P-06-211

Forsmark site investigation

$^{40}Ar/^{39}Ar$ and (U-Th)/He geochronology: Phase 2

Page L, Hermansson T, Söderlund P
Department of Geology, Lund University

Stephens M B, Geological Survey of Sweden, Uppsala

May 2007

Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

ISSN 1651-4416
SKB P-06-211

Forsmark site investigation

$^{40}Ar/^{39}Ar$ and (U-Th)/He geochronology: Phase 2

Page L, Hermansson T, Söderlund P
Department of Geology, Lund University

Stephens M B, Geological Survey of Sweden, Uppsala

May 2007

Keywords: Geochronology, Thermochronology, $^{40}Ar/^{39}Ar$, (U-Th)/He, Hornblende, Biotite, Muscovite, K-feldspar, Apatite.

Abstract

$^{40}Ar/^{39}Ar$ (hornblende, biotite, muscovite, K-feldspar) and (U-Th)/He (apatite) geochronological data from the Forsmark area, as well as $^{40}Ar/^{39}Ar$ (hornblende, biotite) geochronological data from a broader regional study are presented here. These data provide some age constraints on the younger geological evolution at the Forsmark site. The regional study was undertaken in order to help understand how the results from Forsmark fit into the broader geological perspective.

$^{40}Ar/^{39}Ar$ hornblende ages generally yield the time of cooling below 500°C. The ages in Forsmark range from 1.85–1.80 Ga, with a predominance around 1.80 Ga. The variation in ages is interpreted to represent varying effects of dynamic recrystallization in association with deformation, possibly at 1.83–1.82 Ga and subsequently at c. 1.80 Ga. The hornblende ages around 1.80 Ga occur consistently along the high-strain areas surrounding the tectonic lens, but are also present in four samples from within the lens. These ages are interpreted to reflect resetting of the argon system in amphiboles in response to a c. 1.80 Ga tectonothermal event, which can also be seen regionally in central Sweden.

$^{40}Ar/^{39}Ar$ biotite ages generally represent cooling below 300°C. The ages from surface samples range from 1,730–1,665 Ma. Borehole samples yield older and younger ages from samples taken from the top and the bottom of boreholes, respectively. Older ages for biotite at the top of boreholes range from 1,724–1,700 Ma, while at the bottom of boreholes, ages range from 1,660–1,616 Ma. Uplift rates of c. 25–30 m/Ma can be calculated for the 1,700–1,620 Ma time period. $^{40}Ar/^{39}Ar$ muscovite ages, which generally represent cooling below 350°C, have been obtained from two samples in highly strained rocks. The ages fall in the time range 1,750–1,725 Ma. The biotite and muscovite ages from one of the boreholes together indicate a slow cooling rate of c. 0.8°C/Ma during the 1,770–1,665 Ma time period.

$^{40}Ar/^{39}Ar$ K-feldspar ages generally represent cooling through c. 225°C. Step-heating spectra are typical for K-feldspar from slowly cooled regions and demonstrate that the age of the feldspars must be older than c. 1,500 Ma.

In the regional $^{40}Ar/^{39}Ar$ study, there is evidence for amphibole ages around 1.85 Ga and even up to 1.87 Ga in the eastern part of Bergslagen, close to Forsmark. These may represent cooling after a major regional tectonothermal event, or possibly after crystallisation of the rocks themselves. There are also ages present that correspond both to the 1.83–1.82 Ga and 1.81–1.79 Ga cooling/recrystallisation events at Forsmark. In the north-western and south-eastern parts of Bergslagen, a few even younger ages are present. These are in the range 1.78–1.76 Ga.

There is no distinctive trend in the regional $^{40}Ar/^{39}Ar$ biotite results. However, the ages of samples in the western part of Bergslagen are generally younger (1,774–1,694 Ma), while the ages of rocks in the central part are generally older (1,861–1,810 Ma). These biotite ages either overlap or are significantly older than the ages obtained in the Forsmark study area. Further south towards Norrköping, there is evidence from the biotite data for the affects of a younger c. 1,500 Ma tectonothermal event which is prevalent in south-eastern Sweden.

The (U-Th)/He ages obtained from the surface samples in the Forsmark area are generally reproducible and most range between 750 and 530 Ma. These ages indicate that the rocks in the Forsmark area had cooled below 70°C during this time period, which may be associated with the development of the sub-Cambrian peneplain. The ages also indicate that the area has not been heated over 70°C since that period of time. Samples from the borehole generally provide evidence for a slow exhumation of c. 2 m/Ma between c. 500 and 250 Ma. There is also some indications for a disturbance of the (U-Th)/He isotope system around or after c. 250 Ma.

Sammanfattning

I denna rapport presenteras geokronologisk data i form av $^{40}Ar/^{39}Ar$ (hornblände, biotit, muskovit och kalifältspat) och (U-Th)/He (apatit) åldrar från Forsmarksområdet samt $^{40}Ar/^{39}Ar$ (hornblände och biotit) åldrar från en mer regional studie. Den presenterade åldersdatan ger insikt i den yngre geologiska utvecklingen i Forsmark. Den regionala studien initierades för att öka förståelsen för hur Forsmarksområdet passar in i ett mer storskaligt geologiskt perspektiv.

Generellt sett representerar $^{40}Ar/^{39}Ar$-data från hornblände åldern för avsvalning under 500 °C. Hornbländeåldrarna i Forsmark varierar mellan 1,85–1,80 Ga, med majoriteten omkring ca 1,80 Ga. Åldersvariationen tolkas att representera varierande grad av dynamisk omkristallisation, som varit associerad med deformation, mellan 1,83 och 1,82 Ga och därefter vid ca 1,80 Ga. Hornbländeåldrarna som indikerar ca 1,80 Ga återfinns i huvudsak i de mer deformerade områdena längs den tektoniska linsens ytterkanter, men finns också representerat i fyra prov från linsens inre delar. Samtliga åldrar runt 1,80 Ga tolkas att reflektera nollställning av argonsystemet i hornblände på grund av en tektonotermal händelse. Denna händelse återfinns även regionalt i centrala Sverige.

Generellt sett representerar $^{40}Ar/^{39}Ar$-data från biotit åldern för avsvalning under 300 °C. Åldrarna som erhållits från ytprover i Forsmarksområdet varierar mellan 1 730 och 1 665 Ma. Borrhålsdata ger äldre respektive yngre åldrar beroende på om prover är tagna i toppen, eller botten av de undersökta borrhålen. Biotitåldrar från prover tagna i toppen av borrhålen varierar mellan 1 724 och 1 700 Ma, medan åldrar från prover tagna i botten varierar mellan 1 660 och 1 616 Ma. För tidsperioden 1 700–1 620 Ma kan upplyftningshastigheten uppskattas till ca 25–30 m/Ma. $^{40}Ar/^{39}Ar$-data från muskovit, som ofta tolkas som åldern för avsvalning under 350 °C, har erhållits från två prover tagna i hårt deformerade bergarter. Åldrarna faller i tidsintervallet mellan 1 750 och 1 725 Ma. Biotit- och muskovitåldrar, från ett av borrhålen, indikerar en långsam avsvalningshastighet på ca 0,8 °C/Ma under tidsintervallet mellan 1 770 och 1 665 Ma.

$^{40}Ar/^{39}Ar$-data från kalifältspat representerar generellt sett åldern för avsvalning under ca 225 °C. Erhållna åldersspektra har utseenden typiska för kalifältspater från långsamt avkylda regioner och påvisar även att fältspaterna måste vara äldre än ca 1 500 Ma.

I den regionala $^{40}Ar/^{39}Ar$-studien synliggörs bevis för amfiboliåldrar runt 1,85 Ga, men även ända upp till 1,87 Ga, i östra Bergslagen inte långt ifrån Forsmark. Dessa kan representera avkylning efter en större, regional, tektonotermal händelse, eller möjligen efter själva kristallisationen av de provtagna bergarterna. Det finns även bevis för åldrar som motsvarar de två avkylnings-/omkristallisationshändelserna i Forsmark, i tidsintervallen 1,83–1,82 Ga respektive 1,81–1,79 Ga. I de nordvästra och sydöstra delarna av Bergslagen finns ännu yngre åldrar representerade. Dessa återfinns i tidsintervallet 1,78–1,76 Ga.

Det finns ingen uppenbar trend i den regionala $^{40}Ar/^{39}Ar$-datan som har erhållits från biotit. Trots det kan man säga att prover tagna i de västra delarna av Bergslagen generellt sett ger yngre åldrar (1 774–1 694 Ma) än prover tagna i de centrala delarna (1 861–1 810 Ma). Biotitåldrarna antingen överlappar, eller är markant äldre än, de åldrar som erhållits i undersökningsområdet i Forsmark. Längre söderut, i riktning mot Norrköping, finns bevis för att biotiterna påverkats av en yngre, ca 1 500 Ma, tektonotermal händelse, som påvisats tidigare i sydöstra Sverige.

(U-Th)/He-data som har erhållits från ytprover i Forsmarksområdet ger, i huvudsak, reproducerbara åldrar som ligger i tidsintervallet mellan 750 och 530 Ma. Dessa åldrar indikerar att områdets bergarter svalnat till temperaturer under 70 °C, under den nämnda tidsperioden. Avkylningen kan vara associerad med bildningen av det subkambriska peneplanet. Åldrarna indikerar även att området inte har hettats upp över 70 °C efter denna tidsperiod. Borrhålsdata ger huvudsakligen bevis för långsam upplyftning på ca 2 m/Ma mellan ca 500 och 250 Ma. Det finns även indikationer på en störning av (U-Th)/He-systemet omkring, eller senare än, ca 250 Ma.

Contents

1 Introduction

This report presents the results of phase 2 of the bedrock geochronology study at Forsmark. This is one of the activities performed within the site investigation program at Forsmark. The work was carried out in accordance with activity plan AP PF 400-05-048. Table 1-1 lists the controlling documents for the execution of the activity. Both the activity plan and the method description are SKB's internal controlling documents.

The following text presents a brief summary of the geology at the Forsmark site. Felsic to intermediate metavolcanic rocks (Group A) and three groups of meta-intrusive rocks (Groups B, C and D) have been recognised /Stephens et al. 2003/ in connection with the bedrock-mapping activities at Forsmark (Figure 1-1 and Table 1-2). The intrusive rocks that belong to Group B and to Groups C and D, respectively, form two separate calc-alkaline suites of igneous rocks.

The calc-alkaline intrusive rocks in Group B, as well as the supracrustal rocks in Group A, were affected by penetrative ductile deformation under amphibolite-facies metamorphic conditions, prior to intrusion of the younger suite of calc-alkaline intrusive rocks that belong to Groups C and D (Table 1-2). The intrusive rocks included in Groups C and D were also affected by ductile deformation, probably under lower amphibolite- and greenschist-facies metamorphic conditions. However, pervasive ductile deformation at the Forsmark site was completed prior to intrusion of the granites and at least some of the pegmatites included in the Group D rocks.

The Forsmark site can be divided into contrasting structural domains /Stephens et al. 2003/. LS-tectonites, folding and a generally lower degree of ductile deformation characterise a tectonic lens that includes the candidate volume (Figure 1-1). The bedrock in this volume is referred to here as structural domain 1. By contrast, SL-tectonites and an inferred higher degree of ductile deformation characterise the volumes to the south-west and to the north-east of this lens, as well as a folded rock complex to the north-west of the candidate volume inside the lens. The bedrock in these parts is referred to as structural domain 2.

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
(U-Th)/He and $^{40}Ar/^{39}Ar$ geochronology at Forsmark Stage 2	AP PF 400-05-048	1.0
Method description	**Number**	**Version**
Metodbeskrivning för åldersdateringar av mineral och bergarter	SKB MD 132.002	1.0

Table 1-2. Major groups of rock at the Forsmark site.

Rock types	
All rocks affected by brittle deformation. The fractures generally cut the boundaries between the different rock types (sealed boundaries).	
Rocks in Group D affected, in part, by ductile deformation and metamorphism.	
Group D	Fine- to medium-grained granite, aplite, pegmatitic granite and pegmatite. Occur as dykes and minor bodies that are commonly discordant to earlier ductile deformation. Variable age relationships with respect to Group C.
Rocks in Group C affected by ductile deformation under lower amphibolite-facies metamorphic conditions.	
Group C	Fine- to medium-grained granodiorite, tonalite and subordinate granite. Occur as lenses and dykes in Groups A and B. Intruded after some ductile deformation in the rocks belonging to Groups A and B.
Rocks in Groups A and B affected by ductile deformation under amphibolite-facies metamorphic conditions.	
Group B	Biotite-bearing granite (to granodiorite) and aplitic granite, both with amphibolite as dyke-like bodies and irregular inclusions. Granodiorite and tonalite to granodiorite with amphibolite enclaves. Quartz diorite to gabbro, ultramafic rock.
Group A	Volcanic rocks and iron oxide mineralisation. Sulphide mineralisation.

