Abbreviation List/Glossary

Acid flask A three liter round bottom flask used to hold the approximately 0.6% phosphoric acid used in the extraction of dissolved inorganic carbon from an aliquot of sea water. The flask is evacuated and the acid degassed prior to mounting on the sea water DIC extraction line. See Figure 1.

Acid line The thin, flexible plastic tubing through which acid runs while being delivered to an alkalinity titration cell. Used on all types of alkalinity systems. See Figure 3.

ALK Titration alkalinity (also known as total alkalinity), expressed in units of μmoles of hydrogen ion equivalent per kilogram of sea water. Also referred to by others as TA or A_t.

Bladder A pressure compensation device for our alkalinity titration cells. This replaced the plunger system in March 1990, and was used from then onward. Made of latex, the bladder was filled with water while the cell was filled with sample and sealed. The water in the bladder was then removed, being replaced by air. The air could then easily compress to compensate for the volume of the added acid. See Figure 3.

Bottle pair When sampling a single Niskin bottle at sea, two Pyrex glass bottles are filled in sequence. These two bottles are referred to as a bottle pair.

Bottle pair delta The difference in analyzed quantity between the first and second bottles of a bottle pair. Used to determine the quality of analysis (both individual pair quality and that for an entire set of pairs).

C13 $^{13}C/^{12}C$ isotopic ratio of the carbon comprising DIC, given as the reduced ratio or the relative difference from the PDB standard. Expressed in units of parts per thousand or per mil (o/oo).

Capillary tube A pressure compensation system tested for use in our alkalinity titration cells, consisting of a very thin glass tube, open at both ends, inserted through the top of the titration cell. A drop of water was inserted into this tube to create a barrier to the escape of carbon dioxide from the cell. This drop would move to compensate for the volume of acid added during the titration. The use of this device was never fully implemented.

CDRG The Carbon Dioxide Research Group of Scripps Institution of Oceanography, Charles D. Keeling, Principal Investigator.

Cell soak The process of filling an alkalinity titration cell with a sodium chloride solution of 0.7 ionic strength and allowing it to sit while stirring for about 45 minutes to an hour. This process was found to greatly reduce the pre-titration drift often seen with our titration systems.

Constant-volume mercury manometer (CMM) For the purpose of measuring the carbon dioxide extracted from sea water, this instrument is essentially a high precision double-column mercury manometer. One column is kept under vacuum, and the other contains the sample gas. The difference in mercury heights between the two columns is measured via a sight glass attached to a high precision screw cathetometer. See Keeling et al., [1986] for a thorough description. This was the primary calibrating device for both the XR38 manometer and the ECM up until 1999. It was also the measuring device for the time-series stations at Bermuda and Hawaii until 1996. Measurements of DIC from this system are labeled “M” in our data tables.

CTD The initials stand for Conductivity, Temperature, and Depth. For the collection of

sea water, this device most commonly consists of a central electronic instrument tethered to a ship and which, through the use of various probes, measures the three properties listed above, as well as several other chemical properties of sea water. This instrument is surrounded by a rosette of Niskin bottles, each of which can be closed at a specified depth. It is from these Niskin bottles that we commonly obtain our sea water samples.

Delta See "Bottle pair delta".

Dissolved inorganic carbon (DIC) The amount of total inorganic carbon contained in a kilogram of sea water. This is a measure of the total amount of the three species of inorganic carbon: dissolved carbon dioxide, carbonate, and bicarbonate, and is expressed in units of μmoles of carbon per kilogram of sea water. Experimentally defined as all dissolved carbon species converted to CO_2 gas by acidification at room temperature. Also referred to as total CO_2 (TCO2) and total carbon (TC).

Dosimat Made by Metrohm Ltd., this high precision automated burette system was used to deliver acid to our alkalinity titration cells.

Dry side vacuum One of the two mechanical/diffusion pump systems used on the sea water extraction line. This system is referred to as "dry" because raw, or "wet", room air at pressure and the residual water remaining in the line after extractions are never allowed to enter it. This is the active vacuum system during the actual extraction, which in proper operation never produces a pressure over a few hundred millitorr. See Figure 1.

ECM See "Electronic constant-volume manometer".

Electrode amplifier A device used to amplify the signal from the combination pH electrodes used in our titration systems so that it could be read by a digital volt meter. Used on all titration systems after 1991. Prior to this, a Brinkman pH meter was used to read the electrode voltages.

