UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

$^{40}Ar/^{39}Ar$ age-spectrum data for hornblende, plagioclase and biotite from tephras collected at Dan Creek and McCallum Creek, Alaska and in the Klondike Placer district near Dawson, Yukon Territory, Canada

by

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TABLE OF CONTENTS

INTRODUCTION 3

DIGITAL FILES 4

METHODS 5

Sample Preparation 5

Sample Analysis 5

Isotopic Data Reduction 6

SAMPLE DESCRIPTION 8

RESULTS 11

Condensed Tabular Argon Data 14

$^{40}Ar/^{39}Ar$ Data 15

REFERENCES 52

INTRODUCTION

As part of a study of climate change, several tephras from the unglaciated McCallum Creek area in interior Alaska and the Quartz Creek area in the Klondike Placer District near Dawson in the Yukon Territory of Canada were collected and analyzed using $^{40}Ar/^{39}Ar$ age spectrum and total fusion dating techniques. The tephras sampled are all from sedimentary strata that contain fossils useful in constraining the regional climate at the time of their deposition. This publication contains reduced $^{40}Ar/^{39}Ar$ data of hornblende and plagioclase mineral concentrates separated from the tephras and is intended only to be a preliminary publication of these results, in more detail than can be accommodated in today's professional journals. Also included in this report is information on the location of the samples, and a brief description of both the outcrops from which the samples were collected and the individual samples. The data contained herein are not interpreted in a geological context and care should be taken by those unfamiliar with argon isotopic data in the use of these results. No geological meaning is implied for any of the apparent ages presented below and many of the individual apparent ages are not geologically meaningful. This report is primarily a detailed source document for subsequent publications that will integrate this data into a geological context.

DIGITAL FILES

The text data and figures presented in this report are available both as a hard copy Open-File Report and in a digital form. The digital version of this report is available on 3½ high density floppy disk. The format of the digital version differs only slightly from the hardcopy version. All of the text, the tables and figure captions are in a single Wordperfect 5.2 file labeled MCCALLUM.OFR. MCCALLUM.OFR is in the root directory of the disk. The figures can be found under the subdirectory FIGURES. The figures are in the Hp-GL/2 graphics language. They can be reproduced by putting an HP Series III or other compatible printer in graphics mode and then reading out and printing the values in the file. Conversely these files can be opened using commercial software such as HIJACK PRO and then converted into another graphics language. An index of the figures follows.

Figure #	On page #	File #
1	17	21RD88A.HPL
2	18	21RD88C.HPL
3	21	1RD88A.HPL
4	22	1RD88C.HPL
5	27	36RD88A.HPL
6	28	36RD88C.HPL
7	32	17RD88A.HPL
8	33	17RD88C.HPL
9	36	12RD88A.HPL
10	37	12RD88C.HPL
11	42	25RD88A.HPL
12	43	25RD88C.HPL
13	50	7RD88A.HPL
14	51	7RD88C.HPL

METHODS

Sample Preparation

All samples were crushed, ground, and sized using 250, 180, 150, 125, and 106 μm sieves. Phenocrysts of various sorts were effectively removed from the samples by working with the 125 to 106 μm and 150 to 125 μm size fractions. Tephras were stripped of hornblende using a Frantz magnetic separator. The hornblende was then concentrated to greater than 99.9% purity using standard mineral separation techniques including, heavy liquids, additional magnetic separation and, heavy duty ultrasonic cleaning. Plagioclase was concentrated using similar techniques, in addition to leaching for brief periods of time in cold 7% hydrofluoric acid to remove glass that could not be removed by other techniques, to a purity of greater than 99%, the chief impurity being quartz. Finally all of the samples were washed in acetone, alcohol, and deionized water three times.

Approximately 1000 mg of hornblende, and 100-1000 mg of plagioclase were packaged in aluminum capsules and sealed under vacuum in quartz tubes. The samples were then irradiated in the central thimble facility at the TRIGA reactor (GSTR) at the U.S. Geological Survey, Denver, Colorado. The monitor mineral was FCT-3 sanidine (Kunk et al., 1985; and Cebula et al.,1986) which has an age of 27.79 Ma compared against Mmhb-1 at 519.4 Ma(Alexander et al.,1978; and Dalrymple et al., 1981). The type of container, and the geometry of samples and standards is similar to that described by Snee et al. (1988).

Sample Analysis

All samples were analyzed on a VG Isotopes, Ltd, Model 1200 B Mass Spectrometer fitted with an electron multiplier at the U.S. Geological Survey in Reston, VA using the step heating or total fusion methods. Heating for 10 minutes per step followed a schedule of 5-9 steps per sample. The number and temperature of heating steps was selected to limit the percentage of gas released to less than 20% per step for most samples. Several of the plagioclase samples were to small for step heating and were totally fused in a single heating.

Heating of all samples was done in a small volume molybdenum-lined "low blank" tantalum furnace. Temperature was monitored by a W_5Re-$W_{26}Re$ thermocouple and controlled by a proportional, programmable controller. The furnace and the rear manifold were pumped between steps with a turbo molecular pump. Two isolated ion pumps evacuated the front manifold and the mass spectrometer tube between each incremental step. During normal operation, the gas to be analyzed was purified in the rear manifold by a Saes ST707 Fe-V getter operated at room temperature. Gas was equilibrated with the front manifold with an empty cold finger (in the rear manifold)

chilled with liquid N_2 to remove condensables (chiefly water), and cleaned in the front manifold by a Saes ST101 Al-Zr getter operated at 400°C and a Ti (H_2) getter operated at a constant 350°C. An activated charcoal finger submerged in a constant boiling mixture of dry ice and acetone was used to remove gases with a molecular weight greater than 60 or 80 (primarily other noble gases) prior to the admission of the argon-dominated gas to the mass spectrometer by expansion. The argon-rich gas was further purified in the mass spectrometer by a second Saes ST101 active gas getter operated at room temperature. Its successful operation could be monitored by the drop in counts of mass 44 (dominated by CO_2) after the first gas analysis cycle. Argon isotopes with masses 40 through 36 and CO_2, mass 44 were analyzed as a function of time in five analysis cycles. ^{40}Ar, ^{39}Ar, and ^{36}Ar peaks and their baselines were measured as a series of four five-second integrations in each of the five cycles, that were then averaged. ^{38}Ar and ^{37}Ar peaks, and their baselines, were measured for only one five-second integration per cycle. After the analysis the mass spectrometer was evacuated. All phases of the sample heating, cleanup, equilibration and sample analysis were preformed under computer control.

Isotopic Data Reduction

All the Ar isotopic data were reduced using an updated version of the computer program ArAr* (Haugerud and Kunk, 1988) and decay constants recommended by Steiger and Jäger (1977). The isotopic measurements made in the five-cycle analysis had baseline values subtracted and then were regressed to time-zero using standard linear regression techniques. These regressed values and associated statistical estimates of analytical uncertainties of the time-zero peak values were used in the data reduction. System blanks were subtracted for ^{40}Ar and ^{36}Ar (but not for the other Ar isotopes). System blanks were measured for the temperature range over which the samples degassed immediately prior to the time of the sample analysis. Because there was no significant increase in blank with increasing temperature of extraction the results were averaged. The mean of these results was subtracted from each analysis. Errors associated with the blanks (one standard deviation of the mean) were propagated.

Corrections for interfering reactor-produced argon isotopes from Ca, K, and Cl in the sample were made using the production ratios given in Dalrymple et al. (1981). Errors included in calculating ages or ratios include analytical errors in the analysis, decay factor uncertainties, measured atmospheric or calculated initial $^{40}Ar/^{36}Ar$ ratios, the irradiation parameter J, the production ratios of the various reactor-induced argon producing reactions, the initial $^{38}Ar/^{36}Ar$ ratio, and the age of the monitor (Haugerud and Kunk, 1988).

The tables and figures below include the identification of plateau ages, isochron ages, minimum ages, fusion ages and total gas ages. Plateau ages are identified where the ages of two or more contiguous steps overlap within experimental error, and whose

cumulative $^{39}Ar_K$ comprises greater than 50% of the total potassium derived ^{39}Ar (Fleck et al., 1977; Haugerud and Kunk, 1988; Snee et al., 1988). For all samples analyzed by the $^{40}Ar/^{39}Ar$ age spectrum dating technique, all steps were examined for colinearity on isotope correlation diagrams to assess if non-atmospheric argon components were trapped in any samples and to calculate an isochron age. In several instances, points that were deemed to be not collinear were deleted from the isotope correlation diagram. Minimum ages are of a single step (except the first step in the age spectrum) and represent the lowest age measured in a U- or L-shaped spectrum. No analytical precision is stated for minimum ages in Table 1. Fusion ages represent the results of a single analysis in which all of the argon was released by melting in a single step. Total gas ages represent the age calculated from the addition of all of the measured argon peaks for all steps in a single sample. The total gas and fusion ages are roughly equivalent to conventional K/Ar ages. No analytical precision is calculated for total gas ages.

SAMPLE DESCRIPTIONS

The locations and descriptions of samples analyzed in this project are given below. This information is organized by sites and one or more sample descriptions can be found after information on the location, map unit, and a brief site description. Stratigraphic relationships between sites are not known, except as noted. Observations on tephra mineralogy were made from loose grains, using both petrographic and binocular microscopes.

Site: McCallum Creek

Location: 63°13.5"N, 145°38"W

Map Unit: Mt Hayes (A-4) Quadrangle, T19S,R11E section 33

Outcrop description: This outcrop is in lake and stream sediments of the Gakona Formation (?) on the north side of McCallum creek. The outcrop contains one apparent tephra which is as much as 1 m thick. Intercalated with the sediments are lenses of organics. The tephra is not continuous and pinches out within the outcrop. The tephra is in contact with lignite both on its upper and lower surfaces. Sediments in the outcrop contain abundant detrital mafic minerals.

K-91-6-16A Tephra.

Description: The tephra is light tan to white in color and contains two zones of iron staining within it. The sample appears to contain no mafic minerals in hand specimen.

The sample collected for dating was from lower 15 cm of thickest portion of unit and consisted mostly of glass. Minerals separated for dating include hornblende and plagioclase.

Site: Dan Creek

Location: 63°13.5'N, 145°33.5'W

Map unit: Mt Hayes (A-4) Quadrangle, T19S,R11E, section 36

Outcrop description: This site is located near the headwaters of Dan Creek on a steep valley wall on the west side of the drainage, about 1.5 km north of its confluence with Phelam Creek. The outcrop is in sediments of the Gakona Formation (?) which again consists of lake and stream sediments with intercalated organic deposits. The sediments contain abundant detrital

mafic minerals. The outcrop contains two apparent tephras that are continuous within the exposure. Each of the two tephras appears to have been only slightly reworked.

K-91-6-17A Lower of two tephras present at this outcrop.
Description: Light tan to white tephra, 10-50 cm thick. This tephra is bounded on its upper and lower surfaces by thin peat layers and consists mostly of glass shards. In hand sample the tephra appears to contain large quantities of nearly black biotite and some hornblende. Minerals separated for dating include hornblende and plagioclase. In addition the sample contained copious quantities of very dark green chlorite as well as traces of apatite and zircon.

K-90-6-17B Upper of the two tephras present at this outcrop.
Description: Light tan to white tephra, 10 cm to 1 m thick. This tephra consists mostly of glass shards and has a much lower crystalline content than the lower unit at this outcrop. Sparse mafic grains were noted in hand sample. Minerals separated for dating include hornblende and plagioclase.

Site: McCallum Creek Tributary

Location: 63°13.9'N, 145°36.98'E

Map unit: Mt Hayes (A-4) Quadrangle, T19S,R11E, section 34

Outcrop description: This outcrop is located on the south side of an unnamed tributary to McCallum Creek about 0.25 km upstream from its confluence with McCallum Creek. The outcrop is quite steep and is in stream and lake sediments of the Gakona Formation(?). The outcrop contains two apparent tephra separated by sediments. The lower tephra is underlain by a layer of peat.

K-91-6-18A Lower of two tephras present at this outcrop.
Description: Light tan color, glassy tephra with what appears to be visible hornblende in hand specimen. Tephra is ~0.5 m thick, and is continuous in the outcrop. This tephra does not appear to be significantly reworked.

The tephra consists mostly of glass shards with a small admixture of silt-sized sedimentary grains that may have been added during sample collection. Minerals separated from this sample include hornblende and plagioclase. The sample also contained copious quantities of dark green chlorite and traces of apatite and zircon.

K-91-6-18B Lower of two tephras present at this outcrop.
Description: Light tan color, glassy tephra with what appears to be an admixture of clay. No mafics visible in hand specimen. This tephra is 10-15 cm thick and continuous in the outcrop. The sample was collected at the intersection of the stream cut and the ground surface. It appears to have been slightly reworked by repeated freezing and thawing.

The tephra consists mostly of glass shards with an admixture of clay and silt sized sediments. Minerals separated for dating include hornblende and plagioclase.

Site: Quartz Creek

Location: On Quartz Creek near Dawson, Yukon Territory, Canada
Map unit:

Outcrop description: This outcrop is located in white gravels in a mining pit from above the white channel gravels at the Ballitor mine in the Quartz Creek drainage.

