Chapter Four

Results

4.1 Presentation of Results

4.1.1. Age Spectrum and Plateau Age

The step heating experiment yields apparent ages of gas fractions released at different temperatures. Turner et al. (1966) first plotted the apparent age at each temperature step against the cumulative % of ^{39}Ar released. This plot has since then become a standard way of presenting the results of the step heating experiment and is known as the age spectrum. This plot enables one to test the underlying assumptions (Chapter 3, 3.1.1). If the sample has remained a closed system since its crystallization and not subjected to subsequent thermal disturbance, and if potassium was distributed uniformly, all the steps would yield concordant ages and would result in a flat (**Plateau**) age spectrum. Deviation from flatness would indicate subsequent disturbances.

To distinguish between undisturbed and disturbed systems, many criteria were proposed for the identification of a plateau in an age spectrum (Dalrymple & Lanphere, 1974; Fleck et al , 1977; York et al., 1981; Foland et al., 1986; Snee et al., 1988; Dallmeyer and Lecorche, 1990). However, there is no uniform convention on the definition of a plateau. I have defined the plateau in the age spectrum as a portion that has four or more consecutive steps with apparent ages within 2σ comprising of at least 50 % of the total ^{39}Ar released. While the apparent ages don't include error in ***J***, the plateau age is calculated by taking a weighted mean of apparent ages including the error in ***J***. Plateau-like ages are calculated wherever there are plateau-like features but the above criterion for plateau is not strictly met.

4.1.2. Isochron Plot

Merrihue and Turner (1966) first employed the technique of isotope correlation diagram to the step heating results for simultaneously assessing the sample age and isotopic composition of the trapped argon. This has provided an independent check for the model assumption that the trapped argon is of atmospheric composition. The isochron is derived by plotting the total $^{40}Ar/^{36}Ar$ measured in each step (after correcting for the nuclear interferences), constituting the plateau, against the $^{39}Ar_K/^{36}Ar$ (proxy for the parent ^{40}K). This approach is similar to the conventional Rb/Sr isochron method A linear regression is done with due weightage for the errors in both the ratios (York, 1966, 1969). In the case where ^{36}Ar is in small amount, it is measured with poor precision compared to ^{40}Ar and ^{39}Ar. Thus the presence of ^{36}Ar in both the axes results in highly correlated errors. To circumvent this problem another way of plotting was suggested (Turner, 1971b; Roddick et al., 1980) in which $^{36}Ar/^{40}Ar$ is plotted against $^{39}Ar/^{40}Ar$. This is called inverse isochron. However, essentially both the plots should give same age and trapped ratio. I have presented here only isochron plots for the concordant age steps forming plateau, wherever plateau ages were derivable.

4.1.3. Criterion of the Goodness of Fit

A criterion of Mean Square of Weighted Deviate (**MSWD**) is used to test the goodness of fit of straight line to the data (McIntyre et al., 1966). The data are weighted according to the inverse weighted variance. A MSWD much less than the expected value of 1 suggests that experimental errors may be overestimated (Wendt and Carl, 1991), while if the value of MSWD is much higher than unity, a linear relationship between the data may not exist or experimental errors may be underestimated (McDougall & Harrison, 1999).

4.2 Monitor Sample

Results presented here are with respect to the widely used monitor sample McClure Mountain hornblende (MMhb-1), with an age of 520.4 ± 1.7 Ma based on the average results of K-Ar analyses from 15 different laboratories (Alexander et al., 1978; Samson and Alexander, 1987). There has been some debate, however, over the true age of this standard lately (Baksi et al 1996) with U S. Geological Survey reporting an age of 513.9

± 2.3 Ma based on K-Ar data (Dalrymple et al 1993). Renne et al , (1998) have recommended an age of 523 1 ± 2.6 Ma (neglecting the error in the decay constant) based on intercalibration of other primary standards. I have also analysed another standard LP-6 biotite (Table 4.1) for intercalibration with respect to the MMhb-1. The total fusion age obtained, 124.1 ± 2.2 (2σ error) Ma, with respect to the 520.4 ± 1.7 Ma age of the MMHb-1, is within errors of the average K-Ar age of 127.9 ± 2.2 Ma (2σ error) based on several interlaboratory analyses of LP-6 (Odin et al 1982).

Table 4.1 *Argon isotopic composition and total age of LP6 Biotite. The error in age is with error in* ***J.*** ***J= .002296 ± .000014,*** *correction factors are* $(^{36}Ar/^{37}Ar)_{Ca}$ *=0.00016;* $(^{39}Ar/^{37}Ar)_{Ca}$*= 0.00075, and* $(^{40}Ar/^{39}Ar)_{K}$*= 0.046.*

$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ	AGE(Ma) ± 1σ
0 01115	34 32	90 40	0 00786	3079 1	124 1
0.00043	0 21		0.00032	121.3	1 1

The results obtained using the different ages of the monitor samples, however, can be readily compared by recalculating relative to the new age to avoid the confusion by using the following equation (Renne, 2000; Dalrymple et al., 1993):

$$t_u = \frac{\ln[R(e^{\lambda t_{s2}} - 1) + 1]}{\lambda}$$

where t_u is the unknown age of a sample, R is the ratio of the $^{40}Ar^{*}/^{39}Ar_K$ value of the sample to that of the standard, and t_{s2} is the new age of the standard. The value of R can be determined by substitution using the original value (t_{s1}) for the age of the standard:

$$R = \frac{\{\frac{^{40}Ar^{*}}{^{39}Ar_K}\}_u}{\{\frac{^{40}Ar^{*}}{^{39}Ar_K}\}_s} = \frac{\{e^{\lambda t_u} - 1\}}{\{e^{\lambda t_{s1}} - 1\}}$$

The samples used in the present study were irradiated in the three irradiation batches. The J values, correction factors and mean sensivities for each irradiation, are obtained as discussed in the last chapter and are tabulated in Table 4.2. ***J*** values for the individual samples are given with the corresponding data tables The difference in J values within a

batch of irradiation reflects the neutron flux variation. The flux variation is calculated wit the help of Ni wire discussed in chapter 3.

Table 4.2 *Correction factors and mean sensitivity of the irradiation batches.*

SAMPLES IN THE IRRADIATION BATCH	CORRECTION FACTORS			MEAN SENSITIVITY (ccSTP/mV)
	$(^{36}Ar/^{37}Ar)_{Ca}$	$(^{39}Ar/^{37}Ar)_{Ca}$	$(^{40}Ar/^{39}Ar)_{K}$	
LK209, LK182, LK176, LK 24, LK24B, LK198, LK198M, LK48	0.00034	0.00071	0.046	$0.8x10^{-7}$
LK47, LK57, LK67, LK68, LK70, LK86, LK88, LK90	0.00016	0.00075	0.069	$0.7x10^{-7}$
LG290, LG188, LG166, LG197, LG 601, LG 87	0 00015	0.00068	0.079	$0.2x10^{-7}$

Results of the samples from all the major geological units of the Trans Himalaya of Ladakh sector have been presented here, from south to north.

4.3 Indus Suture Zone

The Indus Suture Zone is characterized by sporadic occurrences of ophiolites and ophiolitic mélanges (Fig. 2.2) In Ladakh, this is represented by two main ophiolitic bodies, Shergol ophiolote (Fig.2.3) in the west and Zildat and Nidar ophiolites (Fig.2.4) in the east. Samples from both west and east Ladakh have been analyzed and the results have been presented in the tables 4.3 to 4.5 and figures 4.1 to 4.3. Sample details have been presented in the chapter 2. Sample LK 209 is a pillow lava taken from the village Chiktan in the western Ladakh (Fig.2.2). It has yielded a plateau age of 128.2 ± 2.6 Ma for the first six steps consisting of more than 60% of ^{39}Ar released. The isochron age for this, 126.9 ± 7.6 Ma, is within errors of the plateau age with the trapped ratio of

$^{40}Ar/^{36}Ar$ as 296 9 ±8.4 Ma (Table 4.3 & Fig.4.1). The higher temperature steps have yielded higher ages; however, the integrated age is within errors of the plateau age. The concordance of all the three ages, viz. plateau, isochron and integrated age, for this sample is interpreted to yield the age of formation. The subsequent redistribution of the radiogenic argon within the whole rock could have given rise to the disturbed high temperature part of the spectrum.

Sample LK182 is taken from the Sumdo Nala in the eastern Ladakh (Fig.2.3). This sample yielded a cooling pattern of rising apparent ages from ~14 Ma to ~ 38 Ma, for ~99.5 % of ^{39}Ar released from 450°C temperature step to 950°C. (Table 4.4 &Fig 4.2). It yielded a plateau-like age at the maximum temperature steps (900°C & 950°C) consisting of 23% of the ^{39}Ar released. The cooling pattern of this basalt sample is interpreted to be due to a subsequent resetting tectono-thermal event. Further interpretation and derivation of the cooling history of the sample is done by modeling the age spectrum using the Multi Diffusion Model (MDD), discussed in detail in chapter 5. The inferred cooling history is rapid cooling at ~40Ma followed by slow cooling between 38 and 18 Ma and again subsequent fast cooling.

The sample from LK176, from the same Sumdo Nala (Fig.2.3), yielded a four step plateau age of 46.8 ± 0.7 Ma for the middle temperature steps (from 600 to 750°C), consisting of 64.4% of ^{39}Ar released The isochron age of 46.8 ± 1.3 Ma, for this sample, is same as the plateau age with the trapped $^{40}Ar/^{36}Ar$ ratio of 295.8 ± 11.9 (Table 4 5 & Fig 4.3). The MDD model by assuming monotonic cooling, yields an age spectrum which matches well with the experimentally derived age spectrum for 80 % of the gas released (see chapter 5). The corresponding cooling curves show two-step cooling, starting with an instantaneous cooling at 50 Ma followed by slow cooling from 100°C.

Besides the above samples, I attempted to analyze samples of serpentinites and ultramafics of the lower units of the ophiolites of the suture zone to retrieve the timing of the serpentinization and the tectono-thermal history experienced by the ultramafics. A total number of seven samples of serpentinites and one sample of the ultramafic were studied but the experiment did not give any meaningful data because of the high content of trapped gases with very low K content masking the signal.

4.4 Dras Volcanics

Sample LG 290 is also taken from near the Kharbu village of the western Ladakh (Figs. 2.2 & 2.3). Overall the age spectrum forms the pattern of rising ages like a cooling pattern. However, a plateau-like age of 85.6 ± 0.6 Ma for 8 steps comprising more than 80% of the ^{39}Ar released can be derived (Table 4.6 & Fig. 4.4). The plateau like age is consistent with the earlier estimates of the age of the Dras Volcanics.

Table 4.3 *Argon isotopic composition and apparent ages of sample LK97/209 (Chiktan Pillow Lava) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002369 ± .000028***

TEMP. (°C)	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	AGE(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	1 182	376 17	111 0	3 11	7 12	3.470	318 16
	.021	7.01	13 0(13 1)			.067	6 10
500	4038	148 66	121 14	9.44	19 73	2 9371	368 12
	0049	.87	6 33(6.48)			0059	4 81
550	2638	110 28	133 06	17.84	29 31	2 5796	418 01
	0010	64	2 34(2 79)			0074	2 64
600	1954	89 49	130 80	12 30	35 48	11 123	458 00
	0016	56	2.44(2 86)			037	4 34
650	.16612	79 23	124.40	12 37	38.04	13 114	476 96
	.00059	47	1 68(2.20)			081	2 99
700	1394	72 46	128 89	7.07	43 16	12 421	519 85
	0017	54	2 43(2 84)			025	6 96
750	.10206	53 83	98 41	4.07	43 97	26 805	527 44
	00079	40	1 41(1 81)			.054	5 02
800	.2241	86.74	85 58	2 17	23 65	33 68	387 03
	.0030	58	4.16(4 27)			15	5 74
850	4885	168 58	100.7	1.53	14 37	16 70	345.11
	0089	1.42	10.7(10 7)			31	6.58
900	.5825	194 10	91 53	1.29	11 32	21.77	333 22
	0031	1 22	5 44(5 54)			20	2 58
950	3772	147 46	147 58	2.08	24 41	48 01	390 92
	0045	1 17	6.10(6 33)			6 93	4 77
1000	2154	101 18	153.64	2 92	37 10	89 39	469 79
	0022	88	3 59(3.99)			43	5 85
1050	.2312	112 52	179 61	7 70	39 28	38 99	486 69
	.0020	69	3.16(3 75)			11	4 91
1100	2401	120 21	199 10	7 19	40 98	22 525	500 72
	0019	77	3 31(3 99)			.045	4 88
1150	.2168	114 63	204.02	2 57	44.10	20 84	528.7
	0048	1 44	7 44(7 78)			16	13.2
1200	128	81 13	175 8	2 19	53 26	26 43	632.2
	013	4.09	22.0(22 1)			28	73.0
1250	038	56 59	184 3	1 63	80 24	31 14	1495 5
	022	6.58	35 9(36 0)			21	897 1
1300	017	51 87	189 5	2 54	90 14	32 14	2995 7
	021	6 36	34.5(34 6)			.10	3724 6
TOTAL	25903	110 78	140 65	100 00	30 90	17 74	427 67
	.00098	31	1 57(2 24)			15	1 96

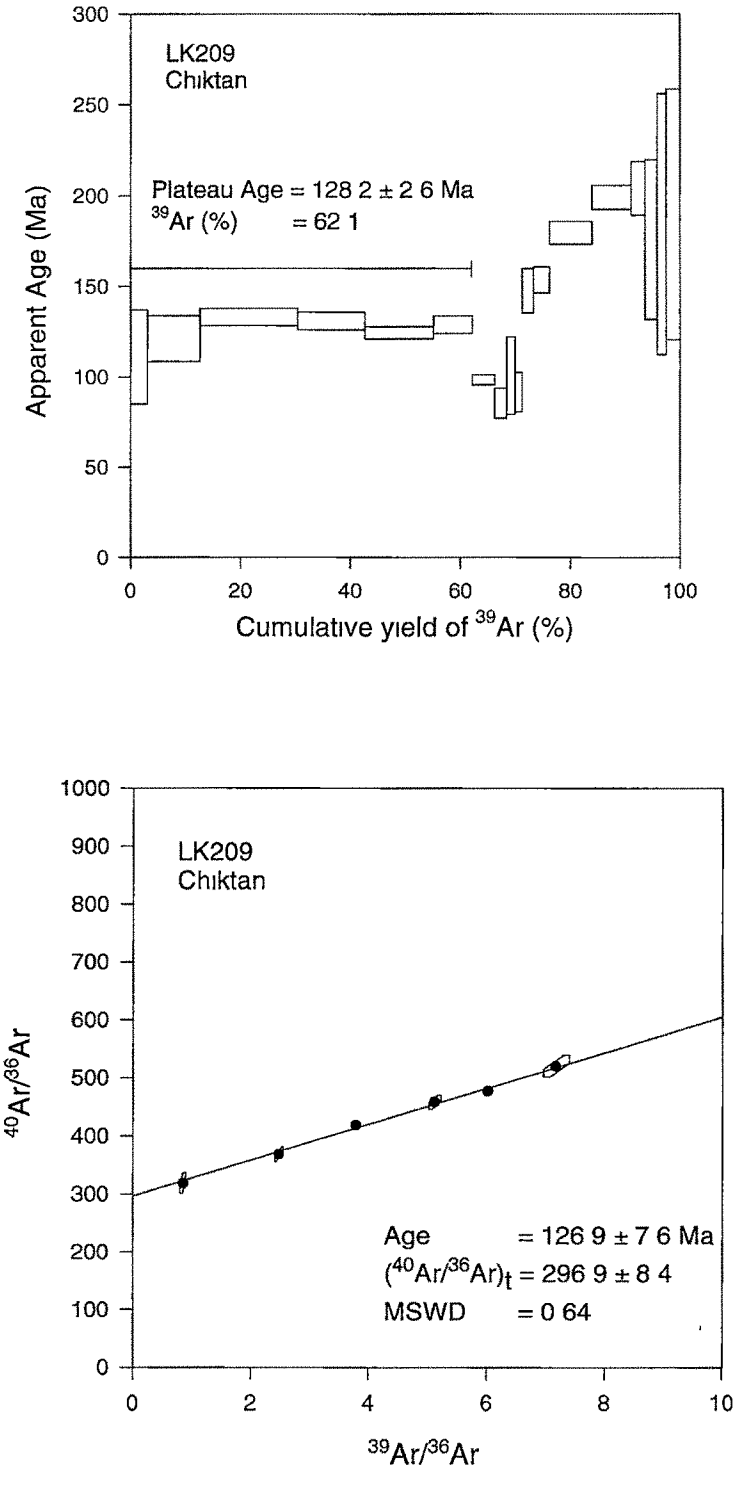

Fig. 4.1 *(Top) $^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LK209. Errors in apparent ages are 2σ without including error in J Plateau age includes error in J.*
(Bottom) $^{40}Ar/^{36}Ar$ vs. $^{39}Ar/^{36}Ar$ correlation diagram is also shown with isochron age (± 2σ). $^{40}Ar/^{36}Ar$ trapped ratio and MSWD value.

