K, RB, U, SR AND PB IN DIAMONDS CONTAINING INCLUSIONS

H.L. Allsopp and H.J. Welke

Bernard Price Institute of Geophysical Research,
University of the Witwatersrand, Johannesburg.

The determinations of the Pb- and Sr-isotopic compositions of syngenetic inclusions contained in diamonds is potentially useful because:

(i) the masking effect of crustal contamination (which is a serious limitation in the study of kimberlites and nodules) can be overcome by preliminary strong acid treatment of the diamonds.

(ii) diamonds containing significant amounts of Pb (e.g. those with sulphide inclusions) should have Pb-isotopic compositions lying on a primary Pb growth curve. Should this be the case it will be possible to test the accuracy of assumed U/Pb (μ) ratios for the mantle, and to estimate the age of particular diamonds.

(iii) diamonds containing significant amounts of Sr (e.g. those with diopside inclusions) will allow of a better assessment of Sr-isotopic evolution models for the mantle-crust system.

With a view to assessing the feasibility of such measurements three batches of diamonds were obtained. The first (with mainly graphite inclusions) was used to test the method, and no results are reported. The second and third batches, both from the Premier Mine, contained green (mainly diopside) and black (mainly graphite and sulphide) inclusions respectively. The weights of the diamonds were 0.27 and 0.32 gm. respectively, and the stones ranged in size from 1 - 2 mm. The diamonds were placed in a covered quartz crucible and burnt at $\sim$850°C in an oxygen atmosphere. The residues were dissolved in a teflon autoclave, and the resulting solutions aliquoted for the separate analyses. Concentrations of K, Rb, Sr, U and Pb were measured by isotope dilution, and special reagents were prepared to ensure that the blank concentration for these elements (except K) was in the sub-nanogram range. Pb- and Sr-isotopic compositions were measured on tracer-free aliquots.

In the results summarised below the weights are given in nanograms (gm. x 10^{-9}), and the figures in brackets are the blanks expressed as percentages of the total. The Sr^{87}/Sr^{86}, Pb^{206}/Pb^{204} and Pb^{207}/Pb^{204} ratios are initial ratios, i.e. correction has been made for the radiogenic component using an assumed age of 1250 m.y. Correction has also been made for mass-spectrometer fractionation and blanks.

"Green" diamonds

K	Rb	K/Rb	Sr	Sr^{87}/Sr^{86}
599 (6.8%)	2.87 (4.1%)	204	59.9 (0.9%)	0.7029 ± .0007

"Black" diamonds

Pb	U	$\frac{Pb^{206}}{Pb^{204}}$	$\frac{Pb^{207}}{Pb^{204}}$
40.2 (32.0%)	1.53 (25%)	16.32 ± .06	15.58 ± .05

The accuracy of the concentration measurements is limited by the level of the blanks. The effect of the reagent-blank, as distinct from the full experiment blank, was small in all cases except U, for which the inclusion concentration was very low. The Pb experiment blank was particularly large; the source of the contamination is unknown, but is thought to be the quartz crucible.

The accuracy of the isotopic ratio measurements was severely limited by mass-spectrometer sensitivity. In the case of Pb, for which there is a large blank correction, an approximate measurement was made of the isotopic composition of the contaminating Pb.

The Pb isotopic composition indicates a μ value of the source region of about 9.0 and a Pb-model age in reasonable agreement with the age of the Premier pipe. The Sr isotopic composition falls on the same trend as that of fresh kimberlites, and the K/Rb ratio of $\sim$200 is approximately the same as that for peridotite nodule diopsides, but much lower than that of eclogite nodule omphacites.

The main purpose of this work was to establish the levels of concentration of the above elements in diamonds with inclusions, and to make a preliminary estimate of the Sr- and Pb-isotope ratios. It is concluded that with improved apparatus it will be possible to make precise measurements of the parameters discussed.