K-91-6-29C Tephra.
1-2 cm thick white tephra with no apparent mafic minerals. Hornblende separated for dating.

RESULTS

$^{40}Ar/^{39}Ar$ Data

The $^{40}Ar/^{39}Ar$ data presented in this report are presented in two different formats. Data within both formats are arranged in the same order as the section on sample descriptions.

The first of these formats is a condensed tabular form (Table 1). The data presented in this table are organized by site. These tables summarize the data contained in the succeeding, more detailed individual data sets. Included in this table are: the sample numbers; the material analyzed; the apparent age and its error (see below for a detailed explanation); the percent ^{39}Ar of the total that this apparent age represents; the number of steps / total number of steps that this apparent age represents; the MSWD for isochron ages; the initial $^{40}Ar/^{36}Ar$ used in calculating the apparent age and its errror (or atmos if 295.5 was used and; a comment listing the type of apparent age.

The second format contains the individual data sets for each sample analyzed (Table 2A-D, Table 3A-D, etc.). The individual data sets include a series of four tables, as well as three graphical representations of some of the age spectrum data. Total fusion analyses have no figures.

The first table in each data set, RAW DATA, includes the computer file number of the individual argon analyses, the temperature of the step, regressed peak values and their precision, the trap current (filament amperage, in microamps) and the manifold splitting option used. The values listed for the indicated peaks and their errors include a correction for ^{40}Ar and ^{36}Ar blanks and their errors. The size of the blank subtracted as well as its uncertainty are listed in the footnotes of this table. Aside from this no corrections have been made to the peak values, which otherwise are raw numbers. Both the trap current and manifold splitting options are related to the effective sensitivity of the mass spectrometer. The peak values listed are multiplied by the appropriate trap current and manifold factors given in the footnote of this table as part of the data reduction. The sensitivity, reproducibility limit, and detection limit of the mass spectrometer are listed in the final line of the footnote.

The second table in each data set, CORRECTIONS, contains, for each temperature step calculated corrections for decay of radioactive isotopes of argon, as well as the production of interfering isotopes during irradiation, and a calculated initial ^{38}Ar value. All of these values have been corrected only for the affects of mass discrimination as discerned by measuring atmospheric argon. The measured atmospheric argon value used to calculate this discrimination factor is 286.8 ± 0.6% for all samples in this report. All tabular data in this table, as well as the two subsequent tables, is indexed on the left by the temperature of the step analyzed.

The third table in each data set, MOLAR VALUES, lists for each temperature step, molar quantities of radiogenic ^{40}Ar, potassium derived ^{39}Ar, chlorine derived ^{38}Ar, calcium derived ^{37}Ar, and initial ^{36}Ar. The apparent age and an estimate of it's precision (see below for an explanation of the precision estimate) are given in the right hand columns.

The final table in each data set includes for each temperature step the percent ^{39}Ar of the age spectrum total that each step contains, the radiogenic yield (percentage of ^{40}Ar that is derived from the decay of potassium), the calculated molar amount of potassium-derived ^{39}Ar contained in each step, the calculated apparent K/Ca and K/Cl ratios for each step, a calculated age for the step, in millions of years, and an estimate of the precision of each age. The intra-sample precision includes estimates of the errors that are unique to a single sample and can be used only for comparisons with other steps of the same sample. This error estimate does not include the error in "J". The J-value and its precision estimate, and the sample weight are listed near the top of this table. The last line of numerical values in this table is labeled total gas. These values are a summation of the indicated values for all steps in the sample. If an age plateau, as defined above, was found, it is listed at the bottom of this table along with an estimate of its inter-package precision, the percent ^{39}Ar contained in the plateau and the temperatures of the first and last steps on the plateau. All precision estimates, in all tables, are at the one sigma level of confidence. The inter-package precision estimate of a plateau age includes the uncertainty in "J". If the intra-sample error of an individual step is less than the reproducibility limit indicated in the footnote of Table 1, the reproducibility limit was used for comparing steps and testing for the presence of an age plateau. Likewise, the plateau age error listed is no smaller than the reproducibility limit of the mass spectrometer.

The first figure with each age spectrum data set includes two graphs. The lower and larger graph plots cumulative percent ^{39}Ar of the steps in the age spectrum against apparent age in millions of years. The precision estimate used to construct the error boxes of each step is two sigma. The upper, smaller graph plots the apparent K/Ca ratio of each step against cumulative ^{39}Ar released. The degree of sample purity or the presence of compositional zoning can be inferred from this figure. Homogeneous samples with no compositional zoning or impurities are reflected by horizontal patterns in this figure, whereas the patterns of those with zoning or impurities typically depart from horizontal.

The third figure included is an inverse isotope correlation diagram. In this figure the corrected $^{39}Ar/^{40}Ar$ ratio of each temperature step of an age spectrum is plotted against its corrected $^{36}Ar/^{40}Ar$ ratio. Since the intercept of the line generated by these points with the X-axis of the graph is the inverse of the $^{40}Ar/^{39}Ar$ ratio of those points included on the line, an age can be directly calculated from this value. The Y-axis intercept is the

inverse of the initial $^{40}Ar/^{36}Ar$ ratio of the sample. This value can be used to indicate the presence of excess argon. Values for these intercepts and their inverse ratios as well as their errors can be found either above or below this figure. Also included are an age calculated from the inverse of the X-axis, an MSWD for the points included in the calculations, a list of points that were not used in the regression and the percent ^{39}Ar included in the line.

For additional information on the sample data sets see Haugerud and Kunk(1988).

TABLE 1. Summary of argon isotopic results from the McCallum Creek, Dan Creek, McCallum Creek tributary, and Quartz Creek sites. The sample column includes the sample field number and the material being dated. See text for additional details.

Sample	Age, ±(Ma)	$\%^{39}Ar$	No. Steps total	MSWD	$^{40}Ar/^{36}Ar$, ±	Comment
SITE: McCallum Creek						
K-91-6-16A Hornblende	5.23,0.05	83.6	4/5		atmos	Plateau age
	5.10,0.15	100	5/5	0.119	303,3	Isochron age
	5.37	100	5/5		atmos	Total gas age
SITE: Dan Creek						
K-91-6-17A Hornblende	4.96,0.03	63.2	2/7		atmos	Plateau age
	4.98,0.09	100	7/7	1.655	307,1	Isochron age
	5.34	100	7/7		atmos	Total gas age
K-91-6-17A Plagioclase	5.04, 0.31	40.2	3/9		315,15	Isochron age
	5.22	10.8	1/9		atmos	Minimum age
	5.94	100	9/9		atmos	Total gas age
K-91-6-17B Hornblende	4.78,0.08	100	7/7		308,2	Isochron age
	4.90	44.5	1/7		atmos	Minimum age
	5.26	100	7/7		atmos	Total gas age
SITE: McCallum Creek tributary						
K-91-6-18A Hornblende	5.22,0.03	59.4	2/7		atmos	Plateau age
	5.01,0.14	100	7/7	1.0	312,6	Isochron age
	5.61	100	7/7		atmos	Total gas age
K-91-6-18A Plagioclase	5.96	100	1/1		atmos	Fusion age
K-91-6-18B Hornblende	7.05,0.11	68.5	4/6		atmos	Plateau age
	6.12	10.4	1/6		atmos	Minimum age
	7.45,0.37	100	6/6		288,3	Isochron age
	7.25	100	6/6		atmos	Total gas age
K-91-6-18B Plagioclase	5.84	100	1/1		atmos	Fusion Age
SITE: Quartz Creek						
K-91-6-29C Hornblende	2.64,0.24	100	9/9		305,2	Isochron age
	2.71	57.3	1/9		atmos	Minimum age
	3.01	100	9/9		atmos	Total gas age

Table 2A. K-91-16A HORNBLENDE #21-23 RD88, 06:45:48 23 Sep 94 v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35155	850	604425	31921	1054	266	1802	200	EALL
	±	1855	17	15	4	12		
35156	1115	299223	24636	1153	5396	887	200	EALL
	±	1768	16	11	39	9		
35157	1130	235470	54454	2657	17161	599	200	EALL
	±	1766	61	17	39	12		
35158	1145	103444	29502	1448	9232	235	200	EALL
	±	1760	36	17	33	9		
35159	1225	186968	55893	2643	16744	408	200	EALL
	±	1770	57	7	33	10		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 14485 ± 1758 ^{36}Ar blank = 59 ± 9
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 2B. K-91-16A HORNBLENDE #21-23 RD88, 06:45:48 23 Sep 94 v 09/06/94

CORRECTIONS										
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
850	46	13079	180	425	0	9	0	3	0	326
1115	36	265873	138	326	0	179	8	70	0	148
1130	79	845989	304	718	0	568	27	223	1	67
1145	43	455339	165	389	0	306	14	120	0	20
1225	81	826237	312	737	0	555	26	218	1	33

All values are in counts and have been corrected for mass discrimination.

Table 2C. K-91-16A HORNBLENDE #21-23 RD88, 06:45:48 23 Sep 94 v 09/06/94

	MOLAR VALUES						
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions (Ma)	
850	4.18887	0.21992	0.006509	0.090468	0.012099	5.931	0.261
1115	2.073376	0.168541	0.006587	1.839018	0.00548	5.724	0.276
1130	1.630263	0.371328	0.013453	5.851573	0.00248	5.138	0.149
1145	0.71597	0.201189	0.007233	3.149477	0.000746	5.236	0.229
1225	1.29397	0.381331	0.012991	5.714840	0.001231	5.185	0.126

All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

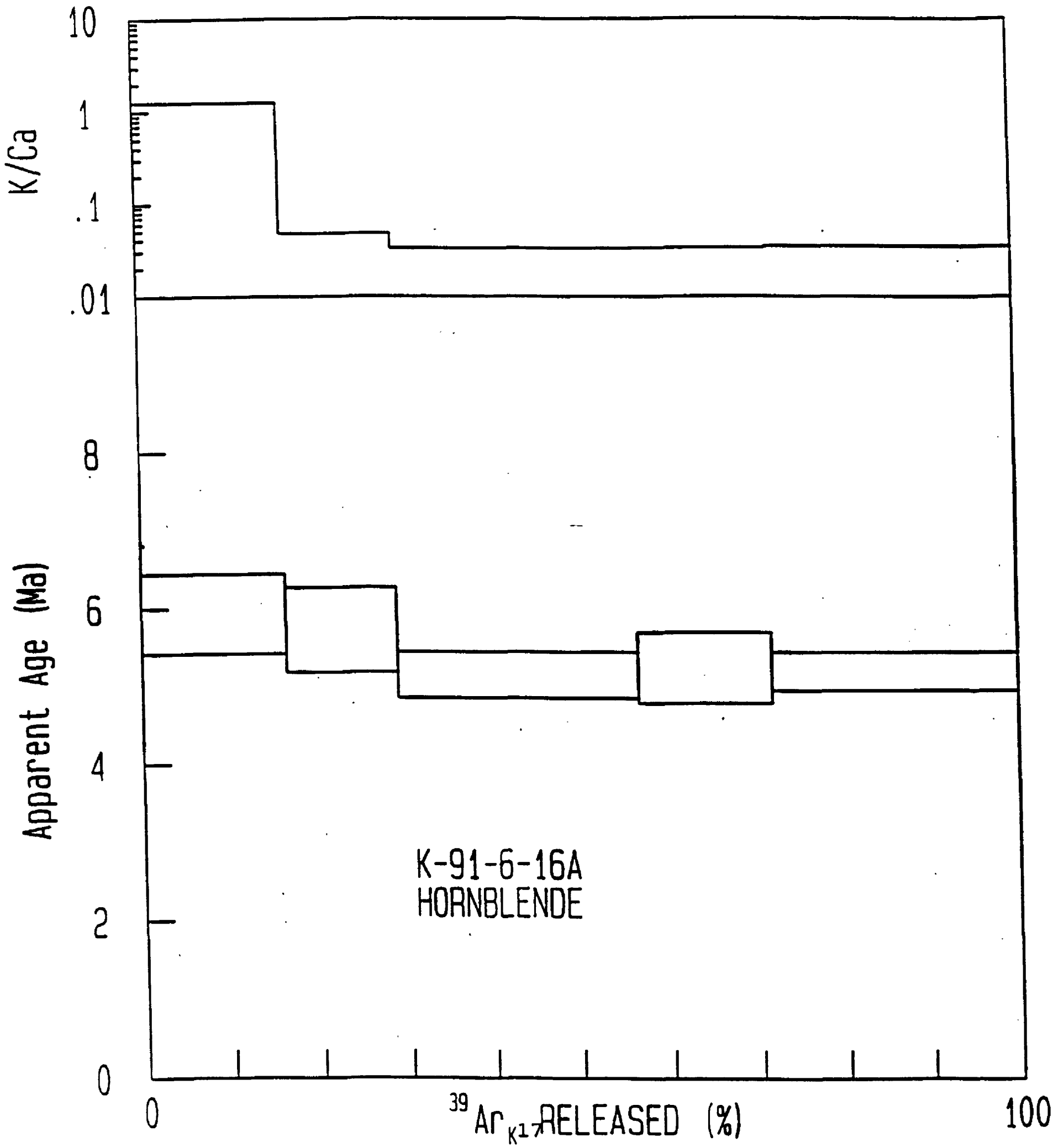
Table 2D. K-91-16A HORNBLENDE #21-23 RD88, 06:45:48 23 Sep 94 v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ (x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .00118 ± .5			HORNBLENDE			Sample wt. = .6048 g		
850	16.4	14.7	0.21992	2.791	1.26	82	5.931	0.261
1115	12.6	21.9	0.168541	2.693	0.05	62	5.724	0.276
1130	27.7	55.1	0.371328	2.417	0.03	67	5.138	0.149
1145	15	69.2	0.201189	2.463	0.03	67	5.236	0.229
1225	28.4	71.9	0.381331	2.439	0.03	71	5.185	0.126
Total Gas	100	51.2	1.342	2.526	0.24	70	5.369	

83.62% of gas on plateau in 1115°C through 1225°C steps Plateau Age = 5.23 ± .05

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 1. Age spectrum diagram for K-91-6-16A Hornblende # 21-23 RD88. Digital file 21RD88A.HPL.



v 09/06/94 (40/36in = 295.5)

Fig. 2. Inverse isotope correlation diagram for K-91-6-16A Hornblende # 21-23 RD88. Regressing all points, MSWD = 0.119, SUMS = 0.356, initial $^{40}Ar/^{36}Ar$ = 302.9 ± 2.7 and age = 5.10 ± 0.15 Ma. Digital file 21RD88C.HPL.