Table 4.4 *Argon isotopic composition and apparent ages of sample LK97/182 (Sumdo Nala) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002113 ± .000032***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	0.011013	6 89	13 79	0 47	52 74	0.2477	625 3
	0 000087	0 10	0 39(0 44)			0 0055	10 4
500	0 003397	5 973	18 85	2 90	83 20	0 2650	1758 5
	0 000030	0 038	0 13(0 31)			0 0013	18 5
550	0.001864	6 907	24 07	8 45	92 03	0 15152	3706 1
	0.000012	0 040	0 13(0 38)			0.00030	29 8
600	0 000763	8 369	30 78	22.90	97 30	0 05572	10961 4
	0 000012	0 048	0 16(0 49)			0.00023	180 3
650	0 003079	9 728	33.30	27 72	90.65	0 05015	3159.0
	0 000025	0 056	0.18(0 53)			0 00031	29 8
700	0 0008544	9 815	36 09	14.19	97 43	0.06657	11487.1
	0 0000074	0 057	0 18(0 57)			0 00056	115 6
750	0 001927	10 988	39 28	5 37	94 82	0 13536	5701 1
	0 000050	0 064	0.22(0 63)			0.00027	151 1
800	0 002510	10 94	38 48	7.27	93 22	0 2452	4360 8
	0 000038	0.10	0 21(0 61)			0.0015	69.3
850	0 003676	11 182	38 08	5 40	90 28	1 3069	3041 4
	0.000080	0 065	0.23(0 61)			0 0047	68 1
900	0 00242	10.674	37 57	3 92	93 30	1 5736	4412 4
	0 00015	0 063	0 26(0 62)			0 0031	270 2
950	0 01440	14 31	37 95	1 06	70 28	10 783	994.2
	0 00067	0 39	0 98(1 13)			0.036	48 5
1000	0 0438	32 96	74 77	0.15	60 75	72 91	752.9
	0 0053	2 07	9 48(9 54)			0 15	102 3
1050	0.064	48 16	107 9	0.08	60 58	89.06	749 7
	0.014	4 01	20.7(20 7)			1.36	174 6
1100	0 131	99.1	216 9	0.07	61 00	90 05	757 8
	0 049	12 4	64 7(64 7)			0 28	300 9
1400	0 126	153 4	396 3	0 08	75 77	57 27	1219 7
	0 082	16.3	86 3(86 5)			0 11	805.5
TOTAL	0 002494	9 629	33 58	100.00	92 35	0 6195	3860 2
	0.000075	0 028	0.12(0 52)			0.0013	116.7

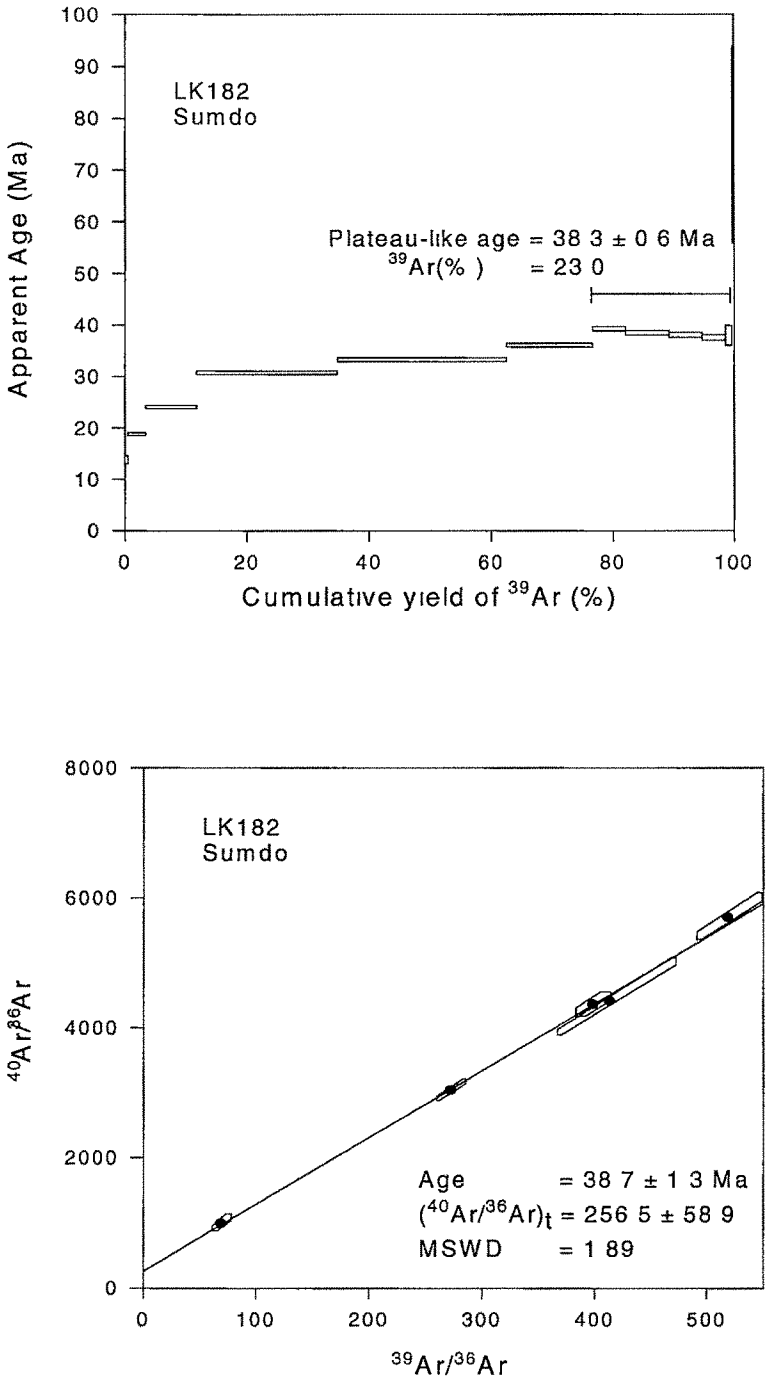

Fig. 4.2 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK182. Apparent age boxes have 2σ errors without including error in J. The plateau-like age includes error in J.*
(Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is also shown with isochron age(±2σ), $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.

Table 4.5 *Argon isotopic composition and apparent ages of sample LK176 (Sumdo Nala) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002256 ± .000027***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	.0506	39.48	97 13	60	62 13	2 274	780.2
	.0013	.55	2 18(2.45)			051	21 6
500	03385	16.66	26 87	3.95	39 94	3 398	491 99
	00038	11	.59(67)			016	6 27
550	017570	12 965	31 36	7 57	59 96	1 784	737 94
	.000091	088	33(50)			067	5 98
600	01230	15 077	45 97	12 48	75 90	1 2575	1226 0
	00023	.089	41(68)			0039	23 8
650	.04560	25 21	47.14	17 46	46 56	7514	552 91
	.00059	15	84(1 00)			0033	7 65
700	00809	14 154	47 24	13 16	83 10	.5357	1748 8
	00014	084	34(65)			0023	32.6
750	.006743	13 642	46 79	21 34	85 39	5559	2023 1
	.000024	.080	28(.61)			0022	12 6
800	.01642	14 996	40 81	9 63	67 64	3 036	913 27
	00013	092	.35(59)			019	8 72
850	03232	19 53	40.14	5 75	51 09	16 111	604 14
	00026	13	53(.71)			032	5 92
900	03061	18 70	38 88	4 06	51 64	21 584	611 0
	00085	14	1.11(1.20)			.043	17 4
950	08201	30 10	23 72	2 00	19 49	38 786	367 04
	.00058	.24	1 10(1.14)			.078	3 80
1000	0597	39 02	84 96	1 10	54.79	126 80	653.6
	0032	.24	3 76(3 88)			49	35 3
1050	0339	32 98	91 13	90	69 64	211 15	973 4
	0057	1 80	8 77(8 83)			2 31	171 1
TOTAL	02226	17 588	44 26	100 00	62 61	6.930	790 30
	00013	041	21(56)			022	4 94

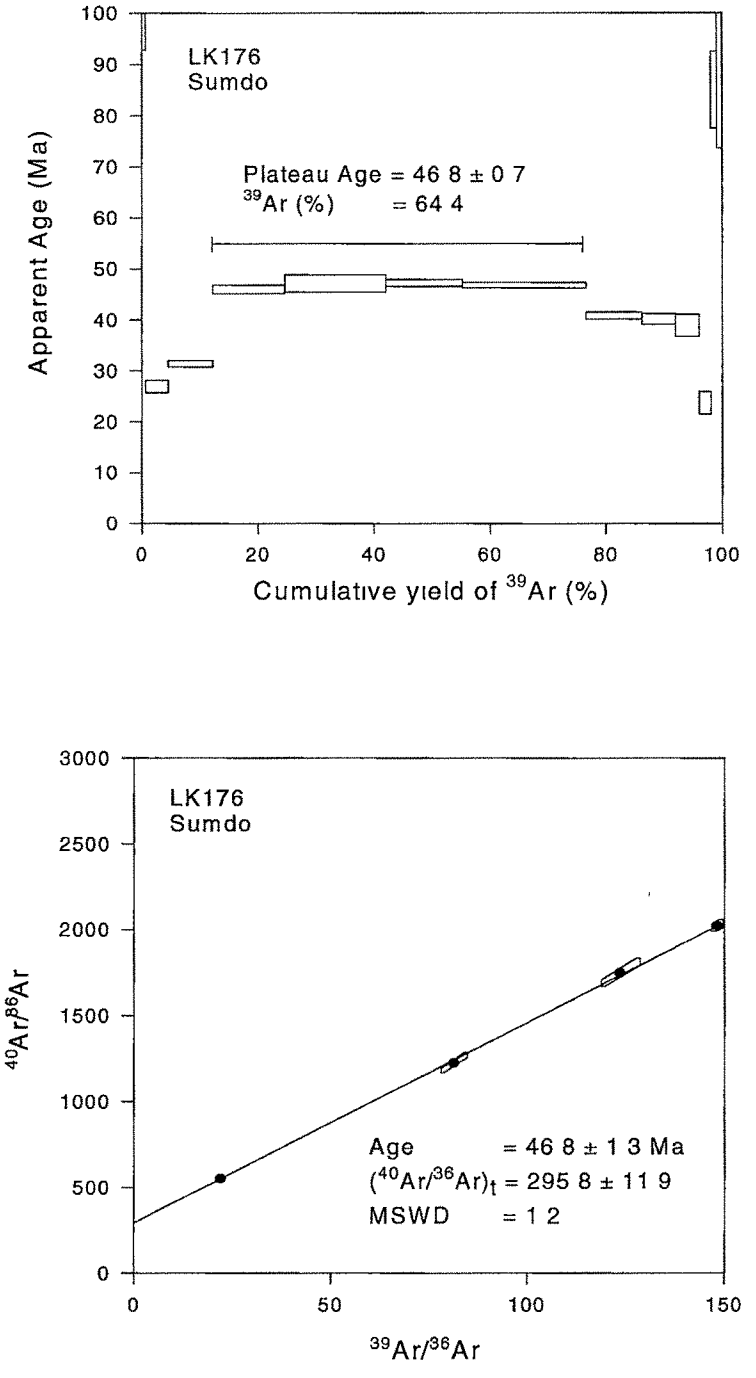

Fig. 4.3 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK176. Error in each apparent age is 2σ without including error in J. The error in plateau age includes error in J.*
(Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is shown with isochron age (±2σ), $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.

Table 4.6 *Argon isotopic composition and apparent ages of sample LG290 (Kharbu, Dras Volcanics) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002447 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
500	1571	53 26	29.98	91	12 86	4 448	339 11
	0033	92	5 78(5 78)			013	9 22
550	0419	15 10	11 99	1 20	18 05	4 597	360.6
	0025	.66	4 34(4 34)			011	26 7
600	01752	13 18	34 99	3 19	60.73	3 4894	752 5
	00094	26	1 64(1 65)			.0070	43 0
650	00669	16 97	64.98	9 85	88 35	3.8590	2537 4
	00031	13	63(72)			0077	117 6
700	00398	20 16	81.88	9.55	94 16	3 8645	5059 6
	00031	.14	68(80)			0077	401.3
750	00342	20 12	82.40	11 21	94.97	5 068	5879.0
	00027	.14	.62(75)			010	462 1
800	.00264	20 22	83 79	6 35	96 14	7 605	7650 5
	.00047	17	90(1.00)			015	1367 4
850	.00464	20.56	82 73	4 87	93 33	7 269	4428 7
	00062	14	.93(1 02)			.015	587 8
900	03558	30 09	84 38	10 00	65.05	6.942	845 60
	00032	19	81(92)			014	9 08
950	.02744	28.45	87.60	11.97	71 50	10.457	1036 8
	.00027	18	.73(86)			.021	11 7
1000	00685	22 68	88 92	17.09	91.07	11 077	3310 6
	.00018	14	56(73)			.022	87.6
1050	.00721	23.67	92.63	9.19	91 00	12 503	3282 8
	00033	17	.75(89)			025	151.2
1100	0647	36.06	73.27	1 02	46.99	37 352	557.4
	0038	.89	6 10(6 12)			075	35 9
1200	0791	54 41	132 02	2 15	57 04	39.501	687 9
	0017	58	3 05(3 12)			079	16 6
1400	1841	94 92	170 48	1 46	42 69	38.839	515.6
	0047	1 82	9 13(9 17)			078	16 4
TOTAL	.01803	24 607	83 14	100 00	78 35	9 1447	1365 0
	.00014	059	.29(52)			0060	10 8

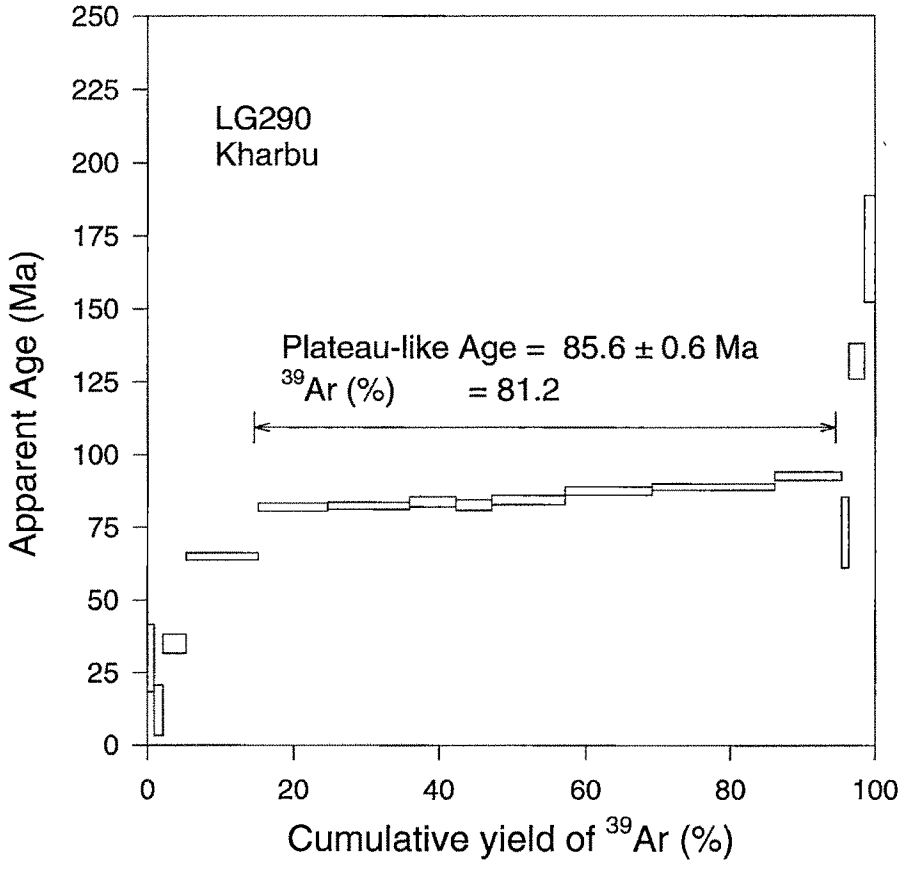

Fig. 4.4 *$^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LK290. The vertical side of the each box is 2σ error in apparent age without including error in J. Error in plateau-like age includes error in J.*

4.5 Ladakh Batholith

Sample LK 24 is a granodiorite from the Shanti Stupa in the vicinity of Leh (Fig.2.2). Whole rock analysis of this sample yielded a complex age spectrum with the three consecutive middle temperature steps (900, 950 & 1000°C) yielding a maximum plateau-like age of 46.3 ± 0.6 Ma consisting of 51% of ^{39}Ar released (Table 4.7 & Fig 4.5). The three point isochron yields an age of 47.3 ± 1.2 Ma with the trapped argon ratio very close to atmospheric as 273.9 ± 20.0.

A biotite (LK24B) separated from this granodiorite yielded an excellent plateau age as 44.6 ± 0.3 Ma for the 13 consecutive steps consisting of 93% of the ^{39}Ar released (Table 4.8 & Fig. 4.6). The corresponding isochron yielded an age of 44.6 ± 0.7Ma with the trapped ratio as 309.5 ± 47.8 and MSWD of 0.63.

Sample LK198 is of a Leucogranite taken from the village Himia in the eastern Ladakh (Figs. 2.2 & 2.4). A cooling pattern for intermediate to higher temperatures (700°C to 1100°C) with a plateau like segment (at 1050°C & 1100°C steps) consisting of 32% of ^{39}Ar released can be seen for the intermediate steps (Table 4.9 & Fig. 4.7). Small amount (~ 10%) of ^{39}Ar was released at initial and final temperature steps.

Muscovite separated from this rock yielded an excellent plateau age of 29.8 ± 0.2 Ma consisting of 100% of ^{39}Ar released (Table 4.10 & Fig. 4.8). Its isochron yielded an age of 29.8 ± 0.4 Ma with the trapped ratio as 288.8 ± 5.3, which is very close to the atmospheric ratio. The MSWD for the fit is 0.39.

