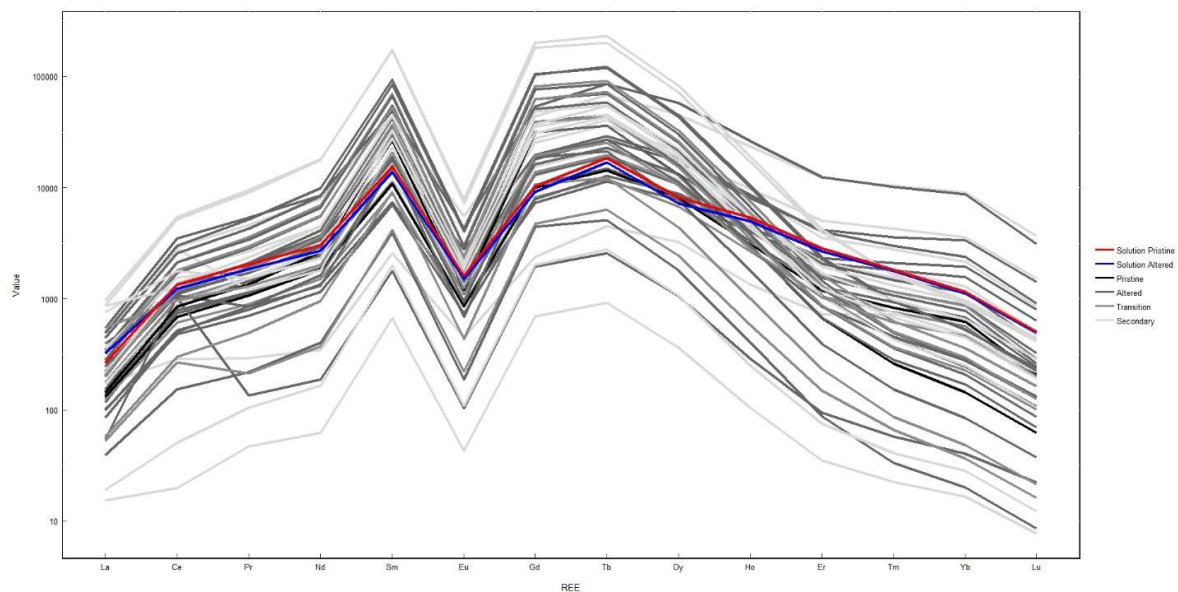
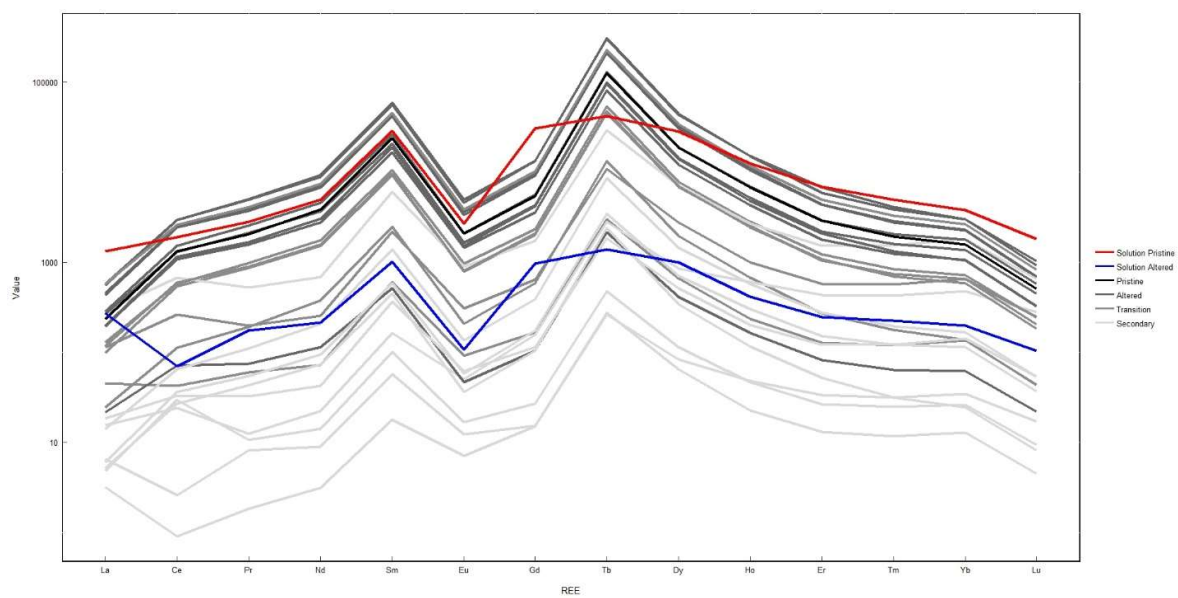


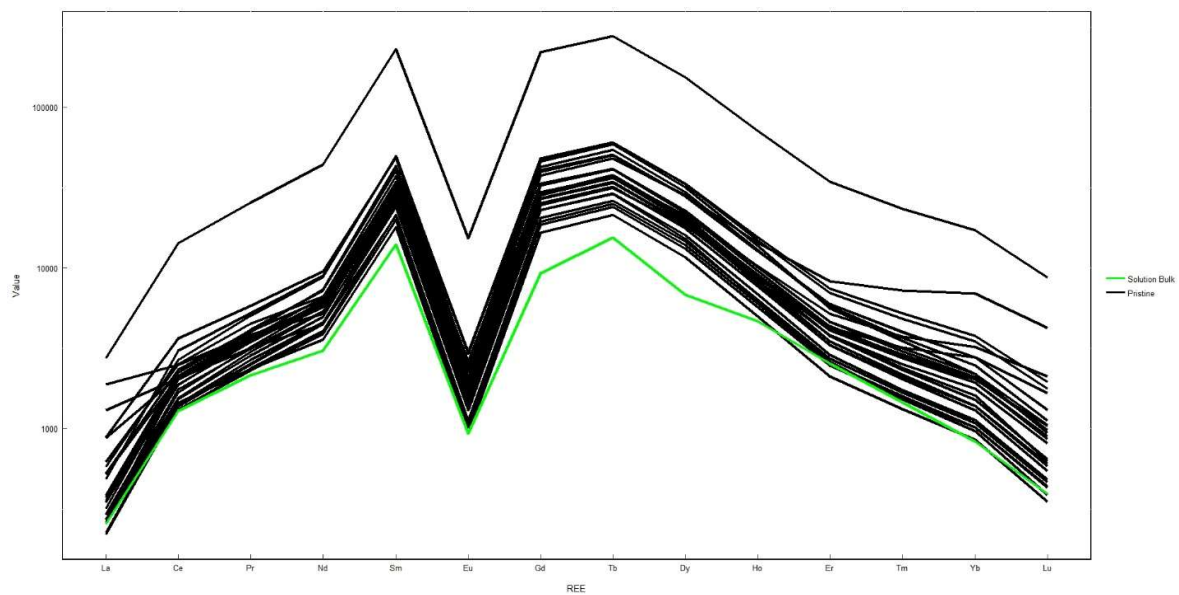
Supplementary Materials



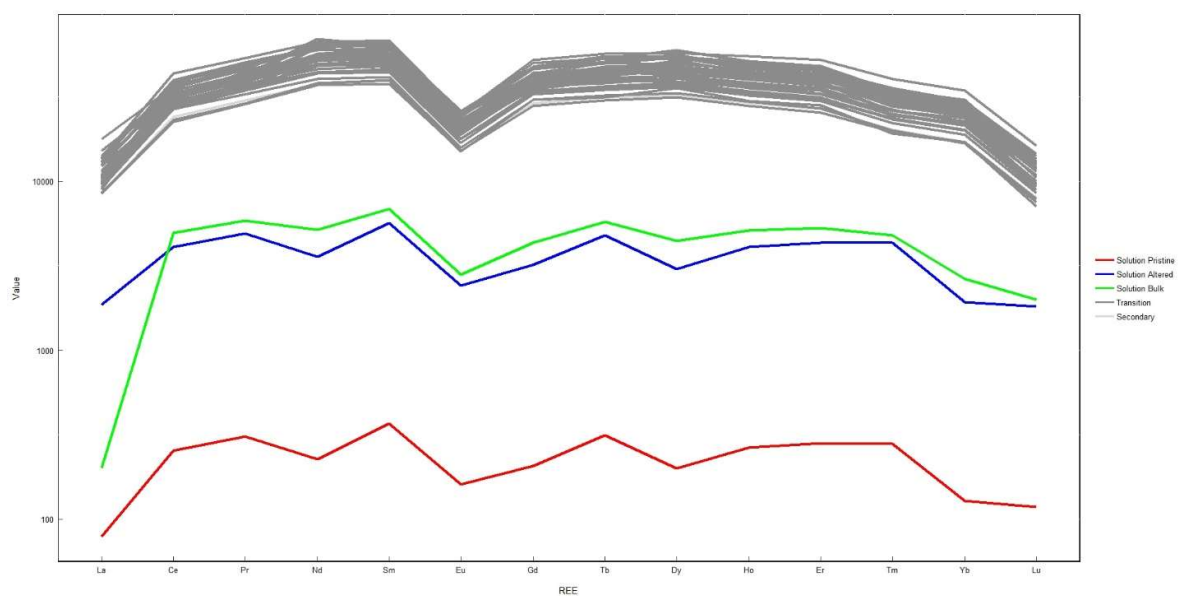
Sample #333, Yancey, Intrusive non-granite related.



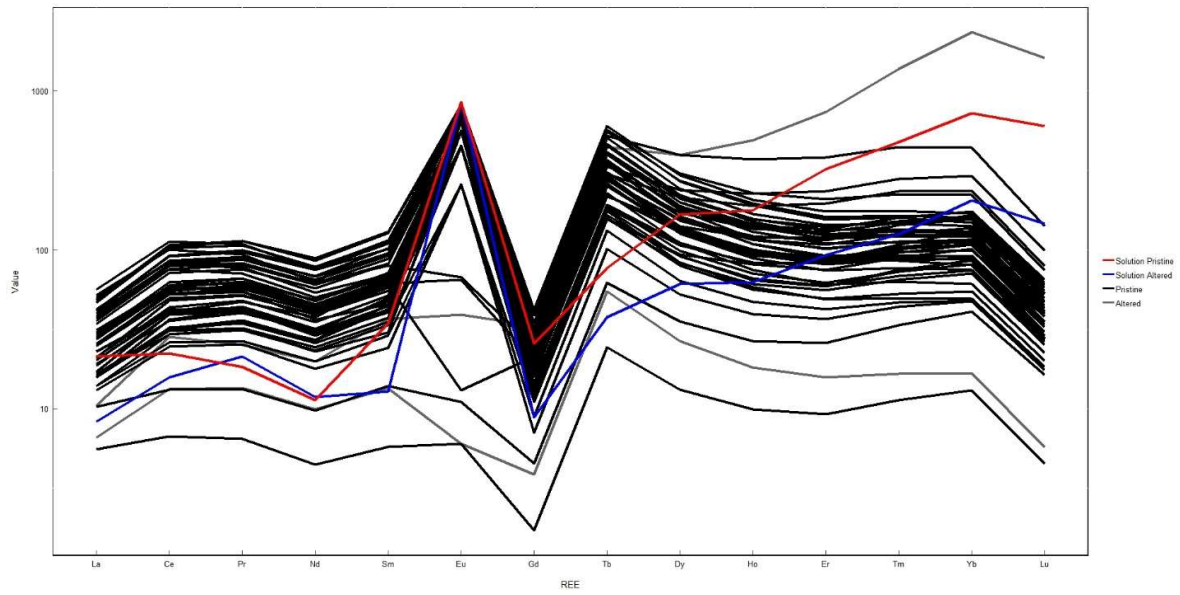
Sample #334, Mitchell 1, Intrusive non-granite related.



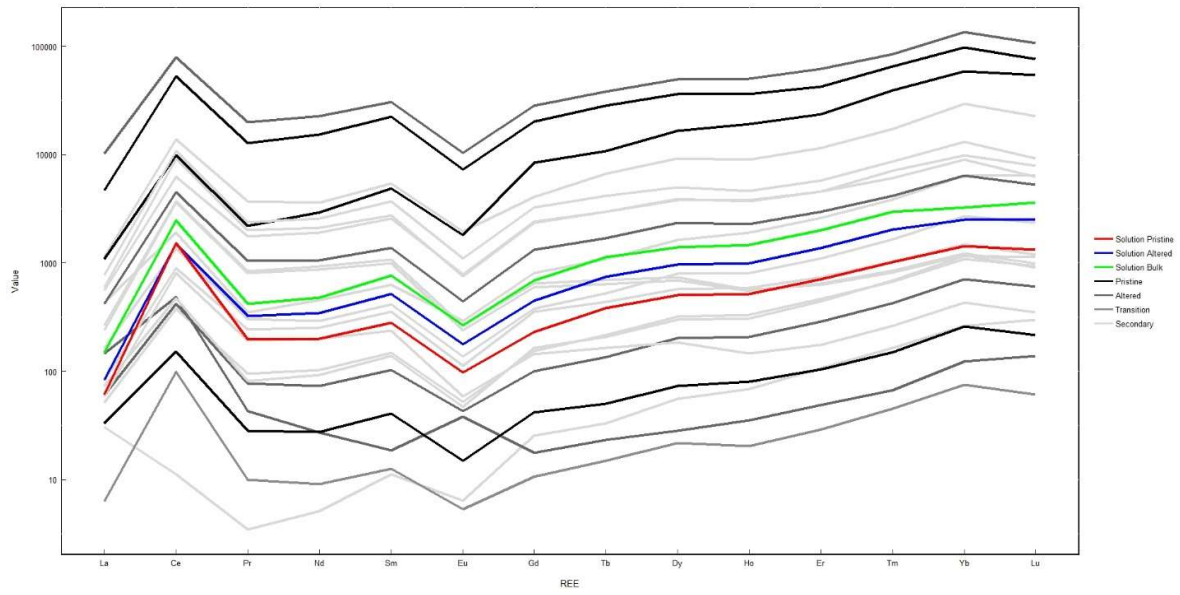
Sample #338, Mitchell 2, Intrusive non-granite related.



