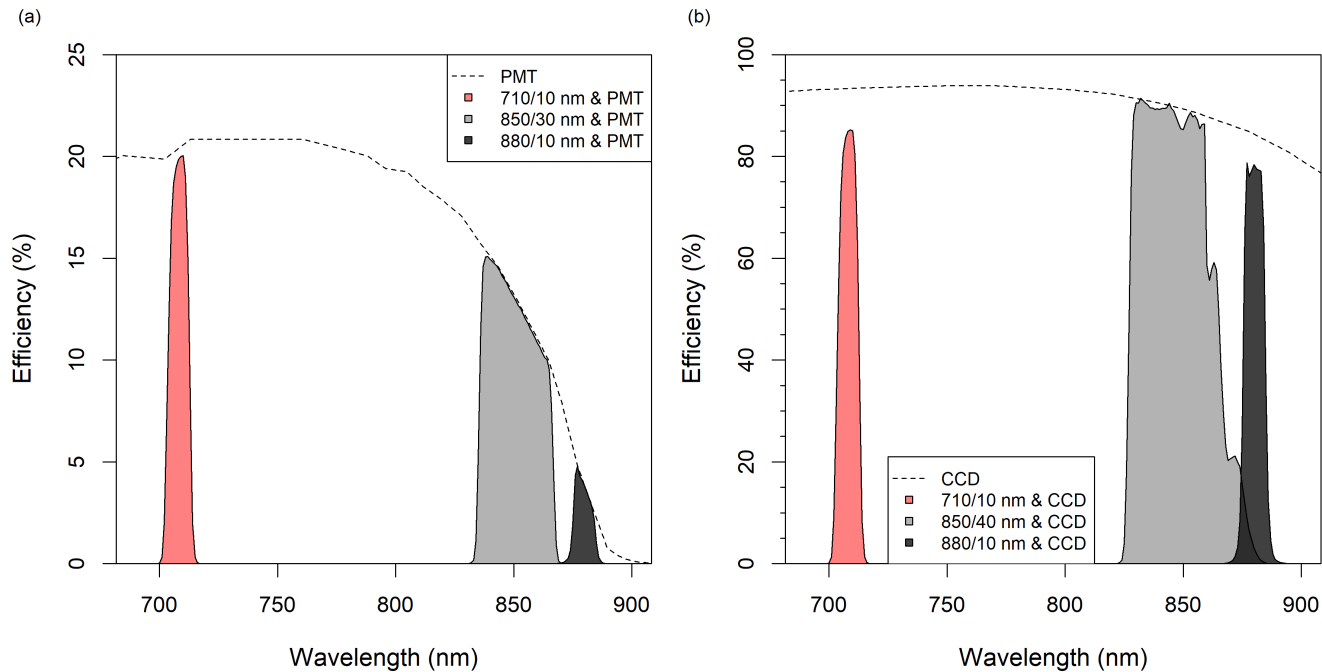


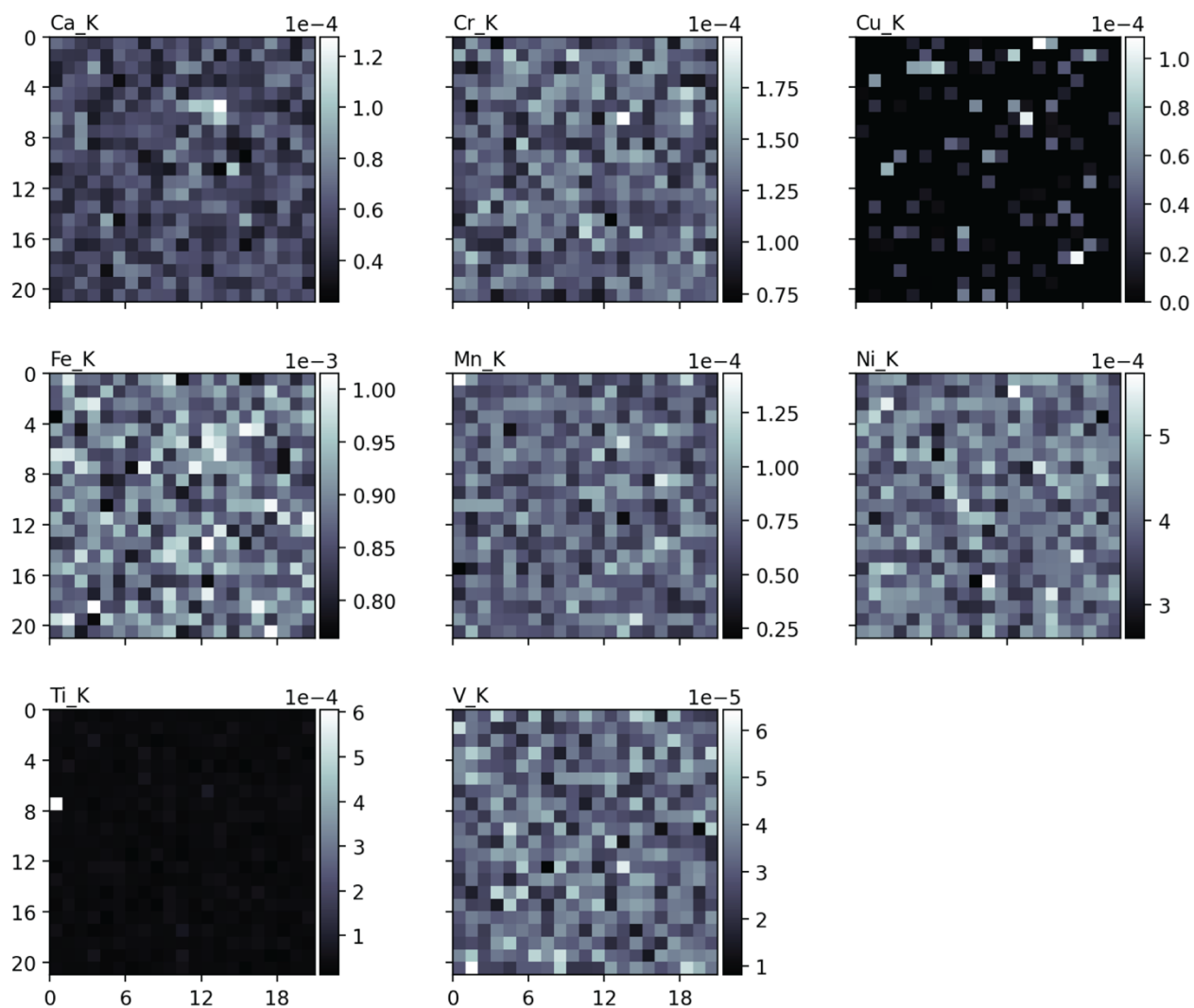
1 **SI Figures**

2 **Figure S1:** Transmission and detection efficiency of the detection systems used for (a) multi-grain and (b) spatially resolved
3 RF. Three bandpass filters were used centered at 710, 850 or 880 nm, with FWHM of 10, 30 (PMT) / 40 (CCD) and 10 nm,