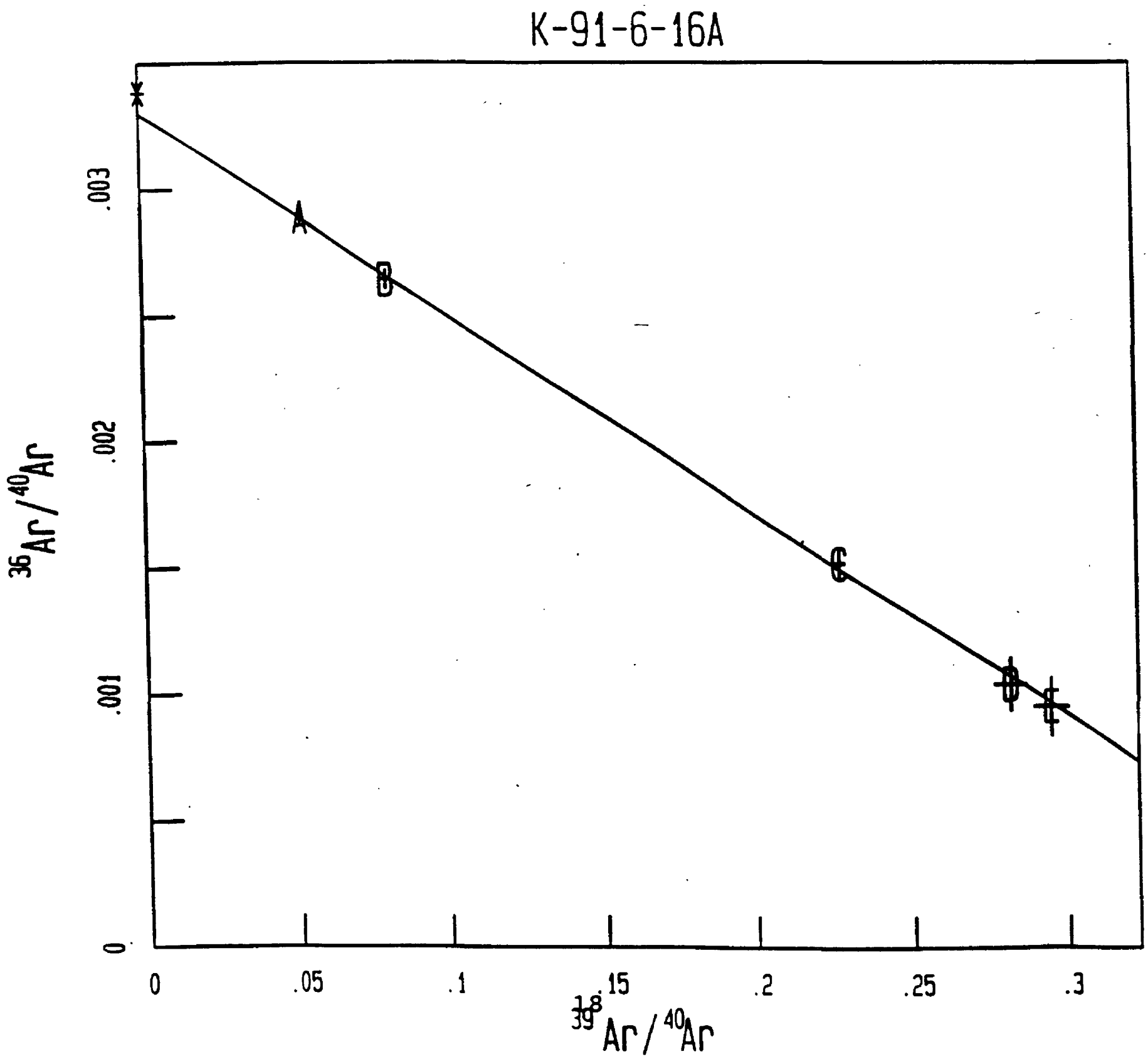


Table 3A. K-91-6-17A HORNBLENDE #1-4 RD88, 03:18:13 23 Sep 94 v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35072	750	573807	53446	1265	515	1496	200	EALL
	±	919	62	15	14	6		
35073	900	867444	33386	1168	358	2653	200	EALL
	±	927	22	6	6	5		
35074	1000	231992	3968	235	285	754	200	EALL
	±	960	7	6	10	6		
35075	1075	192134	6185	324	1291	627	200	EALL
	±	887	24	4	8	4		
35076	1100	222969	30983	1724	11111	639	200	EALL
	±	863	26	15	11	6		
35077	1125	333246	75691	3742	28044	901	200	EALL
	±	907	53	22	14	11		
35078	1225	524785	146005	5799	49305	1254	200	EALL
	±	874	54	12	44	6		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 12592 ± 858 ^{36}Ar blank = 50 ± 3
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 3B. K-91-6-17A HORNBLENDE #1-4 RD88, 03:18:13 23 Sep 94 v 09/06/94

CORRECTIONS										
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
750	77	23904	302	712	0	16	1	6	0	270
900	48	16620	188	445	0	11	1	4	0	481
1000	6	13226	22	53	0	9	0	3	0	136
1075	9	59973	35	82	0	40	2	16	0	111
1100	44	516484	173	408	0	347	16	136	1	90
1125	108	1304172	422	996	0	877	41	344	1	99
1225	209	2294008	816	1924	0	1542	73	605	1	114

All values are in counts and have been corrected for mass discrimination.

Table 3C. K-91-6-17A HORNBLENDE #1-4 RD88, 03:18:13 23 Sep 94 v 09/06/94

MOLAR VALUES							
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions (Ma)	
750	3.975768	0.368194	0.005573	0.165548	0.010019	5.716	0.076
900	6.01216	0.22999	0.008227	0.115102	0.017819	6.728	0.104
1000	1.608109	0.027284	0.002184	0.091597	0.005051	8.765	1.034
1075	1.331711	0.042342	0.002397	0.415325	0.004106	5.797	0.463
1100	1.544513	0.211107	0.009459	3.576742	0.00335	5.446	0.123
1125	2.307263	0.515524	0.019053	9.031521	0.003671	4.917	0.092
1225	3.632367	0.995466	0.02656	15.88608	0.004232	4.961	0.028

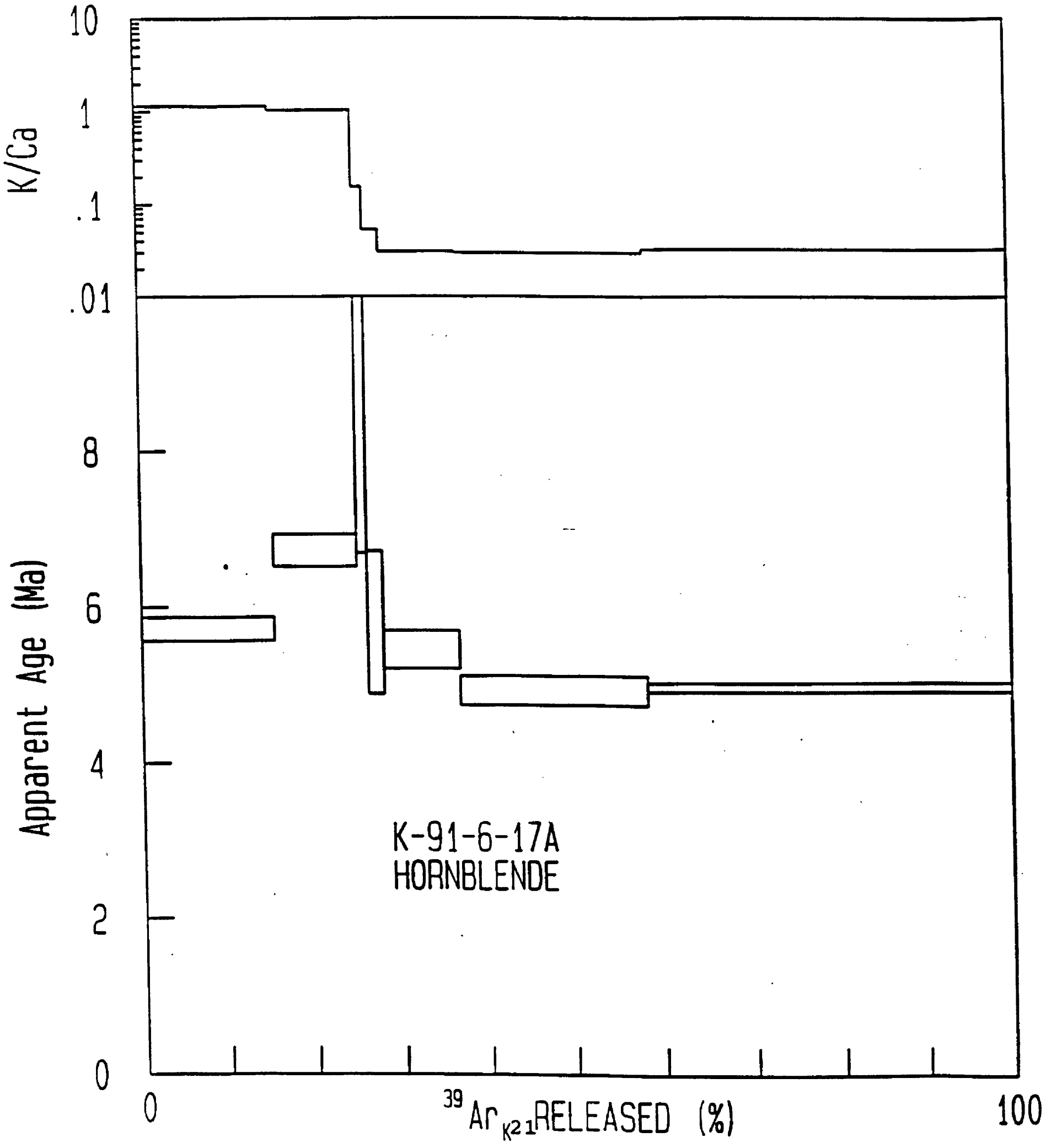
All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Table 3D. K-91-6-17A HORNBLENDE #1-4 RD88, 03:18:13 23 Sep 94 v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ (x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .001151 ± .5			HORNBLENDE			Sample wt. = 1.0024 g		
750	15.4	25.5	0.368194	2.757	1.16	160	5.716	0.076
900	9.6	12.4	0.22999	3.246	1.04	68	6.728	0.104
1000	1.1	7.2	0.027284	4.231	0.15	30	8.765	1.034
1075	1.8	8.9	0.042342	2.797	0.05	43	5.797	0.463
1100	8.8	35.9	0.211107	2.627	0.03	54	5.446	0.123
1125	21.6	53	0.515524	2.371	0.03	65	4.917	0.092
1225	41.7	65.6	0.995466	2.393	0.03	91	4.961	0.028
Total Gas	100	47.3	2.390	2.575	0.30	89	5.339	
63.22% of gas on plateau in 1125°C through 1225°C steps				Plateau Age = 4.96 ± .03				

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 3. Age spectrum diagram for K-91-6-17A Hornblende # 1-4 RD88. Digital file 1RD88A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 4. Inverse isotope correlation diagram for K-91-6-17A Hornblende # 1-4 RD88. Regressing all points, MSWD = 1.655, SUMS = 8.276, initial $^{40}Ar/^{36}Ar$ = 306.8 ± 1.4 and age = 4.98 ± 0.09 Ma. Digital file 1RD88C.HPL