Table 4.7 *Argon isotopic composition and apparent ages of sample LK24 (Leh, Ladakh Batholith)at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J J= .002256 ± .000016***

Temp. °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
500	.16419	55 00	26.19	1 47	11 78	1967	334 98
	00088	33	1 45(1 46)			0072	2 50
550	.06299	26 43	31.53	2 53	29 57	12480	419 59
	00022	15	56(60)			00057	2 59
600	.04755	23 55	38 25	4 94	40 34	09223	495 27
	.00025	14	53(59)			00063	3 59
650	.010805	12 927	39 18	5 82	75 30	07354	1196 39
	.000037	075	26(38)			.00074	7 36
700	01417	13.656	38 12	4 27	69.33	.1060	963 4
	00019	079	35(.44)			0023	14.1
750	023864	16 825	39 34	4 02	58 09	16382	705.06
	000083	098	.35(44)			.00050	4 36
800	.03880	20 84	37 73	4 76	44 97	2734	536 98
	.00018	12	45(52)			0011	3 70
850	05378	26 03	40 78	6 02	38 94	5569	483 99
	00019	15	54(.61)			.0022	2.96
900	018589	16 886	45.78	12 31	67.47	1.8963	908 39
	000086	098	.35(47)			0038	6 20
950	.006169	13 500	46 90	26.61	86.50	4 0312	2188.4
	000025	080	28(43)			0081	14.4
1000	00984	14 33	45.90	12.43	79 71	2 0099	1456.7
	00015	.11	.40(.51)			0040	24 5
1050	.03253	19 30	38 99	8.25	50 18	2 2158	593 18
	00025	15	57(63)			0044	6 01
1100	.04551	22.25	35.46	3.70	39 56	1 2352	488 89
	.00064	24	1.18(1.20)			.0025	8 51
1150	.0600	25 42	31 07	1 26	30 29	2.534	423 9
	0021	64	3.51(3.51)			021	18.0
1200	.0414	21.45	37.16	76	43 01	3 424	518 6
	0031	1 13	5.78(5 79)			.063	47 7
1250	.0453	21 65	33 29	58	38 13	3 634	477 6
	0047	1 58	8 38(8 38)			019	60 3
1300	0237	16 50	38 23	27	57 54	4 244	695 9
	0055	1 64	9.21(9 21)			028	176 3
TOTAL	024546	17 731	42.14	100 00	59 09	1 9476	722 35
	.000068	040	16(.33)			0024	2.45

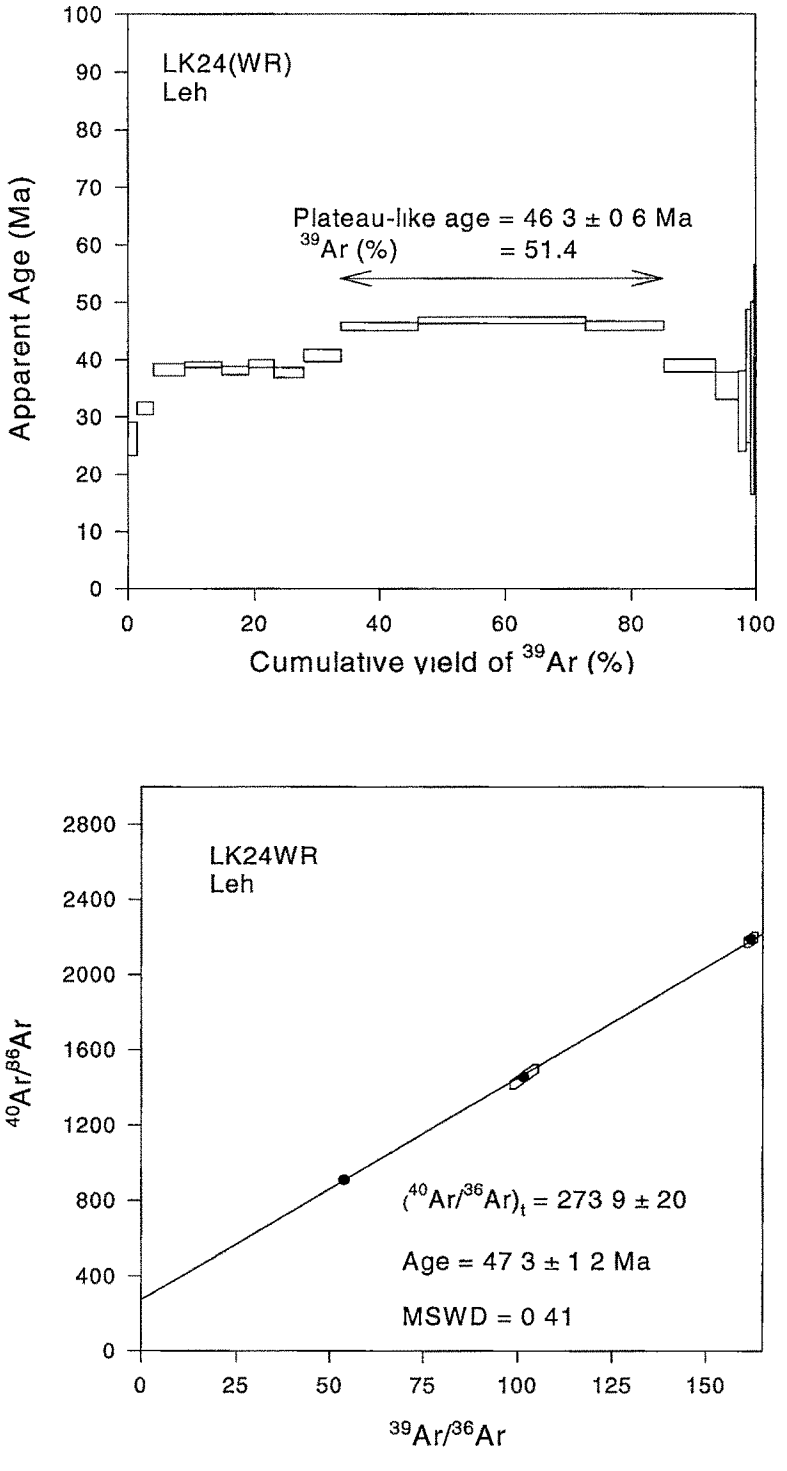

Fig. 4.5 *(Top) $^{40}Ar/^{\beta 9}Ar$ step heating results shown as apparent age spectrum for the sample LK24WR. Vertical side of each box is 2σ error in apparent age without including error in J. The plateau-like age (± 2σ) includes error in J.*
(Bottom) $^{40}Ar/^{\beta 6}Ar$ vs. $^{39}Ar/^{\beta 6}Ar$ correlation diagram is shown with isochron age (± 2σ), $^{40}Ar/^{\beta 6}Ar$ trapped ratio and MSWD value.

Table 4.8 *Argon isotopic composition and apparent ages of sample LK24B (Biotite, Ladakh Batholith, Leh) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002237 ± .000016***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	.06023	22 24	17 85	34	19 99	1738	369 32
	00027	20	82(83)			0060	3 65
500	02256	11 99	21 36	70	44 41	08516	531.59
	.00013	11	.43(45)			00065	5 49
550	013291	12 732	35 18	1 84	69 15	01369	957 97
	000062	081	29(38)			00061	7 04
600	.004585	11 755	41 48	3 57	88 47	.0107	2563.7
	.000091	070	27(39)			0021	52 7
650	003647	12 296	44.70	8 87	91.24	02706	3371.6
	000065	071	26(40)			00028	62 4
700	000815	11 444	44 65	12 28	97 90	003521	14044 5
	.000023	.066	23(39)			000048	410 6
750	001454	11 652	44 72	10 20	96 31	01581	8014 0
	000038	068	24(39)			00026	211 3
800	001522	11.734	44 96	6 03	96 17	01021	7709.0
	000050	069	24(40)			00049	253.9
850	003075	12.147	44.78	7 67	92.52	04084	3950.0
	000039	071	.25(.40)			00077	53 8
900	00231	12.042	45.26	8.45	94 33	.04149	5211.0
	00034	070	47(.56)			00017	773 5
950	.001437	11 580	44 46	15 36	96 33	05667	8059 5
	000033	067	.23(.39)			00011	188.8
1000	000874	11 408	44.43	16.25	97 74	0402	13049 0
	000063	066	.24(.39)			0015	949 6
1050	.000610	11 360	44 55	8.17	98 41	.07106	18632.4
	000042	067	24(.39)			00048	1301.9
1150	0019	11 08	41.97	20	94 96	2 946	5858 3
	0018	80	3 79(3.80)			055	5560 3
TOTAL	.002374	11 762	44 082	100 00	94 04	04864	4954 5
	000034	022	.086(318)			00029	70 6

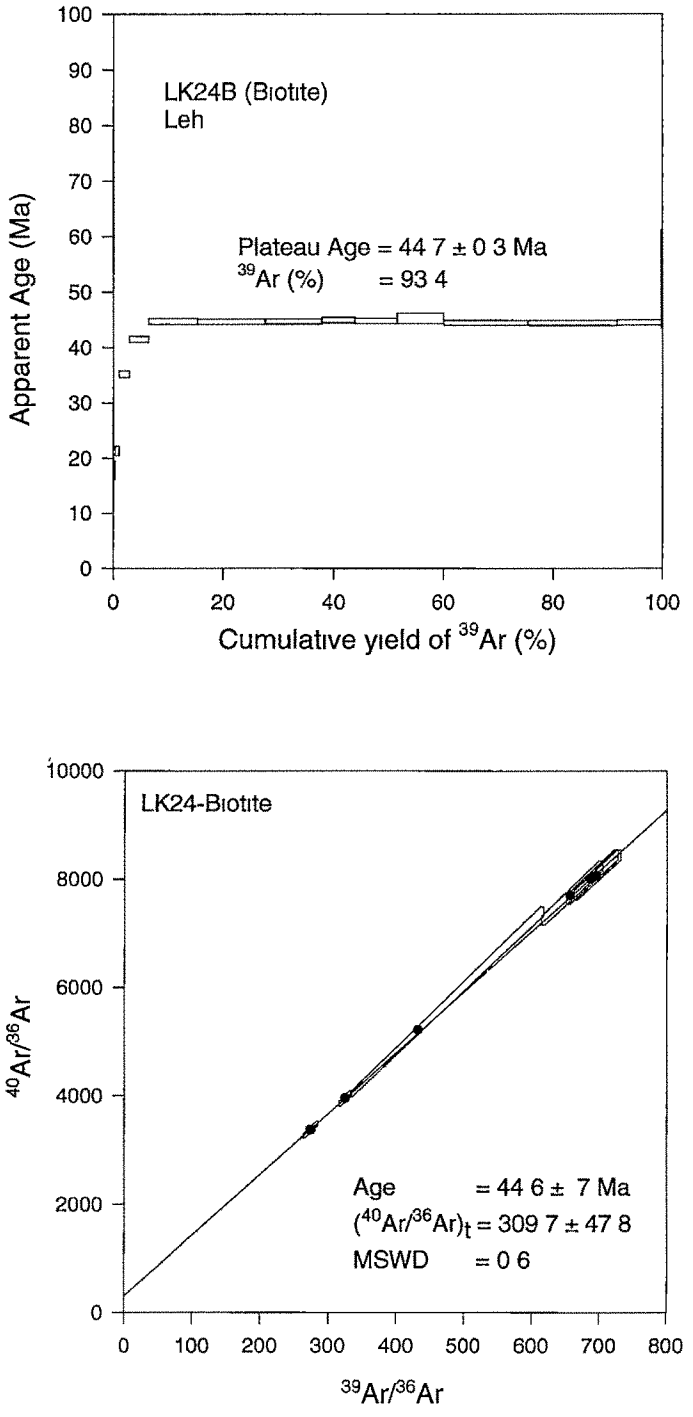

Fig. 4.6 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK24B. The vertical width of the each box is 2σ error in apparent age without including error in J. The plateau age includes error in J.*
(Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is also shown with isochron age (±2σ), $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.

Table 4.9 *Argon isotopic composition and apparent ages of sample LK97/198 (Himia, Ladakh Batholith) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002429 ± .000015***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	.0720	39 89	79 75	1 15	46 65	0474	553 88
	.0012	24	1 74(1 80)			0021	9 92
500	.02359	13 930	30 24	1 63	49 96	1747	590.56
	00012	087	36(41)			0037	4 53
550	019120	12 198	28 47	2 20	53.68	2064	637.97
	000066	076	30(.34)			0018	4 18
600	04454	18 22	22 03	2 39	27 76	21717	409 08
	.00029	11	.54(55)			00043	3 45
650	006190	6 266	19 34	3.53	70 81	1639	1012.3
	000064	042	18(22)			0010	12 1
700	.004645	5 558	18.25	4 19	75 30	1747	1196.51
	.000019	.034	13(17)			0024	8 02
750	006020	6 242	19 45	6 44	71 50	12157	1036 96
	000026	.038	15(.19)			00024	7 15
800	005244	6.324	20 80	6 61	75 50	.08515	1206 05
	000018	039	15(20)			.00017	7 79
850	.004677	6 547	22 49	7.72	78 89	.09668	1399 76
	.000020	040	15(21)			00019	9 62
900	004227	7 220	25 98	6 56	82 70	10547	1707.9
	000015	045	17(23)			00048	11 1
950	005022	7 946	28 10	7 50	81 33	1088	1582 3
	000026	.048	19(.25)			0011	11.8
1000	005347	9 129	32 78	9.13	82 69	1087	1707.4
	000088	054	23(31)			0027	29.5
1050	005641	9 999	36 15	12 00	83 33	.09653	1772 5
	.000051	059	23(32)			00019	18 4
1100	.005293	9 845	35 93	20 91	84 11	08697	1860.0
	000029	.057	22(31)			00059	14 0
1150	01342	13 947	43 22	4.75	71.57	2506	1039.5
	.00017	090	.40(48)			0023	14.4
1200	02458	20 19	55 79	1 09	64 04	.3486	821.6
	00071	.24	1 33(1 37)			0029	25 7
1250	.02958	21 09	53 32	1 11	58 56	.4562	713 0
	00075	26	1 41(1.45)			0077	20 0
1300	0354	22 65	52 59	49	53 76	.5031	639 1
	0026	88	4 99(5 00)			.0057	53 6
1400	0686	33 30	56.19	61	39 11	762	485 3
	0036	1 76	8 71(8.71)			021	36 0
TOTAL	008957	9 760	30 905	100 00	72 88	12978	1089 68
	000036	021	095(211)			.00037	4.85

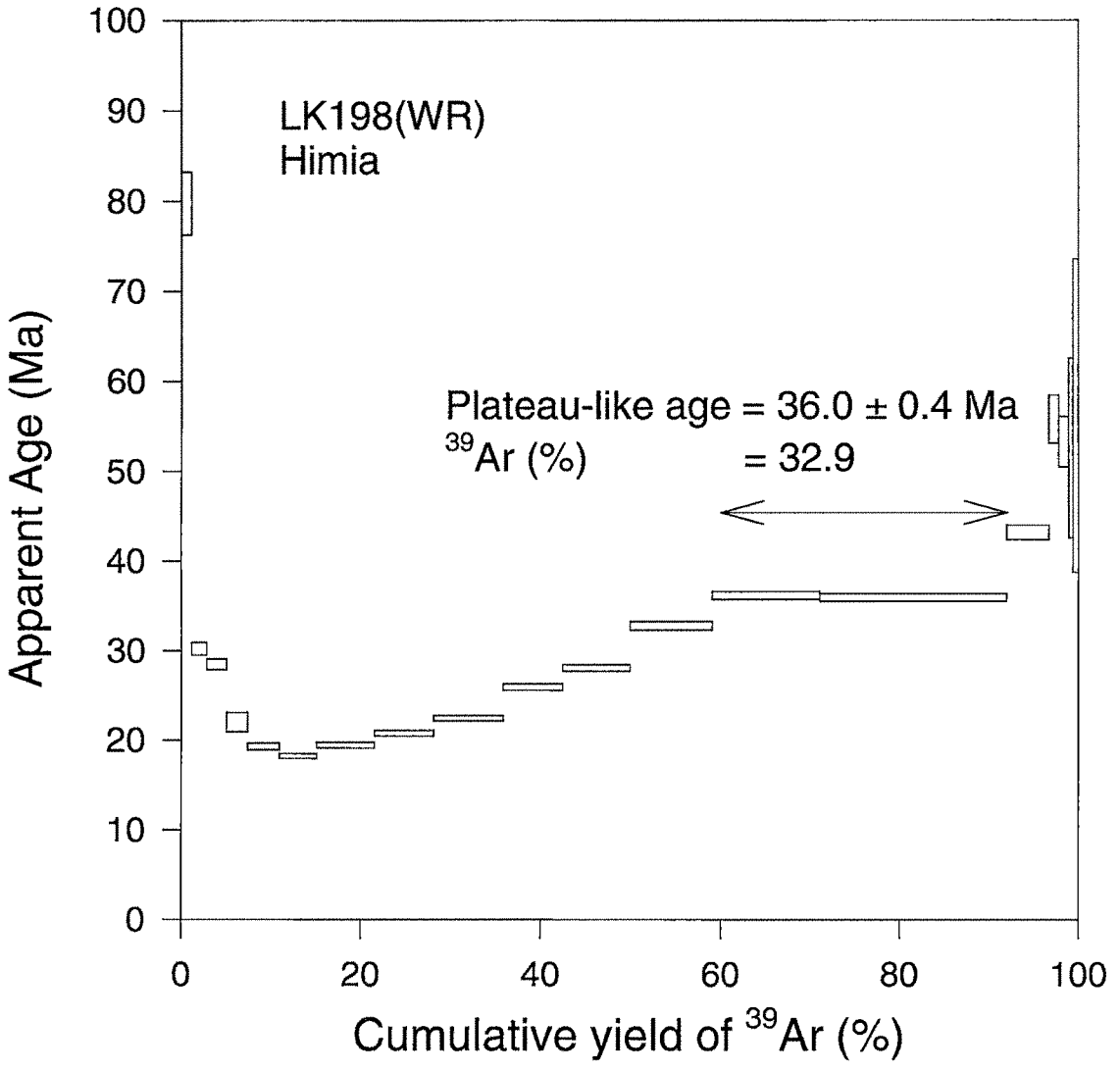

Fig. 4.7 *$^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LK198WR. The vertical width of the each box is 2 σ error in apparent age without including error in J. The plateau-like age includes error in J.*