4 respectively. The filter packs for the CCD system also include plano-convex lenses.



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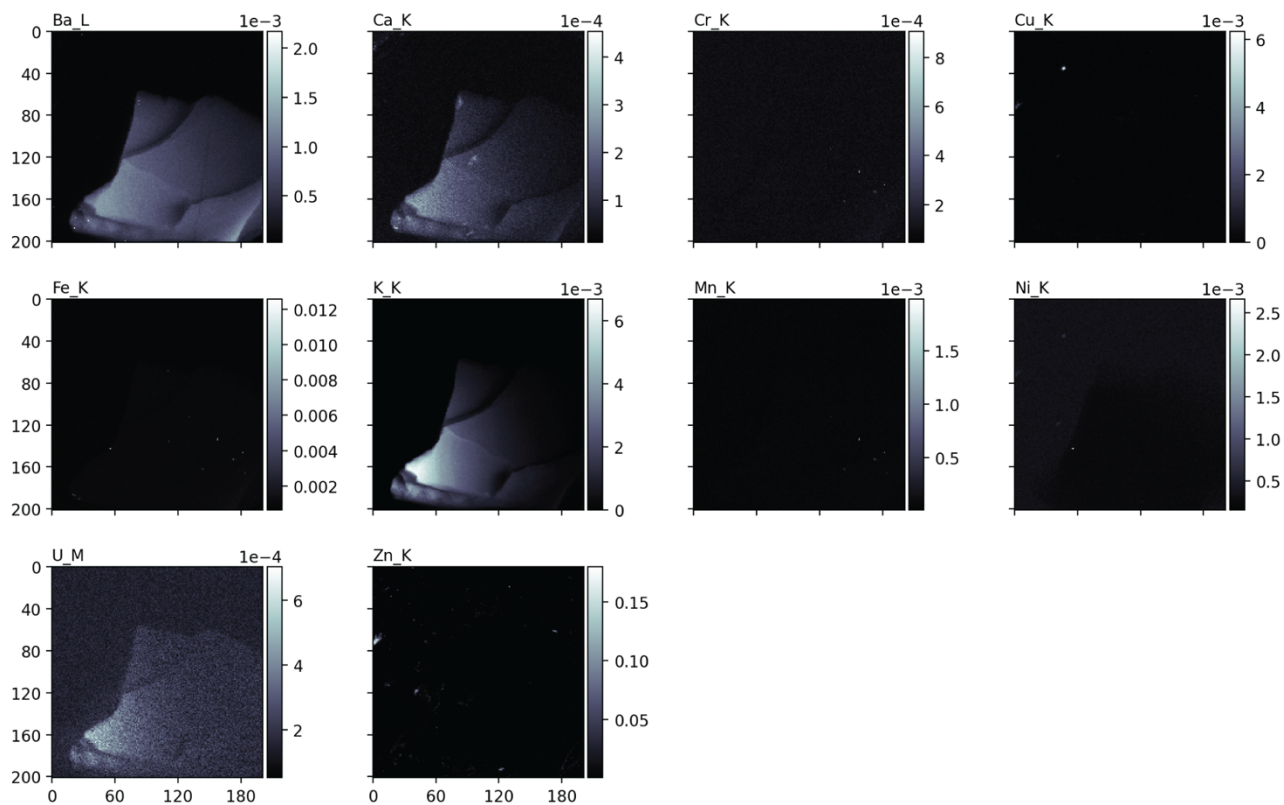
19 **Figure S2:** A 20 x 20 μm $\mu\text{-XRF}$ map at 10 keV of the resin sample holder, with a step size of 1 μm and a dwell time of
20 0.05s.



