Radiometric age determinations in the Kærven area, Kangerdlugssuaq, East Greenland Tertiary igneous Province: $^{40}Ar/^{39}Ar$, K/Ar and Rb/Sr isotopic results

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The Kærven syenite complex was emplaced as part of the magmatic activity related to continental rifting in the Paleogene. Radiometric age determinations have been carried out on samples from selected parts of the complex, which consists of more than 10 significant units. Five amphiboles and two alkali feldspar have been analysed by the $^{40}Ar/^{39}Ar$ method with stepwise heating, five amphiboles and one biotite K/Ar analyses are presented together with Rb/Sr isotope analysis of 6 amphiboles, 2 biotites, 3 alkali feldspars and 32 whole rocks. The results reveal that a late, probably 36 Ma, thermal event caused Ar-loss in the alkali feldspars and excess ^{40}Ar-gain in variable amounts in the analysed minerals. Also the Sr isotopes were disturbed by the secondary heating. Crystallisation ages for parts of the Kærven complex can be established as 58 ± 1 Ma, while other units have younger ages of 56.1 ± 0.8 Ma and 50.4 ± 0.8 Ma. The age for the early Kærven rocks is significantly older than other recorded syenites in the Kangerdlugssuaq area and is comparable only to the estimated age of the initiation of basaltic volcanism along the East Greenland coast at 57 Ma. An Rb/Sr isochron for four nordmarkite whole rocks and a $^{40}Ar/^{39}Ar$ age plateau of an amphibole from one nordmarkite date the part of the Kangerdlugssuaq alkaline intrusion adjacent to the Kærven complex as 54.6 ± 2.4 Ma. This is older than other parts of the Kangerdlugssuaq intrusion, and indicate that this intrusion was multiple and emplaced over several million years

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Introduction

A large number of intrusions were emplaced high in the continental crust in the Kangerdlugssuaq area of East Greenland during the continental break-up of Laurasia and subsequent ocean formation in the North Atlantic region in the Paleogene. The idea that magmatism in the Kangerdlugssuaq area represents the early manifestations of the mantle plume presently erupting through Iceland (Brooks, 1973) has generally received support (Brooks and Nielsen, 1982; Gill et al., 1988; Holm, 1988). The Kangerdlugssuaq fjord in this model delineates the so-called failed arm of the triple junction related to the shift in direction of the coastal rifting at latitude 66°N.

The understanding of the magmatic evolution of this area has importance to the modelling of continental rifting and subsequent oceanic lithosphere formation. Field relations have established a broad framework for the the geological history of the Lower Tertiary in the region. However, compared to the complexity of the magmatic history, rather few radiometric age determinations have been published. Further, in the inland area, where no field relations to the coastal dyke-swarms and lavas can be made, very little information is available on the age relations. As part of a petrological and geochemical study of the Kærven syenite complex (KSC) a number of radiometric isotope methods have been applied to extract age information on the KSC. The complex consists of at least 10 significant intrusive units (Holm et al., in press), which were intruded prior to the emplacement of the large Kangerdlugssuaq intrusion. The resulting age determinations reveal a prolonged intrusive activity and an age near to 60 Ma which is older than any magmatism hitherto recorded from the Tertiary of East Greenland. The KSC is thus particularly interesting with respect to the initiation of mag-

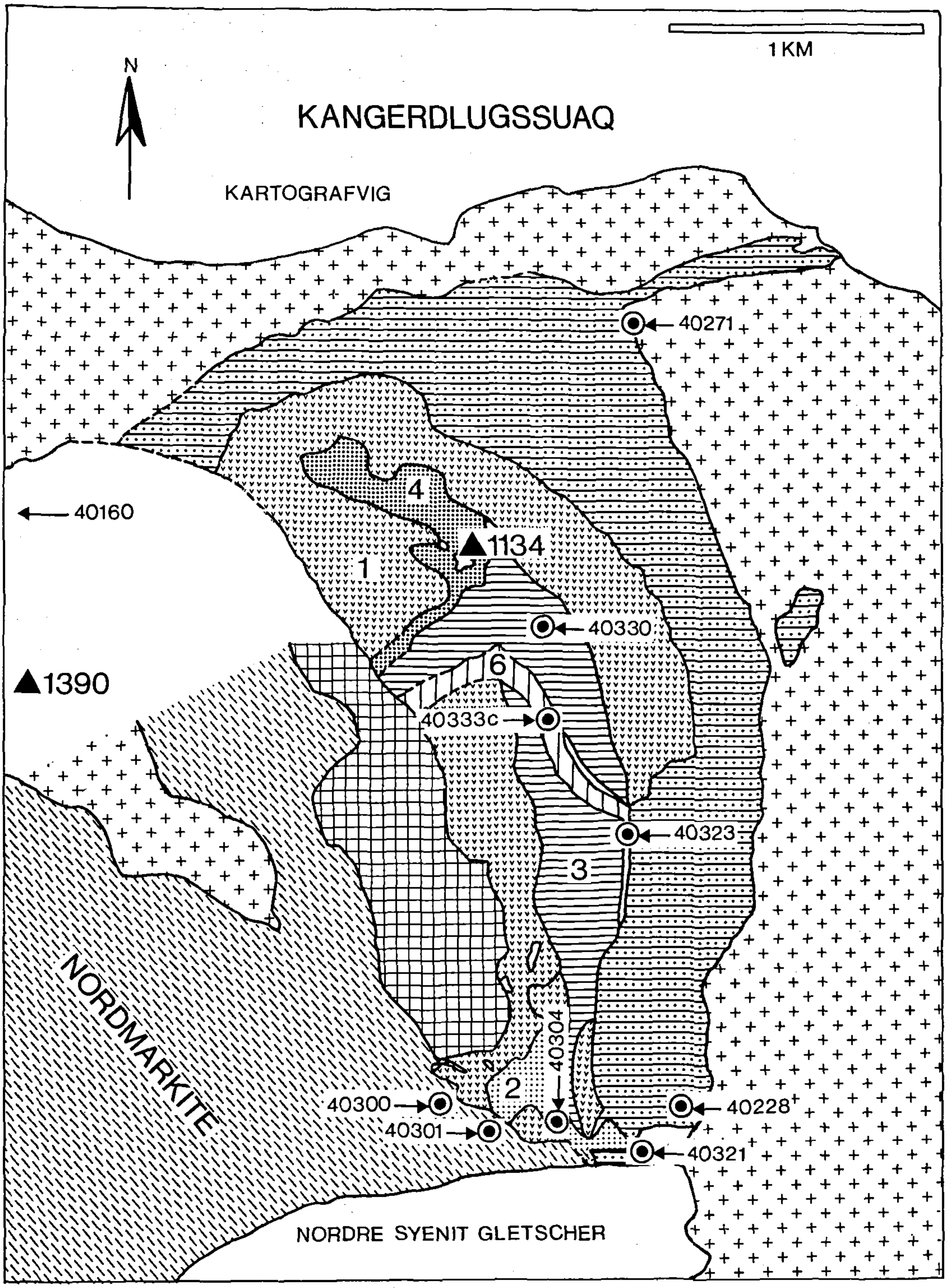

Fig. 1. Geological map of The Kærven area with indication of sample locations. Legend: plus – Precambrian basement; inclined hatched ruling – nordmarkite; horizontal ruling with dots – Kærven gabbro; other – Kærven syenites.

matic activity in the Kangerdlugssuaq area as well as in East Greenland.

Geological background and previous radiometric datings

Aspects of the geological evolution in the Kangerdlugssuaq area has recently been reviewed by Brooks and Nielsen (1982) and by Nielsen (1987). The geology in the Kærven area has been treated by Holm and Prægel (1988), Holm et al. (in press), Nielsen (1989) and Holm and Prægel (1989) and references therein. Magmatism at Kærven was initiated by the intrusion of the Kærven gabbro, which rims the eastern and northeastern parts of the syenite complex. The KSC consists of a number of dyke-like bodies emplaced more or less parallel to the fjord. The Kangerdlugssuaq intrusion cuts through the western parts of the KSC. The KSC consists of syenites, quartz syenites and alkali feldspar quartz syenites and granites all have mineralogical and geochemical features different from those of the nordmarkites of the bordering Kangerdlugssuaq intrusion.

Geochemically the rocks of the KSC constitute a largely coherent trend, which has been modelled largely by the mixing of two components with rather similar characters, such as element abundance patterns and mineralogy but of very different rock-type: syenite and granite.

The samples

The samples for this study have been chosen to represent the geological evolution of Kærven syenite complex. The geographical position of the samples are marked in fig. 1. Suitable minerals in the rocks for K/Ar analysis included amphibole and alkali feldspar, while primary biotite is rare in the Kærven rocks and was only analysed in sample 40304. A secondary biotite analysis is also presented, sample 40228.

Recently, the significance of ^{40}Ar/^{39}Ar age spectra for amphiboles has been questioned as it has been demonstrated that diffusion in this mineral is not by volume diffusion (Gaber et al., 1988). However, this conclusion is not thought to have any consequences for the interpretations presented here.

Analytical methods

Mineral separates of micro-perthite, amphibole and biotite were obtained from ultrasonically cleaned sieve fractions of crushed rocks using heavy liquids and magnetic separator techniques at Institut for Petrologi, University of Copenhagen. Purity of separates of feldspar and biotite is better than 97% while amphibole is variably contaminated with 0–5% clinopyroxene.

K

Dried aliquots of typically 0.1 g amphibole and 0.03 g biotite were dissolved in 40% HF+conc. HNO_3 and evaporated to dryness, 6 N HCl was added and the solution evaporated to dryness, 1 ml 2.5 N HCl was added to dissolve the sample, which was diluted to 250 ml or 500 ml with quartz distilled water. The solution was analysed by flame photometry on a Perkin Elmer 460 spectrophotometer at Institut for Almen Geologi, Geologisk Centralinstitut. Standard solution were made from spec. pure KCl to concentrations of 0.5, 1, 2, 4, ..., 12 ppm, which were checked against international reference material. Each sample was dissolved and analysed in triplicate. The total analytical uncertainty was found to be $1\sigma = 0.63$ rel.%.