Electronic constant-volume manometer (ECM) The second quartz spiral manometer, which replaced the XR38 quartz spiral manometer in 1992. Used to measure DIC for all non-time series sea water samples from 1992 to present and time series samples from 1996 to present. With this manometer, the CO_2 extracted from sea water is frozen into a glass volume attached to a Ruska Instruments differential pressure gauge (DPI). Once thawed, the sample's pressure on one side of the DPI is balanced across its stainless steel diaphragm against a pressure controlled by a Ruska DDR6000 quartz spiral manometer configured as a pressure source. See Guenther et al., [1994] for details. Measurements of DIC from this system are labeled "E" in the database.

Extraction flask A one liter borosilicate glass vacuum flask specially modified for use in the extraction of carbon dioxide from sea water. The flask is modified by the addition of a large ball joint to the top of the flask and a side arm with a second large ball joint at its terminus. See Figure 1.

Fill The process by which an aliquot of sea water is transferred from the original sample bottle into the vessel which will contain the aliquot during analysis. In the case of an extraction fill, the sample goes into a Wong Pipette (see definition). For alkalinity determination, the sample is put into a titration cell.

Fill adapter A one or two piece borosilicate glass fitting used to transfer an aliquot of sea water from a sample bottle to a Wong Pipette. This fitting consists of a ground glass joint that matches the bottle stopper size, a side tube to allow for pressurizing the sample with air, and a long outlet tube that is inserted to about ¾ the depth of the sample in the bottle. The top of the outlet tube has a 14/35 standard taper joint onto which the pipette is

mounted.

Flame off tube (FOT) An ampoule, made of a ten-centimeter long section of ¼ inch (outside diameter) medium wall borosilicate glass tubing, used to store extracted carbon dioxide. The carbon dioxide aliquot is frozen into the tube (pre-sealed at one end) under vacuum. While the carbon dioxide is still frozen, the top of the ampoule is flame sealed, and the carbon dioxide can then be thawed without risk of escape.

GEOSECS Geochemical Ocean Sections Program, 1972-1978.

Gravimetric Titration One of two closed cell methods of titration used to measure total alkalinity. With this method, sea water bottles were fitted with a dispensing spigot and weighed. The sample to be titrated was then introduced into the titration cell through the spigot, and the bottle weighed again. Our database refers to two versions of gravimetric titration systems, "G1" and "G2", which were differentiated in the lab by the type of computer that operated the systems. See Guenther, et al. [1994] for a description of the first gravimetric alkalinity system (G1). System G2 was identical to G1 except that the HP86B computer was replaced with a 16Mhz 386 Zenith PC.

$HgCl_2$ See "Mercuric Chloride".

KCl See "Potassium Chloride".

Mercuric Chloride A salt of mercury used to poison sea water bottles immediately after sampling. 100 µl of saturated solution is added to our 500 ml bottles and 200 µl is added to our one liter bottles.

Niskin A bottle, typically of five or ten liters volume, used to obtain sea water from depth in the open ocean. These bottles, typically made of PVC plastic, consist of a cylinder which is closed at either end by caps that are attached to one another by a spring which runs through the bottle itself. The bottles are lowered into position with the caps cocked open, and the caps spring shut when signaled, either electronically or mechanically, by the operator aboard ship.

NOAA National Oceanic and Atmospheric Administration.

ODF The Oceanographic Data Facility of Scripps Institution of Oceanography. Performed the shore based analyses of salinity and nutrients in the CDRG sea water samples.

Pipette cup The evacuated space behind each oblique bore stopcock on a Wong Pipette. The upper cup is that behind the uppermost Wong Pipette stopcock (as oriented on the DIC extraction line). The lower cup is that behind the lower Wong Pipette stopcock. See Figure 2.

Potassium Chloride Used in both the combination pH electrode and in the reference electrode used with a calomel electrode. Excessive buildup on the fritted openings in these types of electrodes would hinder the electrode's ability to exchange protons across this boundary, greatly inhibiting its ability to function correctly.

Residuals Individual differences, in µeq, between each measured data point and the corresponding fitted data point from our titrations for total alkalinity. The pattern of these residuals are diagnostic of many potential titration deficiencies.

Sample tube An approximately 10 inch long, ¾ inch diameter borosilicate glass tube closed at one end with a stopcock and 14/35 standard taper joint on the other. Used to hold frozen carbon dioxide from sea water extractions under vacuum. These were later replaced by flame off tubes.

SL1A The first stopcock encountered on the sea water extraction line. This separates the

extraction flask/Wong Pipette/acid reservoir assembly from the main part of the line. See Figure 1.

SL1C This stopcock links the front end of the extraction line to the "wet side" vacuum system. It is through this outlet that all raw air or residual water is pumped from the line. See Figure 1.

SL4 The final stopcock on the sea water extraction line. This leads to the dry side vacuum manifold. See Figure 1.

Spiral See XR38.