Table 4.10 *Argon isotopic composition and apparent ages of sample LK97198M (Muscovite, Ladakh Batholith, Himia) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J. J= .002429 ± .000015***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
550	.04292	19 27	26 98	36	34 19	.0677	448 99
	.00015	17	.68(70)			.0019	4 13
600	04987	22.21	30 57	80	33 64	03644	445 31
	00	19	.74(76)			00085	3 92
650	010811	10 299	29 08	1 41	68 98	0143	952 65
	.000037	070	26(31)			0011	6 73
700	.003942	8 509	30 05	4.51	86.31	011322	2158 5
	.000014	051	18(26)			.000062	13 5
750	0009092	7.555	29 82	13 93	96 44	003287	8309 6
	0000034	.044	.16(24)			000054	52 1
800	0004053	7 406	29.82	21 44	98 38	006099	18271 4
	.0000026	043	.15(24)			000064	149 6
850	0009839	7 521	29.60	16.77	96.13	02830	7644 5
	0000097	.044	15(24)			.00040	84 5
900	0008032	7.509	29 76	21 34	96 84	009458	9349.1
	0000062	043	.15(24)			000042	85 8
950	.0007518	7 582	30.12	11.21	97.07	.003839	10085 6
	0000054	044	16(24)			000052	89.1
1000	000137	7 466	30 39	6 15	99 46	00605	54394.6
	000027	.045	.16(.25)			00062	10806.3
1050	000850	7 480	29.59	1 74	96 64	01092	8799 6
	000100	061	26(32)			00018	1033 8
1100	01977	13 80	32 53	.34	57.65	.0628	697.7
	00079	.25	1 37(1.39)			0013	30 5
TOTAL	0016086	7 766	29.840	100 00	93 88	010985	4827 9
	0000047	.018	.062(192)			000082	16 9

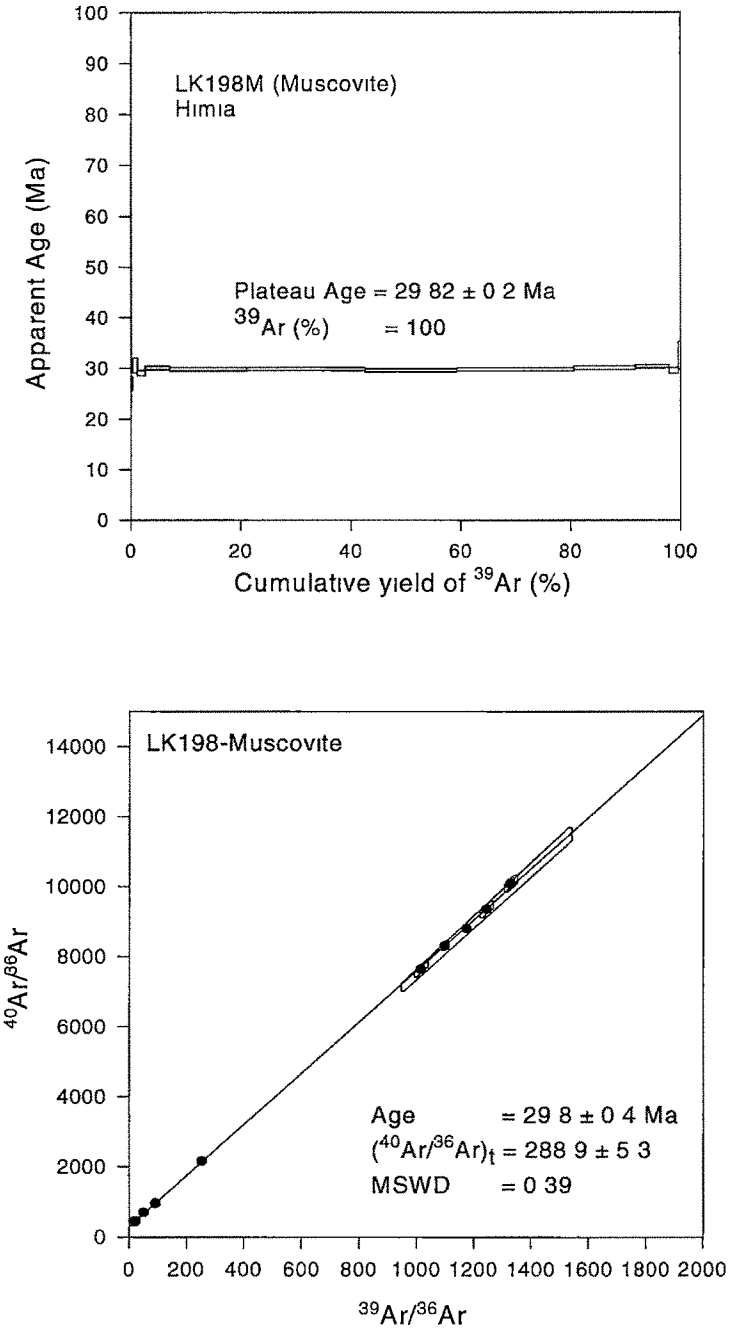

Fig. 4.8 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK198M. The vertical width of the each box is 2σ error in apparent age without including error in J. The plateau age includes error in J.*
(Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is also shown with isochron age (±2σ), $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.

4.6 North of the Ladakh Batholith

4.6.1. Shyok Suture Zone

A total of nine samples were analyzed to cover all the variation in the chemistry of Shyok Suture Zone volcanics, which ranges from tholeiitic basalts to basaltic andesite.

Sample LK 48 is taken from the ophiolitic mélange of the Shyok suture zone near the village Murgi (Figs. 2.2 & 2.5). This has yielded cooling pattern of the rising apparent ages from ~13 Ma to ~ 20 Ma from 650°C to 950°C (Table 4.11 & Fig. 4.9). A very small amount of gas (<1%) released in the first and last step yielded high apparent ages, ~ 30 Ma and ~80 Ma respectively, indicating probably the small amount of excess argon present in the sample.

Sample LK57 from near the village Panamik (Figs. 2.2 & 2.5) yielded a complex age spectrum (Table 4.12 & Fig. 4.10). Overprinting of subsequent tectono-thermal events can be made out from the age spectrum. The apparent ages start from ~ 10 Ma (at 450°C) and go up to ~20 Ma (at 650°C) for the first ~ 40% of the gas released. The apparent ages again become as low as ~ 14 Ma at the seventh temperature step (700°C) and then rise up to as high age as ~ 100 Ma at the maximum temperature step indicating perhaps a superposition of two events. A similar pattern gets repeated for the sample LK 67 which also yielded a disturbed age spectrum. (Table 4.13 & Fig. 4.11), which looks like two separate cooling patterns. The first cooling pattern starts from ~ 12 Ma (at 500°C) and goes up to ~18 Ma (650°C) consisting ~ 30% of the total gas released. The second pattern of the rising ages starts at middle temperature steps from ~11 Ma age and goes up to ~60 Ma consisting of the remaining 70% of the gas released.

Another sample LG 188 taken from the vicinity of the village Tegar (Figs.2.2 & 2.5) yielded a cooling pattern (Table 4.14 & Fig. 4.12) with the apparent ages rising from ~ 14 Ma (at 650°C step) to ~30Ma (at 1200°C step). The same cooling pattern is reproduced by the another sample from the same area, LK68 for the first ~ 60% of the total gas released, however, there is another cooling pattern superimposed, starting from the middle temperature steps at the apparent age ~20 Ma to a very high age of more than 200 Ma, for the remaining ~40% of the gas released (Table 4.15 & Fig. 4.13). Sample

LG 196, taken from the vicinity of the same village however yielded an excess argon pattern with the minimum age as ~30 Ma (Table 4.16 & Fig 4.14).

A basalt sample LG 166 from the village Hunder (Fig 2.2) yielded a typical excess argon pattern with the lower and higher temperature steps yielding very high ages (Table 4.17 & Fig. 4.15). The minimum age at the middle temperature steps of ~50 Ma could be the upper bound on the formation age of this sample. Sample LK 70 from near the village Tirit (Fig. 2.2) also yielded a complex age spectrum and appeared to have two superimposed cooling patterns (Table 4.18 & Fig. 4.16). The first spectrum starts from the apparent age of ~20 Ma (450°C step) and goes up to ~35 Ma (650°C) for the first ~ 55% of the gas released and again the ages become lower than ~25 Ma and then rise to as high values as ~ 100 Ma.

4.6.2. Karakoram Fault Zone

A micaceous segregation from a sheared granite from the Karakoram batholith, LK 47 was collected near the village Murgi (Figs. 2.2 & 2.5). Being crushed and segregated in a fault zone this sample had a large amount of trapped gases, and had to be degassed up to 700°C. It could be analyzed starting from temperature 750°C. However it yielded a very good plateau age of 13.9 ± 0.1 Ma consisting of nine consecutive steps and 99.5% of ^{39}Ar released (Table 4.19 & Fig. 4.17). The isochron of this sample yielded an age of 14.0 ± 0.3 Ma with trapped ratio as 283.6 ± 24.2 and MSWD of 0.2.

Table 4.11 *Argon isotopic composition and apparent ages of sample LK48 (Murgi,Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in J. The errors quoted are in 1σ.* ***J***= *.002253 ± .000014*

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
500	.05212	22 29	27 78	41	30 90	1 47	427 67
	.00027	.14	.55(58)			14	3 22
550	02638	11 701	15 81	2 57	33 39	194	443 60
	.00011	.079	30(32)			018	3 24
600	06699	24.20	17.82	4 97	18 21	096	361 29
	00048	14	72(73)			012	3 18
650	016419	8 115	13 21	7 56	40 21	3880	494 25
	.000057	052	19(21)			0036	3 32
700	023944	10 646	14 45	13 70	33.54	04604	444 62
	.000083	063	23(25)			00047	2.77
750	022677	10 484	15 31	15 92	36 08	09996	462 31
	000079	.062	23(24)			.00089	2.88
800	01400	8 030	15 75	18 16	48 47	.160	573 49
	00020	.048	.28(30)			.013	8 56
850	004167	5 867	18 74	25 72	79 01	1078	1407.74
	000017	035	13(.17)			0023	9 51
900	.006475	7 501	22.56	9 11	74 49	623	1158.4
	000052	.052	20(24)			012	11 9
950	04340	17 91	20 54	.77	28.39	6 63	412 64
	00024	.39	1 57(1 57)			20	9 23
1000	.0996	47 70	72 80	.29	38 32	15 35	479.1
	.0033	1 09	5.67(5 68)			.79	19 3
1150	.276	131 30	192 0	.28	37 98	21 22	476 4
	.015	4 29	18.5(18.5)			43	28.4
1250	077	114 88	340 4	16	80.26	4 02	1496 7
	035	5.97	39 7(39.8)			17	692 0
1400	038	14 51	13 6	34	23 23	2 620	384.9
	022	7 81	41.1(41 1)			070	306.8
TOTAL	01846	9 923	18 07	100 00	45 04	3619	537 64
	.00011	.036	19(22)			0047	3 75

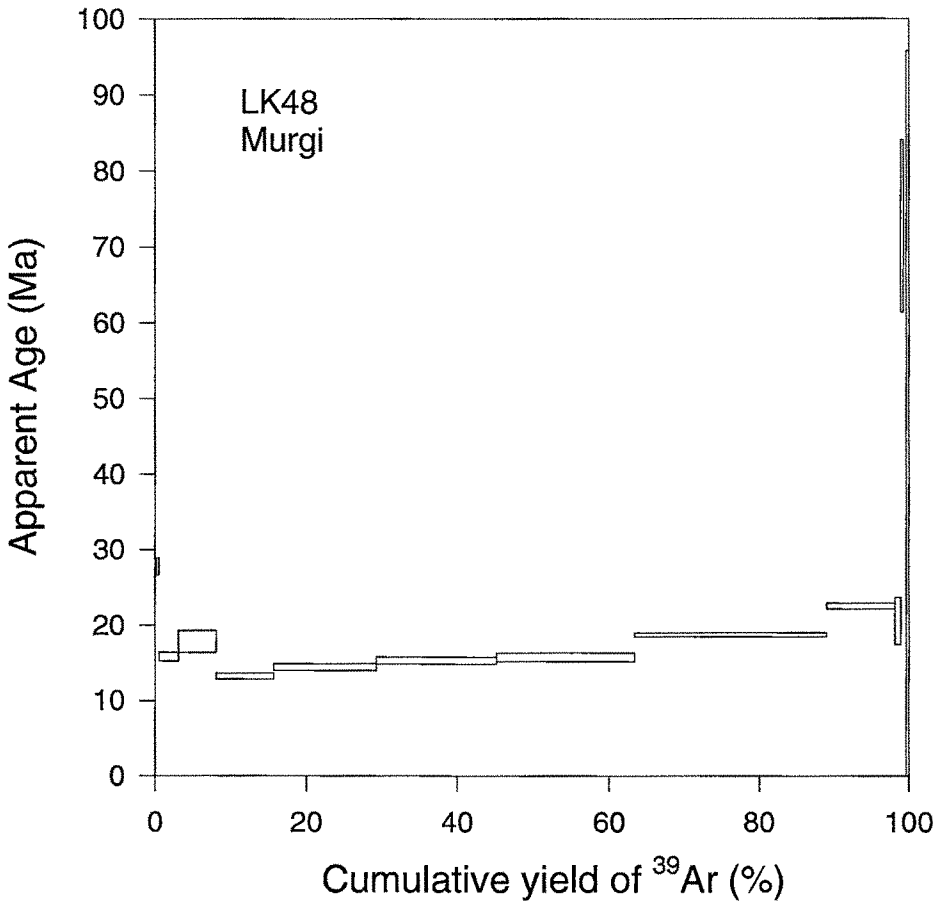

Fig. 4.9 *$^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK48. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.12 *Argon isotopic composition and apparent ages of sample LK57 (between Panamik and Tegar, Shyok Suture Zone)at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002342 ± .000014***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0 02977	13.188	18 45	2 91	33 29	1.177	442 98
	0 00046	0 079	0 064(0 064)			0.015	7 30
450	0 00671	4 079	8 83	4.62	51 40	1 7221	608.0
	0 0013	0 029	0 19(0 20)			0 0058	12 3
500	0.00702	4 450	10 00	4 29	53 38	1 371	633.8
	0 00010	0 034	0 18(0 19)			0 047	10 2
550	0 004142	5 177	16 62	9 42	76 36	0 8375	1250 0
	0 000019	0 032	0 12(0.16)			0 0017	8 99
600	0 00389	5 410	17 90	4 87	78 75	0 90	1390 8
	0 00013	0 039	0.22(0 24)			0 14	46 8
650	0.017174	9 988	20.63	12.97	49 19	0.6305	581 56
	0.000079	0 066	0.22(0 25)			0 0042	4 01
700	0 003929	4 764	15 15	5.99	75.63	0 781	1212 6
	0 000031	0 036	0 14(0 17)			0 011	12 8
750	0.00558	5 018	14 18	3.14	67 16	1 487	899 8
	0 00014	0.054	0 28(0 29)			0 043	25 0
800	0 004152	5 251	16 92	7 45	76 64	1.7712	1264 7
	0.000063	0 037	0.16(0 19)			0.0089	20 8
850	0 004224	5 540	18 03	8 58	77.47	2 3065	1311.45
	0.000016	0 037	0 14(0 18)			0 0046	9 39
900	0 005648	6 849	21 75	12.98	75 63	4 494	1212 71
	0 000035	0.042	0 16(0.20)			0.054	9.92
950	0 01045	8 596	23 11	5 31	64 06	6 680	822 2
	0 00040	0 063	0 55(0 56)			0.053	32 0
1000	0 01435	10.558	26.48	4 27	59 82	7 583	735 5
	0 00045	0 083	0 63(0 65)			0 26	23 5
1050	0.02089	16 33	42 38	30 70	62 18	9 271	781 42
	0 00019	0 12	0 50(0 56)			0 029	8 78
1100	0 01887	24 53	78 32	1 82	77 27	12.392	1299 9
	0.00076	0 24	1 30(1.37)			0 025	53 9
1150	0 01759	28 29	94.97	2.40	81 62	10 46	1607.7
	0 00056	0 28	1 26(1.37)			0 10	53 8
1200	0 01621	27 70	94 25	2 26	82 71	9 410	1708 9
	0 00059	0 35	1.53(1 62)			0.019	66 1
1250	0 019	23 31	73.2	0.92	75 86	9.33	1224 2
	0 017	0 94	20 9(20 9)			0 10	1106.3
1300	0 0293	27 24	76 83	1 43	68 22	10 15	929 8
	0 0013	0 72	3.32(3 35)			0.18	49.1
1350	0.0892	41 72	63.73	0.74	36 82	11 169	467 7
	0 0033	1 59	7.55(7.56)			0 097	24 8
TOTAL	0 1116	9 352	25 39	100 00	64 73	3 416	837 9
	0 00017	0.034	0 26(0 30)			0 011	13 4

