



Mineralogy Models from drill hole data

Visual logging is subjective. Every geologist will log differently. The same geologist will log differently on a Tuesday morning compared to a Friday afternoon. For most mineral deposits it is almost impossible to create a meaningful and useful alteration model from visual logging data.

Without a reliable mineralogy model, metallurgists select test samples based on low, medium, high grade, but they don't sample to test variations in gangue mineralogy. (What could possibly go wrong?)

This case study is a sediment-hosted Cu system in rocks metamorphosed to amphibolite grade. It has been drilled by several different companies over a period of 30 years.

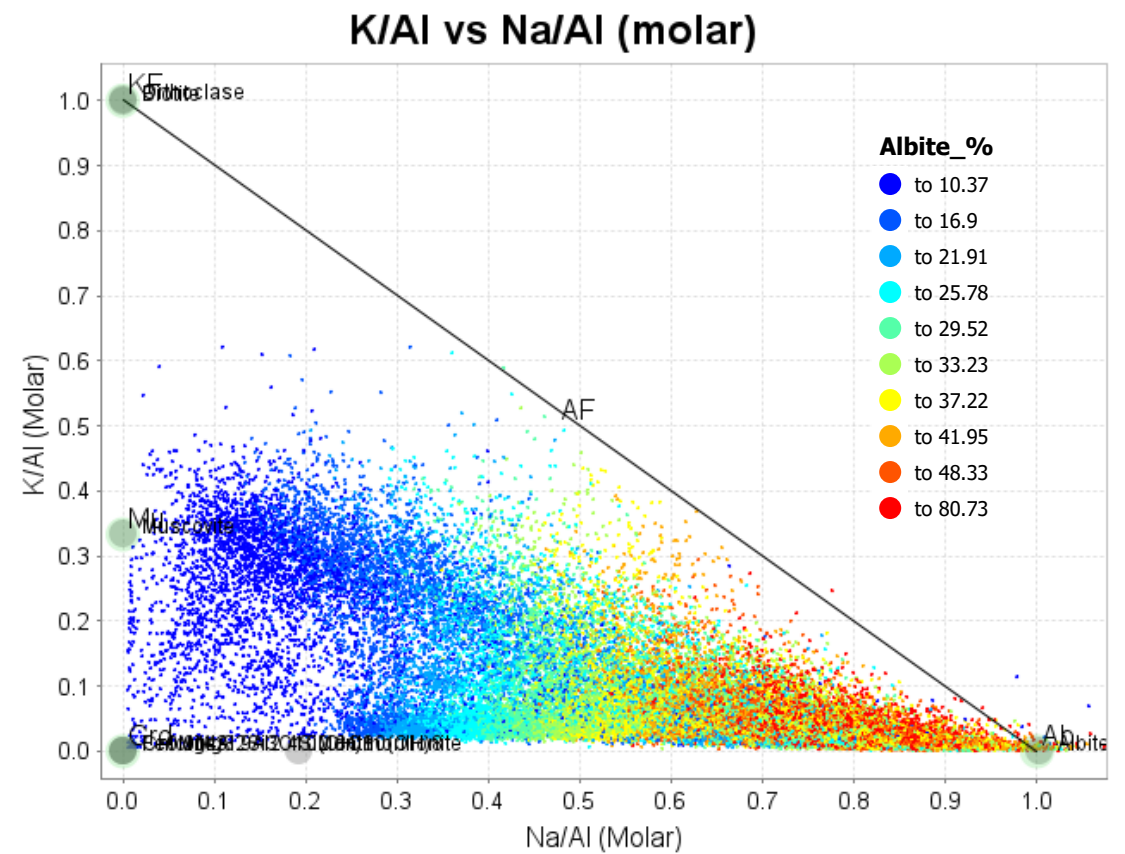
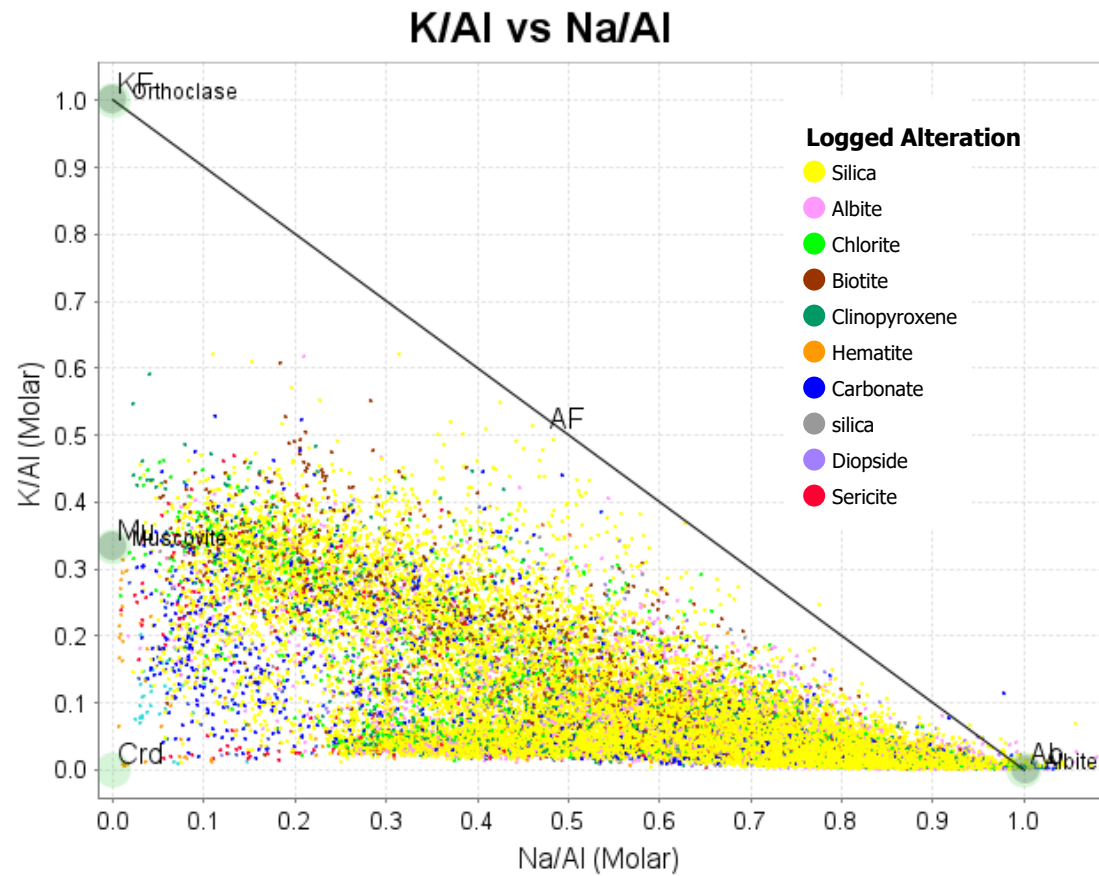
The data presented here shows inconsistency of visual logging. Whole rock chemistry (4AD ICP-OES) is a quantitative data set from which mineral abundances can be calculated with a mass balance algorithm. The mineralogy in this system is dominantly albite (oligoclase)-calcite-biotite-quartz. The fine-grained hydrothermal feldspars were usually logged as "silicification".

