Appendix Figure 1

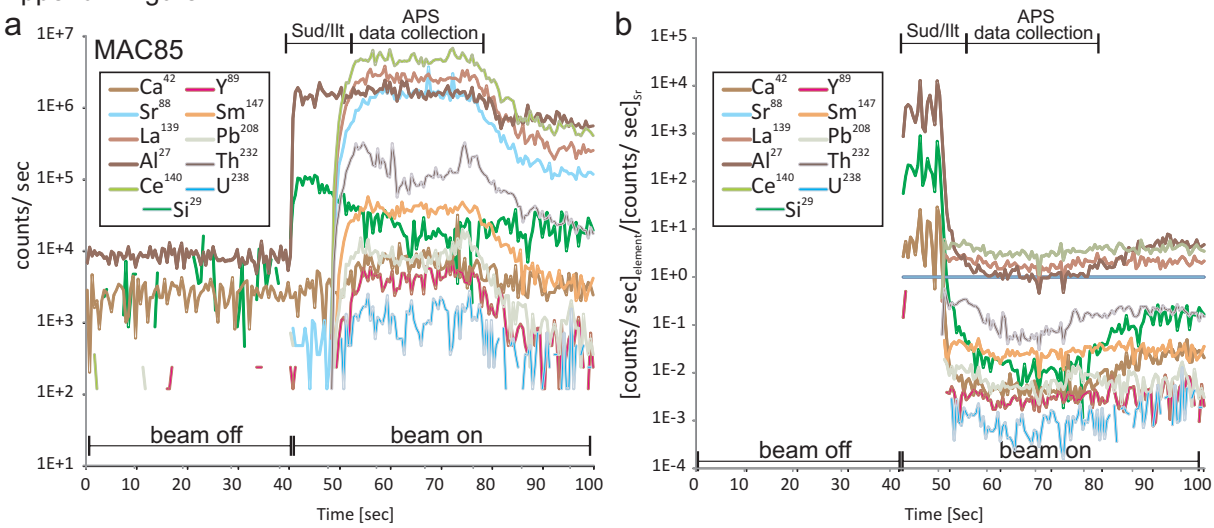


**FIGURE 1.** (**a**) A graph of the LA-ICP-MS analysis of an APS grain from sample MAC85 showing element counts (major and trace) vs. time in seconds. High counts of Y, Th and U correlate with high counts of the major elements in APS minerals (eg., Ce, La, Al, and Sr). This graph clearly shows that trace elements (such as Y, Th and U) are incorporated in the APS crystal structure and were not present as inclusions or contributed by surrounding minerals of sudoite (Sud) or illite (Ilt). **(b)** The same graph as shown in (**a**) but counts/s of each element is normalized to that of Sr.

Appendix Figure 2

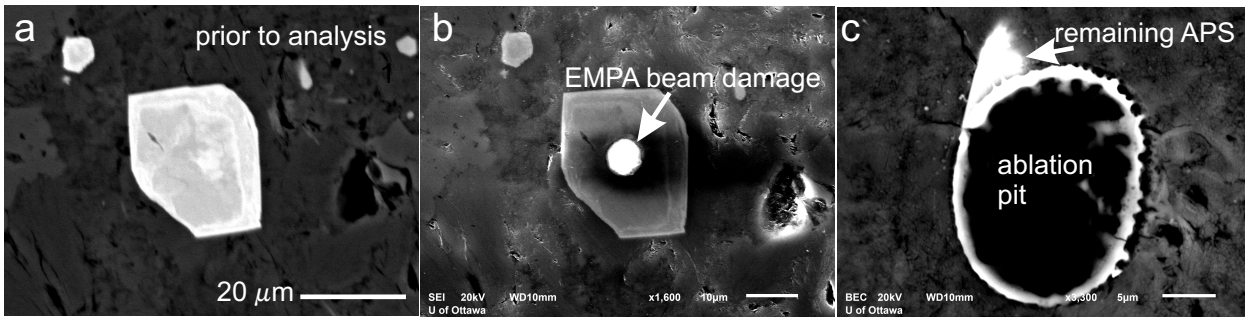


**FIGURE 2.** An APS mineral **(a)** before EMPA analysis and **(b)** after analysis showing beam damage. **(c)** A laser pit after LA ICP-MS analysis. (**a**) and (**c**) are BSE images and (**b**) is a secondary electron image.