Ar

Aliquots, representing the same material, as for K analysis, is weighed into aluminium foil capsules and inserted into the vacuum system, which is then pumped down. The system is baked out over-night at c. 225°C. Very pure ^{38}Ar spike is added to the extraction system immediately before analysis using an on-line gas pipette system. HF-heating is applied for 20 min.s and a final sample temperature of over 1200°C is rutinely applied, which is exceeded in the case of alkali feldspar in this study to well over 1400°C for an extra 10 min.s. The gas clean-up procedure comprise heating of Ti sponge and a liquid nitrogen cold-trap followed by moving the gas into a small volume by the means of a charcoal cold-trap. The released gas is then exposed to c. 700°C hot Ti-sponge a second time. The almost pure inert gasses are subsequently allowed to pass though a leak valve into the on-line AEI MS10C mass spectrometer fitted with a small 1.8 kG permanent magnet. The isotopic gas composition of Ar

Table 1.
Results for Kærven minerals of $^{39}Ar/^{40}Ar$ analysis by the incremental heating technique.

Step	$^{36}Ar_{atm}$	$^{37}Ar_{Ca}$	$^{38}Ar_{Cl}$	$^{39}Ar_{K}$	$^{40}Ar^{*}$	$^{40}Ar^{*}/^{39}Ar_{K}$	$\%^{40}Ar^{*}$	$\%^{39}Ar$ cumulated	apparant age Ma	$\pm 1\sigma$
Sample 40300 amphibole						J = 0.001080				
2	97.27	0.00	1.73	11.30	1925	170.37	6.28	0.05	304.71	>>100
3	145.95	0.00	12.06	38.80	6327	163.07	12.79	0.21	292.65	63.70
4	97.06	0.00	10.33	51.10	3625	70.95	11.22	0.42	133.19	28.87
5	45.26	192.2	12.38	104.4	5430	52.03	28.88	0.85	98.62	15.94
6	51.58	686.3	10.99	154.3	4205	27.26	21.62	1.48	52.35	4.13
7	74.03	2883	27.44	352.04	9201	26.14	29.59	2.92	50.22	3.06
8	43.59	722.9	11.48	279.5	8067	28.86	38.50	4.06	55.37	1.72
9	35.81	761.6	14.03	489.4	13978	28.56	56.90	6.06	54.81	1.38
10	222.0	5531	169.5	4916	143078	29.11	68.54	26.11	55.84	0.84
11	126.6	3522	108.6	2927	87909	30.03	70.13	38.05	57.58	0.58
12	116.6	7520	217.7	5459	157255	28.81	82.00	60.32	55.27	0.58
13	82.79	4474	121.8	2976	86558	29.09	77.94	72.46	55.81	0.50
14	19.15	1007	28.70	691.7	20708	29.94	78.51	75.28	57.41	0.52
15	48.08	5793	115.76	2798	80910	28.92	85.02	86.69	55.48	0.54
16	34.35	432.6	78.64	1783	51120	28.67	83.39	93.96	55.01	0.48
17	84.93	2209	50.93	1206	34741	28.81	58.04	98.88	52.27	0.49
18	242.08	1268	17.37	277.1	7058	25.47	8.98	100.00	48.95	0.72
Sample 40330 amphibole						J = 0.001210				
1	732.6	30.82	6.04	4.68	368	78.67	0.17	0.12	164.05	12.67
2	243.4	6183	44.40	118.8	9876	83.13	10.89	2.94	172.90	20.01
3	114.4	1469	19.17	14.75	4231	286.8	11.12	3.27	537.44	10.34
4	254.1	1440	84.49	203.7	12452	61.13	14.22	8.05	128.75	2.13
5	107.4	2363	151.6	403.8	14635	36.24	31.54	17.47	77.43	1.35
6	68.11	2199	152.1	457.1	14523	31.77	41.90	28.14	68.09	1.09
7	55.69	1956	145.3	496.4	14858	29.94	47.43	39.74	64.19	0.79
8	62.02	2753	186.8	699.4	20008	28.61	52.17	56.10	61.39	1.02
9	87.84	2577	176.7	685.3	19957	29.12	43.45	72.15	62.48	1.17
10	39.81	1399	76.86	305.6	8330	27.54	41.44	79.30	58.54	1.69
11	37.00	1201	60.26	233.9	6752	29.93	38.16	84.77	64.17	2.10
12	58.01	1060	50.08	192.3	5670	29.48	24.85	89.26	63.24	2.52
13	64.43	777.1	36.29	118.0	4940	41.86	20.60	92.02	89.13	3.03
14	44.20	1116	30.41	93.4	3779	40.47	22.44	94.20	86.24	3.56
15	207.85	2261	61.41	232.7	12807	55.03	17.25	99.63	116.31	6.17
16	221.42	475.6	6.69	15.66	1863	118.97	2.77	100.00	242.63	24.50
Sample 40333c amphibole						J = 0.001120				
1	619.0	529.1	17.07	102.3	4605	45.04	2.46	0.63	86.80	12.41
2	143.06	5623	106.1	635.6	15813	24.88	27.21	2.78	49.59	1.80
3	62.26	861.4	32.06	212.1	7671	36.17	29.42	3.50	71.65	2.35
4	172.9	91.55	641.5	4447	120668	27.13	70.23	18.50	54.01	1.38
5	467.7	48679	4038	22969	627879	27.34	81.92	95.98	54.44	0.47
6	72.49	1513	112.5	682.7	19157	28.06	47.20	98.28	55.83	0.80
7	44.08	740.5	43.42	258.5	7600	29.40	36.84	99.16	58.44	1.48
8	48.96	502.0	20.95	136.2	3603	26.46	19.94	99.62	52.69	3.32
9	75.70	351.4	10.20	62.87	2123	33.77	8.67	99.83	66.98	10.40
10	93.24	150.6	3.49	19.70	1886	95.71	6.41	99.90	183.71	37.74
11	251.81	414.2	5.23	31.23	6787	217.3	8.36	100.00	392.98	57.17

is analysed in the static mode by recording the total peaks and back-ground on graph paper. Masses 36, 38 and 40 are measured repeatedly – usually 5 or 6 sequences. The size of mass 28 is monitored during gas inlet and a Zr/Al getter pump is fitted in the mass spectrometer compartment of the vacuumsystem to keep the active gas pressure low during data aquisition. The the net peaks are typed into a computer and reduced as follows: the memory of the mass spectrometer at time zero is substracted, the peak-sizes at inlet time is calculated, they are then corrected for attenuation effects in the amplifiers, for orifice fractionation (if less than 100% of the gas was let

Table 1.
(continued)

Step	$^{36}Ar_{atm}$	$^{37}Ar_{Ca}$	$^{38}Ar_{Cl}$	$^{39}Ar_K$	$^{40}Ar^*$	$^{40}Ar^*/^{39}Ar_K$	$\%^{40}Ar^*$	$\%^{39}Ar$ cumulated	apparant age Ma	$\pm 1\sigma$
Sample 40228 alkali feldspar						J = 0.001200				
1	86.92	40.49	3.27	190.0	12591	66.28	32.90	0.33	138.07	4.43
2	611.19	151.8	9.76	652.1	37277	57.16	17.11	1.45	119.70	6.77
3	69.57	1745	42.09	3138	85631	27.29	80.62	6.86	58.13	0.62
4	74.63	5296	85.86	4974	121034	24.34	84.56	15.33	51.93	0.41
5	48.36	3609	77.78	5130	117288	22.86	89.11	24.06	48.83	0.48
6	33.25	284.6	42.63	3896	90705	23.28	90.20	30.67	49.71	0.38
7	52.65	821.6	59.75	5016	121494	24.22	88.63	39.21	51.68	0.40
8	97.80	1450	63.28	4962	133562	26.92	82.19	47.66	57.35	0.47
9	126.7	558.5	52.24	4266	140525	32.94	78.95	54.91	69.95	0.50
10	142.86	429.6	53.44	3853	158078	41.03	78.91	61.44	86.71	0.72
11	301.22	201.8	251.9	18442	976540	52.95	91.64	93.04	111.14	0.83
12	33.75	0.00	13.32	926.3	52997	57.21	84.16	94.64	119.80	0.99
13	32.32	0.00	12.08	856.5	48095	56.15	83.43	98.26	117.65	1.04
14	64.22	0.00	22.02	1251	71843	57.43	79.10	99.12	120.23	1.96
15	99.72	0.00	10.84	508.2	30520	60.06	50.88	100.00	125.54	1.96
Sample 40301 amphibole										
1	1991	699.2	10.47	149.2	39718	266.28	6.32	0.61	485.6	80.56
2	60.53	4355	32.41	258.0	10369	40.19	36.67	1.67	82.20	2.23
3	60.53	599.5	17.84	375.7	12579	33.48	61.72	3.21	68.74	1.03
4	29.04	1472	107.3	444.5	18809	42.32	68.65	5.03	86.45	1.10
5	52.13	1724	43.36	892.8	43570	48.80	73.86	8.69	99.34	0.98
6	39.25	1177	39.12	911.3	42405	46.53	78.51	12.42	94.85	0.89
7	81.64	2749	80.62	2066	82958	40.15	77.45	20.68	82.12	0.75
8	79.42	3240	93.68	2235	91334	40.86	79.54	30.04	83.54	0.76
9	52.46	2470	70.81	1584	63193	39.90	80.28	36.53	81.63	0.74
10	75.03	7095	177.15	4492	151729	33.78	87.22	54.93	69.34	0.56
11	76.96	15737	338.5	7870	234979	29.86	91.13	87.17	61.42	0.48
12	44.58	6400	129.7	2866	88811	30.99	87.04	98.91	63.72	0.52
13	20.85	584.8	16.35	265.3	9409	35.46	60.41	100.00	72.72	1.24
Sample 40300 amphibole						J = 0.001080				
2	97.27	0.00	1.73	11.30	1925	170.37	6.28	0.05	304.71	>>100
3	145.95	0.00	12.06	38.80	6327	163.07	12.79	0.21	292.65	63.70
4	97.06	0.00	10.33	51.10	3625	70.95	11.22	0.42	133.19	28.87
5	45.26	192.2	12.38	104.4	5430	52.03	28.88	0.85	98.62	15.94
6	51.58	686.3	10.99	154.3	4205	27.26	21.62	1.48	52.35	4.13
7	74.03	2883	27.44	352.04	9201	26.14	29.59	2.92	50.22	3.06
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10	222.0	5531	169.5	4916	143078	29.11	68.54	26.11	55.84	0.84
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12	116.6	7520	217.7	5459	157255	28.81	82.00	60.32	55.27	0.58
13	82.79	4474	121.8	2976	86558	29.09	77.94	72.46	55.81	0.50
14	19.15	1007	28.70	691.7	20708	29.94	78.51	75.28	57.41	0.52
15	48.08	5793	115.76	2798	80910	28.92	85.02	86.69	55.48	0.54
16	34.35	432.6	78.64	1783	51120	28.67	83.39	93.96	55.01	0.48
17	84.93	2209	50.93	1206	34741	28.81	58.04	98.88	55.27	0.49
18	242.08	1268	17.37	277.1	7058	25.47	8.98	100.00	48.95	0.72