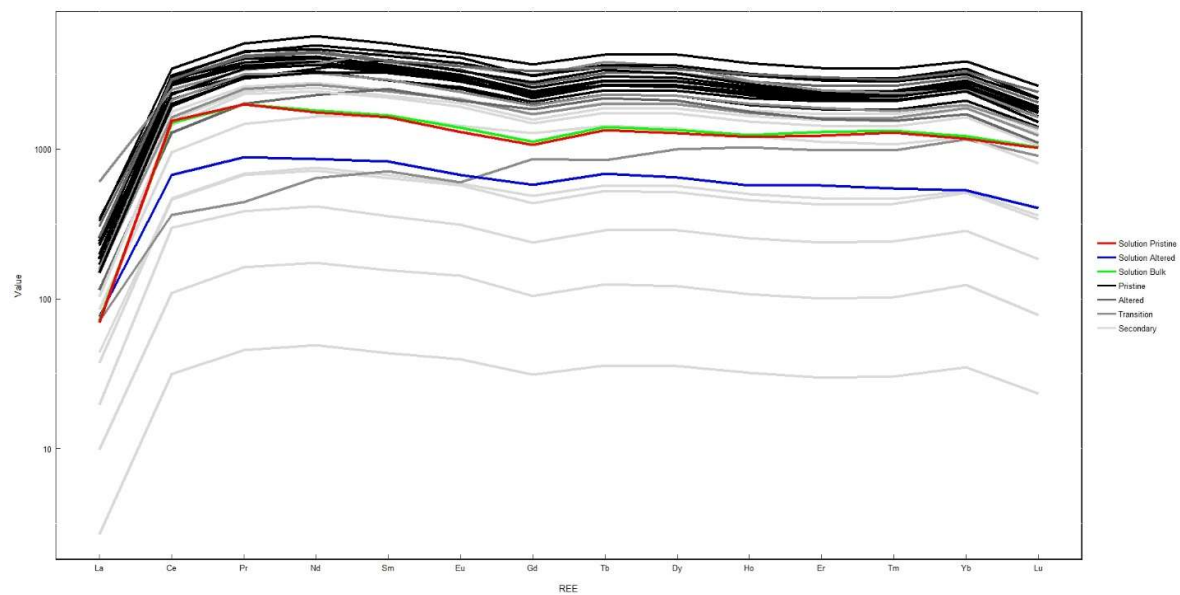
Sample #340, Bancroft, Intrusive non-granite related.



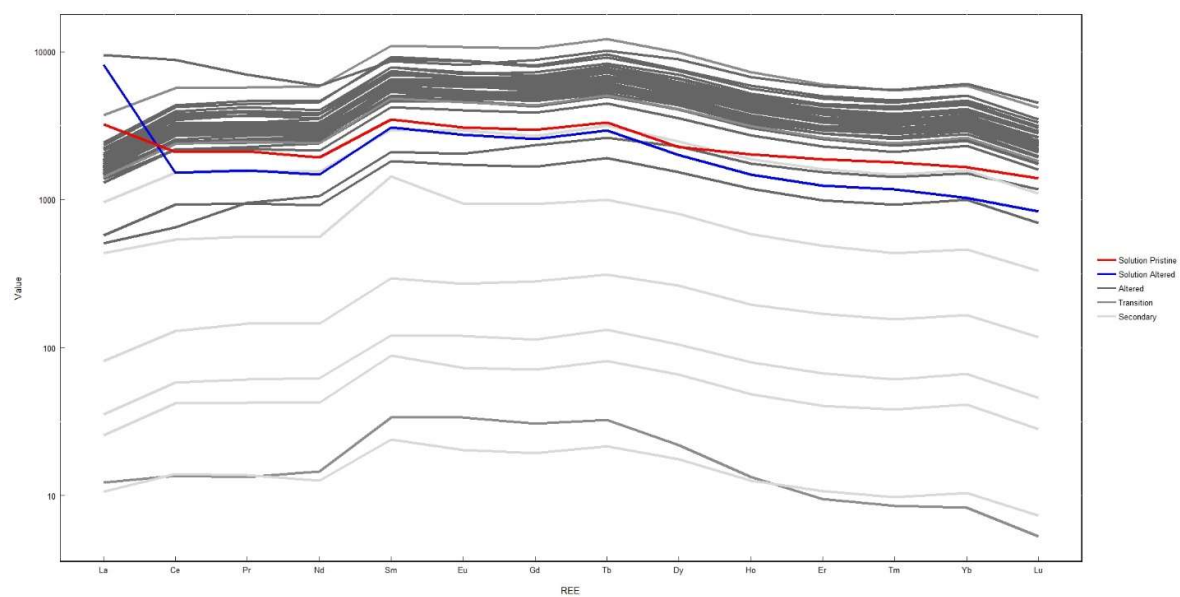
Sample #344, Ruggles, Intrusive non-granite related.



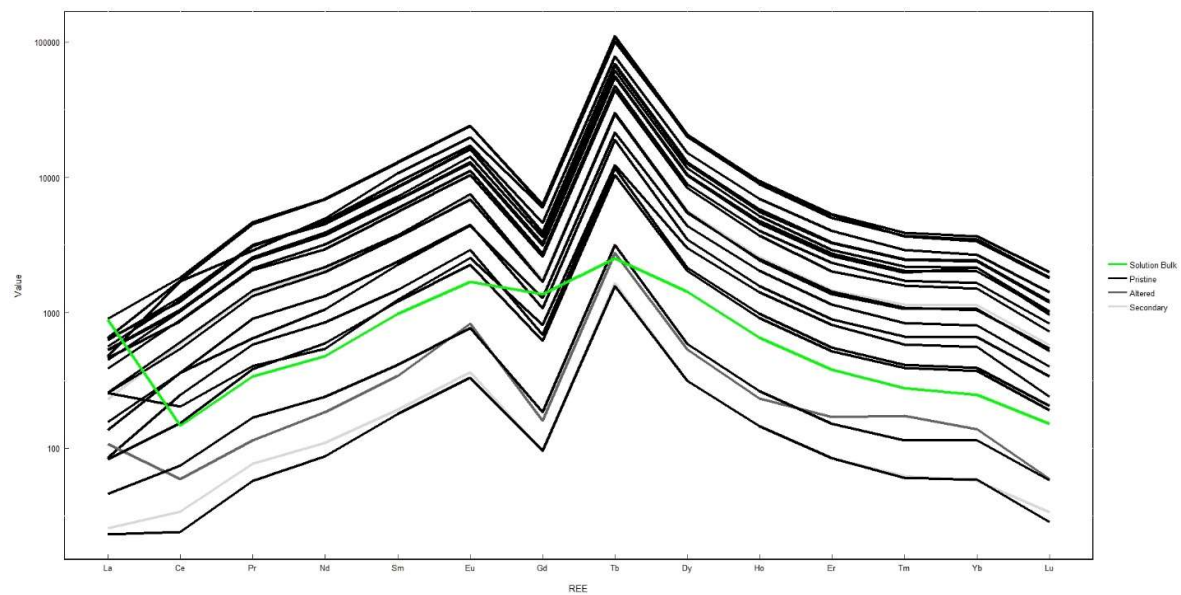
Sample #348, Foster Lake, Intrusive non-granite related.



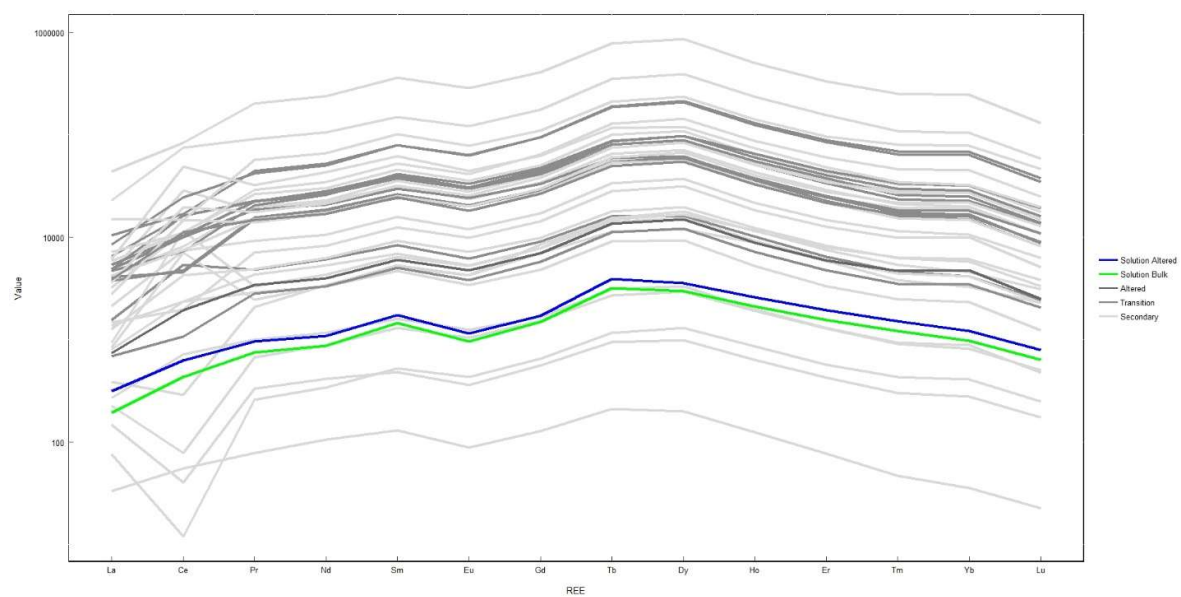
Sample #353, Happy Jack, Sandstone tabular.



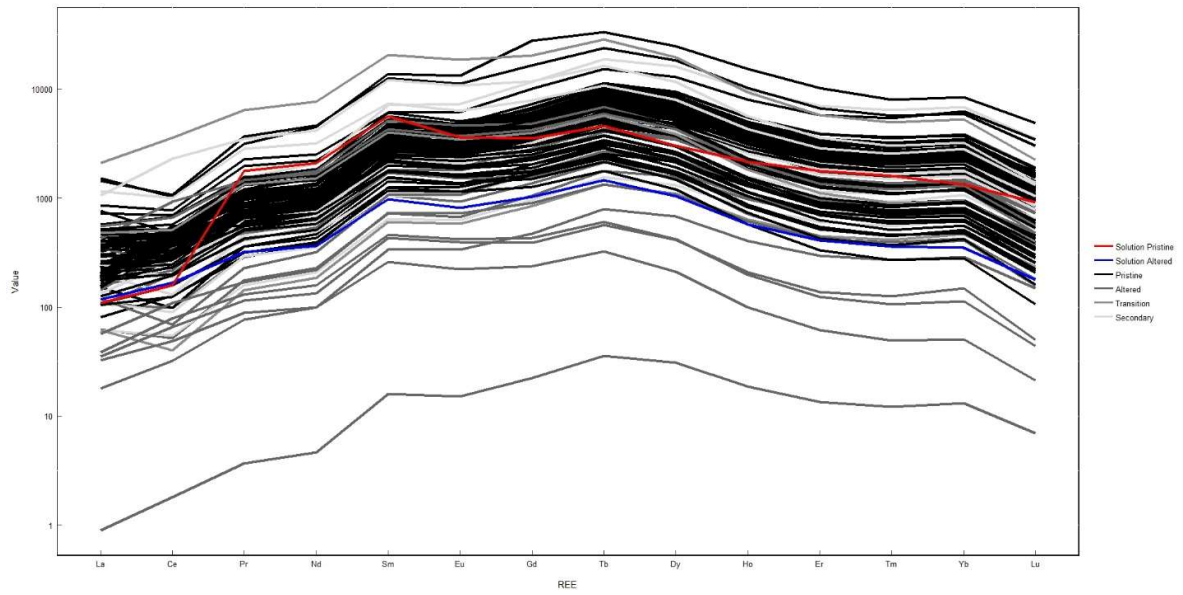
Sample #423, Great Bear 1, Metamorphite.



