Proposal Coversheet

Application Submitted

To: Dr. Arlene Courtney

Program: Ch 462 Experimental Chemistry

Title of Project: Determination of Ground Water Copper Contamination

Suggested Timeline: ~1 week

Date Submitted: January 26, 2008

Principle Investigator

Applicant's Contact Information Proposal #8

Signatures:

Abstract:

Copper is a transition metal most commonly found in nature as an Ore. When in an ion form it appears in colors of a green or blue. Weathering can cause these ions to become mobilized and bioavailable[1,2]. The Environmental Protection Agency lists it as a regulated metal for safety in public water supplies. Our intent for this project is to examine water samples for copper from site showing water contamination. The method used for detection will be atomic absorption spectroscopy. A positive identification will make it possible to propose appropriate recommendations for cleanup and prevention.

[1]Modeling Removal of Cd, Cu, Pb, and Zn in Acidic Groundwater during Neutralization by Ambient Surface Waters and Groundwaters

[2] Adsorption of Cu, Cd, and Ni on Goethite in the Presence of Natural Groundwater Ligands

Determination of Ground Water Copper Contamination

Abstract

Copper is a transition metal most commonly found in nature as an Ore. When in an ion form it appears in colors of a green or blue. Weathering can cause these ions to become mobilized and bioavailable[1,2]. The Environmental Protection Agency lists it as a regulated metal for safety in public water supplies. Our intent for this project is to examine water samples for copper from site showing water contamination. The method used for detection will be atomic absorption spectroscopy. A positive identification will make it possible to propose appropriate recommendations for cleanup and prevention.

Introduction

A home in Oklahoma has surfaces which come into contact with well water producing a blue green residue. This is most likely caused by the presence of transition element ions. Coloration in these metals is caused by d-orbital electron configurations. Many copper salts are blue or blue-green in color. One of the most probable possibilities is that the stains were caused by precipitation of copper.

The natural weathering of rocks rich in sulfide minerals results in the release of dissolved metals, sulfate, and acidity to the environment[3]. If metals are mobilized in an aquifer, they may

[3] Modeling Removal of Cd, Cu, Pb, and Zn in Acidic Groundwater during Neutralization by Ambient Surface Waters and Groundwaters

become bioavailable and thus toxic to some organisms or reach the deep groundwater, which is often used as drinking water[4]. Many different factors can also influence pH levels in ground water. Copper pipes are commonly used in household plumbing. Many water quality parameters, including pH, alkalinity, sulfate, chloride, phosphate, silicates, natural organic matter, dissolved oxygen, disinfectant residuals and temperature can affect copper release under different specific conditions[5]. It is our intent to test for the presence of copper which is mostly commonly found in its +2 oxidation state. Another simple analysis will be checking pH levels.

Discussion of significance

Since private wells are not subject to any government regulation it important for owners to protect themselves through proper maintenance and system testing. The Environmental Protection Agency (EPA) publication on water from private household wells recommends that water should be tested when these is any indication of possible contamination[6]. Currently there are no known long term effects of copper consumption, however, short term effect include gastrointestinal dysfunction, nausea, and vomiting[7]. The EPA began regulation copper levels in water in 1992.

Negating the possible health risks, there is an economic benefit from correcting the water imbalance. Corrosion to pipes could result in large scale damage to a home. Financial savings would also occur from the prevention of staining to sinks, toilets, and bathing areas. It should also be noted that finding a technique for removal of current stains would be beneficial.

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[4] Adsorption of Cu, Cd, and Ni on Goethite in the Presence of Natural Groundwater Ligands
[5] Iron and Copper Release in Drinking-Water Distribntion Systems
[6] Drinking Water From Household Wells
[7] IPC INCHEM

Review of previous work

Literature involving the staining of household surfaces was limited. However, information concerning ground water levels was much more abundant. A study done in 1999 by the United States Geological Survey for Oklahoma that surrounding states didn't show any abnormal levels of copper in ground water. The main source of copper would come from the dissolution of naturally-occurring metallic minerals. A secondary contribution is the result of leaching from well casting and other ground piping[8].