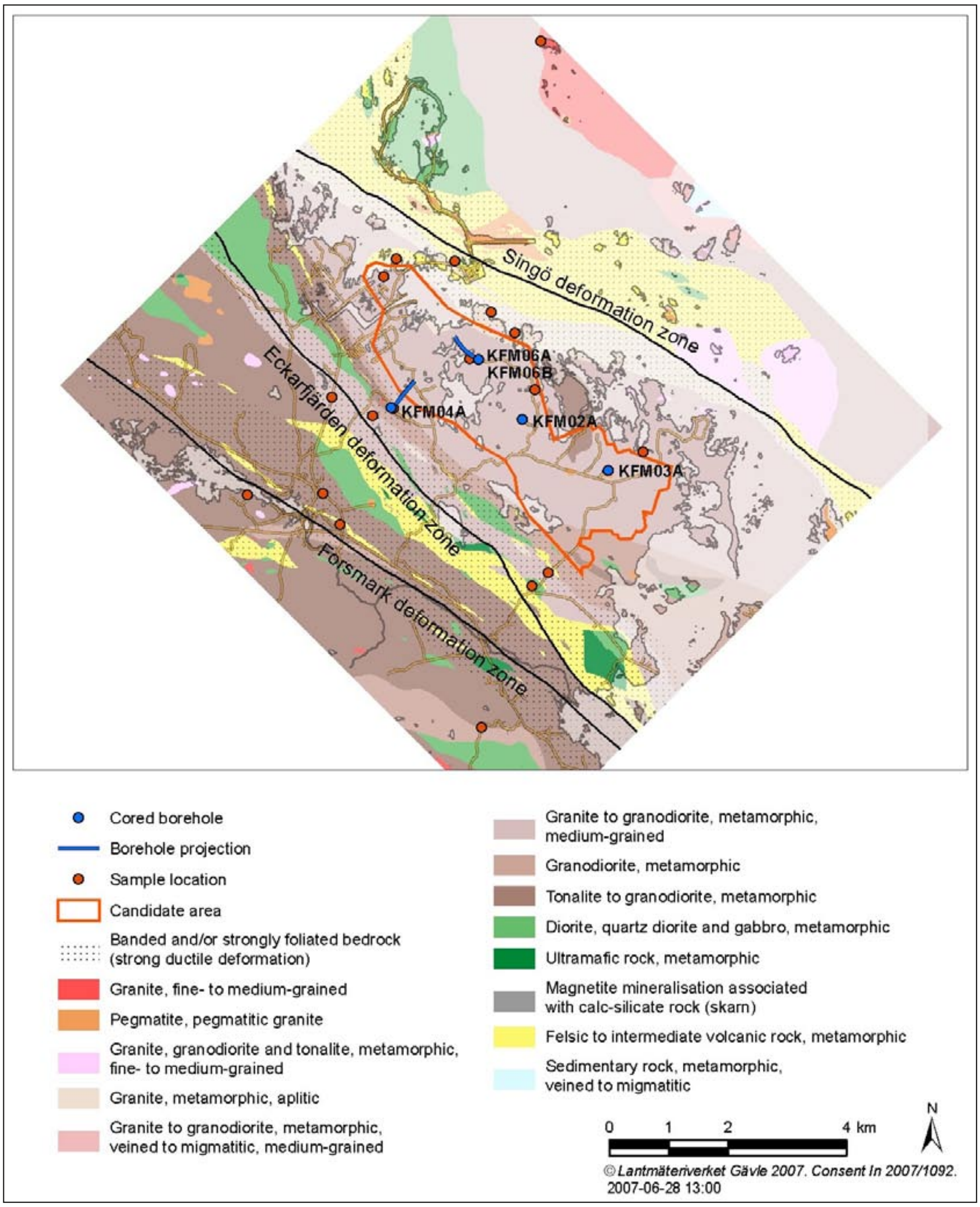


Figure 1-1. *Bedrock geological map of the Forsmark site (version 1.2). The location of samples selected for geochronological purposes in the local Forsmark study are shown.*

The deformation in the bedrock that accompanied and/or followed intrusion of the Group D rocks was discrete in character and was restricted to high-strain zones, with combined ductile and brittle or solely brittle character (Table 1-2). The most conspicuous regional deformation zones in the area strike in a north-west direction and include the Forsmark, Eckarfjärden and Singö deformation zones (Figure 1-1). These zones divide the bedrock into different structural blocks.

Original data from the reported activity are stored in the primary database Sicada, where they are traceable by the Activity Plan number (AP PF 400-05-048). Only data in SKB's databases are accepted for further interpretation and modelling. The data presented in this report are regarded as copies of the original data. Data in the databases may be revised, if needed. Such revisions will not necessarily result in a revision of the P-report, although the normal procedure is that major data revisions entail a revision of the P-report. Minor data revisions are normally presented as supplements, available at www.skb.se.

2 Objective and Scope

Geochronologival studies at Forsmark aim to use different isotopic systems to reconstruct the temperature-time history from crystallization through to the time the rocks were uplifted through the ca 70°C geotherm. The geochronological analytical programme involves analyses of several different minerals using isotopic systems with different blocking temperatures (U-Pb zircon and titanite; $^{40}Ar/^{39}Ar$ hornblende, biotite, muscovite and K-feldspar; and (U-Th)/He apatite). Phase 2 of the study presented here focuses on $^{40}Ar/^{39}Ar$ hornblende, biotite, muscovite and K-feldspar as well as (U-Th)/He apatite.

The geochronological investigations at Forsmark have been subdivided into two principal sub-projects dealing with 1) high-T (> 500°C) geochronology and 2) low-T (< 500°C) geochronology. Both studies involve portions of two Ph D projects carried out by Tobias Hermansson and Pia Söderlund, respectively, which are financed by Lund University with economic and logistical support provided by SKB.

The high-T geochronology project involves conventional U-Pb zircon and titanite analyses aimed at dating crustal growth and the high-T tectonothermal evolution down to titanite cooling c. 550–700°C. Due to the complex nature of some of the zircons it was necessary in Phase 1 of the geochronology programme to use the in situ capability of the NORDSIM instrument at the Swedish Museum of Natural History in Stockholm, to directly date both igneous crystallization ages and to check for any secondary alteration of zircons in the different critical rock units in the area. $^{40}Ar/^{39}Ar$ analyses of hornblende were also obtained to constrain the regional cooling below 500°C.

The low-T thermochronology project involves $^{40}Ar/^{39}Ar$ analyses of muscovite and biotite, which constrain the cooling below c. 350 and 300°C, respectively. $^{40}Ar/^{39}Ar$ analyses of K-feldspar yield information on the ca 150–225°C temperature range, and (U-Th)/He dating of apatite constrains the temperature of uplift through c. 60–70°C.

Samples for geochronology were taken from all of the major rock types in the study area and from within both major structural domains. A complete list of all samples analysed in this study and the geochronological method(s) utilized for each sample is presented in Table 2-1.

This study has predominantly focused on rocks from the Forsmark study area and results obtained from this area are presented in section 5. Both surface samples and samples taken from boreholes in the area have been analysed (Figure 1-1). A complementary $^{40}Ar/^{39}Ar$ study of hornblendes and biotites in a regional perspective, to improve our understanding of how the Forsmark results fit into the larger geological picture, is presented in section 6. The localities of the surface samples taken in the regional study are shown in Figure 2-1.

Table 2-1. Analysed samples.

Sample	Northing in RT, 2.5 gon V (metres)	Easting in RT, 2.5 gon V (metres)	Rock type	Mineral	Method of dating
PFM000256A	6699088	1629974	Metagranodiorite	Apatite	(U-Th)/He
PFM001240A	6693523	1632499	Metagranite	Apatite	(U-Th)/He
PFM002100A	6696132	1633618	Metagranite	Apatite	(U-Th)/He
PFM002207A	6699740	1632290	Metagranite	Apatite	(U-Th)/He
PFM002213A	6700532	1632663	Metagranodiorite	Apatite	(U-Th)/He
PFM005245A	6705094	1633496	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
PFM007035A	6700172	1633052	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007035A	6700172	1633052	Amphibolite	Biotite	$^{40}Ar/^{39}Ar$
PFM007037A	6699213	1633390	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007038A	6698164	1635212	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007039A	6695914	1633344	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007040A	6698781	1630655	Metagranite (B)	Biotite	$^{40}Ar/^{39}Ar$
PFM007041A	6698910	1631010	Metagranite (B)	Biotite	$^{40}Ar/^{39}Ar$
PFM007042A	6701391	1632043	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007043A	6701419	1631060	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007044A	6701132	1630850	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007045A	6696945	1630110	Metagranodiorite (C)	Biotite	$^{40}Ar/^{39}Ar$
PFM007046A	6697474	1629821	Metagranodiorite (B)	Biotite	$^{40}Ar/^{39}Ar$
PFM007047A	6697447	1628558	Metagranite (B)	Biotite	$^{40}Ar/^{39}Ar$
PFM007048A	6677969	1454687	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007048B	6677969	1454687	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
PFM007049A	6631979	1447801	Metagabbro	Amphibole	$^{40}Ar/^{39}Ar$
PFM007050A	6632469	1449524	Metavolcanite	Biotite	$^{40}Ar/^{39}Ar$
PFM007051A	6632458	1449514	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007052A	6664857	1487650	Metatonalite	Biotite	$^{40}Ar/^{39}Ar$
PFM007053A	6667790	1531128	Metagabbro	Amphibole	$^{40}Ar/^{39}Ar$
PFM007054A	6669045	1532369	Metagabbro	Amphibole	$^{40}Ar/^{39}Ar$
PFM007055A	6670083	1533076	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
PFM007056A	6665379	1549469	Metatonalite (?)	Biotite	$^{40}Ar/^{39}Ar$
PFM007059A	6673569	1579200	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007060A	6674429	1582133	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
PFM007061A	6674057	1628699	Metadiorite (?)	Amphibole	$^{40}Ar/^{39}Ar$
PFM007061B	6674050	1628678	Tonalite	Biotite	$^{40}Ar/^{39}Ar$
PFM007062A	6674143	1630469	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007064A	6625755	1616424	Metagabbro (?)	Amphibole	$^{40}Ar/^{39}Ar$
PFM007066A	6603309	1603462	Metagabbro	Amphibole	$^{40}Ar/^{39}Ar$
PFM007068A	6570961	1598346	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007069A	6538460	1597192	Garnet-rich metagranite (?)	Biotite	$^{40}Ar/^{39}Ar$
PFM007072A	6504124	1556283	Amphibolite	Amphibole	$^{40}Ar/^{39}Ar$
PFM007073A	6507705	1558578	Metagranite	Biotite	$^{40}Ar/^{39}Ar$

Sample	Borehole depth from	Borehole depth to	Rock type	Mineral	Method of dating
KFM02A	108.57	108.98	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM02A	408.63	409.04	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM02A	709.99	710.40	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM02A	1000.97	1001.37	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM02A	108.57	108.98	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM02A	408.63	409.04	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM02A	709.99	710.40	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM02A	1000.97	1001.37	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM03A	147.00	147.41	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM03A	836.27	836.70	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM03A	996.93	997.35	Metagranite to granodiorite	Biotite	$^{40}Ar/^{39}Ar$
KFM03A	147.00	147.41	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM03A	439.65	440.07	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM03A	638.12	638.54	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM03A	836.27	836.70	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM03A	996.93	997.35	Metagranite to granodiorite	Apatite	(U-Th)/He
KFM04A	394.84	395.07	Muscovite-bearing schist	Muscovite	$^{40}Ar/^{39}Ar$
KFM04A	427.40	427.65	Muscovite-bearing schist	Muscovite	$^{40}Ar/^{39}Ar$
KFM04A	394.84	395.07	Muscovite-bearing schist	Biotite	$^{40}Ar/^{39}Ar$
KFM04A	427.40	427.65	Muscovite-bearing schist	Biotite	$^{40}Ar/^{39}Ar$
KFM06B	11.57	11.77	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
KFM06A	175.11	175.35	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
KFM06A	401.19	401.42	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
KFM06A	577.03	577.26	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
KFM06A	709.18	709.39	Leucocratic granite	Biotite	$^{40}Ar/^{39}Ar$
KFM06A	993.00	993.29	Metagranite	Biotite	$^{40}Ar/^{39}Ar$
KFM06B	11.57	11.77	Metagranite	K-feldspar	$^{40}Ar/^{39}Ar$
KFM06A	993.00	993.29	Metagranite	K-feldspar	$^{40}Ar/^{39}Ar$

The following PFM numbers were collected and did not yield material suitable for dating		
PFM007036	6699808	1632828
PFM007057	6664077	1553088
PFM007058	6664814	1575645
PFM007063	6625518	1616198
PFM007065	6625861	1616587
PFM007067	6564366	1594922
PFM007070	6538429	1597166
PFM007071	6525349	1579748

