Supplementary Information for

Petrogenesis of Néma 001, an alkali-rich meteorite from the acapulcoite-lodranite parent body

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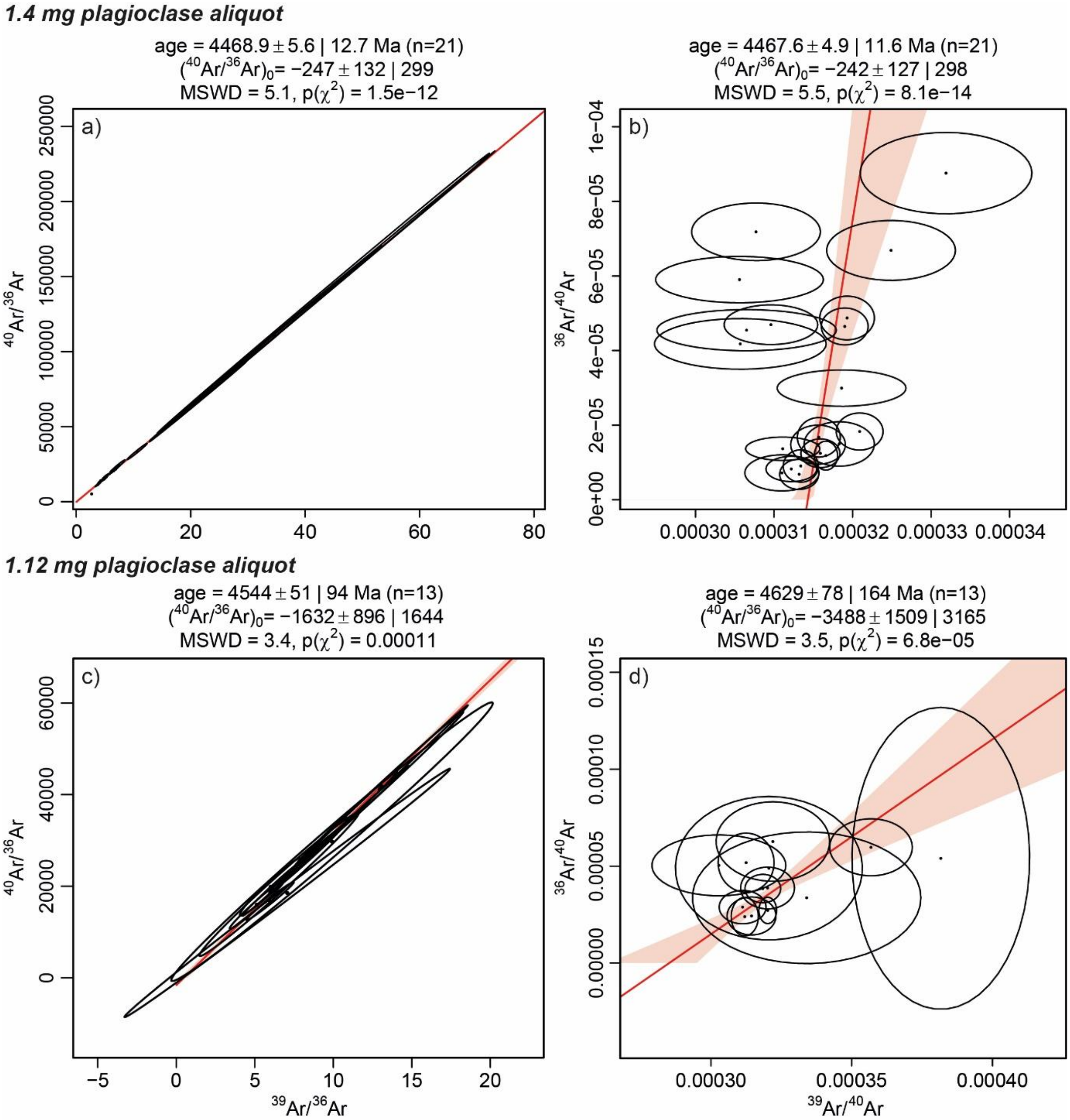
Supplementary Figures 1 to 7.

