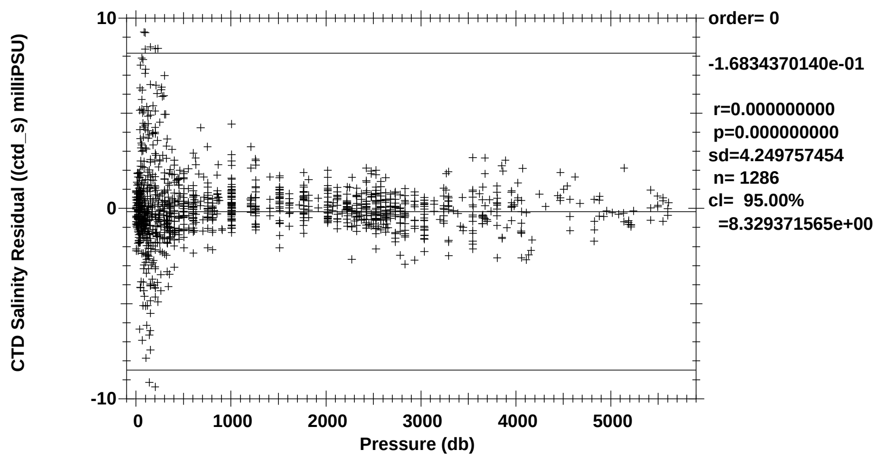


Figure 1.7.3.16 EPZT Salinity residuals by pressure (-0.01°C ≤T1 – T2≤0.01°C).

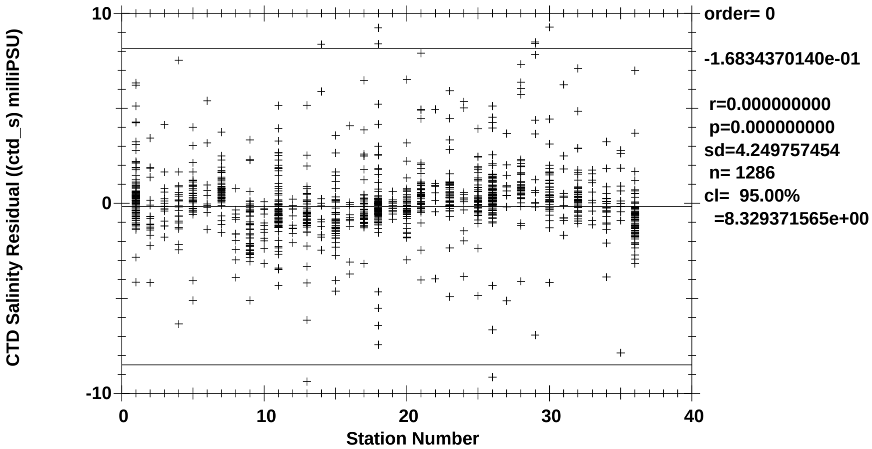


Figure 1.7.3.17 EPZT Salinity residuals by station (-0.01°C ≤T1 – T2≤0.01°C).

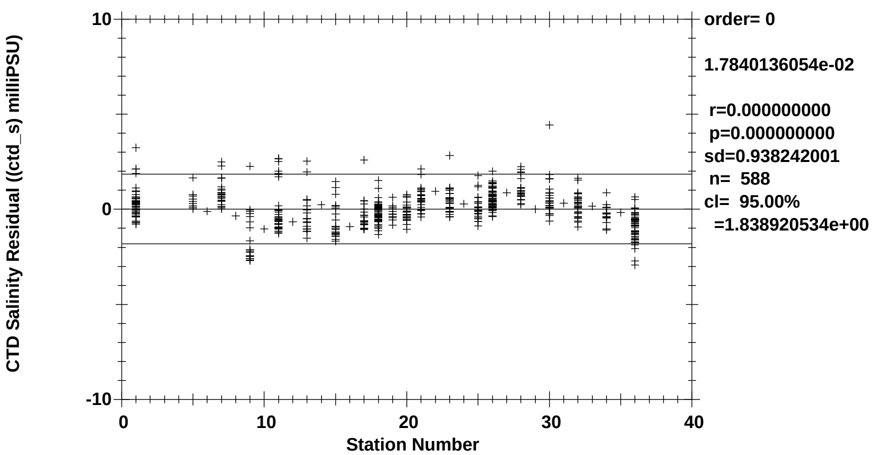


Figure 1.7.3.18 EPZT Deep Salinity residuals by station (Pressure >= 1000 dbars).

Figures 1.7.3.17 and 1.7.3.18 represent estimates of the salinity accuracy of EPZT. The 95% confidence limits are ±0.00833 relative to bottle salinities for all salinities, where T1-T2 is within ±0.01°C; and ±0.00184 relative to bottle salinities for deep salinities, where pressure is more than 1000 decibars.

1.7.4. CTD Dissolved Oxygen

A single SBE43 dissolved O_2 sensor (DO: 43-0875) was used during EPZT. This dissolved O_2 sensor was plumbed into the primary T1/C1 pump circuit after C1.

The SBE43 DO sensor was calibrated to dissolved O_2 water samples taken at bottle stops by matching the down-cast CTD data to the up-cast trip locations on isopycnal surfaces, then calculating CTD dissolved O_2 using a DO sensor response model and minimizing the residual differences from the bottle samples. A non-linear least-squares fitting procedure was used to minimize the residuals and to determine sensor model coefficients, and was accomplished in two stages.

The time constants for the lagged terms in the model were first determined for the sensor. These time constants are sensor-specific but applicable to an entire cruise. Then casts were fit individually to bottle sample data.

No bottle samples were taken in the shallower ranges of Deep and Mid casts on EPZT. Sample data from other casts at the same station or nearby stations were used in order to fit the upper parts of each deeper $CTDO_2$ cast. These bottle values were initially matched by pressure to the down-cast being fit, then adjusted shallower or deeper to maintain the original raw data "structure" of the cast. Bottle oxygen data from nearby casts with similar deep TS structure were also used to help fit CTD O_2 data for casts with one or more mis-tripped bottles.

At the end of the cruise, standard and blank values for bottle oxygen data were smoothed, and the bottle oxygen values were recalculated. The changes to bottle oxygen values were less than 0.01 ml/L for all casts.

CTDO_2 data were re-calibrated to the smoothed bottle values post-cruise. A different fitting option was used, which included both down- and up-cast CTD data. This was cumbersome when shallow bottle data from other casts had to be merged in to the fitting files; but when both down- and up-cast data were fit to match fairly closely, the down-cast fits seem to be better and more consistent than the shipboard versions. Up-cast CTDO_2 data still have inherently more noise and offsetting, due to bottle stops as well as the rosette agitating the water before the CTD sensors see it; so down-cast data are still reported for each CTDO full cast wherever possible.

Overlay plots of raw CTDO_2 voltage for all casts within a station were also used during the final fitting process to ensure the original shallow-range relationships of the casts were maintained during the fitting process. All casts within a station, as well as nearby stations, were compared on plots of Pressure and/or Theta vs O_2 to verify consistency over the course of EPZT.

Final CTDO_2 "trip" data were first updated into the bottle database the usual way, using pressure-series down-cast data. This generated some large bottle-CTD differences, especially in higher-gradient areas, on final check-plots. Out of curiosity, time-series CTDO_2 data were updated into the database, with the same "down-and-up" option used during fitting. This inserted the time-series up-cast CTDO data into the database for most casts. The Deep "corer" casts were an exception, instead using down-cast time-series data, because of software "hanging" at the corer sample (sample 13 or 14), with a database "pressure" deeper than the CTD cast itself.

These mostly up-cast CTDO_2 data generated a bottle-CTD standard deviation one-third the size of the original update method, particularly because of better matches in higher-gradient near-surface areas. A few remaining differences were double-checked, resulting in several re-fits of CTDO_2 data to bottles in near-surface areas. In addition, down-cast pressure-series data were still used for the CTDO_2 values in the database for several casts (1/4 1/11 1/13 1/15 3/5 3/7 5/4 36/8) in order to prevent bottom-of-cast "drifty" up-cast data from skewing the results.

Final CTD dissolved O_2 residuals for SIO/ODF casts are shown in figures 1.7.4.0-1.7.4.2.

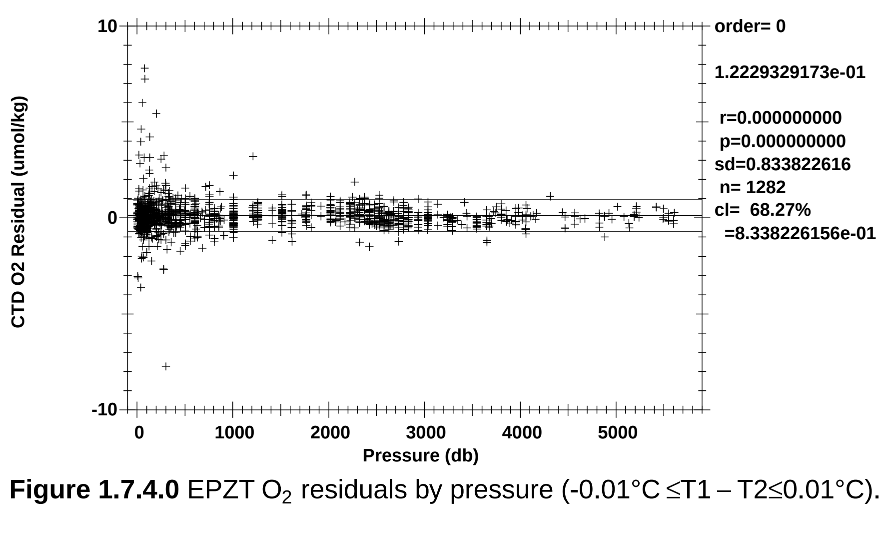


Figure 1.7.4.0 EPZT O_2 residuals by pressure (-0.01°C ≤T1 – T2≤0.01°C).

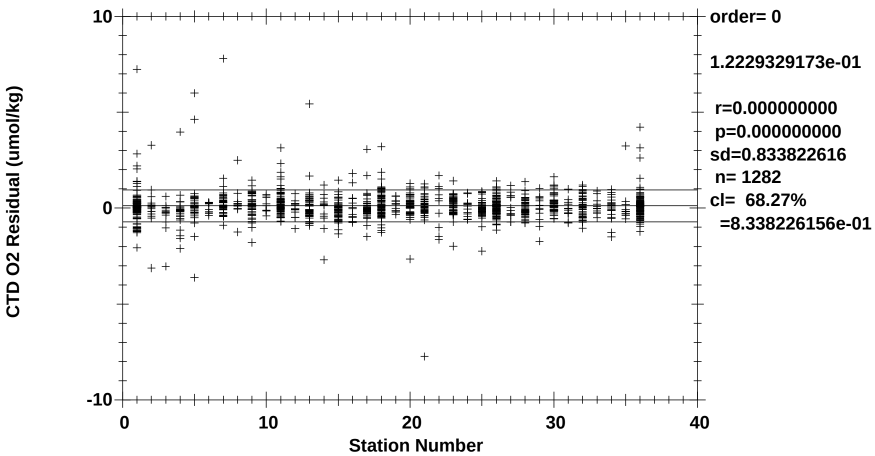


Figure 1.7.4.1 EPZT O_2 residuals by station (-0.01°C ≤T1 – T2≤0.01°C).

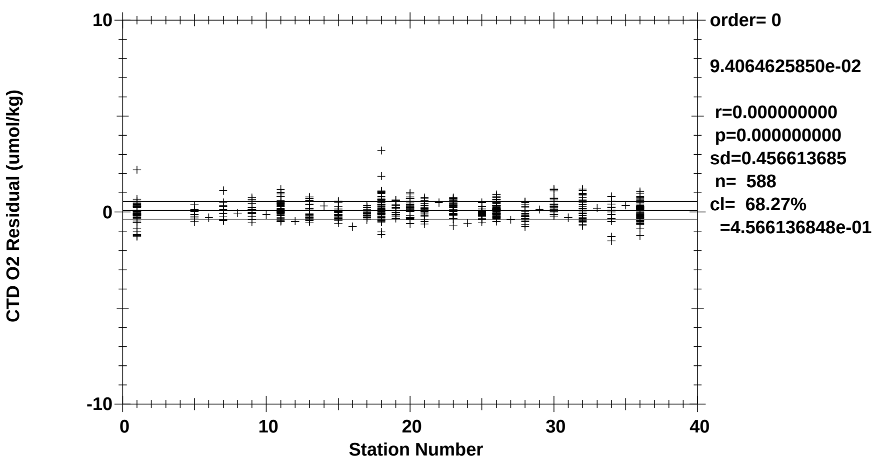


Figure 1.7.4.2 EPZT Deep O_2 residuals by station (Pressure >= 1000 dbars).

The standard deviations of 0.834 μmol/kg for all oxygens and 0.457 μmol/kg for deep oxygens are only presented as general indicators of goodness of fit. SIO/STS makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the SIO/STS DO sensor response model equation for Clark-style cells follows Brown and Morrison [Brow78], Millard [Mill82] and Owens & Millard [Owen85]. SIO/STS models DO sensor responses with lagged CTD data. *In situ* pressure and temperature are filtered to match the sensor responses. Time constants for the pressure response (τ_p), a slow (τ_{Tf}) and fast (τ_{Ts}) thermal response, package velocity (τ_{dP}), thermal diffusion (τ_{dT}) and pressure hysteresis (τ_h) are fitting parameters. Once determined for a given sensor, these time constants typically remain constant for a cruise. The thermal diffusion term is derived by low-pass filtering the difference between the fast response (T_s) and slow response (T_l) temperatures. This term is intended to correct non-linearities in sensor response introduced by inappropriate analog thermal compensation. Package velocity is approximated by low-pass filtering 1st-order pressure differences, and is intended to correct flow-dependent response. Dissolved O_2 concentration is then calculated:

$$O_2ml/L = [C_1 \cdot V_{DO} e^{(C_2 \cdot \frac{P_h}{5000})} + C_3] \cdot f_{sat}(T,P) \cdot e^{(C_4 \cdot T_l + C_5 \cdot T_s + C_7 \cdot P_l + C_6 \cdot \frac{dO_c}{dt} + C_8 \cdot \frac{dP}{dt} + C_9 \cdot dT)} \qquad (1.7.4.0)$$

where:

O_2ml/L	Dissolved O_2 concentration in ml/L;
V_{DO}	Raw sensor output;
C_1	Sensor slope
C_2	Hysteresis response coefficient
C_3	Sensor offset
$f_{sat}(T,P)$	O_2 saturation at T,P (ml/L);
T	*in situ* temperature (°C);
P	*in situ* pressure (decibars);
P_h	Low-pass filtered hysteresis pressure (decibars);
T_l	Long-response low-pass filtered temperature (°C);
T_s	Short-response low-pass filtered temperature (°C);
P_l	Low-pass filtered pressure (decibars);
$\frac{dO_c}{dt}$	Sensor current gradient (μamps/sec);
$\frac{dP}{dt}$	Filtered package velocity (db/sec);
dT	low-pass filtered thermal diffusion estimate (T_s - T_l).
$C_4 - C_9$	Response coefficients.

T values and coefficients used to generate the SBE43 data (ml/L) for each cast are listed in Appendix B. CTD O_2 ml/L data are converted to μmol/kg units on demand.

Manufacturer information on the SBE43 DO sensor, a modification of the Clark polarographic membrane technology, can be found at *http://www.seabird.com/application_notes/AN64.htm*.

A faster-response JFE Advantech Rinko III ARO-CAV Optical DO sensor (S/N 105), with its own oxygen temperature thermistor and not pumped, was installed on the rosette and integrated with the ODF CTD during all casts. ODF is currently evaluating this sensor, comparing its data with the SBE43 data from a recent CLIVAR cruise and considering its possible use as a primary sensor on future expeditions. Please contact ODF (odfdata@sts.ucsd.edu) for further information. Manufacturer information about the Rinko III sensor can be found at *http://www.jfe-advantech.co.jp/eng/ocean/rinko/rinko3.html*.

1.8. Rosette Bottle Sampling

After each rosette deployment except station 37, water samples were drawn from the bottles as follows:

Table 1.8.0 ODF/30L-Niskin Cast Sampling Order

		Demi	Volcano (19)	Super / Full / Hemi / Shelf				Super Only Pu *et.al* 2 Shallow/ 2 Deep	All (exc.19) "Super-GeoFish" Surface
Parameters Sampled	**‡**	**Shallow**	**Deep**	**Shallow**	***Mid**	***Deep**	****Th/Ra Pigments Shallow**		
CFCs	U	x		x	x	x	x (surface)		
He and other Noble Gases	U	x	x	x	x	x	x (surface)		
N_2 / Ar	U	x		x	x	x			
O_2	U	x	x	x	x	x	x	x	
N_2O	U			x**	x	x			
Total Diss. Mn / Al / Fe	U		x		x (21)	x (18,20,21)			x
DIC	U	x		x	x	x	x (surface)		
^{14}C / ^{13}C	U			x	x	x	x (surface)		
Nutrients	U	x	x	x	x	x	x	x	x
Salinity	U	x	x	x	x	x	x	x	x
^{3}H	U	x		x	x	x	x (surface)		
Pigments	U						x		
^{234}Th	U	x		x (34)			x		
^{226}Ra	U						x		
DOC	F	x		x	x	x			x
d ^{15}N-NO_2	F			x	x	x			
d ^{15}N-NO_3	F			x	x	x			
Thiols	F			x**	x	x**			x
Si Isotopes	F			x**	x	x**			
Th / Pa	F			x	x	x			x
Nd / REE	F			x	x	x			x
Pb / Po	F							x	x (Super)
Pu/Np/Cs/Sr	F							x	x (Super)
^{129}I / ^{236}U	F							x	x (Super)
NIOZ Corer	U					x (4-17,20-36)			
Wax Corer	U					x (18)			

‡ U (unfiltered) or F(filtered) sample
* Deep, and Mid, if warranted by station’s multibeam depth.
** Not done/sampled on Hemi station 34.

SIO/ODF 30L Niskin serial numbers were assigned at the start of EPZT, typically corresponding to their rosette/carousel positions. Aside from various repairs along the way, one ODF 30L Niskin was changed out during this leg: NIS-2 was replaced by NIS-22 between stations 17 and 18 due to a spine leak.

Table 1.8.1 GT-C/12L-GoFlo Cast Sampling Order						
Station Type		**Demi**	**Super / Full / Hemi / Shelf**			**All Super-GeoFish**
Parameters Sampled	**‡**	**Shallow**	**Shallow**	**Mid***	**Deep***	**Surface**
"Acropak" bottles:						
Nutrients (ODF)	U	x	x	x	x	x
Salinity (ODF)	U	x	x	x	x	x
Total Diss. Al / Mn / Fe (Resing)	U			x	x	
d ^{15}N-NO_3 (Casciotti)	F	x				x
d ^{15}N-NO_2 (Casciotti)	F	x				x
diss. Al (Resing)	F	x	x	x	x	x
diss. Mn (Resing)	F	x	x	x	x	x
Co (Saito)	F	x	x	x	x	x
Ga / Ba / V / Mo (Shiller)	F	x	x	x	x	x
diss. Fe(II) Acropak (Moffett)	F		x	x	x	
Total diss. Fe (Moffett)	F		x (34,36)	x (36)	x (36)	x (36)
diss. Fe (Sedwick)	F		x	x	x	x
Cu speciation (Barbeau)	F		x	x	x	x
Fe speciation (Buck)	F		x	x	x	x
diss. Trace Metals (Bruland)	F	x	x	x	x	x
diss. Trace Metals (Wu)	F		x	x	x	x
Colloids (Wu)	F		x	x	x	x
Pb / Po (Flegal - shallow)	F	x	x	x	x	x
Pb / Po (Boyle - mid / deep)	F	x	x	x	x	x
Fe / Zn / Cd Isotopes (John)	F		x	x	x	x
Diss. Trace Metals (Bruland)	U					x
"Particulate Membrane" bottles:						
TDS (Cutter)	F	x	x	x	x	
I (Cutter)	F	x	x	x	x	x
diss. Fe(II) MOPS (Sta.1 only) or diss. Fe(II) Syringe (Moffett)	F	x	x	x	x	
Nutrients (ODF)	U	x	x	x	x	x
Salinity (ODF)	U	x	x	x	x	x
Phytoplankton (Twining) - Surface and DCM only	U	x	x			x
MMHg / DMHg / Elemental Hg (Hammerschmidt/Lamborg)	F	x	x	x	x	
Total Hg (Lamborg/Hammerschmidt)	F	x	x	x	x	x
NanoMolar Nutrients (Cutter)	F		x			x
As / Sb (Cutter)	F		x	x	x	x
Se (Cutter)	F		x	x	x	x
Partic./Cellular TM (Twining - shallow, Sherrell/German - mid/deep)	F	x	x	x	x	

‡ U (unfiltered) or F(filtered) sample
* Deep, and Mid, if warranted by station's multibeam depth.

