Field Test Kits

Summary: Except for alkalinity, field kits have, at best, proven to be indicators of water chemistry. They should not be used to quantify chemical concentrations in ground water. They are useful for identifying impacted ground water and providing a qualitative assessment of oxidation-reduction conditions at the point of sampling. Field-measured alkalinity is recommended when quantifying bicarbonate concentrations in ground water.

Background: GWMAP utilized field test kits for nitrate, chloride, alkalinity (bicarbonate), sulfate, ferrous iron, and dissolved manganese. We used these kits for assessing oxidation-reduction conditions (nitrate, sulfate, iron, and manganese) in ground water and for plume tracking (chlorides, nitrate). Methods used by GWMAP included:

- mercuric digital titrator method for chloride;
- sulfaVer 4 method for sulfate;
- sulfuric acid with a digital titrator for alkalinity;
- cadmium reduction method for nitrate;
- 1,10 phenanthroline method for ferrous iron; and
- periodate oxidation method for reduced manganese (samples are filtered with a 0.45 micron filter prior to analysis).

Specific Chemicals

Chloride: Chloride is an excellent tool for tracking some plumes (e.g. septic, feedlot) in the field. We found strong correlations between field- and laboratory-measured chloride concentrations at individual sites. When data from different sites were combined, correlations were not significant. We recommend collection of 20 percent laboratory duplicates when using field kits for chloride.

Sulfate: Sulfate may be an indicator of some types of contamination, but it is more useful for assessing redox conditions. We found strong correlations between field- and laboratory-measured sulfate at individual sites and when combining different sites. Field-measured concentrations slightly over-predict laboratory-measured concentrations. We recommend 10 percent duplicates for laboratory analysis.

Nitrate: Nitrate is an important chemical of concern for many studies (e.g. fertilizers, septics) and it is an important chemical for assessing redox conditions. We used several field kits for nitrate because it was often the primary chemical of concern in GWMAP studies. We found the Hach Pocket colorimeter to be inaccurate. Test strips and color wheels provided reasonable estimates of nitrate concentration. The colorimeter from Chemetric proved to be the most accurate field kit we tested. Laboratory-measured concentrations for the colorimeter increased by 1.4 mg/L for each 1.0 mg/L increase with the field kit. We recommend 10 percent laboratory duplication for the Chemetric colorimeter and 20 percent for tests strips and color wheels.

Alkalinity: Alkalinity is a useful chemical for assessing the dissolved ion concentration in ground water and has some utility for assessing redox conditions. Field- and laboratory-measured concentrations of bicarbonate (alkalinity) were correlated, with laboratory measurements slightly underestimating the concentration. Field-measured alkalinity provides a more accurate estimate of bicarbonate concentrations in ground water than a laboratory measurement. This is the result

of bicarbonate loss (as carbon dioxide) between the time a sample is collected and laboratory analysis is performed. We recommend using field measurements to quantify bicarbonate concentrations in ground water. If there are logistical limitations to using the field kit, laboratory methods are satisfactory.

Iron and Manganese: Iron and manganese are excellent indicators of redox conditions. Presence of reduced iron at concentrations greater than 1 mg/L is a good indication of reducing conditions. The fate of many contaminants, such as nitrate and VOCs, is strongly influenced by oxidation-reduction conditions within the aquifer. Field measurements provide a good indication of the presence of reduced iron or manganese. The field method did not appear to provide an accurate estimate of actual concentrations.

Dissolved versus Total Organic Carbon (DOC and TOC)

Organic carbon provides a food source for microbes, is a substrate for microbes, is important in reactions involving metals, and may indicate contamination from animal or human wastes. DOC is the fraction of carbon passing through a 0.45 micron filter. Many researchers have used the terms TOC and DOC interchangeably. Smaller fractions, however, are likely to be more available to microbes, while larger fractions may indicate contamination by animal waste. Our St. Cloud data showed that DOC accounts for 75 to 100 percent of TOC. There was a nearly 1:1 relationship at TOC concentrations less than 10 mg/L. At higher concentrations, DOC and TOC were poorly correlated. Ten mg/L is a high concentration, however, and may indicate point source contamination (for example, a feedlot). Correlations between ground water and surface water were poor, possibly due to high concentrations of suspended solids in surface water. We recommend sampling for TOC from wells, and for both DOC and TOC from geoprobe and surface water samples.

Comparison of Downhole versus Flow-Through Cell data

Prior to 1997, GWMAP measured pH, oxidation-reduction potential, and dissolved oxygen using a flow-through cell that contained probes. In 1997 we purchased a YSI 600XL multiparameter probe. This probe allowed us to collect downhole measurements of temperature, dissolved oxygen, pH, and oxidation-reduction potential. In a fully-developed well with water moving across the screen, downhole measurements should provide accurate estimates of these field parameters. The downhole capability allows for quicker decisions in the field because purging is not required and stabilization of field parameters is quick. A limitation is the 1.5 inch diameter of the probe, which excludes its use with some geoprobes. A second application of downhole measurements is continuous measurements for the field parameters. Measurements can be collected at fifteen minute (or other time) intervals and the data stored until it is downloaded. These measurements may have value under transient ground water conditions. We observed strong correlations between measurements collected with a flow-through cell and downhole measurements. The correlations were about 1:1 for each field parameter. Use of downhole readings provides an excellent tool for conducting rapid field assessments, collecting continuous field measurements from a well, or simplifying field sampling.

Geoprobe versus Well Samples

Comparisons of water quality data from temporary wells (geoprobe) and monitoring wells indicated slightly lower concentrations of trace inorganics in the geoprobe samples. We observed large differences between well and geoprobe samples for the oxidation-reduction parameters. Concentrations of iron, manganese, ammonia, organic carbon, nitrate, and Kjeldahl nitrogen (total reduced nitrogen) were greater in geoprobe samples, while Eh and dissolved oxygen were lower. There was a lot of variability in the geoprobe data for most oxidation-reduction parameters. Suspended sediments in geoprobe samples are responsible for most differences between wells and geoprobes. We filtered geoprobe samples, but it was difficult to obtain "clean" samples even after considerable pumping. The geoprobe is an excellent tool for conducting investigations of water quality. Samples should be filtered because of high dissolved sediment concentrations. We do not recommend using the geoprobe to quantify water quality. It is a valuable tool for evaluating spatial distribution of chemical(s) and placement of monitoring wells.