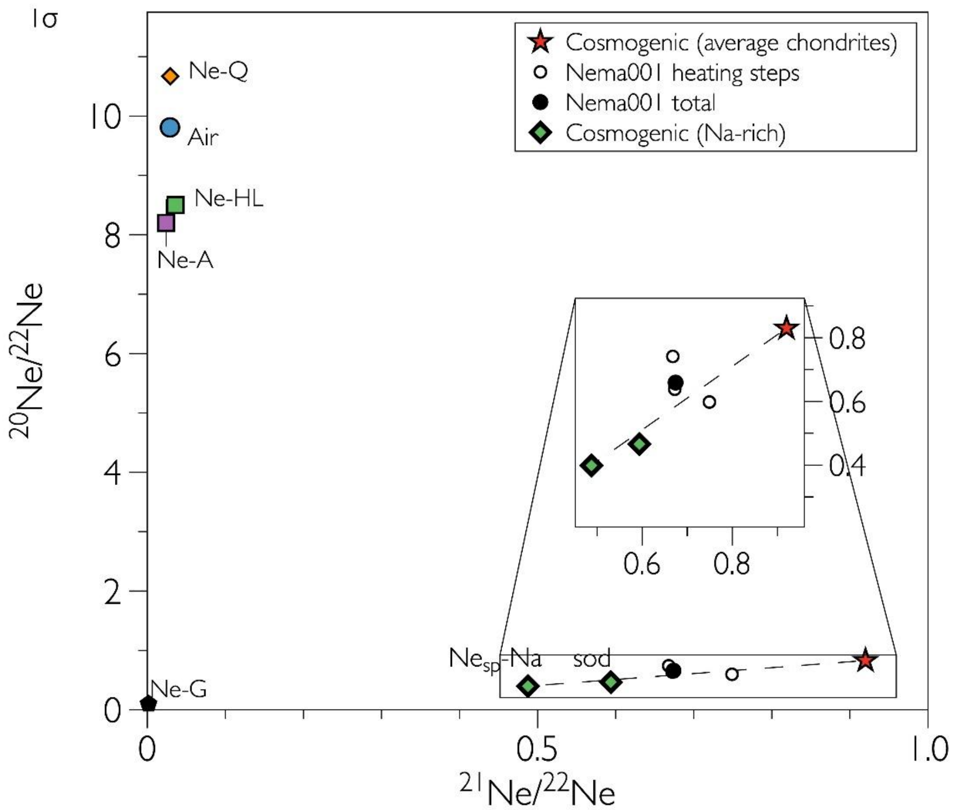
Supplementary Tables (*available at https://doi.org/10.48420/29126567.v3*)

- Table S1. Bulk ICP-MS
- Table S2. EPMA analyses
- Table S3. LA-ICP-MS protocol - Traces
- Table S4. LA-ICP-MS silicates - all
- Table S5. LA-ICP-MS protocol - Dating
- Table S6. Apatite U-Pb dating
- Table S7. LA-ICP-MS apatite - all
- Table S8. Al-Mg dating
- Table S9. Ne isotopes
- Table S10. Ar isotopes
- Table S11. Mineral chemistry
- Table S12. MELTS modelling