into the mass spectrometer), for mass discrimination (which is regularly calibrated relative to atmospheric Ar-samples). Finally correction for atmospheric argon is made relative to mass 36 ($^{40}Ar/^{36}AR_{atm} = 295.5$) and the amount of radiogenic ^{40}Ar is calculated relative to the net ^{38}Ar peak correcting for interference between the two gas components. The argon spike is calibrated regularly against international standard material P-207. This calibration is the major source of analytical error, which totally amounts to $1\sigma = 0.8\%$ in a routine analytical run. The analyses were made partly on the apparatus at Institut for Petrologi, Universit of Copenhagen, and

Table 2.
Results of K/Ar analysis of minerals from the Kærven syenite complex.

Sample	type	K wt %	40 Ar 10-10 mol	40 Arrad % rel.	Age Ma	±10
40160	amph	0.942	1.042	49.6	61.6	0.9
40330	amph	0.755	0.871	52.9	65.3	0.9
			0.857	66.1	64.3	0.9
				mean	64.8	
40228	bio	7.33	8.523	79.5	65.7	0.9
			8.220	80.0	63.5	0.9
				mean	64.8	
40321	amph	0.672	0.662	69.8	55.9	0.8
			0.679	62.7	57.3	0.8
				mean	56.6	
40271	amph	0.651	0.659	52.8	57.4	0.8
			0.671	61.2	58.5	0.8
				mean	56.6	
40323	amph	0.885	0.784	61.9	50.4	0.8
			0.785	67.8	50.4	0.8
				mean	50.4	

partly at Leeds University, using similar procedures.

K/Ar ages were calculated using the decay constants recommended by the IUGS-subcommision (Steiger and Jäger, 1977).

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

The analytical work was carried out at Institut for Petrologi, University of Copenhagen. Samples were irradiated at AWRE, Aldermaston, with a total fast neutron flux of c. 2×10^{17} neutrons/cm^2, which was calculated from Ni wire placed inside the sample aluminium container. The flux was monitored by placing monitor standard samples, international reference material biotite LP-6, alternately with the unknown samples. The flux gradient was minimized by turning the sample container at half-time. The flux gradient was found to be very similar to that reported by Roddick (1983) and the J-value calibration is better than ±0.5 %rel. The LP-6 samples were analysed by one step of total fusion.

Upon analysis of the unknown samples, the procedure is similar to that of conventional Ar, except for: The heating of the sample is at controlled temperatures and of duration 40 minutes

Table 3.
Results of Rb/Sr isotope analysis of mineral samples from the Kærven syenite complex and apparent ages calculated from mineral pairs and rock-mineral(s).

Sample	Type	Rb ppm	Sr ppm	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr_m$	Age calculated from components as indicated Ma	
40160						57.0±2.8	(MSWD = 0.1) wr, kf, amph
	amph	12.17	28.99	1.215	0.7092 ±0.0010	57.8r2.6	
	Kf	184	27	21.12	0.725545±0.000015		kf, amph
40228						52.1±1.6	(MSWD = 11) wr, kf, bio
						51.4±3.2[a]	(zircon fission tracks)
	bio	379	13.7	80.7	0.7717 ±0.0020	47.2±1.4	bio, kf
	Kf	175	371	1.387	0.71857 ±0.000017		
40304						67.3±0.4	(MSWD = 6) wr, bio, amph
	bio	447.	7.0	186.4	0.9022 ±0.0010	67.9±0.3	bio, amph
	amph	7.01	7.91	2.568	0.72482 ±0.00048		
40271	Kf	127	150	2.433	0.714964±0.000036	(123±7)	amph, wr
40330	amph	3.7	18.2	1.161	0.7168 ±0.0008	(231±20)	amph, wr
40321	amph	7.98	9.06	2.550	0.71520 ±0.00028	(−561±48)	amph, wr
40333c	amph	9.49	13.21	2.079	0.70936 ±0.00067	(70±9)	amph, wr
40323	amph	7.5	9.2	2.36	0.7149 ±0.0004	(−48±6)	amph, wr

a) data source: Hansen (1985).

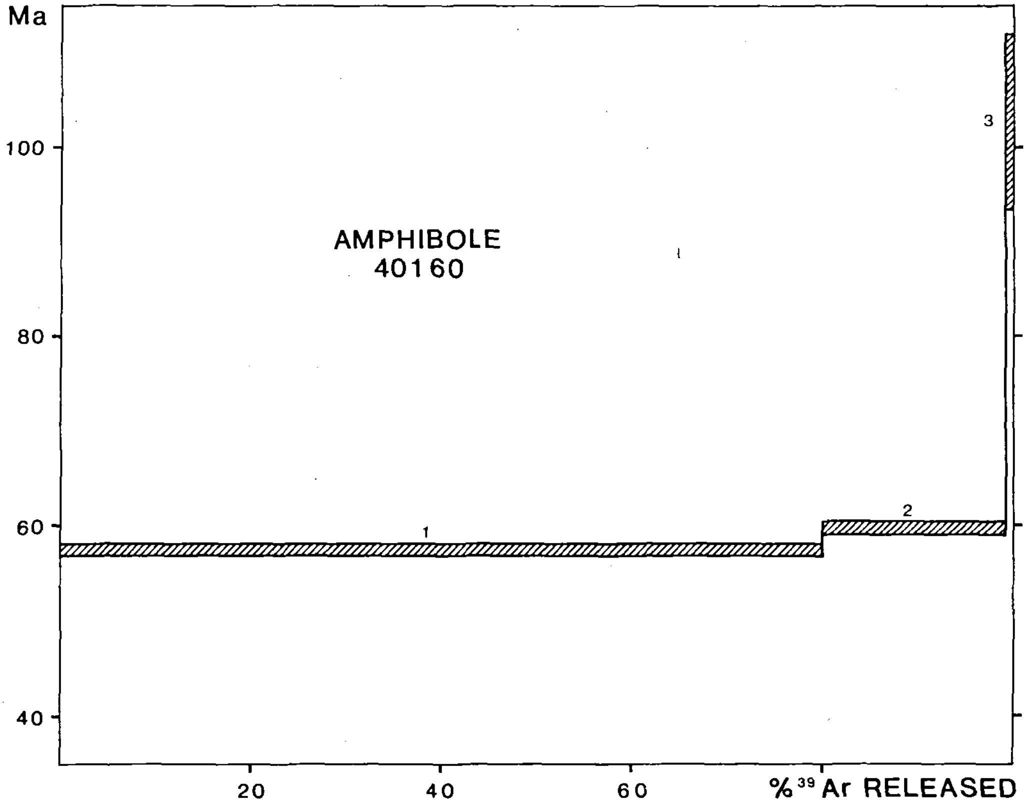

Fig. 2. $^{40}Ar/^{39}Ar$ age spectrum for amphibole 40160.

at each step; no spike is added, and mass 36, 37, 38, 39 and 40 are recorded.

The correction procedure involves correction for interference from isotopes generated in the mass range 36–40 by the irradiation of Ca, Cl and K (Roddick, 1983) as well as a correction for atmospheric argon. In the data table, calculated gas quantities are relative to ^{40}Ar (Table 1). An amount of 200000 is approximately equivalent to 1×10^{-6} cm^3 ^{40}Ar STP.

Rb and Sr abundances and the Rb/Sr ratio
These were analysed at Institut for Petrologi, University of Copenhagen, on powder pellets by X-ray fluorescence using an automatic Philips PW1400 instrument. Matrix correction was applied using the coefficients of Heinrich (1966). The analytical uncertainty of the Rb/Sr ratio measurement is less than 1.5 %rel.

Sr isotopes
Samples were dissolved, as described above for K, and put through ion exchange columns. SrCl was mounted on Ta filaments and analysed using a double filament technique with a Re ionisation filament in a Varian MAT TH-5 mass spectrometer for some samples. Other samples were analysed using the phosphoric acid method using single Ta filaments in a Finnegan MAT261 at Carleton University, Ottawa, Canada or with a Micromass 30 instrument at Leeds University, U.K. All analytical results were corrected for mass fractionaltion by normalising to $^{86}Sr/^{88}Sr = 0.1194$. The analytical precision is tabulated with the results. Accuracy was monitored with international reference material SRM987 and Eimer and Amend $SrCO_3$.