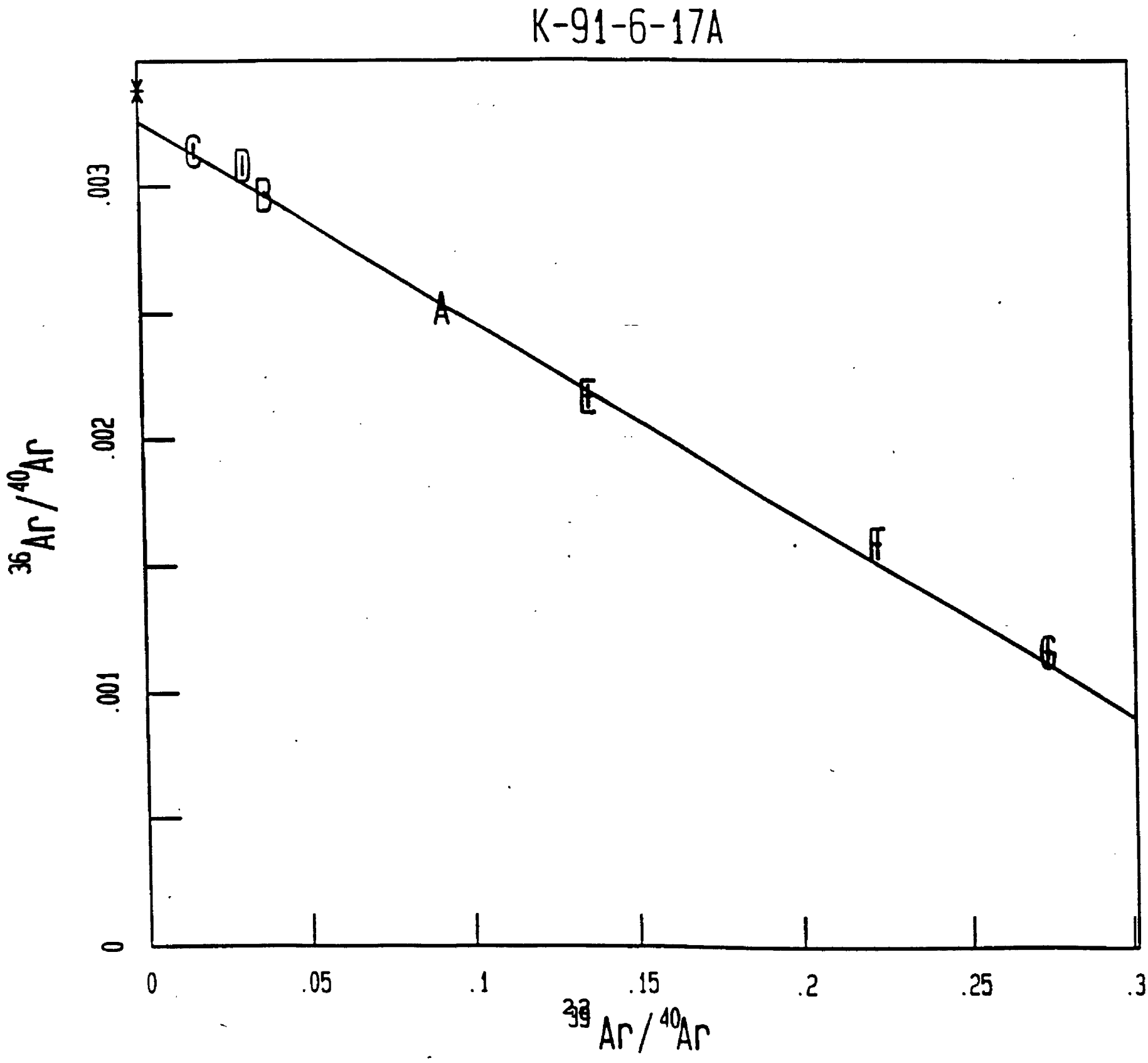


Table 4A. K-91-6-17A PLAGIOCLASE #36-38 RD88, 06:01:18 22 Sep 1994, v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35529	850	552566	15402	669	706	1761	200	EALL
	±	1212	35	9	4	10		
35530	950	180357	26092	458	4781	482	200	EALL
	±	760	40	7	17	8		
35531	1000	71426	16971	127	3712	178	200	EALL
	±	754	26	7	17	4		
35532	1050	82382	20244	166	4418	198	200	EALL
	±	752	17	6	32	2		
35533	1090	89470	19545	164	4196	187	200	EALL
	±	770	32	7	11	4		
35534	1140	50788	15438	118	3238	99	200	EALL
	±	752	34	3	28	4		
35535	1210	35351	11084	75	2296	72	200	EALL
	±	753	13	7	21	3		
35536	1300	43493	14396	115	2742	78	200	EALL
	±	753	27	7	19	2		
35537	1750	105394	18080	150	3981	239	200	EALL
	±	758	24	8	7	2		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 3213 ± 752 ^{36}Ar blank = 16 ± 2
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 4B. K-91-6-17A PLAGIOCLASE #36-38 RD88, 06:01:18 22 Sep 1994, v 09/06/94

			CORRECTIONS							
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
850	25	50714	87	205	0	34	2	13	0	317
950	42	343446	146	345	0	229	11	90	0	71
1000	27	266828	95	224	0	178	8	70	0	19
1050	32	317687	113	267	0	212	10	83	0	20
1090	31	301805	109	258	0	201	9	79	0	19
1140	25	233044	86	204	0	156	7	61	0	7
1210	18	165283	62	146	0	110	5	43	0	5
1300	23	197519	81	190	0	132	6	52	0	5
1750	29	286870	101	238	0	191	9	75	0	29

All values are in counts and have been corrected for mass discrimination.

Table 4C. K-91-6-17A PLAGIOCLASE #36-38 RD88, 06:01:18 22 Sep 1994, v 09/06/94

MOLAR VALUES							
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions	
850	3.830006	0.105918	0.005339	0.348592	0.011753	7.161	0.433
950	1.249296	0.178246	0.001157	2.360739	0.002622	5.656	0.192
1000	0.494498	0.115733	0	1.834079	0.000711	5.223	0.183
1050	0.57032	0.138057	0	2.183655	0.000756	5.34	0.108
1090	0.619482	0.133312	0	2.07448	0.000708	6.538	0.16
1140	0.351487	0.105326	0	1.601833	0.000242	5.652	0.189
1210	0.244639	0.075629	0	1.136071	0.000182	5.361	0.204
1300	0.30095	0.098306	0	1.357634	0.000169	5.428	0.152
1750	0.729936	0.123288	0	1.971775	0.001091	7.023	0.116

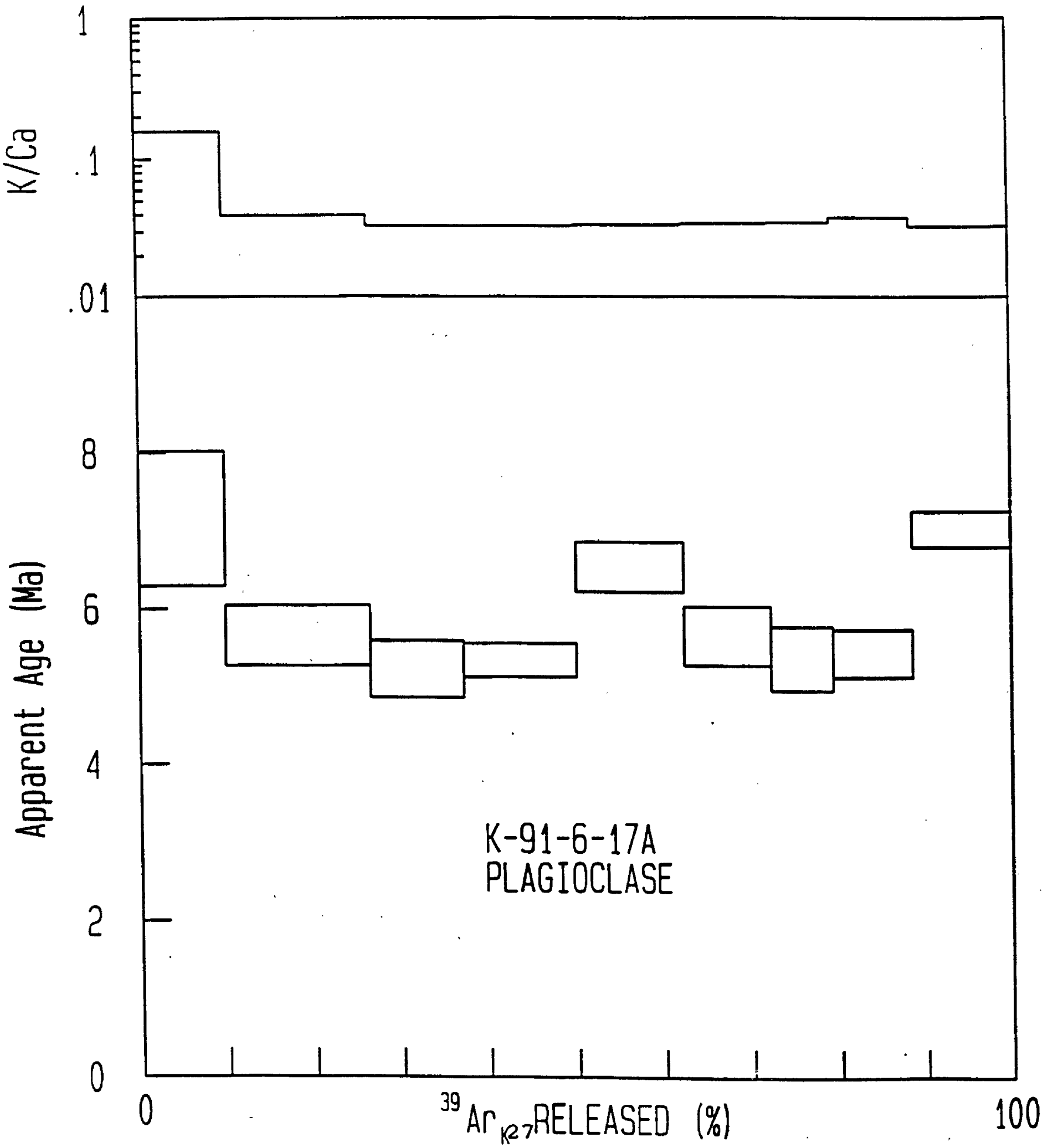
All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Table 4D. K-91-6-17A PLAGIOCLASE #36-38 RD88, 06:01:18 22 Sep 1994, v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ ($x10^{-12}$ moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .00118 ± .5			PLAGIOCLASE				Sample wt. = .6951 g	
850	9.9	9.3	0.105918	3.371	0.16	48	7.161	0.433
950	16.6	38.0	0.178246	2.661	0.04	373	5.656	0.192
1000	10.8	57.5	0.115733	2.457	0.03	0	5.223	0.183
1050	12.9	60.8	0.138057	2.512	0.03	0	5.34	0.108
1090	12.4	66.2	0.133312	3.077	0.03	0	6.538	0.16
1140	9.8	79.7	0.105326	2.659	0.03	0	5.652	0.189
1210	7	78.0	0.075629	2.522	0.03	0	5.361	0.204
1300	9.2	83.4	0.098306	2.554	0.04	0	5.428	0.152
1750	11.5	55.8	0.123288	3.306	0.03	0	7.023	0.116
Total Gas	100	56.8	1.074	2.796	0.05	67	5.942	
NO PLATEAU								

Ages calculated assuming an initial $^{40}Ar/^{36}Ar$ = 295.5 ± 0.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 5. Age spectrum diagram for K-91-6-17A Plagioclase # 36-38 RD88. Digital file 36RD99A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 6. Inverse isotope correlation diagram for K-91-6-17A Plagioclase # 36-38 RD88. Regressing points b,c, and d which contain 40.2% of the ^{39}Ar released, MSWD = 0.186, SUMS = 0.186, initial $^{40}Ar/^{36}Ar$ = 315.2 ± 14.7, and age = 5.04 ± 0.31 Ma. Digital file 36RD88C.HPL.