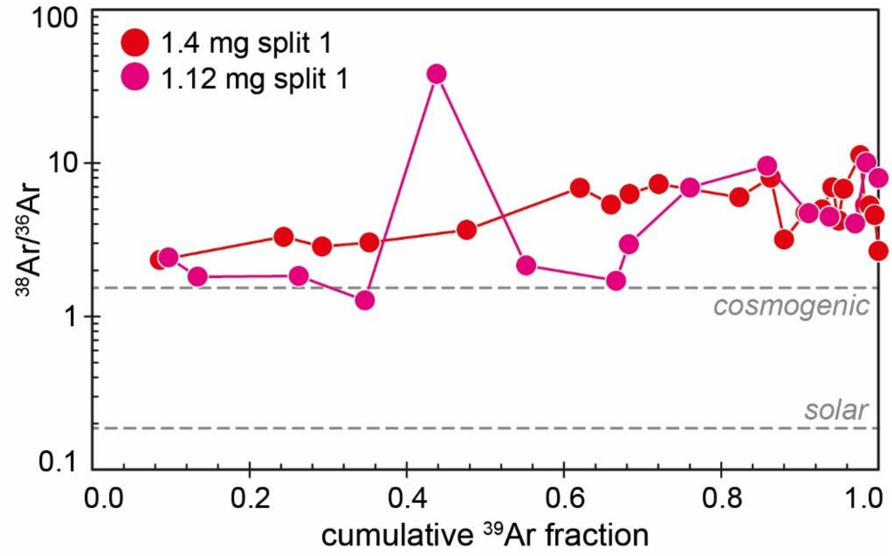
Supplementary Figures



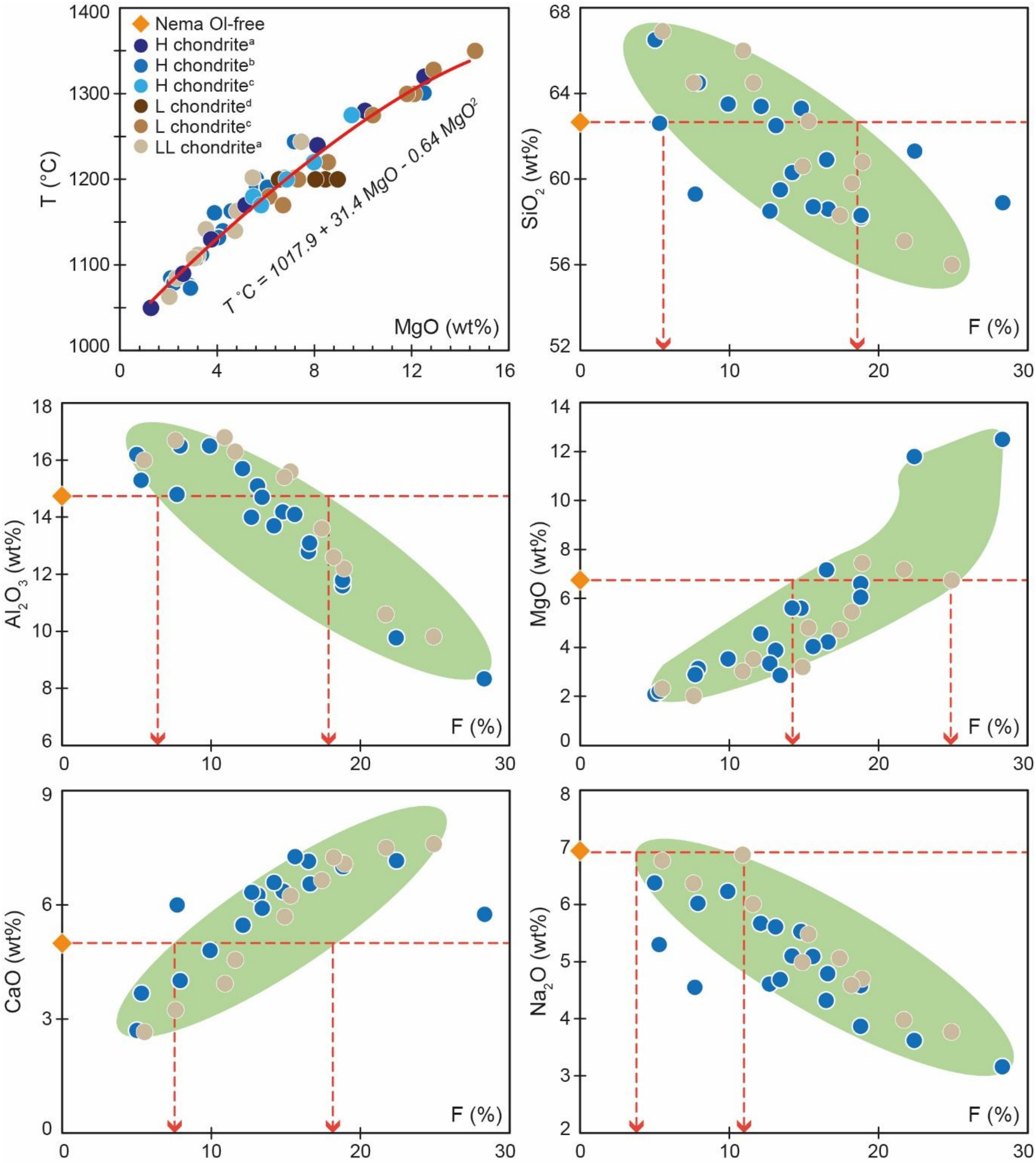
Supp. Figure 1: Normal (a, c) and inverse (b, d) Ar isochron plots for the two plagioclase splits.