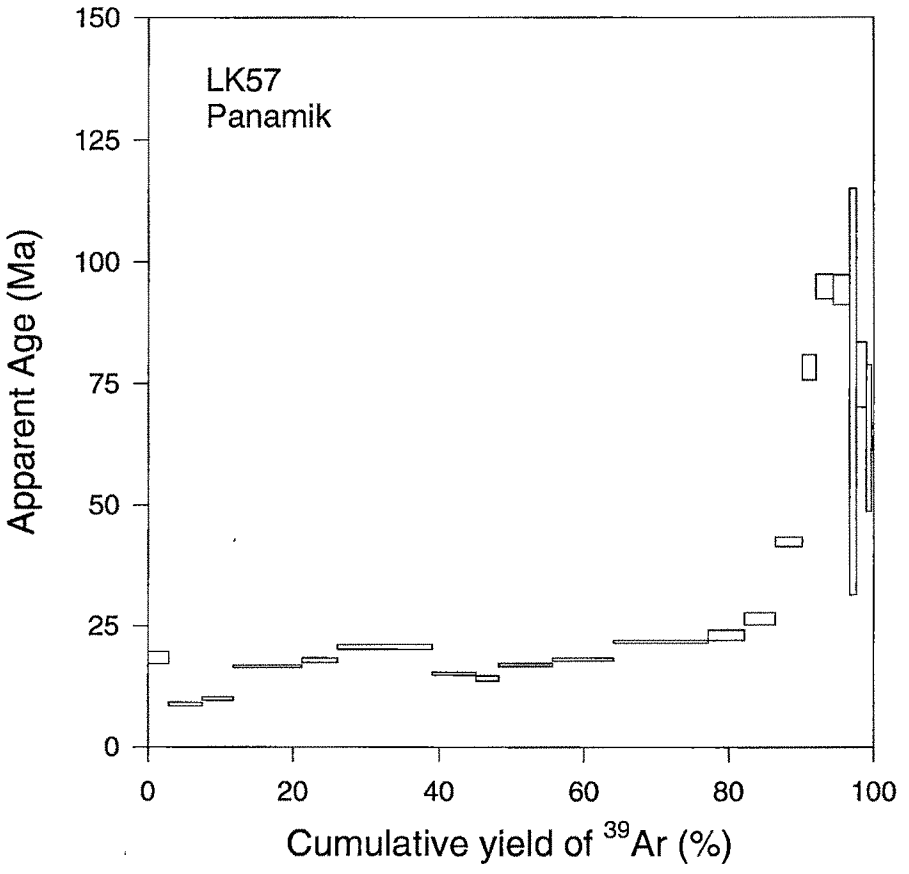

Fig. 4.10 *^{40}Ar/^{39}Ar step heating results shown as apparent age spectrum for the sample LK57. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.13 *Argon isotopic composition and apparent ages of sample LK67 (between Panamik and Tegar, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002294 ± .000014***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0.1552	53 07	29 62	0 63	13 60	1 36	342 01
	0.0013	0 31	1 84(1 85)			0 13	3 36
450	0 02659	11 275	14 08	2.57	30 30	1 19	424 0
	0 00097	0 068	1 20(1 20)			0.14	15 6
500	0 013927	6 946	11 67	7 86	40.75	0 7930	498 71
	0.000049	0.041	0.15(0 17)			0 0080	3 11
550	0.011995	7 950	18 14	9 01	55 42	0 8132	662 78
	0.000042	0 047	0 17(0 20)			0 0072	4 14
600	0 01803	9 875	18 72	4.92	46 05	0.779	547.71
	0 00023	0 59	0 34(0.36)			0 012	7 48
650	0 014923	8 568	17 12	10.55	48 53	0 9233	574 15
	0 000082	0.55	0 20(0 23)			0 0018	4 40
700	0.014384	7.016	11 40	4 63	39 41	1 2004	487 73
	0 000050	0 044	0 16(0 18)			0 0024	3 22
750	0 010423	6 052	12 26	4.71	49 11	1 2964	580 63
	0 000046	0 039	0 15(0 17)			0 0048	4.21
800	0 007696	5 375	12.78	8 09	57 69	1 2018	698 42
	0.000027	0.033	0.12(0 14)			0 0037	4 51
850	0.009680	5.915	12 59	11 79	51 64	1 219	611 07
	0 000054	0 035	0 14(0 16)			0 018	4 67
900	0 010606	6 588	14 23	13 64	52.43	1 7445	621.14
	0 000044	0.039	0 15(0 17)			0 0059	4 15
950	0.014598	7.941	14 95	9 17	45 68	2 3755	544 0
	0 000051	0.048	0 18(0 20)			0 0057	3 49
1000	0 02134	10 71	18 15	4.53	41 15	3.801	502.10
	0 00036	0.11	0 46(0 47)			0 012	9 00
1050	0 0305	15 00	24 65	2 49	39 99	3 5	492 4
	0 0023	0 19	0 86(0 88)			13 6	36 3
1100	0 03408	21 17	45 36	1.36	52.43	6 624	621 19
	0 00014	0.30	1 17(1.20)			0 043	8 83
1150	0 04290	26 65	56 89	0 91	52 42	8 181	621.1
	0 00032	0 56	2 24(2 26)			0 016	13.7
1200	0 0350	23 95	55 44	0 76	56 80	8 454	684 0
	0 0010	0 76	3 25(3.26)			0 043	29 1
1250	0 0376	20 41	38 05	0.61	45.54	8.464	542.6
	0 0015	1 07	4 70(4 70)			0 017	36 0
1300	0 0458	26 73	53.81	1 03	49 39	9 140	583 9
	0.0010	0 80	3 41(3 43)			0.024	21 6
1350	0 0641	23 75	19 74	0 77	20.20	8 258	370.3
	0 0017	1 59	6.83(6 83)			0 017	26 7
TOTAL	0 016048	8 801	16 72	100 00	46 12	1 82	548 40
	0 000070	0 023	0 10(0 14)			0.34	2 73

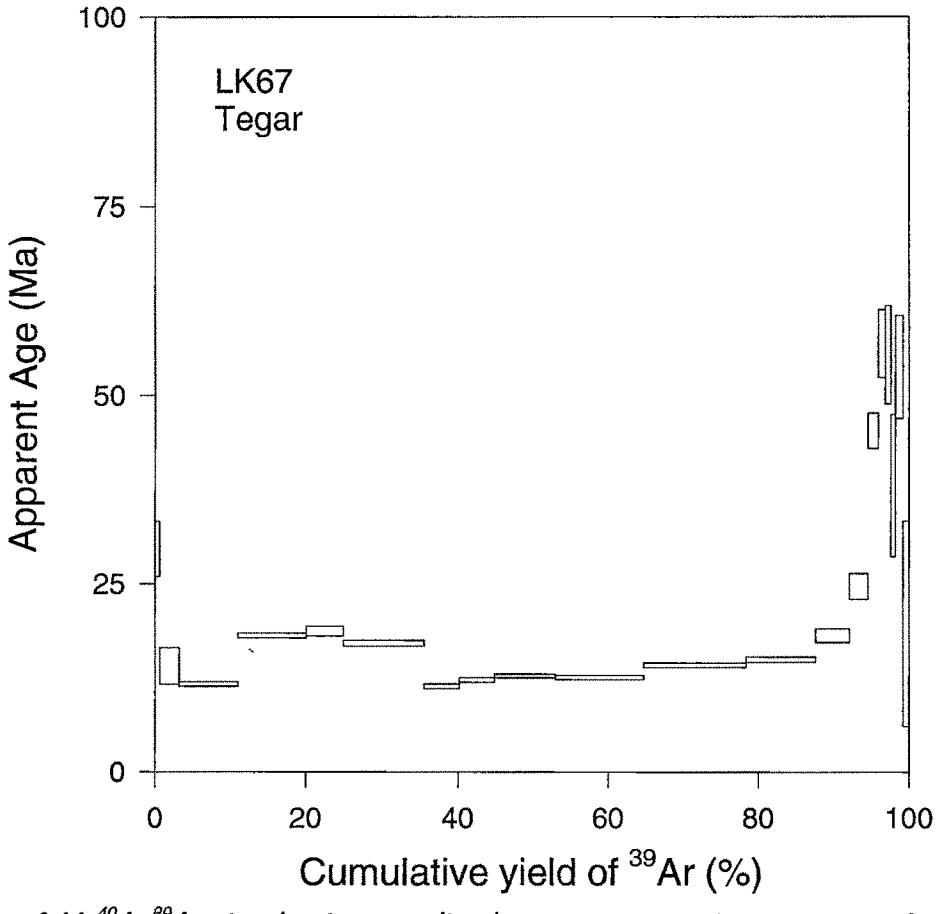

Fig. 4.11 *$^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK67. The vertical side of the each box is 2σ error in apparent age without including error in J*

Table 4.14 *Argon isotopic composition and apparent ages of sample LG188 (Tegar, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002447 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
500	1232	37.40	4 39	46	2 66	4760	303 58
	0016	.40	2 59(2 59)			0046	4 93
550	03847	13 05	7 43	67	12 92	.3781	339 33
	00088	25	1 53(1 53)			0035	9 92
600	01990	7 796	8.43	2.17	24 57	3815	391.75
	.00028	.084	.51(51)			0011	6 91
650	.02751	11 319	14 02	5 28	28 18	47611	411.46
	00015	072	33(34)			00095	3 26
700	02383	10 397	14 74	4 82	32.26	3407	436 24
	.00016	.068	33(34)			.0025	3 96
750	01796	8 624	14 57	10 34	38.44	26624	480.04
	00015	052	27(28)			00053	4 77
800	.01062	6 749	15 86	6.36	53 49	26385	635.29
	.00011	.046	23(24)			00079	7.62
850	009226	6 452	16 37	10 17	57 75	42483	699 35
	000064	040	.17(20)			.00085	6 26
900	004340	5 128	16 89	22 00	74.99	5656	1181 7
	.000038	.031	13(.16)			0021	12.2
950	007587	6 403	18 27	11 16	64 98	1.7612	843.89
	.000059	040	17(20)			0035	8.09
1000	.006988	6 469	19 33	12 33	68.08	2.0900	925 7
	000086	040	19(.21)			0042	12 4
1150	01645	11 048	27.09	5 63	55 99	4 3866	671 4
	.00023	071	40(.42)			.0088	10 1
1200	01730	12 739	33 35	6.96	59 88	3 4714	736 49
	00015	079	35(39)			0069	7.52
1300	.03600	19 32	37 90	1 28	44 93	3 5718	536 6
	00087	25	1 53(1 55)			0075	14 6
1400	0530	20 88	22 87	37	24 98	3 174	393 9
	.0035	1 41	7.59(7 59)			010	37 0
TOTAL	012777	7.978	18 448	100 00	52 67	1.2669	624 35
	000038	017	079(125)			0011	2.16

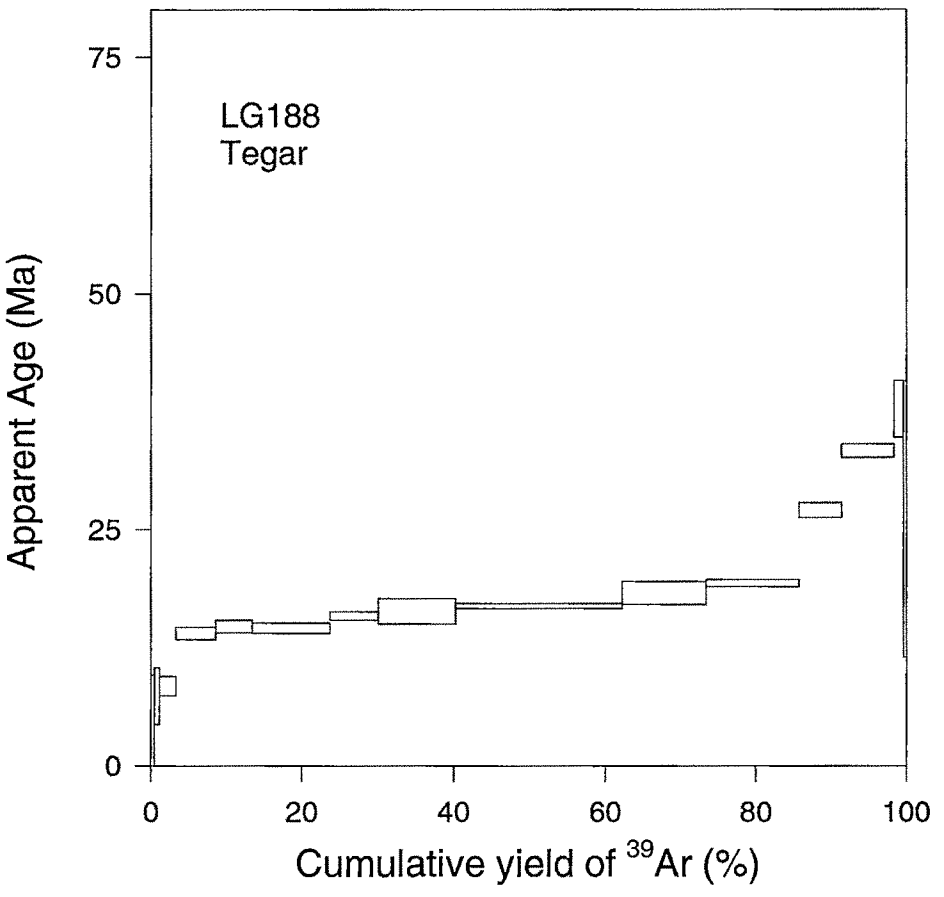

Fig. 4.12 *^{40}Ar/^{89}Ar step heating results shown as apparent age spectrum for the sample LG188. The vertical side of the each box is 2σ error in apparent age without including error in J*

Table 4.15 *Argon isotopic composition and apparent ages of sample LK68 (between Panamık and Tegar, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002321 ± .000014***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0 0320	10 85	5 8	0 64	12 86	1 92	339 1
	0 0081	0 11	10.0(10.0)			0 23	86 3
450	0 005368	2 098	14 64	5.55	68 89	1 0284	949.70
	0 000028	0 032	0 12(0 15)			0 0021	7.32
500	0 003571	5 880	20 09	8.46	82 06	0 7565	1646 9
	0 000016	0 035	0.13(0 17)			0.0056	11.4
550	0 002562	7 001	25.95	12 07	89.19	0.7556	2733.1
	0 000021	0.049	0.15(0 21)			0 0070	26.1
600	0 00273	7.861	29.29	7 77	89 75	0 583	2881 7
	0 00017	0 047	0 26(0 31)			0 023	177 0
650	0 005398	9 459	32 63	21 74	83 14	0 6178	1752 3
	0 000019	0.055	0 20(0.27)			0 0026	10.8
700	0 004286	7 024	23 94	4 73	81.97	1 432	1638.8
	0 000030	0 056	0.17(0 22)			0 017	14.9
750	0 00440	6 861	23 13	4 12	81 05	1 6449	1559.4
	0 00017	0 046	0.27(0 30)			0 0033	60 6
800	0.004504	7 033	23 72	4.00	81.08	1 6177	1561 6
	0 000041	0 048	0 19(0 23)			0.0032	17 3
850	0 00476	7 969	27.30	5 84	82.46	1 7892	1684 5
	0 00016	0 050	0.27(0 31)			0 0041	57 1
900	0.003783	9.400	34 35	8 99	88 11	2 6632	2485 2
	0 000095	0.056	0 23(0.31)			0 0098	63.8
950	0 003744	10.939	40 70	8 11	89 89	3.0635	2921 7
	0 000046	0 066	0 24(0 34)			0.0061	39 0
1000	0.009287	13 552	44 69	4 16	79 75	4 917	1459 3
	0 000045	0 087	0 32(0 41)			0 032	10 9
1050	0.02277	28.84	90 28	1.28	76 67	10 885	1266 6
	0 00018	0 22	0.85(0 99)			0.022	13 7
1100	0 0183	46 76	165 26	0 52	88 41	12 978	2550 0
	0.0015	0 54	2 61(2 77)			0 091	207 8
1150	0 0223	60.95	214 38	0.44	89 21	14 74	2738 0
	0 0023	0 79	3.65(3 84)			0 35	279.7
1400	0 0135	58 07	213 30	1 58	93 14	17 40	4306 3
	0.0037	1 06	5 61(5 73)			0 12	1171 6
TOTAL	0 005066	9 817	34 50	100.00	84 75	1 9475	1937 6
	0 000082	0 025	0.14(0 24)			0 0040	31.5

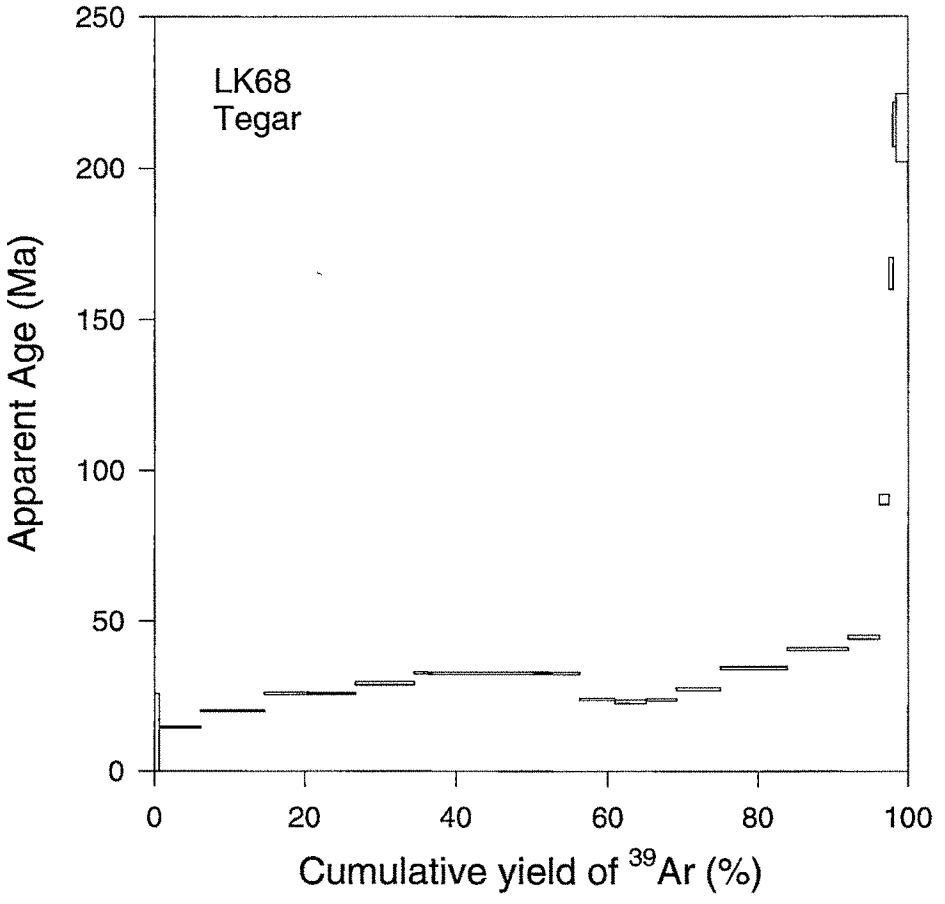

Fig. 4.13 *^{40}Ar/^{39}Ar step heating results shown as apparent age spectrum for the sample LK68. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.16 *Argon isotopic composition and apparent ages of sample LG197 (Tegar, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002362 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
500	1373	112.26	282 10	57	63 85	1 0813	817.4
	0024	89	3 96(4 21)			0044	15 4
550	0687	38 95	77.80	85	47 91	1 068	567.2
	0016	48	2 68(2 71)			031	14.8
600	.02948	21 23	52 56	3 45	58 96	1 3429	720 1
	00040	16	78(83)			0096	11.1
650	02178	14 26	33.04	5 68	54 87	2.0647	654 83
	00026	10	50(.53)			0041	8 86
700	02216	15 56	37 99	6 21	57 92	2.1196	702 20
	.00023	.11	49(53)			.0060	8 48
750	01112	12 157	37.40	12 15	72 96	1 7796	1092.8
	00012	076	32(.38)			0036	13.0
800	00453	8 428	29.96	11 43	84 13	9286	1862 3
	.00012	.058	26(31)			0019	50 1
850	004223	8 141	29 13	17 07	84.67	.6029	1928.0
	000080	.052	22(27)			.0024	38 3
900	003725	8 676	31 99	19 14	87 31	994	2329 4
	000072	.054	22(.28)			011	46 9
950	01077	11 417	34 74	11 11	72 13	6 047	1060 3
	00013	073	31(37)			.012	13 9
1000	.01425	14 57	43.61	3 49	71.11	5 682	1022 8
	00039	.13	70(74)			011	29 2
1050	02675	30 06	91 99	2 09	73.70	9 311	1123 6
	00065	24	1.20(1 30)			.019	28 6
1100	.04023	55 45	176 62	2 40	78 56	21.056	1378 1
	00060	36	1 42(1 69)			.042	22 2
1200	06036	97.82	312 11	3 10	81.76	17 013	1620 5
	00053	.58	1 90(2 47)			034	16 4
1300	0756	114 56	355.44	91	80 50	15 202	1515 7
	0027	99	4.27(4.63)			030	54 6
1400	1310	115 08	299 1	33	66 35	21.14	878.3
	0092	3 55	15 8(15 9)			14	66 8
TOTAL	014526	17.181	54 09	100.00	75 02	3 2346	1182 74
	000066	036	15(33)			0032	5 80