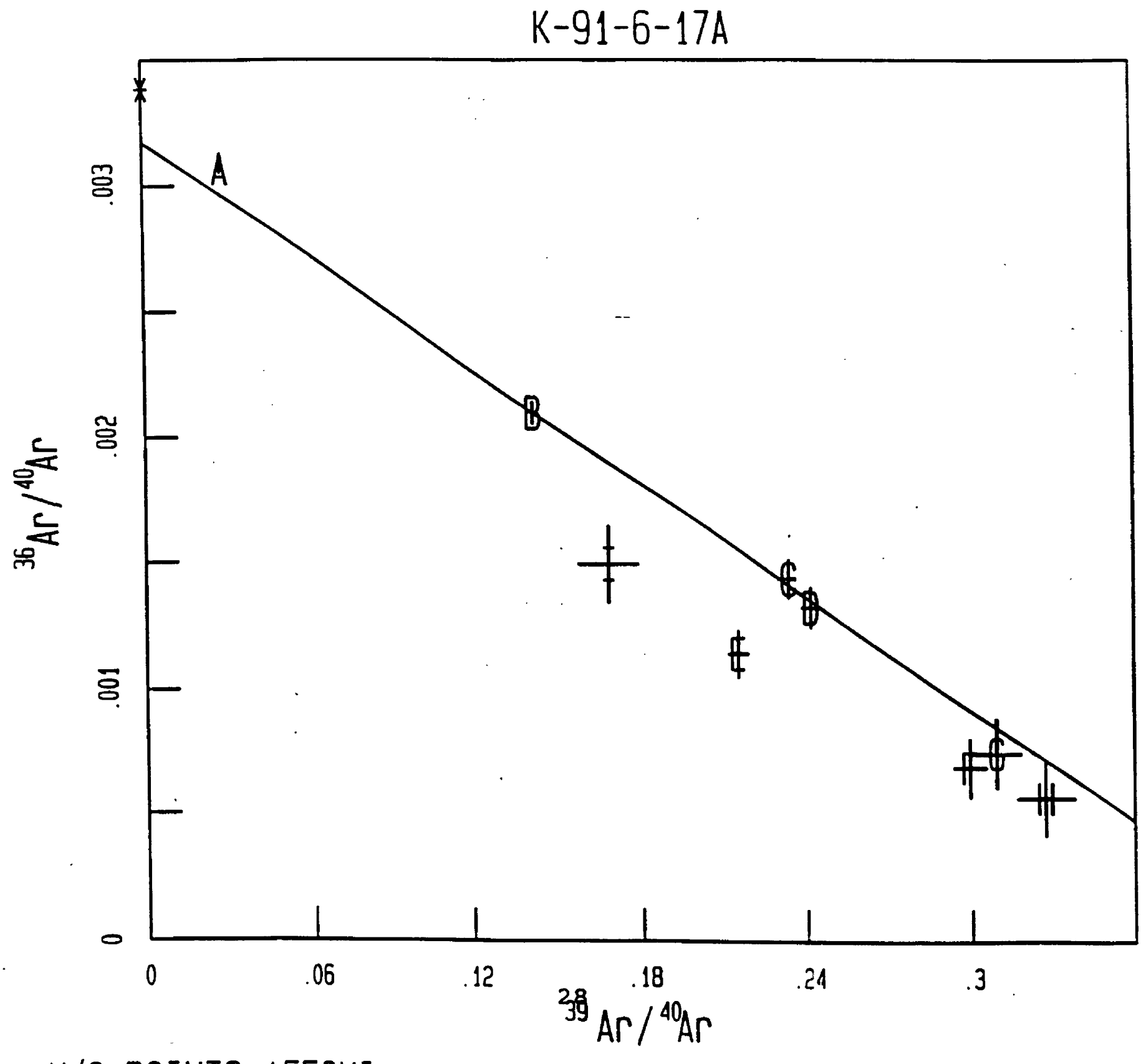


Table 5A. K-91-6-17B HORNBLENDE #17-19 RD88 , 04:10:07 23 Sep 1994, v 09/06/94.

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35126	900	807229	66426	1819	521	2196	200	EALL
	±	1350	32	11	4	5		
35127	1115	382861	30776	1530	7762	1170	200	EALL
	±	1152	34	5	20	6		
35128	1150	516019	122846	6054	39160	1326	200	EALL
	±	1145	108	30	51	6		
35129	1170	95354	13125	596	4228	260	200	EALL
	±	1159	9	10	13	4		
35130	1190	83715	17340	757	5301	210	200	EALL
	±	1144	27	15	15	6		
35131	1225	69685	13278	566	3986	177	200	EALL
	±	1145	29	7	18	3		
35132	1450	73987	11241	464	3188	198	200	EALL
	±	1147	12	9	22	2		

All values are in counts. 40Ar and 36Ar have been corrected for system blank.
^{40}Ar blank = 9763 ± 1142 ^{36}Ar blank = 44 ± 2
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 5B. K-91-6-17B HORNBLENDE #17-19 RD88 , 04:10:07 23 Sep 1994, v 09/06/94.

CORRECTIONS										
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
900	96	25052	375	885	0	17	1	7	0	397
1115	44	373568	172	407	0	251	12	98	0	194
1150	178	1885666	686	1619	0	1267	60	497	2	147
1170	19	203699	73	173	0	137	6	54	0	37
1190	25	255520	97	229	0	172	8	67	0	26
1225	19	192199	74	175	0	129	6	51	0	23
1450	16	153791	63	148	0	103	5	41	0	28

All values are in counts and have been corrected for mass discrimination.

Table 5C. K-91-6-17B HORNBLENDE #17-19 RD88 , 04:10:07 23 Sep 1994, v 09/06/94.

	MOLAR VALUES						
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions (Ma)	
900	5.593437	0.457646	0.009041	0.173367	0.014723	5.693	0.065
1115	2.65295	0.210344	0.008891	2.585157	0.007184	5.285	0.147
1150	3.572489	0.837786	0.030738	13.04902	0.005468	4.898	0.037
1170	0.660524	0.089499	0.003086	1.409605	0.001377	5.941	0.264
1190	0.579672	0.118305	0.003709	1.768191	0.000947	5.314	0.246
1225	0.482572	0.090605	0.002768	1.330002	0.00084	5.422	0.217
1450	0.512475	0.07675	0.002306	1.064207	0.001051	5.513	0.253

All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

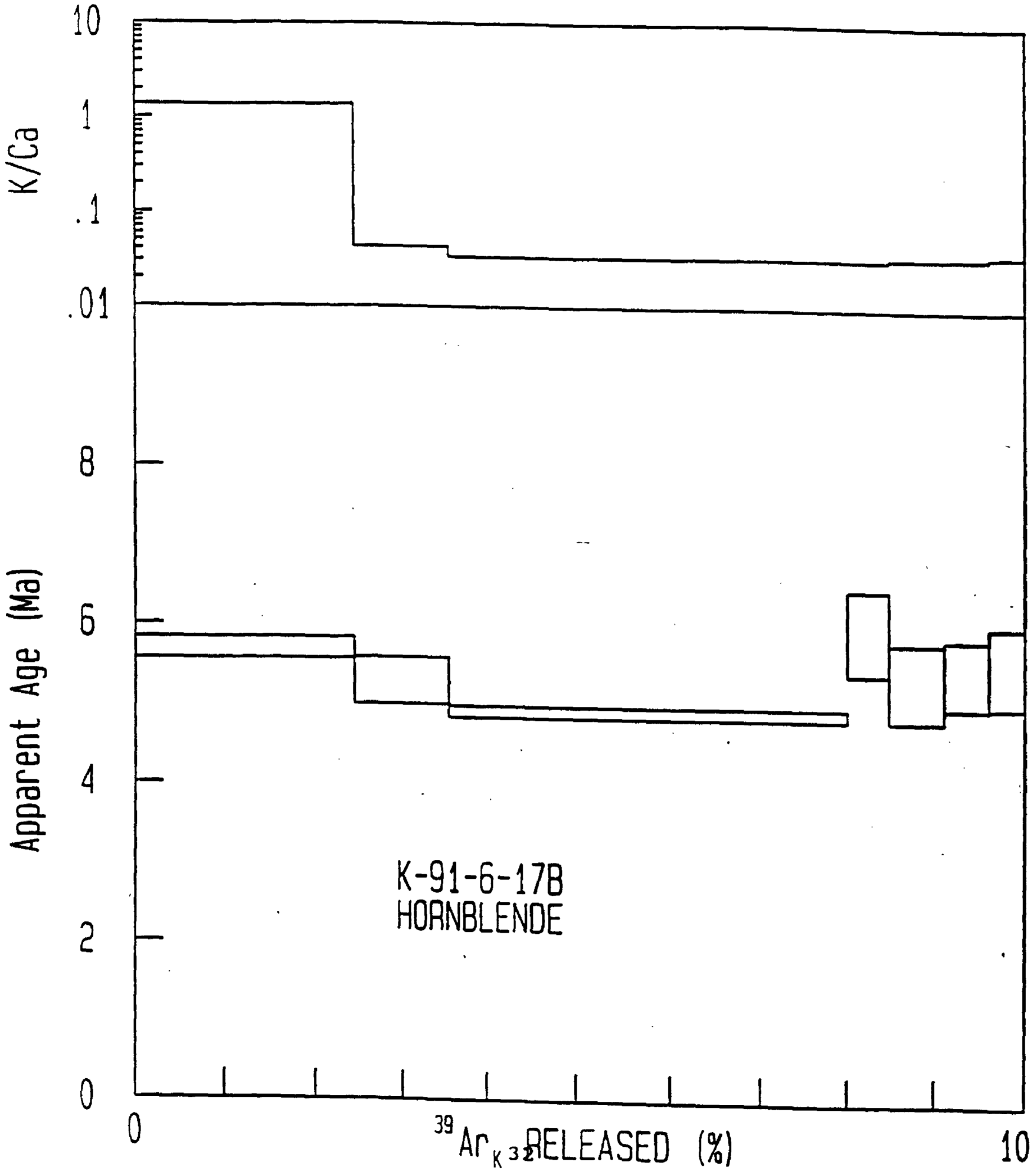
Table 5D. K-91-6-17B HORNBLENDE #17-19 RD88 , 04:10:07 23 Sep 1994, v 09/06/94.

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .001164 ± .5			HORNBLENDE				Sample wt. = .7496 g	
900	24.3	22.2	0.457646	2.715	1.37	123	5.693	0.065
1115	11.2	20	0.210344	2.52	0.04	57	5.285	0.147
1150	44.5	54.8	0.837786	2.336	0.03	66	4.898	0.037
1170	4.8	38.4	0.089499	2.834	0.03	70	5.941	0.264
1190	6.3	51.7	0.118305	2.535	0.03	77	5.314	0.246
1225	4.8	48.6	0.090605	2.586	0.04	79	5.422	0.217
1450	4.1	39.4	0.07675	2.63	0.04	81	5.513	0.253
Total Gas	100	41.1	1.881	2.51	0.36	81	5.261	

NO PLATEAU

Ages calculated assuming an initial $^{40}Ar/^{36}Ar$ = 295.5 ± 0.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 7. Age spectrum diagram for K-91-6-17B Hornblende # 17-19 RD88. Digital file 17RD88A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 8. Inverse isotope correlation diagram for K-91-6-17B Hornblende # 17-19 RD88. Regressing all points, MSWD = 3.142, SUMS = 17.067 initial $^{40}Ar/^{36}Ar$ = 308.3 ± 1.6 and age = 4.74 ± 0.08 Ma. Digital file 17RD88C.HPL.

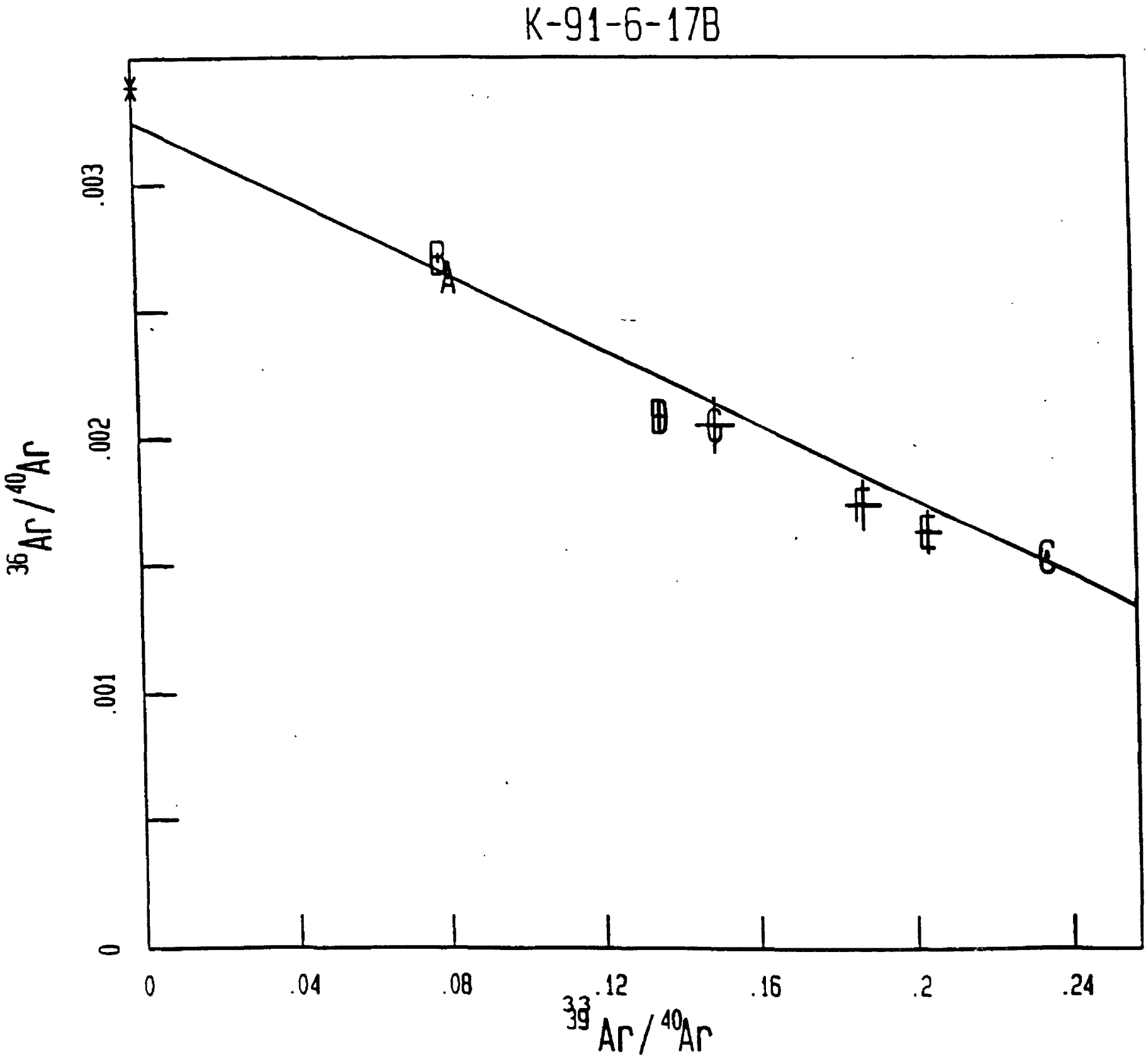


Table 6A. K-91-6-18A HORNBLENDE #12-15 RD88 , 06:59:02 23 Sep 1994, v 09/06/94.