GT-C 12L Goflo serial numbers were assigned prior to the cruise, and were intentionally moved around to various carousel positions over the course of the expedition.

The correspondence between individual sample containers and the rosette bottle position from which the sample was drawn was recorded on the sample log for each cast. These bottle positions were numbered 1-12 for the ODF/30L Niskin Rosette, 13 for NIOZ mono-corer samples, 14 for wax corer samples, 25 for GeoFish surface samples and 1-24 for the GT-C/GoFlo Rosette. The sample log also included any comments or anomalous conditions noted about the rosette and bottles.

Normal sampling practice for the 30L Niskin rosette included opening the drain valve and then the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g. "lanyard caught in lid", "valve left open"), which might later prove useful in determining sample integrity, were routinely noted on the sample log.

Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles.

Once individual samples had been drawn and properly prepared, they were distributed for analysis. Oxygen, nutrient and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to the data processing computer for centralized data management.

Bottle Tripping Issues

The bottles in the table below did not close or were determined to be mistrips, usually by nutrient and dO_2 or dFe chemists, who analyzed and uploaded samples shortly after the casts were completed.

Individual mis-tripped bottles and all samples taken from them were quality-coded 4 (bad), since it is not clear exactly where they closed in the water column. More detailed comments appear in Appendix C.

Table 1.8.2 Bottle Mistrips or Closure Problems

Station	Sample	Bot.Ser.No.	GEOT.No.	Comment
2	501-504	NIS-1-NIS-4	2281-2284	Niskin did not close.
2	512	NIS-12	2292	Niskin closed, but no samples taken.
3	504,512	NIS-4,NIS-12	2313,2321	Niskin did not close.
3	704	NIS-4	2334	Niskin did not close.
3	710	NIS-10	2340	Niskin did not close.
3	712	NIS-12	2342	Niskin did not close.
4	206	NIS-6	2373	Mistrip
5	520	GF-46	2478	Goflo did not fire
6	120	GF-46	3096	Goflo did not fire
7	814	GF-18	3210	Mistrip
7	1212	NIS-12	3266	Niskin did not close.
11	1310	NIS-10	3679	Niskin did not close (lanyard).
13	119-120	GF-02,GF-31	3759-3760	Mistrip
17	105	GF-05	8258	Mistrip
17	107	GF-07	8260	Mistrip; bottom ball leaked, snapped in van.
17	120	GF-20	8273	Mistrip
17	505	GF-47	8314	Mistrip
17	803	GF-47	8361	Mistrip
17	820	GF-46	8378	Spigot broke off, no samples taken.
18	201	GF-48	8410	Mistrip
18	207	GF-51	8416	Mistrip, re-snapped top ball in van.
18	221	GF-47	8430	Mistrip
23	609	NIS-9	9055	Niskin did not close, lanyard caught on latch.
28	806-807	GF-05,GF-28	9670-9671	Mistrip
30	806	GF-05	9815	Mistrip

1.9. SIO/STS Bottle Data Processing

Water samples collected and properties analyzed shipboard were centrally managed in a relational database (PostgreSQL 8.1.23) running on a CentOS-5.9 Linux system. A web service (OpenACS 5.5.0 and AOLServer 4.5.1-1) front-end provided ship-wide access to CTD and water sample data. Web-based facilities included on-demand arbitrary property-property plots and vertical sections as well as data uploads and downloads.

The pressure at which each sample was tripped was marked by the CTD acquisition program for each group. A 3-second average of ODF-processed CTD trip data was loaded into the bottle database after each ODF/30L and GT-C/GoFlo cast. After ODF/30L CTD Oxygen corrections were determined, corrected CTDO values were also added to the database.

At the end of the cruise, all GT-C CTDO data were updated in the database using the post-cast Seasave-processed ".btl" file 5-second averaged CTD data, in order to include processed CTD Oxygen values. The 5-second average used resulted in slightly better agreement between CTD and GoFlo salinity values than the shorter 3-second average used for the Niskin rosette.

The sample log and any diagnostic comments were entered into the database once sampling was completed. Quality flags associated with sampled properties were set to indicate that the property had been sampled, and sample container identifications were noted where applicable (e.g., oxygen flask number).

Analytical results were provided on a regular basis by SIO/STS and other analytical groups during and at the end of the cruise, then incorporated into the database. These results included a quality code associated with each measured value and followed the coding scheme developed for the World Ocean Circulation Experiment Hydrographic Programme (WHP) [Joyc94]. In addition, non-standard quality codes "A" and "B" were used for several properties where the analysts desired to mark them as "Above" or "Below" detection limits for the analysis methods used.

Table 1.9.0 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each SIO/STS hydrographic property reported:

Table 1.9.0 Frequency of WHP quality flag assignments for STS/ODF Samples, Stations 1-37

	Reported levels	WHP Quality Codes 1	2	3	4	5	7	9
ODF/30L Casts:								
Bottle	1372	0	1346	0	13	0	0	13
Refc. Temp	1351	0	1292	59	0	0	0	21
CTD Oxy	1372	0	1371	1	0	0	0	0
CTD Salt	1372	0	1372	0	0	0	0	0
Oxygen	1341	0	1335	4	2	1	0	30
Salinity	1347	0	1339	7	1	0	0	25
Silicate	1347	0	1346	0	1	0	0	25
Nitrate	1347	0	1346	0	1	0	0	25
Nitrite	1347	0	1346	0	1	0	0	25
Phosphate	1347	0	1346	0	1	0	0	25
GT-C and Super-GeoF Casts*:								
Bottle	1743	0	1725	1	16	0	0	1
CTD Oxy	1612	0	1612	0	0	96	0	35
CTD Salt	1743	0	1743	0	0	0	0	0
Salinity	1739	0	1688	28	23	1	0	3
Silicate	1738	0	1721	2	15	2	0	3
Nitrate	1738	0	1721	2	15	2	0	3
Nitrite	1738	0	1721	2	15	2	0	3
Phosphate	1738	0	1723	0	15	2	0	3

* CTD Oxy and CTD Salt for GT-C casts are from Seasave-processed bottle files

Various consistency checks and detailed examination of the data continued throughout the cruise. Data investigation comments are presented in Appendix C.

1.10. Salinity

Equipment and Techniques

A single Guildline Autosal 8400B salinometer (S/N 69-180) located in the hydro lab was used for all salinity measurements. This salinometer had been modified to include a communication interface for computer-aided measurement, a higher capacity pump and two temperature sensors. These sensors were used to measure air and bath temperatures.

Samples were analyzed after they had equilibrated to laboratory temperature, usually within 12-29 hours after collection. The salinometer was standardized for each group of analyses, 36 to 72 samples, using two fresh vials of standard seawater per group.

Salinometer measurements were aided by a computer using LabVIEW software developed by SIO/STS. The software maintained a log of each salinometer run, including salinometer settings and air and bath temperatures. The air temperature was displayed and monitored using a 48-hour strip-chart in order to observe cyclical changes. The program also guided the operator through the standardization procedure and making sample measurements. The analyst was prompted to change samples and flush the cells between readings.

Normal standardization procedures included flushing the cell at least 2 times with a fresh vial of IAPSO Standard Seawater (SSW), setting the flow rate as low as possible during the last fill, and monitoring the STD dial setting. If the STD dial changed by 10 units or more since the last salinometer run (or during standardization), another vial of SSW was opened and the standardization procedure was repeated to verify the setting.

Samples were run using 2 flushes before the final fill. The computer determined the stability of a measurement and prompted for additional readings if there appeared to be drift. The operator could annotate problems in the salinometer log, and routinely added comments about cracked sample bottles, loose thimbles, salt crystals, sample volume or anything unusual about the sample or analysis.

Cases of samples were stacked next to the Autosal while equilibrating to room temperature. The temperature of the deepest sample (coldest) and surface sample (warmest) were monitored to determine when the case was ready to be analyzed.

Sampling and Data Processing

Salinity Measurements Made During GEOTRACES EPZT	
Cast Type	Number of Samples
30-ODF	1347
GT-C + Super-GeoF	1739
McL-Prof Niskins	204
Underway (mid-GeoF + Th)	80
Lost Samples	1
Total Salinity Samples	3371

Salinity samples were drawn into 200 ml Kimax high-alumina borosilicate bottles, which were rinsed three times with the sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and kept closed with Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Prior to sample collection, inserts were inspected for proper fit and loose inserts replaced to insure an airtight seal. The draw and equilibration times were logged for all casts. Laboratory temperatures were logged at the beginning and end of each run.

PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The difference between the initial vial of standard water and the next one run as an unknown was applied as a linear function of elapsed run time to the measured ratios. The corrected salinity data were then incorporated into the cruise database.

Data processing included double checking that the station, sample and box number had been correctly assigned, and reviewing the data and log files for operator comments. The salinity data were compared to CTD salinities and were used for shipboard sensor calibration.

Laboratory Temperature

The salinometer water bath temperature was maintained slightly higher than ambient laboratory air temperature at 21 °C. The ambient air temperature varied from 17 to 25 °C during the cruise.

There were occasional temperature spikes or drops that brought the room temperature outside of the acceptable range of the bath temperature. At these times, or when room temperature was not holding steady, an analysis run would be delayed until room temperature had again stabilized near bath temperature.

Standards

IAPSO Standard Seawater (SSW) Batch P-155 was used to standardize all runs. 132 bottles of SSW were used during U.S. GEOTRACES EPZT.

1.11. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an SIO/STS/ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC LabVIEW software developed by SIO/STS. Thiosulfate was dispensed by a Dosimat 876 buret driver fitted with a 1.0 mL buret. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson *et al.* [Culb91], but with higher concentrations of potassium iodate standard (~0.012N) and thiosulfate solution (~55 gm/L). Pre-made liquid potassium iodate standards and reagent/distilled water blanks were run at least every other day, and when a change in reagents required it to account for the presence of oxidizing or reducing agents.

Sampling and Data Processing

Oxygen Measurements Made During GEOTRACES EPZT	
Cast Type	Number of Samples
30-ODF Lost Samples	1341 1
Total Oxygen Samples	1342

Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Two different 24-flask cases were alternated by cast to minimize flask calibration issues, if any. Using a Tygon and silicone drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed 3 times with minimal agitation, then filled and allowed to overflow for at least 3 flask volumes. The sample drawing temperatures were measured with an electronic resistance temperature detector (RTD) embedded in the drawing tube. These temperatures were used to calculate µmol/kg concentrations, and as a diagnostic check of bottle integrity. Reagents ($MnCl_2$ then NaI/NaOH) were added to fix the oxygen before stoppering. 2g/L of sodium azide was added to the NaI/NaOH mixture for samples on stations 1-14 in order to counteract interference from high nitrite levels. The flasks were shaken twice (10-12 inversions each time) to assure thorough dispersion of the precipitate: once immediately after drawing, and then again after about 20 minutes.

The samples were analyzed within 18 hours of collection, and the data were incorporated into the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The thiosulfate normalities and blanks were monitored for possible drifting or problems when new reagents were used.

Bottle oxygen data were reviewed, ensuring station, cast, bottle number, flask, and draw temperature were entered properly. Any comments made during analysis were also reviewed, making certain that any anomalous actions were investigated and resolved.

After the data were uploaded to the database, oxygen was graphically compared with CTD oxygen and adjoining stations. Any suspicious-looking points were reviewed and comments were made regarding the final outcome of the investigation. These investigations and final data coding are reported in Appendix C.

Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This was done once before using flasks for the first time and periodically thereafter when a suspect volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Standards

Liquid potassium iodate standards were prepared in 6 liter batches and bottled in sterile glass bottles at ODF's chemistry laboratory prior to the expedition. The normality of the liquid standard was determined by calculation from weight. The standard was supplied by Alfa Aesar (lot B05N35) and has a reported purity of 99.4-100.4%. All other reagents were "reagent grade" and were tested for levels of oxidizing and reducing impurities prior to use.

1.12. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate+nitrite, nitrite) were performed on a Seal Analytical continuous-flow AutoAnalyzer 3 (AA3).

The analytical methods used are described by Gordon *et al.* [Gord92] Hager *et al.* [Hage68] and Atlas *et al.* [Atla71].

Silicate

Silicate was analyzed using the technique of Kirkwood *et al.* [Kirk89]. An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid, which was then reduced to a silicomolybdenum blue complex following the addition of ascorbic acid. Oxalic acid was also added to impede PO_4 color development. The sample was passed through a flowcell and the absorbance measured at 660nm.

Reagents

Oxalic Acid (ACS Reagent Grade)

14.8g oxalic acid dissolved in DW and diluted to 1 liter volume. Stored at room temperature in a polypropylene bottle.

Ammonium Molybdate

14.8g Ammonium Molybdate Tetrahydrate dissolved in 1000ml dilute H_2SO_4*.

*(Dilute H_2SO_4 = 54ml conc H_2SO_4 to a liter DW). Added 3 drops 15% ultra pure SDS per liter of solution.

Ascorbic Acid (ACS Reagent Grade)

Stock solution:

2.6g of ascorbic acid dissolved in DW and diluted to 1 liter volume. Refrigerated in a polypropylene bottle.

Nitrate + Nitrite

A modification of Armstrong *et al.* [Arms67] procedure was used for the analysis of nitrate and nitrite. For the nitrate analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. Sulfanilamide was introduced to the sample stream followed by N-(1-naphthyl)ethylenediamine dihydrochloride which coupled to form a red azo dye. The stream was then passed through a flowcell and the absorbance measured at 520nm. The same technique was employed for nitrite analysis, except the cadmium column was not present.

Reagents

Sulfanilamide (ACS Reagent Grade)

10g sulfanilamide dissolved in 1.2N HCl and brought to 1 liter volume. Added 5 drops of 40% surfynol 465/485 surfactant. Stored at room temperature in a dark polypropylene bottle.

N-(1-Naphthyl)-ethylenediamine dihydrochloride (N-1-N) (ACS Reagent Grade)

1g N-1-N dissolved in DW and brought to 1 liter volume. Added 2 drops 40% surfynol 465/485 surfactant. Stored at room temperature in a dark polypropylene bottle. Discarded if the solution turned dark reddish brown.

Imidazole Buffer (ACS Reagent Grade)

13.6g imidazole dissolved in ~3.8 liters DIW. Stirred for at least 30 minutes until completely dissolved. Added 60 ml of NH_4Cl + $CuSO_4$ mix (see below). Added 4 drops 40% Surfynol 465/485 surfactant. Using a calibrated pH meter, adjusted to pH of 7.83-7.85 with 10% (1.2N) HCl (about 20-30ml of acid, depending on exact strength). Final solution brought to 4L with DIW. Stored at room temperature.

NH_4Cl + $CuSO_4$ mix:

2g cupric sulfate dissolved in DIW, brought to 100 ml volume (2%). 250g ammonium chloride dissolved in DIW, brought to 1 liter volume. Added 5ml of 2% $CuSO_4$ solution to the NH_4Cl stock.

Note: 40% Surfynol 465/485 is 20% 465 plus 20% 485 in DIW.
Prepared solution at least one day before use to stabilize.

Phosphate

Phosphate was analyzed using the Murphy and Riley [Murp62] technique. An acidic solution of ammonium molybdate and antimony potassium tartrate was added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of ascorbic acid. The reaction product was heated to ~37°C to enhance color de velopment, then passed through a flowcell and the absorbance measured at 880nm.

Reagents

Antimony Potassium Tartrate stock

2.3g antimony potassium tartrate dissolved in DW and brought up to 100ml volume. Stable for one month.

Ammonium Molybdate (ACS Reagent Grade)

Add 64ml of concentrated H_2SO_4 to about 500ml DW and cool. Dissolve 6g of ammonium molybdate. Add 7ml stock antimony potassium tartrate. Dilute to 1 liter with DW. Store in a dark polypropylene bottle. Stable for one month. Must be colorless.

Ascorbic Acid (ACS Reagent Grade)

Dissolve 8g ascorbic in about 600ml DW. Add 45ml acetone and 1ml 15% ultra pure SDS. Dilute 1 liter volume. Stored in a dark polypropylene bottle and refrigerated. Stable for one week.

Sampling and Data Processing

Nutrient Measurements Made During GEOTRACES EPZT	
Cast Type	Number of Samples
30L-ODF	1347
GT-C + Super-GeoF	1738
McL-Prof Niskins	204
Underway (mid-GeoF + Th)	69
Lost Samples	2
Total Nutrient Samples	3360

New pump tubes were installed before the cruise and after stations 15 and 24. Primary/secondary standards were made up at the beginning of the cruise and every 7-10 days thereafter. A total of 4 nitrite and 5 mixed (nitrate, phosphate, and silicate) standards were made over the course of the cruise. The first was compared to standards brought from shore and each subsequent set was compared to the previous set to ensure continuity between standards. The cadmium column reduction efficiency was checked periodically and ranged between 95%-100% and was replaced when less than 96%.

Nutrient samples were drawn into 40 ml polypropylene screw-capped centrifuge tubes. The tubes and caps were cleaned with 10% HCl and rinsed once with de-ionized water and 2-3 times with sample before filling. Samples were kept in a refrigerator and analyzed within fifteen hours after sample collection. They were removed from the refrigerator about an hour before being analyzed, allowing sufficient time for all samples to reach room temperature. The centrifuge tubes fit directly onto the sampler.

Nutrients, reported in micromoles per kilogram, were converted from micromoles per Liter by dividing by sample density calculated at 1 atm pressure (0 db), *in situ* salinity, and an assumed lab temperature of 20°C.

Standards and Glassware

Primary standards for silicate (Na_2SiF_6), nitrate (KNO_3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Co. and/or Fisher Scientific. The supplier reports purities of >98%, 99.999%, 97%, and 99.999%. The standards were dried for approx 4hrs and allowed to cool down in a desiccator before they were weighed out to 0.01mg. The dry standard is diluted to 1L and the temperature of the solution was recorded. The exact weight, the temperature, and the calibrated volume of the flask were then used to calculate the concentration of the primary standard, and how much of this standard was needed for the desired concentration of secondary standard. The new standards were compared to the old before use. Standardizations were performed at the beginning of each group of analyses with working standards prepared prior to each run from a secondary. The secondary standards were prepared aboard ship by dilution from dry, pre-weighed primary standards. A set of 4 different standard concentrations (Table 1.12.0) were analyzed with each run of 12-30 samples to determine the deviation from linearity, if any, as a function of concentration for each nutrient.

std stations	N+N all	PO4 all	SiO3 all	NO2 1-15	NO2 16-36
1)	0.0	0.0	0	0.0	0.0
3)	15.50	1.2	60	1.50	0.50
5)	31.00	2.4	120	3.00	1.00
7)	46.50	3.6	180	4.50	1.50

Table 1.12.0 U.S. GEOTRACES EPZT Standard Concentrations (µmol/L)

All glass volumetric flasks were gravimetrically calibrated prior to the cruise. The primary standards were dried and weighed prior to the cruise. The exact weight was noted for future reference.

All the reagent solutions, primary and secondary standards were made with fresh distilled deionized water (DW).

Working standards were made up in low nutrient seawater (LNSW). LNSW was collected off the coast of California and filtered before use at sea during the first part of the cruise, through station 22. Additional LNSW was collected on the transit between Seattle and Manta, at position 27.47N 118.61W, and used for stations 23-36.

All data were initially reported in micromoles/Liter. NO3, PO4, and NO2 were reported to two decimal places, and SIL to one. Accuracy was based on the quality of the standards, and is listed with instrument precision in Table 1.12.1:

Nutrient Reported	Accuracy (µmol/L)	Precision (µmol/L)
NO3	0.05	0.05
PO4	0.004	0.004
SIL	2-4	1
NO2	0.05	0.01

Table 1.12.1 U.S. GEOTRACES EPZT Nutrient Accuracy and Precision

The detection limits for the methods/instrumentation are shown in Table 1.12.2:

Nutrient Measured	Detection Limit (µmol/L)
NO3+NO2	0.02
PO4	0.02
Sil	0.5
NO2	0.02

Table 1.12.2 U.S. GEOTRACES EPZT Nutrient Detection Limits

As is standard ODF practice, a deep calibration *check* sample was run with each set of samples and the data are tabulated below. This water was collected at 2000 meters on the second rinse station, during the transit along the coast of Peru, and poisoned with mercuric chloride.