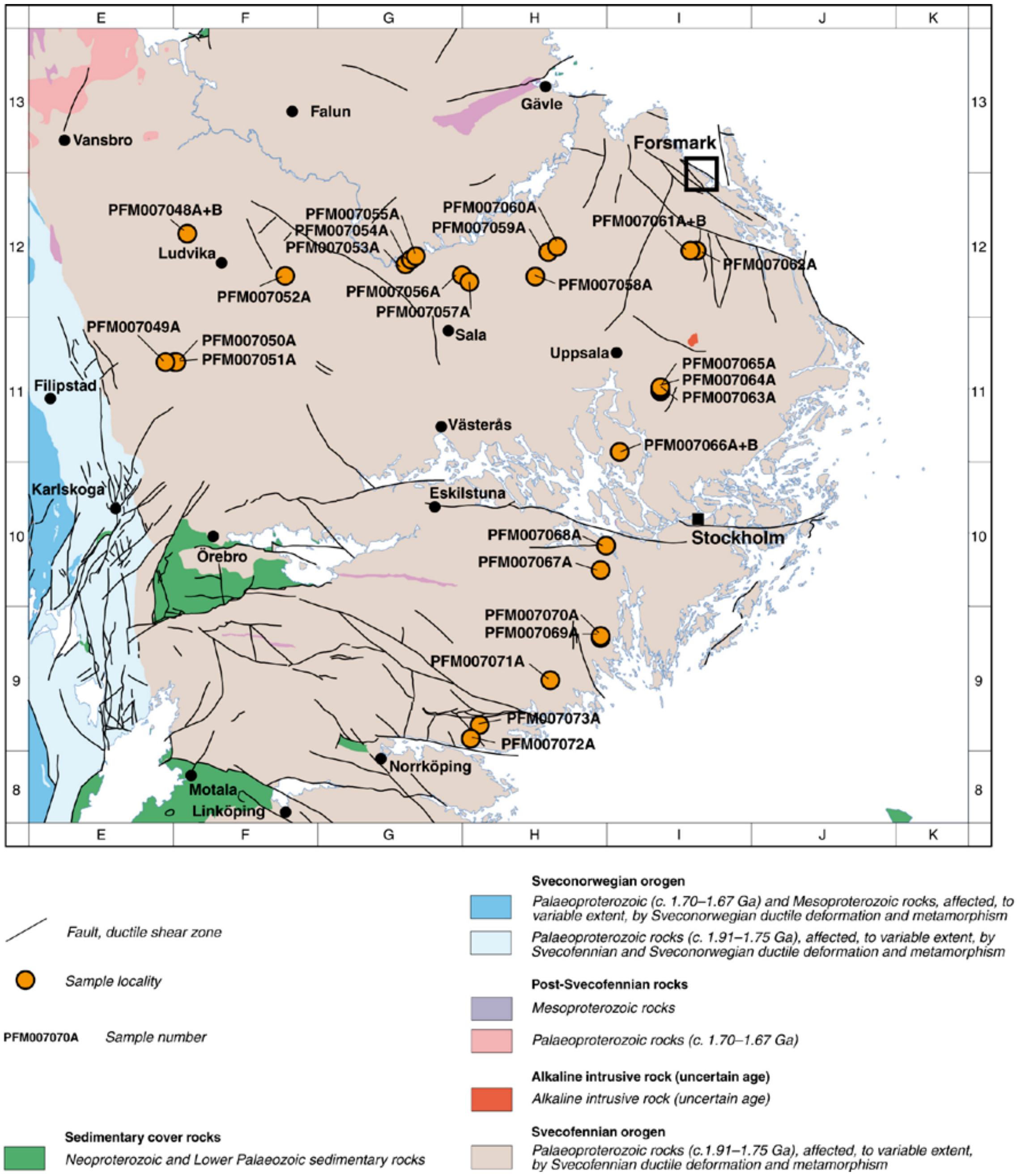


Figure 2-1. *Location of samples for the $^{40}Ar/^{39}Ar$ regional study.*

3 Equipment

3.1 Description of equipment

The following equipment was used for sample preparation and geochronological analyses, see also Figure 3-1 and 3-2:

- Sledge hammer.
- Rock saw.
- Jaw crusher.
- Swing-mill.
- Mill tray.
- Wilfley (water shaking) table.
- Hand magnet.
- Frantz magnet separator.
- Heavy liquids (2-iodine methane).
- Gloves.
- Binocular microscope.
- Tweezers.
- Hiden Hal – 3F/PIC quadrupole mass spectrometer (Vrije University, Amsterdam, Netherlands and SUERC, Scotland, UK).
- HP4500 ICPMS (Vrije University, Amsterdam, Netherlands).
- Agilent HP7500 (Utrecht University, Netherlands).
- Thermox-II (Vrije University, Amsterdam, Netherlands).
- Micromass 5400 Mass Spectrometer (Lund University, Sweden; Figure 3-1).
- New Wave Research 50W CO_2 Laser (Lund University, Sweden; Figure 3-2).

Figure 3-1. *Micromass 5400 Mass Spectrometer.*

Figure 3-2. *New Wave Research 50W CO_2 Laser.*

4 Execution

4.1 Preparatory work

4.1.1 Separation for $^{40}Ar/^{39}Ar$ hornblende dating

All rock samples were crushed by hand or with a jaw-crusher and subsequently milled using a swing-mill. Samples collected for $^{40}Ar/^{39}Ar$ hornblende analyses were processed into a range of grain-sizes to make sure that there was a selection of intact hornblende crystals left. The resulting mix of grain-sizes was sieved under running water in order to divide each sample into fractions of > 2 mm, 2–1 mm, 1–0.5 mm, 0.5–0.25 and < 0.25 mm. The two fractions 1–0.5 mm and 0.5–0.25 mm were in all cases regarded as most likely to contain hornblende crystals suitable for analysis. The fractions were separated into one magnetic and one non-magnetic part using a Frantz magnetic separator. The non-magnetic parts of the two fractions were examined under a binocular microscope and hornblendes were handpicked for analysis.

4.1.2 Separation for (U-Th)/He dating and $^{40}Ar/^{39}Ar$ biotite, muscovite and K-feldspar dating

Apatite is an accessory mineral in most rock types. For this study, c. 0.5 kg of each rock sample was used. For mineral separation, each sample was reduced in size by a crushing procedure using a sledge hammer, a jaw-crusher and a mill tray. After these steps, each sample was placed on a Wilfley table to remove the clay size fraction. The two heaviest fractions from the Wilfley table were collected and dried. The samples were then sieved through a 250 µm and a 75 µm mesh and the middle fraction was placed into a heavy liquid (Lithium poly-tungstat (=LST). ∂=2.84 g/cm^3) to separate the apatite from lighter minerals such as feldspar and quartz. The heavy separate was placed through a Frantz magnet to remove all the magnetic minerals. All mineral separation was performed at the Department of Geology, Lund University, Sweden.

Euhedral to subhedral apatite grains were hand-picked. Investigation of the grains was performed under high enlargement microscope to select those with no visible inclusions. Three to four single grains were then selected for each sample and a photographic record was compiled.

Samples selected for $^{40}Ar/^{39}Ar$ biotite, muscovite and K-feldspar analyses were treated by the same crushing procedure as the samples for apatite extraction. The lightest fractions (above clay fraction) were collected from the Wilfley table for biotite, muscovite and K-feldspar separation. The samples were sieved through a 500 µm mesh and biotite, muscovite and K-feldspar were hand-picked from the largest fraction under a microscope.

4.2 Analytical work

4.2.1 $^{40}Ar/^{39}Ar$ geochronology

All samples were irradiated together with the TCR sanidine standard (28.34 Ma recalculated following /Renne et al. 1998/) for 35 hours in the NRG-Petten HFR RODEO facility in the Netherlands. J-Values were calculated with a precision of 0.25%.

The samples were run in the $^{40}Ar/^{39}Ar$ geochronology laboratory at the University of Lund, Sweden. The laboratory consists of a Micromass 5400 Mass Spectrometer with a Faraday and an electron multiplier. A metal extraction line, which contains 2 SAES C50-ST101 Zr-Al getters and a cold finger cooled to ca –155°C by a Polycold P100 cyrogenic refrigeration unit, is also present. One or two grains of hornblende, biotite, muscovite or K-feldspar were loaded into a copper planchette consisting of a number of 3 mm holes. Samples were step-heated using a defocused 50W CO_2 laser. Sample clean up times were 5 minutes using two hot Zr-Al SAES getters and a cold finger with a Polycold refrigeration unit. The laser was rastered over the samples to provide even heating of all grains. The entire analytical process is automated and is run on a Macintosh with software modified specifically for this laboratory and originally developed by Al Deino at the Berkeley Geochronology Center, USA.

Time zero regressions were fitted to data collected from 10 scans over the mass range of 40 to 36. Peak heights and backgrounds were corrected for mass discrimination, isotopic decay and interfering nucleogenic Ca-, K-, and Cl-derived isotopes. Isotopic production values for the cadmium lined position in the Petten reactor are $^{36}Ar/^{37}Ar(Ca)$ = 0.000270, $^{39}Ar/^{37}Ar(Ca)$ 0.000699, and $^{40}Ar/^{39}Ar(K)$ = 0.00183. ^{40}Ar blanks were calculated before every new sample and after every three sample steps. ^{40}Ar blanks were between 6.0–3×10^{-16}. Blank values for masses 39–36 were all less than 7×10^{-18}. Blank values were subtracted for all incremental steps from the sample signal. The laboratory was able to produce very good incremental gas splits using a combination of increasing time at the same laser output followed by increasing laser output. Age plateaus were determined using the criteria of /Dalrymple and Lamphere 1971/, which specifies the presence of at least three contiguous incremental heating steps with statistically indistinguishable ages and constituting greater than 50% of the total ^{39}Ar released during the experiment.

4.2.2 (U-Th)/He thermochronology

(U-Th)/He thermochronology has been carried out on 16 apatite samples at the Forsmark site (Table 2-1). All analyses were supposed to be run at the Vrije University, Amsterdam, Netherlands but due to technical problems with the mass-spectrometers in Amsterdam, some analyses where carried out at SUERC (Scottish Universities Environmental Research Centre), East Kilbride, Scotland, UK in collaboration with Dr. Finlay Stuart, and others at the University of Utrecht, Netherlands by Dr. Joaquim Juez-Larré, who is employed at the Vrije University.

Helium extraction (Vrije University, Amsterdam)

Helium measurements were conducted on a Hiden Hal-3F/PIC quadrupole mass spectrometer. For each individual sample, the single apatite grain is inserted in an inconel capsule and loaded into separate inconel tubes. The inconel tubes are mounted in a flange multiplexer and pumped to UHV-conditions (~10^{-9} mbar). Each inconel tube containing a sample was heated in an external oven up to 950°C for 30 minutes. These T-t conditions guarantee the complete extraction of helium from the apatite grain size used in this study. After each degassing and before the helium-4 is measured, a sequential clean-up procedure is carried out, consisting of: a) exposure to a SAES getter at 450°C and a SAES 707 getter for the removal of reactive gases and H_2 respectively, b) exposure to one charcoal trap held at nitrogen temperatures to isolate non-reactive condensable gases. The remaining gases (mostly helium) are then expanded into the mass spectrometer for analysis. The amount of helium is determined by peak comparison with a standard (Durango) measured under the same conditions as the samples. All samples analyzed are corrected for background levels by subtracting the hot blank signal.

Helium extraction (SUERC, Scotland)

Helium measurements were conducted on a quadruple mass spectrometer (Hiden Hal-3F/PIC). For each individual sample, the single apatite grain is inserted in platinum foil and loaded in 1.5 mm deep × 2 mm diameter holes in a 6 cm diameter high-purity Cu planchet that sits in a 11.5 cm diameter stainless steel chamber. The laser chamber is connected to the gas clean-up and analysis system, which is pumped to UHV-conditions. The primary power supply is a 25 W continuous wave fiber-coupled diode laser (FDL25: Laservall S.p.A. Donnas (Aoste), Italy) emitting at a wavelength of 808 nm. Laser radiation is generated by optical pumping in a diode laser cell, housed in a 54 × 45 × 18 cm metal enclosure. Laser power output is linearly correlated with input power at least up to 12.5 W, A 5 mW, 632 nm red He-Ne laser runs in the core and the outer 100 mm of the fiber and is used for focusing the 808 nm beam. The temperature of the Pt foils are not measured directly during heating, but are assessed by visual observation of the colour emitted from heated Pt tubes. Complete degassing of apatite fragments and crystals requires heating for 30 s at 500–600°C (0.5W, using the defocused beam). Reheating the sample under the same conditions should not release any additional He above blank levels. Gases liberated by heating the Pt-foil capsules are purified using a hot SAES TiZr getter and two liquid nitrogen cooled charcoal traps. ^{4}He abundances along with ^{3}He, H (mass 2) and CH_4 (mass 16), are determined by an electron multiplier in a Hiden HAL3F quadrupole mass spectrometer operated in static mode. Absolute He concentrations are calculated from peak height comparison against a calibrated standard (Durango).

U-Th measurements (HP4500, Vrije University, Amsterdam)

The grains were unloaded from the inconel capsules and the apatite was transferred to a Teflon beaker. Grains were dissolved with HNO_3 and HF on hot plates, spiked with two artificial isotopes (^{233}U and ^{229}Th) and diluted up to ~3 ml with MiliQwater. In this solution, the uranium and thorium contents were measured using an Inductively Coupled Plasma Mass Spectrometer (ICP-MS). The argon ICP used is a high temperature plasma fireball, into which the aerosol sample is carried by argon gas. A low-flow Teflon nebulizer (90–120 µl/min) was used in order to increase the ICP-MS efficiency for measurements of very low U-Th concentrations in small quantities of the solution. The plasma decomposes and dissociates the particles of the sample and then ionises the resulting atoms. The ions are partially extracted into the vacuum chamber, focused and transferred to a quadruple mass spectrometer, where they are analysed by an electron multiplier detector in a rapid sequential scan. Detection limits are typically at the ng/l (ppt) level. The resulting mass spectra are used to quantify the amount of ^{238}U and ^{232}Th by isotopic ratio comparison to the two artificial isotopes of known concentration.

U-Th measurements (Agilent HP7500, Utrecht University and Thermo X-II, Vrije University, Amsterdam)

Pt foils containing the apatite grains were unloaded from the Cu planchet and transferred to a 7-ml Teflon beaker. Grains are first spiked with two artificial isotopes (^{233}U and ^{229}Th) and dissolved with concentrated HNO_3 and HF on a hot plate (120°C), which will not dissolve the Pt foil. The concentrated acid is allowed to evaporate and samples are re-dissolved in a 0.6 ml 2 normal HNO_3 solution. Finally, all solutions are diluted up to 2 ml with MiliQwater and make ready for analysis. Uranium and thorium contents were measured using a Thermo X-II ICP-MS. A low-flow Teflon nebulizer (100 µl/min) was used in order to increase the ICP-MS efficiency for measurements of very low U-Th concentrations in small quantities of the solution. The ratios between the artificial isotopes (^{233}U and ^{229}Th) and natural (^{238}U and ^{232}Th) isotopes are used to determine the concentration of the latter.

