American Mineralogist (MSA).
Campbell, L. S., Giordano, G., Stock, M. J., Langella, A., Bish, D. L., and Gatta, G. D. (2019), American Mineralogist, vol. 104
DOI: https://doi.org/10.2138/am-2019-6673

**Supplementary file 1**

# Reconstruction of residual melts from the zeolitized explosive products of alkaline-mafic volcanoes

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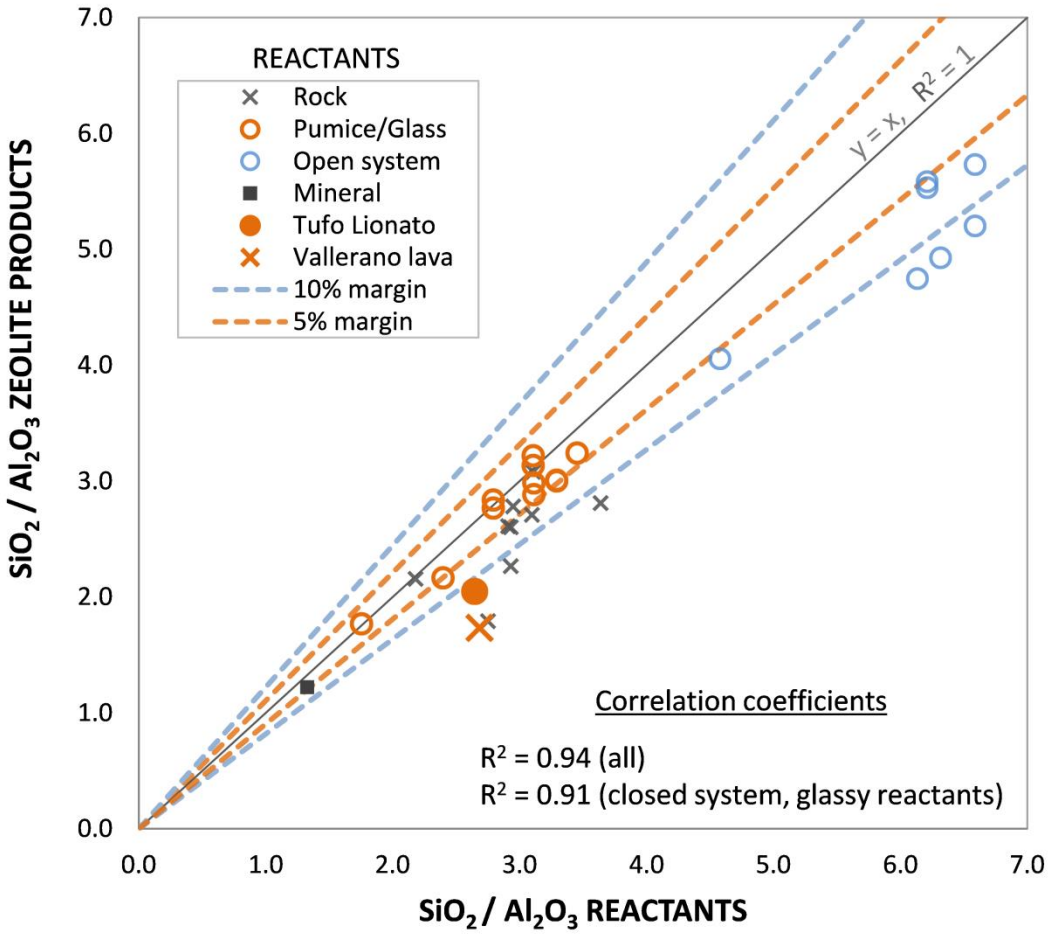
# Supplementary file 1

**Supplementary 1, Figure S1**. $SiO_2/Al_2O_3$ for reactants versus zeolite mineral products ($r^2$=0.94 excluding the Colli Albani rocks of this study). For the low-silica Italian alkaline volcanic deposits, free silica is absent in the zeolite-dominant alteration assemblages, but minor smectite is commonly observed. In the highest range of $SiO_2/Al_2O_3$, greater departure from a perfect correlation is attributed to prolonged interaction with external fluids in an open-system (Broxton et al., 1987, Vaniman et al., 2001). The specified mineral reactant in one study was nepheline (Henderson et al., 2012). Data sources are listed in Supplementary 1, Table S1.1.