Parameter	Concentration (µM)
NO_3	40.03 ± 0.22
PO_4	2.96 ± 0.03
SiO_3	154.46 ± 1.16
NO_2	0.03 ± 0.01

Table 1.12.3 U.S. GEOTRACES EPZT deep check cruise-averaged data

Reference materials for nutrients in seawater (RMNS) were also used as a check sample run occasionally. The RMNS preparation, verification, and suggested protocol for use of the material are described by Aoyama *et al.* [Aoya06] [Aoya07] [Aoya08] and Sato *et al.* [Sato10]. RMNS batch BX was used on this cruise, with each bottle being used once or twice before being discarded and a new one opened. Data are tabulated below, along with the assigned values.

Parameter	Concentration (µmol kg^{-1})	Assigned
NO_3	44.27 ± 0.23	43
PO_4	3.04 ± 0.03	2.906
SiO_3	146.59 ± 1.12	136
NO_2	0.040 ± 0.004	0.034

Table 1.12.4 U.S. GEOTRACES EPZT cruise-averaged concentration of RMNS standard

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Appendix A

U.S. GEOTRACES EPZT: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	ITS-90 Temperature Coefficients corT = tp1∗corP + t0 tp1	t0	Conductivity Coefficients corC = c2∗C^2 + c1∗C + c0 c2	c1	c0
001/02	-1.3432e-07	-0.001033	3.16731e-06	-3.16884e-04	0.005466
001/04	-1.3432e-07	-0.001025	3.16731e-06	-3.16884e-04	0.005466
001/06	-1.3432e-07	-0.001023	3.16731e-06	-3.16884e-04	0.005466
001/08	-1.3432e-07	-0.001021	3.16731e-06	-3.16884e-04	0.005466
001/10	-1.3432e-07	-0.001015	3.16731e-06	-3.16884e-04	0.005466
001/11	-1.3432e-07	-0.001013	3.16731e-06	-3.16884e-04	0.005466
001/13	-1.3432e-07	-0.001003	3.16731e-06	-3.16884e-04	0.005466
001/15	-1.3432e-07	-0.000998	3.16731e-06	-3.16884e-04	0.005466
002/02	-1.3432e-07	-0.000990	3.16731e-06	-3.16884e-04	0.005466
002/05	-1.3432e-07	-0.000986	3.16731e-06	-3.16884e-04	0.005466
003/05	-1.3432e-07	-0.000975	3.16731e-06	-3.16884e-04	0.005466
003/07	-1.3432e-07	-0.000971	3.16731e-06	-3.16884e-04	0.005466
004/02	-1.3432e-07	-0.000968	3.16731e-06	-3.16884e-04	0.005466
004/04	-1.3432e-07	-0.000963	3.16731e-06	-3.16884e-04	0.005466
005/02	-1.3432e-07	-0.000956	3.16731e-06	-3.16884e-04	0.005466
005/04	-1.3432e-07	-0.000950	3.16731e-06	-3.16884e-04	0.005466
005/06	-1.3432e-07	-0.000949	3.16731e-06	-3.16884e-04	0.005466
006/02	-1.3432e-07	-0.000934	3.16731e-06	-3.16884e-04	0.005466
007/02	-1.3432e-07	-0.000924	3.16731e-06	-3.16884e-04	0.005466
007/04	-1.3432e-07	-0.000916	3.16731e-06	-3.16884e-04	0.005466
007/06	-1.3432e-07	-0.000913	3.16731e-06	-3.16884e-04	0.005466
007/10	-1.3432e-07	-0.000905	3.16731e-06	-3.16884e-04	0.005466
007/12	-1.3432e-07	-0.000901	3.16731e-06	-3.16884e-04	0.005466
008/02	-1.3432e-07	-0.000891	3.16731e-06	-3.16884e-04	0.005466
009/02	-1.3432e-07	-0.000881	3.16731e-06	-3.16884e-04	0.005466
009/04	-1.3432e-07	-0.000876	3.16731e-06	-3.16884e-04	0.005466
009/06	-1.3432e-07	-0.000873	3.16731e-06	-3.16884e-04	0.005466
009/10	-1.3432e-07	-0.000864	3.16731e-06	-3.16884e-04	0.005466
010/02	-1.3432e-07	-0.000854	3.16731e-06	-3.16884e-04	0.005466
011/02	-1.3432e-07	-0.000844	3.16731e-06	-3.16884e-04	0.005466
011/04	-1.3432e-07	-0.000839	3.16731e-06	-3.16884e-04	0.005466
011/06	-1.3432e-07	-0.000836	3.16731e-06	-3.16884e-04	0.005466
011/08	-1.3432e-07	-0.000833	3.16731e-06	-3.16884e-04	0.005466
011/10	-1.3432e-07	-0.000830	3.16731e-06	-3.16884e-04	0.005466
011/11	-1.3432e-07	-0.000827	3.16731e-06	-3.16884e-04	0.005466
011/13	-1.3432e-07	-0.000821	3.16731e-06	-3.16884e-04	0.005466
011/15	-1.3432e-07	-0.000820	3.16731e-06	-3.16884e-04	0.005466
012/02	-1.3432e-07	-0.000809	3.16731e-06	-3.16884e-04	0.005466
013/02	-1.3432e-07	-0.000799	3.16731e-06	-3.16884e-04	0.005466
013/04	-1.3432e-07	-0.000794	3.16731e-06	-3.16884e-04	0.005466
013/06	-1.3432e-07	-0.000791	3.16731e-06	-3.16884e-04	0.005466
013/10	-1.3432e-07	-0.000783	3.16731e-06	-3.16884e-04	0.005466

Sta/ Cast	ITS-90 Temperature Coefficients $corT = tp1*corP + t0$ tp1	t0	Conductivity Coefficients $corC = c2*C^2 + c1*C + c0$ c2	c1	c0
014/02	-1.3432e-07	-0.000772	3.16731e-06	-3.16884e-04	0.005466
015/02	-1.3432e-07	-0.000762	3.16731e-06	-3.16884e-04	0.005466
015/04	-1.3432e-07	-0.000757	3.16731e-06	-3.16884e-04	0.005466
015/06	-1.3432e-07	-0.000754	3.16731e-06	-3.16884e-04	0.005466
015/10	-1.3432e-07	-0.000746	3.16731e-06	-3.16884e-04	0.005466
016/02	-1.3432e-07	-0.000736	3.16731e-06	-3.16884e-04	0.005466
017/02	-1.3432e-07	-0.000725	3.16731e-06	-3.16884e-04	0.005466
017/04	-1.3432e-07	-0.000720	3.16731e-06	-3.16884e-04	0.005466
017/06	-1.3432e-07	-0.000717	3.16731e-06	-3.16884e-04	0.005466
017/09	-1.3432e-07	-0.000710	3.16731e-06	-3.16884e-04	0.005466
018/01	-1.3432e-07	-0.000697	3.16731e-06	-3.16884e-04	0.005466
018/04	-1.3432e-07	-0.000689	3.16731e-06	-3.16884e-04	0.005466
018/06	-1.3432e-07	-0.000686	3.16731e-06	-3.16884e-04	0.005466
018/08	-1.3432e-07	-0.000682	3.16731e-06	-3.16884e-04	0.005466
018/10	-1.3432e-07	-0.000679	3.16731e-06	-3.16884e-04	0.005466
018/11	-1.3432e-07	-0.000676	3.16731e-06	-3.16884e-04	0.005466
018/13	-1.3432e-07	-0.000670	3.16731e-06	-3.16884e-04	0.005466
018/17	-1.3432e-07	-0.000666	3.16731e-06	-3.16884e-04	0.005466
019/01	-1.3432e-07	-0.000656	3.16731e-06	-3.16884e-04	0.005466
020/02	-1.3432e-07	-0.000651	3.16731e-06	-3.16884e-04	0.005466
020/04	-1.3432e-07	-0.000645	3.16731e-06	-3.16884e-04	0.005466
020/06	-1.3432e-07	-0.000642	3.16731e-06	-3.16884e-04	0.005466
020/09	-1.3432e-07	-0.000635	3.16731e-06	-3.16884e-04	0.005466
021/02	-1.3432e-07	-0.000622	3.16731e-06	-3.16884e-04	0.005466
021/04	-1.3432e-07	-0.000617	3.16731e-06	-3.16884e-04	0.005466
021/06	-1.3432e-07	-0.000614	3.16731e-06	-3.16884e-04	0.005466
021/09	-1.3432e-07	-0.000607	3.16731e-06	-3.16884e-04	0.005466
022/02	-1.3432e-07	-0.000597	3.16731e-06	-3.16884e-04	0.005466
023/01	-1.3432e-07	-0.000588	3.16731e-06	-3.16884e-04	0.005466
023/04	-1.3432e-07	-0.000581	3.16731e-06	-3.16884e-04	0.005466
023/06	-1.3432e-07	-0.000577	3.16731e-06	-3.16884e-04	0.005466
023/10	-1.3432e-07	-0.000568	3.16731e-06	-3.16884e-04	0.005466
024/02	-1.3432e-07	-0.000558	3.16731e-06	-3.16884e-04	0.005466
025/02	-1.3432e-07	-0.000548	3.16731e-06	-3.16884e-04	0.005466
025/04	-1.3432e-07	-0.000543	3.16731e-06	-3.16884e-04	0.005466
025/06	-1.3432e-07	-0.000540	3.16731e-06	-3.16884e-04	0.005466
025/09	-1.3432e-07	-0.000532	3.16731e-06	-3.16884e-04	0.005466
026/02	-1.3432e-07	-0.000518	3.16731e-06	-3.16884e-04	0.005466
026/07	-1.3432e-07	-0.000509	3.16731e-06	-3.16884e-04	0.005466
026/08	-1.3432e-07	-0.000507	3.16731e-06	-3.16884e-04	0.005466
026/10	-1.3432e-07	-0.000503	3.16731e-06	-3.16884e-04	0.005466
026/12	-1.3432e-07	-0.000500	3.16731e-06	-3.16884e-04	0.005466
026/13	-1.3432e-07	-0.000497	3.16731e-06	-3.16884e-04	0.005466
026/15	-1.3432e-07	-0.000492	3.16731e-06	-3.16884e-04	0.005466
026/17	-1.3432e-07	-0.000490	3.16731e-06	-3.16884e-04	0.005466

Sta/ Cast	ITS-90 Temperature Coefficients corT = tp1∗corP + t0		Conductivity Coefficients corC = c2∗C^2 + c1∗C + c0		
	tp1	t0	c2	c1	c0
027/02	-1.3432e-07	-0.000481	3.16731e-06	-3.16884e-04	0.005466
028/02	-1.3432e-07	-0.000471	3.16731e-06	-3.16884e-04	0.005466
028/04	-1.3432e-07	-0.000466	3.16731e-06	-3.16884e-04	0.005466
028/06	-1.3432e-07	-0.000463	3.16731e-06	-3.16884e-04	0.005466
028/09	-1.3432e-07	-0.000455	3.16731e-06	-3.16884e-04	0.005466
029/02	-1.3432e-07	-0.000445	3.16731e-06	-3.16884e-04	0.005466
030/02	-1.3432e-07	-0.000438	3.16731e-06	-3.16884e-04	0.005466
030/04	-1.3432e-07	-0.000432	3.16731e-06	-3.16884e-04	0.005466
030/06	-1.3432e-07	-0.000429	3.16731e-06	-3.16884e-04	0.005466
030/11	-1.3432e-07	-0.000418	3.16731e-06	-3.16884e-04	0.005466
031/02	-1.3432e-07	-0.000407	3.16731e-06	-3.16884e-04	0.005466
032/02	-1.3432e-07	-0.000392	3.16731e-06	-3.16884e-04	0.005466
032/04	-1.3432e-07	-0.000387	3.16731e-06	-3.16884e-04	0.005466
032/06	-1.3432e-07	-0.000383	3.16731e-06	-3.16884e-04	0.005466
032/10	-1.3432e-07	-0.000374	3.16731e-06	-3.16884e-04	0.005466
033/02	-1.3432e-07	-0.000365	3.16731e-06	-3.16884e-04	0.005466
034/02	-1.3432e-07	-0.000355	3.16731e-06	-3.16884e-04	0.005466
034/06	-1.3432e-07	-0.000346	3.16731e-06	-3.16884e-04	0.005466
035/02	-1.3432e-07	-0.000335	3.16731e-06	-3.16884e-04	0.005466
036/02	-1.3432e-07	-0.000325	3.16731e-06	-3.16884e-04	0.005466
036/04	-1.3432e-07	-0.000319	3.16731e-06	-3.16884e-04	0.005466
036/06	-1.3432e-07	-0.000316	3.16731e-06	-3.16884e-04	0.005466
036/08	-1.3432e-07	-0.000311	3.16731e-06	-3.16884e-04	0.005466
036/10	-1.3432e-07	-0.000308	3.16731e-06	-3.16884e-04	0.005466
036/11	-1.3432e-07	-0.000305	3.16731e-06	-3.16884e-04	0.005466
036/13	-1.3432e-07	-0.000299	3.16731e-06	-3.16884e-04	0.005466
036/15	-1.3432e-07	-0.000298	3.16731e-06	-3.16884e-04	0.005466

Appendix B

Summary of U.S. GEOTRACES EPZT CTD Oxygen Time Constants

(time constants in seconds)

Pressure Hysteresis (τ_h)	Temperature Long(τ_{Tl})	Temperature Short(τ_{Ts})	Pressure Gradient (τ_p)	O_2 Gradient (τ_{og})	Velocity (τ_{dP})	Thermal Diffusion (τ_{dT})
50.0	300.0	4.0	0.50	8.00	200.00	300.0

U.S. GEOTRACES EPZT: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 1.7.4.0)

Sta/ Cast	O_cSlope (c_1)	Offset (c_3)	$P_h$coeff (c_2)	$T_l$coeff (c_4)	$T_s$coeff (c_5)	$P_l$coeff (c_6)	$\frac{dO_c}{dt}$coeff (c_7)	$\frac{dP}{dt}$coeff (c_8)	T_{dT}coeff (c_9)
001/02	5.694e-04	-0.2394	0.0829	-3.301e-03	2.091e-03	-6.305e-03	-5.804e-04	-6.305e-03	-7.688e-03
001/04	1.386e-04	-0.0590	0.8495	-1.532e-02	9.480e-02	1.482e-01	3.837e-03	1.482e-01	3.212e-04
001/06	5.094e-04	-0.2122	0.0781	-1.071e-03	6.226e-03	5.078e-03	2.040e-04	5.078e-03	-1.735e-03
001/08	7.939e-04	-0.3339	0.1395	5.691e-03	-2.518e-02	-3.083e-02	1.428e-04	-3.083e-02	-1.388e-03
001/10	5.174e-04	-0.2188	0.3963	-6.243e-03	1.076e-02	3.509e-02	1.386e-03	3.509e-02	-2.368e-03
001/11	5.721e-04	-0.2382	-0.0301	5.412e-04	-1.586e-03	-1.870e-02	-1.113e-04	-1.870e-02	-3.167e-03
001/13	5.579e-04	-0.2351	0.3338	-3.281e-03	4.177e-03	-2.296e-03	2.171e-04	-2.296e-03	-6.651e-03
001/15	5.621e-04	-0.2319	-0.0919	1.063e-03	-8.794e-04	-2.083e-02	5.053e-04	-2.083e-02	-5.111e-03
002/02	1.862e-04	-0.0788	1.3060	1.267e-01	-5.549e-02	-1.515e+00	3.008e-04	-1.515e+00	1.133e-02
002/05	2.138e-04	-0.0877	-0.3517	-1.244e-01	1.905e-01	1.715e-01	-3.367e-03	1.715e-01	-1.484e-01
003/05	4.026e-04	-0.1713	4.1906	-7.509e-02	1.023e-01	1.736e+00	3.516e-04	1.736e+00	-1.111e-01
003/07	2.784e-05	-0.0110	-0.7538	-1.625e-01	3.442e-01	2.155e-01	-7.104e-03	2.155e-01	-3.904e-01
004/02	4.438e-04	-0.1879	0.3955	2.065e-02	-6.393e-03	-2.790e-01	5.891e-04	-2.790e-01	1.831e-03
004/04	1.564e-03	-0.6594	0.1177	-3.512e-02	-2.489e-02	1.289e-01	8.150e-03	1.289e-01	-4.325e-02
005/02	2.138e-04	-0.0898	0.0624	1.550e-02	4.115e-02	-3.891e-01	2.171e-03	-3.891e-01	-2.309e-02
005/04	7.763e-05	-0.0326	0.5537	-1.479e-03	1.156e-01	-1.494e-01	-6.853e-03	-1.494e-01	-1.284e-02
005/06	5.669e-04	-0.2391	0.1398	-1.853e-02	1.831e-02	-9.871e-03	-3.051e-03	-9.871e-03	-2.656e-02
006/02	5.504e-04	-0.2326	0.2262	5.157e-04	1.418e-03	7.787e-03	2.884e-04	7.787e-03	-3.380e-04
007/02	5.784e-04	-0.2406	-0.0518	-1.970e-03	1.033e-03	-1.309e-02	5.899e-05	-1.309e-02	-6.729e-03
007/04	3.850e-04	-0.1633	0.3341	7.134e-04	1.990e-02	-7.662e-02	-1.745e-03	-7.662e-02	-9.061e-03
007/06	6.689e-04	-0.2821	0.1572	4.415e-04	-9.048e-03	2.367e-02	1.550e-03	2.367e-02	3.106e-03
007/10	5.893e-04	-0.2451	-0.0168	4.414e-04	-2.379e-03	-1.113e-02	1.821e-04	-1.113e-02	-2.070e-03
007/12	5.893e-04	-0.2451	-0.0168	4.414e-04	-2.379e-03	-1.113e-02	1.821e-04	-1.113e-02	-2.070e-03
008/02	5.534e-04	-0.2338	0.3439	-6.290e-03	7.982e-03	2.823e-02	-1.893e-03	2.823e-02	-4.854e-03
009/02	5.593e-04	-0.2367	0.2584	-2.176e-04	1.426e-03	4.705e-03	-5.177e-04	4.705e-03	-8.516e-04
009/04	5.054e-04	-0.2179	0.6881	-2.738e-03	9.255e-03	4.841e-02	-1.665e-03	4.841e-02	1.749e-03
009/06	6.116e-04	-0.2612	0.4527	-3.181e-03	-1.363e-04	5.276e-02	1.152e-03	5.276e-02	6.530e-04
009/10	5.798e-04	-0.2422	-0.0424	-3.188e-03	2.347e-03	-1.067e-02	-3.361e-03	-1.067e-02	-7.796e-03
010/02	6.028e-04	-0.2583	0.4603	-3.389e-03	8.865e-04	5.463e-02	1.148e-04	5.463e-02	1.581e-03
011/02	5.578e-04	-0.2379	0.3878	4.342e-04	8.513e-04	1.473e-02	9.167e-04	1.473e-02	7.301e-04
011/04	4.964e-04	-0.2122	0.5323	6.136e-04	6.257e-03	6.788e-03	7.566e-04	6.788e-03	9.640e-05
011/06	5.781e-04	-0.2523	0.8736	2.434e-04	-1.842e-04	1.662e-02	1.252e-03	1.662e-02	-8.045e-04
011/08	5.715e-04	-0.2398	-0.0133	-3.376e-03	3.403e-03	-7.639e-03	9.019e-05	-7.639e-03	-1.008e-02
011/10	5.765e-04	-0.2437	0.1277	-4.393e-04	1.860e-05	5.714e-03	-2.312e-03	5.714e-03	-1.127e-03
011/11	7.149e-04	-0.2947	-0.2886	1.328e-03	-1.234e-02	1.467e-02	9.579e-04	1.467e-02	5.521e-03
011/13	4.974e-04	-0.2248	2.0902	1.810e-03	5.711e-03	3.406e-02	-6.059e-04	3.406e-02	2.021e-03

