

ANOMALOUS $^{107}\text{Ag}/^{109}\text{Ag}$ IN THE CAPE YORK METEORITE

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Excesses of $^{107}\text{Ag}^*$ were discovered in several iron meteorites belonging to IVB, IIIB, and anomalous groups [1-4]. These workers concluded that the $^{107}\text{Ag}^*$ was most plausibly explained by the decay of extinct ^{107}Pd from a last nucleosynthetic spike in the early solar system. We measured the isotopic composition of Ag in both the metal and sulfide phases of the Cape York (IIIA) octahedrite to explore the Ag isotopic anomaly in a common group of iron meteorites. A piece of Ni-Fe metal was sawed from a specimen of Cape York ~6 mm away from the contact with a troilite nodule. The surface of the sample was removed in 3 leaching steps and the central piece dissolved and analyzed. The chemical procedure [3,4] removes most interfering elements and gives a relatively low blank ($^{109}\text{Ag} = 1.2 \times 10^{10}$ atoms) with a yield of 55-98%. Aliquots of the solutions were spiked separately to determine Ag and Pd concentrations. An unspiked aliquot (A, Table 1) was taken for Ag composition. The total amount of Ag extracted in this sample was 7.6×10^{12} ^{109}Ag atoms. The $^{107}\text{Ag}/^{109}\text{Ag}$ ratios were measured between 990° - 1030°C with both the electron multiplier (EM) and Faraday cup (FC). Mass spectrometric interferences from AsS^+ , CaPO_2^+ , Pd^+ , and Cd^+ were monitored. Generally, the ion beam intensity (I) of these interfering ions, if they appeared, decreased rapidly with increasing temperature and running time except those from CaPO_2^+ . Typically $^{108}\text{I}/^{109}\text{Ag}$ and $^{103}\text{I}/^{109}\text{Ag}$ are less than 10^{-5} and 10^{-3} respectively, which contribute to less than 1% of either ^{107}Ag or ^{109}Ag signals. The interferences from hydrocarbons are completely resolved and were kept at a low level ($<10^{-4}$) by using a cold finger. The results on 1.3 to 3.4×10^{12} atoms of ^{109}Ag from the first aliquot (A) of metal #1 (Table 1) show good agreement for data obtained by both L-I and L-III mass spectrometers and on either EM or FC. The difference between these two sets of data can be explained by the square root of the mass correction law. The data indicate a 7% increase in the $^{107}\text{Ag}/^{109}\text{Ag}$ ratios compared to that in the normal Ag analysis (last entry, Table 1) which were measured just prior to the sample. A second aliquot (B) was separately processed and measured twice on L-I. The results agree with those from A and confirm the anomaly. In order to establish our ability to measure such small shifts, a known amount of ^{109}Ag was added to a third aliquot (C) and the mixture processed through chemistry and the isotopic composition determined. The results (Table 1) show good agreement between two measurements on both mass spectrometers and detectors, and the measured $^{107}\text{Ag}/^{109}\text{Ag}$ ratios agree with that calculated from gravimetry (for FC) indicating our ability to quantitatively determine a 1% shift in this ratio in a sample. To further confirm this result a second piece was leached and the central piece (#B3, Table 1) analyzed. The Ag content of #B3 is 20% lower than for #1 while the Pd content is the same. Ag from an aliquot A of #B3 measured on LI gave a 9% shift in the $^{107}\text{Ag}/^{109}\text{Ag}$ ratios. For the second aliquot (B), HBr was used instead of HCl in the first anion-exchange step to separate both Ag and Pb. $^{107}\text{Ag}/^{109}\text{Ag}$ ratios obtained from aliquot B agree with those from A. Two additional aliquots (C and D) were then spiked with different amounts of ^{109}Ag to further test our ability to resolve small isotopic shifts. The results (Table 1) clearly demonstrate that isotopic shifts of 1% and 2% are quantitatively measured. A piece of sulfide was sawed out of the nodule and the surface removed in 6 steps with hot 12M HCl, leaving a core of 0.54 g. The sulfide core was dissolved and analyzed. The Ag concentration in the sulfide core is about a factor of 20 higher than in the metal, but the Pd concentration is 10^3 less. The $^{107}\text{Ag}/^{109}\text{Ag}$ value for the core is normal within errors. The Ag concentra-