Titration cell A water jacketed borosilicate glass vessel in which alkalinity titrations are carried out. The cell is closed during titrations. The gravimetric cells hold approximately 170 ml of sea water, while the volumetric cells hold approximately 100 ml. The cell top has openings to accommodate a pH electrode, a thermistor, a pressure compensation device, and an inlet for the sample. Newer cells (those with the volumetric system and system G2) also have an outlet with a Teflon stopcock near the bottom to allow for draining of the cell without disassembling it. See Figure 3.

Torr A unit of pressure equivalent to 1 mm of mercury. 760 Torr are equivalent to one standard atmosphere.

TR1 Trap number one on sea water extraction line. A 500ml round bottom flask with a 24/40 standard taper joint immersed in a bath of ethanol/dry ice slurry (approximate temperature about -70˚C). This is the primary water trap. See Figure 1.

Trial It is common to titrate a sample more than once when analyzing for alkalinity. To differentiate multiple titrations from a single sample bottle, each titration is given its own trial number. Individual trials are abbreviated T1, T2, etc.

U3 Final "U" shaped trap on sea water extraction line. Constructed from a section of glass bent in a "U" shape so that a standard size dewar flask will fit over it with ease. This trap is located just outside of the main extraction line and is chilled with liquid nitrogen. Used as the ultimate trap to catch any carbon dioxide that accidentally escapes the extraction line headed toward the dry side vacuum manifold. Also serves to prevent any unwanted "backwash" from the vacuum manifold from entering the extraction line. See Figure 1.

Volumetric Titration One of two closed-cell titration methods used to measure total alkalinity. With this method, precision ground syringes, driven by a stepper motor, were used to dispense a known volume of sea water into the titration cell. The database refers to titrations performed with this method as "V". This system was developed for use on board ship during the WOCE program. See Dickson, et al. [2000] for a description of this system.

Water trap A cold trap which is used to remove gaseous water from a stream of air or carbon dioxide under vacuum. Two types are used in the course of a sea water extraction. One trap is kept at approximately –72 ˚C by a slurry of dry ice and ethanol, the other is kept at approximately –105˚C by ethanol chilled with liquid nitrogen.

Wet side vacuum One of two mechanical/diffusion pump systems used on the sea water extraction line. It is through this system that all atmospheric air or residual water (anything "wet") is pumped from the line. See Figure 1.

WOCE World Ocean Circulation Experiment, 1990-1997.

Wong Pipette (WP) A borosilicate glass pipette used to contain approximately 40 cc of sea water to be extracted for DIC. This pipette consists of a borosilicate glass tube with

stopcocks on either end that define the volume and 14/35 standard taper joints attached to each stopcock. See Figure 2.

XR38 Quartz spiral manometer used early in the CDRG program to measure the amount of carbon dioxide extracted from sea water. XR38 is the model number as designated by the manufacturer, Ruska Instrument Corporation. This was the primary instrument for all non-time series sea water samples measured from 1984 to 1992. With this instrument, the sample was frozen into a glass volume, defined by an oblique-bore stopcock, onto which a quartz bourdon tube was directly attached. The sample was thawed, equilibrated at about 38 ˚C, and the pressure recorded. For a brief description of this instrument see Guenther et al. [1994]. Measurements of DIC from this system are labeled "S" in our data tables.

