

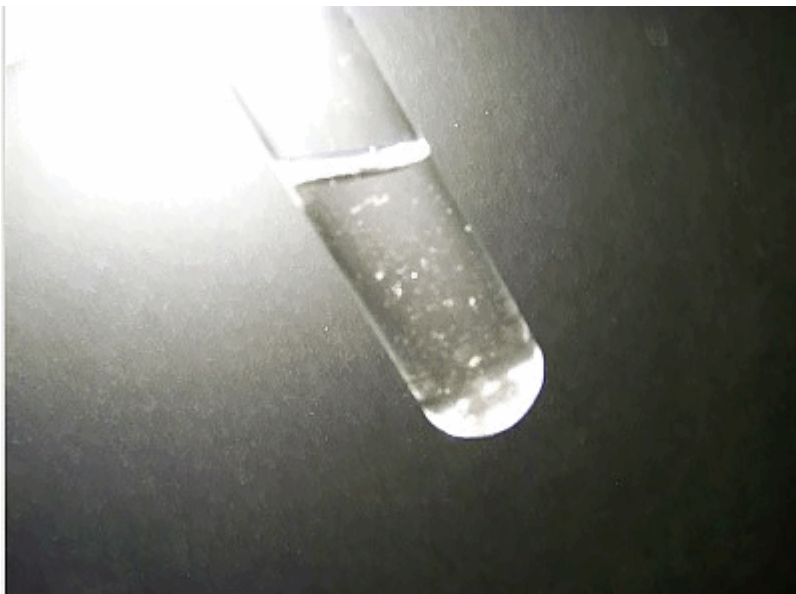
Preliminary Rainwater Analysis : Aluminum Concentration

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ABSTRACT

A method and means to identify the species and concentration of several different trace metals in ionic form has been established. The method employed is that of differential cyclic chronopotentiometry, which is a subset of the science of voltammetry. The brief paper presents a preliminary examination of a rainwater sample for the existence of trace metals. The sample under examination shows the existence of aluminum in a soluble form. An estimate of the concentration level of the aluminum has been made; this level exceeds that of the recommended standards for drinking water. The results indicate that public concerns about the toxicity levels of certain trace metals in the general environment are warranted, and that a more thorough evaluation of the state of atmospheric quality by the responsible agencies is required.



Rainwater Sample of this Study Collected under "Clean" Conditions
Note that Visible Pollution is also Evident

The determination of trace metals can be an expensive and sophisticated proposition. One of the more modern methods of detection at trace levels involves the use of Inductively Coupled Plasma (ICP); such means and skill sets are not practiced by the public under normal circumstances. The determination of inorganic compounds at trace levels has always presented a serious challenge to this Institute, and in the past all such efforts have been relegated to that which can be gleaned primarily from qualitative testing methods. One interesting alternative, with a long history and of increasing importance, is the science of voltammetry. Many are familiar with the fact that elements and compounds have unique electromagnetic spectrums,

such as those employed in the disciplines of spectroscopy including, for example, infrared spectrometry and atomic absorption. It is valuable to know that many of these same elements also have an 'electrochemical signature', and that they behave in unique and identifiable ways when exposed to variations in voltage and current. It is from this fact that voltammetry was born, and its origin dates back to the the days of Michael Faraday. The basic principle of voltammetry is to examine the relationships of oxidation and reduction within a medium or a reaction; there are numerous variations upon the specifics of this theme. Voltammetry equipment is dramatically more modest in cost than ICP and mass spectrometry, and yet it can still produce usable results that are, on many occasions, commensurate with the more advanced equipment and technology. Such equipment, in its most basic form, is now employed at the Institute and it is yielding promising results in the important domain of inorganic analysis, such as metals and halogens.

The study here refers only to an inorganic analysis that has been made; at a later date a presentation on biological aspects of the rainwater sample will occur as time and circumstances permit.

The rain sample was collected on Oct 30 2015 with new and clean containers with a clear path to the sky above. The sample was then evaporated to 33% of the original volume for the purpose of increasing the concentration level sufficient for testing purposes. The sample was compared to a control volume of distilled water.

The potentiostat used in the voltammetry work is a CV-27 model from Bioanalytical Sciences. The unit has passed all test procedures as described in the manual. The output from the potentiostat is coupled to a Pico 2000 series digital oscilloscope, whereby both voltage input and output can be displayed as a function of time. The basic mode of operation for the testing process is therefore one of chronopotentiometry.

A series of calibration tests were made with a variety of trace metals, including calcium, magnesium, sodium, potassium, iron and aluminum.

