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THE VISCOSITY OF LOW-SiO_2 MIXED Na-K ALUMINOSILICATE MELTS, WITH AND WITHOUT FLUORINE

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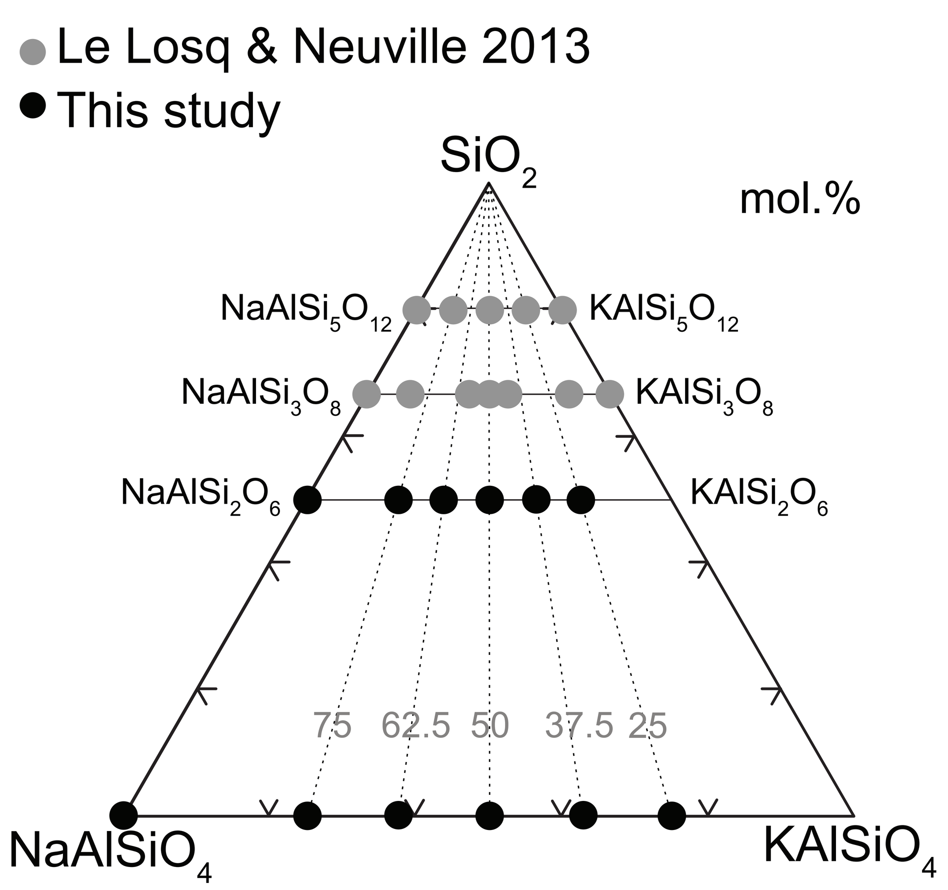
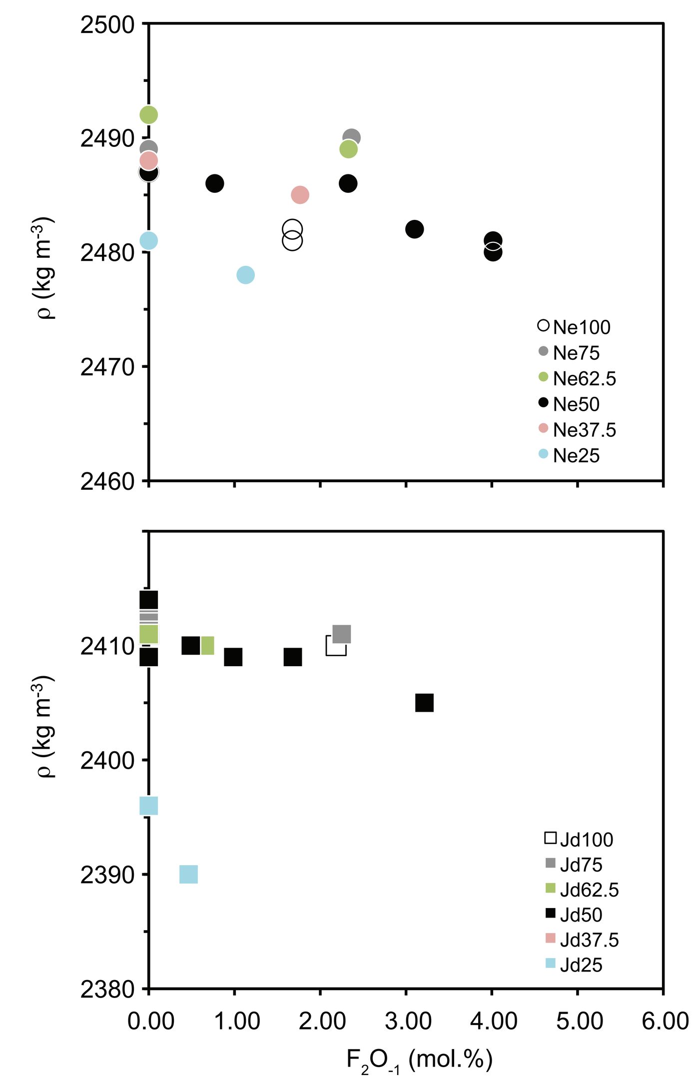
Samples, Goals, and Methods