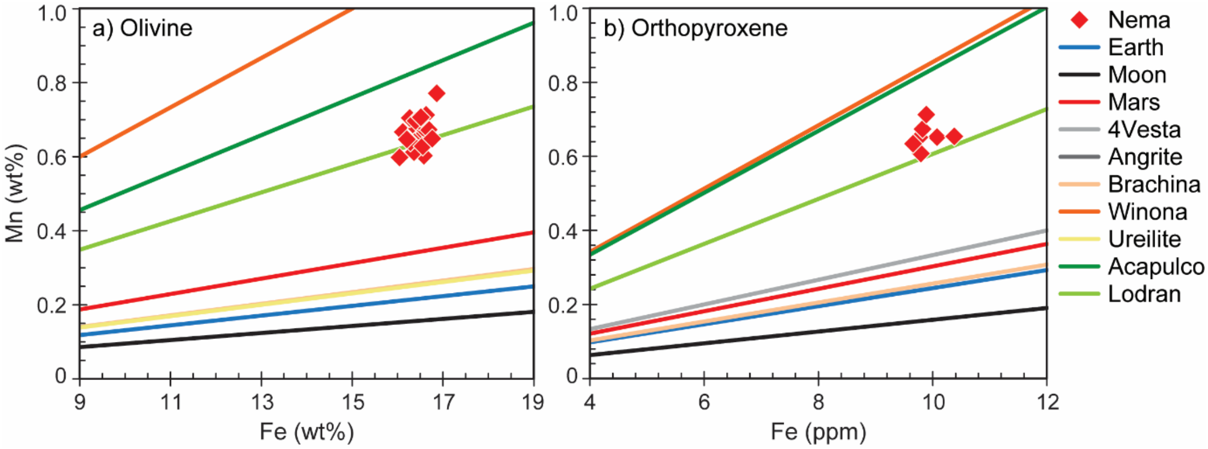
Supp. Figure 2: Three Ne isotope plot displaying the isotopic composition of neon released from a bulk aliquot of Néma 001 during laser heating steps (empty circles) and the isotopic composition of total neon measured at IPGP (filled circle). All heating steps plot between cosmogenic neon produced from spallation of pure Na (NeSp-Na) or sodalite (sod) (see Pravdivsteva et al., 2020 and references therein) and average cosmogenic neon measured in chondrites (Wieler, 2002). The isotope compositions for neon from phase Q (Ne-Q; Busemann et al., 2000), the Earth's atmosphere (Air; Ozima & Podosek, 2001), and other primordial components found in meteorites (Ne-HL, Ne-A, and Ne-G; Ott, 2014) are also plotted. Uncertainties are smaller than the size of the symbols.



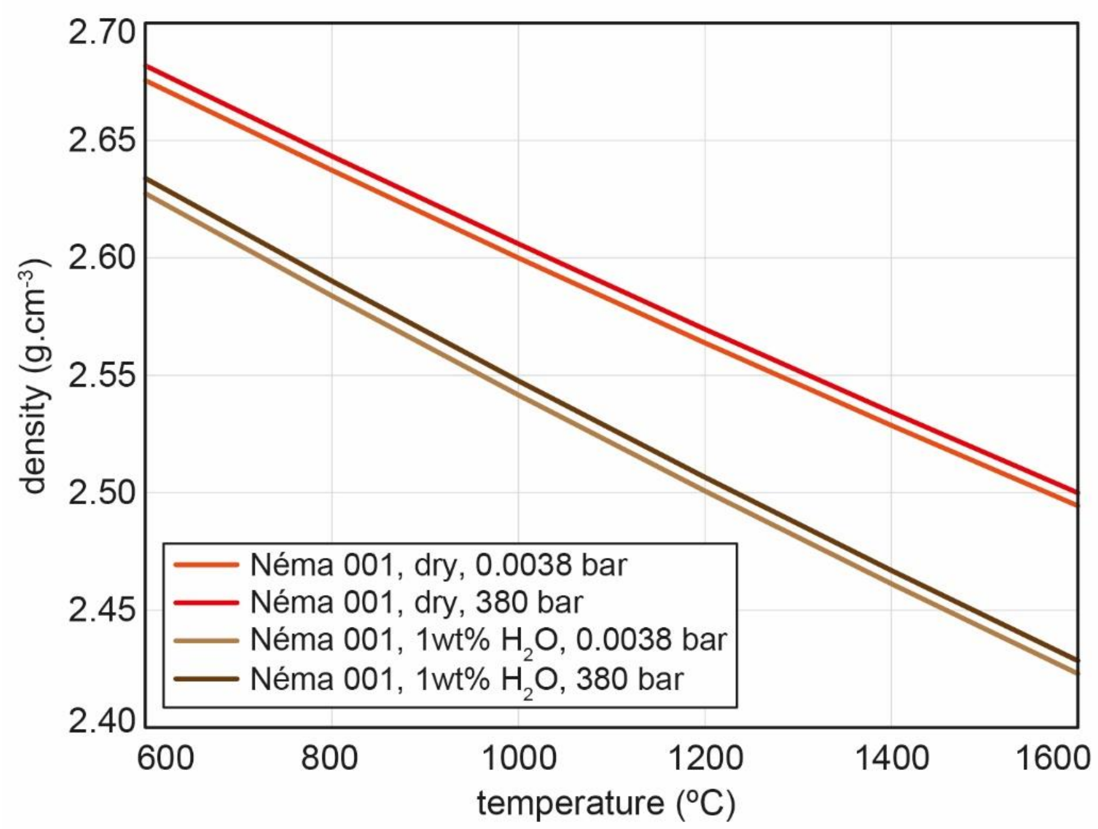
Supp. Figure 3: $^{38}Ar/^{36}Ar$ vs. cumulative ^{39}Ar fraction plot displaying the step-heating results for the two plagioclase splits of Néma 001. The cosmogenic and solar $^{38}Ar/^{36}Ar$ ratios are from Hennessy and Turner (1980).