Sta/ Cast	O_c Slope (c_1)	Offset (c_3)	P_h coeff (c_2)	T_l coeff (c_4)	T_s coeff (c_5)	P_l coeff (c_6)	$\frac{dO_c}{dt}$ coeff (c_7)	$\frac{dP}{dt}$ coeff (c_8)	T_{dT} coeff (c_9)
011/15	5.753e-04	-0.2406	-0.0295	-1.205e-03	9.486e-04	-9.543e-03	-8.554e-06	-9.543e-03	-5.299e-03
012/02	4.692e-04	-0.2022	0.7270	5.048e-04	9.002e-03	2.014e-02	-2.628e-03	2.014e-02	1.753e-03
013/02	5.314e-04	-0.2266	0.3904	1.742e-03	1.912e-03	6.904e-03	2.832e-04	6.904e-03	9.639e-04
013/04	6.104e-04	-0.2562	0.1584	-5.973e-04	-2.585e-03	3.093e-02	5.757e-04	3.093e-02	2.867e-03
013/06	5.341e-04	-0.2275	0.6563	8.742e-04	2.525e-03	3.900e-02	1.174e-03	3.900e-02	4.344e-03
013/10	5.852e-04	-0.2446	-0.0137	1.043e-03	-1.920e-03	-9.258e-03	2.561e-04	-9.258e-03	-1.965e-03
014/02	5.823e-04	-0.2483	0.5572	-3.700e-03	3.200e-03	3.997e-02	-1.455e-03	3.997e-02	1.362e-04
015/02	5.729e-04	-0.2377	-0.0300	4.419e-04	-2.634e-04	-1.275e-03	2.991e-04	-1.275e-03	-1.055e-03
015/04	5.487e-04	-0.2250	0.1070	-5.021e-04	2.287e-03	8.379e-03	-1.164e-03	8.379e-03	-6.891e-05
015/06	5.471e-04	-0.2364	0.7350	-2.177e-04	2.557e-03	2.579e-02	3.100e-05	2.579e-02	1.641e-03
015/10	5.627e-04	-0.2303	-0.0833	6.467e-04	2.030e-04	-1.141e-02	-1.298e-03	-1.141e-02	-2.082e-03
016/02	5.320e-04	-0.2206	0.1629	-3.851e-04	3.606e-03	8.515e-04	-8.814e-04	8.515e-04	-1.043e-03
017/02	5.649e-04	-0.2405	0.3284	2.262e-04	7.248e-04	1.280e-03	6.489e-04	1.280e-03	-1.576e-03
017/04	5.552e-04	-0.2313	0.1093	1.336e-03	-9.129e-07	1.171e-02	5.517e-04	1.171e-02	2.274e-03
017/06	5.386e-04	-0.2263	0.2743	-8.101e-04	3.574e-03	8.904e-03	-9.493e-04	8.904e-03	3.183e-04
017/09	5.618e-04	-0.2327	-0.0823	9.934e-04	-1.134e-04	-1.079e-02	1.205e-03	-1.079e-02	-1.905e-03
018/01	5.643e-04	-0.2341	-0.1295	1.689e-03	-1.064e-03	-1.295e-02	8.972e-04	-1.295e-02	-1.354e-03
018/04	5.365e-04	-0.2204	-0.1303	7.590e-04	2.057e-03	-5.099e-03	9.156e-04	-5.099e-03	-1.237e-03
018/06	5.793e-04	-0.2361	-0.1651	5.963e-04	-1.023e-03	8.679e-03	1.376e-03	8.679e-03	1.155e-04
018/08	5.798e-04	-0.2483	0.1682	3.730e-03	-3.855e-03	3.552e-03	3.783e-03	3.552e-03	2.748e-03
018/10	6.003e-04	-0.2605	0.0543	2.358e-03	-3.713e-03	1.202e-03	1.360e-03	1.202e-03	1.447e-03
018/11	6.180e-04	-0.2765	0.7126	9.656e-04	-3.105e-03	2.269e-02	-1.376e-04	2.269e-02	2.074e-03
018/13	9.599e-04	-0.4848	2.7893	-1.713e-02	-1.645e-03	1.993e-01	-4.235e-03	1.993e-01	4.368e-03
018/17	5.984e-04	-0.2577	-0.1102	3.046e-03	-4.423e-03	-5.063e-03	1.990e-03	-5.063e-03	1.526e-03
019/01	5.875e-04	-0.2610	0.4998	1.815e-03	-1.896e-03	6.225e-03	1.225e-03	6.225e-03	4.855e-04
020/02	5.999e-04	-0.2605	0.1528	-5.651e-04	-8.961e-04	1.224e-03	-2.582e-03	1.224e-03	-1.775e-03
020/04	5.607e-04	-0.2387	0.0783	1.385e-03	9.749e-05	-6.153e-03	4.286e-04	-6.153e-03	-1.489e-03
020/06	5.914e-04	-0.2524	0.4669	1.112e-04	-9.647e-04	2.288e-02	-3.373e-04	2.288e-02	1.733e-03
020/09	6.087e-04	-0.2690	0.1414	-2.572e-04	-1.463e-03	-3.638e-03	-1.352e-03	-3.638e-03	-2.242e-03
021/02	5.742e-04	-0.2440	0.1636	1.145e-03	-9.007e-04	-1.026e-03	2.859e-04	-1.026e-03	-3.824e-04
021/04	5.824e-04	-0.2461	0.0683	2.575e-03	-2.711e-03	-6.485e-03	7.715e-04	-6.485e-03	-3.232e-04
021/06	5.778e-04	-0.2413	0.0719	2.076e-03	-2.026e-03	-5.561e-03	-2.569e-04	-5.561e-03	-4.398e-04
021/09	5.560e-04	-0.2292	-0.1582	-1.625e-03	2.932e-03	-1.016e-02	-2.203e-03	-1.016e-02	-5.030e-03
022/02	6.058e-04	-0.2659	0.7151	-4.698e-03	3.281e-03	3.689e-02	-1.540e-03	3.689e-02	-2.159e-03
023/01	5.891e-04	-0.2513	-0.0006	2.159e-03	-2.824e-03	-6.809e-03	5.690e-04	-6.809e-03	5.867e-04
023/04	5.918e-04	-0.2548	0.2920	1.056e-03	-1.614e-03	5.722e-03	2.169e-05	5.722e-03	-1.119e-04
023/06	5.794e-04	-0.2462	0.2358	1.646e-03	-1.582e-03	7.133e-03	2.841e-04	7.133e-03	9.356e-04
023/10	5.508e-04	-0.2266	-0.1739	1.964e-03	-2.482e-04	-1.270e-02	6.855e-04	-1.270e-02	-1.475e-03
024/02	5.459e-04	-0.2293	0.0343	1.775e-03	5.386e-04	1.691e-03	1.838e-03	1.691e-03	3.001e-04
025/02	5.890e-04	-0.2557	0.3412	1.877e-03	-2.209e-03	5.518e-04	7.568e-04	5.518e-04	1.369e-04
025/04	6.186e-04	-0.2706	0.4828	1.462e-04	-2.251e-03	2.256e-02	-5.177e-05	2.256e-02	4.922e-04
025/06	6.413e-04	-0.2809	0.4660	5.626e-04	-4.107e-03	3.379e-02	1.186e-03	3.379e-02	2.202e-03
025/09	5.800e-04	-0.2463	-0.1377	1.017e-03	-1.033e-03	-1.345e-02	-1.512e-03	-1.345e-02	-1.671e-03
026/02	5.766e-04	-0.2431	-0.0664	2.642e-03	-2.439e-03	-4.974e-03	1.192e-03	-4.974e-03	6.927e-04
026/07	5.830e-04	-0.2484	0.1120	2.446e-03	-2.592e-03	2.828e-03	3.632e-04	2.828e-03	1.001e-03
026/08	6.323e-04	-0.2767	0.5617	1.487e-03	-4.303e-03	1.744e-02	1.146e-04	1.744e-02	1.358e-03
026/10	5.948e-04	-0.2567	-0.0749	2.493e-03	-3.272e-03	-9.824e-03	2.378e-04	-9.824e-03	4.133e-04
026/12	5.735e-04	-0.2391	0.0605	1.677e-03	-1.280e-03	-1.991e-03	1.544e-04	-1.991e-03	8.202e-05

Sta/ Cast	O_c Slope (c_1)	Offset (c_3)	P_h coeff (c_2)	T_l coeff (c_4)	T_s coeff (c_5)	P_l coeff (c_6)	$\frac{dO_c}{dt}$ coeff (c_7)	$\frac{dP}{dt}$ coeff (c_8)	T_{dT} coeff (c_9)
026/13	5.904e-04	-0.2520	0.0749	2.187e-03	-2.715e-03	3.961e-03	1.191e-03	3.961e-03	1.108e-03
026/15	5.906e-04	-0.1768	-4.3759	2.260e-03	-5.312e-03	-8.320e-02	-1.108e-03	-8.320e-02	-2.488e-03
026/17	5.795e-04	-0.2462	-0.1315	2.094e-03	-2.052e-03	-1.195e-02	-1.434e-04	-1.195e-02	3.862e-05
027/02	5.937e-04	-0.2594	0.5650	-6.626e-04	1.653e-04	2.225e-02	-1.024e-03	2.225e-02	-5.773e-05
028/02	5.694e-04	-0.2390	-0.1920	-5.887e-04	1.086e-03	-9.023e-03	-2.137e-03	-9.023e-03	-2.928e-03
028/04	5.498e-04	-0.2271	-0.2206	8.851e-04	8.501e-04	-6.915e-03	4.154e-04	-6.915e-03	-1.215e-03
028/06	5.644e-04	-0.2333	0.2501	-1.162e-03	2.066e-03	-2.577e-06	-1.864e-03	-2.577e-06	-2.310e-03
028/09	5.633e-04	-0.2348	-0.2010	-1.647e-03	2.581e-03	-1.441e-02	-4.995e-03	-1.441e-02	-4.063e-03
029/02	5.639e-04	-0.2465	1.1038	-2.880e-03	4.455e-03	2.786e-02	-3.476e-03	2.786e-02	-2.472e-03
030/02	4.946e-04	-0.1828	-0.3973	3.533e-03	1.097e-03	-1.668e-02	6.838e-04	-1.668e-02	1.752e-03
030/04	5.613e-04	-0.2321	-0.1783	2.462e-03	-1.549e-03	6.418e-03	2.739e-03	6.418e-03	1.896e-03
030/06	5.545e-04	-0.2276	0.0604	1.045e-03	3.576e-04	1.889e-04	-1.929e-03	1.889e-04	-5.262e-05
030/11	5.486e-04	-0.2210	-0.2209	2.606e-03	-1.098e-03	-1.449e-02	-3.532e-04	-1.449e-02	4.647e-04
031/02	5.196e-04	-0.2064	-0.3926	1.642e-03	1.671e-03	-4.239e-03	3.014e-04	-4.239e-03	4.500e-04
032/02	5.561e-04	-0.2355	0.6105	1.039e-03	6.227e-04	5.732e-03	-2.678e-03	5.732e-03	-2.523e-04
032/04	5.317e-04	-0.2074	0.1827	9.579e-04	1.609e-03	4.277e-03	2.274e-04	4.277e-03	-7.378e-04
032/06	5.599e-04	-0.2309	-0.1092	9.855e-04	-9.404e-05	-3.461e-04	-1.063e-03	-3.461e-04	8.894e-04
032/10	5.788e-04	-0.2442	-0.0927	3.910e-04	-2.204e-04	-1.803e-02	-2.590e-03	-1.803e-02	-2.391e-03
033/02	5.583e-04	-0.2293	-0.1000	1.656e-03	-5.234e-04	-2.554e-03	1.206e-03	-2.554e-03	-2.987e-04
034/02	5.530e-04	-0.2277	-0.0700	2.738e-03	-1.300e-03	-5.729e-03	9.192e-04	-5.729e-03	2.875e-04
034/06	5.566e-04	-0.2289	-0.2150	2.175e-03	-1.062e-03	-1.910e-02	-9.893e-04	-1.910e-02	-6.552e-04
035/02	5.773e-04	-0.2450	-0.0634	1.709e-03	-1.513e-03	7.466e-04	9.330e-04	7.466e-04	6.923e-04
036/02	5.964e-04	-0.2638	0.2837	1.948e-03	-2.663e-03	-1.736e-03	-1.107e-03	-1.736e-03	6.160e-04
036/04	5.678e-04	-0.2409	-0.0434	1.229e-03	-5.392e-04	-2.308e-04	-3.974e-04	-2.308e-04	4.332e-05
036/06	5.632e-04	-0.2374	-0.0224	1.588e-03	-7.808e-04	-4.304e-03	-1.336e-03	-4.304e-03	4.455e-04
036/08	6.150e-04	-0.2769	-0.1035	1.542e-03	-3.061e-03	-1.868e-02	-2.723e-03	-1.868e-02	-7.531e-04
036/10	6.013e-04	-0.2632	0.0572	8.690e-04	-1.831e-03	-2.105e-03	-3.073e-03	-2.105e-03	-2.660e-04
036/11	5.051e-04	-0.1900	-0.2341	1.051e-03	2.841e-03	-8.924e-03	-3.752e-04	-8.924e-03	-9.357e-04
036/13	8.913e-04	-0.4092	0.6793	-9.795e-03	-4.005e-03	1.353e-01	-2.563e-03	1.353e-01	-4.083e-04
036/15	5.439e-04	-0.2182	-0.2216	8.170e-04	8.672e-04	-2.154e-02	-2.478e-03	-2.154e-02	-1.896e-03

Appendix C

U.S. GEOTRACES EPZT: Bottle Quality Comments

Comments from the Sample Logs and the results of SIO/STS's data investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, micromoles per kilogram for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, and Phosphate. The sample number is the cast number times 100 plus the bottle number. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and re-reading of charts (i.e. nutrients).

Comments from other analysts, submitted through the shipboard data website with their sample values, are also included in this table.

Quality codes in this table are from the coding scheme developed for the World Ocean Circulation Experiment Hydrographic Programme (WHP) [Joyc94]. These flags can also be found at *http://cchdo.ucsd.edu/woce_flags.html*.

In addition, non-standard quality codes "A" and "B" were used for several properties where the analysts desired to mark them as "Above" or "Below" detection limits for the analysis methods used.

Station /Cast	Sample No.	Property	Quality Code	Comment
1/1	101	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	102	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	103	bottle	2	Spigot leaking.
1/1	103	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	104	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	105	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	106	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	107	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	108	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	109	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)

Station /Cast	Sample No.	Property	Quality Code	Comment
1/1	110	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	111	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	112	salt	2	Value matches duplicate. (Analyst: Salt 12 thimble came out with cap. Probable contamination.)
1/1	113	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	114	no2	4	Other nutrient values higher than expected, no analytical problems noted. Salt fine, perhaps mis-sampled for nutrients only.
1/1	114	no3	4	Value higher than expected, no analytical problems noted. Salt fine, perhaps mis-sampled for nutrients only.
1/1	114	po4	4	Value higher than expected, no analytical problems noted. Salt fine, perhaps mis-sampled for nutrients only.
1/1	114	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	114	sio3	4	Value higher than expected, no analytical problems noted. Salt fine, perhaps mis-sampled for nutrients only.
1/1	115	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	116	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	117	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	118	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	119	dfe2_mops	5	sample lost due to broken tubing
1/1	119	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	120	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	121	dfe2_mops	5	sample lost due to broken tubing
1/1	121	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	122	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/1	123	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)

Station /Cast	Sample No.	Property	Quality Code	Comment
1/1	124	dfe2_mops	5	sample lost due to broken tubing
1/1	124	salt	2	Salinity values for cast are ok: all samples are deep, and all dups within 0.004 of each other. (Analyst: All samples appear to have been collected in random order.)
1/2	201	salt	2	Value matches CTD data. (Analyst: thimble popped out with cap. Reading suspect.)
1/2	207	bottle	2	Niskin leaky.
1/2	208	bottle	2	Niskin leaky.
1/5	501	dfe2_mops	5	No data (ND) reported
1/5	501	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 1 rim chipped and rough. Seal may have been compromised.)
1/5	507	bottle	2	Bottle hanging but full when recovered.
1/6	601	bottle	2	Niskin vent open.
1/6	604	salt	2	Value matches CTD data. (Analyst: Salt 28 thimble came out with cap. Readings a bit farther apart than normal.)
1/6	608	bottle	2	Niskin leaky.
1/8	802	salt	2	Value matches CTD data. (Analyst: Salt 2 - Readings erratic with initial jump. Seems high.)
1/8	807	salt	2	Value matches CTD data. (Analyst: Salt 7 - Readings kept climbing. Probably contamination. Source not clear.)
1/8	809	bottle	2	Niskin leaky.
1/10	1001	salt	2	Values match each other (duplicates) and CTD data. (Analyst: Salts 25 and 26 exhibit the same pattern of climbing readings. Lots of particulate matter in sample.)
1/10	1002	salt	2	Values match each other (duplicates) and CTD data. (Analyst: Salts 25 and 26 exhibit the same pattern of climbing readings. Lots of particulate matter in sample.)
1/10	1005	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 29 - Readings kept increasing. High particle count in sample.)
1/10	1007	bottle	2	Niskin leaky.
1/10	1008	bottle	2	Niskin leaky.
1/10	1009	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 33 - Thimble popped out early. Reading kept climbing. Probable contamination.)
1/10	1012	bottle	2	Niskin leaky.
1/11	1109	bottle	2	Niskin top not sealed, leaky.
1/11	1109	o2	3	Value low, does not match duplicate or CTD data. No analytical errors noted.
1/13	1302	bottle	2	Niskin leaky.
1/13	1304	salt	2	Deep cast, value is within 0.001 of CTD data. (Analyst: Salt 16 - Thimble popped out while cap was being removed. Probable contamination. Should be closer to salt 15 in value.)
1/13	1309	bottle	2	Niskin top not sealed, leaky.
1/14	1407	dfe2_mops	5	sample lost due to broken tubing
1/14	1409	dfe2_mops	5	sample lost due to broken tubing
1/14	1411	dfe2_mops	5	sample lost due to broken tubing
1/14	1415	dfe2_mops	5	sample lost due to broken tubing
1/14	1419	dfe2_mops	5	sample lost due to broken tubing
1/14	1421	dfe2_mops	5	sample lost due to broken tubing
1/14	1423	dfe2_mops	5	sample lost due to broken tubing
1/15	1504	o2	3	deep bottle o2 appears to be slightly high (1.5 umol/kg) vs nearby bottles and CTD; code questionable.

Station /Cast	Sample No.	Property	Quality Code	Comment
1/15	1508	bottle	2	Niskin leaky.
1/15	1509	salt	2	Deep cast, value within 0.002 of CTD data. (Analyst: Salt 9 - thimble came out and water poured from thimble down bottle. Contaminated. Watched 5 samples increase each read. Suspect actual reading should be closer to 1.98428)
1/25	2525	bottle	2	CTD data for Surface FISH sample from 001/04 (30-ODF) down-cast.
2/1	101	bottle	2	Leaking from spigot.
2/1	102	dfe2_syr	6	Reported as GT No. 2252, but assume it is 2253.
2/1	105	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 5 - Thimble loosened by cap threads. Very wet. Possible contamination.)
2/1	106	dfe2_syr	2	Duplicate values reported, used first value
2/1	110	dfe2_syr	2	Duplicate values reported, used first value
2/1	113	dfe	2	Note: Calibrated for higher concentrations
2/1	114	dfe2_syr	6	Reported as GT No. 2559, corrected to 2259
2/1	117	dfe	2	Note: Calibrated for higher concentrations
2/1	118	dfe2_syr	2	Duplicate values reported, used first value
2/1	121	bottle	2	Air leaking from top ball.
2/1	121	dfe	2	Note: Calibrated for higher concentrations
2/1	122	dfe2_syr	2	Duplicate values reported, used first value
2/2	204	bottle	2	Niskin leaky.
2/2	208	bottle	2	Niskin leaky.
2/2	211	sbe35rt	3	SBE35RT +0.07/-0.02 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
2/5	501	bottle	4	Bottle did not close: 3 NO-confirms, with carousel repositioned between each attempt.
2/5	502	bottle	4	Bottle did not close: 3 NO-confirms, with carousel repositioned between each attempt.
2/5	503	bottle	4	Bottle did not close: 3 NO-confirms, with carousel repositioned between each attempt.
2/5	504	bottle	4	Bottle did not close: 3 NO-confirms, with carousel repositioned between each attempt.
2/5	512	bottle	9	Bottle closed, but no samples collected.
2/25	2525	bottle	2	CTD data for Surface FISH sample from 002/05 (30-ODF) up-cast.
2/25	2525	dfe	2	Note: Calibrated for higher concentrations
3/1	103	dfe	2	Note: Calibrated for higher concentrations
3/1	104	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 4 - Thimble came out with cap. Thimble and cap were full of brackish water. Probable contamination.)
3/1	107	dfe	2	Note: Calibrated for higher concentrations
3/1	109	dfe	2	Note: Calibrated for higher concentrations
3/1	113	bottle	2	Still leaking from top ball.
3/1	113	dfe	2	Note: Calibrated for higher concentrations
3/1	113	no2	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	113	no3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	113	po4	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	113	salt	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.