Mineralogy estimated from assays is more reliable than alteration categories assigned from visual logging. Spectral systems report "spectral contributions" of minerals that are active in various wavelength ranges, but SWIR for example, doesn't respond to quartz, feldspars or sulfides.

We do not need perfection, but we do need a useful model. We are not trying to do a Ph.D. We are trying to map and model variability in a mineral system.

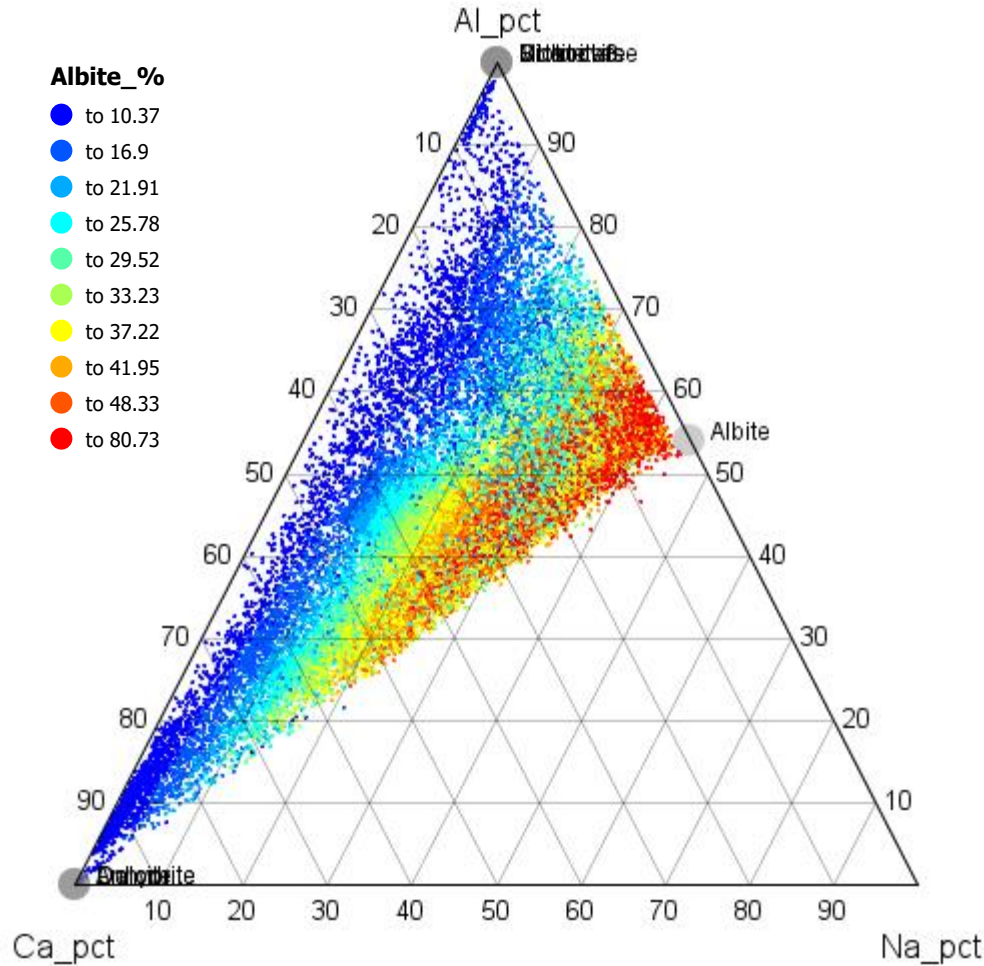
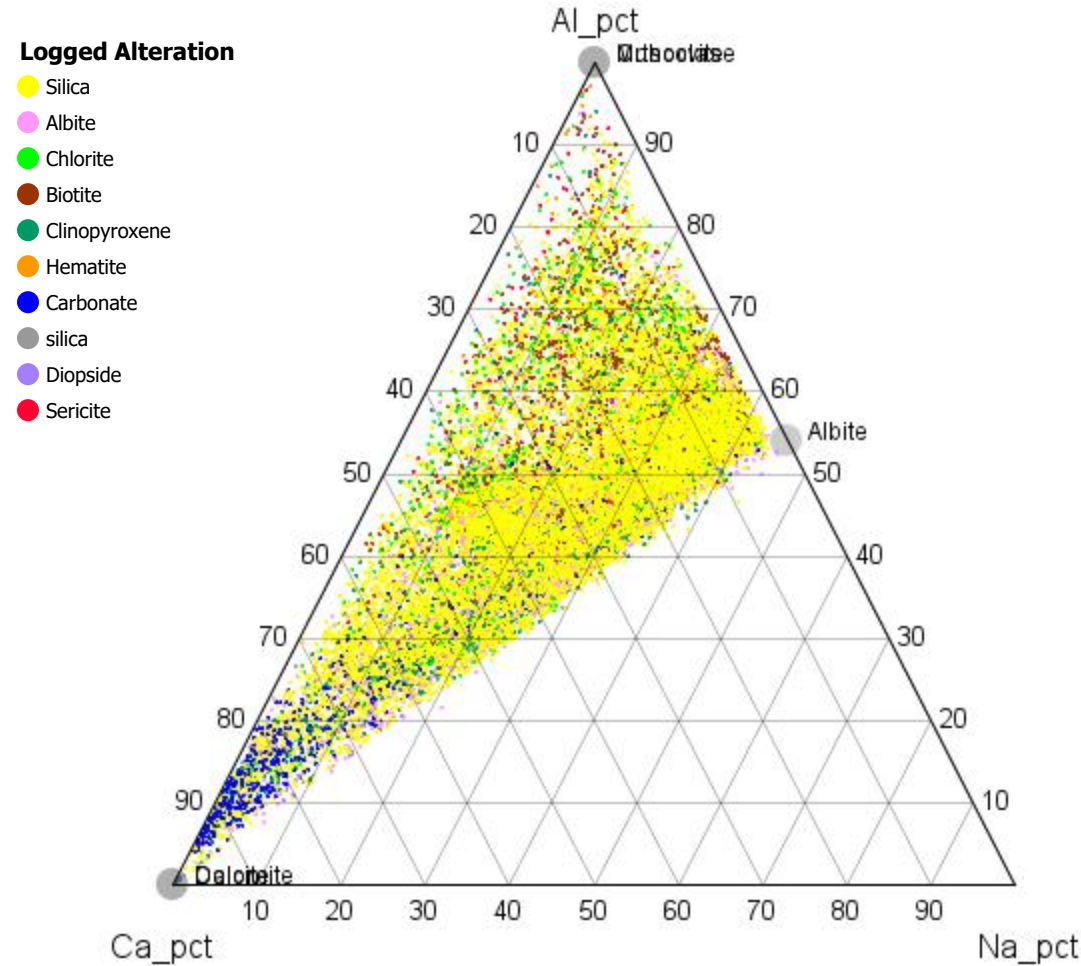
K/Al vs Na/Al (molar)