1 pixel = 1 μm

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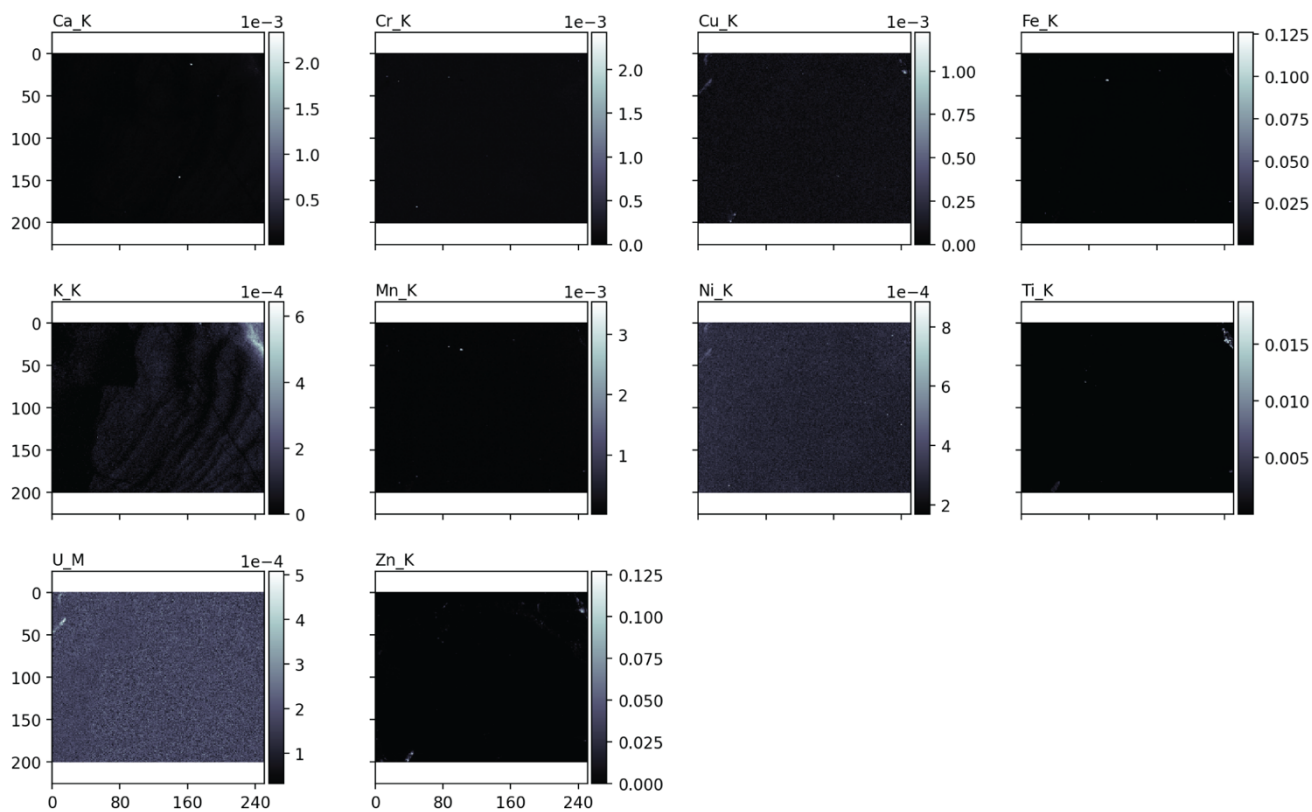
26 **Figure S3:** A 200 x 200 μm $\mu\text{-XRF}$ map at 10 keV of the microcline sample (NMNH143966), with a step size of 1 μm and a
27 dwell time of 0.1 s.