Station /Cast	Sample No.	Property	Quality Code	Comment
3/1	113	sio3	3	Values should be duplicates but are approx. 2uM different. Not sure which is correct.
3/1	114	sio3	3	Values should be duplicates but are approx. 2uM different. Not sure which is correct.
3/1	115	dfe	2	Note: Calibrated for higher concentrations
3/1	115	dfe2_btl	5	No data (ND) reported
3/1	115	no2	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	115	no3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	115	po4	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	115	salt	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	115	sio3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	119	dfe	2	Note: Calibrated for higher concentrations
3/1	119	no2	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	119	no3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	119	po4	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	119	salt	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	119	sio3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	121	dfe	2	Note: Calibrated for higher concentrations
3/1	121	no2	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	121	no3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	121	po4	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	121	salt	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/1	121	sio3	2	Sampled out of sequence. File fixed so that values match duplicates and CTD data.
3/5	504	bottle	4	Bottle did not close: repositioned carousel twice, total 3x NO-confirms.
3/5	510	o2	3	Bottle close to surface bottle value, appears to be too high for sharp gradient on both down and up casts. Analyst noted no obvious errors.
3/5	510	sbe35rt	3	SBE35RT +0.105/+0.065 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
3/5	512	bottle	4	Bottle did not close, but did confirm.
3/7	704	bottle	4	Bottle did not close; confirmed, but apparent mechanical issue with carousel.
3/7	709	sbe35rt	3	SBE35RT +0.025/-0.045 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
3/7	710	bottle	4	Bottle did not close; confirmed, but apparent mechanical issue with carousel.

Station /Cast	Sample No.	Property	Quality Code	Comment
3/7	712	bottle	4	Bottle did not close; confirmed, but apparent mechanical issue with carousel.
3/25	2525	bottle	2	CTD data for Surface FISH sample from 003/07 (30-ODF) up-cast.
3/25	2525	dfe	2	Analyzed separately with calibration for lower concentrations
4/1	107	bottle	2	Air leak.
4/1	113	dfe	2	Verified with repeat analysis
4/1	115	dfe2_btl	5	No data (ND) reported
4/1	117	dfe2_btl	5	No data (ND) reported
4/1	119	dfe2_btl	5	No data (ND) reported
4/1	122	bottle	2	Leaked when pressurized, snapped ball.
4/2	206	bottle	4	Mistrip: deck saw bottle trip at surface.
4/2	206	no2	4	Mistrip.
4/2	206	no3	4	Mistrip.
4/2	206	o2	4	Mistrip.
4/2	206	po4	4	Mistrip.
4/2	206	salt	4	Mistrip.
4/2	206	sio3	4	Mistrip.
4/4	403	bottle	2	Niskin leaky.
4/4	412	bottle	2	Niskin leaky.
4/4	413	corer	2	some sediments recovered, but partially emptied upon retrieval.
4/25	2525	bottle	2	CTD data for Surface FISH sample from 004/04 (30-ODF) up-cast.
5/1	109	dfe2_btl	5	never analyzed
5/1	111	dfe2_btl	5	never analyzed
5/1	115	dfe	2	Verified with repeat analysis
5/1	116	dfe2_syr	5	never analyzed
5/2	205	o2	4	Flask 696 neck cracked. Value high, probable exposure to air.
5/2	205	salt	2	Value matches CTD. (Analyst: Salt 5 - readings erratic and unpredictably variable.)
5/2	209	salt	2	Value approx. 0.003 low compared to CTD data; gradient. (Analyst: Salt 9 - Readings kept climbing.)
5/2	212	bottle	2	Niskin bottom seal leak.
5/4	410	sbe35rt	3	SBE35RT -0.08 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
5/4	412	bottle	2	Niskin leaky.
5/5	509	no2	2	Sampling error, drawn into tube 11.
5/5	509	no3	2	Sampling error, drawn into tube 11.
5/5	509	po4	2	Sampling error, drawn into tube 11.
5/5	509	salt	2	Sampling error, drawn into tube 11.
5/5	509	sio3	2	Sampling error, drawn into tube 11.
5/5	511	dfe	2	Verified with repeat analysis
5/5	511	no2	5	Sampling error, none drawn.
5/5	511	no3	5	Sampling error, none drawn.
5/5	511	po4	5	Sampling error, none drawn.
5/5	511	salt	5	Sampling error, none drawn.
5/5	511	sio3	5	Sampling error, none drawn.
5/5	513	no2	3	Values should be duplicates but are approx. 1.2uM different. Not sure which is correct.
5/5	513	no3	3	Values should be duplicates but are approx. 3uM different. Not sure which is correct.
5/5	514	no2	3	Values should be duplicates but are approx. 1.2uM different. Not sure which is correct.

Station /Cast	Sample No.	Property	Quality Code	Comment
5/5	514	no3	3	Values should be duplicates but are approx. 3uM different. Not sure which is correct.
5/5	515	bottle	2	Handle leaking.
5/5	516	dfe2_syr	5	never analyzed
5/5	520	bottle	4	Did not fire.
5/6	603	bottle	2	Niskin leaky.
5/6	612	bottle	2	Niskin leaking badly. Water feels anomalously warm.
5/6	613	corer	5	no sediments recovered from corer.
5/25	2525	bottle	2	CTD data for Surface FISH sample from 005/06 (30-ODF) up-cast.
6/1	120	bottle	4	GoFlo in position 20 did not fire. No samples taken.
6/1	121	salt	2	samples recorded during salt run were labeled 20-23, but goflo position 20 was not sampled. re-aligned samples with correct depth, all samples now agree with CTD values.
6/1	122	salt	2	samples recorded during salt run were labeled 20-23, but goflo position 20 was not sampled. re-aligned samples with correct depth, all samples now agree with CTD values.
6/1	123	salt	2	samples recorded during salt run were labeled 20-23, but goflo position 20 was not sampled. re-aligned samples with correct depth, all samples now agree with CTD values.
6/1	124	salt	2	samples recorded during salt run were labeled 20-23, but goflo position 20 was not sampled. re-aligned samples with correct depth, all samples now agree with CTD values.
6/2	203	bottle	2	Niskin leaky.
6/25	2525	bottle	2	CTD data for Surface FISH sample from 006/02 (30-ODF) up-cast.
7/2	203	bottle	2	Niskin slightly leaky, bottom end cap.
7/2	211	bottle	2	Niskin slightly leaky, bottom end cap.
7/5	523	dfe2_btl	5	never analyzed
7/6	602	bottle	2	Niskin slightly leaky.
7/8	807	salt	4	Value approx. 0.01 high compared to duplicate and CTD data. (Analyst: Salt 7 - Readings very erratic and slow to stabilize.)
7/8	814	bottle	4	Mistrip.
7/8	814	no2	4	Other nutrient values high compared to duplicate.
7/8	814	no3	4	Value high compared to duplicate.
7/8	814	po4	4	Value high compared to duplicate.
7/8	814	salt	4	Value approx. 0.005 lower than duplicate. Mistrip.
7/8	814	sio3	4	Value high compared to duplicate.
7/11	1109	dfe2_btl	5	never analyzed
7/11	1119	dfe	2	Verified with repeat analysis
7/11	1123	dfe	2	Verified with repeat analysis
7/12	1203	bottle	2	Bottom cap leak.
7/12	1211	bottle	2	Bottom cap leak.
7/12	1212	bottle	4	Bottle did not close.
7/25	2525	bottle	2	CTD data for Surface FISH sample from 007/05 (GT-C) up-cast.
8/2	201	bottle	2	Slight bottom cap leak.
8/2	203	bottle	2	Niskin bottom leak.
8/2	210	sbe35rt	3	SBE35RT -0.03 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
8/25	2525	bottle	2	CTD data for Surface FISH sample from 008/02 (30-ODF) up-cast.
9/1	105	dfe2_btl	2	Duplicate values reported, used first value
9/2	203	bottle	2	Bottom cap leak.
9/4	403	bottle	2	Bottom cap leak.

Station /Cast	Sample No.	Property	Quality Code	Comment
9/4	408	sbe35rt	3	SBE35RT -0.10/-0.11 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
9/4	410	salt	2	Value matches CTD data (Analyst: Salt 10 - Readings erratic.)
9/6	609	sbe35rt	3	SBE35RT +0.11/-0.40 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
9/9	905	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 5 - Thimble came out with cap. Readings erratic.)
9/9	913	dfe	2	Verified with repeat analysis
9/9	919	bottle	2	Top ball not seated properly, snapped.
9/10	1011	bottle	2	Slight leak from bottom end cap.
9/25	2525	bottle	2	CTD data for Surface FISH sample from 009/05 (GT-C) up-cast.
10/1	103	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 10 - Thimble came out with cap. Readings rose rapidly during first sample. Possible contamination.)
10/1	108	no2	2	nut tubes 8 and 10 apparently both sampled from goflo in position 8.
10/1	108	no3	2	nut tubes 8 and 10 apparently both sampled from goflo in position 8.
10/1	108	po4	2	nut tubes 8 and 10 apparently both sampled from goflo in position 8.
10/1	108	sio3	2	nut tubes 8 and 10 apparently both sampled from goflo in position 8.
10/1	110	no2	2	nut tube 12 apparently sampled from goflo in position 10.
10/1	110	no3	2	nut tube 12 apparently sampled from goflo in position 10.
10/1	110	po4	2	nut tube 12 apparently sampled from goflo in position 10.
10/1	110	sio3	2	nut tube 12 apparently sampled from goflo in position 10.
10/1	112	no2	5	goflo in position 12 apparently not sampled.
10/1	112	no3	5	goflo in position 12 apparently not sampled.
10/1	112	po4	5	goflo in position 12 apparently not sampled.
10/1	112	sio3	5	goflo in position 12 apparently not sampled.
10/2	203	bottle	2	Leak at bottle end cap.
10/2	207	sbe35rt	3	SBE35RT +0.03 vs CTDT1/CTDT2; unstable SBE35RT reading.
10/2	209	sbe35rt	3	SBE35RT +0.025 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
10/2	210	sbe35rt	3	SBE35RT -0.04/-0.03 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
10/2	211	bottle	2	Leak at bottle end cap.
10/25	2525	bottle	2	CTD data for Surface FISH sample from 010/02 (30-ODF) up-cast.
11/1	106	salt	2	Deep cast. Value within 0.002 of duplicate. (Analyst: Salt 6 - Readings erratic.)
11/1	111	salt	3	Value approx. 0.005 lower than duplicate.
11/1	119	dfe2_btl	2	3514+1h: value was 0.00
11/4	409	sbe35rt	3	SBE35RT -0.28/-0.33 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
11/4	411	bottle	2	Bottom cap leak.
11/5	512	dfe2_syr	5	never analyzed
11/6	604	sbe35rt	3	SBE35RT -0.08/-0.075 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
11/6	605	sbe35rt	3	SBE35RT -0.095/-0.085 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
11/6	611	bottle	2	Slight leak at bottom end cap.
11/6	612	bottle	2	Slight leak at bottom end cap.
11/8	803	bottle	2	Bottom end cap leak.
11/8	811	bottle	2	Bottom end cap leak.
11/9	904	dfe2_syr	5	never analyzed

Station /Cast	Sample No.	Property	Quality Code	Comment
11/9	915	dfe	2	Verified with repeat analysis
11/9	917	dfe	2	Verified with repeat analysis
11/9	924	dfe2_syr	4	first sample; bubble in line
11/10	1001	bottle	2	Bottom end cap leak.
11/10	1002	bottle	2	Top end cap leak.
11/10	1004	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 28 - Thimble popped out wet. Possible contamination.)
11/11	1103	bottle	2	Bottom end cap leak.
11/11	1108	bottle	2	Big leak on bottom end cap.
11/11	1111	bottle	2	Top end cap leak.
11/13	1307	bottle	2	Bottom end cap leak.
11/13	1310	bottle	4	Bottle did not close, lanyard on wrong latch.
11/13	1312	bottle	2	Slight bottom end cap leak.
11/25	2525	bottle	2	CTD data for Surface FISH sample from 011/05 (GT-C) up-cast.
11/25	2525	dfe	2	Verified with repeat analysis
12/25	2525	bottle	2	CTD data for Surface FISH sample from 012/02 (30-ODF) up-cast.
13/1	119	bottle	4	mistrip: nutrients revealed incorrect values.
13/1	119	dfe2_btl	4	anomalous high value: bottle mis-tripped.
13/1	119	no2	4	mistrip.
13/1	119	no3	4	mistrip.
13/1	119	po4	4	mistrip.
13/1	119	salt	4	mistrip.
13/1	119	sio3	4	mistrip.
13/1	120	bottle	4	mistrip: nutrients revealed incorrect values.
13/1	120	no2	4	mistrip.
13/1	120	no3	4	mistrip.
13/1	120	po4	4	mistrip.
13/1	120	salt	4	mistrip.
13/1	120	sio3	4	mistrip.
13/1	121	dfe	2	Verified with repeat analysis
13/1	122	bottle	2	Leaked when bottom recovered, ball re-snapped in van.
13/2	201	salt	3	Values approx. 0.003 high compared to CTD data.
13/2	202	salt	3	Values approx. 0.003 high compared to CTD data.
13/2	206	bottle	2	Winch overshot NIS-6 firing depth by 11m, went back down to trip.
13/4	406	sbe35rt	3	SBE35RT -0.045/-0.04 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
13/5	501	dfe	2	Verified with repeat analysis
13/5	503	dfe	2	Verified with repeat analysis
13/5	508	dfe2_syr	4	mis-trip
13/6	608	sbe35rt	3	SBE35RT +0.07/+0.09 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
13/9	912	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 12 - Thimble came out with cap, very wet. Probably contamination.)
13/9	919	bottle	2	Bottle did not open all the way.
13/10	1005	salt	3	Value approx. 0.005 high compared to CTD data.
13/25	2525	bottle	2	CTD data for Surface FISH sample from 013/05 (GT-C) up-cast.
13/25	2525	dfe	2	Verified with repeat analysis
14/1	117	bottle	2	Lanyard tight.
14/2	208	sbe35rt	3	SBE35RT +0.025 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.

Station /Cast	Sample No.	Property	Quality Code	Comment
14/2	210	sbe35rt	3	SBE35RT +0.08/+0.075 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
14/25	2525	bottle	2	CTD data for Surface FISH sample from 014/02 (30-ODF) up-cast.
15/1	108	dfe2_syr	2	2 values reported, used the first value
15/1	112	dfe2_syr	2	2 values reported, used the first value
15/1	123	dfe	2	Verified with repeat analysis
15/2	203	salt	3	Value approx. 0.003 high compared to CTD data.
15/2	210	salt	2	Value matches CTD data. (Analyst: Salt 10 - Thimble popped out early. Probable contamination.)
15/5	523	dfe	2	Verified with repeat analysis
15/6	603	salt	2	Value matches CTD data. (Analyst: Salt 27 - Contamination, cause unknown.)
15/6	605	sbe35rt	3	SBE35RT -0.03 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
15/6	607	sbe35rt	3	SBE35RT -0.02/-0.03 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
15/9	910	dfe2_syr	2	2 values reported, used the first (A) value
15/9	912	dfe2_syr	2	2 values reported, used the first (A) value
15/9	916	dfe2_syr	2	2 values reported, used the first (A) value
15/9	921	dfe	2	Verified with repeat analysis
15/9	922	dfe2_syr	2	2 values reported, used the first (A) value
15/9	924	salt	4	Value is approx. 0.03 higher than duplicate and CTD data. (Analyst: Salt 24 - Readings erratic and kept climbing slowly.)
15/10	1011	sbe35rt	3	SBE35RT -0.015 vs CTDT1/CTDT2, reading seems stable, but large difference for this deep. Code questionable.
15/10	1013	bottle	4	Deck: Lost sediment core as corer came out of the water; "missed it by that much".
15/10	1013	corer	3	corer barrel shifted as it exited water, but some scrapped sediments saved from inside the barrel.
15/25	2525	bottle	2	CTD data for Surface FISH sample from 015/05 (GT-C) up-cast.
16/1	105	salt	3	Value is approx. 0.005 higher than duplicate. (Analyst: salt 5 - Readings kept climbing. Thimble came out full of water. Probable contamination.)
16/1	115	bottle	2	Leaked when removed air valves, re-snapped bottom ball.
16/2	208	sbe35rt	3	SBE35RT +0.025 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
16/25	2525	bottle	2	CTD data for Surface FISH sample from 016/02 (30-ODF) up-cast.
17/1	101	as_3	B	As(III) value <0.01, below detection limit
17/1	105	as_3	B	As(III) value <0.01, below detection limit
17/1	105	bottle	4	Mistrip.
17/1	105	no2	4	Potential mistrip, confirmed with salts.
17/1	105	no3	4	Potential mistrip, confirmed with salts.
17/1	105	po4	4	Potential mistrip, confirmed with salts.
17/1	105	salt	4	Value approx. 0.02 lower than duplicate, CTD data.
17/1	105	sio3	4	Potential mistrip, confirmed with salts.
17/1	106	dfe2_syr	5	missing label on syringe, not analyzed.
17/1	107	bottle	4	Bottom ball leaked, snapped in van. Nutrients revealed mistrip.
17/1	107	dfe	2	"Analytically sound, but questionable GoFlo bottle!"
17/1	107	no2	4	Mistrip.
17/1	107	no3	4	Mistrip.
17/1	107	po4	4	Mistrip.
17/1	107	salt	4	Mistrip.

Station /Cast	Sample No.	Property	Quality Code	Comment
17/1	107	sio3	4	Mistrip.
17/1	109	bottle	2	Bottom ball leaks when pressurized.
17/1	113	as_3	B	As(III) value <0.01, below detection limit
17/1	113	dfe	2	Verified with repeat analysis
17/1	116	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 16 - Thimble came out with cap, very wet. Suspect liquid from thimble ran into bottle.)
17/1	120	bottle	4	Mistrip revealed with nutrient data.
17/1	120	dfe2_syr	4	Mis-trip
17/1	120	no2	4	Mistrip.
17/1	120	no3	4	Mistrip.
17/1	120	po4	4	Mistrip.
17/1	120	salt	4	Mistrip.
17/1	120	sio3	4	Mistrip.
17/1	122	salt	3	Value approx. 0.005 lower than duplicate.
17/4	404	sbe35rt	3	SBE35RT -0.105/-0.125 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
17/5	505	bottle	4	Mistrip revealed by nutrient and salt data.
17/5	505	no2	4	Other nutrient values low compared to duplicate, mistrip.
17/5	505	no3	4	Value low compared to duplicate, mistrip.
17/5	505	po4	4	Value low compared to duplicate, mistrip.
17/5	505	salt	4	Value approx. 0.06 higher than duplicate, mistrip.
17/5	505	sio3	4	Value low compared to duplicate, mistrip.
17/5	511	salt	3	Value approx. 0.01 higher than duplicate, gradient.
17/6	608	sbe35rt	3	SBE35RT -0.045/-0.055 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
17/6	610	sbe35rt	3	SBE35RT -0.025/-0.035 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
17/8	803	bottle	4	Mistrip revealed with nutrient data.
17/8	803	dfe	2	"Analytically sound, but questionable GoFlo bottle!"
17/8	803	no2	4	Mistrip.
17/8	803	no3	4	Mistrip.
17/8	803	po4	4	Mistrip.
17/8	803	salt	4	Mistrip.
17/8	803	sio3	4	Mistrip.
17/8	807	as_3	B	As(III) value <0.01, below detection limit
17/8	809	as_3	B	As(III) value <0.01, below detection limit
17/8	809	bottle	2	Leaked from bottom, snapped bottom ball.
17/8	810	salt	4	Value is approx. 0.006 higher than duplicate. (Analyst: Salt 10 - Thimble came out with cap, dry salt present. Possible contamination.)
17/8	811	as_3	B	As(III) value <0.01, below detection limit
17/8	813	bottle	2	Snapped bottom ball, leaking.
17/8	813	dfe	2	"Analytically sound, but questionable GoFlo bottle!"
17/8	815	as_3	B	As(III) value <0.01, below detection limit
17/8	815	bottle	2	Leaky spigot.
17/8	815	dfe	2	Verified with repeat analysis
17/8	817	as_3	B	As(III) value <0.01, below detection limit
17/8	820	bottle	9	Spigot broke off, no samples taken.
17/9	902	bottle	2	Leaky spigot. Post-sampling, discovered spine leak in NIS-2; replaced with NIS-22 before station 18.
17/25	2525	bottle	2	CTD data for Surface FISH sample from 017/05 (GT-C) up-cast.
18/2	201	bottle	4	Nutrient data revealed mistrip.