Results

The results of the mineral analyses are presented in Table 1 ($^{40}Ar/^{39}Ar$), Table 2 (K/Ar) and Table 3 (Rb/Sr). The most detailed information is from the age spectra obtained by the $^{40}Ar/^{39}Ar$ method with incremental heating technique. It is evident

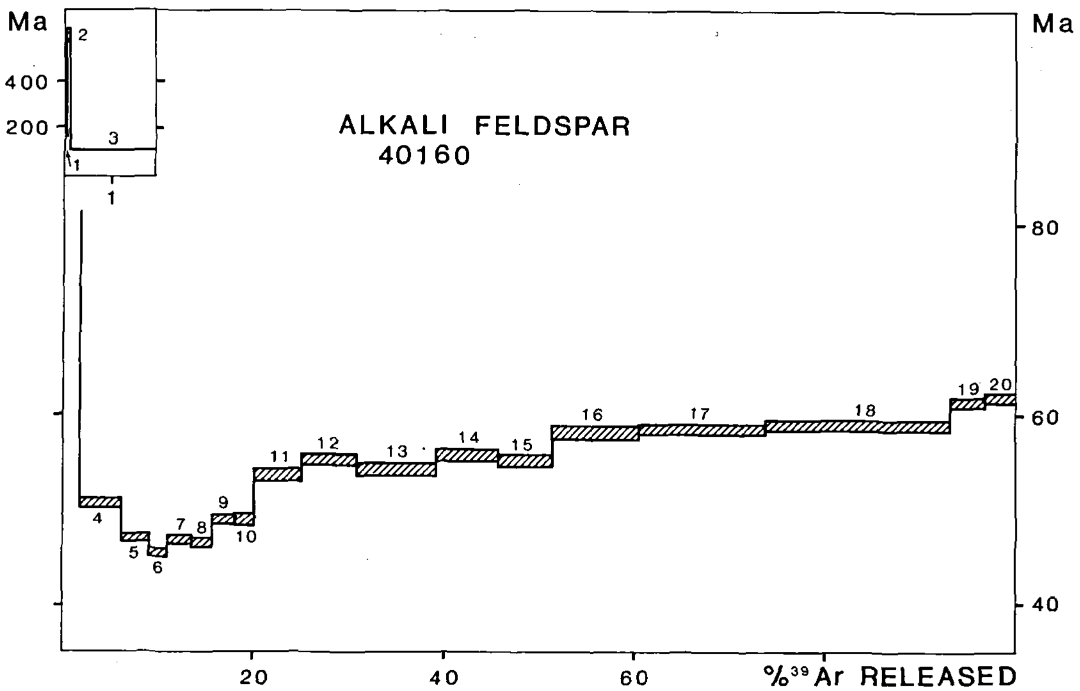

Fig. 3. $^{40}Ar/^{39}Ar$ age spectrum for alkali feldspar *40160*. *The curve is a theoretical profile for diffusion of* ^{40}Ar fitted to the age spectrum.

from the range of calculated ages for most samples, that no simple dating can be expected by the K/Ar or $^{40}Ar/^{39}Ar$ methods. Geologically meaningless excessive ages are frequently obtained by the analysis of argon released at both low-temperature and high-temperature steps. Only by the analysis of a considerable amount of samples, considering the rather restricted areal extent of the KSC, it has been possible to get the sufficient confirmation of the inferred ages.

Samples analysed by the $^{40}Ar/^{39}Ar$-method

Sample 40160

This sample is from the northern part of the complex and is a marginally peralkaline alkali granite. The separated amphibole is a ferro-richterite. This rock does not carry clinopyroxene, which in other rocks has given severe separation techniqual problems, and the separate is quite pure. Alkali feldspar was also separated.

K/Ar analysis of amphibole yielded an age of 61.6 ± 0.9 Ma. $^{40}Ar/^{39}Ar$ apparent ages were calculated for the same amphibole in two major steps and one minor at high temperatures (fig. 2). The two steps yielded 57.5 ± 0.7 and 59.7 ± 0.7 Ma and represent nearly all the released argon. The third, insignificant step, yielded 103 Ma. The weighted mean age of steps one and two is 58.1 ± 1.1 Ma.

A twenty step age spectrum was obtained from alkali feldspar (fig. 3). This high resolution spectrum reveals excess Ar in the outer parts of the grains (step 1–5), followed by an Ar diffusion profile which includes the major part of the released Ar (steps 6–18). The minimum calculated age is 45.5 Ma in step 6. Ages increase through the profile to 58.8 ± 0.6 Ma in step 18. The three steps 16–18 may be considered a plateau in the definition by e.g. Berger and York (1981), but is really the central, nearly flat part of the diffusion profile. The significantly higher calculated ages of steps 19 and 20 cannot be modelled as parts of the profile. Most likely they represent additional small amount of excess argon released from more retentive Ca-positions in inpurities of plagioclase in the analysed separate. This age spectrum indicate a relatively low amount, approximately 25%, of Ar-loss, if a log-normal grain size distribution is assumed (Turner, 1968). Calculations

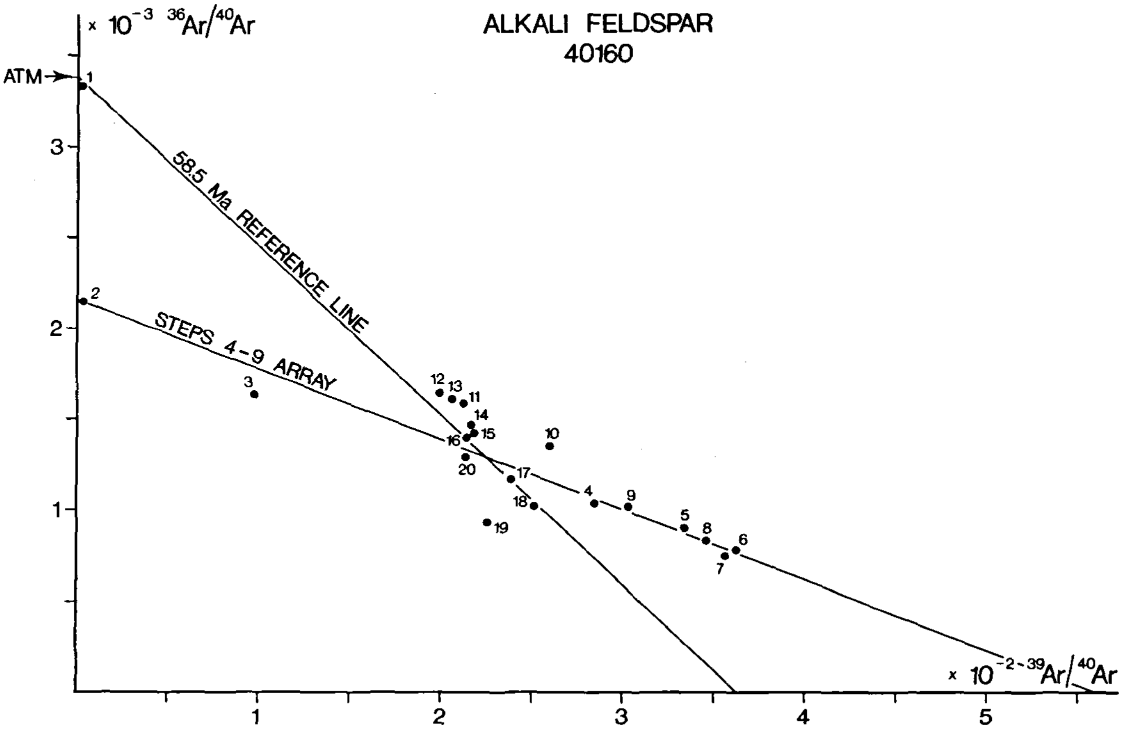

Fig. 4. $^{36}Ar/^{40}Ar$ versus $^{39}Ar/^{40}Ar$ correlation diagram for alkali feldspar 40160. Steps (2–)4–9 form an array of points indicating a fixed composition of extraneous argon of $^{40}Ar/^{36}Ar$ = c. 466 at an age of c. 38 Ma. The plateau age of steps 16–18 (cf. fig. 3) is shown for reference. Steps 10–15 are intermediate in both apparent age and composition of the extraneous Ar component.

demonstrate that the loss of Ar from the crystal sites, analysed in steps at high-temperature, is negligible, if only limited amounts of Ar was lost (Turner, 1968). The age of step 18, or, statistically more significant, steps 16 through 18, may yield the crystallisation age. The weighted mean calculated age for steps 16–18 is 58.5 ± 0.4 Ma in close aggreement with the age indicated by amphibole in this sample. The age obtained by the K/Ar method is not very different, but is a bit higher probably owing to excess Ar, and confidence cannot be attached to this result.

The Ar release pattern of alkali feldspar (fig. 3) demonstrates that this specimen was cooled below around 100°C at a time later than the minimum age recorded (Harrison and McDougall, 1983). The precise time cannot be calculated because of the excess argon. However, the time of Ar closure in the alkali feldspar can be somewhat constrained by a tentative extrapolation of the diffusion profile curve to $^{39}Ar_{released} = 0\%$. This procedure leads to an indicated age of c. 36 Ma for the latest cooling of this part of Kærven. the relatively small Ar-loss from alkali feldspar suggests that the temperature did not exceed c. 200°C since the crystallisation of the feldspar. This is supported by the amphibole Ar-data from this sample. Only very minor Ar could have been lost from the amphibole, although it is impossible from the two-step spectrum to make a rigorous statement.