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tions in the fifth and first leaches are similar and are ~30% less than that in the core. The $^{107}\text{Ag}/^{109}\text{Ag}$ ratios for them are also the same as normal Ag within limits of errors. The $^{107}\text{Ag}/^{109}\text{Ag}$ ratios in the metal phases of Cape York clearly show 7-9‰ increase compared to normal Ag. The excess $^{107}\text{Ag}^*$ for Cape York is 1.1 to 1.3×10^{11} atoms per gram of metal (Table 2) which is similar to that found in group IIIB, IVB, and anomalous iron meteorites. Furthermore, the $^{107}\text{Ag}^*/^{108}\text{Pd}$ ratios, $(2.0-2.5) \times 10^{-5}$ for Cape York are similar to those, $(0.07-2.0) \times 10^{-5}$ found in these other meteorites. The correlation of "high" $^{107}\text{Ag}/^{109}\text{Ag}$ ratios with Pd/Ag in the metal phase of Cape York supports the explanation that $^{107}\text{Ag}^*$ was derived from in situ decay of ^{107}Pd . In addition, Ag in the sulfide indicates the presence of normal Ag in a phase with low Pd/Ag. It appears that ^{107}Pd was present in a wide variety of iron meteorites and is not restricted to rare classes. The diffusion of $^{107}\text{Ag}^*$ was sufficiently slow during the cooling history that Ag was not isotopically homogenized between the metal and sulphide phases and a partially quenched $^{107}\text{Pd}-^{107}\text{Ag}$ isochron has been preserved.

Ref. [1] Kelly W.R. and Wasserburg G.J. (1978) GRL 5, 1079; [2] Kelly W.R., Tera F., and Wasserburg G.J. (1978) Anal. Chem. 50, 1279; [3] Kaiser T., Kelly W.R., and Wasserburg G.J. (1980) GRL 7, 271; [4] Kaiser T. and Wasserburg G.J. (1982) in preparation. Div. Contribution No. 3736 (406).

Table 1. Ag Isotopic Composition

Sample	Amount Analyzed $^{109}\text{Ag}(10^{12}\text{atoms})$	Mass Spect.	$^{107}\text{Ag}/^{109}\text{Ag}^a$	
			EM	FC
Metal #1				
Aliquot A	1.9	LIII	1.096±0.005	1.088±0.003
	1.3	LIII	1.099±0.003	1.089±0.002
	3.4	LI	1.096±0.002	1.087±0.002
Aliquot B	2.6	LI	1.097±0.003	-
	2.8	LI	1.097±0.004	1.089±0.005
Aliquot C + $^{109}\text{Ag}^b$	8.8	LIII	(1.085±0.003)	(1.076±0.001)
	10	LI	(1.086±0.001)	(1.077±0.002)
Metal #B3				
Aliquot A	14	LI	1.100±0.002	1.091±0.002
Aliquot B	11	LIII	1.098±0.003	1.091±0.002
Aliquot C + $^{109}\text{Ag}^c$	10	LI	(1.076±0.002)	(1.070±0.002)
	11	LIII	(1.077±0.002)	(1.069±0.002)
Aliquot D + $^{109}\text{Ag}^d$	9	LI	(1.088±0.002)	(1.079±0.002)
	8	LIII	(1.088±0.002)	(1.079±0.003)
Sulfide core	24	LI	1.092±0.003	1.084±0.002
	20	LIII	1.090±0.002	1.083±0.002
Leach-5	15	LIII	1.092±0.002	1.084±0.003
Leach-1	22	LI	1.090±0.002	1.081±0.002
NBS978 Normal ^e	5.5-22	LI & LIII	1.090±0.002	1.081±0.002

^aAll errors are 2σ. ^bThe $(^{107}\text{Ag}/^{109}\text{Ag})_G$ ratio calculated from gravimetry (G) is 1.077 for Faraday cup data. ^c $(^{107}\text{Ag}/^{109}\text{Ag})_G = 1.070$ for F.C. ^d $(^{107}\text{Ag}/^{109}\text{Ag})_G = 1.080$ for F.C. ^eAverage of 10 measurements.

Table 2. Pd and Ag Abundance and Pd/Ag Ratios

Sample	Abundances, Atoms/g Metal			$\frac{^{107}\text{Ag}}{^{109}\text{Ag}}$	$\frac{^{108}\text{Pd}}{^{109}\text{Ag}}$	$\frac{^{107}\text{Ag}^*}{^{108}\text{Pd}} \times 10^{-5}$
	$^{108}\text{Pd} \times 10^{15}$	$^{109}\text{Ag} \times 10^{13}$	$^{107}\text{Ag}^* \times 10^{11}$			
Metal #1	5.32	1.548±0.008	1.08±0.44	1.088±0.002	344	2.0±0.8
Metal #B3	5.23	1.287±0.008	1.29±0.36	1.091±0.002	406	2.5±0.7
FeS core	0.0037	25.1±0.1	-	1.084±0.002	15	-