In this figure, there are 32,000 data points (assay intervals) with 30 different codes for the dominant alteration mineral.



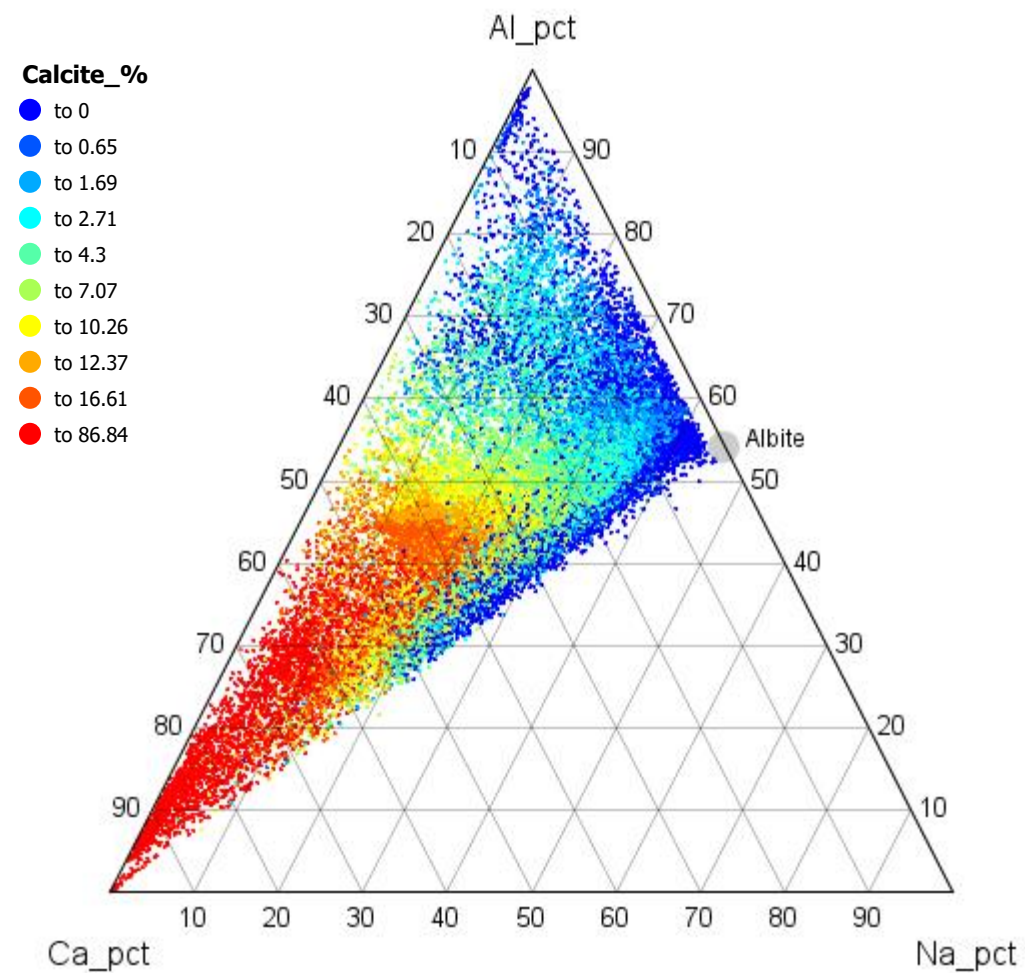
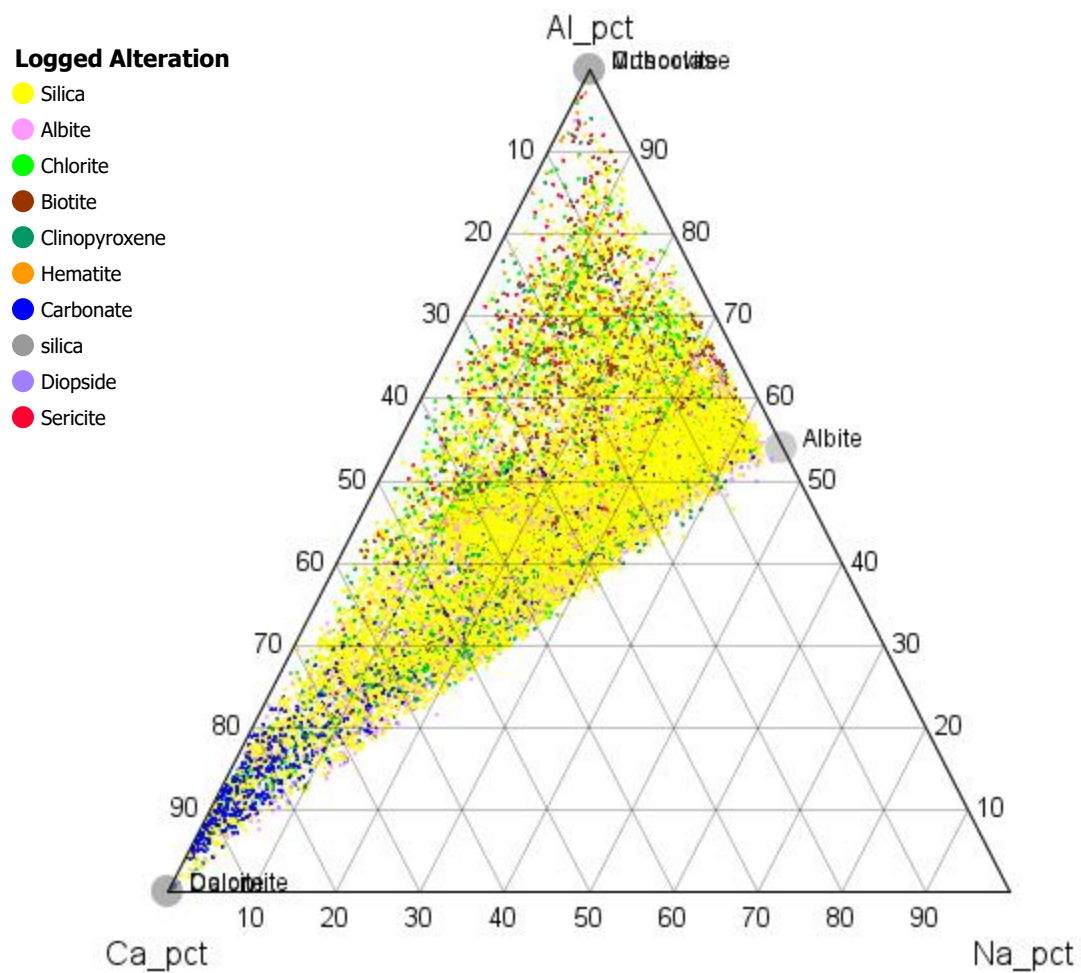
Al-Ca-Na ternary