Extraneous radiogenic Ar entered the marginal parts of the alkali feldspar crystals during the final cooling. Steps 1–5 clearly contain excess Ar, but also steps 6 and possibly 7 in fig. 3 are raised slightly from the general decrease in the age spectra towards the left. Further support to the age information discussed above for the alkali feldspar of this sample may be lend from the variation of the $^{39}Ar/^{40}Ar$ and $^{36}Ar/^{40}Ar$ ratios. In a plot of these two ratios (Roddick, 1980) age is read off the x-intercept of a regression line through the data points while the extraneous Ar is given by the y-intercept. The extraneous Ar may be atmospheric but in this case also radiogenic (excess) Ar is involved. In fig. 4 steps 4

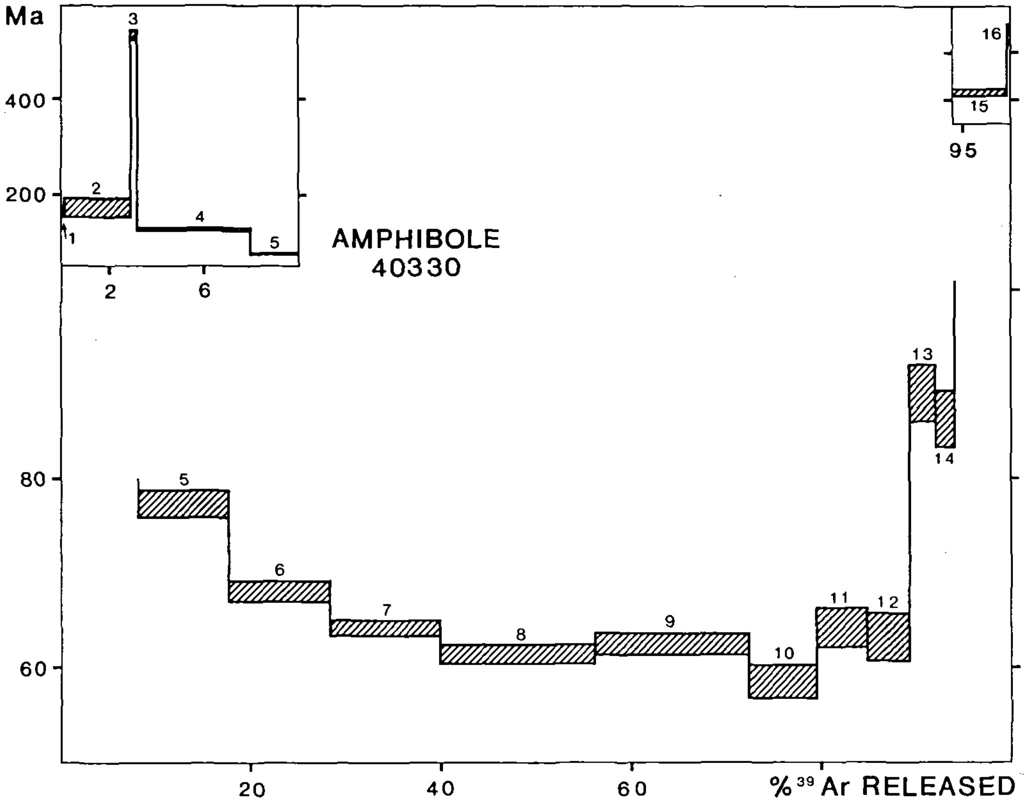

Fig. 5. $^{40}Ar/^{39}Ar$ age spectrum for amphibole 40330.

through 9 define a line to which the small steps 2 and 3 also are related. This line indicate that for these steps a radiogenic component of 38.1 ± 1.2 Ma and extraneous Ar of $^{40}Ar/^{36}Ar = 466 \pm 14$ constitute the Ar of the samples. Heizler and Harrison (1988) recently discussed the significance of such linear arrays and assigned age significance to them. In the present case, the data can be interpreted as the degassing during the analysis of steps 2 through 9 of a domain dominated by an excess ^{40}Ar component. In the subsequent steps the degassing domains have extraneous Ar composed of relatively decreasing amounts of ^{40}Ar and increasing amounts of atmospheric Ar. Finally steps 16–18 contain only atmospheric and radiogenic Ar yielding the age indicated in the age spectrum analysis: 58.5 Ma.

The Rb and Sr abundances and the Sr isotopic ratios in whole rock, amphibole and alkali feldspar were analysed. An age of 57.8 ± 2.6 Ma is defined by the mineral pair. The three points collectively give 57.5 ± 2.8 Ma (MSWD = 0.1). Thus, both Rb/Sr and $^{40}Ar/^{39}Ar$ dating yield the same age within the analytical error for this rock. The best age estimate is considered to be the mean of the two independent $^{40}Ar/^{39}Ar$ determinations: 58.3 ± 0.8 Ma.

Sample 40330

Sample 40330 is from the largest unit, #3, of the complex and is a fayalite bearing quartz syenite running N–S in the southeastern part of the complex (Holm et al., in press). This sample was blasted with dynamite and is considered very fresh. The ferro-hornblende separate is contaminated with a few percent clinopyroxene.

The age spectrum of amphibole from this sample displays the problem of contamination by clinopyroxene (fig. 5). The form is the typical so-called saddle spectrum, best know from plagioclase (Lanphere and Dalrymple, 1976), but also seen in clinopyroxene and occasionally amphibole (Harrison and McDougall, 1981). Excess argon is clearly present in the first 40% and last 10% ^{39}Ar released. Steps *8*, *9*, *11* and *12* yields the same age, but the age of step 10 is signif-

Table 4.
Comparison of the indicated crystallisation ages and, in brackets, results which may have age significance.

Sample	Type	Analytical method				
		^{39}Ar/^{40}Ar		K/Ar	Rb/Sr	Fission tracks
		plateau	indication			
Kærven syenite complex						
40160	wr				57.0±2.8	
	amph	58.1±1.1		61.6±0.9	57.8±2.6	
	kf	58.5±0.4				
40333c	wr					
	amph	54.4±1.0			58.5±1.2	
40321	amph			56.1±0.8		
40271	amph			58.0±0.8		
40323	amph			50.4±0.8		
40304	bio, wr, amph				(67.3±0.4)	
40330						
	amph		(≈58.5±1.7^{a})	(64.8r0.9)		
40228	zirkon					51.4±3.2
Kangerdlugssuaq intrusion//nordmarkite						
66585	wr					
40297	wr					
40299	wr				53.5±3.0	
40300	wr					
	amph	55.6±1.7				

a) an age of >58.3±0.8 Ma may further be indicated (see text).

icantly lower. The weighted mean age of steps 8–12 is 61.8 ± 2.2 and must be considered a maximum age because of the massive amount of excess Ar in this sample. However, the large size, c. 50% of the released ^{39}Ar, and the relative small increase in age between steps 8, 7 and 6, is probably an indication that the crystallisation age is not much younger. It is concluded that the age of unit 3 of the KSC is < 61.8 ± 2.2 Ma, but probably not younger than 58.5 Ma – the minimum age of step 10 of the spectrum. Sample 40330 may thus be of approximatelythe same age as the well constrained sample 40160. It is not possible to judge whether the excess argon is present in the amphibole or the minor clinopyroxene component. K/Ar analysis yields the expected high age owing to excess Ar.

The Rb/Sr age of 232 Ma was calculated from the analysis of whole rock and amphibole and is not geologically acceptable, as this syenite is a part of the Tertiary complex.

Sample 40333c

This sample is from a granite dyke running NW–SE in the central part of the complex. From field relations it is known that unit 6 is younger than unit 3, the age of which is rather poorly constrained above. The ferroedenite from this sample has a more regular ^{40}Ar/^{39}Ar age spectrum (fig. 6). A well defined plateau of three steps of the same age, within the analytical error, comprising 95% of the released ^{39}Ar yields a weighted mean of 54.4 ± 1.0 Ma, which can be regarded as the crystallisation age. The first three low-temperature steps of a mere 4% of the ^{39}Ar released from this sample show a combination of high and low ages and indicate a thermal event during which the pressure of ^{40}Ar at the grain boundaries was significant. The temperature was not higher than a few hundred degrees celcius if the closure temperature (Dodson, 1973) of amphibole is taken as ≈530°C (Harrison and McDougall, 1980). The final high temperature steps, nos. 7–11 probably also evidence excess argon, but here accomodated in the Ca crystal lattice sites.

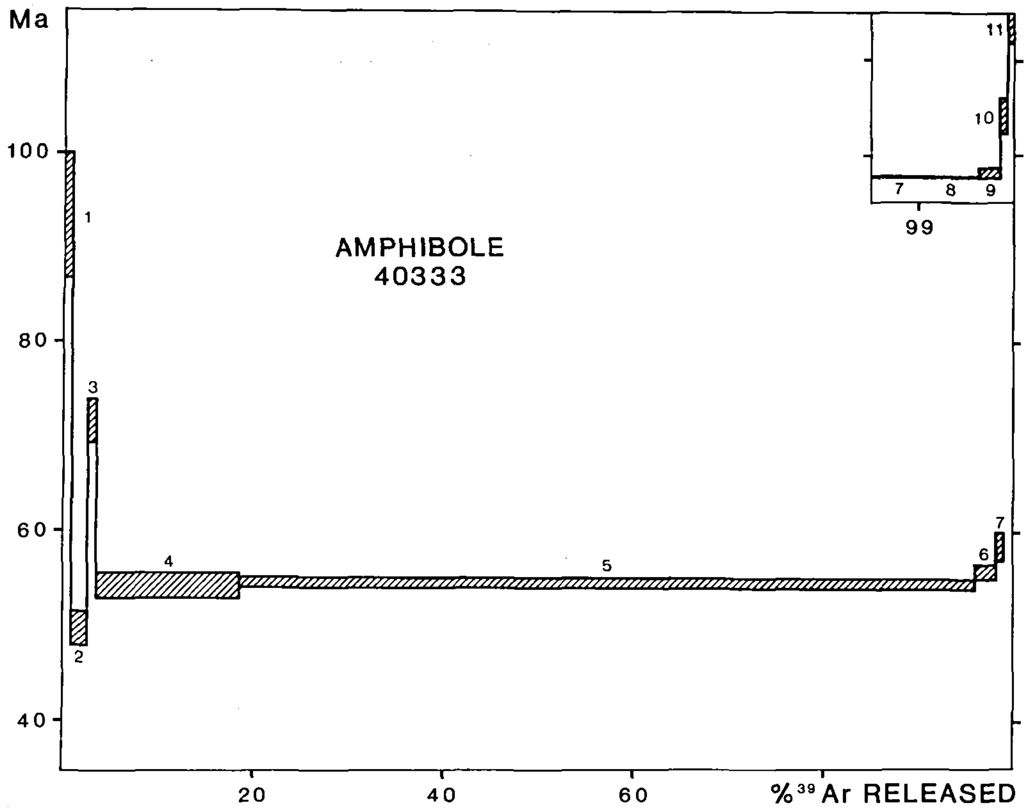

Fig. 6. $^{40}Ar/^{39}Ar$ age spectrum for amphibole 40333c.

Sample 40228

This is a 10 m wide syenite dyke situated in the southern part of the Kærven gabbro. Only alkali feldspar was analysed by the incremental heating technique. This age spectrum has no indication of crystallisation age because of the extremely dominant component of excess Ar (fig. 7). Little, if any, part of the spectrum can be related to the in situ decay of potassium in this feldspar. Of the 15 analysed steps only three, 5–7, yielding ages of 49–51 Ma, may be devoid of excess Ar. This age is considered a maximum age for this part of the spectrum. However, Ar loss may have occurred as seen in 40160 KF, and the spectrum is of little and significance, but testifies a considerable invasion of excess Ar.