1 pixel = 1 μm

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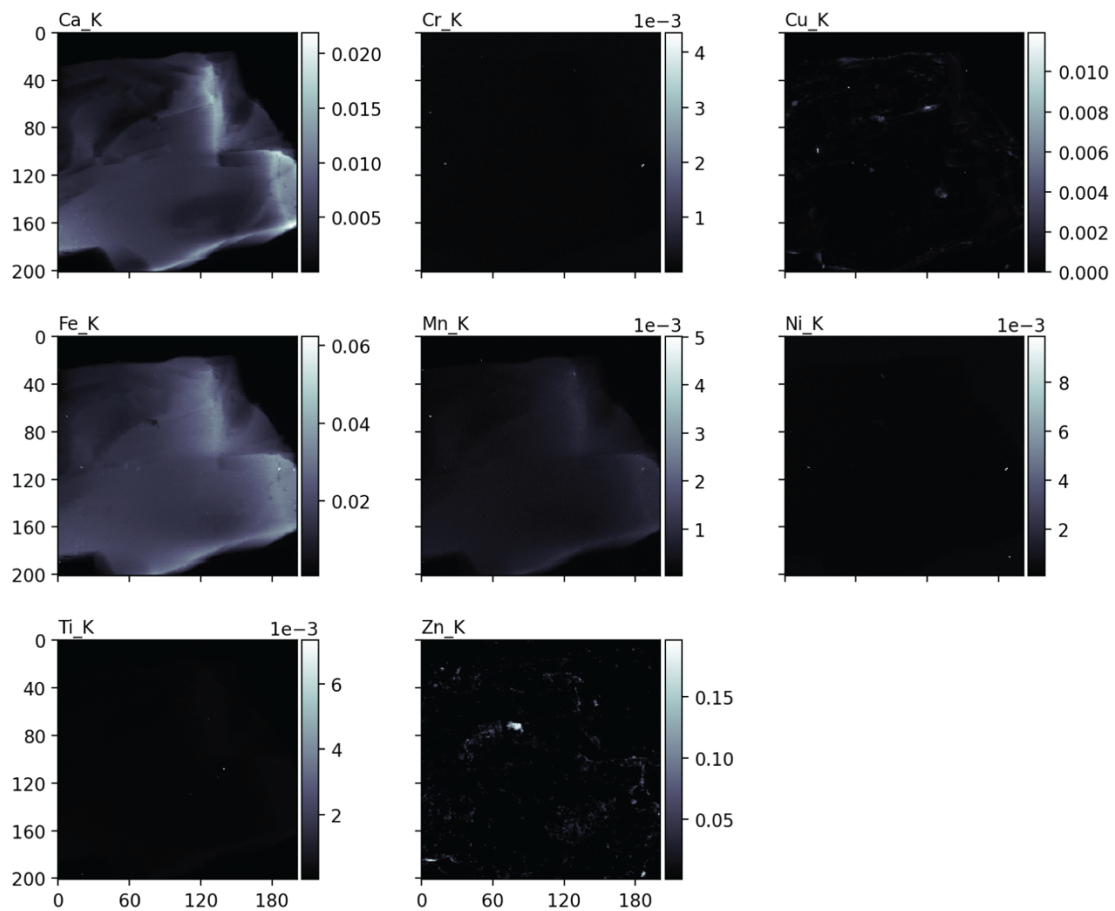
39 **Figure S4:** A 250 x 200 μm $\mu\text{-XRF}$ map at 10 keV of the albite sample (SBU Amelia Albite), with a step size of 1 μm and a
40 dwell time of 0.1 s.



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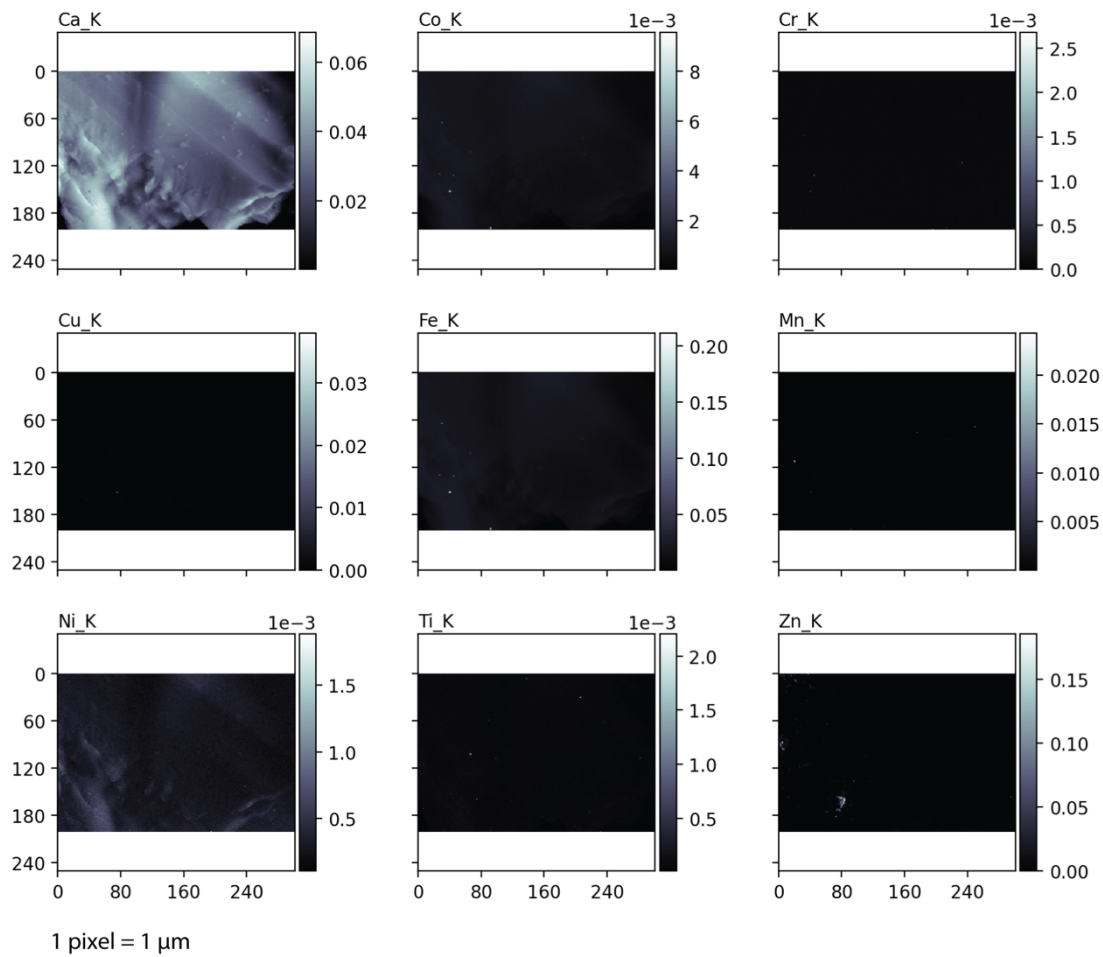
53 **Figure S5:** A 200 x 200 μm $\mu\text{-XRF}$ map at 10 keV of the labradorite sample (NMNH115900), with a step size of 1 μm and a
54 dwell time of 0.1 s.



