New graphical approaches to the discrimination of crust- and mantle-derived low-Cr garnet: major-element-based methods

MF Hardman[a], DG Pearson[a], T Stachel[a], and RJ Sweeney[b]

[a] *Earth and Atmospheric Sciences, University of Alberta, AB, Canada*

[b] *RJ Sweeney Consulting Ltd., Eastbourne, East Sussex, United Kingdom*

In diamond exploration, the use of compositional data to identify diamond-related peridotitic xenocrysts has long been a widely used and powerful tool. In contrast, the application of similar methods to eclogitic garnet chemistry remains a challenge. The inability to unequivocally classify certain "eclogitic" garnet compositions as either mantle- or crust-derived implies that a high abundance of lower-crustal garnets will increase diamond-exploration expenditures by introducing a number of "false positives." This may lead to misdirection of exploration efforts and increased costs.

To remedy this situation, we produced new geochemical data for > 700 new kimberlite-hosted, crust- and mantle-derived garnets from cratons worldwide, producing the first significant database of crustal garnet compositions from cratonic regions. Crustal samples are primarily plagioclase-bearing garnet-granulites while mantle samples are a mixture of eclogite and pyroxenite. Garnets contain < 1.00 wt. % Cr_2O_3 in all instances. These data are supplemented with a large literature database (~ 5,000 analyses).

The commonly used garnet classification scheme of Schulze (2003) uses Fe, Mg, and Ca to separate low-Cr garnets of crust and mantle origin. Our new dataset reveals that this classification scheme mis-classifies some 66 % of crustal garnet-granulites. Hence this approach is flawed in locations where garnet-granulite-derived garnets are abundant, as in many kimberlite indicator mineral trains. Here we propose a new garnet major-element-based classification scheme that is more proficient than existing methods and more robust with respect to the treatment of compositional data. This method utilizes the minor element Ti, placing increased requirements on the quality of garnet analyses (i.e., increased accuracy in classification comes at an analytical cost).

It is clear that any low-Cr garnet classification scheme, including the one proposed here, must be trained and tested with databases containing cratonic garnet-granulite compositions, which provide the toughest discrimination challenge. Our new scheme represents one of the most robust graphical schemes to date for low-Cr crust and mantle garnet classification.

Corresponding author: mhardman@ualberta.ca