Separated secondary biotite, alkali feldspar and the whole rock were analysed for strontium isotopes. The pairs whole rock-biotite and feldspar-biotite both yield 47 Ma (Table 3). This sample has the most pervasive imprint of secondary heating as evidenced by the argon results, and as the mica is secondary, the measured age may illustrate its formation age which could very well be coinciding with a homogenisation age for the feldspar. Thus, the age of 47 Ma is possibly the peak of the thermal event.

The whole rock, feldspar and biotite do not define an isochron, probably an indication that disequilibrium between minerals was introduced during the thermal event. The age calculated from the regression line through the three data points is 52.1 ± 1.6 Ma which corresponds to the fission track age obtained from zircons: 51.4 ± 3.2 Ma (Hansen, 1985). This zircon cooling age is similar to the minimum age proposed on basis of the $^{40}Ar/^{39}Ar$ age spectrum, and corresponds to a temperature of c. 240°C. Later heating (at 47 Ma) did not attain this temperature. The crystallisation of biotite was probably facilitated by fluids.

Samples 40300 and 40301

These samples are nordmarkites from the Kangerdlugssuaq intrusion immediately west of the KSC. Hastingsite of sample 40301 is contami-

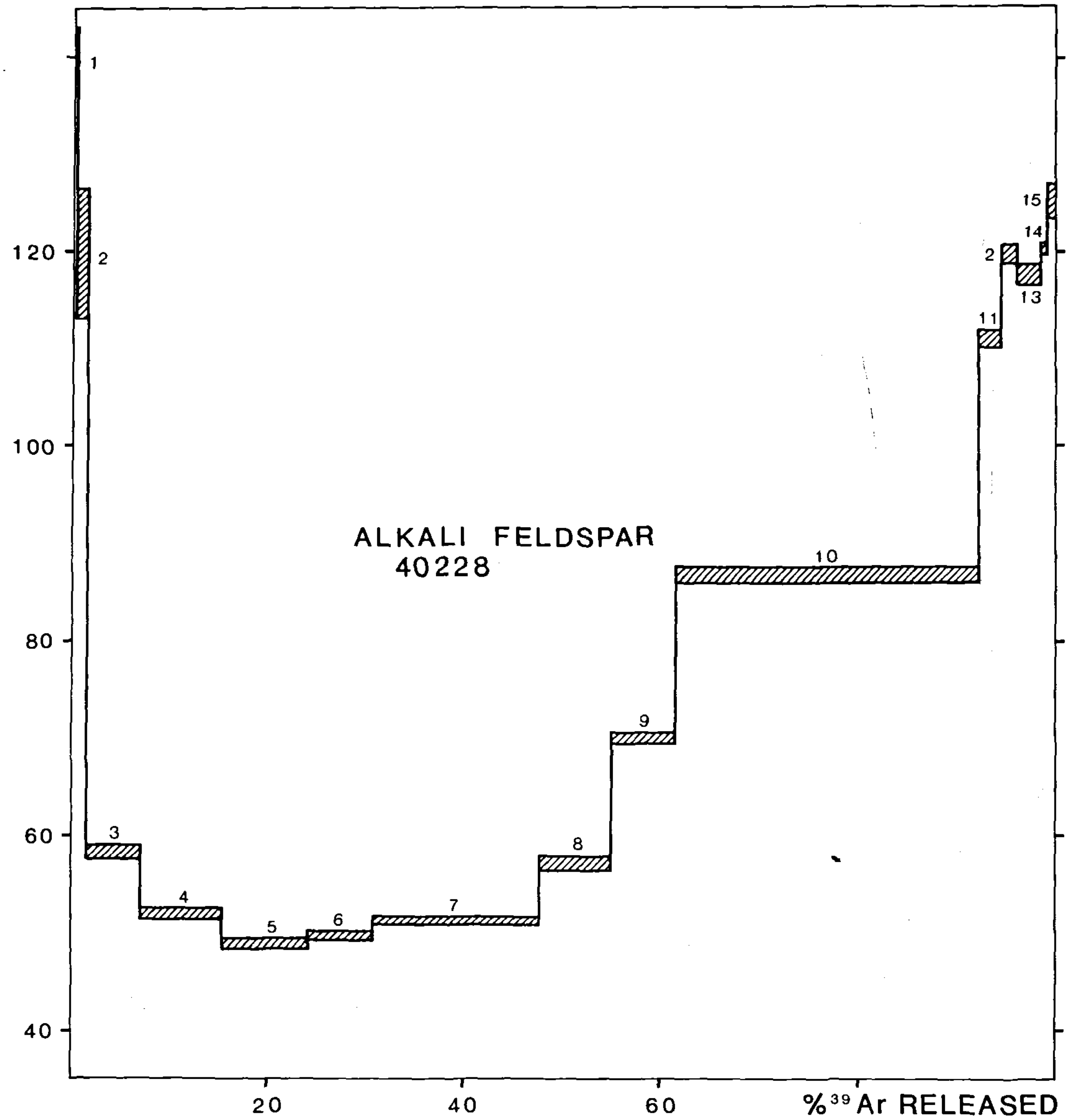

Fig. 7. ^{40}Ar/^{39}Ar age spectrum for alkali feldspar 40228. The curve has the form of the diffusion profile for alkali feldspar 40160, but is fitted to the spectrum of sample 40228.

nated by a few percent of clinopyroxene, which probably is the main cause for excess argon in several steps (fig. 8). The sole age information from this rock is that 61 Ma is an upper limit for the crystallisation. Sample 40300 is from a location a little W of 40301. Amphibole in this separate constitutes more than 99%. Only minor excess Ar is immediately apparent in this sample (fig. 9). However, the plateau of steps 8 through 17 slopes from ≈59 Ma to lower ages in the high temperature part. The reason for this is not known, but it may be related to excess argon being present in minor and decreasing amount in the lower temperature steps of the plateau. Further indications of complex K/Ar relations in the sample stems from the rather large variation in calculated age of the high temperature steps, which is, in fact, too big to define a plateau (Lanphere and Dalrymple, 1976). A weighted mean of steps 15–17 yields an age of 55.6 ± 1.7 Ma, which is considered an age very close to the crystallisation age.

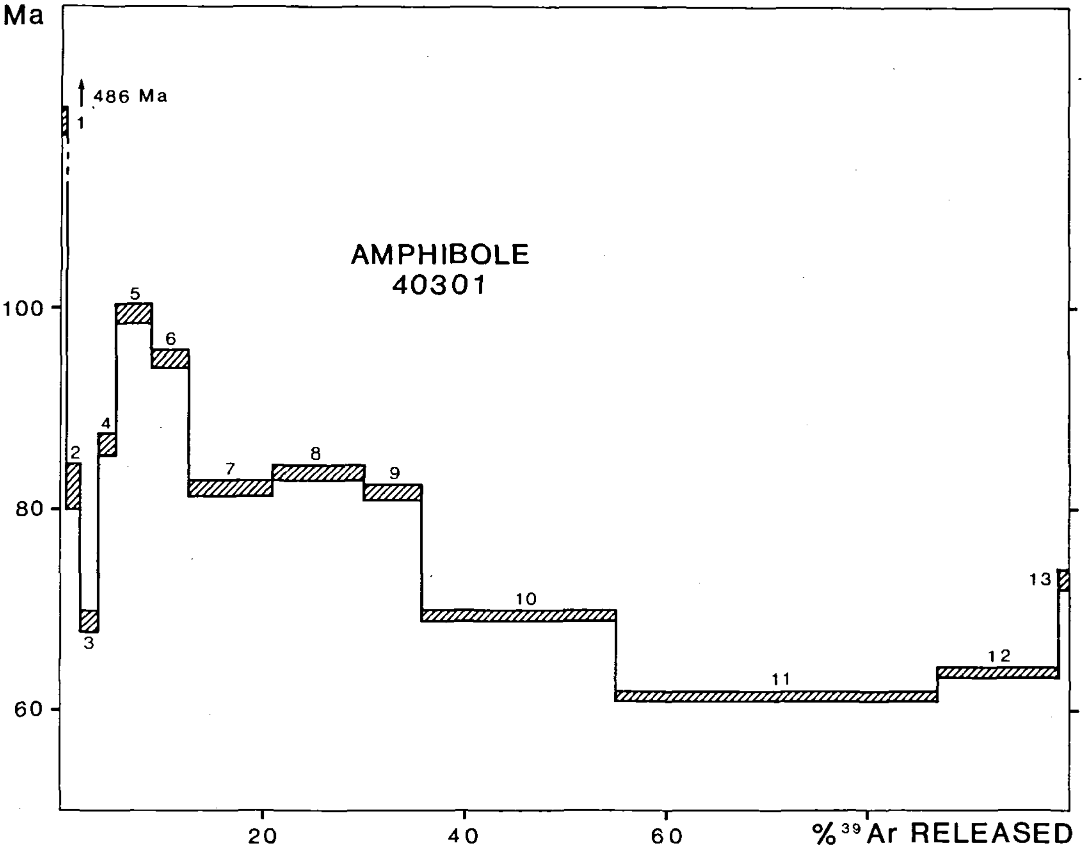

Fig. 8. ^{40}Ar/^{39}Ar age spectrum for amphibole 40301.

