Generating large volumes of TTG arc crust: An experimental study

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We are experimentally testing a new numerical model of arc magma evolution [1]. Buoyancy-driven flow and segregation and subsequent matrix compaction of a primitive host magma may yield an evolved granitic melt, which is compositionally similar to many parts of the Earth's early continental arc crust. (TTG). Segregation along mineral grain edges and chemical reaction due to steep geothermal gradients will change the melt composition as it migrates upward. In [1], the model predicts the pressure, temperature, and composition changes in time and space as melt is produced for a given rock type and melt/matrix compositions. The model shows that it is possible to produce tonalite, then trondjemite in large volumes in contrast to direct partial melting of a metabasalt under lowermost crustal conditions.

We are conducting piston-cylinder experiments at 1.4 GPa and at temperatures between 900 and 1000^{o}C on a metabasalt with conditions and compositions based on the model parameters. We add low degree hydrous partial melt (5%,10%,15%) which was previously determined by direct partial meltiing experiments on the same starting material. These are added in varying modal amounts (10%-50%) to simulate the compositional evolution of migrating melt chemically interacting with its source material to test whether or not large volumes of TTG melts can be developed in this way.

Preliminary results show that when we add the 5% and 15% melt composition in a 50% -50% mode with the metabasalt starting material, the compositions of the new melt is granodioritic and more sodic than melt derived by direct partial melting. These results also show that the volume of melt generated by adding in these low degree partial melts is vastly greater than the melt created solely by direct partial melting of the source rock (>50% melt as opposed to 10-15% melt). The new melts co-exist with garnet and clinopyroxene solid product phases and it is likely that the melts will carry a depleted HREE signature.

[1]: Jackson, M.D., Gallagher, K., Petford, N., Cheadle, M. J., (2005) *Lithos*, **79**, 43-60.