Durango standard calibration

Verification of the analytical technique and procedures is provided by routine analyses of an apatite standard. As a standard we used the 160–180 m fraction of crushed and sieved Durango apatite crystals that were originally 1–2 cm in size. Each standard aliquot analyzed contained less than 10 µg of Durango. Nine Durango standards were measured for (U-Th)/He in the analyses. The results yielded a range of (U-Th)/He ages between 31 ± 3 Ma and 34 ± 3 Ma against a reported age of 32 ± 1 Ma /McDowell et al. 2005/.

4.3 Data Handling

$^{40}Ar/^{39}Ar$ geochronology data were produced, plotted and fitted using the argon programme provided by Al Deino of the Berkeley Geochronology Center, USA. Data was subsequently exported to MS Excel tables. (U-Th)/He ages were calculated with an in-house program used at Vrije University, Amsterdam. Data was subsequently exported to MS Excel tables.

5 Forsmark $^{40}Ar/^{39}Ar$ (hornblende, biotite, muscovite, K-feldspar) and (U-Th)/He (apatite) study

Sample localities for the Forsmark study are shown in Figure 1-1. The data from the geochronological study are presented in a series of tables, each table being placed at the end of the relevant section: Table 5-1 $^{40}Ar/^{39}Ar$ surface hornblende, Table 5-2 $^{40}Ar/^{39}Ar$ surface biotite, Table 5-3 $^{40}Ar/^{39}Ar$ biotite from borehole KFM02A, Table 5-4 $^{40}Ar/^{39}Ar$ biotite from borehole KFM03A, Table 5-5 $^{40}Ar/^{39}Ar$ biotite and muscovite from borehole KFM04A, Table 5-6 $^{40}Ar/^{39}Ar$ biotite and K-feldspar from borehole KFM06A and KFM06B, Table 5-7 (U-Th)/He from boreholes KFM02A and KFM03A. The results are also presented in a series of plots as appropriate for the different techniques. Step-heating spectra for the $^{40}Ar/^{39}Ar$ data are given for each sample and the (U-Th)/He data are plotted in age vs. borehole length diagrams.

5.1 $^{40}Ar/^{39}Ar$ hornblende ages from surface samples

PFM007035A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B deformed amphibolite dyke in a metagranite-pegmatite. The sampling locality lies within the more intensely deformed structural domain 2 along the Apelviken peninsula, and inside the bedrock block between the Eckarfjärden and Singö deformation zones (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,804 ± 4 Ma (Figure 5-1). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

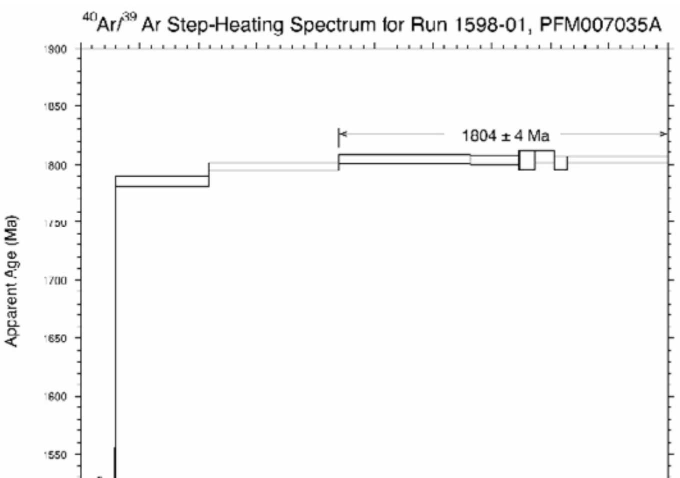


Figure 5-1. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007035A.

PFM007037A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B amphibolite dyke. The sampling locality lies within the less deformed tectonic lens (structural domain 1) from the bedrock block between the Eckarfjärden and Singö deformation zones (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,807 ± 4 Ma (Figure 5-2). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

PFM007038A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B amphibolite dyke. The sampling locality lies within the less deformed tectonic lens (structural domain 1) from the bedrock block between the Eckarfjärden and Singö deformation zones (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,819 ± 4 Ma (Figure 5-3). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

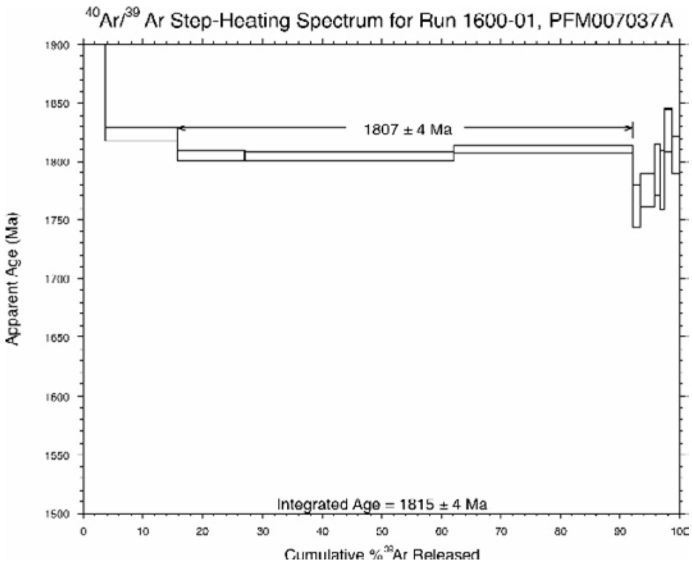


Figure 5-2. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007037A.*

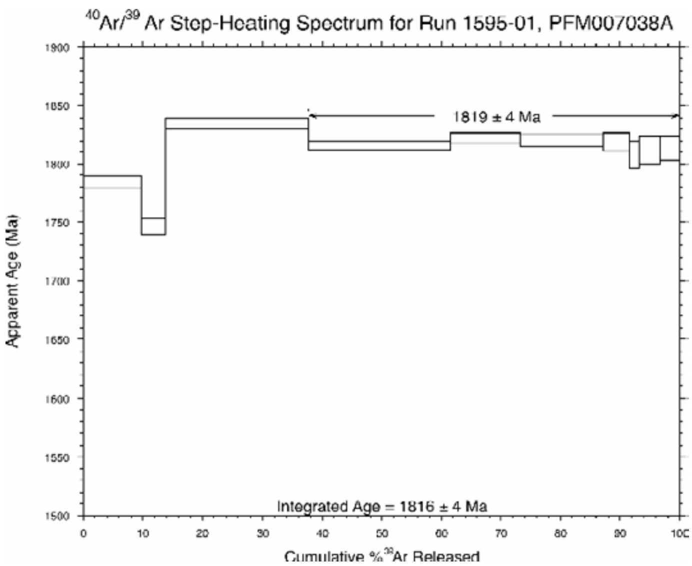


Figure 5-3. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007038A.*

PFM007039A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B amphibolite in a metagabbro. The sampling locality lies within a subordinate, less deformed tectonic lens within the more intensely deformed belt (structural domain 2) close to the Eckarfjärden deformation zone (Figure 1-1). The forced fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,854 ± 7 Ma (Figure 5-4). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

PFM007042A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B coarse-grained amphibolite in a banded unit. The sampling locality lies within the intensely deformed bedrock inside structural domain 2, immediately south of the Singö deformation zone (Figure 1-1). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,807 ± 6 Ma (Figure 5-5). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

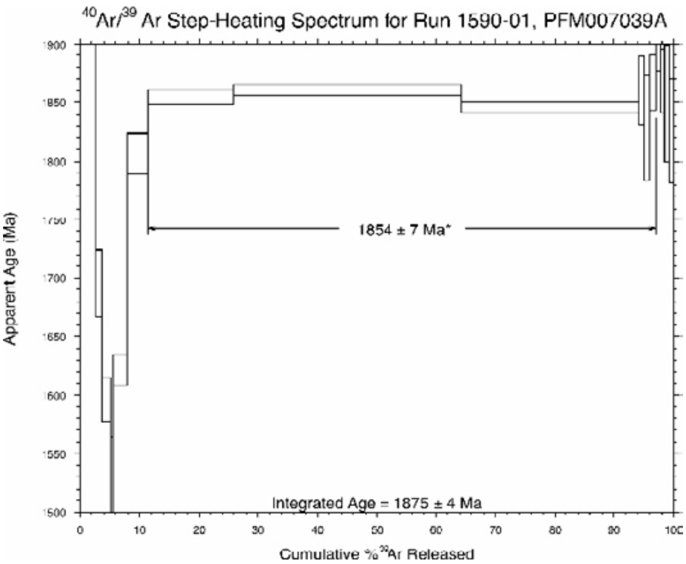


Figure 5-4. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007039A.

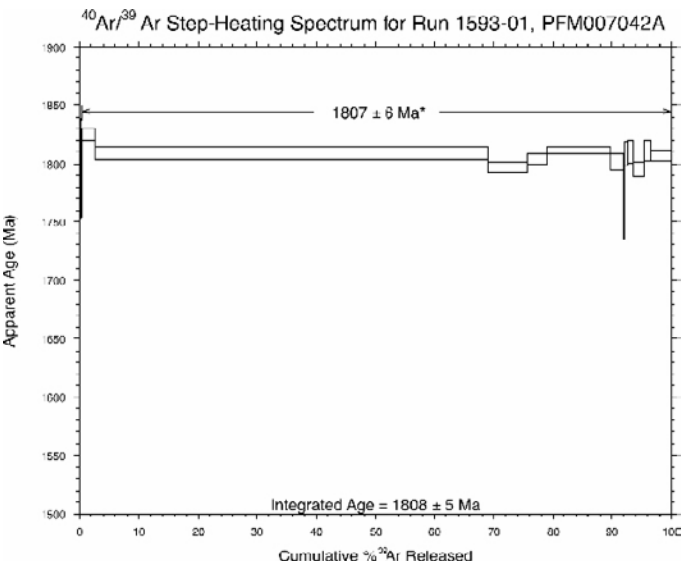


Figure 5-5. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM00742A.

PFM007043A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B amphibolite. The sampling locality is taken from near the hinge of where the banded rocks belonging to structural domain 2 inside the tectonic lens are folded just north of the nuclear power plant (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,802 ± 4 Ma (Figure 5-6). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

PFM007044A

$^{40}Ar/^{39}Ar$ hornblende sample from a Group B amphibolite dyke within metagranite. The sampling locality is taken from rocks inside structural domain 1, in the hinge of the major fold structure in the north-western part of the tectonic lens (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,810 ± 4 Ma (Figure 5-7). The age is interpreted as the age of cooling below the closure temperature of hornblende (c. 500°C).

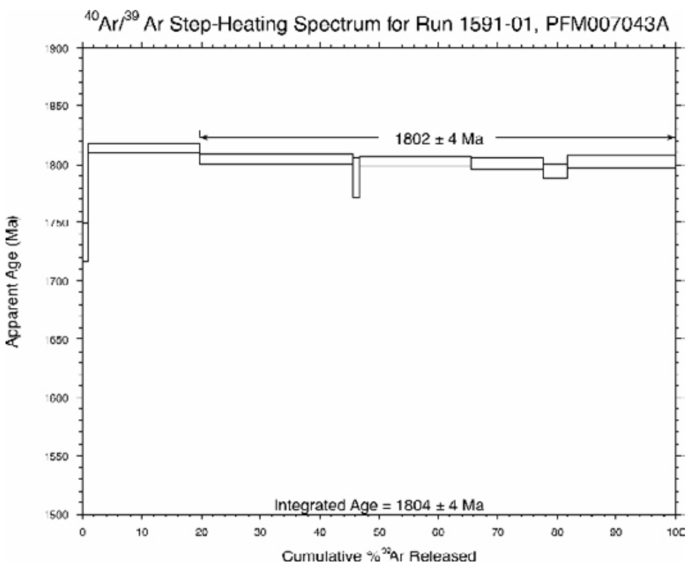


Figure 5-6. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007043A.

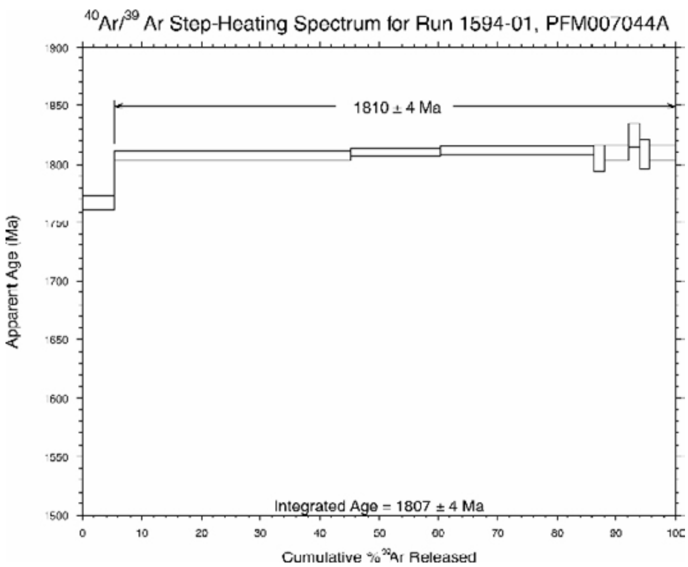


Figure 5-7. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007044A.