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35096	750	392222	23715	742	283	1135	200	EALL
	±	963	20	8	4	3		
35097	900	890978	36588	1322	372	2713	200	EALL
	±	951	23	10	2	7		
35098	1075	287612	7917	482	1459	924	200	EALL
	±	865	14	3	7	7		
35099	1100	209981	18859	1092	6787	634	200	EALL
	±	860	24	17	37	5		
35100	1125	407858	86976	5239	32865	1117	200	EALL
	±	879	106	11	31	11		
35101	1175	397770	107596	5109	34160	912	200	EALL
	±	883	77	20	77	5		
35102	1225	195683	45041	2650	15016	454	200	EALL
	±	873	71	9	3	7		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 12593± 858 ^{36}Ar blank = 50 ± 3
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27 X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 6B. K-91-6-18A HORNBLENDE #12-15 RD88 , 06:59:02 23 Sep 1994, v 09/06/94

CORRECTIONS										
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
750	34	13327	134	316	0	9	0	4	0	205
900	53	17523	207	487	0	12	1	5	0	491
1075	11	68742	44	105	0	46	2	18	0	164
1100	27	320026	105	248	0	215	10	84	0	99
1125	125	1550437	485	1145	0	1042	49	409	2	126
1175	155	1612293	601	1419	0	1084	51	425	1	86
1225	65	709086	252	594	0	477	22	187	1	47

All values are in counts and have been corrected for mass discrimination.

Table 6C. K-91-6-18A HORNBLENDE #12-15 RD88 , 06:59:02 23 Sep 1994, v 09/06/94.

	MOLAR VALUES						
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions (Ma)	
750	2.718113	0.163364	0.004302	0.092263	0.007608	6.089	0.116
900	6.175183	0.252053	0.009053	0.121316	0.018218	6.646	0.126
1075	1.993535	0.05424	0.00369	0.475914	0.006091	7.549	0.616
1100	1.454941	0.12847	0.006356	2.215573	0.003677	6.068	0.202
1125	2.824074	0.592149	0.028388	10.73372	0.004674	5.158	0.083
1175	2.753333	0.733961	0.025309	11.16183	0.003181	5.229	0.032
1225	1.354809	0.307083	0.014161	4.908923	0.001754	5.764	0.101

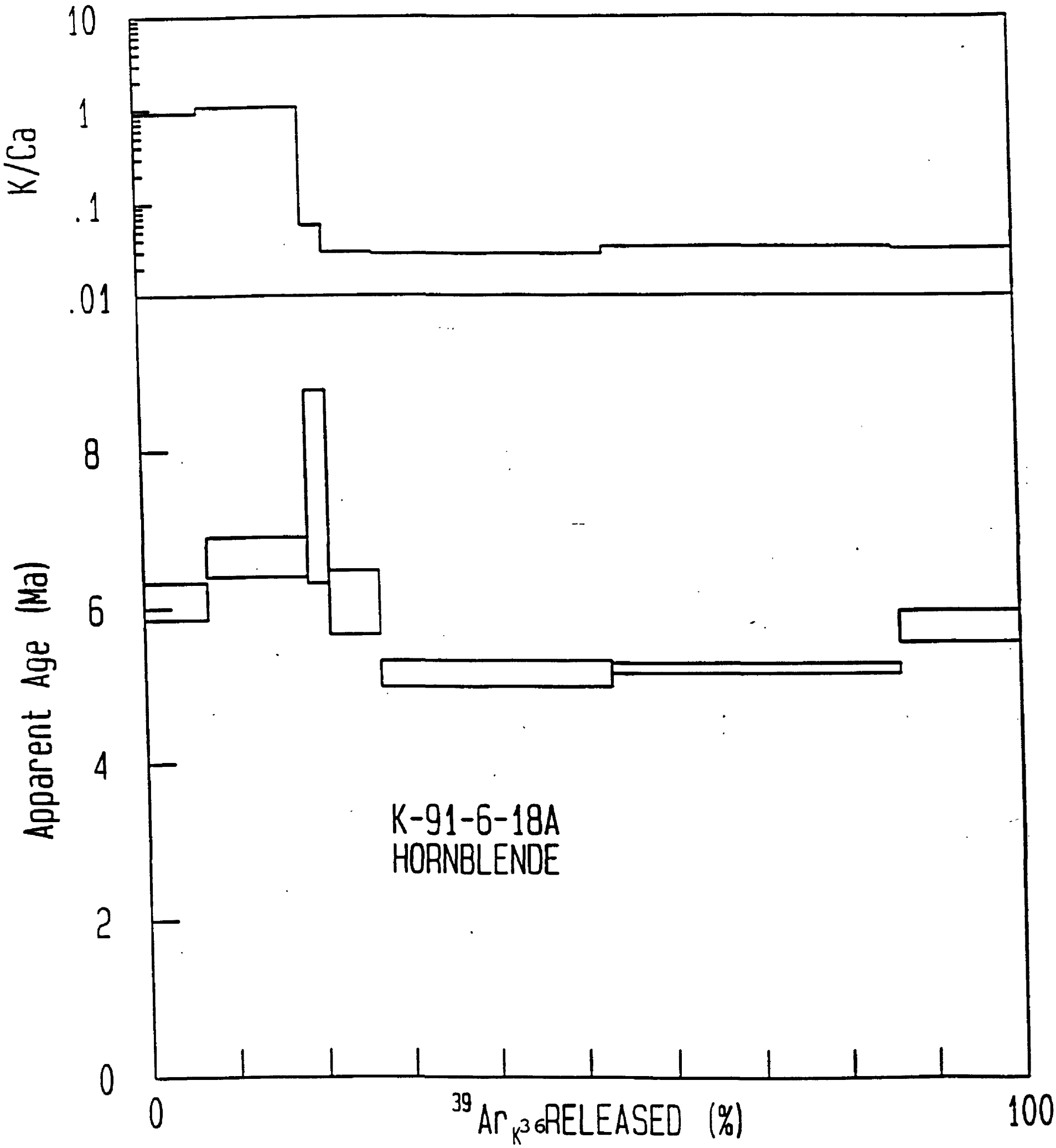
All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Table 6D. K-91-6-18A HORNBLENDE #12-15 RD88 , 06:59:02 23 Sep 1994, v 09/06/94.

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ (x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .001175 ± .5				HORNBLENDE			Sample wt. = 1 g	
750	7.3	17.3	0.163364	2.877	0.92	92	6.089	0.116
900	11.3	12.8	0.252053	3.141	1.08	67	6.646	0.126
1075	2.4	9.7	0.05424	3.569	0.06	36	7.549	0.616
1100	5.8	25.3	0.12847	2.868	0.03	49	6.068	0.202
1125	26.5	51.1	0.592149	2.437	0.03	50	5.158	0.083
1175	32.9	65.9	0.733961	2.471	0.03	70	5.229	0.032
1225	13.8	61.7	0.307083	2.724	0.03	52	5.764	0.101
Total Gas	100	48.1	2.231	2.652	0.22	62	5.612	
59.43% of gas on plateau in 1125 °C through °C 1175 steps .					Plateau Age =		5.22	0.03

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 9. Age spectrum diagram for K-91-6-18A Hornblende # 12-15 RD88. Digital file 12RD88A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 10. Inverse isotope correlation diagram for K-91-6-18A Hornblende # 12-15 RD88. Regressing points D, E, and F, which contain 65.2% of the ^{39}Ar released, MSWD = 1.02, SUMS = 1.02, initial $^{40}Ar/^{36}Ar$ = 311.9 ± 6.4 and age = 5.01 ± 0.14 Ma. Digital file 12RD88C.HPL.

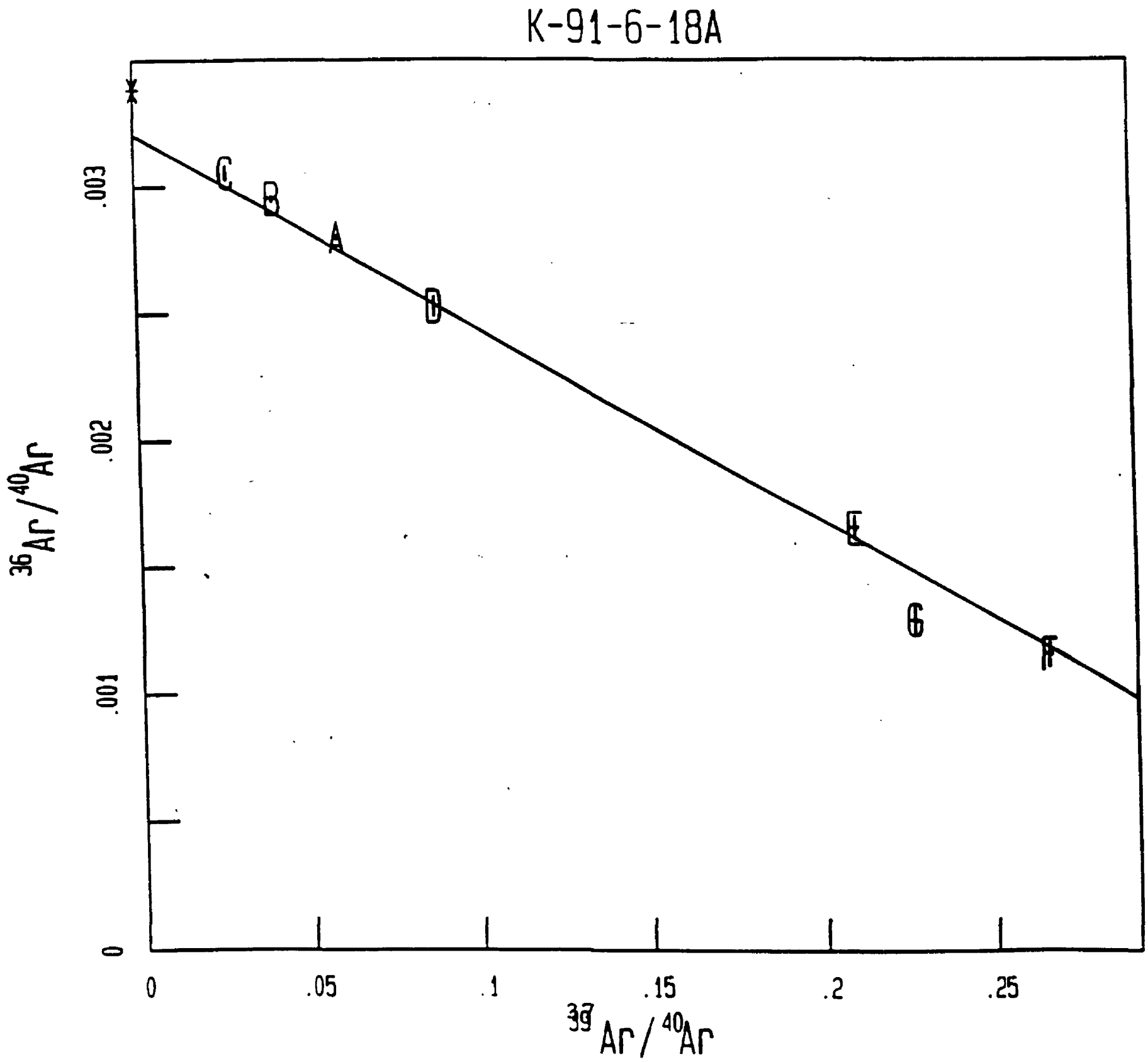


Table 7A. K-91-18A PLAGIOCLASE #32 RD88, 07:33:40 23 Sep 94 v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35886	1650	1041448	141441	2419	16132	2712	200	ALL
	±	1706	255	20	27	18		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 21885 ± 351 ^{36}Ar blank = 82 ± 10
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 7B. K-91-18A PLAGIOCLASE #32 RD88, 07:33:40 23 Sep 94 v 09/06/94

CORRECTIONS											
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
1650	244	1666480	793	1870	0	1107	52	434	0	411

All values are in counts and have been corrected for mass discrimination.

Table 7C. K-91-18A PLAGIOCLASE #32 RD88, 07:33:40 23 Sep 94 v 09/06/94

MOLAR VALUES							
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precisions (Ma)	
1650	3.402944	0.456279	0.002854	5.380645	0.007185	5.96	0.081

All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.