1 pixel = 1 μm

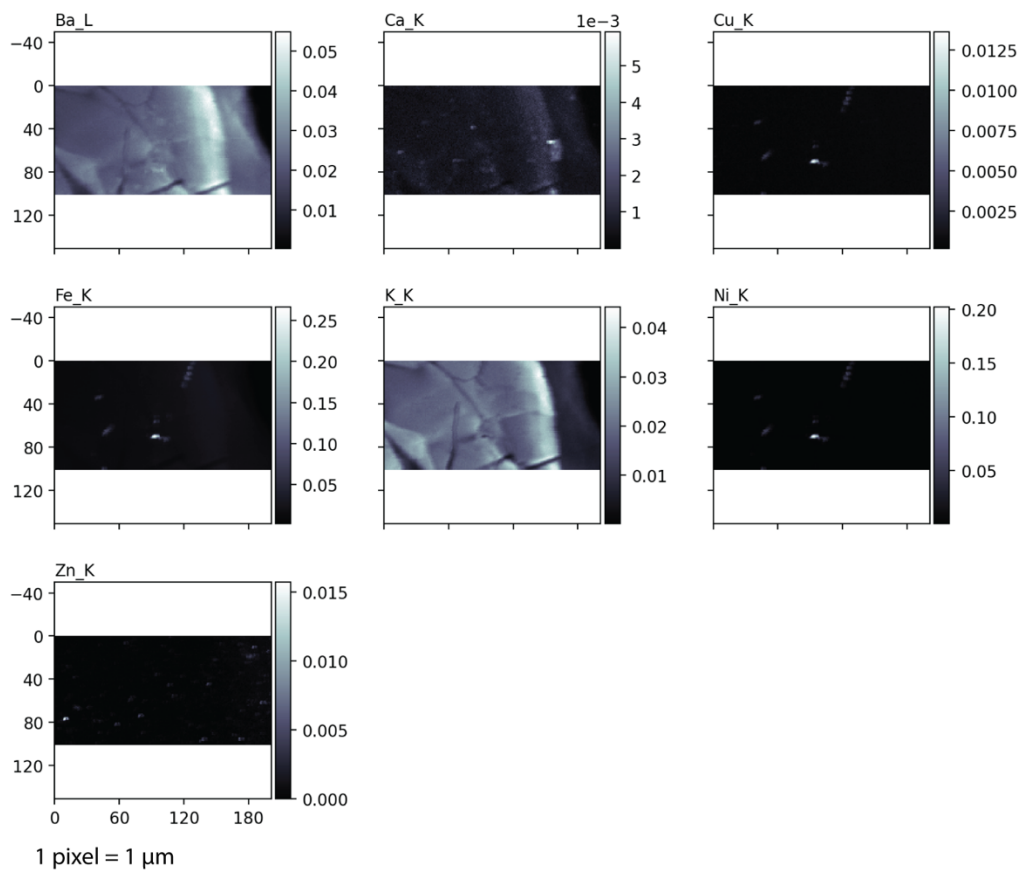
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63 **Figure S6:** A 300 x 200 μm $\mu\text{-XRF}$ map at 10 keV of the anorthite sample (NMNH137041), with a step size of 1 μm and a
64 dwell time of 0.1 s.



