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From: SA Agulhas Radio Room <sa.agulhas@andrapido.com>

Date: Sun, Feb 14, 2010 at 1:52 PM

Subject: Scholes cabin 5 (p): Oxygen titrations

To: Stirlingj.Scholes@gmail.com

To: Subject:

Dear Stirling,

You will have gathered that oxygen is an important part of the ocean story. Indeed, you have probably been told that the oceans are the 'lungs of the world', producing oxygen for us to breathe. People say the same about the Amazon rainforest. It is not strictly true in either case. In their natural state, all ecosystems produce and consume oxygen more-or-less in equal amounts - ie, in the long term they are neither a net source nor a net sink. Right now, because of the fact that they are taking up the excess carbon dioxide produced by people, the ecosystems on land (including the undisturbed parts of the Amazon) are producing more oxygen than they consume. The situation in the ocean is a bit more complex, because it depends on the relative importance of the biological pump. The uptake of carbon dioxide by the solubility pump has no effect on oxygen.

We measure oxygen in seawater in lots of places on this ship! The CTD has an oxygen electrode. I have another one in the pCO₂ instrument, which simultaneously measures pH and salinity. The whole purpose of my Equilibrator Intake Mass Spectrometer is to measure the oxygen to argon ratio very accurately. But just to be sure, we also measure oxygen the old-fashioned way, as a check and calibration.

It is called the Winkler method, named after its inventor in 1888. You take a sample of fresh seawater very carefully, so that it contains no bubbles and fills the bottle to the brim, and immediately record its temperature. Then you add manganese chloride and alkaline iodide. The dissolved oxygen is chemically bound to the manganese, forming manganese hydroxide, which is insoluble, and precipitates out. You dissolve the precipitate in strong sulphuric acid and then measure how much iodine is left in the solution by titrating with sodium thiosulphate. 'Titrating' means adding another reagent, drop by measured drop, until you have consumed all the target chemical. Iodine turns starch bright purple, so in the old days you put in a drop of starch solution as an 'indicator' to tell you when you had used up all the iodine.

Although we still use this old and faithful method, we have a clever instrument that helps us to do the titration accurately. It is a computer-controlled pipette, which adds precise drops, connected to a device that optically measures the amount of iodine left in solution. As the 'end point' is approached, it makes the drops smaller and less frequent so that we get better accuracy. The seawater sample stands on a magnetic stirrer, which spins a little Teflon-coated magnetic bar inside the sample bottle, to keep everything well mixed. It looks very pretty.

We are in the open ocean again, getting used to the long, rolling swells.

The forward lab is once again bustling with activity, and once every two hours, three or four people crowd into my aft lab too, taking seawater samples, filtering them and reading numbers off the instruments here. I am back on UCTD duty, but in the more user-friendly supper-to-midnight shift. Today we must replace the UCTD line with a new one.

Love, Dad.