RESEARCH QUESTIONS:

1. What is the effect of Na-K mixing, and
2. What is the effect of dissolved fluorine

on the viscosity of melts with compositions along the $NaAlSi_2O_6$-$KAlSi_2O_6$ (jadeite-leucite) and $NaAlSiO_4$-$KAlSiO_4$ (nepheline-kalsilite) joins of the quartz-nepheline-kalsilite system?

WHY THIS SYSTEM?

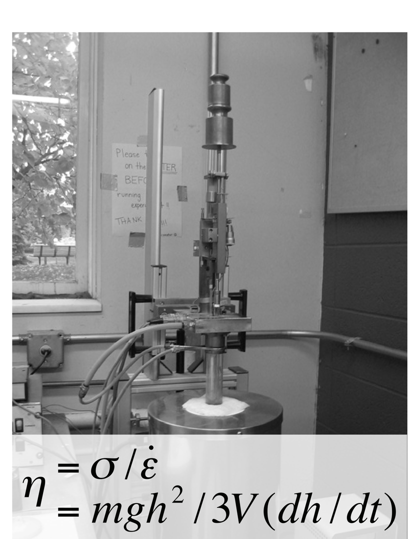
All melts nominally fully polymerized (NBO/T=0), yet:

a. Have different Al/Si ratios

b. Have different Na/K ratios

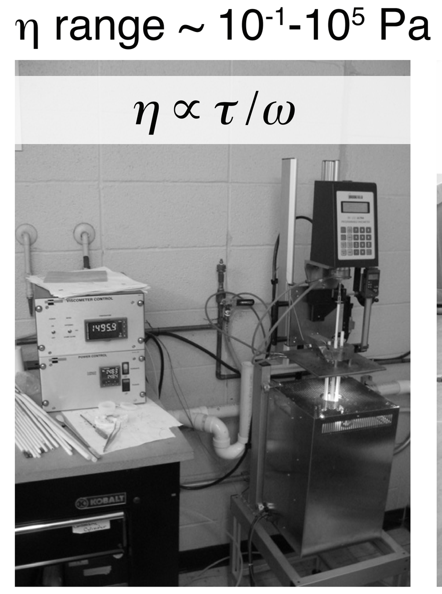
F bonds with Al (Zeng & Stebbins, 2000; Mysen et al., 2004; Schaller et al., 1992) and depolymerizes the melts.