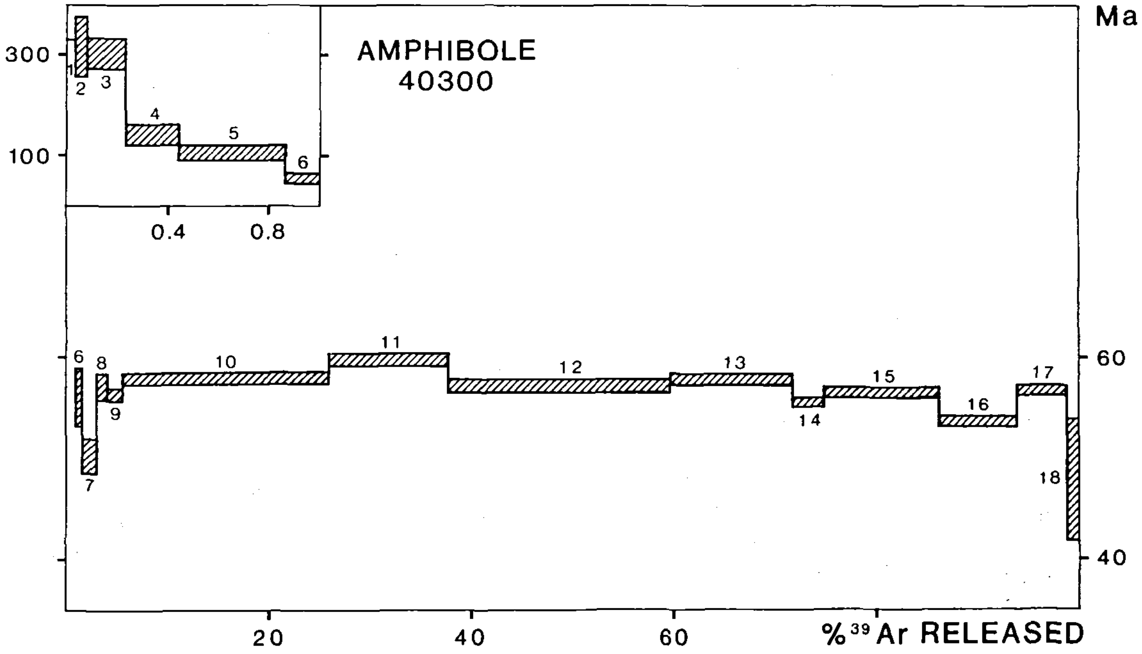

Fig. 9. ^{40}Ar/^{39}Ar age spectrum for amphibole 40300.

Table 5.
Whole rock Rb/Sr element and isotopic data.

Sample	Rb ppm	Sr ppm	^{87}Rb/^{86}Rb	^{87}Sr/^{86}Sr
Kangerdlugssuaq nordmarkites				
40297 wr	49	58	2.449	0.706490±0.000080
40299 wr	109	64	5.014	0.708450±0.000050
40300 wr	75	55	3.923	0.707508±0.000006
66585 wr	74	63	3.486	0.707280±0.000040
40301 wr	62	60	2.995	0.707520±0.000090
Kaerven group 1				
40160 wr	108	21	15.26	0.720899±0.000020
40302 wr	95	68	4.087	0.712280±0.000020
40323 wr	84	46	5.501	0.712781±0.000016
40325 wr	92	57	4.832	0.712550±0.000050
40333 Cwr	105	51	6.031	0.713283±0.000012
66493 wr	130	12	29.23	0.731297±0.000164
66495 wr	108	38	8.368	0.715780±0.000035
66551 wr	105	6.2	43.95	0.744680±0.000110
66577 wr	83	85	2.957	0.710400±0.000100
66589 wr	101	86	3.448	0.711640±0.000070
66592 wr	114	18	17.89	0.721490±0.000170
Kaerven group 2				
40271	61	110	1.603	0.714820±0.000110
40293 wr	78	81	2.788	0.715650±0.000140
40326 Awr	113	29	11.79	0.722869±0.000024
66502 wr	18	389	0.1378	0.713080±0.000060
Kaerven group 3				
40228 wr	78	245	0.913	0.718230±0.000040
40321 wr	55	78	2.055	0.719131±0.000014
Kaerven group 4				
40329 wr	62	24	8.036	0.727680±0.000030
40331 wr	64	63	3.026	0.722570±0.000310
66497 wr	52	10	15.89	0.733026±0.000042
40330 wr	41	38	3.25	0.723678±0.000015
66554 wr	51	24	6.113	0.727532±0.000044
Kaerven group 5				
40304 wr	52	164	0.9223	0.72486±0.000012
Kaerven ungrouped				
66503 wr	81	99	2.268	0.710598±0.000039
Melts with large basement component and basement				
40324 Awr	27	493	0.159	0.736470±0.000060
40327 wr	39	405	0.2781	0.724060±0.000050
66544 wr	44	329	0.3928	0.729800±0.000050

Rb/Sr analyses of five rocks from the nordmarkite (Table 5 and fig. 10) reveal that sample 40301 is off the linear array defined by the other four samples. The thermal event, which had a pronounced effect on the argon age spectrum in this sample, also seems to have affected the Rb/Sr system. Leaving this rock out, allows the calculation of an isochron of 53.5 ± 3.0 (MSWD = 0.5). The Rb/Sr and the ^{40}Ar/^{39}Ar ages are thus in aggreement. The more precise ^{40}Ar/^{39}Ar age is preferred. This age is significantly older than previous estimates for the Kangerdlugssuaq intrusion.

Additional K/Ar results

The step-heating experiments collectively show that amphibole only lost negligible amounts of argon during post magmatic heating in the Kærven area. Excess Ar was, however, variably introduced. If a regional thermal event caused the irregularities of the various age spectra, the apparent K/Ar ages of amphiboles are most likely maximum age estimates. If local intrusion caused the temperature rise, this assumption may be invalid. There are, however, no indications in the Kærven complex at the present erosional level for intrusive activity later than ca. 50 Ma (the Kangerdlugssuaq intrusion cf. Pankhurst et al., 1976) and only marginally lowering of amphibole Ar contents would be expected.

Two of the K/Ar results (table 2) – amphibole from 40321 and 40271 – are consistent with the 58 Ma age. Sample 40321 is situated in a large syenite dyke in the Kærven gabbro near the contact of the syenite complex and the gabbro. Sample 40271 is a dyke in the basement at the very contact to the gabbro. These peripheral samples were probably not reheated by later syenite intrusions, and may closely date the time of their injection: 57 ± 1 Ma for 40321 and 58 ± 1 Ma for 40271.

The low age of amphibole 40323, 50.4 ± 0.8 Ma, is most likely a crystallisation age, as no amphibole in the complex seems to have lost Ar. However, severe heating from later intrusive event close to the location of 40323 cannot be ruled out, although such later intrusion is not backed by field evidence. Thus, most likely sample 40323 retained its radiogenic Ar after initial crystallisation at 50 Ma. This rock is the youngest recorded in the KSC and is of comparable age to the undersaturated rocks of the Kangerdlugssuaq intrusion.

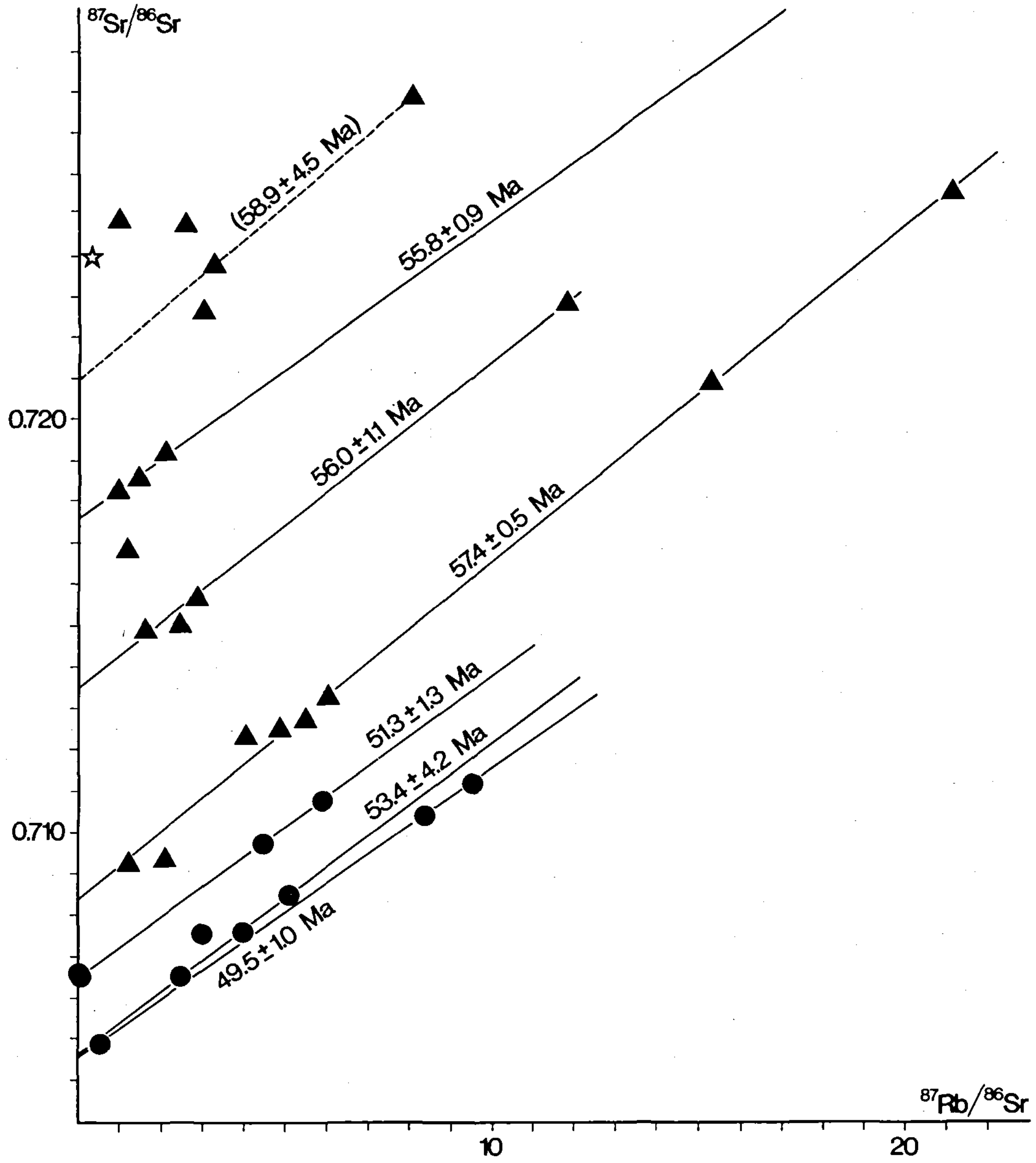

Fig. 10. ^{87}Sr/^{86}Sr vesrus ^{87}Rb/^{86}Sr for whole rock samples from the Kærven syenite complex (triangles) and the adjacent nordmarkites of the Kangerdlugssuaq intrusion (circles) and basement xenoliths or basement derived/influenced melt (star). Except for the 53.5 Ma isochron for four nordmarkites, the lines in the diagram are drawn through sample positions, for which no isochron is defined.