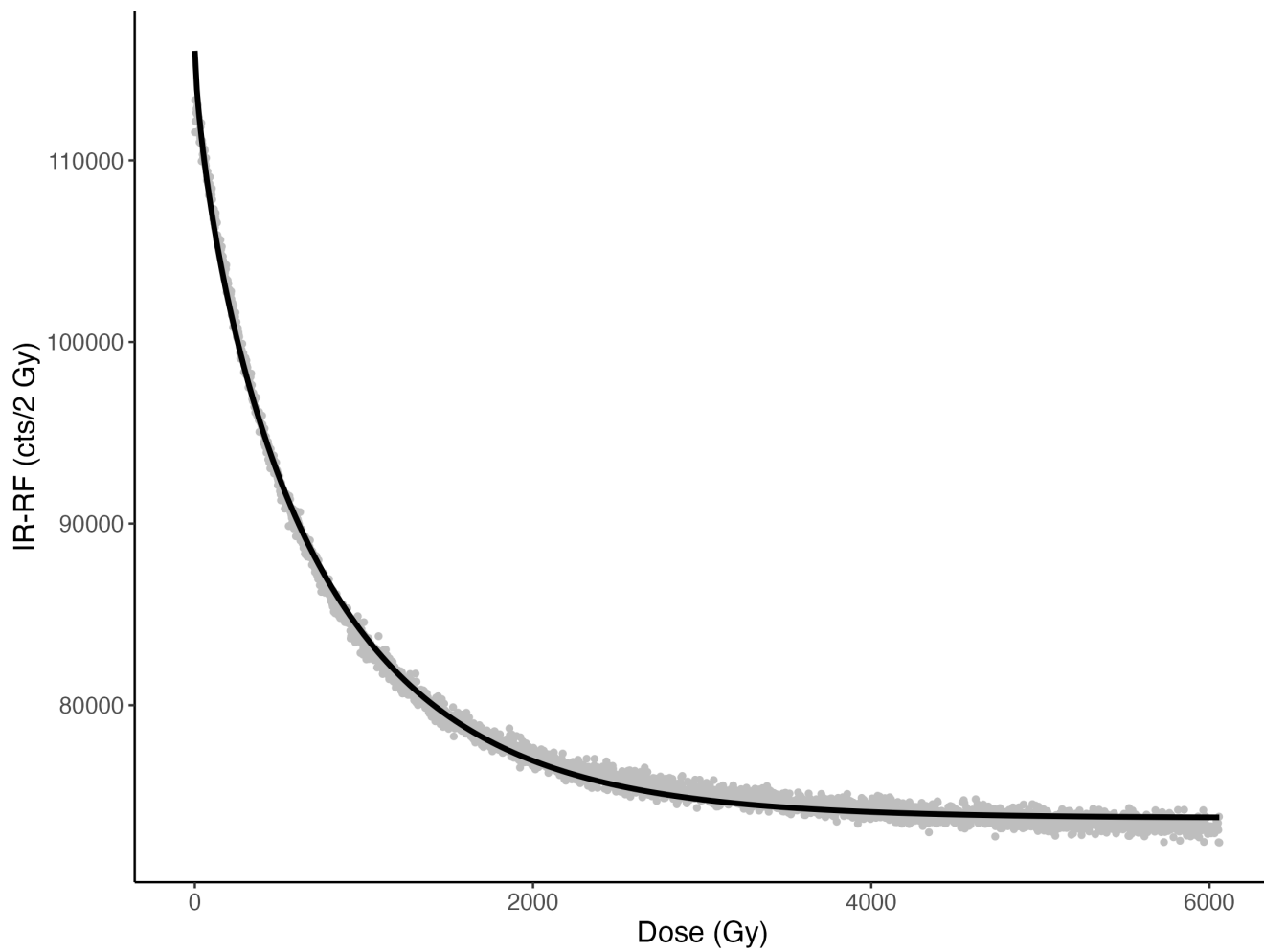
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74 **Figure S7:** A 200 x 100 μm $\mu\text{-XRF}$ map at 10 keV of the sanidine sample (FCs), with a step size of 1 μm and a dwell time
75 of 0.05 s.



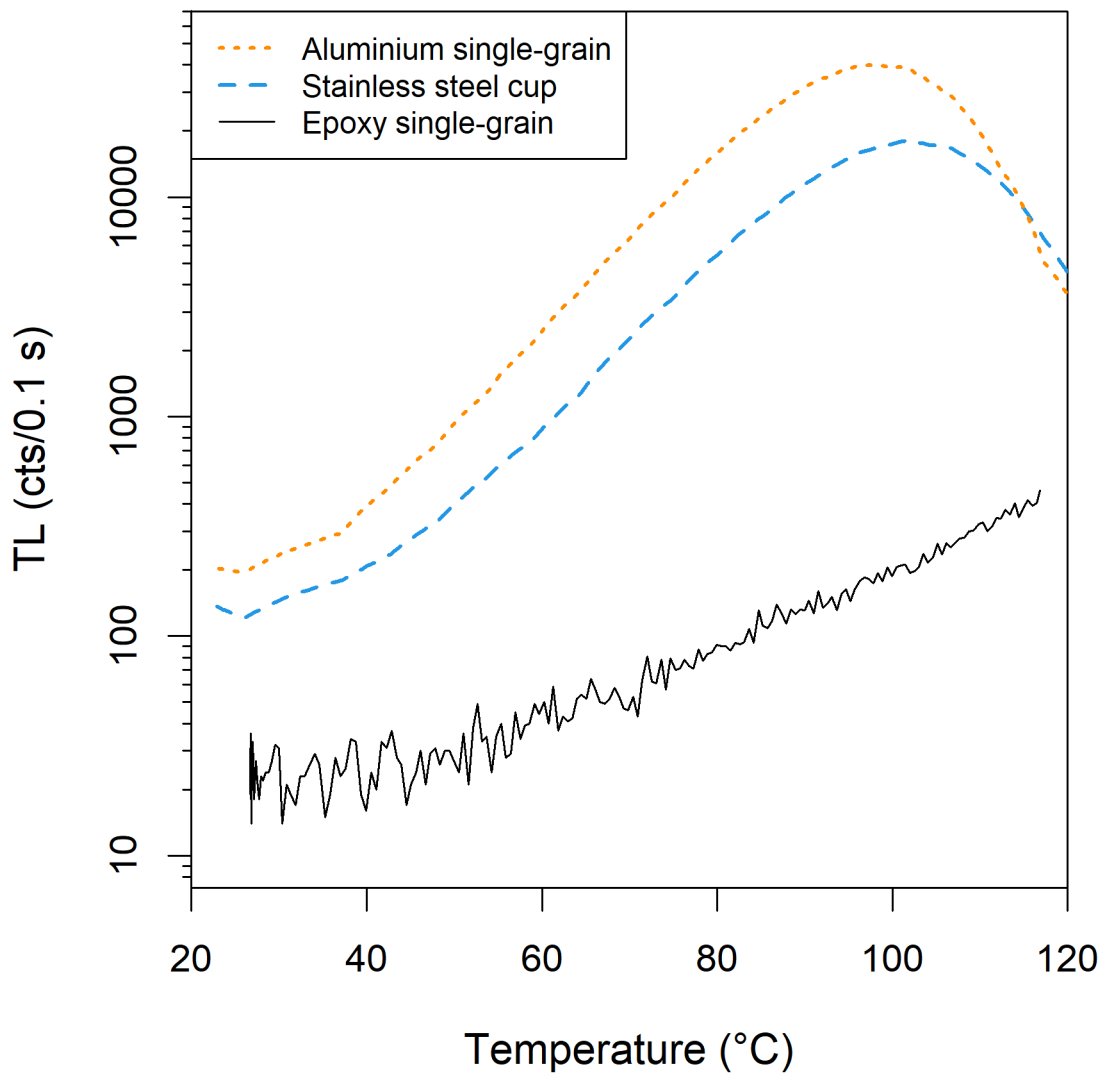
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86 **Figure S8:** IR-RF dose response curve of the microcline sample (grey) detected through an 850/30 nm filter fit with the stretched
87 exponential function proposed by Erfurt and Krbetschek, 2003 (black line).