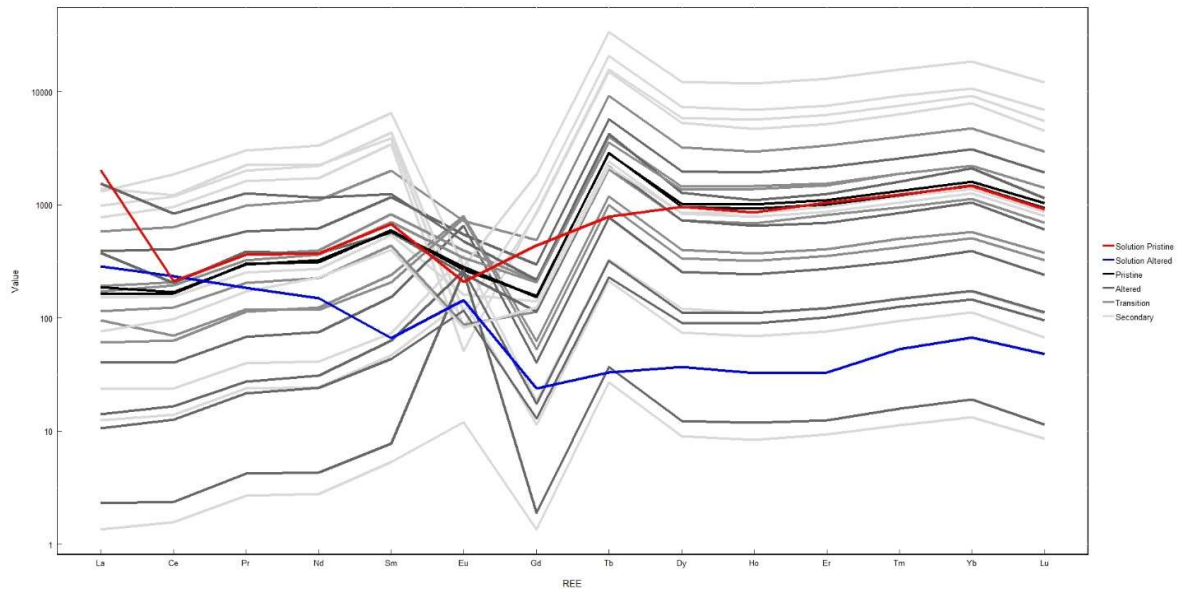
Sample #437, Shinkolobwe1, Metamorphite.



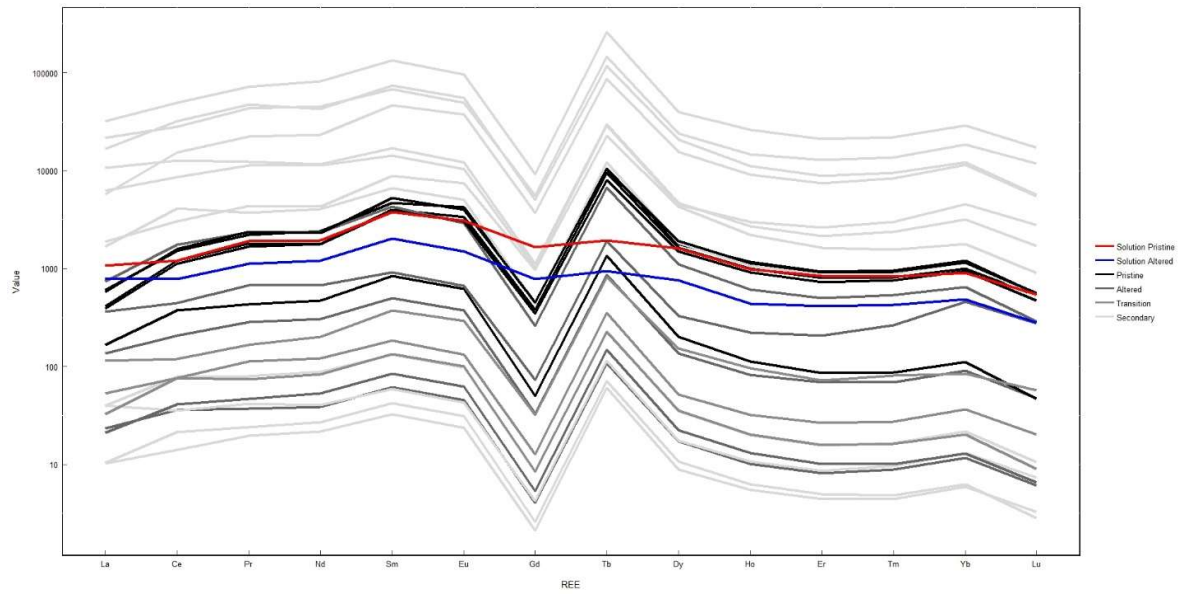
Sample #511, Rabbit Lake, Proterozoic unconformity.



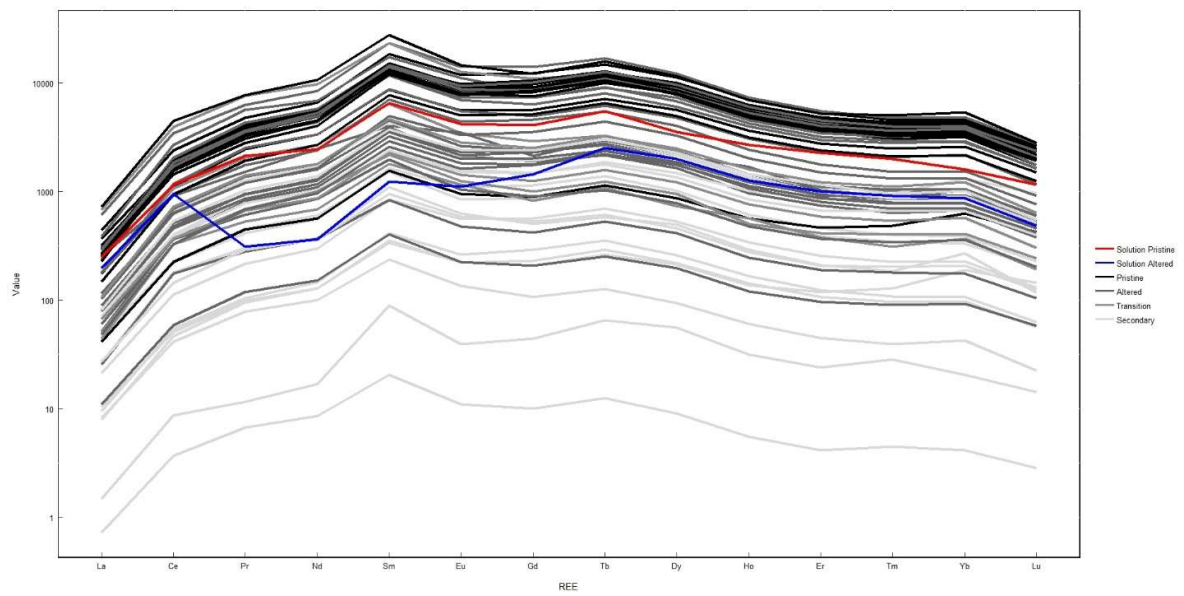
Sample #516, Australia 1, Metamorphite.



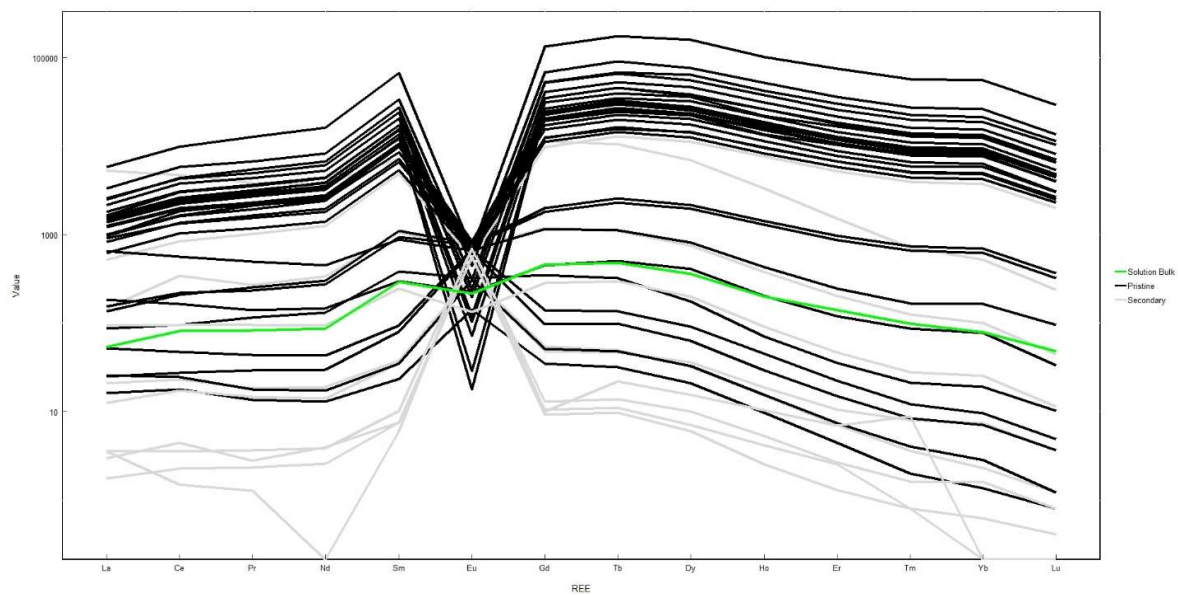
Sample #522, Billiken, Metamorphite.



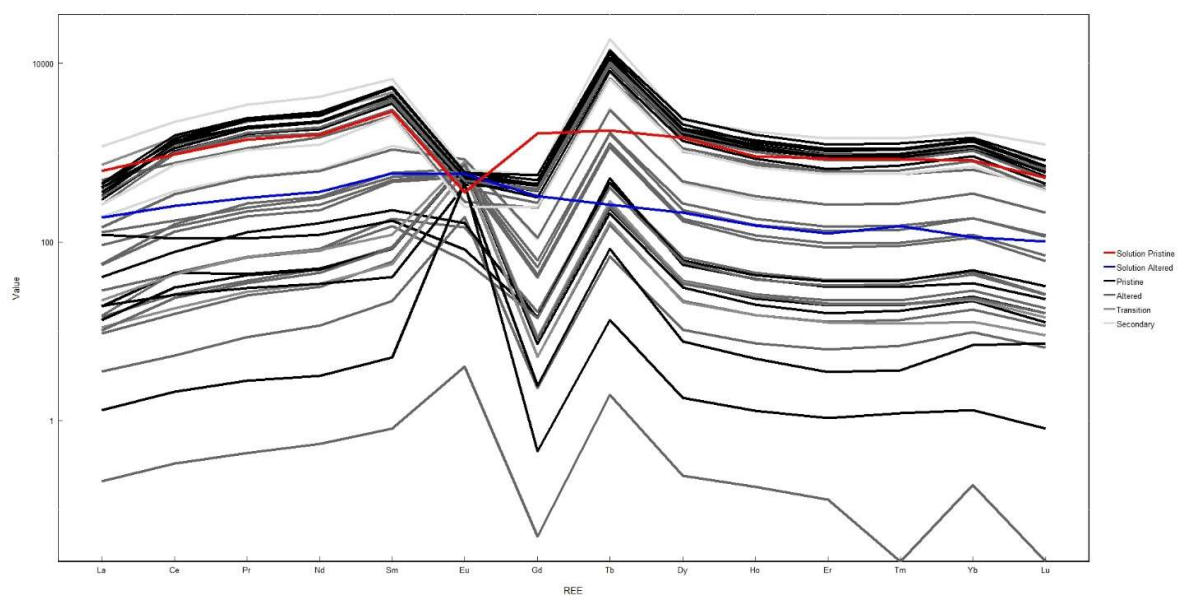
Sample #531, Marshall 1, Metamorphite hydrothermal vein.