Table 7D. K-91-18A PLAGIOCLASE #32 RD88, 07:33:40 23 Sep 94 v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ ($x10^{-12}$ moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .00118 ± .5			PLAGIOCLASE			Sample wt. = .2525 g		
1650	100	37.6	0.456279	2.805	0.04	387	5.96	0.081
Total Gas	100	37.6	0.456279	2.805	0.04	387	5.96	

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Table 8A. K-91-6-18B HORNBLENDE #25&26 RD88, 07:18:27 23 Sep 1994, v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35180	1120	295251	13251	403	116	895	200	EALL
	±	1776	31	11	4	9		
35181	1130	175170	24089	1216	6227	408	200	EALL
	±	1759	22	4	19	9		
35182	1150	57389	9125	415	2576	145	200	EALL
	±	1759	29	3	19	9		
35183	1225	88223	13480	660	3841	204	200	EALL
	±	1760	18	2	8	10		
35184	1450	123998	9375	495	2637	341	200	EALL
	±	1813	28	10	25	11		
35185	1700	191344	18207	906	5321	509	200	EALL
	±	1769	10	12	22	10		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 14485 ± 1758 ^{36}Ar blank = 59 ± 9
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 8B. K-91-6-18B HORNBLENDE #25&26 RD88, 07:18:27 23 Sep 1994, v 09/06/94

CORRECTIONS										
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
1120	19	5849	75	176	0	4	0	2	0	162
1130	35	312771	135	318	0	210	10	82	0	59
1150	13	129479	51	120	0	87	4	34	0	20
1225	20	193132	75	178	0	130	6	51	0	27
1450	14	132656	52	124	0	89	4	35	0	55
1700	27	267814	102	240	0	180	8	71	0	79

All values are in counts and have been corrected for mass discrimination.

Table 8C. K-91-6-18B HORNBLENDE #25&26 RD88, 07:18:27 23 Sep 1994, v 09/06/94

	MOLAR VALUES						
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precision (Ma)	
1120	2.046277	0.091292	0.002655	0.040443	0.006011	6.282	0.514 2
1130	1.213413	0.164549	0.006443	2.162589	0.002173	7.377	0.282 9
1150	0.39749	0.062281	0.002109	0.895249	0.000738	6.118	0.765 0
1225	0.611076	0.092001	0.003425	1.335346	0.001017	7.17	0.527 7
1450	0.859238	0.063993	0.002876	0.917197	0.002053	8.383	0.846 5
1700	1.325769	0.124227	0.005012	1.851674	0.002937	7.831	0.41 9

All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

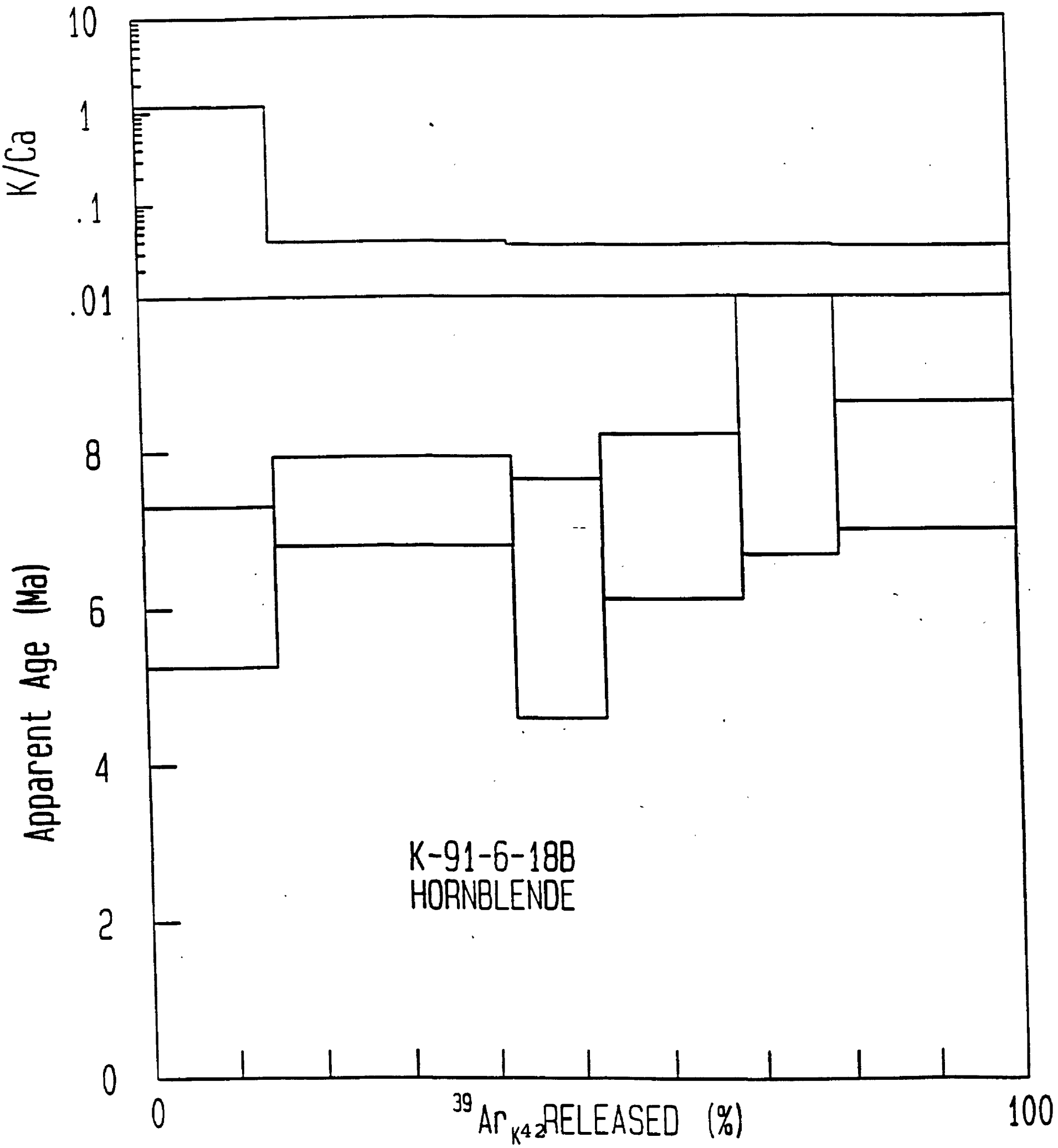
Table 8D. K-91-6-18B HORNBLENDE #25&26 RD88, 07:18:27 23 Sep 1994, v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ (x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .00118 ± .5			HORNBLENDE				Sample wt. = .4013 g	
1120	15.3	13.2	0.091292	2.956	1.17	83	6.282	0.514
1130	27.5	47.1	0.164549	3.473	0.04	62	7.377	0.282
1150	10.4	45.1	0.062281	2.879	0.04	71	6.118	0.765
1225	15.4	50.8	0.092001	3.375	0.04	65	7.170	0.527
1450	10.7	29.4	0.063993	3.947	0.04	54	8.383	0.846
1700	20.8	34.5	0.124227	3.687	0.03	60	7.831	0.410
Total Gas	100	37.8	0.5893	3.412	0.21	65	7.249	

68.54% of gas on plateau in 1120°C through 1225°C steps Plateau Age = 7.05 ± .11

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Fig. 11. Age spectrum diagram for K-91-6-18B Hornblende # 25-26 RD88. Digital file 25RD88A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 12. Inverse isotope correlation diagram for K-91-6-18B Hornblende # 21-23 RD88. Regressing all points, MSWD = 0.735, SUMS = 2.94, initial $^{40}Ar/^{36}Ar$ = 287.7 ± 5.1 and age = 7.45 ± 0.37 Ma. Digital file 25RD88C.HPL.

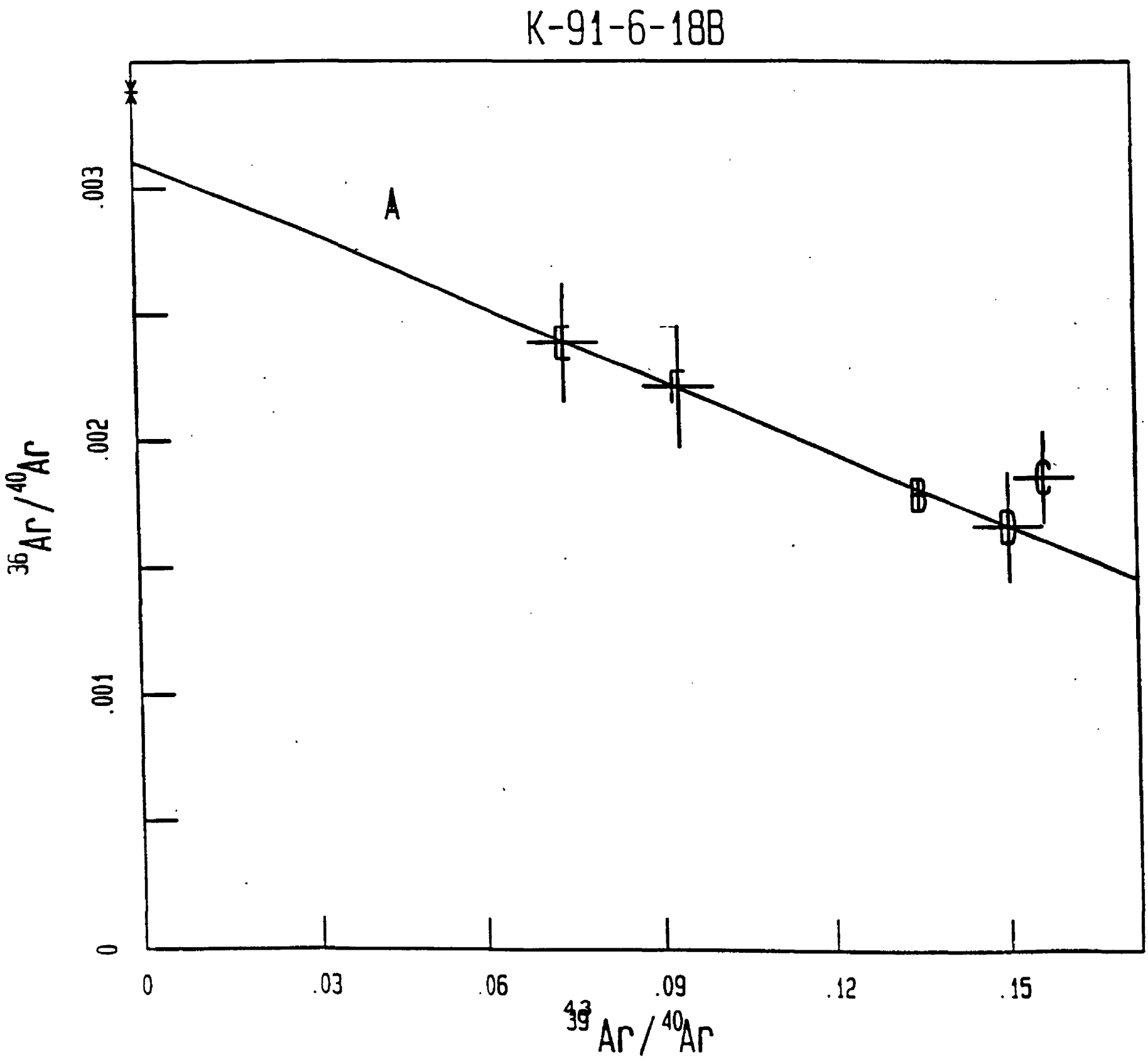


Table 9A. K-91-6-18B PLAGIOCLASE #31RD88, 07:28:27 23 Sep 1994, v 09/06/94

RAW DATA								
File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35887	1650	737805	104219	1771	11347	1900	200	ALL
	±	1557	187	13	24	11		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 21885 ± 351 ^{36}Ar blank = 82 ± 10
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 9B.K-91-6-18B PLAGIOCLASE #31RD88, 07:28:27 23 Sep 1994, v 09/06/94

CORRECTIONS											
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
1650	180	1173119	584	1378	0	780	37	306	0	288

All values are in counts and have been corrected for mass discrimination.

Table 9C. K-91-6-18B PLAGIOCLASE #31RD88, 07:28:27 23 Sep 1994, v 09/06/94

MOLAR VALUES							
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precision	
1650	2.410713	0.336323	0.002021	3.78768	0.00503	5.841	0.075

All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.