Suppl. 1 Figure S1



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# Supplementary file 1

Table S1.1

TABLE S1.1. DATA SOURCES USED IN FIGURE S1.

| Location | Reactants | Products | Reactant context |
|---|---|---|---|
| Vico, Italy | Perini et al. (1997) | Campbell et al. (2016) | Rock |
| Skye, UK | Font et al. (2008) | Campbell et al. (2016) | |
| Mt. Etinde, Cameroon | Etame et al. (2012) | Etame et al. (2012) | |
| Kaiserstuhl, Germany | Weisenberger and Spürgin (2009) | Weisenberger and Spürgin (2009) | |
| Dunedin, NZ | Price and Chappell (1975) | Graham et al. (2003) | |
| Yucca Mtn. USA | Broxton et al. (1987) | Broxton et al. (1987) | Open system |
| Magadi, Kenya | Surdam and Eugster (1976) | Surdam and Eugster (1976) | |
| Campi Flegrei, Italy | Tomlinson et al. (2012) | de Gennaro et al. (2000) | Pumice or glass |
| Campi Flegrei, Italy | Langella et al. (2013) | Langella et al. (2013) | |
| Vulsini, Italy | Langella and Adabbo(1994) | Langella and Adabbo(1994) | |
| Sabatini, Italy | Cappelletti et al. (2015) | Cappelletti et al. (2015) | |
| Oricola, Italy | Stoppa et al. (2005) | Stoppa et al. (2005) | |
| Olduvai, Tanzania | McHenry et al. (2010) | Campbell (unpubl.) | |
| Colli Albani, Italy | Conticelli et al. (2010) | Campbell (unpubl.) | |
| Montana, USA | Henderson et al. (2012) | Henderson et al. (2012) | Mineral (nepheline) |
| C. Albani, Tufo Lionato | Boari et al. (2009) | This study | Matrix glass |
| C.Albani, Vallerano lava | Boari et al. (2009) | Passaglia (1970) | Rock |

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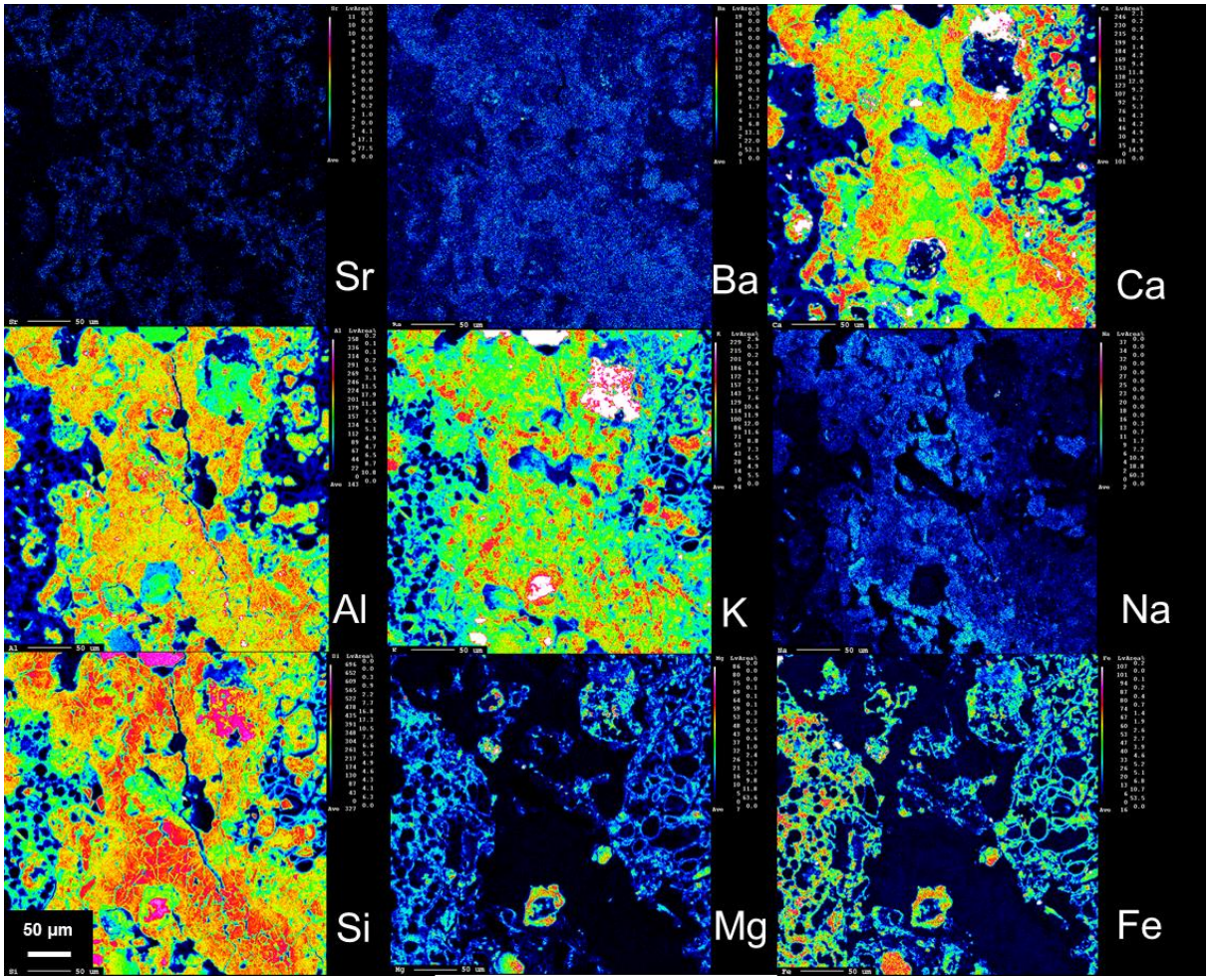
# Supplementary file 1