Table 5-1. ^{40}Ar/^{39}Ar hornblende data from the surface.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	^{36}Ar/^{39}Ar	%^{36}Ar(Ca)[b]	^{40}Ar*/^{39}Ar	^{39}Ar (Mol-14)	%^{39}Ar[c]	Cum. %^{39}Ar	%^{40}Ar*[d]	Age (Ma)	± 2σ
PFM007035A. Run ID# 1598-01 (J = 0.01067 ± 0.000015):												
1598-01A	1.8	0.040	0.01	0.011	0	97.344	0.042	2.4	2.4	96.7	1,285.03	2.05
1598-01B	1.9	0.014	0.04	0.008	0	120.933	0.012	0.7	3.1	98.1	1,495.05	4.38
1598-01C	2	0.216	0.03	0.003	0.9	122.778	0.005	0.3	3.4	99.2	1,510.49	9.70
1598-01D	2.1	0.253	0.03	0.013	0.3	112.728	0.009	0.5	3.9	96.8	1,424.74	5.13
1598-01E	2.2	0.245	0.04	0.011	0.3	101.807	0.009	0.5	4.4	96.8	1,326.69	5.61
1598-01F	2.3	0.034	0.01	0.009	0.1	107.319	0.018	1	5.4	97.7	1,376.84	3.44
1598-01G	2.4	0.009	0.04	0.011	0	114.144	0.005	0.3	5.7	97.3	1,437.07	8.72
1598-01H	2.5	0.014	0.03	0.001	0.2	125.994	0.005	0.3	6	99.7	1,537.09	9.06
1598-01I	2.7	0.506	0.03	0.002	4	158.459	0.274	15.8	21.8	99.7	1,785.71	2.21
1598-01J	•2.7	0.209	0.03	0.001	2	160.218	0.383	22	43.8	99.7	1,798.25	1.66
1598-01K	•2.8	1.306	0.03	0.001	17.1	161.079	0.392	22.6	66.4	99.8	1,804.36	2.09
1598-01L	•2.8	0.062	0.03	0.003	0.3	160.901	0.141	8.1	74.5	99.5	1,803.10	1.91
1598-01M	•2.9	0.225	0.03	0.004	0.8	160.900	0.049	2.8	77.3	99.3	1,803.09	3.87
1598-01N	•3.0	0.352	0.03	0.000	51.9	161.309	0.056	3.2	80.5	100	1,805.99	2.41
1598-01O	•3.2	0.762	0.02	0.003	3.1	160.630	0.040	2.3	82.8	99.4	1,801.18	2.72
1598-01P	3.4	1.063	0.03	0.001	10.1	161.018	0.298	17.2	100	99.8	1,803.93	1.10
Integ. Age											1,777.00	4.00
(•) Plateau Age								61.1			1,804.00	4.00
PFM007037A. Run ID# 1600-01 (J = 0.01067 ± 0.000015):												
1600-01C	2	0.003	0.06	0.029	0	192.410	0.015	3.6	3.6	95.8	2,013.59	5.23
1600-01D	2.1	0.043	0.07	0.009	0.1	163.750	0.050	12.2	15.8	98.4	1,823.17	2.80
1600-01E	•2.1	0.031	0.08	0.007	0.1	161.169	0.047	11.4	27.2	98.7	1,805.00	2.37
1600-01F	•2.2	0.029	0.09	0.005	0.1	161.092	0.144	35	62.1	99	1,804.46	1.95
1600-01G	•2.2	0.021	0.10	0.005	0.1	162.003	0.124	30	92.2	99.1	1,810.89	1.74
1600-01H	2.2	0.075	0.04	0.020	0.1	155.176	0.005	1.2	93.4	96.4	1,762.07	8.95
1600-01I	2.3	0.023	0.05	0.012	0	156.992	0.010	2.4	95.8	97.8	1,775.19	7.01

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1600-01J	2.4	0.270	0.05	0.007	0.5	159.412	0.004	1	96.8	98.8	1,792.52	11.36
1600-01K	2.6	0.418	0.05	0.017	0.3	158.207	0.003	0.7	97.5	97	1,783.91	12.80
1600-01L	2.8	0.024	0.00	0.003	0.1	164.320	0.005	1.2	98.7	99.6	1,827.16	9.26
1600-01M	3.2	0.325	0.04	0.004	1	161.190	0.005	1.3	100	99.2	1,805.15	8.42
Integ. Age											1,815.00	4.00
(•) Plateau Age								76.4			1,807.00	4.00
PFM007038A. Run ID# 1595-01 (J = 0.01067 ± 0.000015):												
1595-01A	1.8	0.421	0.00	0.050	0.1	158.218	0.053	9.8	9.8	91.5	1,783.99	2.52
1595-01B	1.9	3.213	0.01	0.007	6.5	152.938	0.022	4.1	13.9	98.8	1,745.78	3.59
1595-01C	2	6.716	0.06	0.005	19.3	165.346	0.127	23.7	37.6	99.3	1,834.32	2.42
1595-01D	•2.0	9.349	0.06	0.002	52.2	162.750	0.128	24	61.6	99.8	1,816.15	2.13
1595-01E	•2.0	11.493	0.05	0.001	158	163.645	0.063	11.7	73.3	100.1	1,822.44	2.05
1595-01F	•2.1	9.784	0.06	0.003	49.9	163.391	0.074	13.9	87.2	99.8	1,820.66	2.65
1595-01G	•2.1	3.381	0.03	0.000	211.5	163.141	0.024	4.4	91.6	100	1,818.91	3.84
1595-01H	•2.2	3.756	0.01	0.001	88.7	161.576	0.009	1.7	93.3	100	1,807.88	6.24
1595-01I	•2.3	8.487	0.03	0.000	410.2	162.088	0.018	3.4	96.6	100.2	1,811.49	6.01
1595-01J	•2.5	1.365	0.01	0.000	65.1	162.453	0.018	3.4	100	100	1,814.07	5.14
Integ. Age											1,816.00	4.00
(•) Plateau Age								62.4			1,819.00	4.00
PFM007039A. Run ID# 1590-01 (J = 0.01067 ± 0.000015):												
1590-01A	2	9.369	0.26	1.081	0.1	354.112	0.009	2.7	2.7	52.5	2,821.76	9.38
1590-01B	2.1	5.313	0.04	0.114	0.6	146.112	0.003	0.9	3.6	81.3	1,695.15	14.27
1590-01C	2.2	3.169	0.01	0.055	0.8	133.298	0.005	1.6	5.2	89.1	1,596.09	9.44
1590-01D	2.2	3.246	0.01	0.082	0.5	123.724	0.002	0.5	5.6	83.6	1,518.36	23.14
1590-01E	2.3	22.729	0.15	0.076	4.1	136.443	0.008	2.4	8	86.2	1,620.91	6.90
1590-01F	2.5	57.119	0.39	0.199	4	161.320	0.012	3.4	11.4	73.7	1,806.07	8.75
1590-01G	•2.6	60.754	0.45	0.063	13.3	168.304	0.049	14.5	25.9	91.1	1,854.81	3.02
1590-01H	•2.7	61.374	0.47	0.023	36.6	169.123	0.129	38.2	64.2	97.5	1,860.43	2.01

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1590-01I	•2.7	63.010	0.48	0.017	52.5	166.968	0.101	30	94.2	98.6	1,845.58	2.25
1590-01J	•2.7	69.304	0.31	0.009	101.2	169.040	0.003	0.9	95.1	100	1,859.87	14.53
1590-01K	•2.8	67.401	0.45	0.015	62.8	164.465	0.003	1	96	99	1,828.18	22.13
1590-01L	•2.9	68.759	0.37	0.005	202.6	170.041	0.004	1.1	97.1	100.9	1,866.73	11.68
1590-01M	3	71.091	0.32	0.009	104.2	176.220	0.002	0.7	97.8	100.1	1,908.51	15.72
1590-01N	3.2	71.740	0.31	0.019	52.7	170.402	0.002	0.7	98.5	98.4	1,869.19	13.67
1590-01O	3.4	69.717	0.41	0.032	29.7	167.499	0.003	0.8	99.3	96.1	1,849.25	24.71
1590-01P	3.8	77.211	0.72	0.056	19.1	164.079	0.002	0.7	100	92.3	1,825.48	21.90
Integ. Age											1,875.00	4.00
(•) Plateau Age								85.7			1,854.00	7.00
PFM007042A. Run ID# 1593-01 (J = 0.01067 ± 0.000015):												
1593-01B	2	16.903	0.01	0.065	3.6	159.796	0.002	0.1	0.1	89.6	1,795.26	21.62
1593-01C	2.1	18.654	0.04	0.032	8.1	156.607	0.006	0.3	0.4	94.7	1,772.42	8.83
1593-01D	•2.2	18.510	0.03	0.007	36.2	163.991	0.042	2.2	2.7	99.2	1,824.86	2.56
1593-01E	•2.3	12.705	0.04	0.003	63.9	161.679	1.257	66.3	69	99.8	1,808.61	2.65
1593-01F	•2.3	12.875	0.04	0.002	83.3	160.048	0.124	6.5	75.6	99.9	1,797.05	2.11
1593-01G	•2.4	13.182	0.04	0.004	49.4	161.031	0.064	3.4	78.9	99.7	1,804.02	2.04
1593-01H	•2.4	12.955	0.04	0.002	80.1	162.098	0.207	10.9	89.8	99.9	1,811.57	1.43
1593-01I	•2.4	13.115	0.03	0.002	106.3	160.671	0.038	2	91.9	100	1,801.47	3.47
1593-01J	•2.5	13.643	0.03	0.035	5.4	154.939	0.004	0.2	92.1	94	1,760.36	12.67
1593-01K	•2.5	13.445	0.01	0.014	13.5	161.741	0.010	0.5	92.6	97.9	1,809.04	5.06
1593-01L	•2.6	13.241	0.01	0.004	42.7	161.890	0.018	1	93.6	99.6	1,810.10	4.86
1593-01M	•2.8	15.024	0.03	0.001	171.7	159.784	0.034	1.8	95.3	100.2	1,795.17	3.04
1593-01N	•2.9	14.522	0.04	0.000	832.8	162.070	0.022	1.1	96.5	100.3	1,811.37	4.30
1593-01O	•0.0	13.762	0.05	0.003	55.1	161.430	0.067	3.5	100	99.7	1,806.85	2.10
Integ. Age											1,808.00	5.00
(•) Plateau Age								99.6			1,807.00	4.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM007043A. Run ID# 1591-01 (J = 0.01067 ± 0.000015):												
1591-01C	2.2	13.221	0.00	0.014	12.9	151.143	0.006	1	1	97.6	1,732.60	7.90
1591-01D	2.3	9.281	0.04	0.005	26.3	162.418	0.104	18.6	19.6	99.4	1,813.82	2.11
1591-01E	•2.4	8.611	0.04	0.002	55.2	161.052	0.145	25.9	45.5	99.8	1,804.17	1.99
1591-01F	•2.5	8.716	0.01	0.002	68.8	158.875	0.006	1.1	46.7	99.9	1,788.69	8.56
1591-01G	•2.6	8.479	0.04	0.002	53.8	160.835	0.107	19	65.7	99.8	1,802.63	1.99
1591-01H	•2.7	8.451	0.03	0.002	63.8	160.576	0.067	11.9	77.6	99.9	1,800.80	2.37
1591-01I	•2.7	8.556	0.02	0.003	45.4	159.637	0.024	4.3	81.9	99.7	1,794.12	3.40
1591-01J	•2.8	8.614	0.04	0.002	72.8	160.748	0.101	18.1	100	99.9	1,802.02	2.49
Integ. Age											1,804.00	4.00
(•) Plateau Age								80.4			1,802.00	4.00
PFM007044A. Run ID# 1594-01 (J = 0.01067 ± 0.000015):												
1594-01A	1.9	11.068	0.03	0.011	14.2	155.940	0.038	5.4	5.4	98.3	1,767.60	2.97
1594-01B	•2.0	13.250	0.04	0.002	80.8	161.488	0.280	39.8	45.2	99.9	1,807.26	2.05
1594-01C	•2.0	13.148	0.03	0.002	94.6	161.851	0.106	15.1	60.3	100	1,809.82	1.62
1594-01D	•2.1	13.000	0.03	0.002	71.8	162.063	0.183	26	86.3	99.9	1,811.32	1.85
1594-01E	•2.1	12.152	0.01	0.004	46.1	161.127	0.013	1.9	88.2	99.6	1,804.71	5.71
1594-01F	•2.2	13.064	0.01	0.002	78.4	161.851	0.027	3.9	92	99.9	1,809.82	3.16
1594-01G	2.3	14.530	0.01	0.000	529.2	163.906	0.014	1.9	94	100.3	1,824.27	5.11
1594-01H	2.5	14.234	0.01	0.002	80.4	161.629	0.012	1.7	95.7	99.9	1,808.25	6.43
1594-01I	2.7	14.961	0.02	0.002	85.6	161.846	0.030	4.3	100	99.9	1,809.78	3.01
Integ. Age											1,807.00	4.00
(•) Plateau Age								86.7			1,810.00	4.00

5.2 $^{40}Ar/^{39}Ar$ biotite ages from surface samples

PFM005245

$^{40}Ar/^{39}Ar$ biotite sample from metagranite. The sampling locality is taken from the crustal block north of the Singö deformation zone (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,665 ± 7 Ma (Figure 5-8). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

PFM007035A

$^{40}Ar/^{39}Ar$ biotite sample from Group B amphibolite lens within strongly deformed metagranite on the Klubbudden peninsula. The sampling locality is situated north-east of the candidate area in the more intensely deformed structural domain 2, relatively close to the Singö deformation zone (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,715 ± 3 Ma (Figure 5-9). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