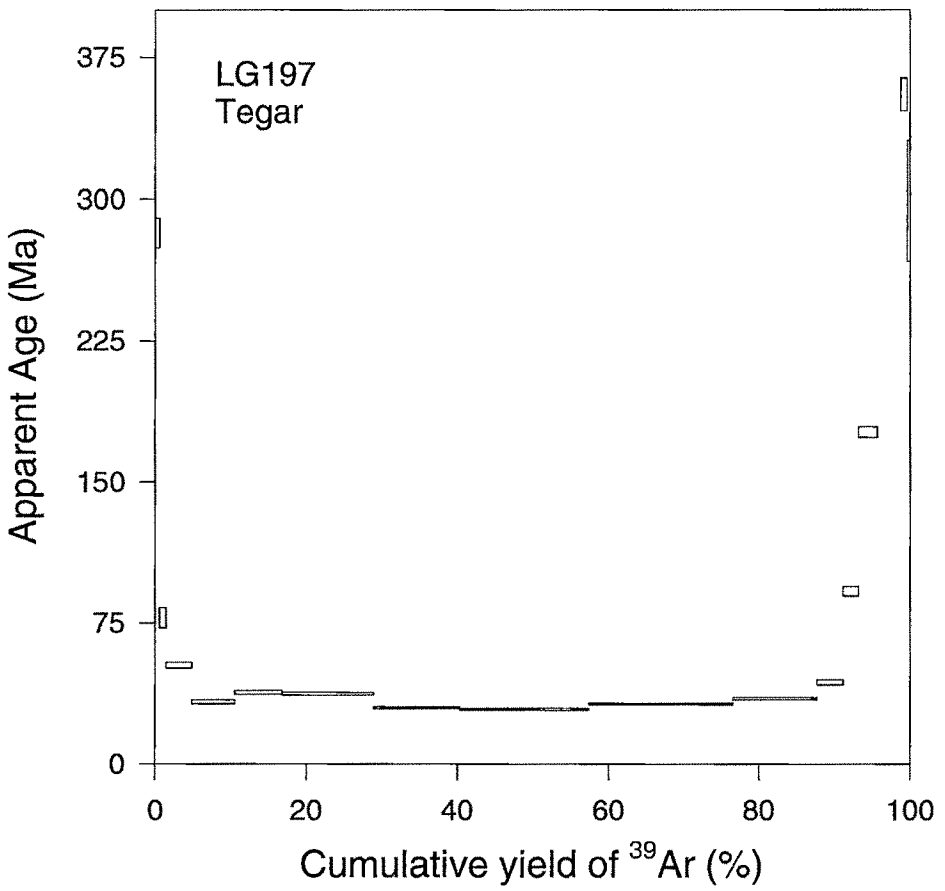

Fig. 4.14 *$^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LG197. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.17 *Argon isotopic composition and apparent ages of sample LG166 (Hunder, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002362 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
450	.099 012	94 8 3 1	259 17(17)	03	69 08	2 121 014	956 116
500	0978 0081	85 7 2 2	227. 12(12)	05	66 27	2 259 018	876. 76
550	.2709 .0037	256 3 1 8	627 8 5(5 8)	37	68.77	2 0351 0052	946 14
600	.10180 .00041	83 62 48	214 8 1 6(2 0)	1.72	64 03	1 4962 0030	821 4 5 3
650	.05511 00028	48 76 33	133.28 98(1 21)	4 49	66 60	1 2584 0025	884.7 6 4
700	02904 .00011	29 22 17	85 84 .60(.76)	12 43	70.63	8210 .0024	1006 2 6.2
750	.006691 .000035	14 047 081	50 70 30(40)	25 20	85 92	.45894 00092	2099 15
800	003302 000027	12 347 072	47 81 26(37)	15 43	92 10	38084 00097	3740 36
850	.004273 .000041	14 747 086	56 55 31(.44)	10 82	91.44	6155 0021	3451 38.
900	.005637 000043	17 39 .10	65 78 36(51)	11.98	90 42	6696 0013	3085 28
950	.007964 .000048	21.40 12	79 36 .44(.62)	9 38	89.00	8260 0017	2687 21
1000	.01469 00011	36 17 .21	130 73 73(1.01)	4 16	88 00	1.0674 0021	2462 22
1050	02687 .00016	62 38 36	218 2 1 2(1.6)	2 77	87.27	1.1879 0024	2321. 18
1100	.06855 00060	133 72 .79	428 2 2 4(3.2)	67	84 85	2 367 019	1951. 20
1150	1877 .0028	347 5 3 8	946 2 5 9(7.2)	18	84 04	6 862 094	1851 30
1200	.2264 0054	405.0 3.1	1058 7 7 2(8 5)	08	83.48	7 358 .047	1788 44
1300	.2928 0082	543 2 5 5	1319 8 8.5(9.9)	08	84 07	9 339 043	1855 53
1400	.2763 0055	457 6 3 5	1146 3 7.8(9 1)	15	82.16	8.501 065	1656. 35
TOTAL	015992 000031	25 636 .047	86 95 .16(49)	100 00	81.57	72438 00060	1603 0 3 9

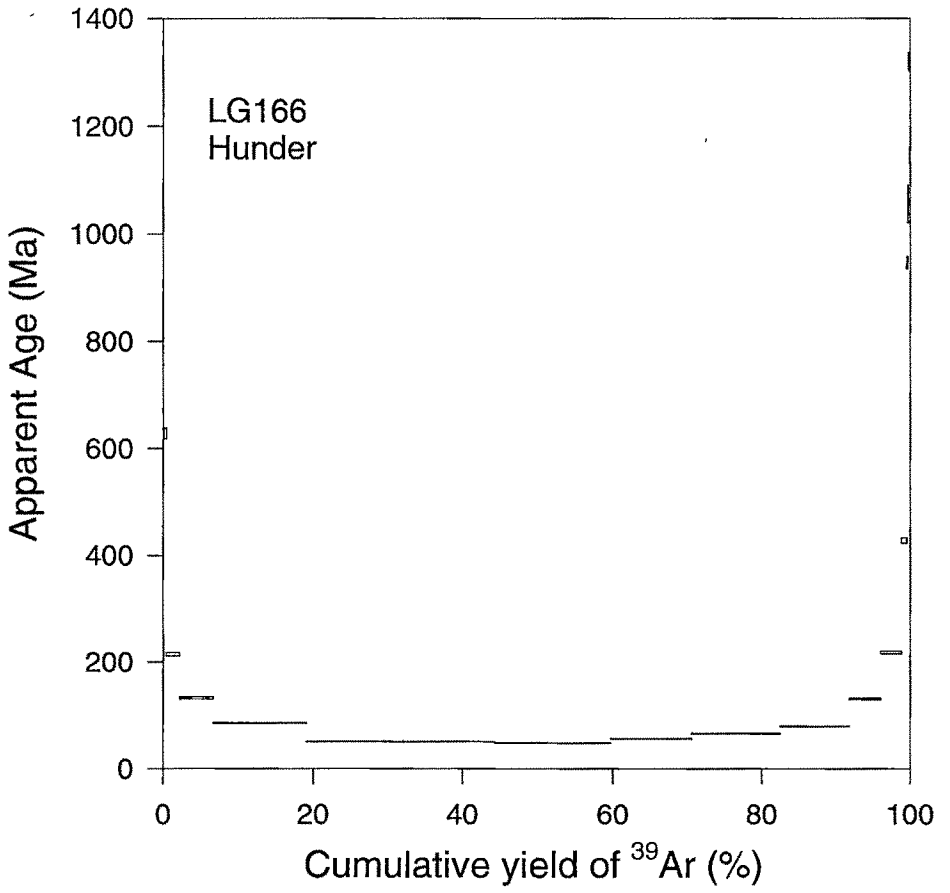

Fig. 4.15 *^{40}Ar/^{89}Ar step heating results shown as apparent age spectrum for the sample LG166. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.18 *Argon isotopic composition and apparent ages of sample LK70 (between Panamik and Tegar, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002417 ± .000015***

Temp. °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0.16439	57 14	36 95	0 28	14 99	0.7256	347.59
	0 00057	0 33	1 29(1.31)			0 0059	2 12
450	0.04923	19 64	22 06	1 67	25 93	0 1293	398 95
	0 00048	0.12	0 71(0.73)			0.0013	4 35
500	0 01049	7 39	18 62	4 37	58 07	0.306	704 8
	0 00017	0 15	0 50(0 51)			0 022	15 6
550	0 005009	6 148	20 24	7 68	75 93	0 1820	1227 5
	0 000069	0.086	0 14(0 19)			0 0023	18 2
600	0 004249	7.749	28 09	13 70	83 80	0 0934	1823 9
	0 000034	0 064	0 17(0 25)			0 0075	17.3
650	0 00588	9 711	34 43	25 82	82 12	0.0506	1652 6
	0 00014	0 056	0 27(0.35)			0 0056	40.2
700	0.0020772	7 744	30.82	11 91	92 07	0 102	3728 0
	0 0000082	0 045	0 17(0 26)			0 023	24 0
750	0 003263	6 943	25 87	5.68	86.11	0 1984	2127 5
	0 000031	0 041	0 16(0.23)			0 0085	23.0
800	0 003369	7 439	27.87	4 80	86 62	0.5016	2208 2
	0 000063	0 044	0 19(0 25)			0.0034	42 7
850	0 004010	9 036	33 91	5 44	86.89	0 655	2253 4
	0 000015	0.054	0.20(0 29)			0 013	14 6
900	0 006617	11 859	42 66	5 91	83.51	1 675	17 92 2
	0 000036	0 084	0 26(0 37)			0 013	13.3
950	0 004807	12 890	49.32	5 46	88 98	1.242	2681 4
	0 000065	0 076	0 29(0 43)			0.068	38 9
1000	0.004951	15.768	61 31	4 74	90 72	0 516	3185 1
	0.000018	0 095	0 35(0 52)			0 015	20 4
1050	0 02520	27 41	85 01	1.14	72 84	0 627	1088 0
	0.00043	0 21	0 97(1.10)			0 031	20 0
1100	0.001113	106 09	410 54	0 37	99 69	1 80	95345.2
	0 000061	1 68	4 86(5.38)			0.16	5353.2
1150	0 0767	121 13	385 07	0 35	81 30	17 98	1579 8
	0.0020	2.16	6.21(6 59)			1 47	45 9
1200	0 1052	61 33	127 2	0 19	49 30	76 71	582 9
	0 0052	3 00	13 5(13 5)			0 48	40.3
1250	0 1073	65.91	143.3	0 25	51 91	101 82	614 4
	0.0053	2 36	11 4(11 4)			1 24	37.4
1300	0 0779	102 52	316 9	0 25	77 54	24 30	1315 4
	0 0060	2 86	12 2(12 4)			0 16	108.2
TOTAL	0.007146	10.827	37 60	100 00	80 50	0.8670	1515 1
	0.000046	0 029	0 11(0 26)			0.0080	10 2

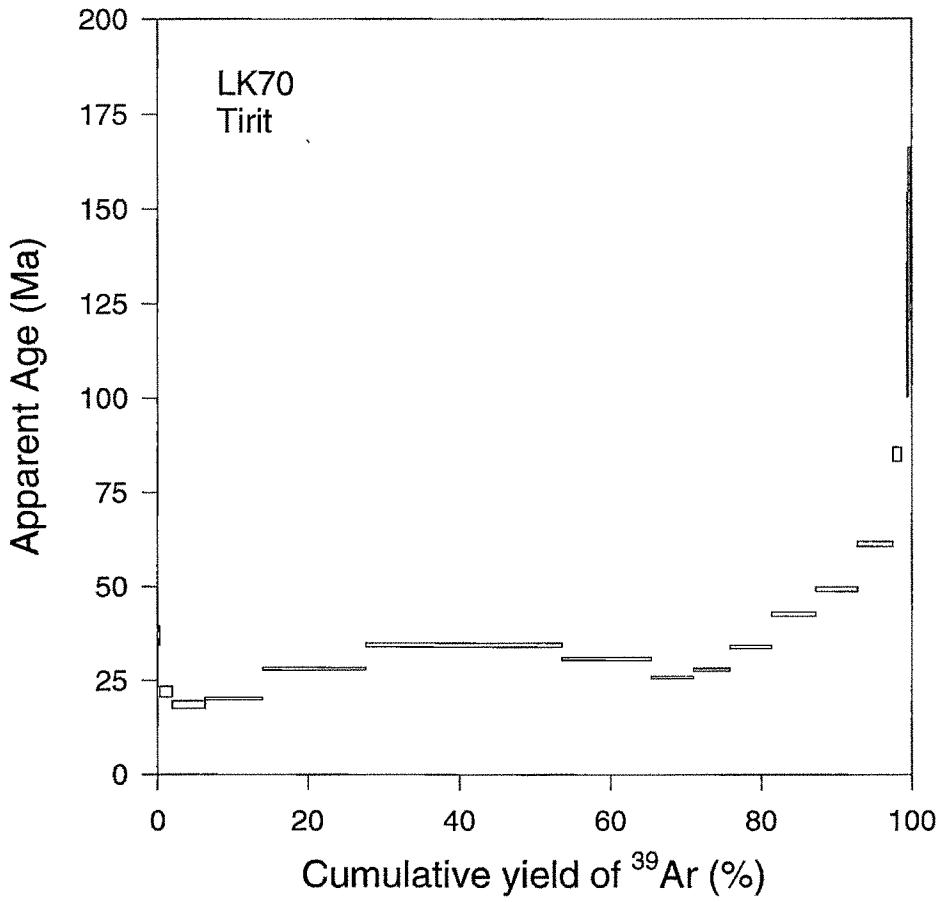

Fig. 4.16 *$^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK70. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.19 *Argon isotopic composition and apparent ages of sample LK47 (Murgi, Karakoram Fault Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .0022383 ± .0000132***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^{*}$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
750	.004008	4 463	13 19	2.13	73 47	654	1113 7
	000034	033	13(15)			043	12 1
800	00385	4 539	13 68	3 56	74 92	408	1178.1
	00012	051	.23(24)			069	37 6
850	003419	4 369	13 508	8 04	76 88	2534	1277.89
	000012	026	093(122)			0094	8 13
900	0026922	4 179	13 610	13 98	80 96	2493	1552 38
	0000094	025	087(118)			0021	9 71
950	.002594	4 135	13 55	12 83	81 46	.125	1594.0
	000045	027	10(13)			018	28 9
1000	002072	4 015	13 685	12 13	84 75	1204	1937 4
	.000015	024	086(.118)			0095	17 3
1050	0015376	3 895	13 839	16 13	88 34	.0892	2533 4
	0000064	024	.085(118)			0019	17 4
1100	001078	3.723	13.69	9 67	91 44	149	3453.5
	.000013	029	085(14)			.020	49 5
1150	00313	4 42	14.07	1 45	79 11	.895	1414 5
	.00016	18	.75(76)			.018	94.6
1200	0193	20 71	59 56	.29	72 42	59.71	1071.3
	0014	1 32	5.36(5.37)			3.85	104.9
1250	0407	30 09	71.48	10	60 01	29 89	738 9
	0050	56	6 06(6.07)			1 32	91 1
TOTAL	003564	4 455	13 682	100.00	76 36	1 093	1249 91
	000020	.011	043(.091)			019	7 56