**Supplementary 1, Figure S2.** X-ray maps for *Tufo Lionato* (Villa Adriana sample) acquired by conventional WDS electron microprobe (operating conditions detailed in Campbell et al., 2016). High-Al zeolites occupy vesicles in two different scoria types and also represent the the interstitial fine ash component of the rock. Sr almost exclusively resides in the zeolites.



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# Supplementary file 1

**Supplementary 1, Figure S3.** Observed (blue) and Rietveld-refined (red) X-ray powder diffraction patterns for *Tufo Lionato* (IT16 Fioranello). Gray curve represents the difference between observed and calculated patterns, and the tic marks at the bottom of the plot represent the possible positions of all reflections for each component. Details of the determined mineralogy are provided in Table 1 (reproduced here).

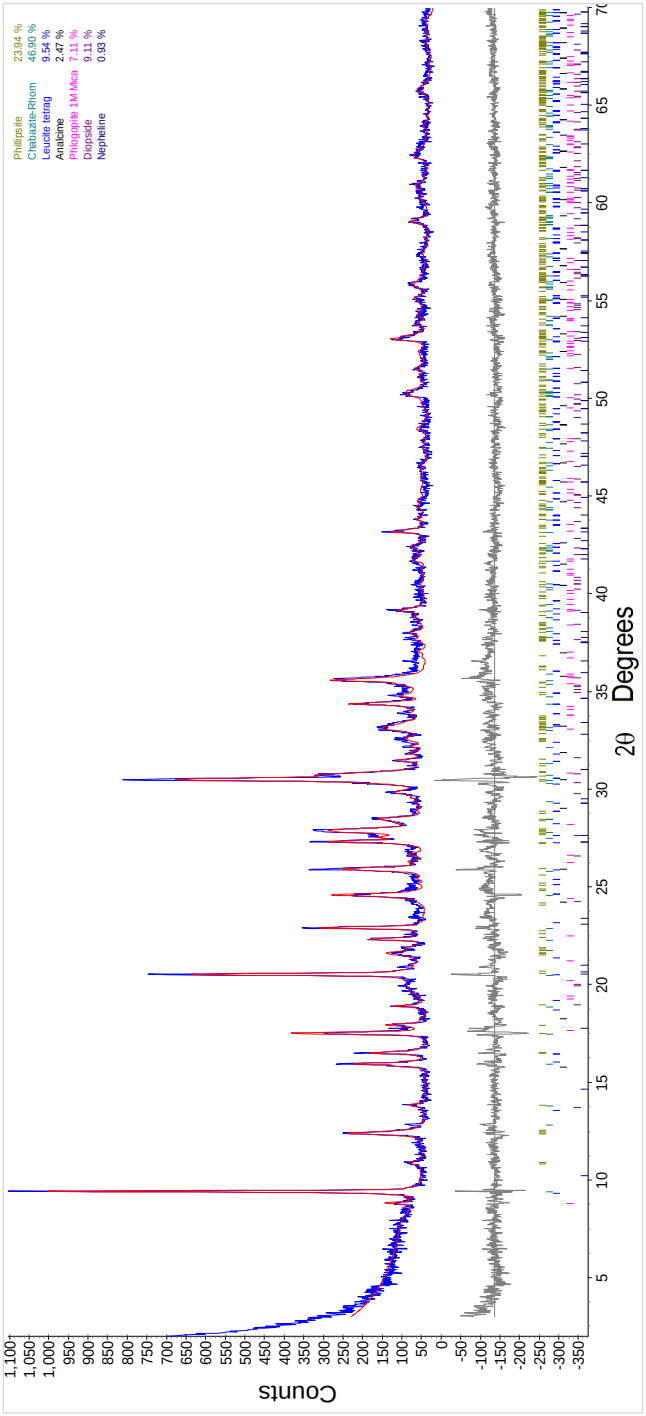


**Table 1.** Rietvelt-refined weight percentages and unit cell parameters for the mineral constituents of Tufo Lionato.

| Parameters | Phillipsite | Chabazite | Leucite | Analcime | Phlogopite 1M Mica | Diopside | Nepheline |
|---|---|---|---|---|---|---|---|
| Unit-cell Volume (Å3) | 1013.8(8) | 837.60(16) | 2351.7(10) | 2595(2) | 492.1(5) | 441.4(7) | 729.7(11) |
| Wt% - Rietveld | 22(1) | 42(1) | 9(1) | 2.3(3) | 6.4(6) | 8.1(6) | 0.8(3) |