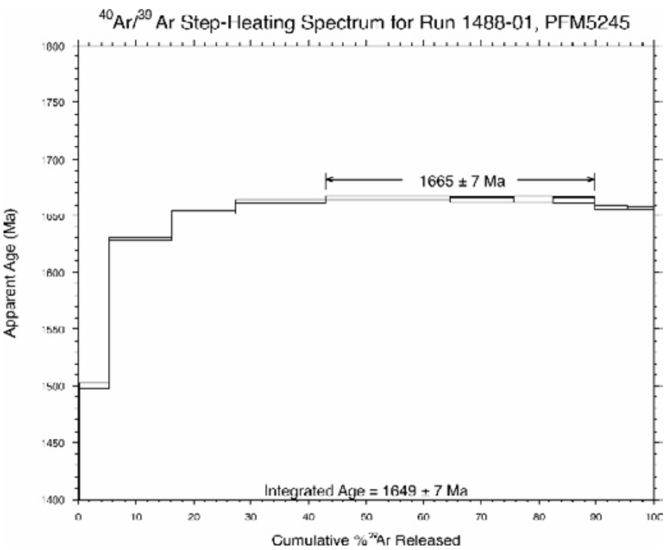


Figure 5-8. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM005245.*

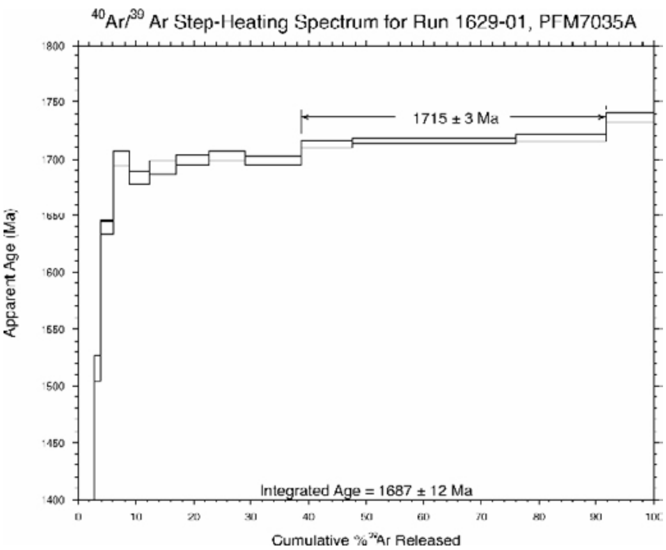


Figure 5-9. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007035A.*

PFM007040A

$^{40}Ar/^{39}Ar$ biotite sample from a Group B foliated metagranite that is situated close to the Eckarfjärden deformation zone in structural domain 2 (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,681 ± 3 Ma (Figure 5-10). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

PFM007041A

$^{40}Ar/^{39}Ar$ biotite sample from a highly foliated Group B metagranite that is situated close to the Eckarfjärden deformation zone (structural domain 2) near borehole KFM04A (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,666 ± 5 Ma (Figure 5-11). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

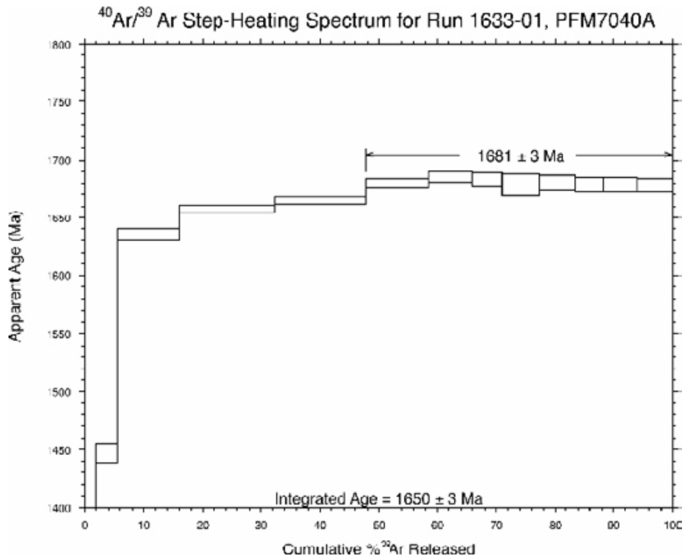


Figure 5-10. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007040A.*

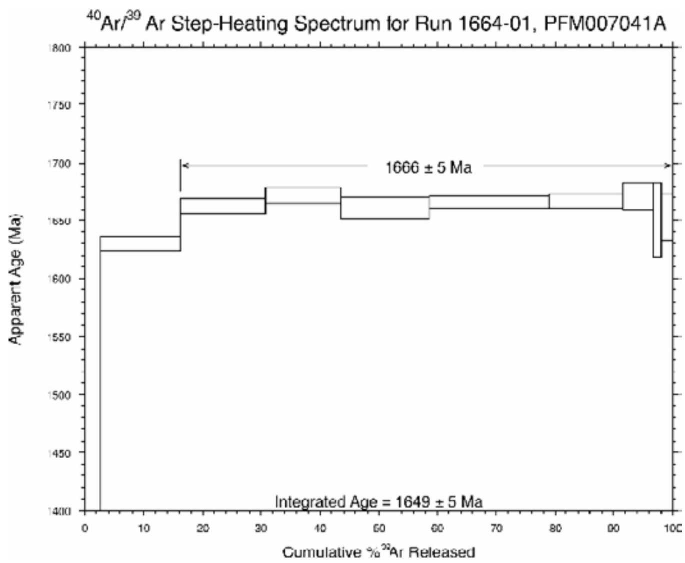


Figure 5-11. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007041A.*

PFM007045A

$^{40}Ar/^{39}Ar$ biotite sample from a fine-grained. Group C metagranodiorite/metatonalite that is situated immediately north of the Forsmark deformation zone (Figure 1-1). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,665 ± 8 Ma (Figure 5-12). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

PFM007046A

$^{40}Ar/^{39}Ar$ biotite sample from a banded metagranodiorite/metatonalite that is situated between the Forsmark and Eckarfjärden deformation zones in structural domain 2 (Figure 1-1). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,690 ± 8 Ma (Figure 5-13). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

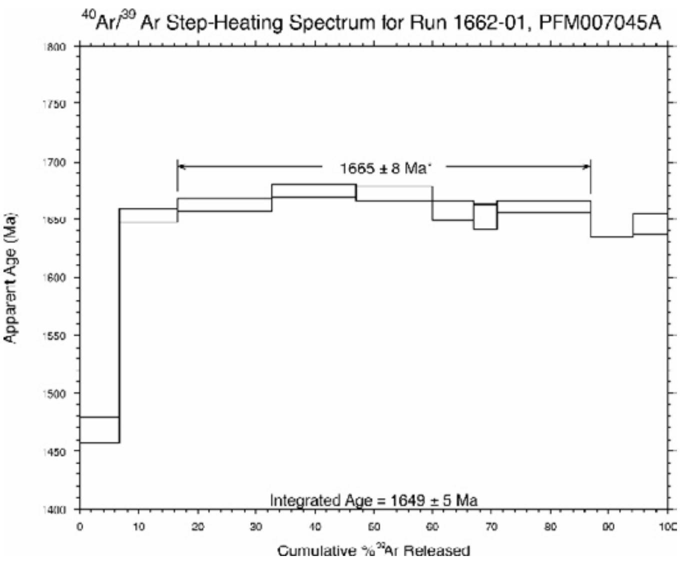


Figure 5-12. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007045A.

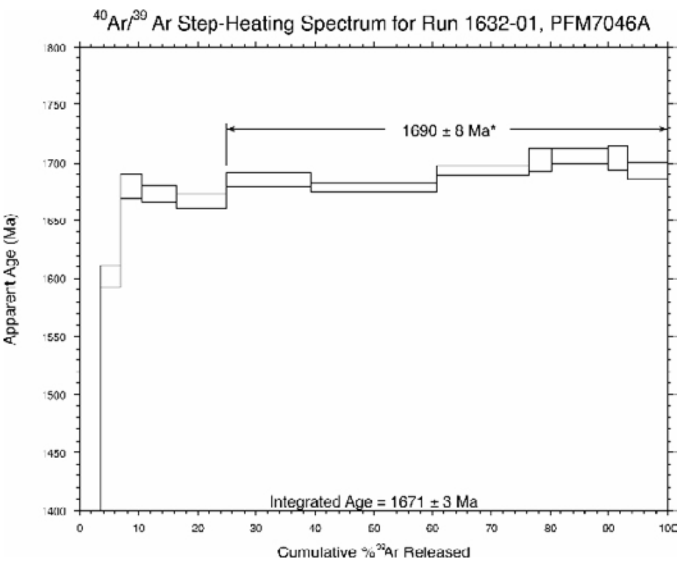


Figure 5-13. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007046A.

PFM007047A

$^{40}Ar/^{39}Ar$ biotite sample from a Group B highly foliated metagranite that is situated immediately south of the Forsmark deformation zone (Figure 1-1). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,730 ± 3 Ma (Figure 5-14). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

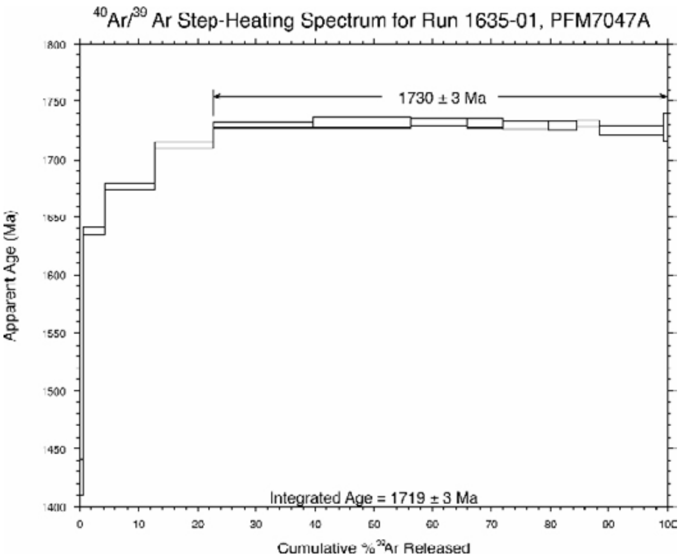


Figure 5-14. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007047A.*

Table 5-2. $^{40}Ar/^{39}Ar$ biotite data from the surface.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^*/^{39}Ar$	^{39}Ar (Mol–14)	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^*$[d]	Age (Ma)	± 2σ
PFM5245. Run ID# 1488-01 (J = 0.009461 ± 0.000029):												
1488-01A	1.7	–48.266	0.52	0.827	–0.8	46.352	0.000	0	0	16.1	656.01	229.22
1488-01B	1.8	0.792	0.04	0.177	0.1	63.335	0.001	0.2	0.2	54.8	847.04	10.11
1488-01C	1.9	0.006	0.01	0.012	0	137.066	0.042	5.2	5.4	97.4	1,500.11	1.15
1488-01D	2	0.040	0.97	0.002	0.3	155.023	0.085	10.7	16.1	99.7	1,628.85	0.85
1488-01E	2.1	0.121	0.98	0.001	2.6	158.534	0.089	11.2	27.3	99.9	1,652.98	0.79
1488-01F	2.2	0.011	0.98	0.001	0.3	159.963	0.124	15.6	42.9	99.9	1,662.71	0.82
1488-01G	•2.4	0.039	0.98	0.001	0.9	160.412	0.173	21.7	64.7	99.9	1,665.76	0.69
1488-01H	•2.6	0.051	0.97	0.001	1	160.217	0.086	10.9	75.6	99.9	1,664.43	0.83
1488-01I	•2.8	0.085	0.97	0.001	1.3	160.317	0.055	6.9	82.4	99.9	1,665.11	1.11
1488-01J	•3.1	0.126	0.97	0.001	2.1	160.097	0.058	7.3	89.8	99.9	1,663.62	1.14
1488-01K	3.5	0.040	0.01	0.001	0.9	159.202	0.045	5.7	95.5	99.9	1,657.54	0.99
1488-01L	4.5	0.162	0.01	0.001	2.5	159.118	0.036	4.5	100	99.8	1,656.96	0.91
Integ. Age											1,649.00	7.00
(•) Plateau Age								46.8			1,665.00	7.00
PFM7035A. Run ID# 1629-01 (J = 0.01067 ± 0.000012):												
1629-01A	2	0.358	–0.00	1.544	0	44.872	0.008	0.6	0.6	9	705.79	271.05
1629-01B	2.2	0.264	0.01	0.141	0	28.105	0.009	0.7	1.3	40.2	473.16	189.18
1629-01C	2.4	0.006	0.00	0.085	0	43.219	0.010	0.8	2.2	63.2	684.14	206.81
1629-01D	2.6	0.016	0.01	0.107	0	92.635	0.009	0.7	2.9	74.6	1,240.01	6.67
1629-01E	2.8	0.226	–0.01	0.094	0	123.324	0.012	1	3.9	81.6	1,515.03	5.90
1629-01F	3	0.017	–0.00	0.067	0	138.803	0.028	2.3	6.2	87.6	1,639.32	2.94
1629-01G	3.2	0.006	–0.02	0.036	0	146.703	0.031	2.6	8.8	93.3	1,699.59	3.20
1629-01H	3.4	0.004	–0.01	0.023	0	144.575	0.043	3.6	12.4	95.5	1,683.55	2.59
1629-01I	3.6	0.012	–0.01	0.012	–0.1	145.721	0.055	4.6	17	97.6	1,692.21	3.37
1629-01J	3.9	0.028	–0.00	0.006	–0.1	146.635	0.068	5.7	22.7	98.7	1,699.08	2.32
1629-01K	4.2	0.006	–0.00	0.003	0	147.065	0.077	6.5	29.1	99.5	1,702.30	1.98
1629-01L	4.6	0.001	–0.00	0.003	0	146.518	0.114	9.6	38.7	99.5	1,698.21	1.97