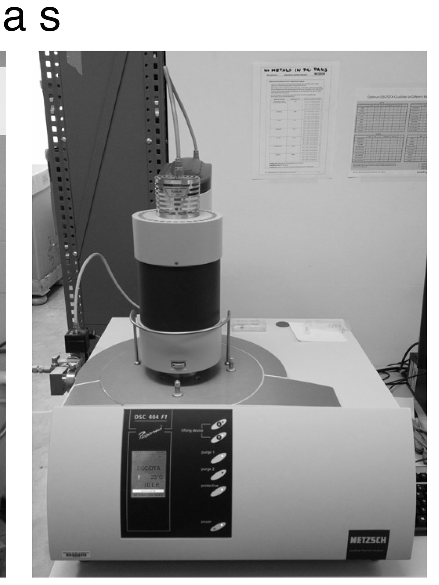
synthesis of glasses (T = 1600-1745°C)



parallel-plate viscometer
max T = 1100°C
η range 10^9-10^{12} Pa s

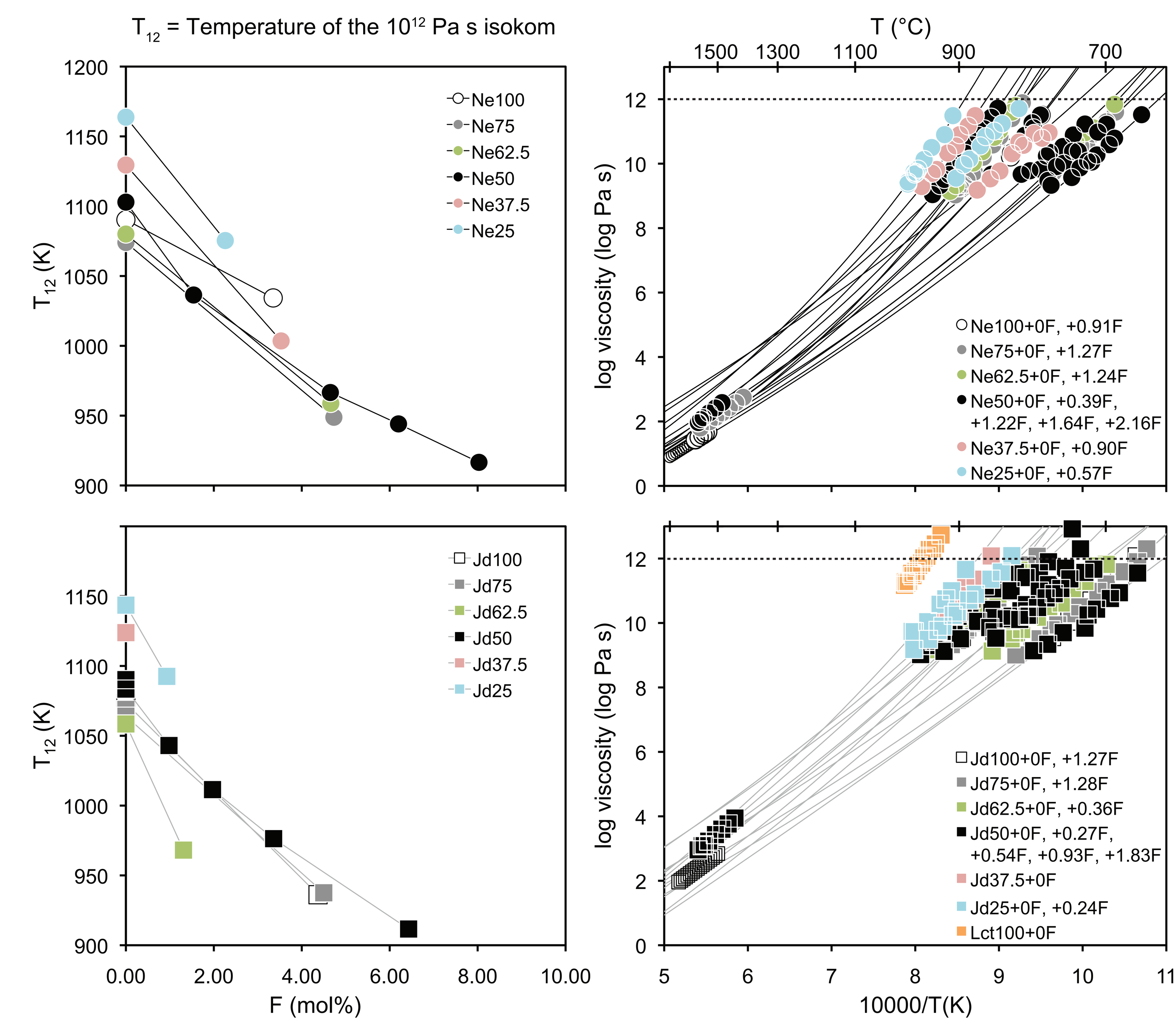
concentric-cylinder viscometer
max T = 1600°C
η range ~ 10^{-1}-10^5 Pa s