Station /Cast	Sample No.	Property	Quality Code	Comment
18/2	201	no2	4	Mistrip.
18/2	201	no3	4	Mistrip.
18/2	201	po4	4	Mistrip.
18/2	201	salt	4	Mistrip.
18/2	201	sio3	4	Mistrip.
18/2	207	bottle	4	Re-snapped top ball. Nutrients revealed mistrip.
18/2	207	no2	4	Mistrip.
18/2	207	no3	4	Mistrip.
18/2	207	po4	4	Mistrip.
18/2	207	salt	4	Mistrip.
18/2	207	sio3	4	Mistrip.
18/2	221	bottle	4	Nutrient data revealed mistrip.
18/2	221	no2	4	Mistrip.
18/2	221	no3	4	Mistrip.
18/2	221	po4	4	Mistrip.
18/2	221	salt	4	Mistrip.
18/2	221	sio3	4	Mistrip.
18/2	223	as_3	B	As(III) value <0.01, below detection limit
18/2	223	bottle	2	Noise from spigot.
18/2	224	bottle	2	Still leaking when pressurized.
18/4	407	sbe35rt	3	SBE35RT +0.045/+0.025 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
18/5	507	bottle	2	Snap top ball.
18/5	516	bottle	2	Leaking from bottom when air plug removed.
18/5	521	dfe	2	"Analytically sound, but questionable GoFlo bottle!"
18/5	523	bottle	2	Making noise, bottom ball.
18/6	604	sbe35rt	3	SBE35RT -0.05/-0.085 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
18/6	606	sbe35rt	3	SBE35RT -0.035/-0.03 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
18/9	911	bottle	3	Value approx. 0.005 higher than duplicate.
18/9	913	bottle	2	Leaky spigot.
18/9	919	bottle	2	Neoprene rubber broke.
18/11	1112	sbe35rt	3	SBE35RT -0.025 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading.
18/13	1305	bottle	2	Large nipples still pushed in and dripping on recovery.
18/13	1306	bottle	2	Large nipples still pushed in and dripping on recovery.
18/13	1308	sbe35rt	3	SBE35RT +0.02/-0.03 vs CTDT1/CTDT2; all 3 readings disagree, in a gradient. Only coded SBE35RT questionable.
18/13	1309	sbe35rt	3	SBE35RT -0.75/-0.055 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
18/13	1310	sbe35rt	3	SBE35RT -0.02/-0.04 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
18/14	1411	salt	3	Value approx. 0.006 higher than duplicate.
18/14	1413	as_3	B	As(III) value <0.01, below detection limit
18/14	1417	dfe	2	Verified with repeat analysis
18/14	1419	as_3	B	As(III) value <0.01, below detection limit
18/14	1420	bottle	2	Leaked about 1 liter.
18/14	1422	salt	4	Value is approx. 0.003 higher than duplicate. (Analyst: Salt 22 - Thimble came out with cap. Probable contamination.)

Station /Cast	Sample No.	Property	Quality Code	Comment
18/17	1704	bottle	2	dFeII sample collected in a bottle, later filtered in the lab by J.Moffett (not the same as Acropak-filtered on GT-C GoFlos).
18/17	1705	bottle	2	dFeII sample collected in a bottle, later filtered in the lab by J.Moffett (not the same as Acropak-filtered on GT-C GoFlos). Remainder sample pressure-filtered through 0.45um/47mm diam. Supor Filter, 15L collected in 20L cubitainer for Th/Pa/Nd/REE/LDEO_Archive (may be separated into 3 distinct samples after returning to LDEO). 60mL removed from cubitainer for Th/Pa colloids, acidified w/Saville-distilled 6M HCl. Filter/particles saved for Sherrell Partic.TM analysis.
18/17	1706	bottle	2	dFeII sample collected in a bottle, later filtered in the lab by J.Moffett (not the same as Acropak-filtered on GT-C GoFlos).
18/25	2525	bottle	2	CTD data for Surface FISH sample from 018/05 (GT-C) up-cast.
19/1	101	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	102	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	103	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	104	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	105	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	106	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	107	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	108	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	109	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	110	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	111	noaa_uf	B	Mn is less than 0.35nM - below detection limit
19/1	112	noaa_uf	B	Mn is less than 0.35nM - below detection limit
20/1	107	salt	3	Value approx. 0.004 higher than duplicate.
20/1	117	as_3	B	As(III) value <0.01, below detection limit
20/5	506	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 6 - Thimble came out with cap, wet. Readings erratic. Probable contamination.)
20/8	804	salt	3	Value approx. 0.006 higher than duplicate.
20/25	2525	bottle	2	CTD data for Surface FISH sample from 020/05 (GT-C) up-cast.
21/1	106	bottle	2	Spigot leaky.
21/5	503	dfe	2	Verified with repeat analysis
21/5	517	bottle	2	Shrimp in bottle ended up in Acropak, removed before sampling.
21/5	517	dfe	2	Verified with repeat analysis
21/6	607	sbe35rt	3	SBE35RT -0.02/+0.01 vs CTDT1/CTDT2; all 3 readings disagree, in a gradient. Only coded SBE35RT questionable.
21/8	801	as_3	B	As(III) value <0.01, below detection limit
21/8	813	dfe	2	Verified with repeat analysis
21/8	821	as_3	B	As(III) value <0.01, below detection limit
21/9	913	corer	2	very little sediment recovered, probably due to sediment leaking out on its way up.
21/25	2525	bottle	2	CTD data for Surface FISH sample from 021/05 (GT-C) up-cast.
22/2	205	sbe35rt	3	SBE35RT -0.035 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
22/2	207	sbe35rt	3	SBE35RT -0.02/-0.03 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
22/25	2525	bottle	2	CTD data for Surface FISH sample from 022/02 (ODF) up-cast.
23/2	218	salt	3	Value approx. 0.008 higher than duplicate and CTD data.
23/6	609	bottle	4	Bottle did not close, lanyard caught on latch.
23/6	610	sbe35rt	3	SBE35RT -0.045/-0.05 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.

Station /Cast	Sample No.	Property	Quality Code	Comment
23/9	904	salt	3	Value approx. 0.013 higher than duplicate and CTD data.
23/10	1013	corer	2	very little sediment recovered, probably due to sediment leaking out on its way up.
24/2	206	sbe35rt	3	SBE35RT -0.035 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
25/1	109	salt	3	Value approx. 0.008 higher than duplicate and CTD data.
25/2	208	sbe35rt	3	SBE35RT +0.003 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading for deep data.
25/2	211	sbe35rt	3	SBE35RT +0.004 vs CTDT1/CTDT2; unstable SBE35RT reading for deep data.
25/4	406	sbe35rt	3	SBE35RT -0.04 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
25/8	804	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/8	807	salt	3	Value approx. 0.005 higher than duplicate and CTD data.
25/8	809	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/8	814	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/8	816	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/8	821	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/8	823	salt	3	Value approx. 0.004 higher than duplicate and CTD data.
25/9	908	bottle	2	Leaky.
25/9	908	salt	3	Value approx. 0.003 higher than expected based on CTD trace.
26/1	103	salt	3	Value approx. 0.013 lower than duplicate and CTD data.
26/1	122	salt	3	Value approx. 0.005 higher than duplicate and CTD data.
26/2	208	bottle	2	Leaky.
26/10	1008	bottle	2	Bottom end cap leak.
26/10	1009	salt	3	Value approx. 0.003 higher than duplicate and CTD data. (Analyst: Salt 33 - Thimble came out with cap. Possible contamination.)
26/11	1103	salt	2	Value corresponds with CTD trace. (Analyst: Salt 3 - Thimble came out with cap. Wet. Probable contamination.)
26/11	1104	salt	3	Value approx. 0.008 higher than duplicate and CTD data.
26/11	1110	salt	3	Value approx. 0.013 higher than duplicate and CTD data.
26/12	1208	salt	3	Value approx. 0.004 lower than duplicate and CTD data.
26/17	1706	salt	2	Value matches CTD data. (Analyst: Salt 6 - Thimble came out with cap. Probable contamination.)
27/1	103	salt	4	Value approx. 0.006 higher than duplicate and CTD data. (Analyst: Salt 3 - Thimble popped half way out early, full of water. Possible contamination.)
28/1	110	salt	4	Value approx. 0.008 higher than duplicate and CTD data. (Analyst: Salt 10 - Thimble came out with cap, full of water. Possible contamination.)
28/1	113	bottle	2	Did not slow down to trip bottles.
28/1	114	bottle	2	Did not slow down to trip bottles.
28/1	121	salt	2	Value matches duplicate and CTD data. (Analyst: Salt 21 - Thimble came out with cap, full of water. Probable contamination.)
28/4	405	sbe35rt	3	SBE35RT +0.04 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
28/4	406	sbe35rt	3	SBE35RT -0.04 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
28/4	407	sbe35rt	3	SBE35RT -0.01/-0.03 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
28/5	522	salt	3	Value approx. 0.003 higher than duplicate and CTD trace.

Station /Cast	Sample No.	Property	Quality Code	Comment
28/6	607	sbe35rt	3	SBE35RT +0.05/-0.01 vs CTDT1/CTDT2, and CTDS1-CTDS2 are stable; SBE35RT reading coded questionable.
28/8	801	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 1 tripped at the shallowest level instead of the deepest. CTD trip data modified to realign bottles with proper trip depths.
28/8	803	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 3 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	805	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 5 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	806	bottle	4	Mistrip confirmed with salt and nutrient data.
28/8	806	no2	4	Mistrip.
28/8	806	no3	4	Mistrip.
28/8	806	po4	4	Mistrip.
28/8	806	salt	4	Mistrip. (Analyst: Salt 6 - Readings erratic.)
28/8	806	sio3	4	Mistrip.
28/8	807	bottle	4	Unrelated to lanyard issue, this bottle is a mistrip (mtm). nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 7 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	807	no2	4	Mistrip.
28/8	807	no3	4	Mistrip.
28/8	807	po4	4	Mistrip.
28/8	807	salt	4	Mistrip.
28/8	807	sio3	4	Mistrip.
28/8	809	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 9 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	811	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 11 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	813	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 13 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	815	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 15 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	817	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 17 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.

Station /Cast	Sample No.	Property	Quality Code	Comment
28/8	819	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 19 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	821	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 21 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
28/8	823	bottle	2	nutrient, salt and dfe data indicate "odd" (Acropak) goflos hooked onto carousel latches with wrong "even" (membrane) goflos; sample 23 tripped one level deeper than intended. CTD trip data modified to realign bottles with proper trip depths.
29/1	109	salt	2	Value approx. 0.005 lower than duplicate; gradient. (Analyst: Salt 9 - Thimble came out with cap. Possible contamination.)
29/1	114	bottle	2	Had to re-snap ball.
29/2	205	sbe35rt	3	SBE35RT +0.025 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
29/2	206	sbe35rt	3	SBE35RT +0.03/+0.02 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
29/2	207	sbe35rt	3	SBE35RT +0.06 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
30/2	212	salt	2	Value matches CTD data. (Analyst: Salt 12 - Thimble came out with cap. Possible contamination.)
30/4	405	sbe35rt	3	SBE35RT +0.075/+0.085 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
30/5	511	bottle	2	Did not spit.
30/5	521	bottle	2	Did not spit.
30/5	521	salt	3	Value is approx. 0.016 higher than duplicate and CTD trace.
30/5	523	bottle	2	Did not spit.
30/6	611	bottle	2	Niskin leaking at top.
30/8	801	bottle	2	Did not spit.
30/8	806	bottle	4	Mistrip confirmed with nutrient and salt data.
30/8	806	no2	4	Mistrip.
30/8	806	no3	4	Mistrip.
30/8	806	po4	4	Mistrip.
30/8	806	salt	4	Value approx. 0.016 lower than duplicate and CTD trace. Mistrip.
30/8	806	sio3	4	Mistrip.
30/8	819	bottle	2	Did not spit, leaky spigot.
30/8	821	bottle	2	Did not spit.
30/8	823	bottle	2	Leaky spigot.
30/8	824	salt	2	Value matches duplicate and CTD trace. (Analyst: Salt 24 - Thimble came out with cap. Probable contamination.)
30/10	1003	bottle	2	Did not spit.
30/10	1004	salt	3	Value approx. 0.006 higher than duplicate and CTD trace.
30/10	1006	salt	3	Value approx. 0.003 higher than duplicate. (Analyst: Salt 6 - Thimble came out with cap. Probable contamination.)
30/10	1009	bottle	2	Did not spit.
30/10	1017	bottle	2	Did not spit.
31/1	104	bottle	2	GF#03 Had to re-snap bottom ball, leaking outside.
31/1	109	bottle	2	GF#08 did not spit.
31/1	115	bottle	2	GF#18 did not spit.

Station /Cast	Sample No.	Property	Quality Code	Comment
31/1	121	bottle	2	GF#21 did not spit.
31/2	206	sbe35rt	3	SBE35RT +0.04/+0.03 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
32/5	515	bottle	2	GF#29 did not spit much.
32/5	519	bottle	2	GF#33 did not spit.
32/5	523	bottle	2	GF#01 did not spit much.
32/9	901	bottle	2	GF#05 did not spit.
32/9	904	salt	3	Value approx. 0.005 higher than duplicate and CTD trace.
32/9	909	bottle	2	GF#19 top ball leaking.
32/9	917	salt	4	Value approx. 0.012 higher than duplicate and CTD trace. (Analyst: Salt 17 - Thimble came out with cap. Wet. Readings erratic. Probable contamination.)
32/9	921	bottle	2	GF#01 did not spit.
32/9	921	salt	4	Value approx. 0.006 higher than duplicate and CTD trace. (Analyst: Salt 21 - Thimble popped out early. Readings erratic. Possible contamination.)
32/9	923	bottle	2	GF#03 did not spit.
33/1	123	bottle	2	GF#05 did not spit.
33/2	207	sbe35rt	3	SBE35RT -0.025/-0.04 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
34/1	117	bottle	2	GF#01 did not spit.
34/1	119	bottle	2	GF#03 did not spit.
34/1	120	salt	3	Value approx. 0.004 higher than duplicate and CTD trace.
34/1	121	bottle	2	GF#05 did not spit.
34/2	206	sbe35rt	3	SBE35RT -0.025/-0.03 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
34/2	211	bottle	2	Leaky top cap.
34/5	513	salt	2	Value matches duplicate and CTD trace. (Analyst: Salt 13 - Thimble loose in bottle. Possible contamination.)
34/5	515	bottle	2	GF#01 did not spit.
34/5	519	bottle	2	GF#05 did not spit.
34/6	606	o2	3	May be a duplicate draw from niskin 5.
35/1	113	bottle	2	GF#01 did not spit.
35/1	117	bottle	2	GF#05 did not spit.
35/1	121	bottle	2	GF#11 did not spit at all.
35/2	205	sbe35rt	3	SBE35RT -0.06/-0.055 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
35/2	208	sbe35rt	3	SBE35RT +0.045/+0.05 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
35/2	212	o2	5	Flask broken, sample lost.
36/1	101	as_3	B	As(III) value <0.01, below detection limit
36/1	103	as_3	B	As(III) value <0.01, below detection limit
36/1	106	as_3	B	As(III) value <0.01, below detection limit
36/1	108	as_3	B	As(III) value <0.01, below detection limit
36/1	110	as_3	B	As(III) value <0.01, below detection limit
36/1	110	salt	2	Value matches duplicate and CTD trace. (Analyst: Salt 10 - Thimble came out with cap. Wet. Probable contamination.)
36/1	112	as_3	B	As(III) value <0.01, below detection limit
36/1	113	as_3	B	As(III) value <0.01, below detection limit
36/1	113	bottle	2	GF#03 leaking, snapped bottom ball, did not spit.
36/1	114	bottle	2	GF#18 stop cock leaking.
36/1	115	bottle	2	GF#05 did not spit.

Station /Cast	Sample No.	Property	Quality Code	Comment
36/1	116	as_3	B	As(III) value <0.01, below detection limit
36/1	118	as_3	B	As(III) value <0.01, below detection limit
36/1	120	as_3	B	As(III) value <0.01, below detection limit
36/1	121	bottle	2	GF#13 did not spit much.
36/1	121	salt	2	Value matches duplicate and CTD trace. (Analyst: Salt 21 - Thimble came out with cap. Wet. Readings erratic. Possible contamination.)
36/1	122	as_3	B	As(III) value <0.01, below detection limit
36/1	124	as_3	B	As(III) value <0.01, below detection limit
36/1	124	salt	3	Value is approx. 0.005 higher than duplicate and CTD trace.
36/4	406	sbe35rt	3	SBE35RT +0.065/+0.075 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
36/4	408	sbe35rt	3	SBE35RT -0.025/-0.045 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
36/4	410	sbe35rt	3	SBE35RT -0.025 vs CTDT1/CTDT2; somewhat unstable SBE35RT reading in a gradient.
36/5	511	bottle	2	GF#03 did not spit.
36/5	513	bottle	2	GF#05 did not spit.
36/6	605	sbe35rt	3	SBE35RT -0.09 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
36/9	902	as_3	B	As(III) value <0.01, below detection limit
36/9	902	salt	4	Value is approx. 0.004 higher than duplicate and CTD trace. (Analyst: Salt 2 - Thimble came out with cap. Possible contamination.)
36/9	904	as_3	B	As(III) value <0.01, below detection limit
36/9	906	as_3	B	As(III) value <0.01, below detection limit
36/9	907	bottle	2	GF#01 did not spit much.
36/9	908	as_3	B	As(III) value <0.01, below detection limit
36/9	911	bottle	2	GF#05 did not spit.
36/9	912	as_3	B	As(III) value <0.01, below detection limit
36/9	913	bottle	2	GF#07 did not spit much.
36/9	914	as_3	B	As(III) value <0.01, below detection limit
36/9	916	as_3	B	As(III) value <0.01, below detection limit
36/9	917	bottle	2	GF#13 did not spit much.
36/9	918	as_3	B	As(III) value <0.01, below detection limit
36/9	920	as_3	B	As(III) value <0.01, below detection limit
36/9	922	as_3	B	As(III) value <0.01, below detection limit
36/9	923	bottle	2	GF#29 did not spit much.
36/9	924	as_3	B	As(III) value <0.01, below detection limit
36/11	1110	bottle	2	Bottom end cap leak.
36/11	1111	bottle	2	Bottom end cap leak.
36/13	1305	sbe35rt	3	SBE35RT +0.045 vs CTDT1/CTDT2; very unstable SBE35RT reading in a gradient.
36/13	1306	sbe35rt	3	SBE35RT -0.02 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
36/13	1307	sbe35rt	3	SBE35RT +0.08/+0.075 vs CTDT1/CTDT2; unstable SBE35RT reading in a gradient.
36/13	1310	bottle	2	Bottom end cap leak.
36/13	1311	bottle	2	Top end cap leak.

References

Joyc94.

Joyce, T., ed. and Corry, C., ed., “Requirements for WOCE Hydrographic Programme Data Reporting,” Report WHPO 90-1, WOCE Report No. 67/91, pp. 52-55, WOCE Hydrographic Programme Office, Woods Hole, MA, USA (May 1994, Rev. 2). UNPUBLISHED MANUSCRIPT.