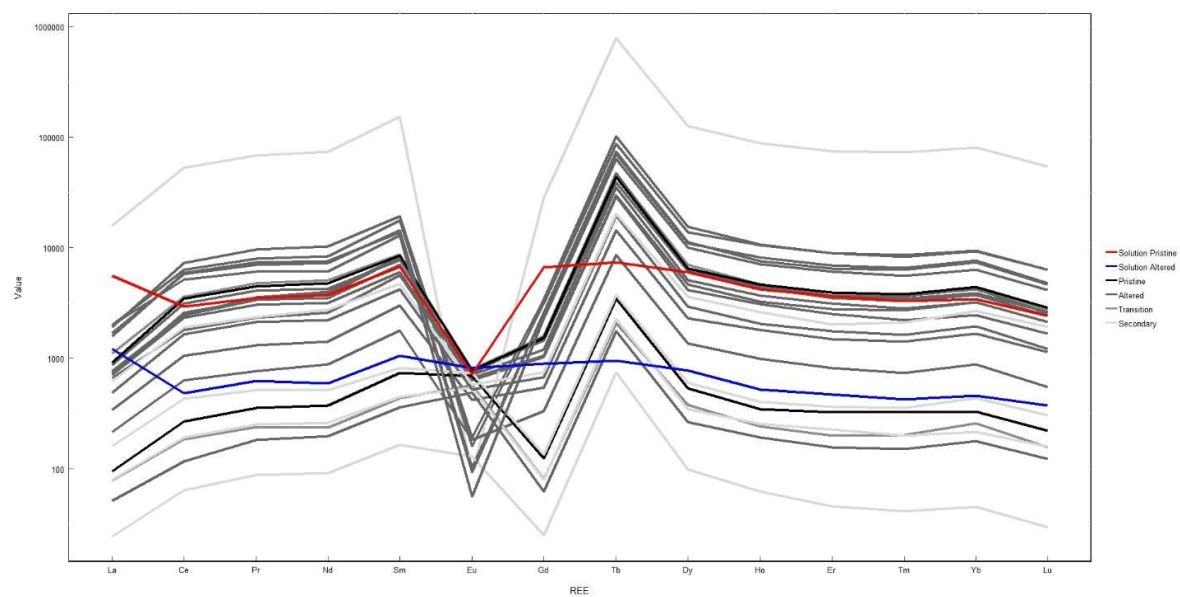
Sample #564, Jachymov, Intrusive granite related.



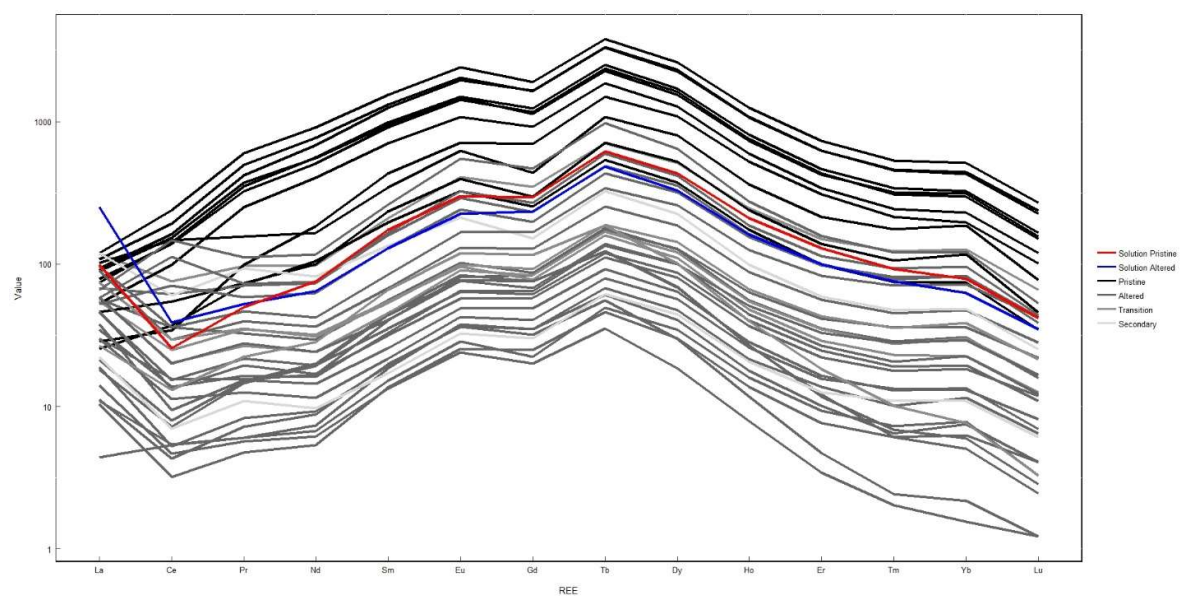
Sample #604, Australia 2, Proterozoic unconformity.



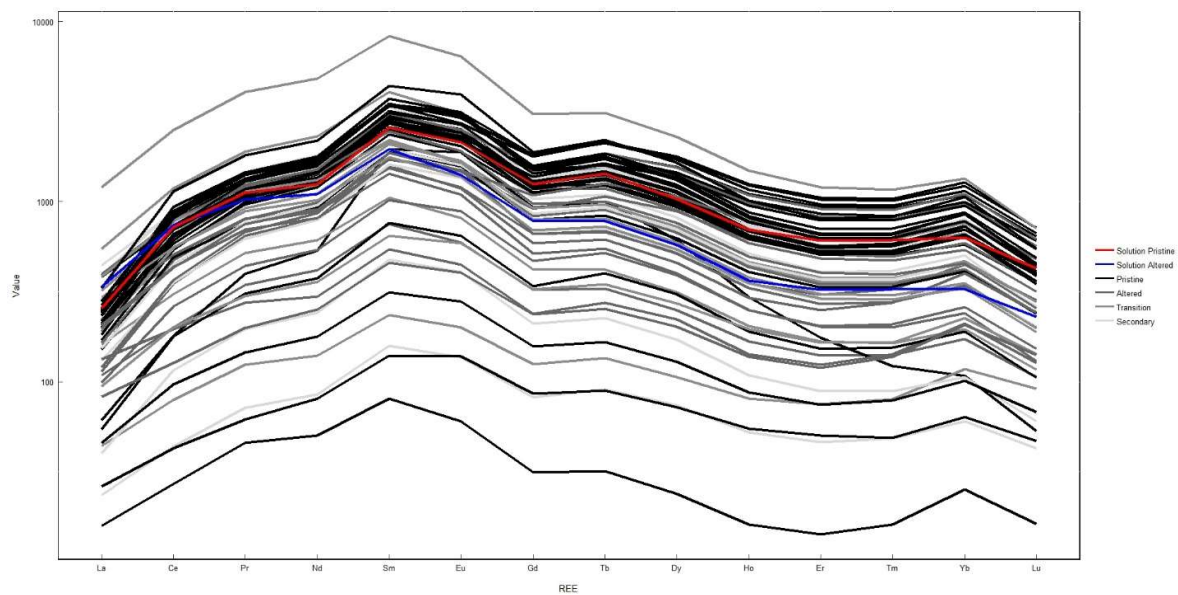
Sample #623, Marshall 2, Metamorphite hydrothermal vein.



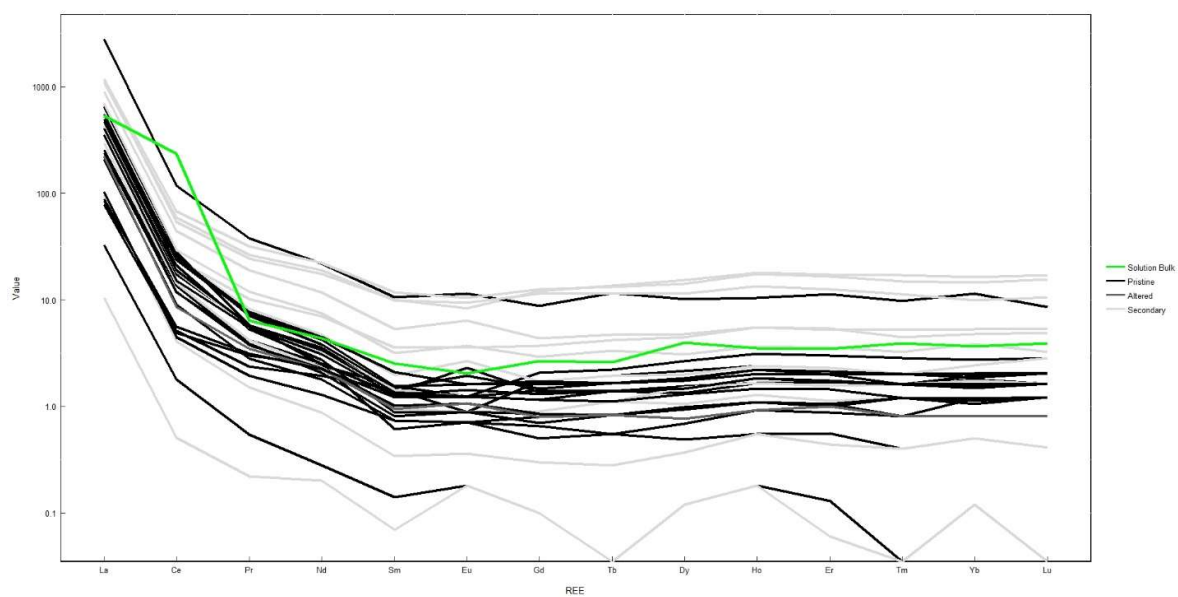
Sample #626, Great Bear 2, Metamorphite.



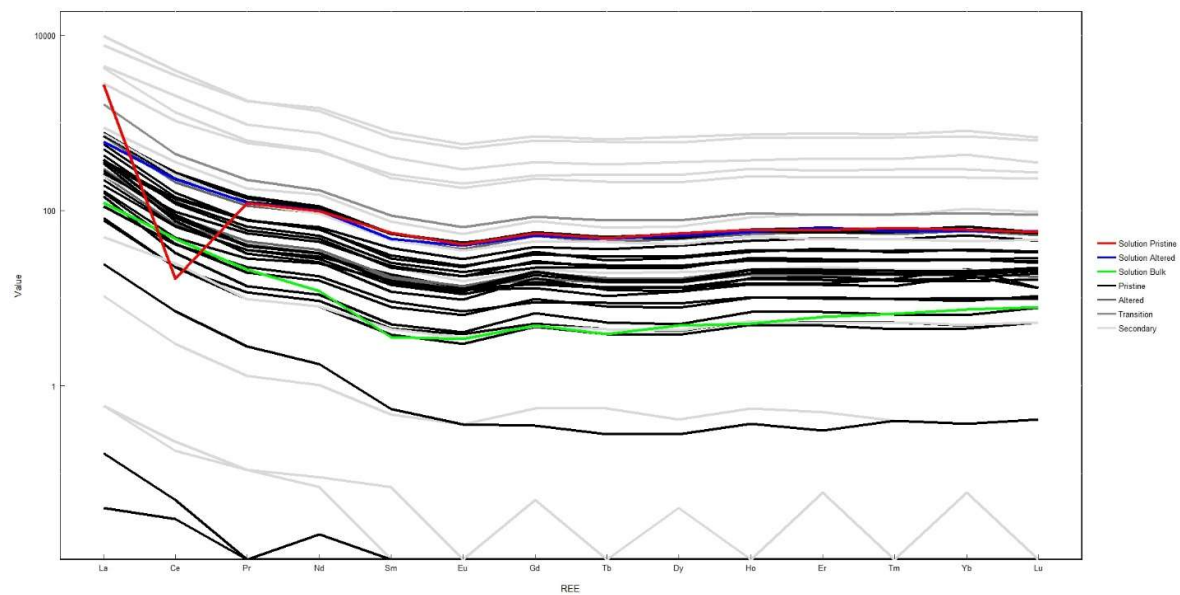
Sample #662, Shinkolobwe 2, Metamorphite.



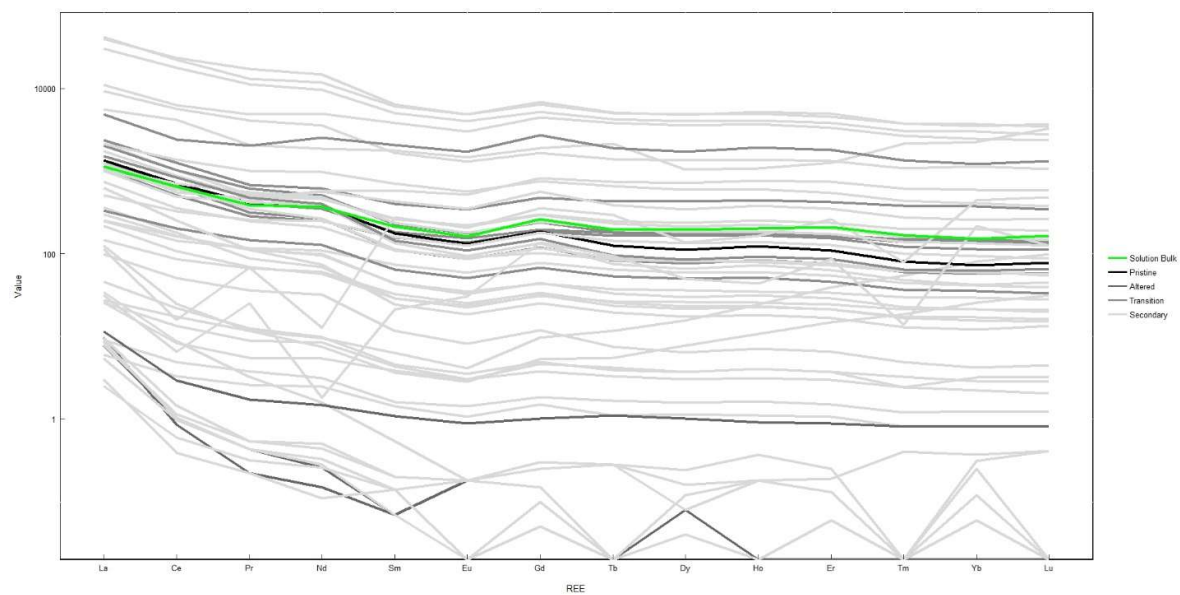
Sample #809, Marshall 3, Metamorphite hydrothermal vein.