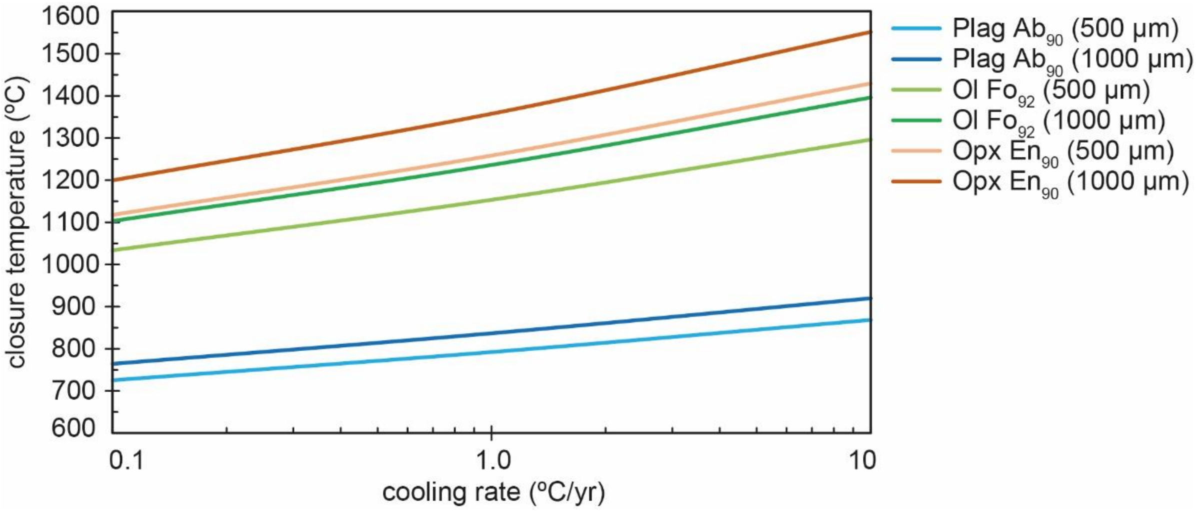
Supp. Figure 4: Temperature vs. bulk MgO abundance (top left) and bulk major oxide abundances vs. degree of partial melting (F) for silicate liquids produced by melting ordinary chondrite precursors at 1050-1350 °C and fO_2 between IW-2.4 and IW+0.8 (Jurewicz et al., 1995 (c); Feldstein et al., 2001 (d); Usui et al., 2015 (b); Collinet and Grove, 2020 (a)).



Supp. Figure 5: Mn (wt%) vs. Fe (wt%) abundance in olivine (a) and pyroxene (b) for Néma 001 compared to a range of planetary materials. References for Fe and Mn abundances are Papike et al. (2003) for Earth, Moon, Mars, and 4Vesta; Prinz et al. (1977) for the angrite Angra Dos Reis; Nehru et al. (1983) for Brachina; Benedix et al. (1998) for Winona; Berkley et al. (1980) for the ureilite Novo Urei; Keil and McCoy (2018) for Acapulco and Lodran.



Supp. Figure 6: Density, calculated using the DensityX programme (Iacovino and Till, 2019), for a melt with the major element composition of Néma 001, with either 0 or 1 wt% H_2O, for temperatures between 600 and 1600 °C, and lithostatic pressures of 0.0038 and 380 bars (corresponding to depths of 1 m and 100 km, respectively, on a putative parent body with a lithostatic column density of 3.8 g.cm^{-3} and a gravitational acceleration *g* of 0.1 m.s^{-2}; e.g., Lucas et al., 2022).



Supp. Figure 7: Closure temperature calculated for Mg diffusion in Ab_{90} plagioclase, Fo_{92} olivine, and En_{90} orthopyroxene for cooling rates between 0.1-10 °C/yr that corresponds to estimates for the first fast cooling phase down to ~750 °C for acapulcoites-lodranites (Lucas et al., 2022). Calculations carried out using the equation of Dodson (1973) for a cylinder, and Mg diffusion parameters of Van Orman et al. (2014) for plagioclase, Chakraborty et al. (1994) for olivine, and Schwandt et al. (1998) for orthopyroxene.

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