Rb/Sr analyses on whole rock and mineral samples

Rb/Sr analysis was performed on the samples analysed for Ar plus additional samples. The results for 32 samples are listed in Table 5. The complex petrogenesis of the Kærven rocks is evident from the Rb/Sr results (fig. 10). No isochron is defined by the Kærven data. The only isochron defined by the analysed rocks, is for the nordmarkites of the adjacent part of the Kangerdlugssuaq intrusion: 53.5 ± 3.0 (MSWD = 0.5). In order to evaluate the data, an inverse procedure is applied. Those samples, which have well constrained ages indicated by K/Ar or ^{40}Ar/^{39}Ar analysis (above), have been fitted in fig. 10 with lines of inclinations derived from the K/Ar ages. In the case of sample 40160, the 58.3 Ma line fits several samples rather well, although no isochron is defined. From the figure it is apparent that a group of rocks were derived from magmas with rather similar initial $(^{87}Sr/^{86}Sr)_0^{40160} = 0.7083$. This value is well above the value derived for the nordmarkites: $(^{87}Sr/^{86}Sr)_0 = 0.7046$. The line in the diagram through sample 40333c, based on the K/Ar age of 54.4 Ma for amphibole from 40333c, does not trend near the high Rb/Sr samples of this group. A line of 50.4 Ma was drawn through sample 40323 which yielded this K/Ar age. Samples 40333c, 66495 and 66493 are from the same intrusive unit, but cannot be accounted for by the 54.4 Ma line or by the two other lines. Although these rocks probably constitute a group relative to the rest of the Kærven samples, it is concluded that the Rb/Sr isotope system does not allow precise age information to be extracted for these rocks owing to the presence of a variation in the $^{87}Sr/^{86}Sr$ ratio, which is not solely related to the in situ decay of Rb since emplacement.

The Kærven amphiboles crystallised as late interstitial phases (Holm and Prægel, 1988). The results of calculated ages from Rb/Sr analysis of rock-amphibole pairs (Table 3) clearly indicate disequilibrium. Both very high and negative ages are calculated. This can only be explained by the presence in the rocks of components derived from material with $^{87}Sr/^{86}Sr$ ratios different to those of the amphiboles. These components did not systematically have higher or lower $^{87}Sr/^{86}Sr$ ratios. Secondary alteration is not thought to be a viable explanation for this variation, as all these rocks petrographically and geochemically appear very fresh, and e.g. 40330, which yields a rock-amphibole age of 231 ± 20 Ma, is virtually prestine material obtained by blasting. The good quality of the Ar-data on the interstitial amphiboles further attests to the unaltered character. The processes responsible cannot be constrained by the data presented here. However, likely mechanisms are (1) incorporation into rising magmas of xenocrysts from already emplaced magmatic cumulates, (2) mixing between partially crystallised magmas or (3) subsolidus exchange of Rb and/or Sr with hydrothermal solutions at high temperatures. The Sr isotope disequilibrium on the mineral scale support the implications from the whole rock Rb/Sr data.

Biotite-whole rock results have been presented in the preceding section for samples 40160 and 40228, which also were analysed for Ar isotopes. For syenite 40304 whole rock, edinitic hornblende and primary biotite were analysed. Also in this rock the amphibole and whole rock are in disequilibrium, the pair yielding a negative age. One age of 67.3 ± 0.4 Ma is calculated for both biotite-whole rock-amphibole and biotite-whole rock, but an MSWD of 6 for the three point regression is evidence of the disequilibrium. The significance of the calculated biotite age is not known. On basis of the disequilibrium in this rock it is presently not regarded as a reliable dating.

Comparison with datings of the Kangerdlugssuaq intrusion and the Snout Series and conclusions

The concordant Rb/Sr mineral and whole rock isochrons from the undersaturated parts of the Kangerdlugssuaq intrusion (Pankhurst et al., 1976) and similar fission track ages of zircon and sphene from the felsic rocks in the whole Kangerdlugssuaq area promoted the conclusion that the major alkaline intrusions were emplaced over a very short period close to 50 Ma (Gleadow and Brooks, 1979). The new data for the Kærven area clearly require a modification of this statement.

The rocks dated from the Kangerdlugssuaq intrusion were foyaite, pulaskites and transitional pulaskites from the central parts of the intrusion and one quartz nordmarkite from near the outer contact, N of Kælvegletscher. The samples dated in this study are nordmarkites, a rock-type which has not previously been dated. They are, however, not significantly different from the quartz nordmarkites. Field work in the Kærven area indicates that also the Kangerdlugssuaq intrusion was multiply emplaced (Holm et al., in press). The nordmarkites W of Kærven may be a separate intrusion. For these nordmarkites, the Rb/sr isochron age and the $^{40}Ar/^{39}Ar$ plateau age point to an average age of 54.6 ± 2.4 Ma, a significantly older age than the 48.9 ± 1.9 Ma whole rock isochron for undersaturated Kangerdlugssuaq rocks, as well as the 48.8 ± 1.0 Ma mineral isochron for transitional pulaskite, EG4583 (Pankhurst et al., 1976), and the mean fission track age of 50.9 ± 1.5 Ma for sphene and zircon (Gleadow and Brooks, 1979).

The intrusive rocks to the south of Kærven, which occupies the area between the Kangerdlugssuaq intrusion and the basement are called the Snout Series (Deer and Kempe, 1976). Fission tracks in zircons from this intrusion yield an age for of 48.0 ± 0.7 (Gleadow and Brooks, 1979). Based on the data presented in this work indicating post intrusion thermal events, this age for the Snout Series could very well be a cooling age significantly younger than the crystallisation age.

The age information from Kærven provide evidence that intrusion was initiated at 58.3 ± 0.8 Ma, ca. 9 million years before the undersaturated rocks of the Kangerdlugssuaq intrusion were emplaced. Several units of the KSC were emplaced in a few million years. Intrusion at Kærven took place as late as 50.4 ± 0.8 Ma, although no indication of continuous activity is found. The oldest magmatic manifestations in the region, hitherto indicated, is the main event of flood basalt extrusion along the rift zone near the present-day coast line. The age of this volcanism is constrained by the magnetic anomalies, which are not well dated. A best estimate of the CFB of East Greenland is at present 54–57 Ma (Gleadow and Brooks, 1979; Brooks and Gleadow, 1977; Brooks and Nielsen, 1982). The oldest age of intrusion in the Kærven complex is thus comparable to the very start of magmatic activity in the Tertiary East Greenland.

Concordant apatite fission track ages of c. 36 Ma for rocks in the vicinity of the coast in the Kangerdlugssuaq region indicate cooling by uplift at that time (Gleadow and Brooks, 1979). This uplift was accompanied by alkaline dyke injection, the latest recorded magmatic activity in the area (Brooks and Nielsen, 1982). The argon loss evidenced by the ^{40}Ar/^{39}Ar alkali feldspar age spectra have a superposed component of excess Ar. This inhibits the closing time for argon diffusion to be read directly from the analytical data. However, extrapolation of the diffusion profile of one alkali feldspar to the grain boundary conditions indicate an age of 36 Ma for the high resolution spectrum of alkali feldspar 40160. This age is confirmed by interpretation of the information yielded by low-T steps in an Ar isotope ratio correlation diagram. It is thus indicated that the regional event at c. 36 Ma of cooling through around 100°C as recorded by apatite, at Kærven is marked by the of closure of alkali feldspar for argon diffusion at approximately the same temperature.

If the crystallisation of secondary biotite in sample 40228 marks the presence of fluids at the maximum temperature of the metamorphism, which ended at 36 Ma, the Rb/Sr isotopic biotite-rock and biotite-feldspar age of 47 Ma may date the thermal maximum.

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Dansk sammendrag

Kærven syenitkomplekset er blevet undersøgt ved K/Ar, ^{40}Ar/^{39}Ar og Rb/Sr metoderne til radiometrisk aldersbestemmelse. Syenitkomplekset er intruderet i forbindelse med den kontinentale opsprækning, der fandt sted i tidligt i Tertiær, og som førte til separationen af Grønland fra Europa og dannelsen af Nordatlanten. Kærven syenitkomplekset består af mindst 10 enheder, som emplaceredes før den tilgrænsende Kangerdlugssuaqintrusion. Fem amfibol- og to alkalifeldspatseparater er analyseret ved ^{40}Ar/^{39}Ar metoden med trinvis opvarmning. Desuden præsenteres konventionel K/Ar analyse af fem amfiboler og en biotit samt Rb/Sr isotopanalyse af 6 amfiboler, 2 biotiter, 3 alkali feldspater og 32 bjergartsprøver. Resultaterne vidner om en sen opvarmning af dele af Kærvenområdet ca. 36 Ma. Denne førte til både ^{40}Ar tab fra og optagelse af »excess« Ar i prøverne i variabelt omfang. Ligeledes blev Sr isotoperne påvirket under den sekondære opvarmning. Resultaterne viser at dele af Kærvenkomplekset krystalliserede ca. 58 ± 1 Ma, medens andre dele er yngre: 56.1 ± 0.8 Ma og 50.4 ± 0.8 Ma. De tidligst intruderede enheder er væsentligt ældre end hidtil rapporteret for områdets syeniter, og deres alder på ca. 58 Ma kan kun sammenlignes med den anslåede alder for indledning af den basaltiske vulkanisme langs Østgrønlands kyst ca. 57 Ma. En Rb/Sr isokron for bjergarter og et ^{40}Ar/^{39}Ar aldersplateau i amfiboler fra nordmarkiter i Kangerdlugssuaqintrusionen umiddelbart vest for Kærven daterer denne del af intrusionen til 54.6 ± 2.4 Ma. Denne alder er ældre end andre dele af intrusionen og indikerer at Kangerdlugssuaqintrusionen er multipel.

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