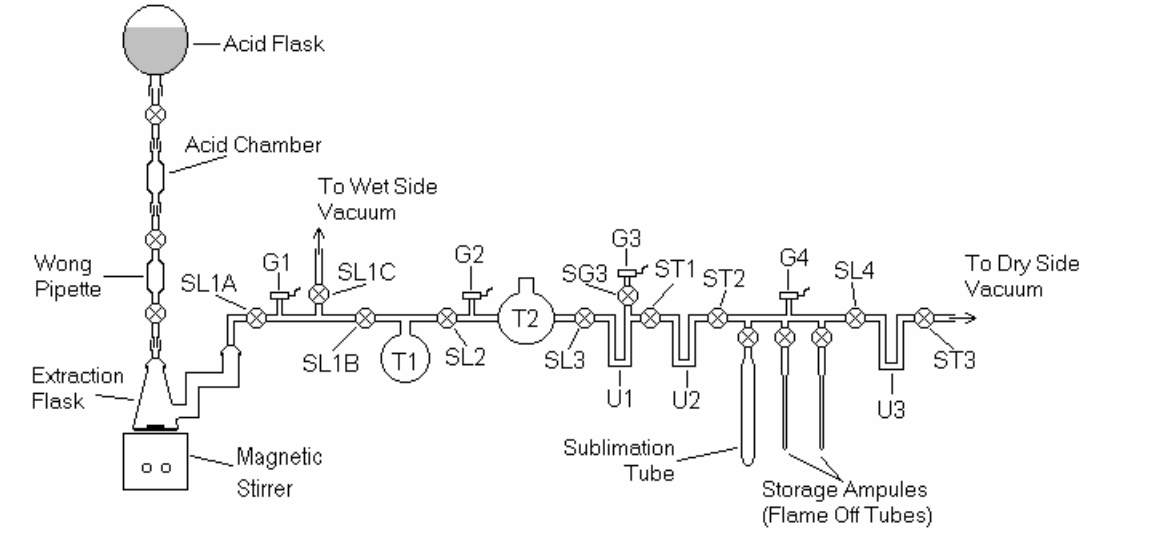

Figure 1. The DIC Extraction Line. All stopcocks are labeled S***, where *** is an alphanumeric code unique to each stopcock. The four stainless steel pressure gauges are labeled G1, G2, G3, and G4. T1 is the primary water trap, and T2 is the primary CO_2 trap. U1 is the secondary water trap, U2 is the secondary CO_2 trap, and U3 is the backup CO_2 trap.

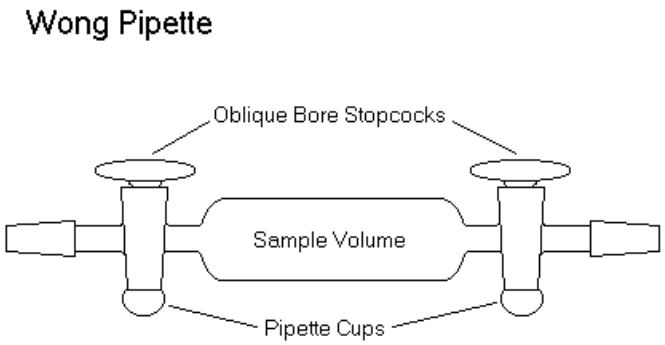

Figure 2. A Wong Pipette. The sample volume contains approximately 40 cc of sea water. Each end is a 14/35 standard taper joint.

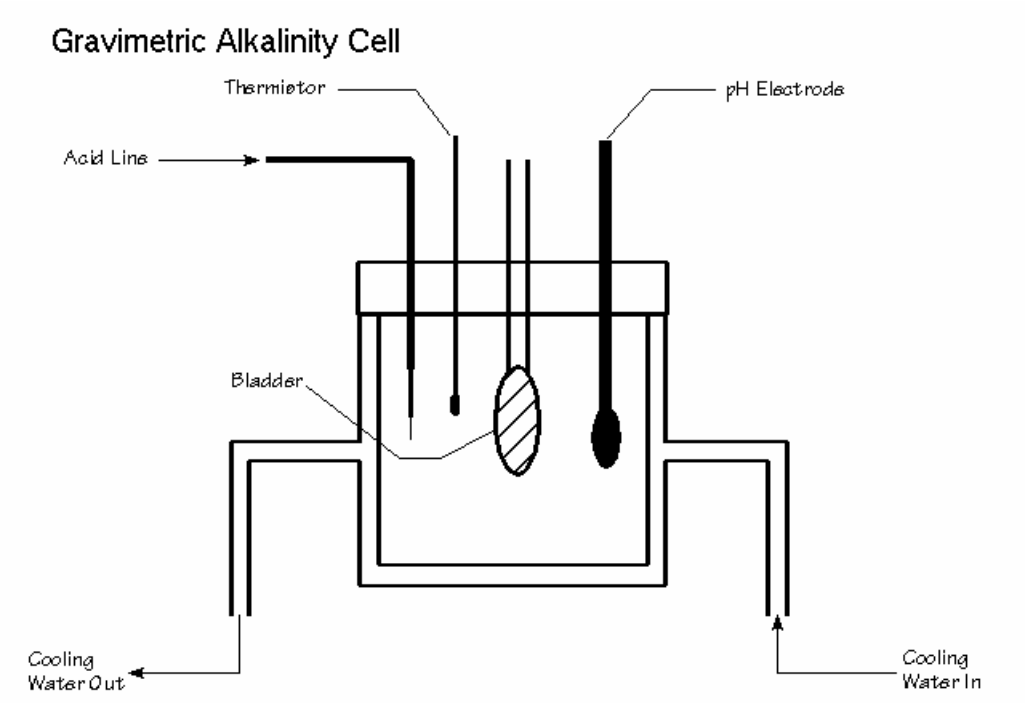

Figure 3. A schematic drawing of a gravimetric alkalinity titration cell. The sample inlet port and the outlet drain are not shown. This cell is drawn showing a bladder as the pressure compensation device. Older gravimetric cells would have had a plunger in the bladder's port.

REFERENCES

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