Appendix D

U.S. GEOTRACES EPZT: Pre-Cruise Sensor Laboratory Calibrations

ODF/30L CTD 569 Sensors - Table of Contents

* data reported for these sensors during U.S. GEOTRACES EPZT

Pressure Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 0569
CALIBRATION DATE: 29-JUL-2013
Mfg: SEABIRD Model: 09P CTD Prs s/n: 75672

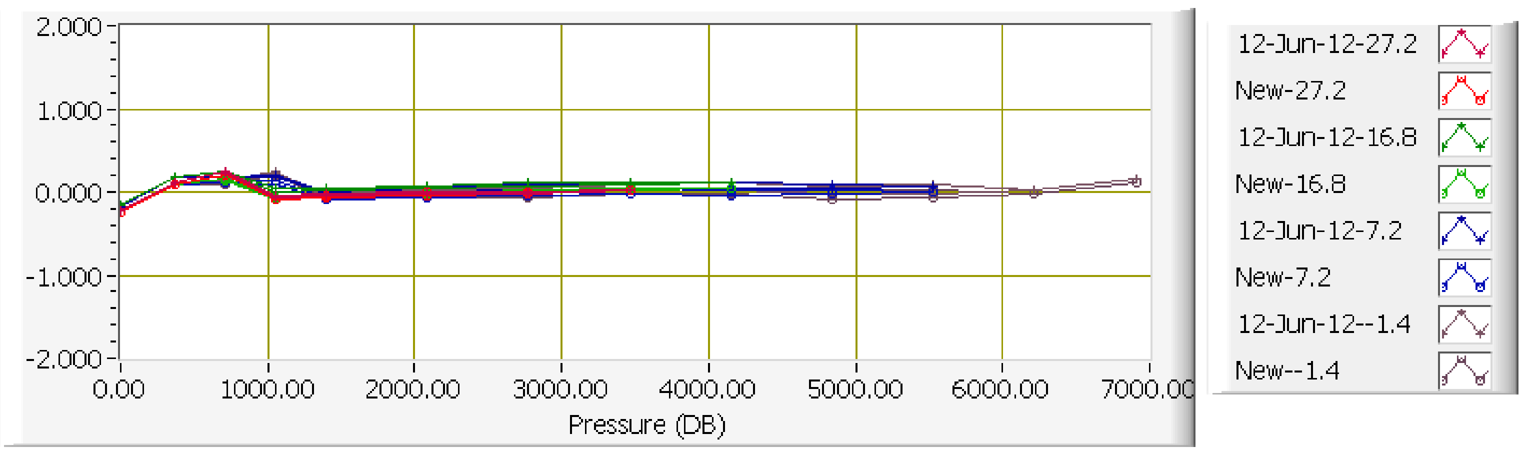
C1= -4.262217E+4
C2= -2.383807E-1
C3= 1.107273E-2
D1= 3.735278E-2
D2= 0.000000E+0
T1= 3.044501E+1
T2= -4.104917E-4
T3= 3.738515E-6
T4= 9.322246E-9
T5= 0.000000E+0
AD590M= 1.28617E-2
AD590B= -8.28826E+0
Slope = 1.00000000E+0
Offset = 0.00000000E+0

Calibration Standard: Mfg: RUSKA   Model: 2400   s/n: 34336
t0=t1+t2*td+t3*td*td+t4*td*td*td
w = 1-t0*t0*f*f
Pressure = (0.6894759*((c1+c2*td+c3*td*td)*w*(1-(d1+d2*td)*w)-14.7)

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
32861.133	0.16	0.42	-0.23	-0.26	28.57	27.235
33064.106	364.94	364.85	0.12	0.09	28.59	27.235
33254.414	709.11	708.89	0.24	0.21	28.60	27.236
33443.699	1053.27	1053.35	-0.06	-0.08	28.60	27.236
33631.625	1397.51	1397.56	-0.02	-0.05	28.62	27.236
34003.872	2085.97	2085.98	0.00	-0.01	28.62	27.236
34371.508	2774.48	2774.49	0.00	-0.01	28.65	27.237
34734.651	3463.09	3463.05	0.03	0.03	28.65	27.238
34371.515	2774.48	2774.50	-0.01	-0.02	28.65	27.238
34003.896	2085.97	2086.01	-0.03	-0.04	28.65	27.238
33631.649	1397.51	1397.59	-0.05	-0.07	28.66	27.238
33443.721	1053.27	1053.36	-0.07	-0.09	28.68	27.239
33254.435	709.11	708.90	0.23	0.20	28.68	27.239
33064.124	364.94	364.85	0.12	0.09	28.68	27.239
32858.663	0.16	0.40	-0.15	-0.24	18.21	16.747
33061.613	364.94	364.85	0.18	0.09	18.21	16.746
33251.928	709.11	708.95	0.25	0.16	18.22	16.746

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
33441.140	1053.27	1053.33	0.03	-0.06	18.22	16.746
33629.050	1397.52	1397.56	0.04	-0.05	18.22	16.746
34001.249	2085.97	2085.99	0.07	-0.02	18.23	16.746
34368.810	2774.49	2774.47	0.11	0.02	18.23	16.746
34731.915	3463.09	3463.05	0.12	0.04	18.23	16.745
35090.694	4151.76	4151.73	0.11	0.04	18.23	16.745
34731.926	3463.09	3463.07	0.10	0.02	18.23	16.745
34368.834	2774.49	2774.51	0.06	-0.02	18.23	16.746
34001.265	2085.97	2086.02	0.04	-0.05	18.23	16.746
33629.063	1397.52	1397.58	0.03	-0.07	18.23	16.745
33441.158	1053.27	1053.35	0.01	-0.08	18.23	16.745
33251.940	709.11	708.97	0.23	0.14	18.23	16.744
33061.628	364.94	364.86	0.17	0.08	18.24	16.744
32855.539	0.16	0.41	-0.18	-0.25	8.69	7.229
33058.456	364.94	364.84	0.17	0.10	8.69	7.229
33248.775	709.10	709.00	0.18	0.11	8.69	7.229
33437.836	1053.26	1053.13	0.21	0.13	8.69	7.229
33625.842	1397.51	1397.58	0.01	-0.07	8.69	7.229
33997.992	2085.96	2085.99	0.05	-0.04	8.69	7.229
34365.516	2774.47	2774.47	0.08	-0.00	8.70	7.229
34728.567	3463.07	3463.03	0.12	0.04	8.70	7.229
35087.306	4151.73	4151.70	0.11	0.03	8.70	7.229
35441.840	4840.46	4840.44	0.10	0.02	8.70	7.229
35792.302	5529.24	5529.24	0.07	0.00	8.70	7.228
35441.868	4840.46	4840.49	0.04	-0.03	8.70	7.228
35087.339	4151.73	4151.77	0.04	-0.04	8.69	7.228
34728.605	3463.08	3463.11	0.05	-0.03	8.69	7.227
34365.544	2774.47	2774.53	0.03	-0.05	8.69	7.227
33998.016	2085.96	2086.04	0.00	-0.08	8.69	7.226
33625.857	1397.51	1397.61	-0.02	-0.10	8.69	7.226
33437.856	1053.26	1053.17	0.17	0.10	8.69	7.226
33248.777	709.11	709.00	0.18	0.11	8.69	7.226
33058.474	364.94	364.88	0.14	0.07	8.69	7.226
32851.988	0.16	0.41	-0.23	-0.25	-0.02	-1.414
33054.911	364.95	364.86	0.11	0.09	-0.01	-1.414
33245.218	709.12	709.02	0.13	0.10	-0.01	-1.414
33434.230	1053.29	1053.09	0.22	0.19	-0.01	-1.414
33622.256	1397.54	1397.61	-0.03	-0.07	-0.01	-1.414
33994.384	2086.01	2086.03	0.03	-0.02	0.00	-1.414
34361.898	2774.54	2774.55	0.04	-0.01	0.01	-1.414
34724.923	3463.15	3463.12	0.09	0.04	0.01	-1.414
35083.628	4151.83	4151.78	0.11	0.06	0.01	-1.414
35438.158	4840.57	4840.56	0.07	0.01	0.01	-1.414
35788.579	5529.37	5529.34	0.09	0.03	0.01	-1.415
36135.085	6218.25	6218.26	0.03	-0.02	0.01	-1.414

Sensor Output	Standard	Sensor New_Coefs	Standard-Sensor Prev_Coefs	Standard-Sensor NEW_Coefs	Sensor_Temp	Bath_Temp
36477.652	6907.15	6907.05	0.15	0.11	0.01	-1.414
36135.093	6218.25	6218.28	0.02	-0.03	0.01	-1.415
35788.629	5529.37	5529.44	-0.01	-0.07	0.01	-1.414
35438.209	4840.57	4840.66	-0.03	-0.09	0.01	-1.415
35083.670	4151.83	4151.86	0.03	-0.02	0.01	-1.414
34724.949	3463.15	3463.16	0.04	-0.01	0.01	-1.414
34361.927	2774.54	2774.60	-0.01	-0.06	0.01	-1.414
33994.407	2086.01	2086.08	-0.03	-0.07	-0.00	-1.415
33622.273	1397.54	1397.64	-0.06	-0.10	-0.00	-1.415
33434.222	1053.29	1053.07	0.25	0.21	0.00	-1.414
33245.220	709.12	709.03	0.12	0.10	-0.00	-1.414
33054.908	364.95	364.86	0.11	0.09	-0.01	-1.415
32851.969	0.16	0.36	-0.18	-0.20	-0.00	-1.415



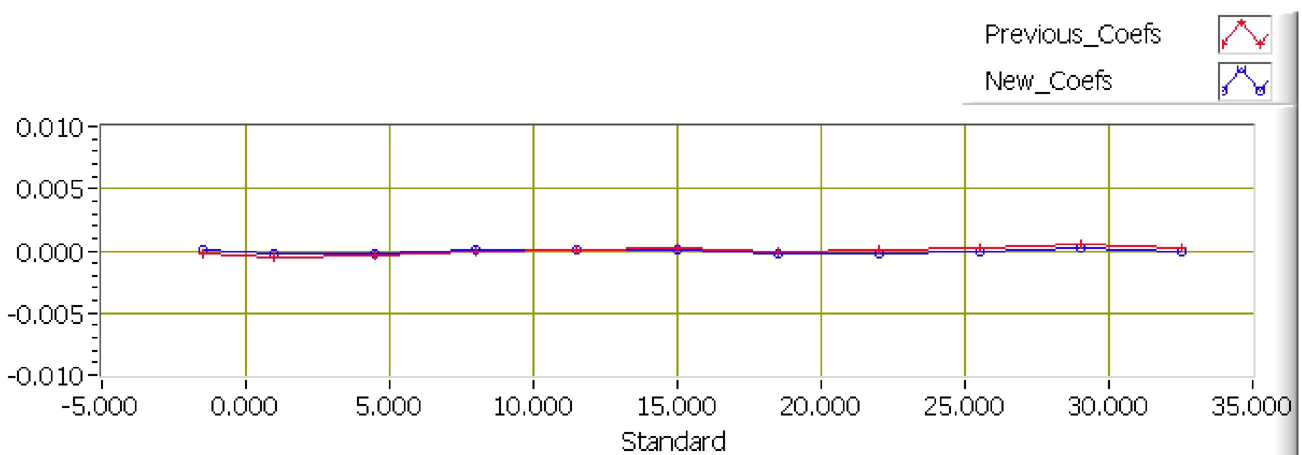
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 2333
CALIBRATION DATE: 20-Aug-2013
Mfg: SEABIRD   Model: 03
Previous cal: 14-May-13
Calibration Tech: CAL

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.33445229E-3	a = 4.33464292E-3	
h = 6.42607195E-4	b = 6.42815984E-4	
i = 2.36892570E-5	c = 2.37216855E-5	
j = 2.36630976E-6	d = 2.36788147E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
2866.8252	-1.4969	-1.4971	-0.00025	0.00015
3031.9216	1.0034	1.0036	-0.00052	-0.00017
3274.4583	4.5040	4.5042	-0.00044	-0.00017
3530.7891	8.0066	8.0064	-0.00004	0.00014
3801.1108	11.5081	11.5080	0.00003	0.00012
4085.1372	15.0014	15.0012	0.00016	0.00014
4384.7979	18.5053	18.5055	-0.00005	-0.00016
4699.0732	22.0042	22.0044	0.00002	-0.00017
5028.9871	25.5060	25.5061	0.00026	-0.00001
5374.2617	29.0045	29.0043	0.00052	0.00020
5735.6150	32.5035	32.5036	0.00027	-0.00008



Sea-Bird Electronics, Inc.

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SENSOR SERIAL NUMBER: 2659
CALIBRATION DATE: 28-Aug-13

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -1.01196119e+001
h =  1.42654861e+000
i = -1.17273496e-003
j =  1.54999667e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  3.40836838e-006
b =  1.42365610e+000
c = -1.01140513e+001
d = -8.49616190e-005
m =  5.3
CPcor = -9.5700e-008 (nominal)
```

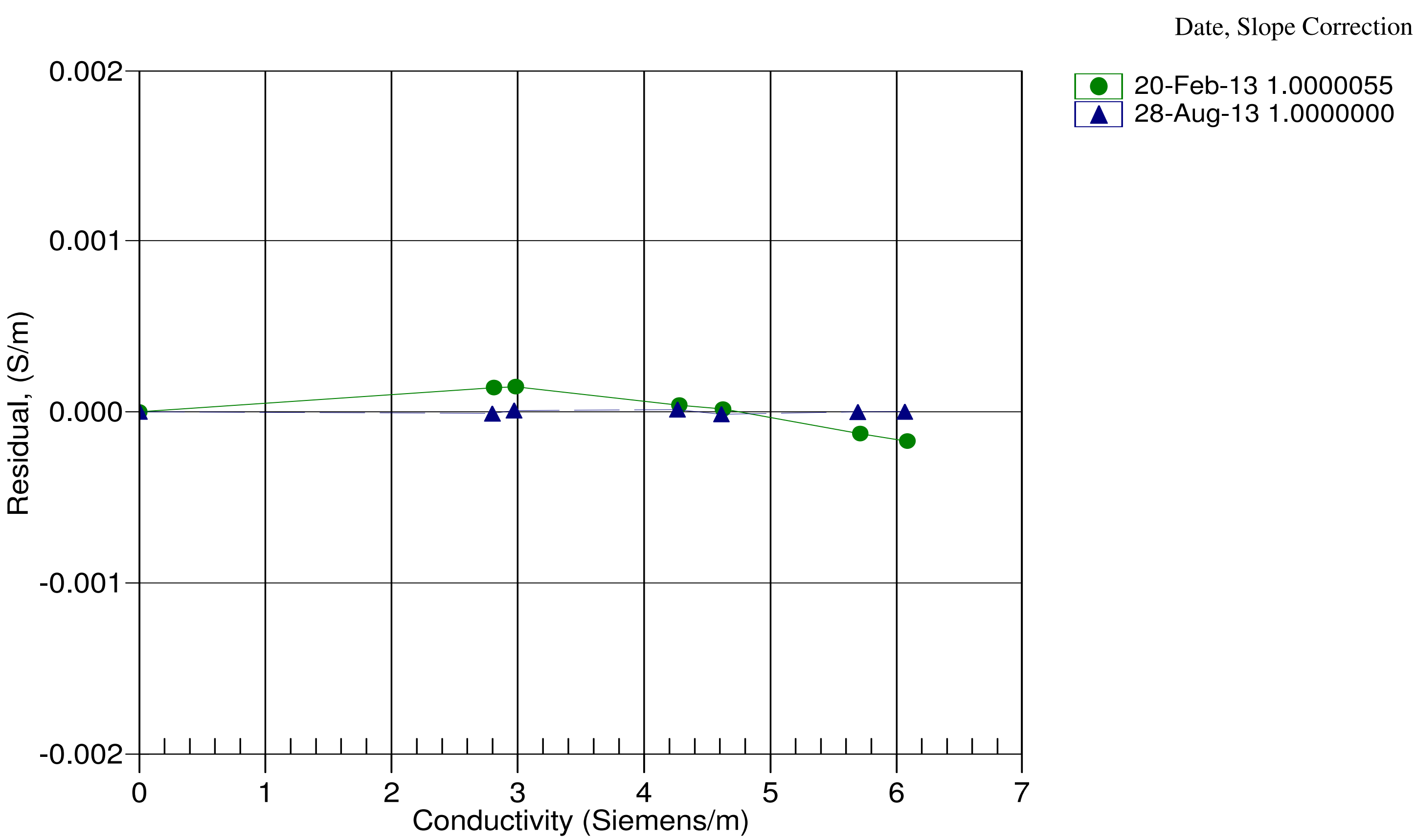
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.66531	0.00000	0.00000
-1.0000	34.7398	2.79899	5.17207	2.79898	-0.00001
1.0000	34.7402	2.97008	5.28683	2.97009	0.00001
15.0000	34.7412	4.26337	6.08420	4.26339	0.00001
18.5000	34.7411	4.60947	6.28031	4.60945	-0.00001
29.0001	34.7404	5.69130	6.85696	5.69129	-0.00000
32.5001	34.7364	6.06364	7.04441	6.06364	0.00000

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



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SENSOR SERIAL NUMBER: 0875
CALIBRATION DATE: 13-Sep-13

SBE 43 OXYGEN CALIBRATION DATA

COEFFICIENTS

Soc = 0.4576
Voffset = -0.5165
Tau20 = 0.95

A = -3.6815e-003
B = 1.9772e-004
C = -3.0113e-006
E nominal = 0.036

NOMINAL DYNAMIC COEFFICIENTS

D1 = 1.92634e-4
D2 = -4.64803e-2

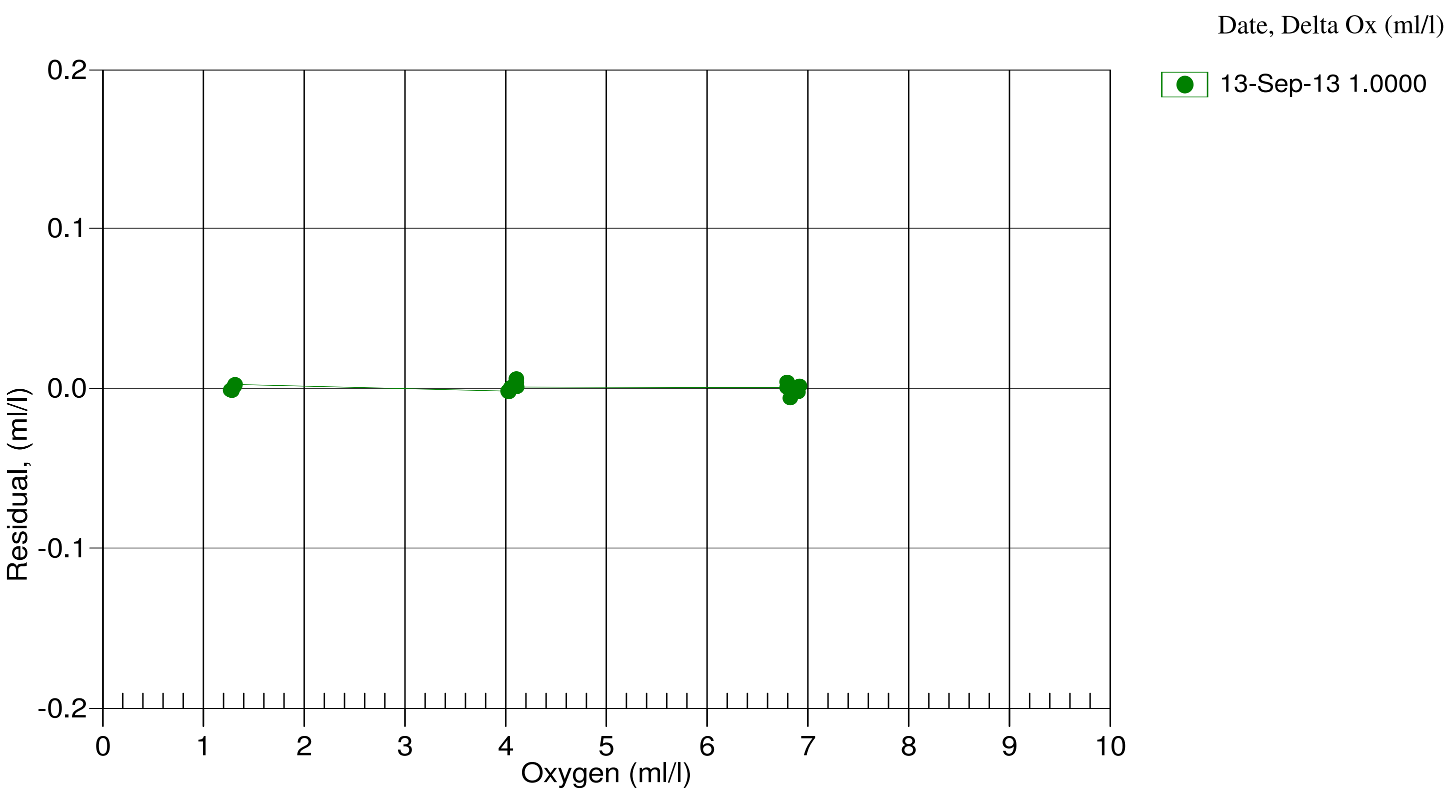
H1 = -3.30000e-2
H2 = 5.00000e+3
H3 = 1.45000e+3

BATH OX (ml/l)	BATH TEMP ITS-90	BATH SAL PSU	INSTRUMENT OUTPUT(VOLTS)	INSTRUMENT OXYGEN(ml/l)	RESIDUAL (ml/l)
1.27	2.00	0.00	0.804	1.27	-0.00
1.28	6.00	0.00	0.841	1.27	-0.00
1.28	12.00	0.00	0.896	1.28	-0.00
1.30	20.00	0.00	0.973	1.30	0.00
1.31	26.00	0.00	1.030	1.32	0.00
1.32	30.00	0.00	1.069	1.32	0.00
4.03	2.00	0.00	1.432	4.03	-0.00
4.03	6.00	0.00	1.543	4.03	-0.00
4.05	12.00	0.00	1.716	4.05	0.00
4.11	20.00	0.00	1.956	4.11	0.01
4.11	26.00	0.00	2.123	4.11	0.00
4.11	30.00	0.00	2.238	4.11	0.00
6.79	2.00	0.00	2.061	6.79	0.00
6.79	6.00	0.00	2.249	6.80	0.00
6.81	12.00	0.00	2.533	6.81	-0.00
6.83	20.00	0.00	2.903	6.82	-0.01
6.90	30.00	0.00	3.406	6.90	-0.00
6.92	26.00	0.00	3.221	6.92	0.00

Oxygen (ml/l) = Soc * (V + Voffset) * (1.0 + A * T + B * T^2 + C * T^3) * OxSol(T,S) * exp(E * P / K)

V = voltage output from SBE43, T = temperature [deg C], S = salinity [PSU], K = temperature [Kelvin]

OxSol(T,S) = oxygen saturation [ml/l], P = pressure [dbar], Residual = instrument oxygen - bath oxygen



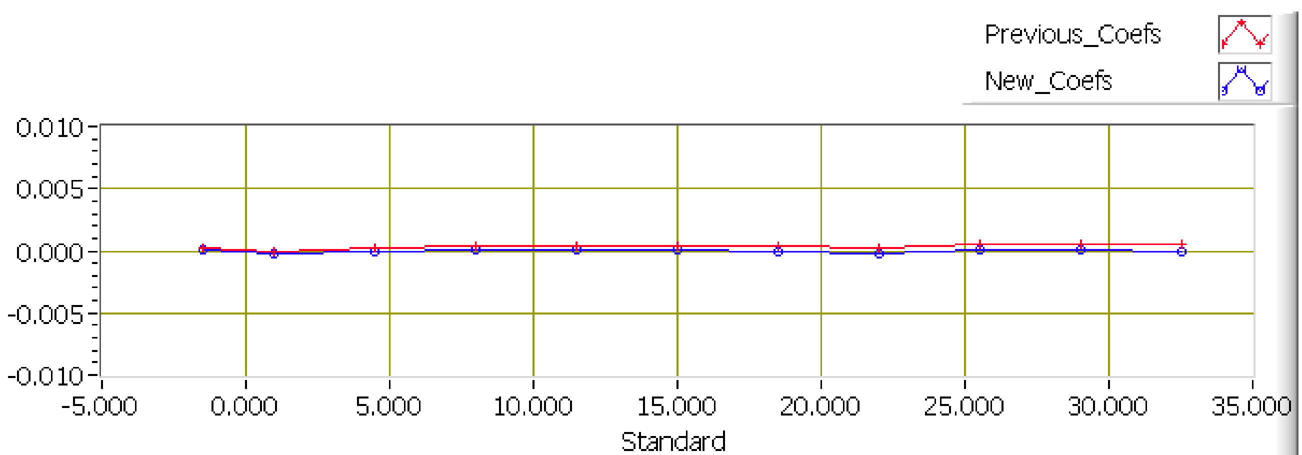
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 2202
CALIBRATION DATE: 20-Aug-2013
Mfg: SEABIRD   Model: 03
Previous cal: 21-May-13
Calibration Tech: CAL

ITS-90_COEFFICIENTS	IPTS-68_COEFFICIENTS ITS-T90	
g = 4.35827590E-3	a = 4.35847436E-3	
h = 6.46176984E-4	b = 6.46388903E-4	
i = 2.35597772E-5	c = 2.35925289E-5	
j = 2.24861242E-6	d = 2.25017477E-6	
f0 = 1000.0	Slope = 1.0	Offset = 0.0

Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149
Temperature ITS-90 = 1/{g+h[ln(f0/f)]+i[ln2(f0/f)]+j[ln3(f0/f)]} - 273.15 (°C)
Temperature IPTS-68 = 1/{a+b[ln(f0/f)]+c[ln2(f0/f)]+d[ln3(f0/f)]} - 273.15 (°C)
T68 = 1.00024 * T90 (-2 to -35 Deg C)

SBE3 Freq	SPRT ITS-T90	SBE3 ITS-T90	SPRT-SBE3 OLD_Coefs	SPRT-SBE3 NEW_Coefs
2963.7114	-1.4969	-1.4970	0.00018	0.00011
3133.6946	1.0034	1.0036	-0.00002	-0.00016
3383.3374	4.5040	4.5041	0.00016	-0.00007
3647.1108	8.0066	8.0064	0.00042	0.00013
3925.1956	11.5081	11.5081	0.00038	0.00003
4217.2893	15.0014	15.0013	0.00042	0.00005
4525.3564	18.5053	18.5053	0.00038	-0.00003
4848.3958	22.0042	22.0044	0.00027	-0.00016
5187.4116	25.5060	25.5060	0.00050	0.00005
5542.1528	29.0045	29.0044	0.00055	0.00009
5913.2974	32.5035	32.5035	0.00046	-0.00004



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SENSOR SERIAL NUMBER: 3399
CALIBRATION DATE: 27-Aug-13

SBE4 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -1.01550688e+001
h =  1.53620039e+000
i = -2.40970655e-003
j =  2.69156986e-004
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  5.48535536e-007
b =  1.52981722e+000
c = -1.01420638e+001
d = -8.13503595e-005
m =  6.3
CPcor = -9.5700e-008 (nominal)
```