| Unit-cell parameters: | | | | | | | |
| a (Å) | 9.902(2) | 9.4493(6) | 13.068(2) | 13.741(4) | 5.326(4) | 9.746(9) | 9.979(6) |
| b (Å) | 14.286(5) | | | | 9.209(5) | 8.903(7) | |
| c (Å) | 8.682(4) | | 13.771(4) | | 10.167(5) | 5.298(4) | 8.461(7) |
| alpha (°) | | 93.897(4) | | | | | |
| beta (°) | 124.37(3) | | | | 99.36(6) | 106.23(7) | |

*Note:* Dioctahedral smectite was not quantified but is evidenced by the broad, low-angle signal, the 02ℓ band, and the 06ℓ band near 62°2θ.

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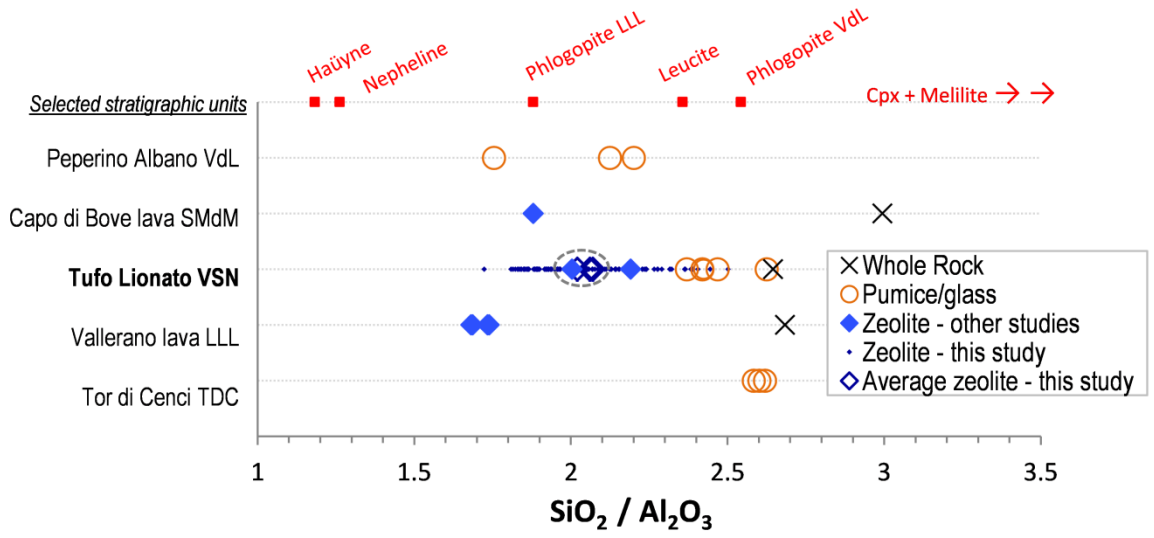
**Supplementary 1, Figure S4.** Compositional framework ($SiO_2/Al_2O_3$ ratio) for different components of the Colli Albani deposits. See Giordano et al. (2010) for stratigraphic abbreviations (VdL, etc.). Rock, mineral and pumice data are from Freda et al. (1997), Gaeta (1998), Palladino et al. (2001), Marra et al. (2009), Boari et al. (2009), Conticelli et al. (2010), De Benedetti et al. (2010) and Cross et al. (2014), and zeolite data are from Passaglia (1970), Galli and Loschi Ghittoni (1972), Passaglia and Vezzalini (1985), and this study. The dashed-oval represents the $SiO_2/Al_2O_3$ composition of a profuse, hypothetical former glass that was erupted during the Villa Senni caldera-forming event, as determined in this study.

Figure S4

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