differential scanning calorimeter
max T = 1500°C
heating rate = 20K/min

Results

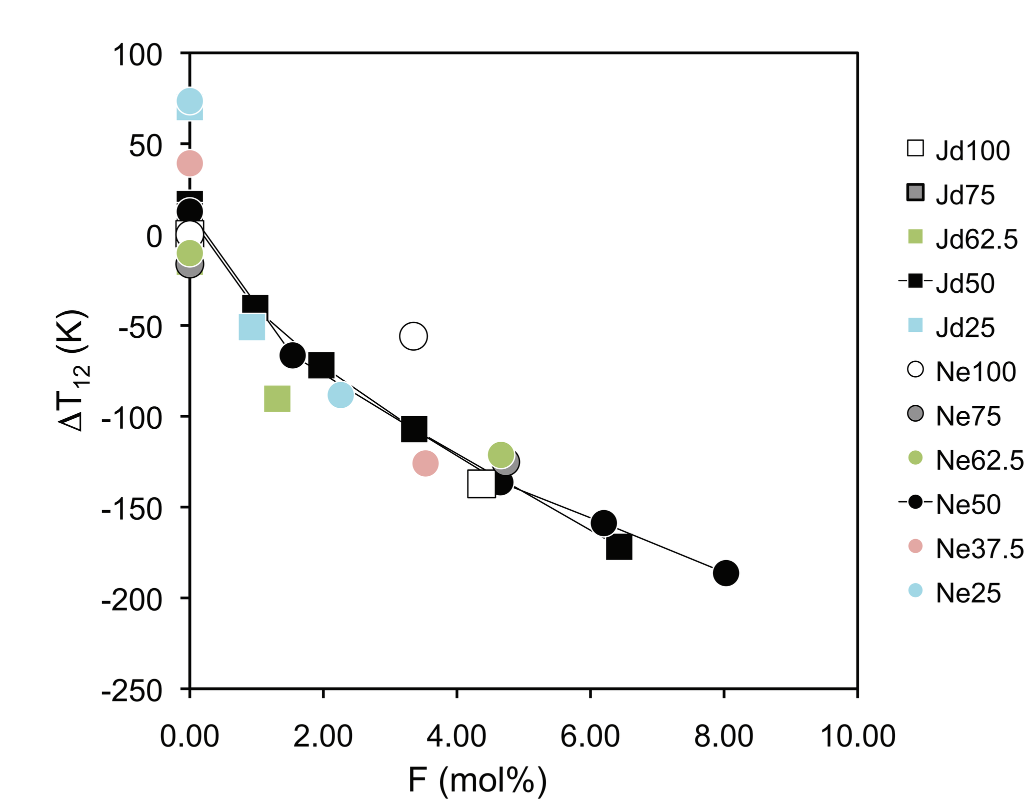


K-rich melts are more viscous than Na-rich melts. At high temperatures, jadeite-leucite melts are overall more viscous than nepheline-kalsilite melts. At low temperatures, the opposite is true. High temperature results are consistent with those of Riebling (1966; see smaller symbols on right hand side figures above). Data for fluorine-free leucite from Whittington.