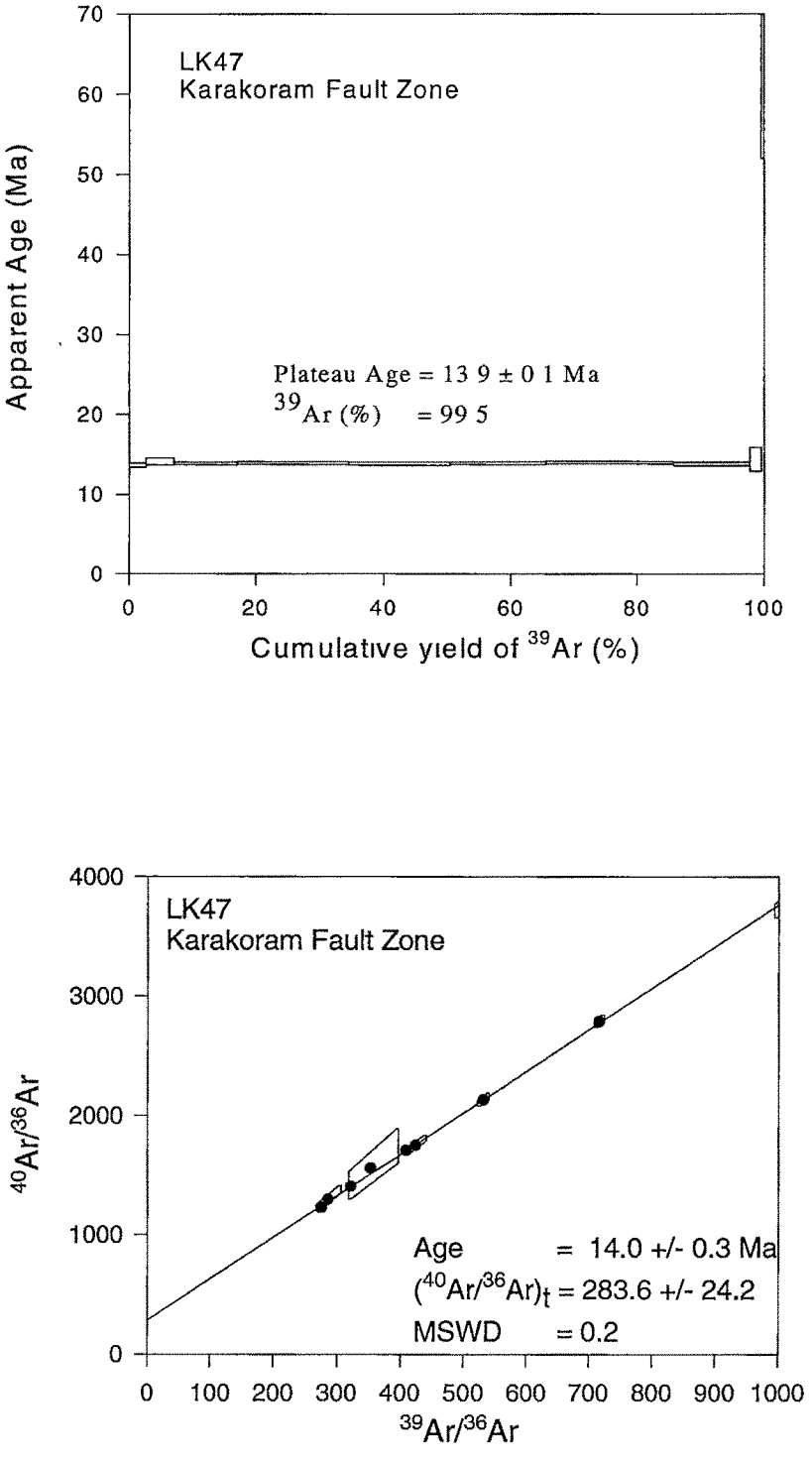

Fig. 4.17 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LK47. The vertical side of the each box is 2σ error in apparent age without including error in J. Error in plateau-age includes error in J. (Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is also shown with isochron age, $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.*

4.6.3. Khardung Volcanics

LK 86, an acidic volcanic sample, from the village Tirit is in direct contact with the Shyok volcanics (Figs 2.2 & 2.5). It yielded a complex age spectrum (Table 4.20 & Fig 4.18). For the first three consecutive steps and more than 40% of ^{39}Ar released the ages continuously rise from ~ 50 Ma to ~ 65 Ma. For the next three consecutive steps ages fall to ~ 30 Ma and then again continuously rise up to more than ~ 60 Ma. It appears to be the superimposition of the two cooling patterns similar to the Shyok Volcanics.

Rhyolite LK 88 from near the village Khardung, type locality of the Khardung, volcanics (Figs.2.2 & 2.5), yielded a plateau age of 52 .0 ± 0.4 Ma for the first five steps consisting of ~ 80 % of the cumulative ^{39}Ar released (Table 4.21 & Fig. 4.19). The remaining steps yielded continuously rising ages up to ~ 100 Ma. The isochron plotted for the five plateau steps yielded an age of 52.8 ± 0.9 Ma and the trapped ratio as 274.8 ± 38.5 Ma and MSWD of 1.5.

Another rhyolite LK 90 also taken from the vicinity of the village Khardung yielded a similar age spectrum. The plateau age for the first six consecutive steps consisting of 82 % of the gas released is 56.4 ± 0.4 Ma (Table 4.22 & Fig.4.20). The remaining steps yield continuously rising apparent ages up to ~ 120 Ma. The isochron age is 56.6 ± 0.9 Ma with the trapped ratio of 284.4 ± 28.5 and the MSWD 3.3.

Sample LG 601, an acidic volcanic sample, near the village Dungti (Fig.2.2) didn't yield a plateau. The age spectrum indicates thermal disturbances experienced by this sample subsequent to crystallization. Eight middle temperature steps yielded a mean age of 64.0 ± 1.2 Ma consisting of ~ 64% of ^{39}Ar released (Table 4.23 & Fig. 4.21). The correlation diagram of these eight steps yielded an age of 61.4 ± 2 4 Ma with trapped ratio as 303.2 ± 9.7 and MSWD 3.2. This age is interpreted to be the age of last major tectono-thermal event experienced by this sample.

LG 87, another acidic volcanic sample, near the village Chushul (Fig.2.2) yielded a plateau age of 57.0 ± 0.3 Ma for eleven consecutive steps consisting of more than 90 % of ^{39}Ar released (Table 4.24 & Fig 4.22). Its isochron age is 57.5 ± 0.9 Ma with the trapped ratio as 288 8 ± 7.7 Ma and MSWD 2.7.

Table 4.20 *Argon isotopic composition and apparent ages of sample LK86 (Between Khalsar and Khardung, Shyok Suture Zone) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002573 ± .000016***

Temp. °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0 00241	12 120	52 18	7.71	94 11	0 058	5019 9
	0 00012	0 070	0 32(0 46)			0 010	259 0
450	0 000739	13 878	62 31	15 03	98 43	0 103	18771 2
	0 000028	0 080	0 31(0 50)			0 015	708 9
500	0 000530	14 670	66 13	17 33	98 93	0 054	27680 2
	0 000018	0 085	0 33(0.53)			0 011	925 5
550	0.0005285	13 517	60 97	18 73	98 84	0 0580	25578 0
	0 0000038	0 078	0 30(0 49)			0 0034	222 9
600	0.0014177	9 954	43 72	8 37	95 79	0.09224	7020 9
	0.0000056	0 058	0 23(0 36)			0 00050	44 9
650	0 006294	8 644	31 22	5 75	78.48	0 1365	1373.46
	0 000023	0 050	0 20(0 28)			0 0031	8 63
700	0 002824	7 737	31.75	2 78	89 22	0 641	2740.0
	0 000058	0 046	0 20(0 28)			0 043	58 5
750	0 00447	7 982	30 65	1 64	83.44	0.815	1784 6
	0 00010	0 050	0 25(0 31)			0 026	41 9
800	0 004491	8 356	32.33	2.31	84 12	0.542	1860 6
	0.000052	0 051	0 21(0 30)			0 049	23 7
850	0.005194	8 870	33 73	1 49	82 70	0.921	1707 7
	0 000037	0 057	0 24(0 32)			0 0063	15 7
900	0 006023	9.236	34 28	2.37	80.73	0.3846	1533.6
	0 000071	0 056	0 24(0 33)			0 0028	19 9
950	0.00720	9.556	34 15	2 59	77 72	0 371	1326 4
	0 00022	0.058	0 37(0 43)			0 055	41 1
1000	0.00766	9 889	35.05	3.55	77 12	0 388	1291.4
	0.00011	0 058	0 28(0.35)			0 034	20.2
1050	0 005923	9 886	37 37	3 22	82 30	0 443	1669 2
	0 000022	0 059	0 24(0 33)			0 042	10 7
1100	0 00288	10 491	44 19	2.48	91 88	0 793	3640 9
	0.00022	0.065	0 39(0.48)			0 083	274 6
1150	0.00334	11 468	48 00	2 43	91 40	0 540	3435 3
	0 00034	0 085	0.57(0 65)			0 020	349 5
1200	0 00268	14 65	63 21	1.14	94 60	0 705	5472.7
	0.00085	0 20	1.42(1 47)			0 056	1729 1
TOTAL	0 002062	12.118	52 64	100 00	94 97	1.04	5875 8
	0 000045	0 027	0 12(0 35)			0.11	129 0

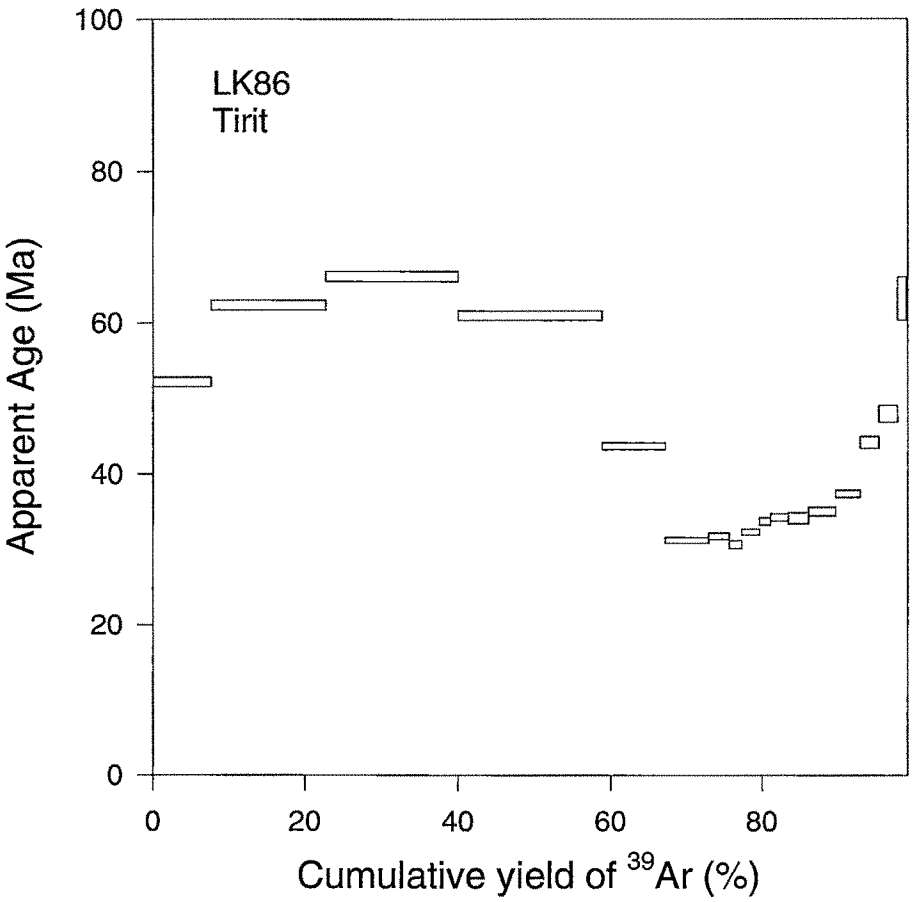

Fig. 4.18 *$^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LK86. The vertical side of the each box is 2σ error in apparent age without including error in J.*

Table 4.21 *Argon isotopic composition and apparent ages of sample LK88(Khardung, Khardung Volcanics) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002347 ± .000014***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0 006786	14.12	50 56	2 98	85 79	0 1566	2080 2
	0 000089	0 20	0 34(0 45)			0 0019	29 9
450	0 002643	13 04	51 16	7.66	94 01	0 0629	4932 7
	0 000045	0 12	0.28(0 41)			0 0022	87 8
500	0 0011938	13 100	53 18	25 48	97.31	0 00924	10973 4
	0 0000041	0 076	0 27(0 42)			0 00010	67 1
550	0.0011599	12 83	52.13	31.47	97 33	0 01423	11064 6
	0.0000084	0 16	0 63(0 70)			0 00012	153.4
600	0 006408	14 540	52 77	13.26	86 98	0 03555	2269 0
	0 000026	0 084	0 30(0 44)			0 00073	14 6
650	0 007283	14 190	50 26	4.19	84 83	0 0875	1948 5
	0 000029	0.089	0 33(0.44)			0 0021	13 3
700	0 016677	15.09	42 52	1 26	67 34	0 316	904.77
	0 000058	0 10	0.38(0 46)			0 028	6 32
750	0 02562	18 33	44 97	0 71	58.69	0 560	715 28
	0 00019	0.15	0.60(0 66)			0 042	7 52
800	0 02620	20.03	51.28	1.11	61 34	0 3241	764 40
	0 00016	0.13	0.53(0 61)			0 0042	6 54
850	0.02357	21.13	58 99	1 75	67 03	0.299	896 38
	0 00016	0 13	0 50(0 61)			0.042	7 78
900	0 024606	22.32	62 61	1 46	67.42	0 243	907 01
	0.000085	0.14	0.53(0 65)			0 030	6.11
950	0 03101	21 81	52 75	1.19	57 98	0.281	703 19
	0 00033	015	0 69(0.76)			0 014	8 75
1000	0.03794	28 76	72 81	1 25	61 01	0 304	757.97
	0.00030	0 20	0 80(0 91)			0 022	7 67
1050	0.03681	30 27	80 30	1 32	64.07	0 2853	822.39
	0 00017	0 22	0 77(0 91)			0 0094	6.42
1100	0 03674	32.98	91 32	1 27	67 08	0 214	897 62
	0 00015	0.30	1 10(1 22)			0 020	8 27
1150	0.03041	35 46	108 77	0 93	74.66	0 530	1166 3
	0.00098	0 62	2.68(2 76)			0 022	42 7
1200	0 0350	36 9	109 2	0 80	71.97	0 582	1054 3
	0 0097	10.0	10 9(10 9)			0 044	301 0
1250	0 0197	28.74	94 5	0 63	78 70	0 355	1455 5
	0.0037	2 27	10 1(10 1)			0.024	293 0
1300	0 0150	28 83	100.4	0.81	84 63	0 509	1922 0
	0.0045	2 19	10 2(10.2)			0 049	592.2
1350	0 026	37.66	122 7	0 46	79 66	0 834	1452 5
	0 017	0 58	19 5(19 5)			0.052	929 5
TOTAL	0 006407	15 207	55 51	100 00	87 55	0 0785	2373 4
	0 000094	0 075	0 27(0 43)			0.0013	36 1

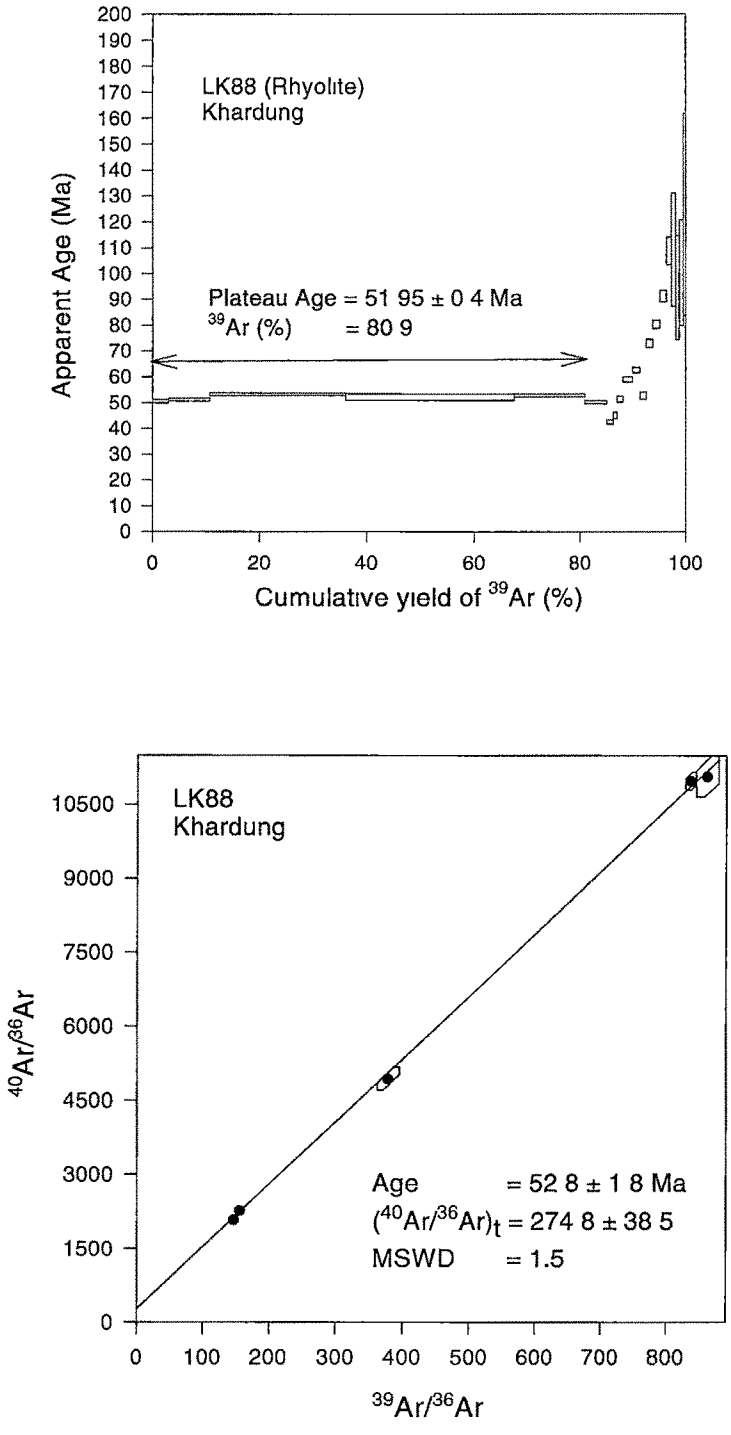

Fig. 4.19 *(Top) $^{40}Ar/^{\beta 9}Ar$ step heating results shown as apparent age spectrumfor the sample LK88. The vertical side of the each box is 2σ error in apparent age without including error in J. Error in plateau-age includes error in J.*
(Bottom) $^{40}Ar/^{\beta 6}Ar$ vs $^{39}Ar/^{\beta 6}Ar$ correlation diagram is also shown with isochron age, $^{40}Ar/^{\beta 6}Ar$ trapped ratio and MSWD value.