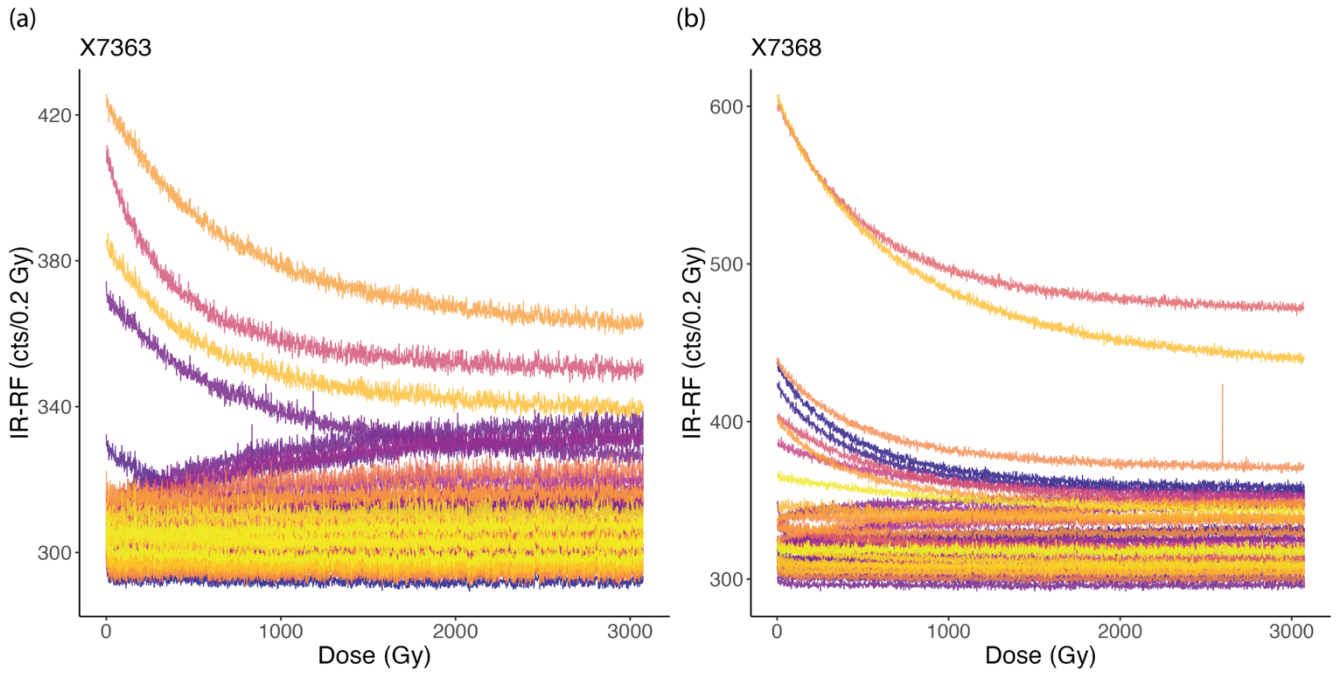
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98 **Figure S9:** Comparison of the quartz 100°C thermoluminescence (TL) peaks between three sample holders: aluminum
99 single-grain disc (yellow dashed line), stainless steel cup (blue dashed line), and the resin single-grain sample holder (black
100 solid line).



