

DIAMOND PROFILING : A NEW APPROACH FOR FORENSIC APPLICATION

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INTRODUCTION

It is commonly viewed that trace element analysis of “gem quality diamonds” is a problem to identify their provenance since most of them have their total level of impurities made of inclusions and substituted ions at concentration less than 1 µg/g (or 1 ppm). As we know from previous studies of natural and synthetic diamonds, its crystal lattice is not especially accommodating to foreign atoms beyond the 1-10 ppm levels other than nitrogen, boron, hydrogen and oxygen. Because of the low level of impurities included in most gem stones it has been a real challenge in the past to generate a large number of analyses with good analytical precision in order to identify the key elements for the fingerprinting application. The main constraints being the instrumental technique and retention of the intrinsic monetary value, by reducing the sampling size and limiting the destructive analysis.

PREVIOUS STUDIES

Previous destructive analytical techniques have demonstrated that using bulk analysis of diamond matrices which contain visible inclusions under a 50X magnification petrographic microscope can provide some successful results in identifying the diamond provenance if the sample size of each deposit is chemically representative. They also demonstrated that some selected key elements, e.g., Na, Mg, Al, Si, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Rb, Sr, Zr, Mo, Ag, Sn, Cs, Ba, rare-earth elements (La-Lu), Hf, Ta, W, Pt, Pb, Th and U were among those considered as good prospects for diamond fingerprinting. As an example some will have a greater predominant discriminatory weight than others for specific diamond deposits (e.g., W, Pb, Mo and Rb between some Russian vs African diamond deposits).

ANALYTICAL TECHNIQUE AND DEVELOPMENT

Knowing the chemical and physical characteristics of diamonds, we will focus our research on trace element signature of rough gem quality diamonds using a laser ablation inductively coupled plasma - mass spectrometer (LA-ICP-MS) in order to: (a) improve the

analytical precision, limit of detection and thereafter the quantitative results; and (b) minimize the lost value of the stone after a completed analysis. The new instruments recently installed at the RCMP consist of an excimer laser (GeoLas system with a ComPex 110 from Microlas/Lambda Physik, Germany) and a double-focusing magnetic/electrostatic sector ICP-MS (Element2 from Thermo Finnigan MAT, Germany). The analytical development will be divided into four main stages. The first stage will be devoted to the instruments optimization, performance and to minimize the interference levels. The second stage will focus on the external calibration technique (solid vs liquid). The third stage will initiate preliminary quantitative analyses of rough gem quality diamonds from three different mines. We will focus on the transitional elements (i.e., Sc to Zn) which have been recognized as a real potential for fingerprinting but were sacrificed in the past because of their mass interferences and background levels from mass spectrometry techniques. The fourth stage will focus on the preliminary statistical analysis of the new data set generated from the geochemical signature of the rough gem diamonds.

DATA BASE APPLIED TO THE DIAMOND ANALYSES

Following the results of the development studies a new data base will be implemented and will include the physical characteristics and the chemical characteristics of the diamonds. The physical characteristics will cover a series of observations oriented toward their morphology, color, visible inclusions, etc. The chemical characteristics will cover the results obtained by LA-ICP-MS and other analytical techniques that may be implemented as necessary (e.g., Fourier transform infrared spectroscopy and Raman spectroscopy).

CONCLUSION AND FUTURE APPLICATIONS

It is our goal within the National Police Service of the Royal Canadian Mounted Police to work conjointly with strategic domestic and international partnerships for developing a new forensic diamond profiling program and the data base to enhance our ability to support law enforcement, our government and their

international counterparts on issues involving illicit diamonds.

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