

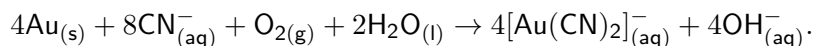
Chemistry 3250
Ethics case study 2:
Statistics vs point measurements

Adapted from “Nearing the Limit” case study, J. Kovac, *The Ethical Chemist*, Pearson: Upper Saddle River, NJ, 2004

Due: Tuesday, March 6, 12:15 p.m.

Cyanide and gold mining

- Cyanide is used in gold mining to extract gold from low-grade ores. The reaction is



The gold is then recovered by electrodeposition.

- This process is typically carried out right at the mine site.
- Cyanide is extremely toxic, so cyanide contamination of water is always a concern.
- Cyanide monitoring is routinely performed near mines.
- In Canada, the maximum acceptable concentration of cyanide in drinking water is 200 $\mu\text{g}/\text{L}$.

Monitoring a mine

- You are working in the environmental monitoring lab of a gold mining company.
- Every quarter, you collect samples from a series of wells around the mine, as well as surface water (i.e. river and lake) samples from a wider region surrounding the mine.

The wells were drilled strictly for monitoring purposes. No one is relying on them for drinking water.

The mine is not particularly close to any surface water. The main risk to surface water is from leaching of the cyanide residues in a tailings pond, which is likely (but not guaranteed) to be detected in the wells before it shows up in surface water.

- There is a town nearby. Some of the people who live outside of the town rely on wells for their drinking water. The town uses water from a river.

Reporting

- The practice at the mine has been to report averages of the data collected at related sites (e.g. all the wells, all the samples from a particular river or lake) to the mine management, who in turn pass on these results to appropriate monitoring authorities.
- This has the advantage of generating a standard deviation for the measurements which can be used to judge their reliability.

Data collection, Feb. 3, 2012

- The last quarterly surface water samples were collected in January. All samples were normal.
- On Feb. 3, 2012, you collect your quarterly samples from the wells.
- The analyses are carried out the following day.

The following data were obtained for the twelve wells:

Well:	1	2	3	4	5	6
[CN ⁻]/ $\mu\text{g L}^{-1}$	105	60	220	111	102	172
Well:	7	8	9	10	11	12
[CN ⁻]/ $\mu\text{g L}^{-1}$	113	120	129	70	86	59

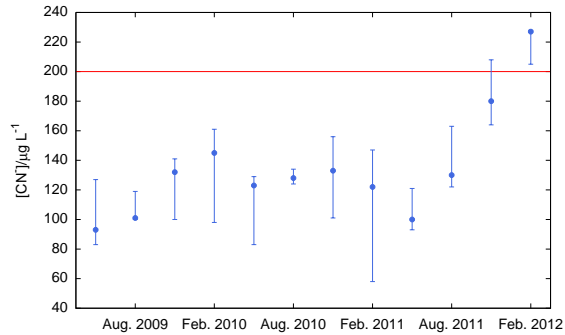
Average and standard deviation: $112 \pm 46 \mu\text{g L}^{-1}$

What you do

- Each value is the average of three trials from a given field sample. Your first thought is that something might have gone wrong in analyzing the sample from well 3, so you check your results again. There are no calculation errors, and the three trials are consistent with each other: 205, 228 and $227 \mu\text{g L}^{-1}$.
- Your lab also takes periodic samples from the tailings ponds, which are heavily contaminated with cyanide, so your second thought is that the sample might have become contaminated in the lab during analysis. You have no easy way of checking this, of course.

What you do (continued)

- You go back into your records for well 3 and plot the following high/low/median graph using the three trials for samples from this site over the last three years (since you started working in the lab).



A little chat with your boss

- Having looked at the data, you have concerns.
- You take these concerns to your boss. He looks at your data and points out two things:
 1. The average of the twelve wells is still much lower than the maximum safe level.
 2. There is a lot of scatter in the data, so randomly throwing up a point that far from the mean will happen from time to time.

A little chat with your boss (continued)

- Your boss additionally points out the following:
 - If you sign off on a report that indicates that a level above the maximum safe level has been measured, the company will be forced to investigate the source of the cyanide.
 - Such an investigation would be costly.
 - Reporting the average from the twelve wells and not individual measurements is consistent with past practice.

- Given the geology of the area, any cyanide that had escaped the plant or a tailings pond would migrate slowly. Your next regularly scheduled sample collection day would be in May. By then, you can see if the high levels persist in well 3, or if high levels start showing up in the other wells.

A little chat with your boss (continued)

- You suggest that maybe you should just go resample well 3.
- Your boss gets angry and tells you that you have better things to do, and that he has laid out a perfectly reasonable plan.

What do you do?