The goals of the investigations include both the ability to identify the species as well as concentration; both goals have been achieved with the above elements in an ionic state in sufficient concentration, i.e., on the order of a few parts per million (PPM). The work will extend to other species and combinations thereof in the future.

The particular variation of chronopotentiometry that has been utilized is that of cyclic chronopotentiometry, i.e, the alternating sweep between positive and negative voltages in the effort to identify the peak potential that characterizes the redox reaction of the particular element.

In addition, it has been found that the derivative of the chronopotentiogram is a key and critical factor in the determination of the species. A careful analysis of the derivative of the cyclic chronopotentiogram can be used with favor to identify the peak potential of the element.

When this point is identified and collated with the identifying element,

concentration levels can also be established if a set of known standards is available. Concentration determinations on the order of a few parts per million have been achieved on multiple occasions.

Further careful evaluation of the derivative of the cyclic chronopotentiogram in combination with variable voltage sweeps can be used to identify separate components within a mixture of ionic species; this has been accomplished with a combination of three elements in ionic form in aqueous media to date.

The current work, under these preliminary conditions and examinations, leads to an assessment of a concentration level estimate of aluminum (+3, ionic state) within the rain sample at approximately 2.5 PPM. A conservative approach in all manners of examination has been adopted in the preparation of this estimate, and the condensing of the sample is accounted for.

The Environmental Protection Agency in 2012 lists the secondary regulations for aluminum in drinking water as being within the range of 0.05 to 0.2 mg/L. This corresponds to a range of 0.05 to 0.2 PPM for this same standard. It is an interesting observation within the same report that Secondary Drinking Water Regulations exist as non-enforceable federal guidelines. The wisdom of that classification process can be determined by the reader.

Continuing with the most conservative approach possible, one is led to the assessment that this particular rain sample from a rural location in northern Idaho exceeds the EPA drinking water standard and health advisory by roughly a factor of 12.

The following reference statement from the United States Geological Survey (Bulletin 1827-A, 1967) may be of interest in the evaluation of importance that is to take place:

PURPOSE AND SCOPE

Aluminum is an abundant constituent of rock minerals; in fact, only oxygen and silicon exceed aluminum in abundance among the elements present in the outer part of the earth's crust. Aluminum is, however, a very minor dissolved constituent in natural water. In routine water analyses the element is seldom determined, but the available information shows that, except for waters having a pH below 4.0, concentrations rarely exceed a few tenths of a part per million.

It is a point of interest that many individuals have ascribed the detection of aluminum within the atmosphere over a period of many years to my name. Such was never the case. My earlier work did indeed establish the precept that ionizable metallic salts are at the core of atmospheric pollution that we now live under, but the testing of aluminum, specifically, was not a part of that process. The chemistry of aluminum is quite different from that of the alkali earth metals, and the documentation of its existence by others has always raised intriguing questions of physics. Prior to this current work, most of the inorganic analyses that I have made have been restricted to

qualitative tests. No means of testing aluminum at the trace levels has existed for the Institute prior to this occasion. Hopefully, this situation is now mildly improved with the current voltammetric studies. This paper adds itself to a long list of documented actions by the citizenry on the consideration that aluminum is certainly, and has been, entitled to.

As a starting point, we might wish to consider the role that aluminum may play within a geoengineered environment, and it may be worthwhile to look at the exothermic energetics of nano-particulates of aluminum under exposure to moisture. It raises some tantalizing prospects for additional capabilities of an induced or artificial plasma state.

It is also an observation that visible pollutants in rainwater may be most pronounced with the advent of a storm. This is logical, and this has certainly been observed in the cases of excessive fires in this region. Time will tell if it is the circumstance of other samples. It remains to be seen how the gradation of pollutants varies with respect to the duration of the rainfall. Nevertheless, this study does exist as a valid data point and the merit of consideration is not weakened by any progression of dilution. The concentration gradient with respect to storm length for invisible pollutants, such as those in ionic form, remains as a topic of equal interest for the future.

There is, of course, considerable debate on the issue of the sources of contamination within our water supplies on this planet. I will not engage in that debate in this paper, as the purpose here is to simply provide another data point of reference that may be of service in helping to establish the accountability that is required. There are arguments by some that wish to frame a state of 'normalcy' for us, regardless of the level of contamination that as a species we now infest ourselves with. Regardless of various machinations that may be in vogue, we may all ask the questions of where standards evolve from, and whether or not we knowingly wish to deny the legacy of health knowledge that has been acquired over decades, if not centuries. We should also be called upon to use our united common sense and intuition, pray coupled with the best scientific information available, to act as stewards for our future, and to be worthy of such a title.

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