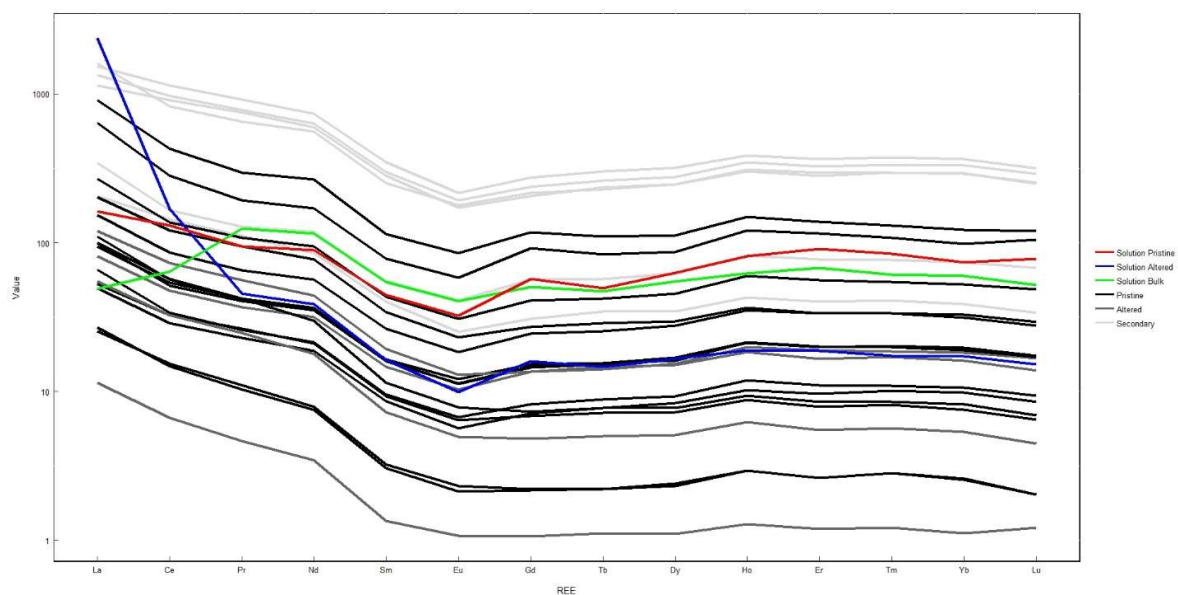
Sample #1232, Big Indian Wash 1, Sandstone.



Sample #1237, Adair Mine 1, Sandstone.

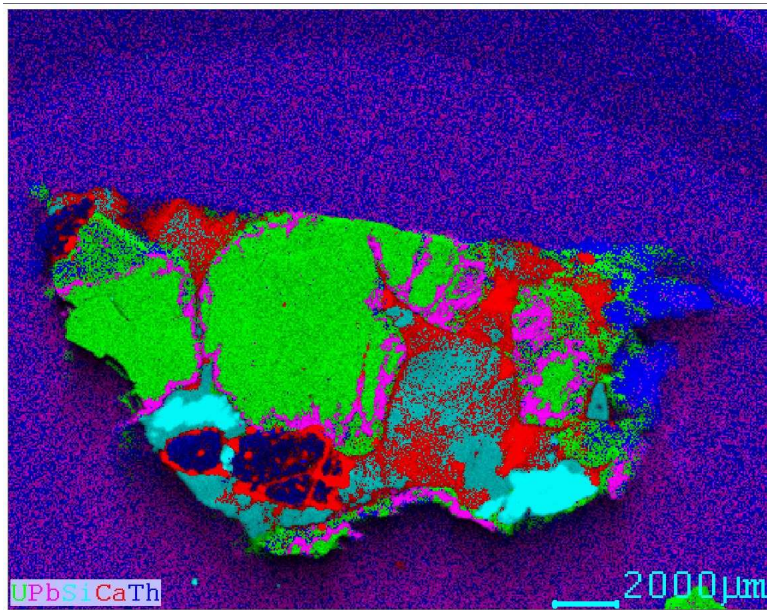


Sample 1262, Adair Mine 2, Sandstone.

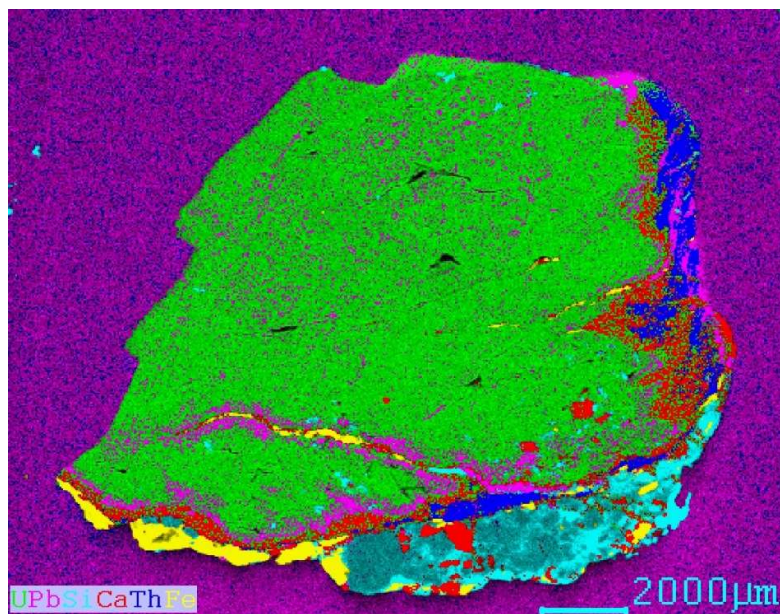


Sample #1303, Big Indian Wash 2, Sandstone.

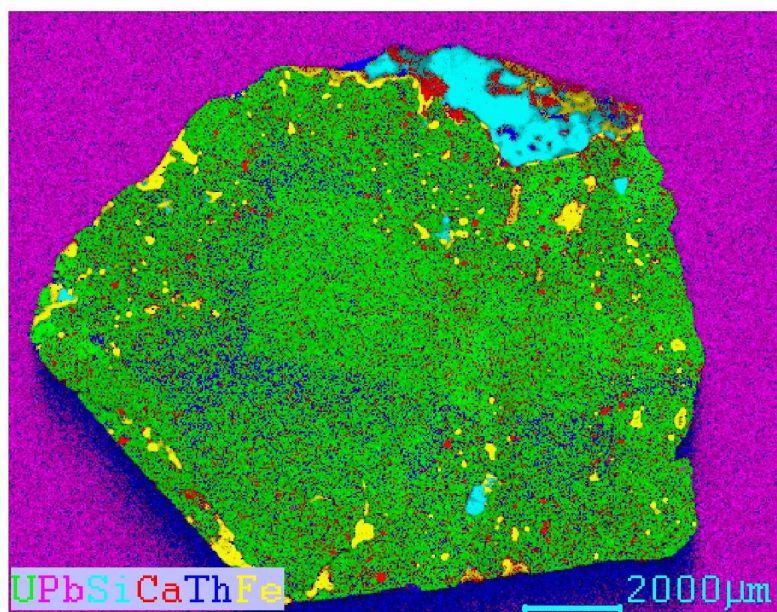
Figure S1. Chondrite normalized rare earth element composition of all samples ($n = 23$) examined in this study. The solution analyses are compared to the in-situ analysis with the pristine solution given in red, altered in blue and bulk in green. The in-situ colored based on their measured UO_2 abundance; Pristine is black with a $\text{UO}_2 > 80$ wt. %, altered is dark gray with a UO_2 of 70–80 wt. %, transition gray (UO_2 65–70 wt. %) and secondary being light gray ($\text{UO}_2 < 65$ wt. %).



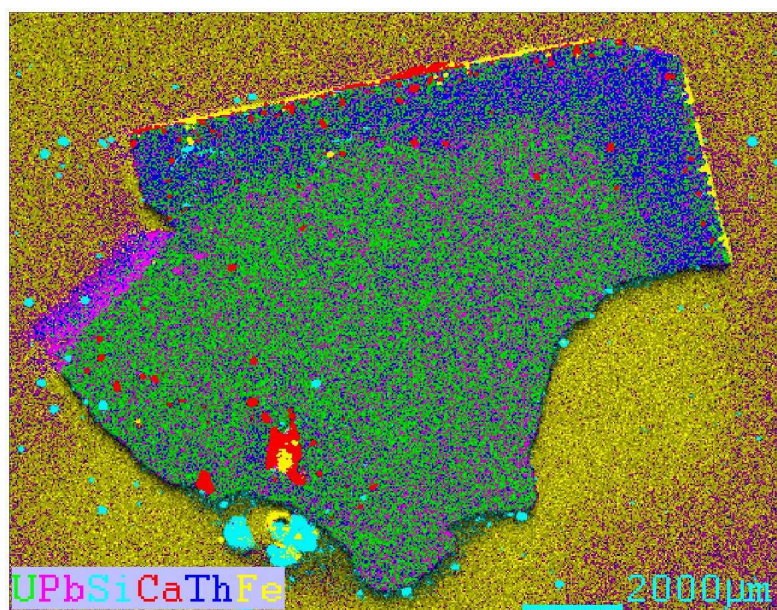
Yancey #333.



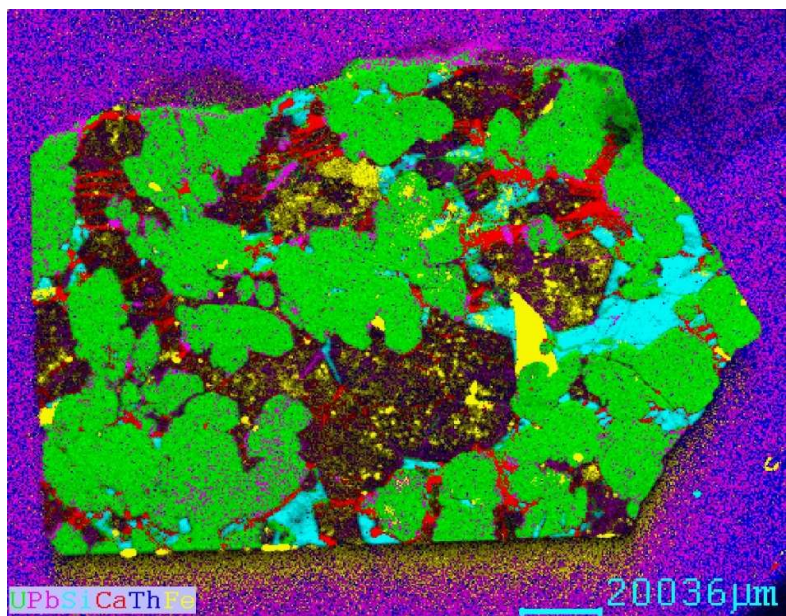
Mitchell 1 #334.



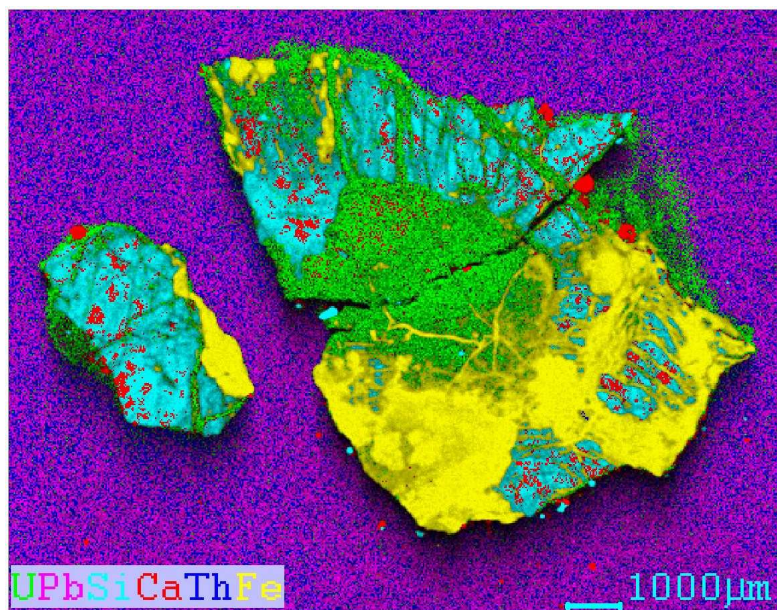
Mitchell 2 #338.