Table 4.22 *Argon isotopic composition and apparent ages of sample LK90 (Khardung, Khardung Volcanics) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002458 ± .000016***

Temp. °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	^{40}Ar*%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
400	0 00719	15 571	58.66	3 67	86.35	0 165	2165 2
	0 00020	0 094	0 42(0 56)			0 013	61 0
450	0 001851	13 334	55 83	12 21	95 90	0 04547	7204 8
	0.000019	0 090	0 29(0 45)			0 00092	83 2
500	0 001320	13.280	56 27	17 53	97 06	0 3310	10060 1
	0 000015	0 077	0 29(0 46)			0 00021	123 8
550	0 00195	13 34	55 71	19.06	95 67	0 0273	6832 0
	0 00011	0 13	0 53(0 64)			0 0079	376 6
600	0.0022784	13 862	57 56	18 68	95 14	0 09095	6084.3
	0.0000079	0 089	0 34(0 50)			0 00079	40 8
650	0.008618	14.98	54 32	11 00	83 00	0 0401	1738 6
	0 000075	0 11	0 44(0 55)			0 0010	18 9
700	0 00795	13 53	48 91	2 43	82 63	0 00090	1701 7
	0.00029	0 13	0 65(0 72)			0.00041	63 8
750	0 00973	13 37	45 94	1 09	78 49	0.590	1373 8
	0 00024	0 12	0 54(0 61)			0.015	35 2
800	0.02724	19 96	52 05	0 87	59 67	0 604	732 7
	0.00044	0 16	0 82(0 88)			0.058	13 0
850	0.02715	21 48	58 72	0.88	62 66	0 500	791 29
	0 00011	0 16	0 66(0 76)			0 062	6 43
900	0 02692	22.59	63.76	1.05	64.79	0.2866	839.29
	0.00012	0 17	0 64(0.75)			0 0033	6 59
950	0 02308	23 93	74 31	1.24	71 49	2.83	1036.6
	0 00096	0.18	1.40(1 48)			0.12	43 6
1000	0.03205	27 27	77 24	1 54	65 27	0 265	850 74
	0 00030	0 20	0 87(0.99)			0 028	9 81
1050	0.03397	30.18	87 17	2.14	66 74	0.1433	888 35
	0.00012	0.25	1.00(1 13)			0 0031	7 64
1100	0.02807	32.43	103 96	2 52	74 42	0 12198	1155 3
	0.00024	0.32	1 10(1.27)			0.00050	13.5
1150	0 02232	37 29	131.20	1.61	82.31	0.1989	1670 2
	0 00064	0.65	2 54(2 67)			0 0015	54 4
1200	0 0229	38 50	135 43	0 82	82 39	0 3866	1677 6
	0.0016	1.41	6 09(6.15)			0.0021	132 2
1250	0 0297	40 40	135.1	0.62	78 31	0 535	1362 2
	0 0030	2.44	10 7(10 7)			0 023	160.3
1300	0 0153	36 90	138 2	0 64	87.75	0.4940	2412 8
	0 0044	2.98	13.4(13 4)			0 0087	720.9
1350	0 0305	21 04	52 6	0.41	57 15	0 7780	689 7
	0 0069	5 83	26 6(26 6)			0 0016	245.9
TOTAL	0 006691	16 046	61 33	100 00	87 68	0 1243	2398.3
	0 000055	0 054	0 23(0 45)			0.0024	21 1

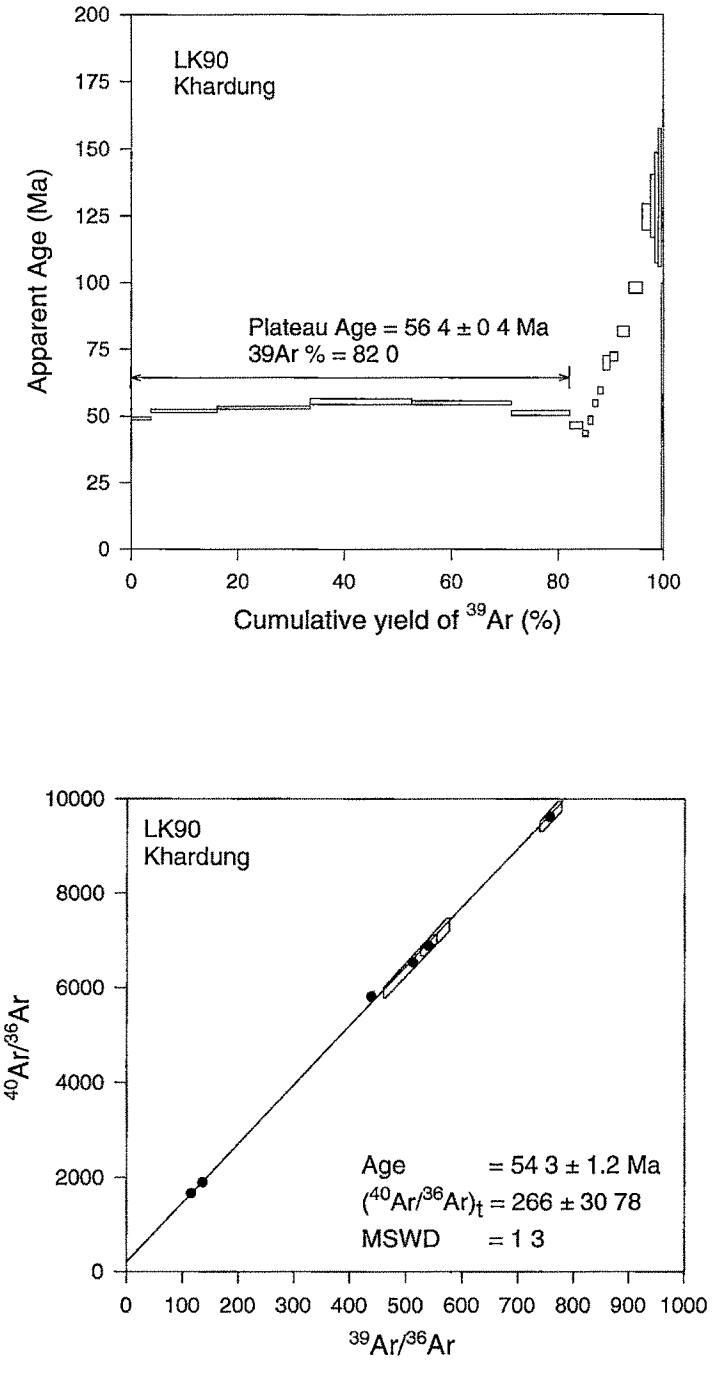

Fig. 4.20 *(Top) $^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LK90. The vertical side of the each box is 2σ error in apparent age without including error in J. Error in plateau-age includes error in J. (Bottom) $^{40}Ar/^{36}Ar$ vs. $^{39}Ar/^{36}Ar$ correlation diagram is also shown with isochron age, $^{40}Ar/^{36}Ar$ trapped ratio and MSWD value.*

Table 4.23 *Argon isotopic composition and apparent ages of sample LK601 (Dungti, Khardung Volcanics) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002447 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
550	1967	69 77	50 6	1 38	16 67	11 161	354 6
	0067	2 19	11 6(11 6)			030	15 7
600	1034	37 82	31 82	5 05	19 23	12.52	365 86
	0018	.41	2 74(2 75)			20	7 24
650	0653	28 90	41 86	7.39	33 20	12 892	442 36
	0012	27	1 91(1 92)			.049	9 25
700	.1066	44 42	56 08	9.37	29 06	12 607	416 54
	.0019	.31	2 68(2 70)			025	7 96
750	.1414	59 36	75 95	5.63	29 61	12 868	419.83
	.0015	44	2 54(2 57)			026	5 41
800	1255	55.31	78 71	4 45	32 96	14.898	440 80
	0021	48	3 26(3 28)			030	8.36
850	.0537	34 22	79 20	4.93	53 62	13 517	637 2
	.0019	38	2 83(2 86)			031	23 6
900	.0413	26 22	60.77	8.07	53 41	15 960	634 2
	.0013	.22	1 84(1 87)			032	20 4
950	03310	26 99	74 39	15 66	63 76	23 07	815 4
	00071	21	1.20(1 26)			.16	18.4
1000	.03896	28 59	73 81	11.18	59.73	28 476	733 7
	00097	20	1 43(1 48)			.057	18 8
1050	.043	30 58	77 27	9 89	58 51	29 171	712 2
	.013	8 66	1.86(1 90)			058	213 4
1100	1143	64 39	130 26	3 00	47 54	57 76	563 3
	0028	1.08	5 50(5 55)			12	16 5
1200	1763	115 34	259 48	7 93	54 83	83 91	54 21
	.0013	.93	3 59(3.81)			17	6 77
1400	.5022	274 80	486 0	6 07	46 00	169 04	47 22
	0059	2.80	10 7(11 0)			34	8 18
TOTAL	1039	56 97	112.30	100 00	46 09	34 584	48 1
	0029	1 56	1 01(1 16)			.038	15 6

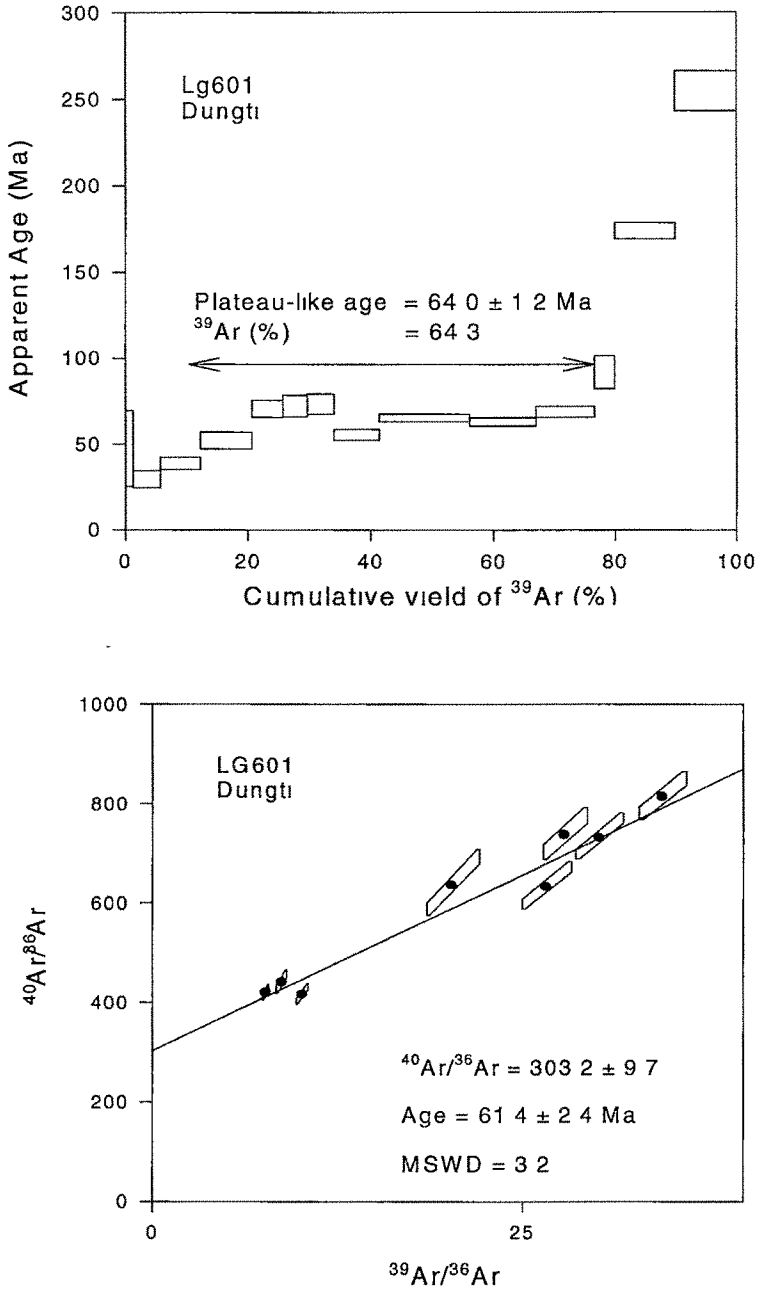

Fig. 4.21 *(Top) $^{40}Ar/^{89}Ar$ step heating results shown as apparent age spectrum for the sample LG601. The vertical side of the each box is 2σ error in apparent age without including error in J Error in plateau-like age includes error in J. (Bottom) $^{40}Ar/^{86}Ar$ vs. $^{39}Ar/^{86}Ar$ correlation diagram is also shown with isochron age, $^{40}Ar/^{86}Ar$ trapped ratio and MSWD value.*

Table 4.24 *Argon isotopic composition and apparent ages of sample LG87 (Chushul, Khardung Volcanics) at different temperature steps. The errors in ages are without and with (bracketed) errors in* ***J****. The errors quoted are in 1σ.* ***J= .002447 ± .000013***

Temp °C	$^{36}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{39}Ar$ ± 1σ	Age(Ma) ± 1σ	^{39}Ar%	$^{40}Ar^*$%	$^{37}Ar/^{39}Ar$ ± 1σ	$^{40}Ar/^{36}Ar$ ± 1σ
600	09625	36 64	35 80	49	22 36	1 802	380.62
	00072	.24	1 28(1 29)			.019	3 66
650	09314	37 34	42 79	1 38	26 28	1 6291	400 85
	.00040	.22	91(94)			0091	2.68
700	03929	24 69	56 80	95	52.97	3 1107	628 29
	00039	16	76(81)			0062	7 17
750	03848	24 19	55 69	3.64	52.99	2 3444	628 61
	.00016	14	54(62)			0047	4 12
800	.02915	21.68	56 76	4.07	60 27	1 3788	743 84
	00013	.13	49(57)			0028	5 00
850	02206	20 06	58 79	4 17	67 50	1.0341	909 35
	.00011	.12	45(54)			0021	6 44
900	.019247	18 82	57 02	7.70	69 77	1 1790	977 55
	000079	11	41(51)			0051	6 36
950	.011053	17 102	60 05	16 70	80 90	5302	1547 27
	.000043	.099	.37(48)			.0011	9 85
1000	.00996	16 327	58 12	13 55	81 98	4061	1639 8
	00014	094	39(49)			0074	24 1
1050	01130	16 49	57 11	8 36	79.74	433	1458 8
	00017	34	1.04(1 08)			.010	30 5
1100	011213	16.215	56.05	9.18	79 57	5408	1446 1
	000054	.094	36(.46)			0011	10.1
1150	010955	16.308	56 78	10 80	80 15	.49935	1488.6
	.000051	.095	36(46)			00100	10 3
1200	012813	16 385	54 75	12 52	76.89	7964	1278 72
	.000055	.095	36(46)			.0016	8 48
1250	01718	16 82	51 08	1 93	69 82	1.6396	979 0
	00038	12	69(74)			0049	22 6
1300	02971	18 41	42 00	2 74	52.31	2 1820	619.67
	00025	12	57(61)			0044	6 44
1400	01905	17.73	52 60	1.82	68 24	1 9703	930 5
	.00045	16	88(92)			.0050	23 3
TOTAL	016570	17 877	56 39	100 00	72 61	8466	1078 91
	000036	043	.15(33)			0015	3 10

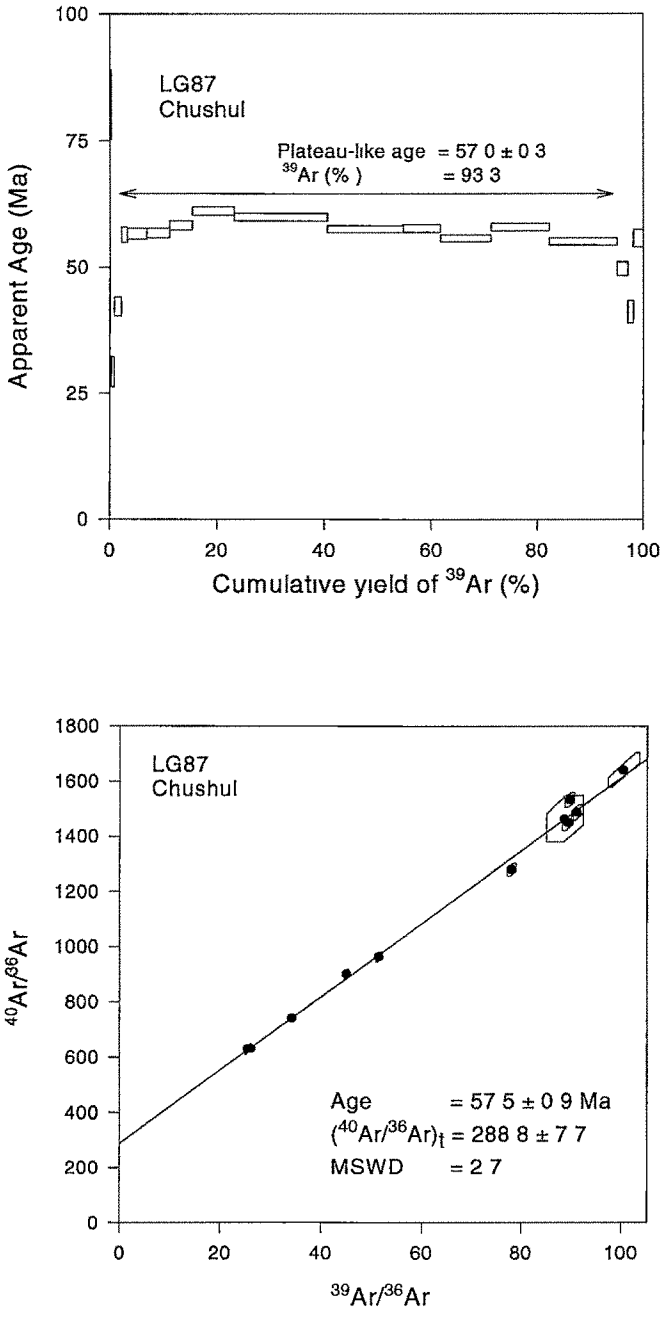

Fig. 4.22 *(Top) $^{40}Ar/^{39}Ar$ step heating results shown as apparent age spectrum for the sample LG87. The vertical side of the each box is 2σ error in apparent age without including error in J. Error in plateau-like age includes error in J. (Bottom) $^{40}Ar/^{36}Ar$ vs. $^{39}Ar/^{36}Ar$ correlation diagram is also shown with isochron age, $^{40}Ar/^{36}Ar$ trapped ratio and MSWD value.*