Rapid Multielemental Analysis of Garnet with LA-ICP-TOF-MS – Implications for Diamond Exploration Studies

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Garnet arguably constitutes the most important mineral in diamond exploration studies; not only can the presence of mantle garnet in exploration samples point to kimberlite occurrences, but its minor and trace element composition can further be used to assess the "diamond potential" of a kimberlite. The content of Cr and Ca, especially, has been found to be a reliable tool to test whether garnets originate from within the diamond stability field in the mantle [1]. Trace element patterns can further indicate the mantle host rock of the garnets, for example, whether they originate from a depleted or ultra-depleted mantle section [2].

Routinely, two separate analytical methods are necessary to fully characterize the composition of garnet; major and minor elements are usually determined by electron probe micro-analysis (EPMA), whereas determination of trace elements requires the more sensitive method of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

Here, we demonstrate rapid measurement of the entire suite of elements in garnet employing a new, commercially available time-of-flight (TOF) mass spectrometer, the icpTOF (TOFWERK AG, Thun, Switzerland), coupled to a fast wash-out laser ablation system (Teledyne Cetac Technologies Inc., Omaha, NE, USA). Using garnets from exploration samples taken from the Horn Plateau, Northwest Territories, Canada [3], we directly compare the icpTOF results to EPMA and LA-ICP-MS data. We examine whether the icpTOF can reliably characterize the garnets in Cr versus Ca space and at the same time reproduce their trace element patterns, thereby offering a cost effective method of analysis.

The method of LA-ICP-TOF-MS, with its high speed of data acquisition and its ability to record the entire mass spectrum simultaneously, may have great benefits for (diamond) exploration studies. Moreover, the method can be used for fast, high-resolution imaging, which is applicable to a wide range of geological materials and settings [4].

[1] Grütter et al. (2004). Lithos, 77(1), 841-857. [2] Stachel et al. (2005). Elements, 1(2), 73-78. [3] Poitras et al. (2016). 44th Annual Yellowknife Geoscience Forum Abstracts; Northwest Territories Geological Survey, Yellowknife, NT. [4] Gundlach-Graham et al. (2015). Analytical Chemistry, 87(16), 8250-8.