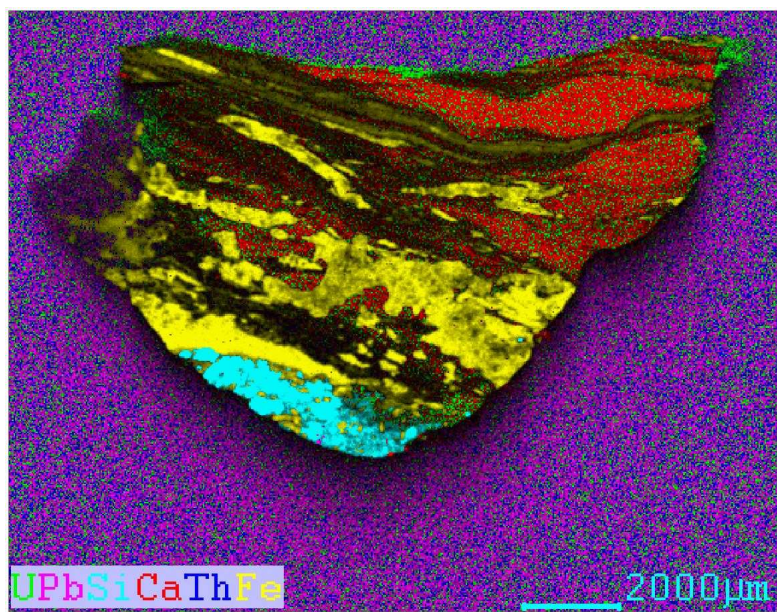
Bancroft #340.



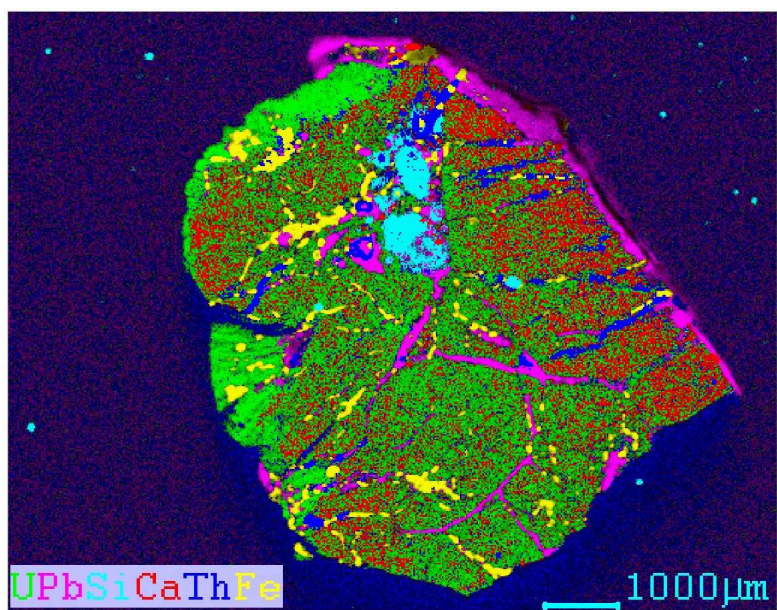
Ruggles #344.



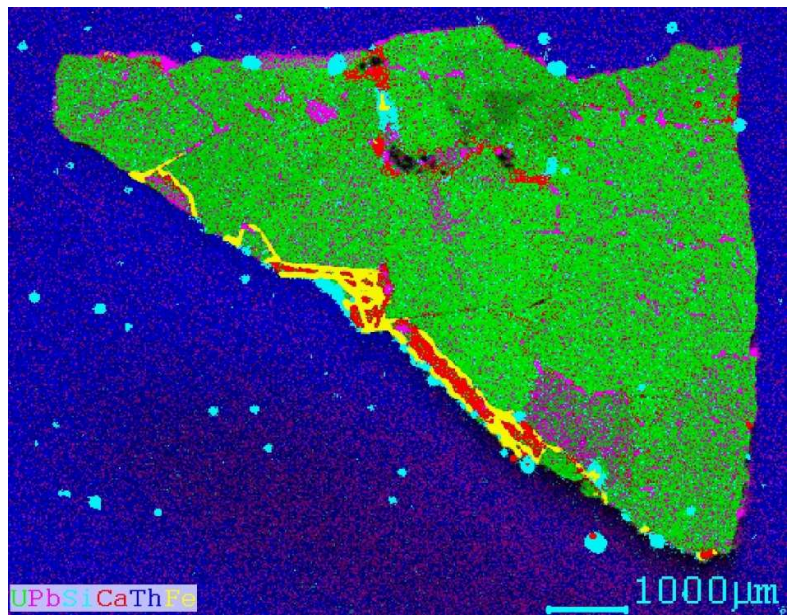
Foster Lake #348.



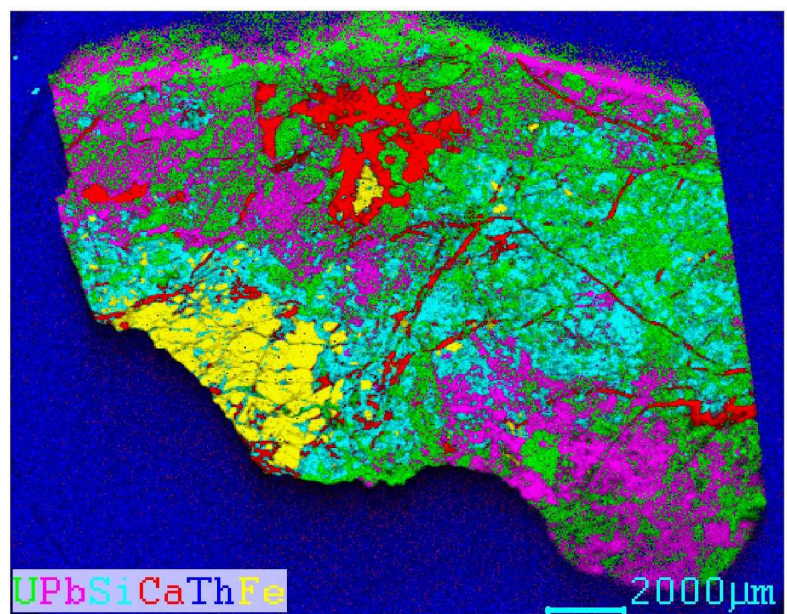
Happy Jack #353.



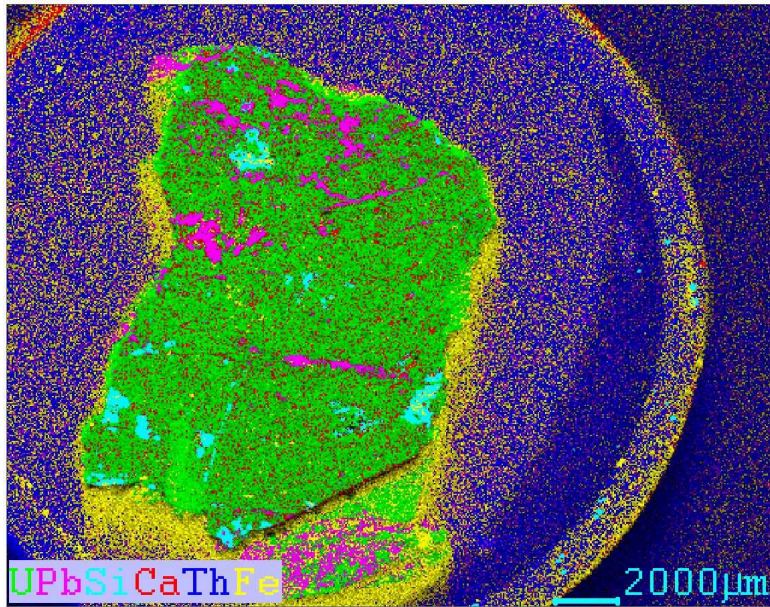
Great Bear 1 #423.



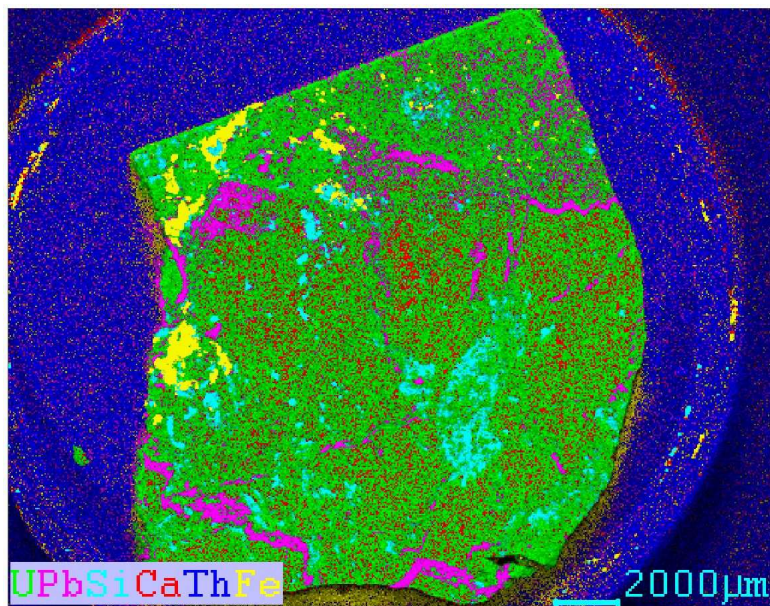
Shinkolobwe 1 #437.



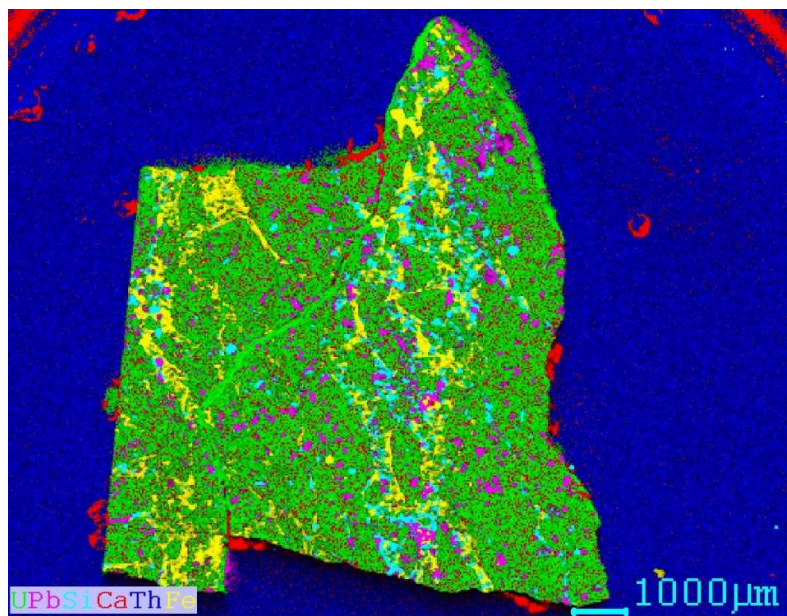
Rabbit Lake #511.



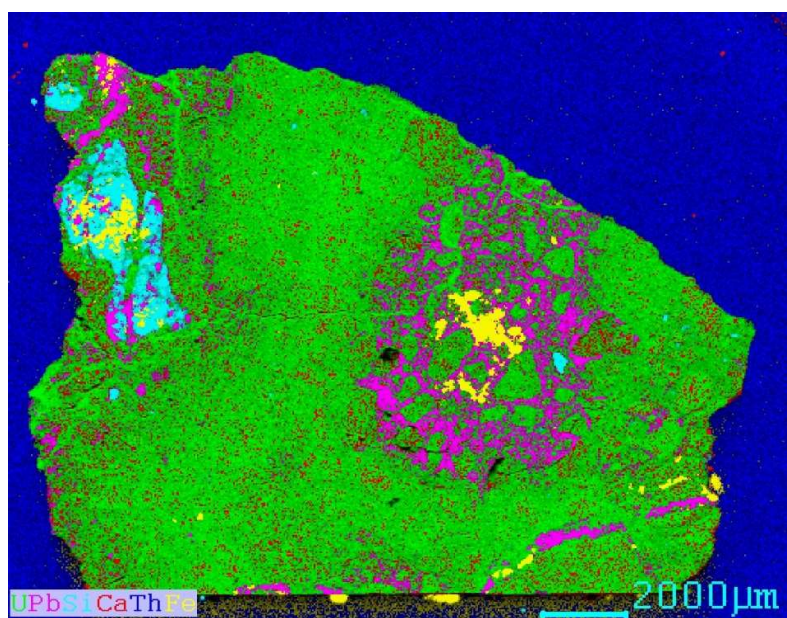
Australia 1 #516-T.