An interesting project done by a research group involved sampling drinking fountains to determine contaminates. Samples were collected as the first draw at the beginning of the work week. These samples were acidified to prevent the precipitation of heavy metals and analyzed using United States Environmental Protection Agency (USEPA) approved procedures and quality control. They found Cu in 100% of their 40 samples. Many also exceeded the EPA's action level as high as 3.9 fold. The conclusion of research indicated that drinking water fountains can be an unanticipated and unwanted source for ingestion of Cu[9].

Materials and methods

According to the AOAC's Official Methods of Analysis the appropriate method for determining the content of copper would be using atomic absorption spectroscopy (AAS)[10].

Reagents/Apparatus:

a) Distilled H_2O

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[8] Water Quality in the Central High Plains Aquifer, Colorado, Kansas, New Mexico, Oklahoma, and Texas
[9] Lead and Copper in Drinking Water Fountains-Information for Physicians
[10] Cadmium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Silver, Zinc, in Water

b) Nitric acid - 500 mL HNO_3 diluted to 1 L with H_2O

c) Hydrochloric acid - 500 mL HCl diluted to 1 L with H_2O

d) Standard Pyrex, quartz, or Teflon labware

e) Buck Scientific Atomic Absorption/Emission Spectrophotometer 200-A

Methods:

In order to prepare the sample first pass a known volume through a 0.45 μm membrane. Use first 50-100 mL to rinse flask and discard. Collect filtrate and preserve by adding 3 mL of prepared nitric acid. Transfer the residue and membrane to a 250 mL beaker and add 3 mL HNO_3 cover with watch glass and heat gently to dissolve membrane. Increase heat and evaporate to dryness. Cool, and add 3 mL HNO_3, and heat until digestion is complete, generally indicated by light colored residue. Add 2 mL HCl, and heat gently to dissolve residue. Wash watch glass and beaker with H_2O and filter. Wash filter and discard. Dilute filtrate with H_2O to concentration within range instrument. Transfer aliquot of well mixed sample to beaker and add 3 mL HNO_3. Heat, and evaporate to dryness Do not boil.). Cool, and add 3 mL HNO_3, and heat until digestion is complete, generally indicated by light colored residue. Add 2 mL HCl, and heat gently to dissolve residue. Wash watch glass and beaker with H_2O and filter. Wash filter and discard. Dilute filtrate with H_2O to concentration within range instrument. To prepare a standard solution, dissolve 1.000 g Cu in mL HNO_3 and dilute to 1L with H_2O. The operating parameters of the AAS for Cu should be a wavelength of 324.7 nm with an acetylene flame. The optimum range should be 0.1 to 10 mg/L.

Prepare a calibration curve using an average of the standards to measure your - sample against.

Discussion of possible outcomes

A positive identification will make it possible to propose appropriate recommendations for cleanup and prevention. Negative results will requires a revision of the hypothesis and testing procedures

Budget and timeline

All needed items are available in the lab. The experiment should take up on week in the lab to allow for multiple aliquots.

Total Time: ~1 week Total Cost: $0

References

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2. Behra, P.; Buerge-Weirich, D; Hari, R.; Sigg, L.; Xue, H. Adsorption of Cu, Cd, and Ni on Goethite in the Presence of Natural Groundwater Ligands *Environ. Sci. Technol.* **2002**, 36, 328-336

3. Shi, B.; Taylor J.S. Iron and Copper Release in Drinking-Water Distribntion Systems *Journ. Environ. Health* **2007**, 70:2, 29-36

4. EPA Drinking Water From Household Wells, **2002**

5. IPC INCHEM. Copper. http://www.inchem.org/documents/ehc/ehc/ehc200.htm#SectionNumber:7.3 (accessed Nov 9, 2008)

6. U.S Geological Survey. Andrews, W.J.; Becker, M.F.; Bruce, B.W.; Pope, L.M. Ground-Water Quality in the Central High Plains Aquifer, Colorado, Kansas, New Mexico, Oklahoma, and Texas. **1999**

7. Afshar, M.; Barczyk, M.; Broyles, G.; Barau, K.; Cech, I.; Emery, R.; Smolensky, M.H. Lead and Copper in Drinking Water Fountains-Information for Physicians *Southern Medical Journal* **2006,** 99:2, 137-142

8. Cadmium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Silver, Zinc, in Water; Official Methods of Analysis of AOAC International, Cunniff, P. AOAC International Gaitherburg, MD **1998,** 16 ed., Chapter 11, p. 15-17