This plot shows a very sharp boundary to the data cloud between the albite node and the Ca apex. This is a feldspar-calcite control.



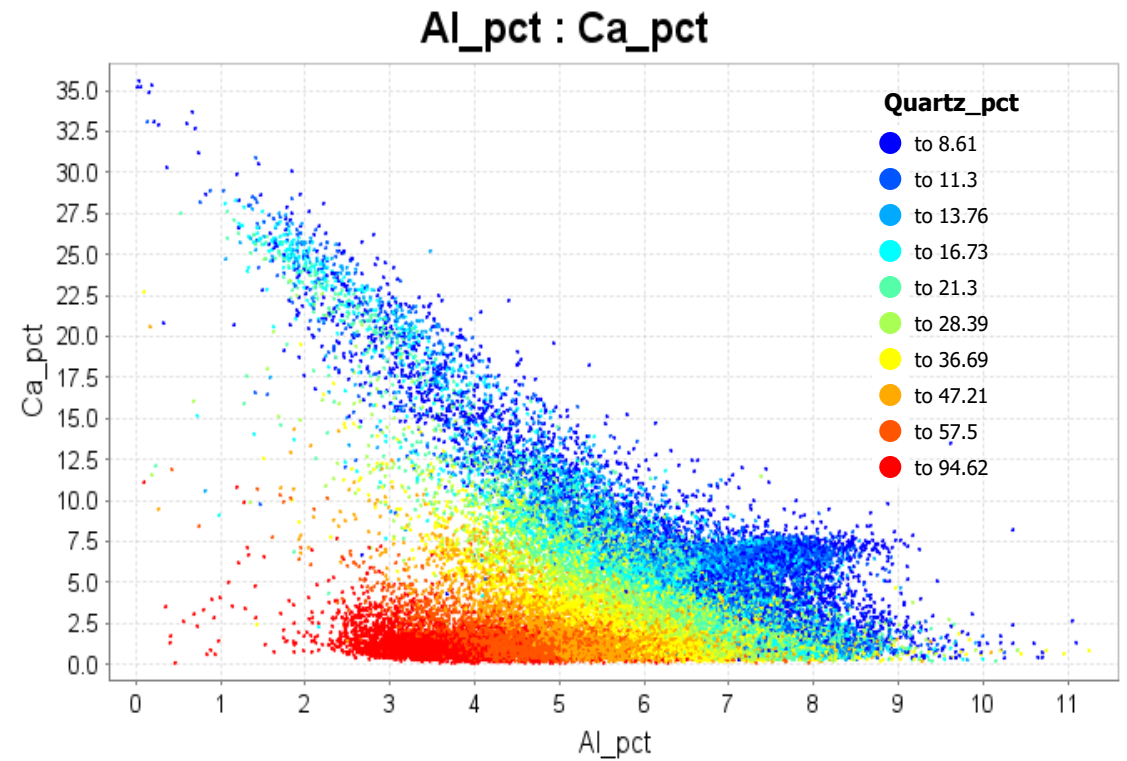
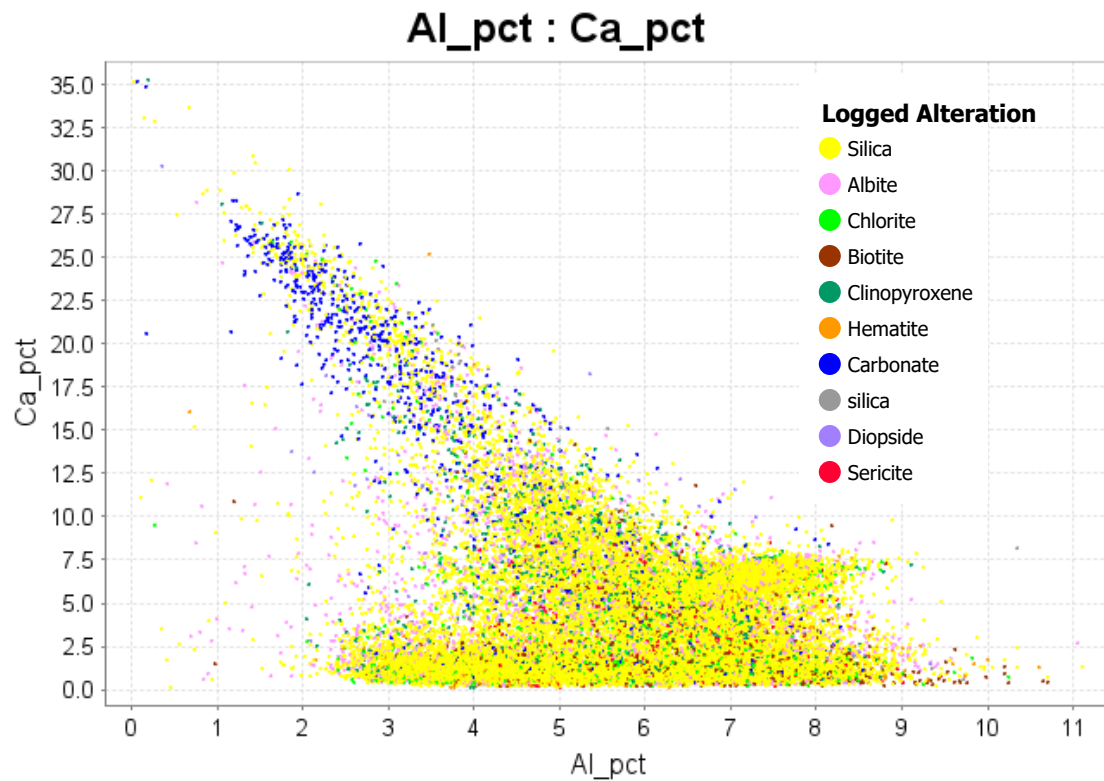
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Al vs Ca

The sediments include alternating sand and silt bands. There are more phyllosilicates (with high Al) in the silt, and the sandy layers contain more quartz (Al decreases as quartz increases). Even though SiO₂ was not analyzed, the estimates of quartz_pct are surprisingly accurate.



Al-K-Mg ternary

We write the composition of biotite as $\text{K(Fe,Mg)}_3\text{AlSi}_3\text{O}_{10}(\text{OH})_2$, ie $\text{K:Al} = 1$, but the Al atoms per formula unit in hydrothermal biotite is always more than 1 (usually more like 1.4). The data cloud in this plot shows a biotite control. Biotite>Muscovite is consistent with temperatures >350 degrees, along with oligoclase rather than albite.