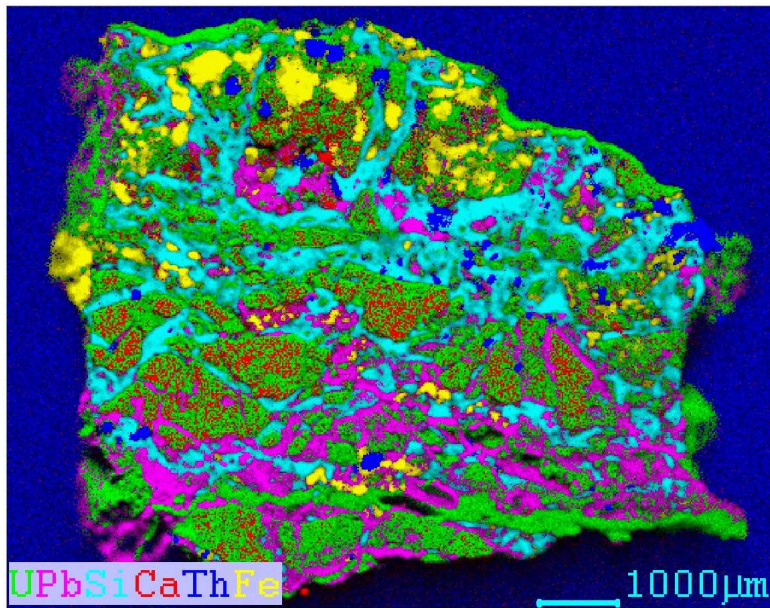
Australia 1 #516-B.



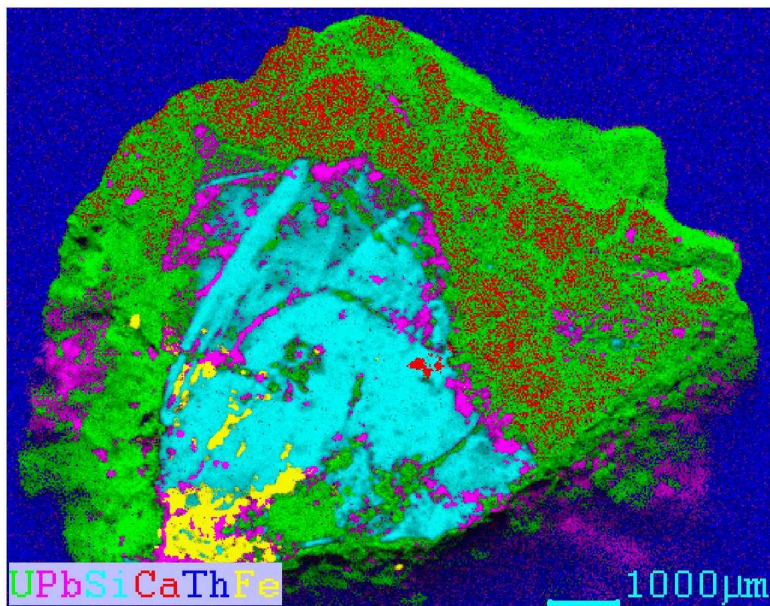
Billiken #522.



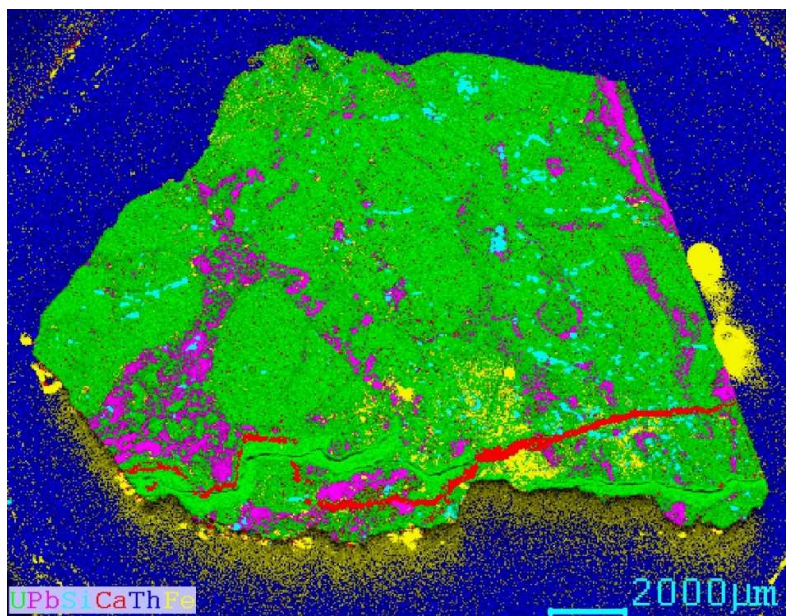
Marshall 1 #531.



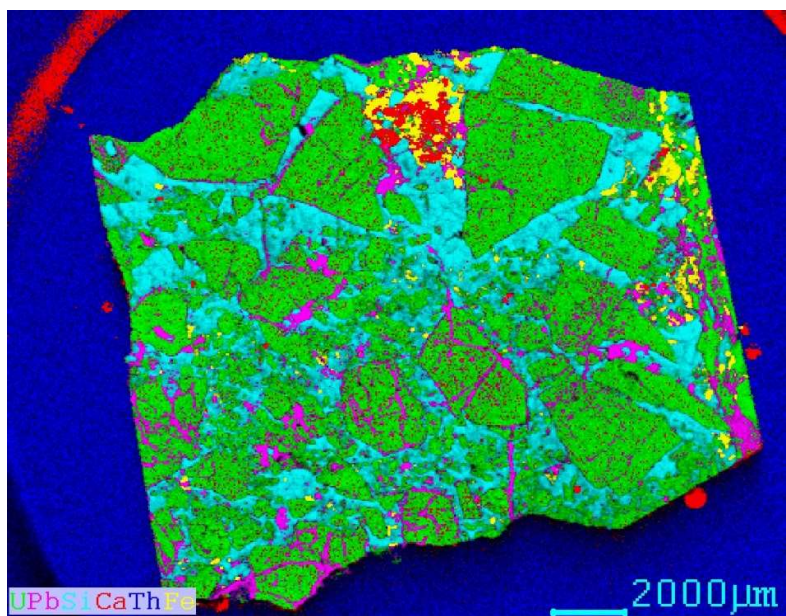
Jachymov #564.



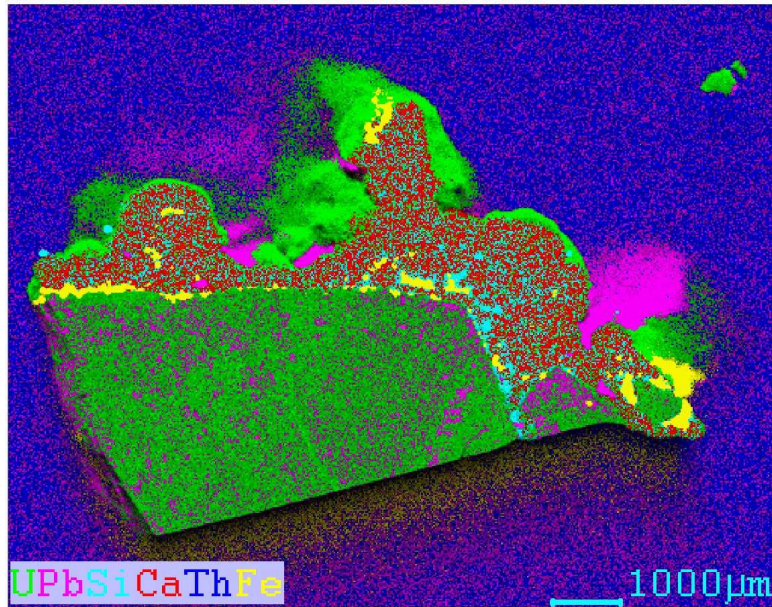
Australia 2 #604.



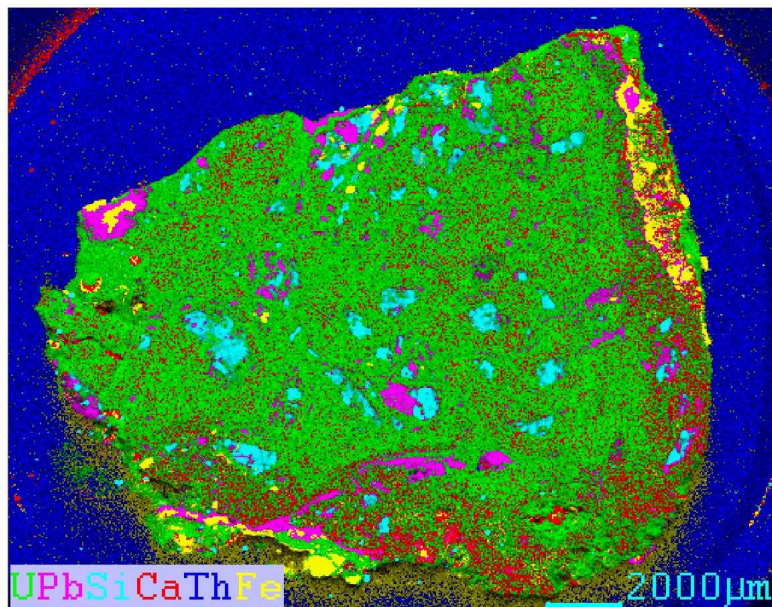
Marshall 2 #623.



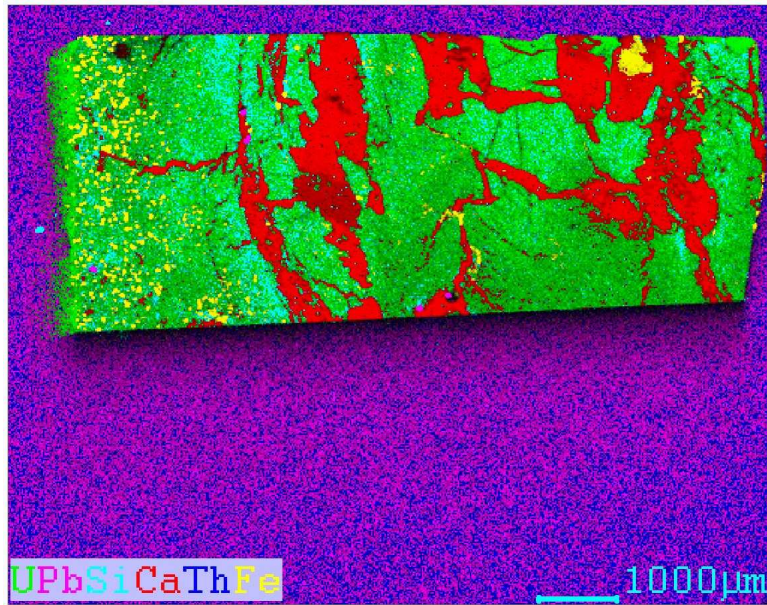
Great Bear 2 #626.



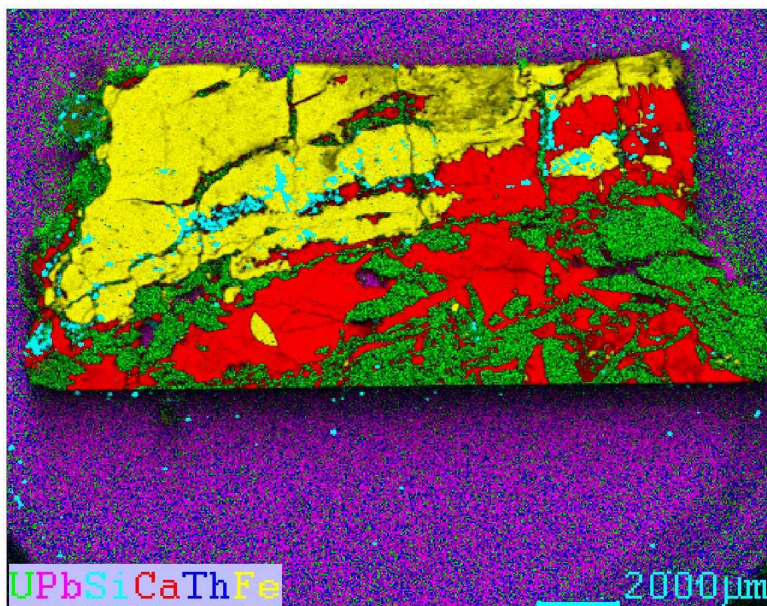
Shinkolobwe 2 #662.



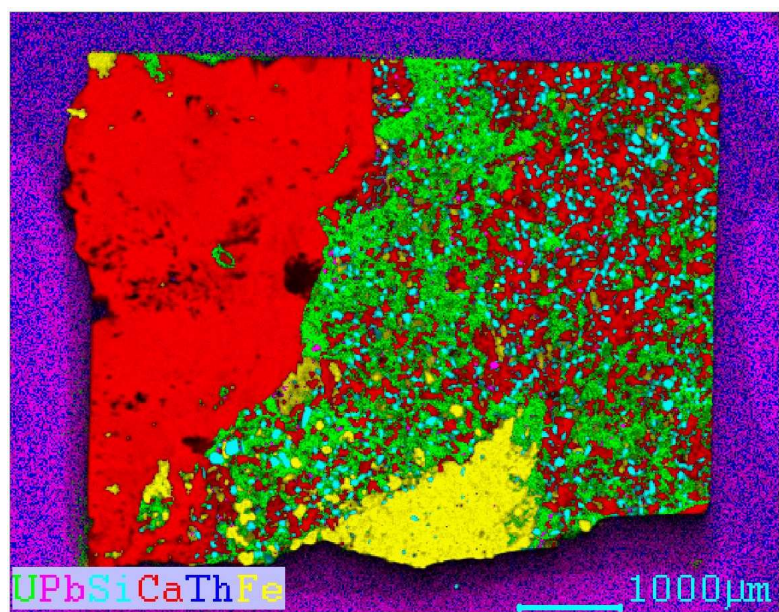
Marshall 3 #809.