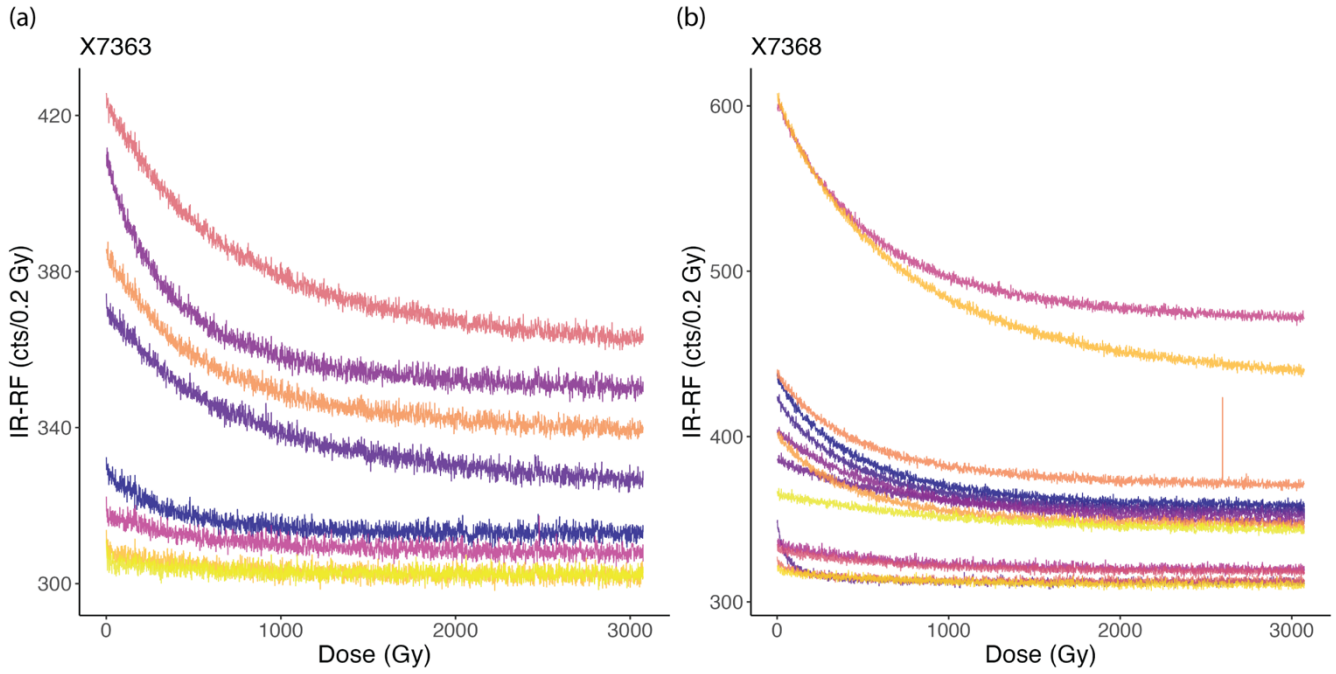
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Figure S10: SR IR-RF Dose Response Curves (DRCs) for natural samples: (a) X7363 and (b) X7368.



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124 **Figure S11:** SR IR-RF Dose Response Curves (DRCs) for natural samples: (a) X7363 and (b) X7368 that are classified as
125 having a 'category 1' DRC that decreases with dose accumulation.



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SI Tables

Table S1: Element composition of Anorthite, Microcline, Labradorite, Albite, and Fish Canyon Tuff Sanidine.

Sample Name	Composition (wt %)												
	Al ₂ O ₃	CaO	Fe ₂ O ₃	FeO	H ₂ O	K ₂ O	MgO	MnO	Na ₂ O	SiO ₂	TiO ₂	SrO	BaO
Anorthite (NMNH 137041) ¹	36.03	19.09	-	0.62	-	0.03	<0.02	-	0.53	44	0.03	-	-
Microcline (NMNH 143966) ¹	18.3	0.02	0	0.04	-	15.14	0.03	0.04	1.3	64.24	0.01	-	-
Labradorite (NMNH 115900) ¹	30.91	13.64	0.34	0.15	0.05	0.18	0.14	0.01	3.45	51.25	0.05	-	-
Albite (SBU Amelia Albite) ²	19.19	-	-	-	-	0.29	-	-	9.78	70.73	-	-	-
Fish Canyon Tuff Sanidine (FCs) ³	19.57 ± 0.16	0.21 ± 0.03	-	0.11 ± 0.02	-	12.60 ± 0.17	-	-	2.70 ± 0.07	64.60 ± 0.31	-	0.13 ± 0.03	0.88 ± 0.43

¹ Data sourced from the Smithsonian Microbeam Standards Dataset (Jarosewich, 1980)

² Data sourced from the Stony Brook Microbeam Analysis Lab Probe

³ Data sourced from Zimmerer and McIntosh (2011). Values are averages of 15 analyses; errors are reported as one standard deviation.

References

Jarosewich, E., Nelen, J. A., and Norberg, J. A. (1980) Reference Samples for Electron Microprobe Analysis. *Geostandards Newsletter* 4, p. 43-47

Zimmerer, M. J., McIntosh, W. C.: 40Ar/39Ar dating, sanidine chemistry and potential sources of the Las Tablas Tuff, northern New Mexico, *in: Geology of the Tusas Mountains and Ojo Caliente Area*, Koning, Daniel J.; Karlstrom, Karl E.; Kelley, Shari A.; Lueth, Virgil W.; Aby, Scott B., *ed(s)*, New Mexico Geol. Soci. Guidebook, 62, 215-222, 2011