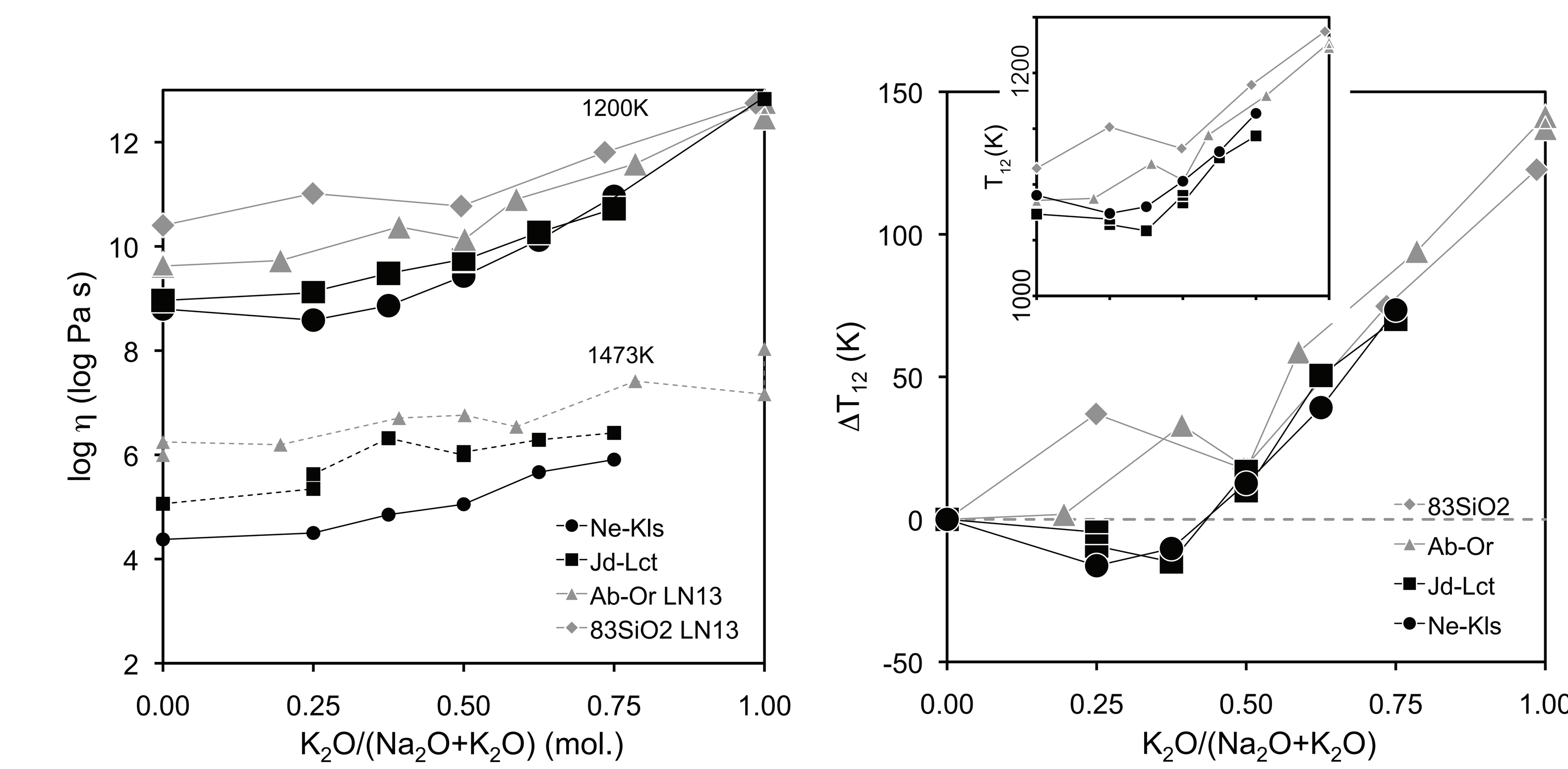
Fluorine reduces the viscosity of all melts studied and its effect of T_{12} reduction is similar for both joins.