Table 9D. K-91-6-18B PLAGIOCLASE #31RD88, 07:28:27 23 Sep 1994, v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ (x10^{-12} moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .00118 ± .5			PLAGIOCLASE				Sample wt. = .1805 g	
1650	100	38.3	0.336323	2.748	0.05	403	5.841	0.075
Total Gas	100	38.3	0.336323	3.412	0.05	402	5.841	

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

Table 10A. K-91-6-29C HORNBLENDE #7-10 RD88, 06:27:06 23 Sept 1994, v 09/06/94

RAW DATA

File	Temp	^{40}Ar	^{39}Ar	^{38}Ar	^{37}Ar	^{36}Ar	Trap	Manifold
35510	750	193428	19886	658	125	576	200	EALL
	±	765	20	4	3	5		
35511	900	845636	29487	1685	182	2721	200	EALL
	±	1366	38	10	2	4		
35512	1000	98465	1962	307	155	327	200	EALL
	±	722	7	3	4	5		
35513	1050	63307	1102	266	133	212	200	EALL
	±	726	16	2	4	5		
35514	1100	108992	5829	971	953	360	200	EALL
	±	717	6	7	7	5		
35515	1125	226549	38845	6468	7658	737	200	EALL
	±	890	54	18	19	4		
35516	1175	654966	233262	35442	42928	2064	200	EALL
	±	759	345	67	101	16		
35517	1225	201003	63339	11748	11651	612	200	EALL
	±	724	40	30	23	4		
35518	1450	75479	13044	2406	2370	241	200	EALL
	±	723	22	9	14	4		

All values are in counts. ^{40}Ar and ^{36}Ar have been corrected for system blank.
^{40}Ar blank = 4966 ± 716 ^{36}Ar blank = 23 ± 3
Precisions are at the 1 sigma level, and are from linear regression statistics.
Trap current factors: 40 = 5.66 100 = 0 200 = 1
Manifold factors: All = 1, Split1 = 3.3, Split2 = 10.89, Split 3 = 35.937
EAll = 2.12, Esplit1 = 6.6, Esplit2 = 21.78
Sensitivity = 3.27X 10^{-18} moles/count. Reproducibility limit = .25 %. Detection limit = 40 counts.

Table 10B. K-91-6-29C HORNBLENDE #7-10 RD88, 06:27:06 23 Sept 1994, v 09/06/94

			CORRECTIONS							
Temp (°C)	^{39}Ar decay	^{37}Ar decay	----- ^{40}Ar	K-derived ^{38}Ar	----- ^{37}Ar	----- ^{39}Ar	Ca-derived ^{38}Ar	----- ^{36}Ar	Cl-derived ^{36}Ar	initial ^{38}Ar
750	31	8635	112	265	0	6	0	2	0	104
900	47	12602	166	393	0	8	0	3	1	493
1000	3	10699	11	26	0	7	0	3	0	59
1050	2	9202	6	15	0	6	0	2	0	38
1100	9	66037	33	77	0	44	2	17	0	62
1125	61	530930	217	513	0	354	17	139	2	107
1175	368	2977602	1306	3081	0	1988	94	780	13	226
1225	100	808525	355	837	0	540	25	212	4	71
1450	21	164554	73	172	0	110	5	43	1	36

All values are in counts and have been corrected for mass discrimination.

Table 10C. K-91-6-29C HORNBLENDE #7-10 RD88, 06:27:06 23 Sept 1994, v 09/06/94

MOLAR VALUES							
Temp (°C)	$^{40}Ar^*$	^{39}Ar K derived	^{38}Ar Cl derived	^{37}Ar Ca derived	^{36}Ar Initial	Apparent Age and precision	
750	1.340139	0.137015	0.003376	0.059384	0.003862	3.053	0.163
900	5.86113	0.20317	0.012203	0.086666	0.018283	4.741	0.123
1000	0.682525	0.013475	0.002322	0.073576	0.002182	5.874	1.754
1050	0.438826	0.007554	0.001978	0.063284	0.001409	6.221	3.262
1100	0.755351	0.039868	0.006512	0.454149	0.002297	4.04	0.583
1125	1.569021	0.265271	0.041258	3.651264	0.00398	3.113	0.076
1175	4.531434	1.593916	0.221675	20.47715	0.008389	2.707	0.044
1225	1.390976	0.432808	0.074769	5.560239	0.002621	2.994	0.043
1450	0.522742	0.089139	0.01545	1.131633	0.001319	3.138	0.225

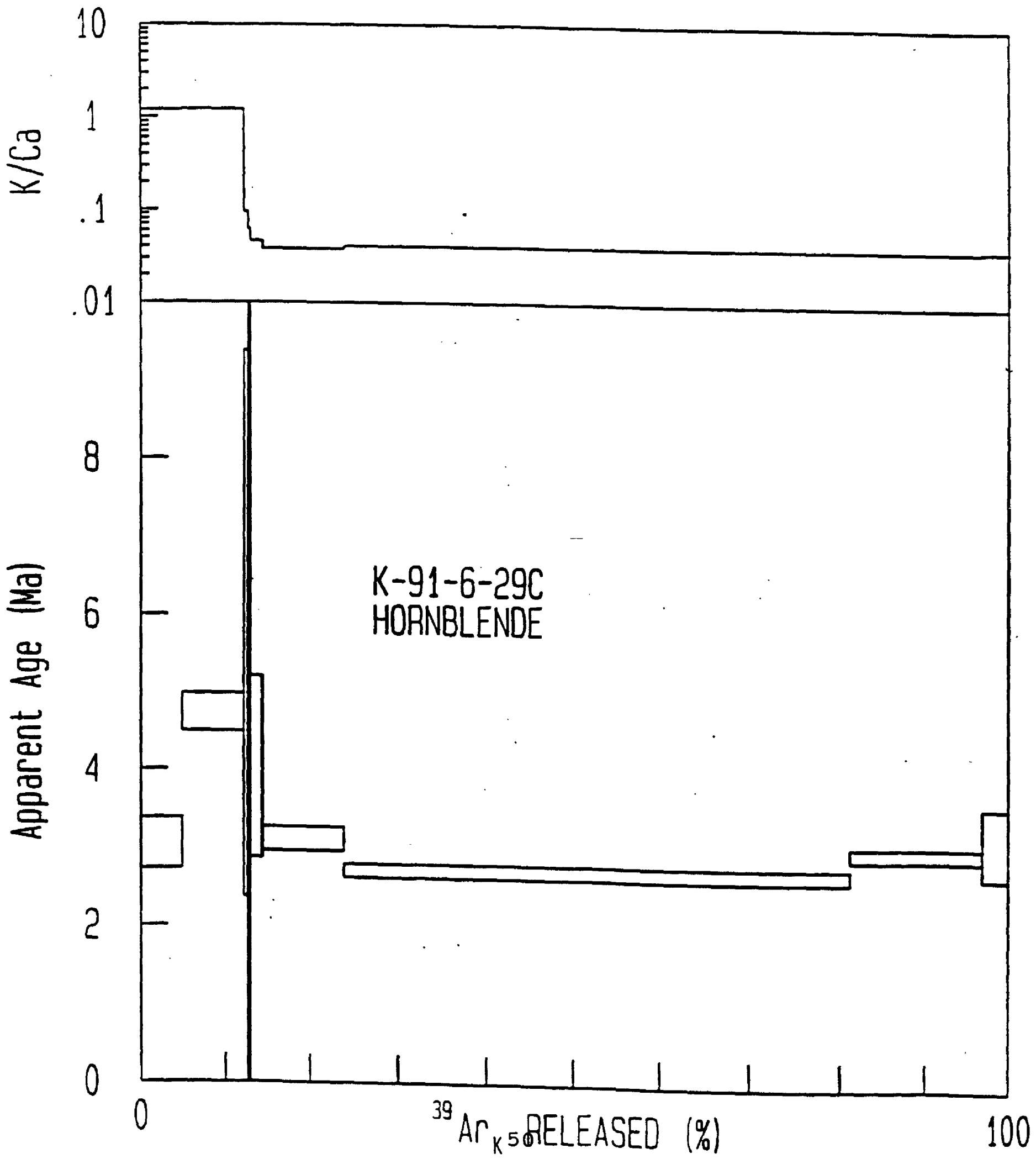
All gas quantities are in moles x 10^{-12}.
Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.

Table 10D. K-91-6-29C HORNBLENDE #7-10 RD88, 06:27:06 23 Sept 1994, v 09/06/94

Temp (°C)	Percent ^{39}Ar of Total	Radiogenic Yield (%)	$^{39}Ar_K$ ($x10^{-12}$ moles)	$^{40}Ar_R/^{39}Ar_K$	Apparent K/Ca	Apparent K/Cl	Apparent Age and Precision (Ma)	
J = .001166 ± .5				HORNBLENDE			Sample wt. = 1.052 g	
750	4.9	14.9	0.137015	1.453	1.2	98	3.053	0.163
900	7.3	7.8	0.20317	2.257	1.22	40	4.741	0.123
1000	0.5	5.5	0.013475	2.797	0.1	14	5.874	1.754
1050	0.3	5.1	0.007554	2.963	0.06	9	6.221	3.262
1100	1.4	10.1	0.039868	1.923	0.05	15	4.04	0.583
1125	9.5	25	0.265271	1.481	0.04	16	3.113	0.076
1175	57.3	45.3	1.593916	1.288	0.04	17	2.707	0.044
1225	15.6	44.3	0.432808	1.424	0.04	14	2.994	0.043
1450	3.2	25.5	0.089139	1.493	0.04	14	3.138	0.225
Total Gas	100	37.5	0.089139	1.434	0.18	22	3.014	

Ages calculated assuming an initial $^{40}Ar/^{36}Ar = 295.5 \pm 0$.
All precision estimates are at the one sigma level.
Ages of individual steps do not include error in the irradiation parameter J.
No error is calculated for the total gas age.

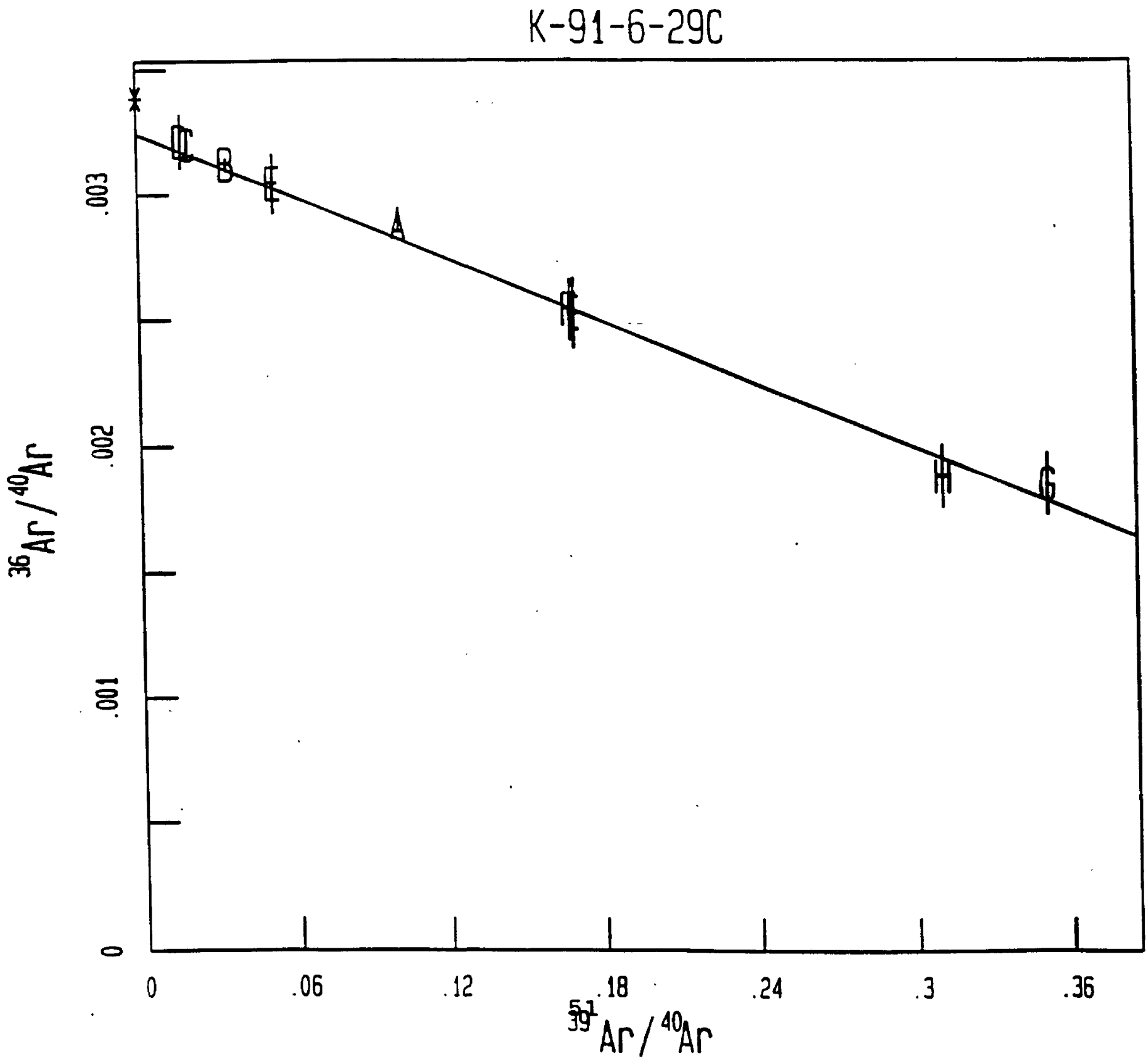
Fig. 13. Age spectrum diagram for K-91-6-29C Hornblende # 7-10 RD88. Digital file 7RD88A.HPL.



v 09/06/94

(40/36in = 295.5)

Fig. 14. Inverse isotope correlation diagram for K-91-6-29C Hornblende # 7-10 RD88. Regressing points E, F, G, and H, MSWD = 2.08, SUMS = 0.623, initial $^{40}Ar/^{36}Ar$ = 308.5 ± 11.4 and age = 2.64 ± 0..24 Ma. Digital file 7RD88C.HPL.



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