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1629-01M	•5.0	0.012	0.00	0.002	0.1	148.459	0.104	8.7	47.4	99.7	1,712.72	1.58
1629-01N	•7.0	0.012	0.00	0.002	0.1	148.868	0.340	28.6	76	99.7	1,715.76	1.38
1629-01O	•10.0	0.017	0.00	0.001	0.2	149.250	0.188	15.8	91.7	99.7	1,718.60	1.84
1629-01P	14	0.019	–0.00	0.000	0.7	151.660	0.099	8.3	100	99.9	1,736.41	2.25
Integ. Age											1,687.00	6.00
(•) Plateau Age								53.1			1,715.00	3.00
PFM7040A. Run ID# 1633-01 (J = 0.01067 ± 0.000012):												
1633-01A	2	0.216	0.00	1.067	0	63.076	0.010	1.9	1.9	16.7	928.43	12.33
1633-01B	2.3	0.032	0.01	0.145	0	115.177	0.020	3.8	5.7	72.9	1,446.01	4.07
1633-01C	2.6	0.026	0.01	0.025	0	138.236	0.056	10.4	16	94.9	1,634.91	2.33
1633-01D	2.9	0.032	0.01	0.008	0.1	141.239	0.088	16.3	32.4	98.4	1,658.12	1.80
1633-01E	3	0.017	0.01	0.003	0.1	142.213	0.083	15.4	47.7	99.3	1,665.58	1.50
1633-01F	•3.3	0.028	0.01	0.001	0.3	144.090	0.059	10.8	58.5	99.7	1,679.88	2.08
1633-01G	•3.6	0.036	0.01	0.002	0.3	144.828	0.040	7.4	66	99.6	1,685.47	2.35
1633-01H	•4.0	0.022	–0.00	0.004	–0.1	144.515	0.028	5.1	71	99.2	1,683.10	2.99
1633-01I	•4.5	0.038	–0.01	0.004	–0.1	143.948	0.034	6.4	77.4	99.3	1,678.80	4.68
1633-01J	•5.0	0.059	0.01	0.003	0.3	144.165	0.032	6	83.4	99.4	1,680.44	2.96
1633-01K	•5.5	0.021	0.00	0.001	0.2	143.944	0.027	4.9	88.3	99.8	1,678.77	3.18
1633-01L	•7.0	0.011	0.01	0.002	0.1	143.860	0.031	5.7	94	99.6	1,678.13	3.19
1633-01M	•11.0	0.068	–0.00	0.001	–1	143.837	0.033	6	100	99.8	1,677.96	2.78
Integ. Age											1,650.00	3.00
(•) Plateau Age								52.3			1,681.00	3.00
PFM007041A. Run ID# 1664-01 (J = 0.01064 ± 0.00002):												
1664-01A	1.4	1.122	0.01	0.098	0.2	88.243	0.002	2.7	2.7	75.2	1,194.52	8.68
1664-01B	1.5	0.227	–0.01	0.016	0.2	137.975	0.011	13.5	16.2	96.6	1,629.86	3.03
1664-01C	•1.6	0.266	–0.01	0.010	0.4	142.231	0.012	14.6	30.8	98	1,662.66	3.16
1664-01D	•1.7	0.027	–0.00	0.007	0.1	143.482	0.011	12.6	43.4	98.6	1,672.19	3.40
1664-01E	•1.8	0.011	–0.01	0.005	0	141.953	0.013	15.3	58.7	99	1,660.53	4.67

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1664-01G	•2.0	0.062	–0.00	0.004	0.2	142.671	0.017	20.1	78.8	99.3	1,666.01	2.47
1664-01H	•2.2	0.089	–0.00	0.004	0.3	142.827	0.011	12.7	91.5	99.1	1,667.20	3.11
1664-01I	•2.5	0.043	0.00	0.001	0.9	143.381	0.004	5.3	96.8	99.9	1,671.42	5.88
1664-01J	•3.0	1.688	0.05	0.032	0.7	140.710	0.001	1.3	98.1	93.7	1,651.00	16.20
1664-01K	•4.5	1.067	0.06	0.025	0.6	140.930	0.002	1.9	100	95	1,652.70	10.43
Integ. Age											1,649.00	5.00
(•) Plateau Age								83.8			1,666.00	5.00
PFM007045A. Run ID# 1662-01 (J = 0.01064 ± 0.00002):												
1662-01A	1.4	0.113	0.00	0.211	0	118.020	0.006	6.7	6.7	65.4	1,467.57	5.61
1662-01B	1.5	0.017	0.01	0.007	0	141.030	0.010	9.9	16.6	98.6	1,653.46	3.26
1662-01C	•1.6	0.021	0.02	0.005	0.1	142.278	0.015	16	32.6	98.9	1,663.02	2.50
1662-01D	•1.7	0.043	0.02	0.002	0.3	143.889	0.014	14.4	47	99.5	1,675.28	2.93
1662-01E	•1.8	0.015	0.01	0.000	0.6	143.543	0.012	12.9	59.9	99.9	1,672.65	3.20
1662-01F	•1.9	0.086	–0.00	0.008	0.1	141.578	0.007	7	67	98.3	1,657.67	4.57
1662-01G	•2.0	0.289	0.02	0.010	0.4	140.876	0.004	4.1	71	98	1,652.28	5.42
1662-01I	•2.4	0.145	0.01	0.002	1	142.078	0.015	15.9	86.9	99.6	1,661.49	2.31
1662-01J	3	0.204	0.03	0.008	0.3	139.662	0.007	7.3	94.2	98.3	1,642.93	4.15
1662-01K	4.5	0.256	0.04	0.010	0.4	140.136	0.006	5.8	100	98	1,646.59	4.75
Integ. Age											1,649.00	5.00
(•) Plateau Age								70.3			1,665.00	8.00
PFM7046A. Run ID# 1632-01 (J = 0.01067 ± 0.000012):												
1632-01A	2	0.067	–0.02	3.722	0	84.920	0.001	0.9	0.9	7.2	1,163.73	37.86
1632-01B	2.2	0.036	–0.02	0.507	0	99.201	0.004	2.6	3.5	39.9	1,302.49	7.54
1632-01C	2.4	0.013	–0.01	0.122	0	133.917	0.006	3.4	6.8	78.7	1,601.00	4.63
1632-01D	2.6	0.016	–0.03	0.062	0	143.998	0.006	3.7	10.5	88.7	1,679.18	5.15
1632-01E	2.9	0.075	–0.00	0.044	0	143.311	0.010	5.9	16.3	91.7	1,673.96	3.70
1632-01F	3.2	0.079	0.00	0.024	0	142.437	0.014	8.7	25	95.3	1,667.29	2.71
1632-01G	•3.6	0.053	0.01	0.013	0.1	144.888	0.023	14.2	39.2	97.4	1,685.92	2.98

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1632-01H	•4.0	0.011	0.01	0.010	0	143.984	0.036	21.5	60.7	97.9	1,679.07	1.82
1632-01I	•4.5	0.051	0.00	0.007	0.1	145.831	0.026	15.7	76.4	98.5	1,693.04	2.08
1632-01J	•5.0	0.092	0.00	0.003	0.5	147.101	0.006	3.9	80.2	99.5	1,702.58	4.95
1632-01K	•5.5	0.075	0.01	0.008	0.1	147.527	0.016	9.8	90	98.5	1,705.77	3.04
1632-01N	•8.0	0.090	–0.01	–0.000	–2.6	147.298	0.006	3.4	93.3	100	1,704.05	5.04
1632-01O	•11.0	0.055	–0.00	0.008	0.1	145.877	0.011	6.7	100	98.4	1,693.38	3.53
Integ. Age											1,671.00	3.00
(•) Plateau Age								75			1,690.00	8.00
PFM7047A. Run ID# 1635-01 (J = 0.01067 ± 0.000012):												
1635-01A	1.5	0.071	0.00	0.568	0	112.825	0.015	0.6	0.6	40.2	1,425.58	7.92
1635-01B	1.7	0.020	0.00	0.028	0	138.618	0.087	3.6	4.2	94.4	1,637.88	1.66
1635-01C	1.9	0.023	0.01	0.008	0	143.691	0.201	8.4	12.6	98.4	1,676.85	1.38
1635-01D	2.1	0.010	0.01	0.004	0	148.397	0.244	10.2	22.8	99.1	1,712.26	1.62
1635-01E	•2.3	0.004	0.01	0.002	0	150.715	0.404	16.8	39.6	99.6	1,729.45	1.18
1635-01F	•2.5	0.013	0.01	0.002	0.1	151.007	0.399	16.6	56.3	99.7	1,731.60	2.29
1635-01G	•2.7	0.001	0.00	0.001	0	151.059	0.231	9.6	65.9	99.8	1,731.98	1.59
1635-01H	•2.9	0.002	0.00	0.000	0.1	150.970	0.143	5.9	71.8	99.9	1,731.33	2.25
1635-01I	•3.3	0.001	0.01	0.001	0	150.718	0.186	7.8	79.6	99.8	1,729.47	1.62
1635-01J	•3.8	0.003	0.01	0.001	0	150.644	0.120	5	84.6	99.7	1,728.92	1.91
1635-01K	•4.5	0.013	0.01	0.001	0.3	150.887	0.092	3.8	88.5	99.9	1,730.72	1.62
1635-01L	•6.0	0.003	0.01	0.002	0	150.154	0.258	10.8	99.2	99.7	1,725.30	1.96
1635-01M	•11.0	0.004	–0.00	0.005	0	150.526	0.019	0.8	100	99	1,728.05	5.79
Integ. Age											1,719.00	3.00
(•) Plateau Age								77.2			1,730.00	3.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

5.3 $^{40}Ar/^{39}Ar$ biotite, muscovite and K-feldspar ages from borehole samples

5.3.1 KFM02A

This near-vertical borehole intersects the bedrock in the central part of the candidate area, inside the tectonic lens in structural domain 1 (Figure 1-1). The borehole is intersected by several gently dipping fracture zones /SKB 2005/.

KFM02A-100 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 108.57–108.98 m borehole length interval (adjusted). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,722 ± 5 Ma (Figure 5-15). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

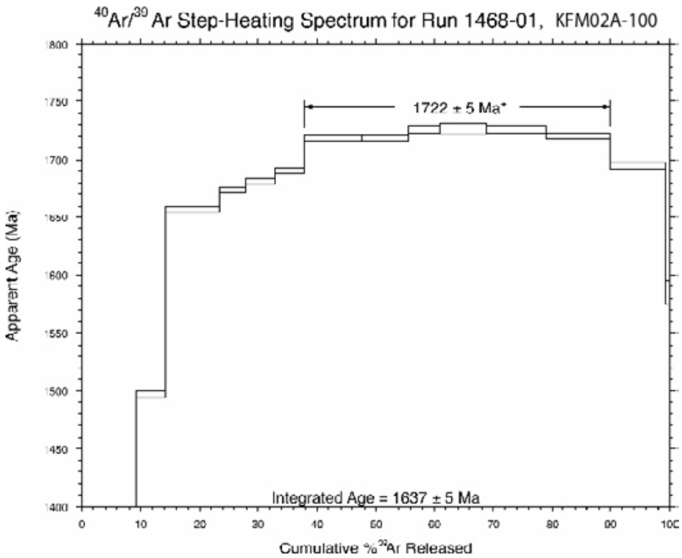


Figure 5-15. *KFM02A-100 biotite.*

KFM02A-408 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 408.63–409.04 m borehole length interval (adjusted). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,660 ± 7 Ma (Figure 5-16). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C). A second split was analysed which yielded an age of 1,692 ± 7 Ma (Figure 5-17). The first age is preferred as it is much less disturbed.

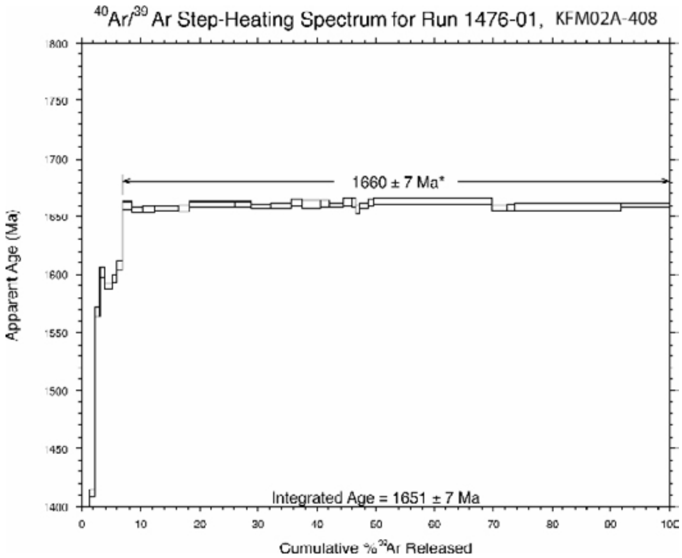


Figure 5-16. KFM02A-408 biotite.

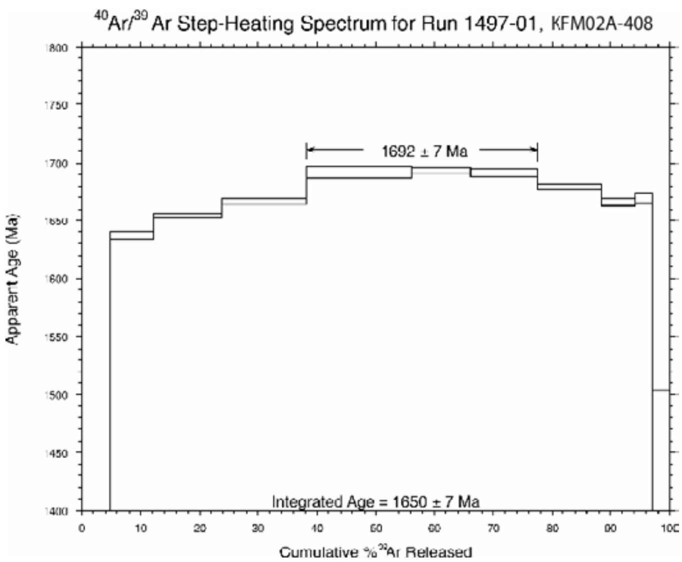


Figure 5-17. KFM02A-408 biotite.

