

Feasibility of Phosphate Measurements by GLOBE Students

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The GLOBE program wants to ensure that the data it is collecting will be reliable in order to benefit scientists and students who would access it. This publication proposes that phosphate measurements not be added as a hydrology protocol because the reliability of the data would be in question.

In order to determine if it is plausible for GLOBE students to measure phosphate as part of the hydrology protocol, some background research was conducted along with a comparison of several phosphate kits. Phosphate levels in many North American water bodies fall below the detection limits (30 nanomolar) of standard phosphate measuring methods. The reason for such low phosphate levels is that it is a limiting nutrient. It is in such high demand by the biomass in a water body that it is generally consumed before it can reach nanomolar concentrations. In a recent study by Wu *et al.*, it was determined that phosphate levels in the oceans were in the nanomolar range. Again, phosphate is considered a limiting nutrient in the oceans. Another recent report by Hudson *et al.*, proves what scientists recognized for years, that most conventional methods give gross overestimations of phosphate levels in natural water bodies. New measuring techniques show phosphate levels that are 100 to 1000 times lower than those reported by current conventional methods.

The above phosphate levels discussed are in the form of ortho- or reactive phosphate. However, phosphate occurs naturally in several forms. The other forms are the condensed phosphate (meta- or poly-) and organic phosphate, both of which require hot acid digestion for determination. Therefore, in a comparative study of phosphate kits that would be feasible for use by GLOBE students, only those measuring orthophosphate could be used due to safety issues. The kits that were chosen were in the \$40-80 range. This comparison was conducted with the knowledge that the results obtained would be severe overestimations of the actual phosphate levels.

One Hach kit (model # 2248-33) and two LaMotte kits (model #'s 3121 and 7416) were used for the comparison. All three kits exhibited quick and easy sample preparation. However, all three kits used a colorimetric based sample determination. As with all colorimetric determination a great deal of subjectivity was introduced. This was very noticeable in the Hach kit, which used a color wheel for comparison. The color wheel had such a gradual increase in color that a single value could not be agreed upon by several observers. The LaMotte kits used a series of colored standards in a clever viewing tray, which made determination easier. However, all three kits were difficult to use in areas with shadows due to the nature of the optics of the viewing chambers. The kits had to be used in direct sunlight for a good comparison.

Each kit was tested three different times at three different sites. Each kit gave very reproducible results for each of the three trials, but the results varying from kit to kit were drastic at times. The first site was a spring in Agua Caliente Park in northeastern Tucson. This site was chosen because being a spring, the water should have had minimal contact with biomass before being measured. The results are summarized above. At this site the LaMotte 3121 kit and the Hach kit gave similar results while the LaMotte 7416 kit gave

results that were an order of magnitude lower. The second site was at the exit of a pond at Agua Caliente site. Here the phosphate levels were below the detection limits of all three kits. This makes sense since the pond was full of plants and animals. The final site studied was the Roger Road Sewage Treatment Plant in Tucson. Here we expected to see higher phosphate levels due to detergents in the effluent. Here, as can be seen above, the Hach kit gave a value that was consistently two orders of magnitude greater than those obtained by the LaMotte kits. Water samples from the three testing sites were then sent to an Arizona State University Analytical Laboratory. The results are also tabulated above. This laboratory also utilized a colorimetric technique for phosphate determination. The total phosphate determination required an extra step of acid digestion of the sample. These lab results clearly exemplify the fact that large discrepancies occur when measuring phosphate.

With the discrepancy between the phosphate kits and lab results, the low natural phosphate levels, and the knowledge that values obtained are severe overestimations (of the actual phosphate levels in the water samples,) it does not seem plausible to add phosphate measurements to the GLOBE curriculum. In order to obtain an accurate value a much more intensive procedure must be executed. Since phosphate is a limiting nutrient, we expect that most values obtained by students would be below the detection limits of the kits anyway.

Figure 1: Results from Phosphate Tests

<i>Values in ppm</i>	LaMotte 7416	LaMotte 3121	Hach 2248-33	Lab Results	
				Ortho	P-Total
Agua Caliente Spring	0.05	0.2	0.1	0.013	0.013
Trial 2	0.05	0.2	0.1		
Trial 3	0.05	0.2	0.1		
Agua Caliente Pond Runoff	0	0	0	0.008	0.036
Trial 2	0	0	0		
Trial 3	0	0	0		
Roger Road Treatment Plant	0.6	0.6	16	3.76	4.25
Trial 2	0.6	0.7	16		
Trial 3	0.6	0.7	16		

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