Gas Phase Chromatography of FrBr and $BiBr_3$.

E. R. Sylwester, D. C. Hoffman, J. Adams, Y. H. Chung, K. E. Gregorich, M. B. Hendricks, M. R. Lane, C. Laue, D. M. Lee, C. A. McGrath, D. A. Shaughnessy, D. A. Strellis, P. A. Wilk.

The Heavy Element Volatility Instrument (HEVI)[1] was used to investigate the volatility of the Fr and Bi bromides. HEVI is an isothermal gas phase chromatography system which separates short lived isotopes based on their volatility. A He/KBr gas jet was used to transport the recoil products- the 4.8-min. ^{221}Fr and its granddaughter the 45-min. ^{213}Bi - from a $^{225}Ra/^{225}Ac$ source.

The recoil products were continuously collected on a quartz wool plug kept at 900° C in a quartz chromatography column. HBr was added at a rate of 100 ml/min in order to form the volatile bromide species of Fr, which were then swept into the isothermal section of the chromatography column. The separated species were reattached to KBr aerosols and transported through a capillary system onto a glass wool filter. After a collection time of 5 minutes, the filter was taken out and counted on a PIPS (Passivated Ion implanted Planar Silicon) detector.

The volatility of each species was established by determining yield as a function of the temperature of the column. Due to the long half-life of the Bi granddaughter, the chemistry and collection time used (5 minutes each) was insufficient to provide an accurate measure of volatility. The alpha peak from the ^{217}At daughter was also seen, however due to the extremely short half-life of this species (32ms) no information about the chemical behavior could be determined; instead, the Astatine appeared wherever the Fr parent was found. FrBr was shown to be volatile at 550° C while preliminary data on $BiBr_3$ show it to be volatile around 250° C.

In past experiments the species studied in HEVI have shown an unusually high (non-zero) yield at the low temperatures of 50-150° C. This yield was observed to drop to 0% at about 150-200° C before rising in the expected volatility curves for each species. The 4.8-min. ^{221}Fr recoil product was used to investigate this effect by varying the amount of HBr and quartz wool used in column and again determining the yield as a function of temperature.

The high low-temperature yield effect was seen to appear at temperatures up to 250° C even with no halogenating agent (HBr) present and no quartz wool in the column. With the addition of quartz wool, the effect was seen to drop but still appeared at temperatures up to 150° C. With the addition of more quartz wool, the effect again dropped in yield but was still present at the temperatures of 50 and 100° C. In none of these experiments did the addition or lack of the halogenating agent make any significant difference in the low-temperature yield.

These results indicate that the low-temperature yield observed is not a result of the chemical volatility of the compound- which would require a halogenating agent. Instead it is a function of mass transport that allows a percentage of the activity to pass through the column unimpeded, in effect acting as a gas jet instead of a chromatography column. This effect is reduced by the presence of the quartz wool at the beginning (900° C) section of HEVI, which breaks up the KBr clusters which are responsible for transport in the gas jet, and reduces the amount of activity entering the isothermal section of the column without the presence of a halogenating agent.

Footnotes and References

1. B. Kadkhodayan et al., *Nucl. Instr. Meth.* A317, 254 (1992).