Water Age Testing

Water Age Testing Synopsis: The Clear Creek C.S.D. needs to have the water age tested for several reasons. First reason is to know how reliable our water source is. Second reason to know how long our water has been underground. The third reason is to determine to what extent our water system is influenced by surface water. It is believed that our water source is an underground lava tube. Determination of groundwater age is important because it is an indication of how susceptible the groundwater is to contamination as well as how long it takes for the aquifer to be replenished. Short residence times, or 'young' groundwater can be more susceptible to contamination from activities on the land surface since the aquifer is frequently being replenished. Accidental chemical spills and land use changes have less effect on an old source of groundwater. On the other hand, groundwater that is not often replenished, 'old' groundwater, can indicate that overuse of the resource could be a potential issue.

The USGS Groundwater Dating lab has been analyzing groundwater samples for decades and tests for anthropogenic trace gases dissolved in the water to determine the last time the water was in equilibrium with the atmosphere. From these measurements, an estimate of groundwater age can be made. Anthropogenic sources include a variety of industrial, commercial, and military activities along with non-sustainable disposal practices of municipal, agricultural, and industrial wastes. Both chlorofluorocarbons (CFCs) and sulfur hexafluoride (SF_6) are gases that were introduced into the atmosphere by human activities and are very stable in the environment. The stability of these compounds makes them good age tracers for determining groundwater age.

The age of the groundwater is determined by calculating the concentration of these tracer gases in the water and finding when in history that concentration would have resulted from equilibrium with the atmosphere. Supplemental nitrogen/argon (N_2/Ar) analysis provides important information regarding the conditions of the air/water equilibrium most notably, temperature. Dissolved gas concentrations are temperature dependent and knowing the temperature at which the water was recharged provides the most accurate estimation of groundwater age. The N_2Ar analysis includes determination of gases that are indicators of microbial activity

within the aquifer. Concentrations of oxygen, carbon dioxide, and methane are also provided through this analysis.

It is suggested that all three sample types are submitted to ensure the most thorough investigation into our groundwater. In some cases, CFCs and SF_6 can be subjected to contamination during the residence time in the aquifer. If a tracer gas is contaminated by an underground source, an age determination cannot be made. For the purposes of CFC and SF_6 dating, the term ‘contaminated’ refers to water that has concentrations that are greater than that possible for equilibrium with tropospheric or even urban air. Groundwater from urban and industrial areas is often contaminated with CFCs, but concentrations are rarely more than a few parts per billion. The addition of contaminant concentrations of CFCs to groundwater can usually be attributed to anthropogenic point sources such as discharge from septic tanks, leaking sewer lines, leakage from underground storage tanks, discharge or injection of industrial wastes, and recharge from rivers carrying effluent from sewage treatment plants. SF_6 is primarily of anthropogenic origin but also occurs naturally in fluid inclusions in some minerals and igneous rocks, and in some volcanic and igneous fluids. Occasionally, long residence times in contact with SF_6 rich geologic formations can increase the SF_6 concentration over the datable range. Compared to CFCs, since there are relatively few uses of SF_6, few environments are contaminated by anthropogenic sources.

Human practices are the source of many water-quality contaminants in the YRB, they must be described as an integral part of the environmental setting. Part of the process of the scientific method in this case is eliminating all possibilities. So, if we have a natural source like a lava tube then the SF6 could be elevated beyond the datable range of concentrations. Each age tracer can have sources of contamination and, therefore, it is advisable to test the groundwater for all the above tracers in the event one provides contaminated results. Supplemental N2/Ar analysis yields important information regarding the conditions at which the water was recharged and allows us to make a more accurate determination of the age of the water. In Summary, the USGS can give us a report on the approximate age of our water using the information from the samples as described above.

See also comments below from an associate of the USGS

Thanks Allison and Hi JD,

Points to get across:
Groundwater age is a good piece of information for groundwater source managers to have as it is an indicator of

- Susceptibility to contamination due to activities on the land surface including spills and land use such as agriculture and urban/suburban activities
- Reliability of the source in reaction to drought conditions
- Influence of surface water interactions