# Appendix Figure 3

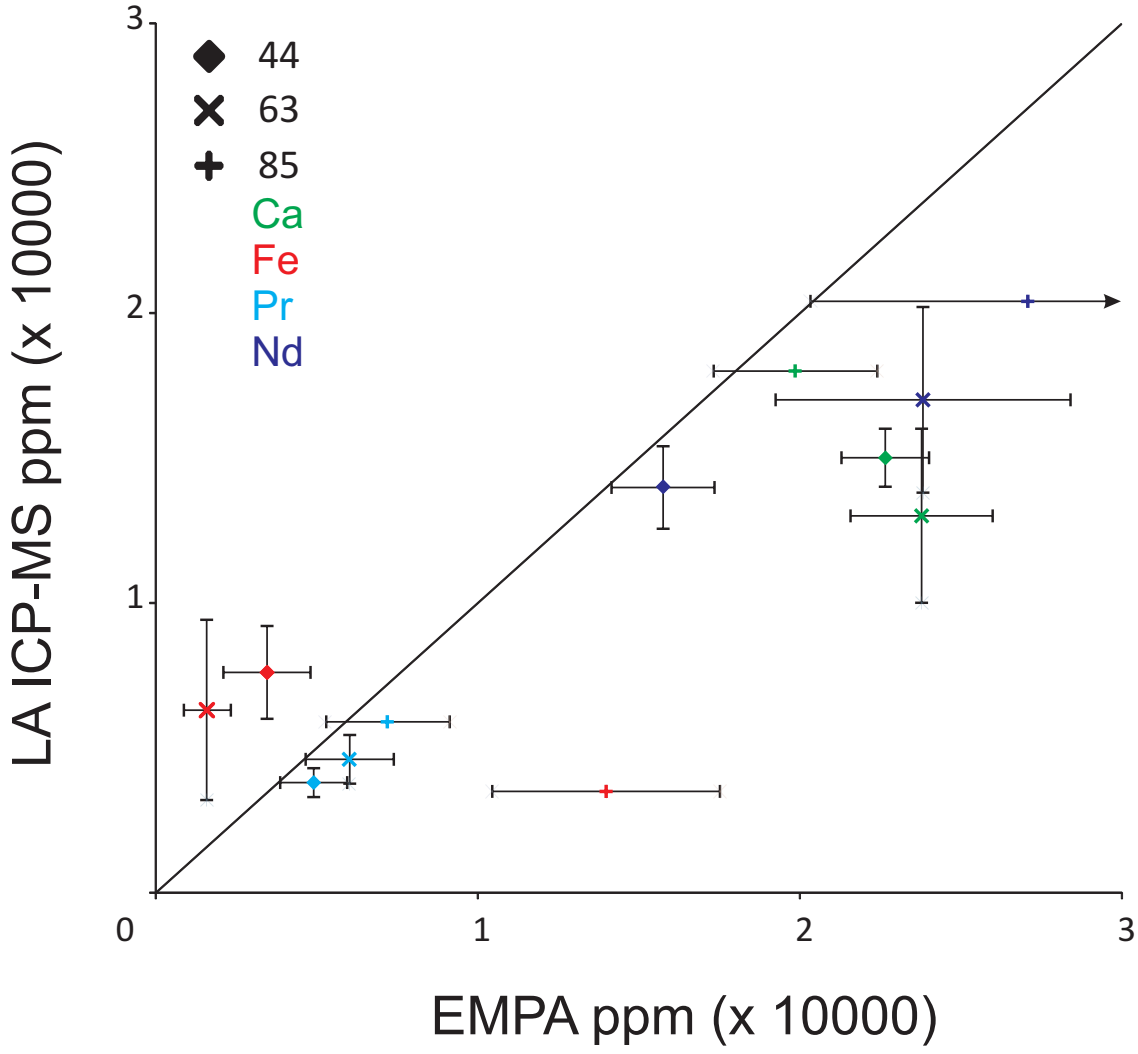


**FIGURE 3.** A binary plot comparing the average concentrations of Ca (green), Fe (red), Pr (cyan), and Nd (blue) in APS mineral grains from samples MAC44 (diamonds), MAC63 (**x**), and MAC85 (crosses) obtained with EMPA (Table 2) and LA ICP-MS (Table 3). Horizontal and vertical bars represent one standard deviation of the data (Tables 2 and 3). LA ICP-MS data of sample MAC85 is of one grain.