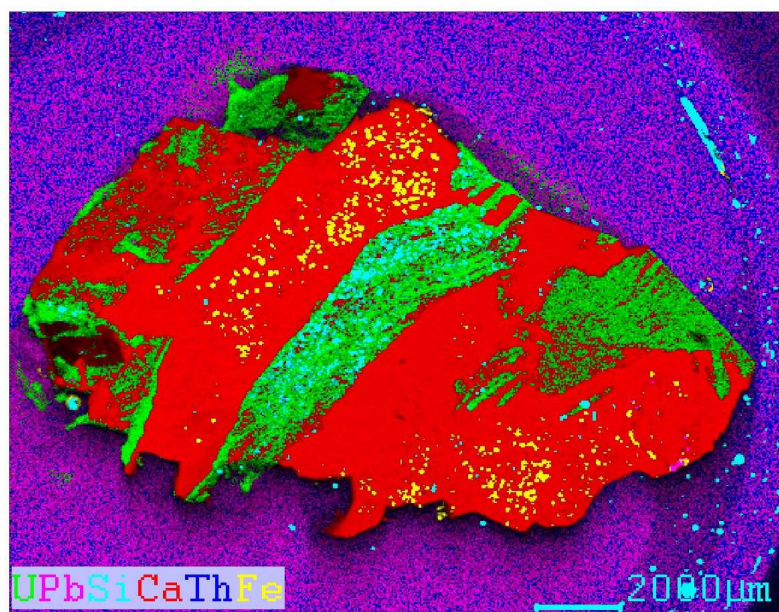
Big Indian Wash 1 #1232.



Adair Mine 1 #1237.



Adair Mine 2 #1262.



Big Indian Wash 2 #1303.

Figure S2. XRF of major elements (U, Pb, Si, Ca, Th, and Fe) for all 23 samples examined in this study.

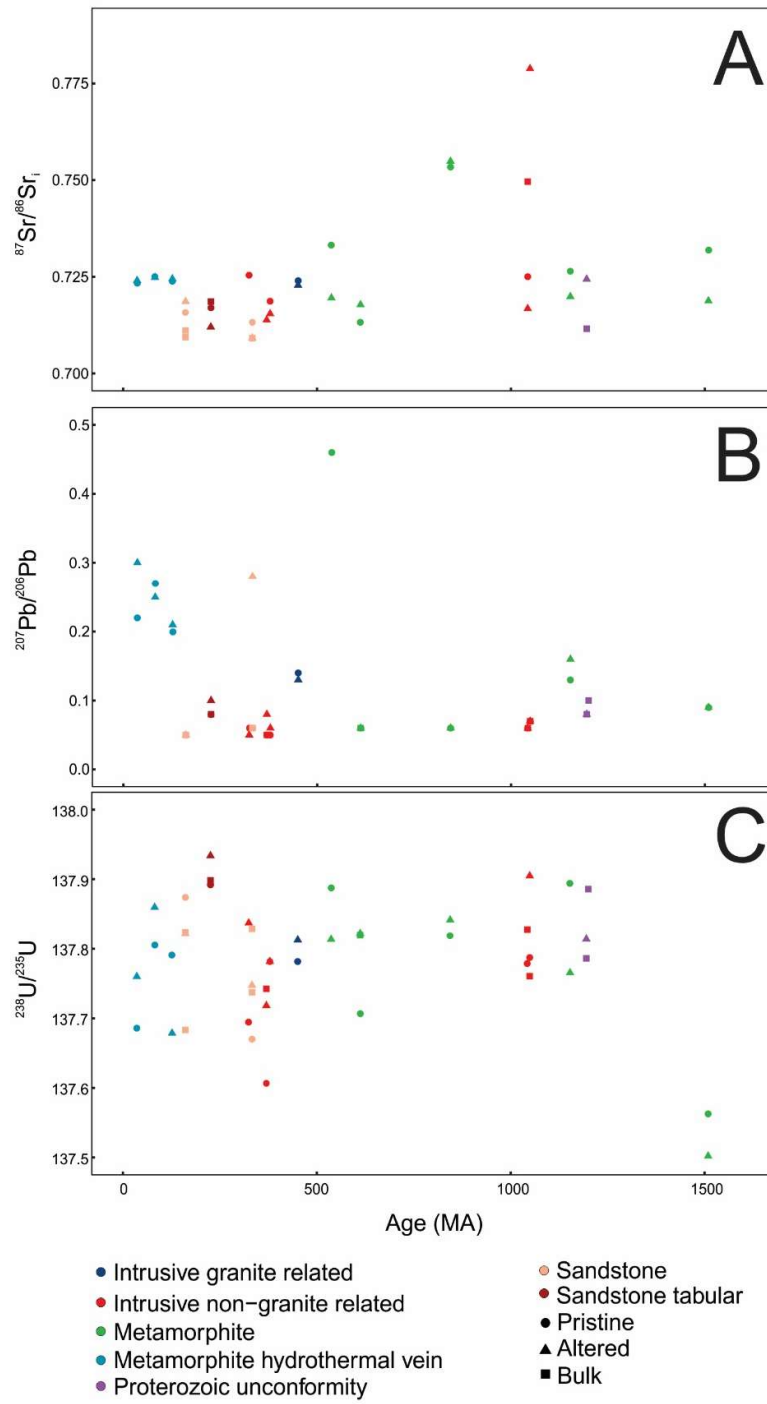


Figure S3. Isotopic composition (Table S3) of pristine, altered, and bulk solution aliquots as a function of their age. (A) $^{87}\text{Sr}/^{86}\text{Sr}_i$, (B) $^{207}\text{Pb}/^{206}\text{Pb}$, and (C) $^{238}\text{U}/^{235}\text{U}$.

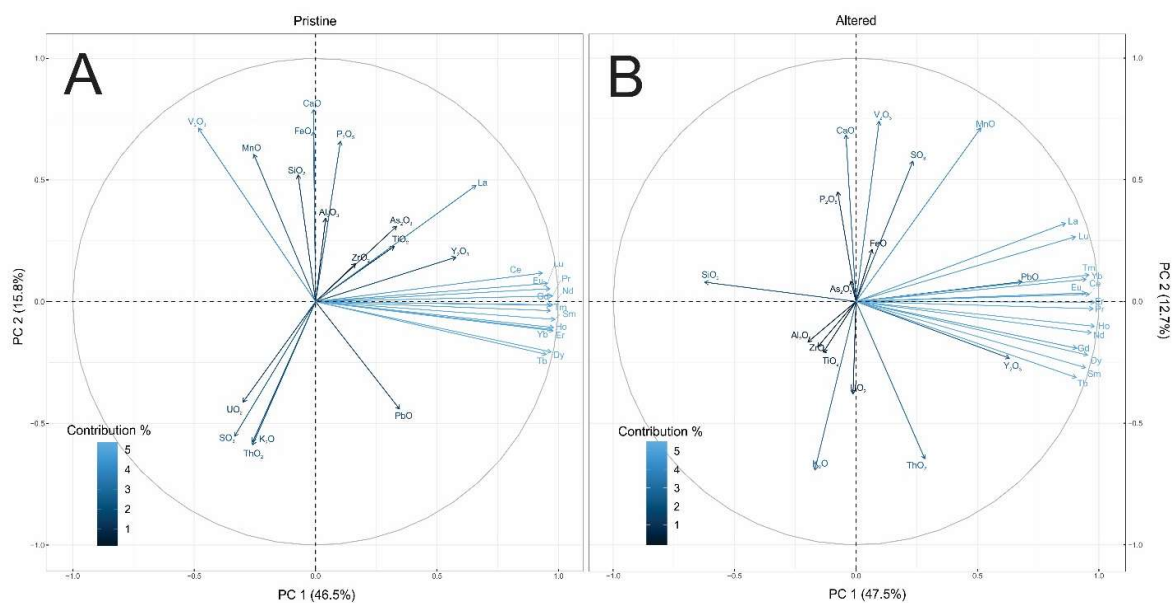


Figure S4. Variable contribution (%) to pristine (A) and altered (B) samples for PCA using EMP (wt. %), and REEs (ppm; Figure 9).

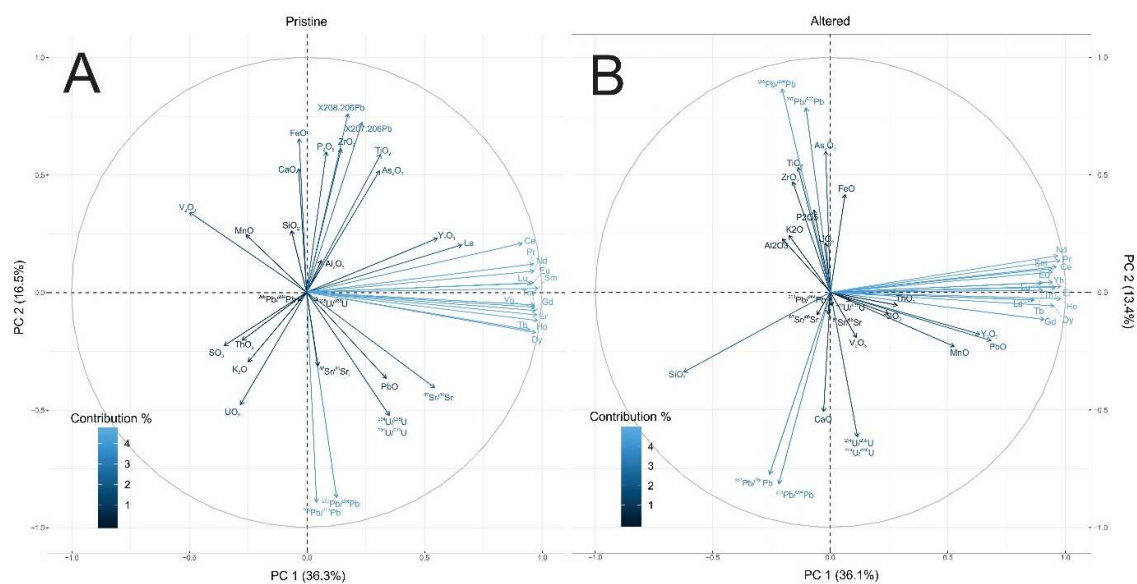


Figure S5. Variable contribution (%) to pristine (A) and altered (B) samples for PCA using EMP (wt. %), REEs (ppm) and Sr, Pb, and U isotopic compositions (Figure 10).

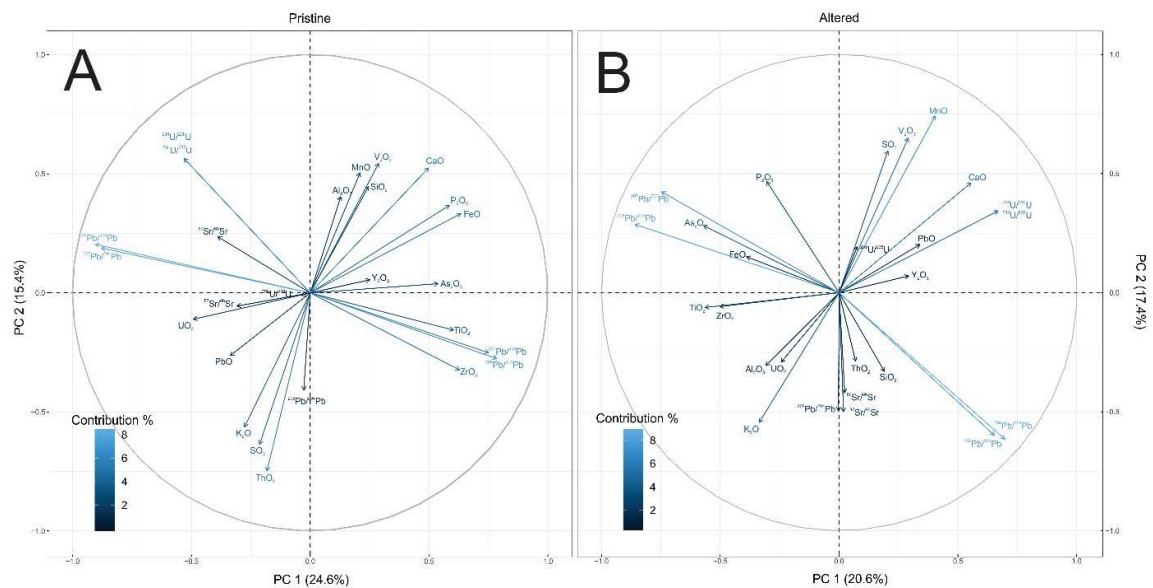


Figure S6. Variable contribution (%) to pristine (**A**) and altered (**B**) samples for PCA using EMP (wt. %) and Sr, Pb, and U isotopic compositions (Figure 11).