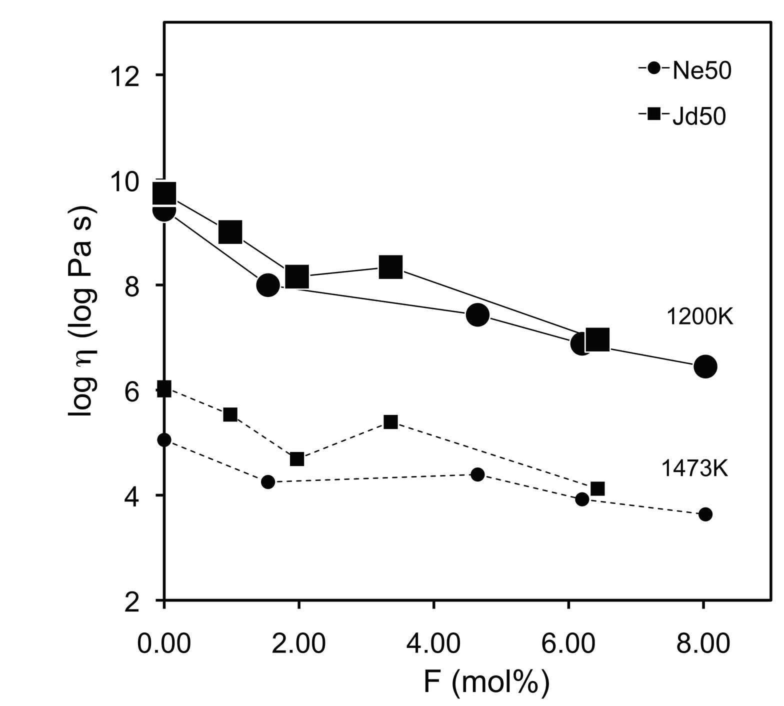
ΔT_{12} of fluorine-free compositions is shown relative to the Na-end member on the vertical axis.

ΔT_{12} for each Na:K ratio is shown relative to the fluorine-free base composition.



Discussion





Increasing the K:Na ratio results in a viscosity decrease at K/(Na+K) ratios <0.375 in jadeite-leucite and nepheline-kalsilite melts, relative to the Na end-member melts. In the melts with higher SiO_2, a viscosity increase is observed instead. Further increase in K:Na ratio results in a viscosity increase relative to the Na end-member. No viscosity "dip" is observed across the jadeite-leucite and nepheline-kalsilite joins.

Overall, Na/K mixing produces a greater spread in T_{12}, across the four joins, specifically at K/(Na+K) ratios between 0.25-0.50. The 1200K isothermal viscosity values appear to converge for the K end-members.

There doesn't seem to be a marked difference in the magnitude of T_{12} reduction due to the addition of fluorine based on either Al/Si or Na/K ratios, suggesting the mechanisms of fluorine dissolution are independent of the type of alkali or of Al/Si ratio in these melts.

Acknowledgements & References

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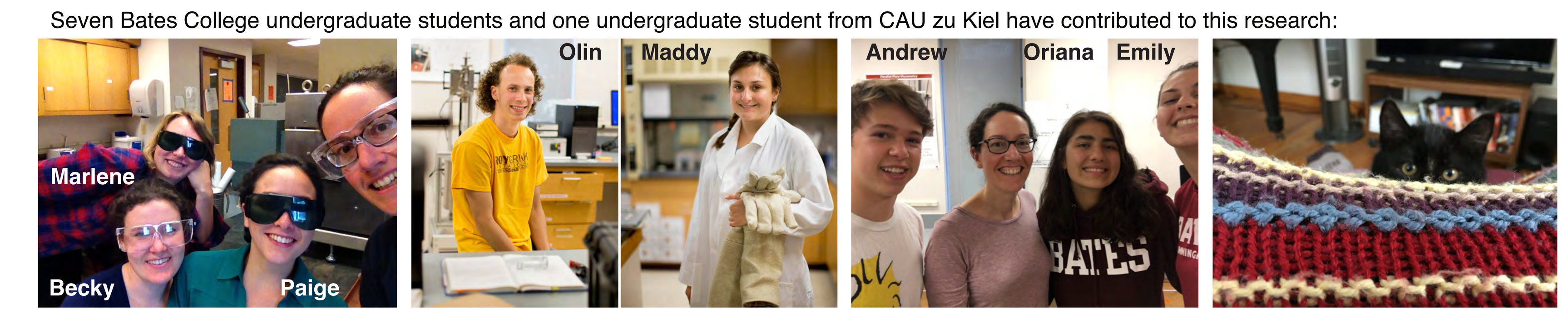

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