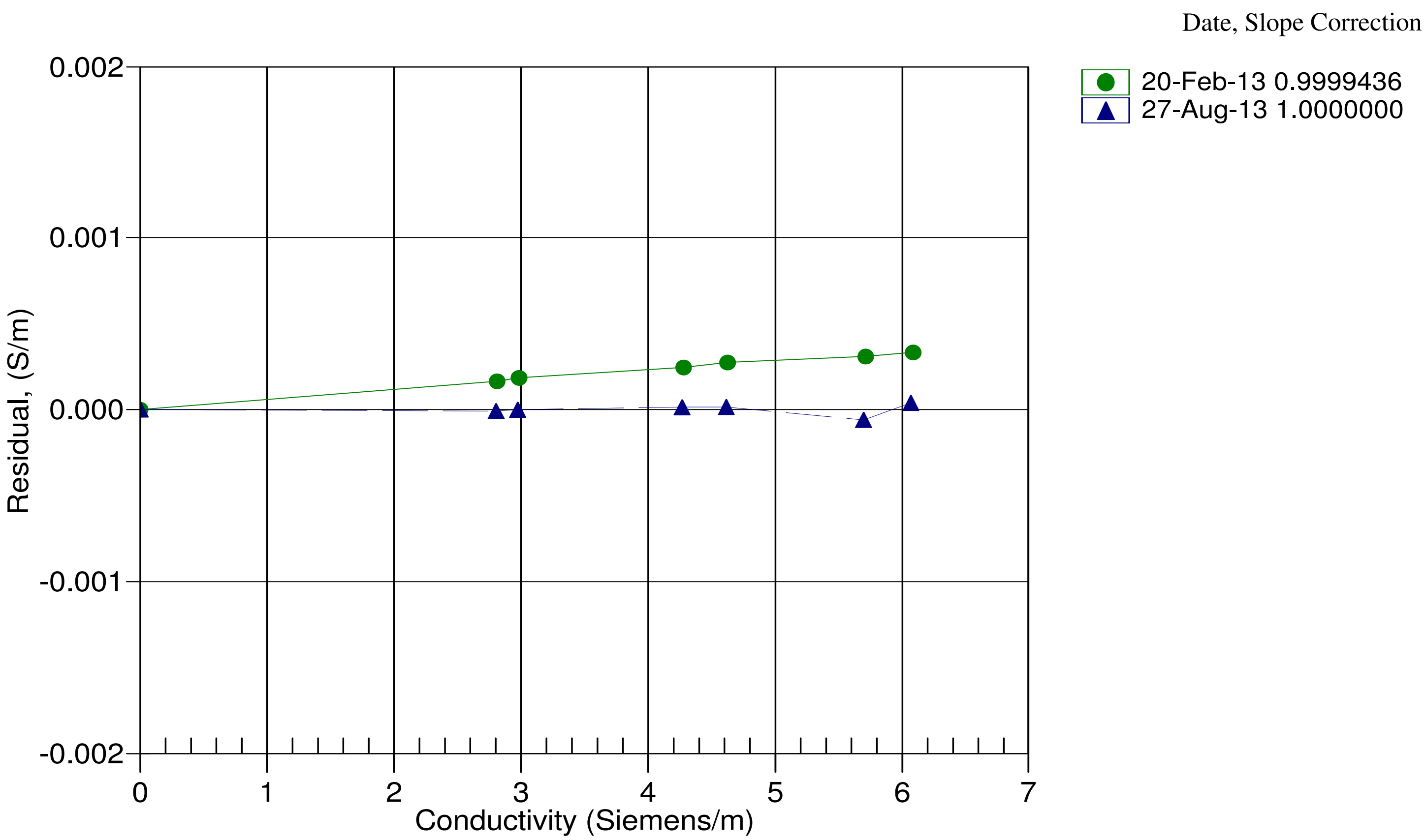
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
0.0000	0.0000	0.00000	2.57480	0.00000	0.00000
-1.0000	34.7609	2.80053	4.99269	2.80052	-0.00001
1.0000	34.7614	2.97172	5.10341	2.97172	-0.00000
15.0000	34.7623	4.26569	5.87274	4.26570	0.00001
18.5000	34.7624	4.61199	6.06196	4.61200	0.00001
29.0000	34.7623	5.69447	6.61821	5.69441	-0.00006
32.5000	34.7557	6.06662	6.79887	6.06666	0.00004

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



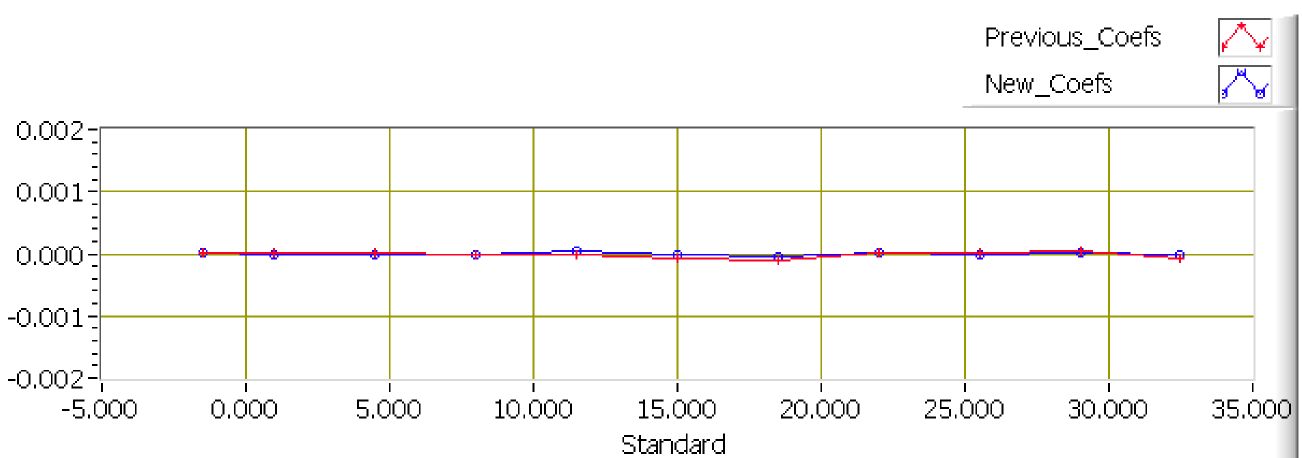
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 0034
CALIBRATION DATE: 18-Jun-2013
Mfg: SEABIRD   Model: 35
Previous cal: 07-Dec-12
Calibration Tech: CAL

ITS-90_COEFFICIENTS
a0 = 4.397003089E-3
a1 = -1.190275919E-3
a2 = 1.813764110E-4
a3 = -1.011904489E-5
a4 = 2.167420508E-7
Slope = 1.000000 Offset = 0.000000
Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149

Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149
Temperature ITS-90 = 1/{a0+a1[ln(f)]+a2[ln2(f)]+a3[ln3(f)]+a4[ln4(f)} - 273.15 (°C)

SBE35 Count	SPRT ITS-T90	SBE35 ITS-T90	SPRT-SBE35 OLD_Coefs	SPRT-SBE35 NEW_Coefs
716838.6659	-1.5025	-1.5025	0.00001	0.00001
642388.7534	0.9977	0.9977	0.00003	-0.00001
552221.8919	4.4985	4.4985	0.00001	-0.00002
475988.6132	7.9993	7.9993	-0.00003	-0.00000
411364.5191	11.5013	11.5013	-0.00001	0.00006
356570.8333	14.9962	14.9962	-0.00009	-0.00001
309816.6856	18.4974	18.4974	-0.00012	-0.00006
269921.2202	21.9969	21.9968	0.00001	0.00003
235773.4779	25.4961	25.4962	0.00001	-0.00001
206474.8573	28.9949	28.9949	0.00005	0.00002
181267.4388	32.4938	32.4938	-0.00008	-0.00001



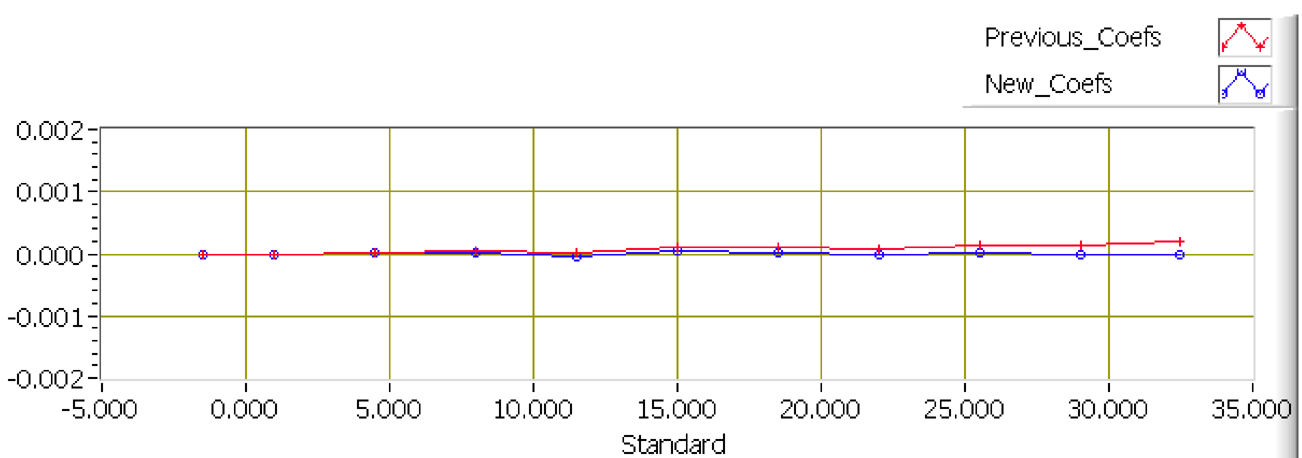
Temperature Calibration Report
STS/ODF Calibration Facility

SENSOR SERIAL NUMBER: 0011
CALIBRATION DATE: 18-Jun-2013
Mfg: SEABIRD   Model: 35
Previous cal: 07-Dec-12
Calibration Tech: CAL

ITS-90_COEFFICIENTS
a0 = 4.943006005E-3
a1 = -1.360822866E-3
a2 = 2.010795666E-4
a3 = -1.114346435E-5
a4 = 2.364998519E-7
Slope = 1.000000 Offset = 0.000000
Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149

Calibration Standard: Mfg: ASL   Model: F18   s/n: 245-5149
Temperature ITS-90 = 1/{a0+a1[ln(f)]+a2[ln2(f)]+a3[ln3(f)]+a4[ln4(f)} - 273.15 (°C)

SBE35 Count	SPRT ITS-T90	SBE35 ITS-T90	SPRT-SBE35 OLD_Coefs	SPRT-SBE35 NEW_Coefs
790244.8256	-1.5025	-1.5025	-0.00000	-0.00000
707510.8124	0.9977	0.9977	-0.00001	-0.00000
607389.7035	4.4985	4.4984	0.00001	0.00001
522826.4216	7.9993	7.9993	0.00004	0.00001
451217.9235	11.5013	11.5014	0.00001	-0.00005
390577.8366	14.9962	14.9961	0.00012	0.00004
338895.6623	18.4974	18.4974	0.00011	0.00001
294848.4583	21.9969	21.9969	0.00007	-0.00003
257197.2567	25.4961	25.4961	0.00013	0.00001
224932.8734	28.9949	28.9949	0.00014	0.00000
197209.9015	32.4938	32.4938	0.00019	-0.00000



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C-Star Calibration

Date	September 13, 2013	S/N#	CST-400DR	Pathlength	25 cm

	Analog output
V_d	0.060 V
V_{air}	4.773 V
V_{ref}	4.658 V

Temperature of calibration water	22.0 °C
Ambient temperature during calibration	22.6 °C

Relationship of transmittance (Tr) to beam attenuation coefficient (c), and pathlength (x, in meters): $Tr = e^{-cx}$

To determine beam transmittance: $Tr = (V_{sig} - V_{dark}) / (V_{ref} - V_{dark})$

To determine beam attenuation coefficient: $c = -1/x * \ln (Tr)$

V_d Meter output with the beam blocked. This is the offset.
V_{air} Meter output in air with a clear beam path.
V_{ref} Meter output with clean water in the path.
Temperature of calibration water: temperature of clean water used to obtain V_{ref}.
Ambient temperature: meter temperature in air during the calibration.
V_{sig} Measured signal output of meter.

Transmissometer Air Calibration M&B Calculator

STS	**13 Nov. 2013**			**CST-400DR**		
Readings	Factory Cal Sheet Info			AVG Deck/Lab Readings		Avg. Value
Air	4.773		4.742	4.743	4.743	4.743
Water	4.685					N/A
Blocked	0.060		0.055	0.055	0.055	0.055
Air Temp.	18.801	18.792	18.797	18.795	18.800	18.792
M	**19.608**			Air Temp. Average		18.796
B	**-1.078**					

Transmissometer Air Calibration M&B Calculator

STS	**13 Nov. 2013**			**CST-400DR**		
Readings	Factory Cal Sheet Info			AVG Deck/Lab Readings		Avg. Value
Air	4.773			4.741		
Water	4.658			N/A		
Blocked	0.06			0.055		
Air Temp.	20.346	20.360	20.370	20.368	20.372	20.377
M	**19.730**			Air Temp. Average		20.366
B	**-1.085**					

Transmissometer Air Calibration M&B Calculator

STS	**24 Nov. 2013**			**CST-400DR**		
Readings	Factory Cal Sheet Info			AVG Deck/Lab Readings		Avg. Value
Air	4.773		4.740	4.737	4.739	4.739
Water	4.685					N/A
Blocked	0.060		0.055	0.055	0.055	0.055
Air Temp.	23.707	23.682	23.621	23.785	23.677	23.680
M	**19.625**			Air Temp. Average		23.692
B	**-1.079**					

Transmissometer Air Calibration M&B Calculator

STS	**06 Dec. 2013**			**CST-400DR**		
Readings	Factory Cal Sheet Info			AVG Deck/Lab Readings		Avg. Value
Air	4.773		4.737	4.737	4.737	4.737
Water	4.685					N/A
Blocked	0.060		0.055	0.055	0.055	0.055
Air Temp.	27.314	27.329	27.347	27.360	27.362	27.347
M	**19.632**			Air Temp. Average		27.343
B	**-1.080**					

Transmissometer Air Calibration M&B Calculator

STS	**18 Dec. 2013**			**CST-400DR**		
Readings	Factory Cal Sheet Info			AVG Deck/Lab Readings		Avg. Value
Air	4.773		4.730	4.730	4.727	4.729
Water	4.685					N/A
Blocked	0.060		0.055	0.055	0.055	0.055
Air Temp.	30.160	30.157	30.217	30.302	30.218	30.220
M	**19.665**			Air Temp. Average		30.212
B	**-1.082**					