KFM02A-700 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 709.99–710.40 m borehole length interval (adjusted). Two splits of this sample were analysed giving nearly identical ages. A plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,653 ± 7 Ma (Figure 5-18). A second split was analysed that yields a plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram of 1,652 ± 7 Ma (Figure 5-19). The ages are interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

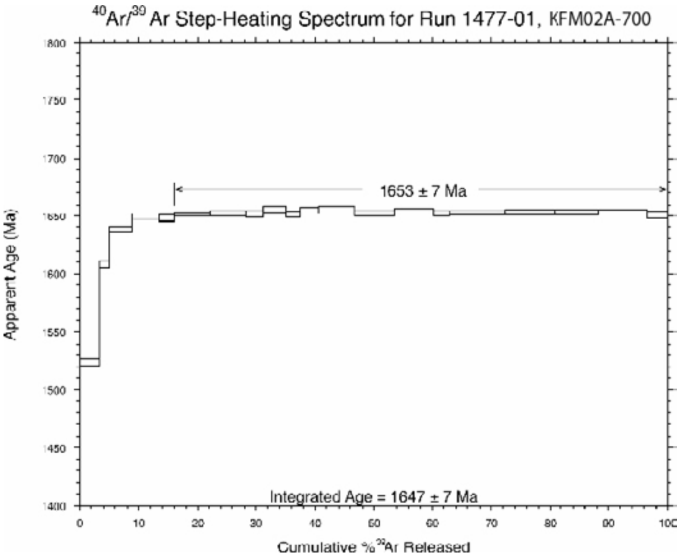


Figure 5-18. *KFM02A-700 biotite.*

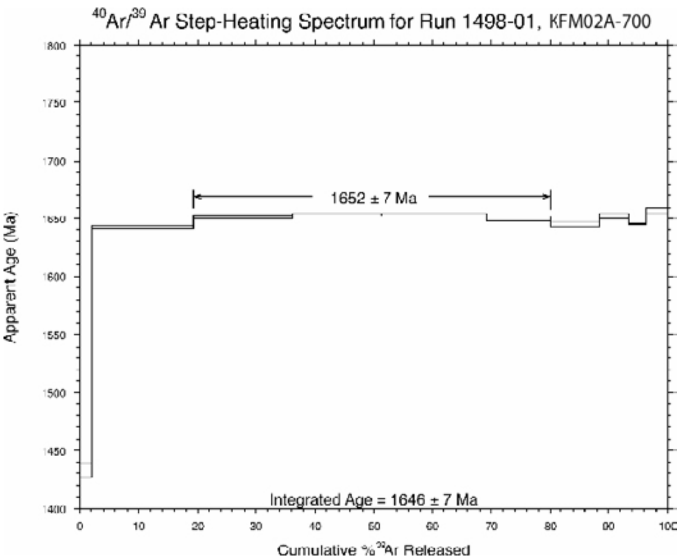


Figure 5-19. *KFM02A-700 biotite.*

KFM02A-1000 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 1,000.97–1,001.37 m borehole length interval (adjusted). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,640 ± 7 Ma (Figure 5-20). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

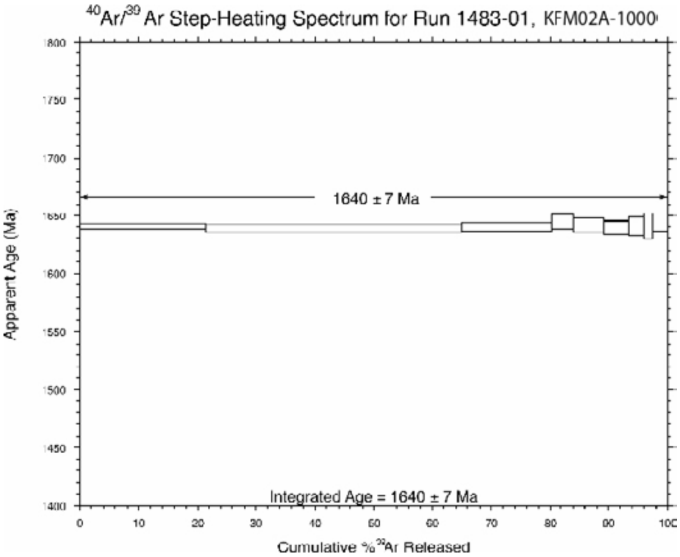


Figure 5-20. *KFM02A-1000 biotite.*

Table 5-3. $^{40}Ar/^{39}Ar$ biotite data from borehole KFM02A.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM02A-100. Run ID# 1468-01 (J = 0.009386 ± 0.000018) Biotite:												
1468-01A	1.3	0.060	–0.02	0.006	0.1	–1.561	-95438364938.667	–0.1	–0.1	–510.1	–26.63	39.33
1468-01B	1.5	–0.388	–0.05	–0.024	0.2	11.854	64533566571.071	0.1	0	253.4	190.33	39.53
1468-01C	1.7	–1.168	–0.17	–0.033	0.5	12.940	36777062475.826	0	0	393.5	206.80	55.59
1468-01D	1.9	0.601	0.11	3.278	0	80.818	67641154176.838	0.1	0.1	7.7	1,018.39	47.76
1468-01E	2	0.464	0.01	0.331	0	55.956	1215761536046.170	1	1	36.4	761.55	3.84
1468-01F	2	0.286	0.00	0.083	0	49.663	2845298164222.050	2.3	3.3	66.8	690.30	1.65
1468-01G	2.1	0.158	0.01	0.083	0	67.564	4191475802457.940	3.3	6.6	73.4	886.03	1.55
1468-01H	2.1	0.120	0.01	0.053	0	110.118	3295632963484.610	2.6	9.2	87.5	1,280.52	1.64
1468-01I	2.1	0.133	0.01	0.054	0	137.668	6265869342252.870	5	14.2	89.6	1,496.46	1.48
1468-01J	2.2	0.106	0.01	0.010	0.1	160.443	11666233770512.900	9.2	23.4	98.2	1,657.32	1.15
1468-01K	2.2	0.000	0.01	0.003	0	162.845	5560254769764.100	4.4	27.8	99.5	1,673.49	1.15
1468-01L	2.3	0.028	0.01	0.003	0.1	163.987	6326522709797.460	5	32.8	99.4	1,681.11	1.29
1468-01M	2.3	0.016	0.01	0.000	0.9	165.390	6285016402203.980	5	37.8	100	1,690.45	1.21
1468-01N	•2.4	0.083	0.01	0.002	0.5	169.697	12254542895643.700	9.7	47.5	99.6	1,718.79	1.30
1468-01O	•2.5	0.073	0.01	0.001	0.7	169.682	10166742893734.900	8.1	55.6	99.8	1,718.70	1.35
1468-01OP	•2.6	0.083	0.01	0.001	1.6	170.756	6812179242223.090	5.4	61	99.9	1,725.70	1.35
1468-01OQ	•2.8	0.207	0.01	0.002	1.4	170.850	9863539073861.940	7.8	68.8	99.7	1,726.31	2.30
1468-01OR	•3.1	0.425	0.01	0.003	2.1	170.777	12740461298272.800	10.1	78.9	99.5	1,725.84	1.70
1468-01OS	•3.5	0.444	0.01	0.004	1.7	169.944	14140316624050.600	11.2	90.1	99.4	1,720.41	1.14
1468-01OT	4	0.466	0.01	0.006	1.2	166.061	11651328160520.400	9.2	99.3	99	1,694.89	1.42
1468-01U	4.8	1.278	0.01	0.015	1.2	149.940	905742332992.515	0.7	100	97.1	1,584.92	5.25
Integ. Age											1,637.00	5.00
(•) Plateau Age								52.3			1,722.00	5.00
KFM02A-408. Run ID# 1476-01 (J = 0.009461 ± 0.000029) Biotite:												
1476-01A	2.1	12.508	1.07	0.529	0.3	–149.029	5778018786.459	0	0	–1,968.2	NAN(000).00000	–1,045.94
1476-01B	2.3	5.865	0.38	2.085	0	29.379	37744853777.859	0	0	4.5	442.47	59.26
1476-01C	2.5	0.643	0.03	0.529	0	75.661	213601359868.095	0.1	0.1	32.6	974.02	11.39

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1476-01D	2.7	0.494	0.05	0.288	0	93.533	475639868809.976	0.2	0.2	52.4	1,143.57	5.60
1476-01E	2.9	0.239	0.03	0.141	0	111.014	1047987778373.650	0.4	0.6	72.7	1,295.31	2.92
1476-01F	3.1	0.111	0.01	0.079	0	114.344	2176512410098.560	0.7	1.3	83.1	1,322.82	1.89
1476-01G	3.2	0.003	0.00	0.036	0	125.384	2798973658242.350	1	2.3	92.2	1,411.14	1.51
1476-01H	3.3	–0.050	0.00	0.013	–0.1	146.388	2164428882141.520	0.7	3	97.4	1,568.08	2.01
1476-01I	3.4	–0.055	0.00	0.012	–0.1	151.112	2425112407911.170	0.8	3.9	97.6	1,601.58	2.09
1476-01J	3.5	–0.002	0.01	0.016	0	149.451	3859584771001.820	1.3	5.2	97	1,589.87	1.34
1476-01K	3.6	0.061	0.01	0.011	0.1	150.385	2244729794371.090	0.8	5.9	97.9	1,596.47	1.83
1476-01L	3.7	0.068	0.01	0.011	0.1	152.002	2688041024866.010	0.9	6.8	98	1,607.82	1.89
1476-01M	•3.8	–0.084	0.00	0.003	–0.4	159.547	4843554797319.490	1.6	8.5	99.5	1,659.88	1.63
1476-01N	•3.9	0.001	0.01	0.003	0	159.011	5558674940213.460	1.9	10.4	99.5	1,656.23	1.32
1476-01O	•4.0	0.001	0.00	0.003	0	159.052	5670002362265.880	1.9	12.3	99.5	1,656.52	1.31
1476-01P	•4.0	0.001	0.01	0.003	0	159.216	11737547398781.900	4	16.3	99.4	1,657.63	1.09
1476-01Q	•4.1	0.007	0.01	0.002	0	159.251	5949502097998.300	2	18.3	99.6	1,657.87	1.42
1476-01R	•4.1	0.004	0.01	0.001	0.1	159.700	23284099999762.600	7.9	26.2	99.8	1,660.92	1.21
1476-01S	•4.2	–0.016	0.01	0.001	–0.3	159.687	7812259270891.600	2.7	28.9	99.8	1,660.83	1.06
1476-01T	•4.2	0.001	0.01	0.001	0	159.516	9317669577870.050	3.2	32.1	99.8	1,659.67	0.99
1476-01U	•4.2	0.020	0.01	0.002	0.2	159.525	10128277762300.200	3.4	35.5	99.7	1,659.73	1.25
1476-01V	•4.3	0.048	0.01	0.003	0.3	159.935	5641377113427.640	1.9	37.4	99.5	1,662.52	1.50
1476-01X	•4.3	0.008	0.01	0.001	0.2	159.755	9278569568400.250	3.2	40.6	99.9	1,661.30	1.67
1476-01Y	•4.4	0.002	0.00	0.000	0.5	159.772	4435934347929.570	1.5	42.1	100	1,661.42	1.44
1476-01Z	•4.4	0.002	0.01	0.001	0	159.585	6844210780002.600	2.3	44.4	99.9	1,660.14	1.03
1476-01AA	•4.5	0.002	0.00	0.000	0.5	160.038	4434227563818.840	1.5	45.9	100	1,663.22	1.64
1476-01AB	•4.6	0.045	0.01	0.003	0.2	159.927	1734065509094.170	0.6	46.5	99.5	1,662.47	2.01
1476-01AC	•4.8	0.031	0.01	0.001	0.4	159.068	1842599196245.150	0.6	47.1	99.8	1,656.62	1.88
1476-01AD	•5.1	0.011	0.01	0.001	0.2	159.538	4283901523588.500	1.5	48.6	99.9	1,659.82	1.23
1476-01AE	•5.5	0.093	0.02	0.004	0.4	159.920	3214069990381.450	1.1	49.7	99.3	1,662.42	1.43
1476-01AG	•7.0	0.081	0.01	0.002	0.7	160.085	59127168697393.000	20.1	69.8	99.7	1,663.54	1.21
1476-01AH	•8.0	0.049	0.01	0.002	0.3	159.288	7533899289074.440	2.6	72.3	99.6	1,658.12	1.31

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1476-01AI	•10.0	0.037	0.01	0.002	0.2	159.375	4026691538903.860	1.4	73.7	99.6	1,658.71	1.55
1476-01AJ	•14.0	0.112	0.01	0.002	0.9	159.400	52818248514446.500	18	91.7	99.7	1,658.88	1.70
1476-01AK	•0.0	0.273	0.01	0.002	1.9	159.616	24548085568636.300	8.3	100	99.6	1,660.35	0.99
Integ. Age											1,651.00	7.00
(•) Plateau Age								93.2			1,660.00	7.00
KFM02A-408. Run ID# 1497-01 (J = 0.009461 ± 0.000029) Biotite:												
1497-01A	1.7	2.376	0.03	0.318	0.1	79.444	105543325254.467	0.3	0.3	45.8	1,011.26	18.05
1497-01B	1.8	0.263	0.01	0.068	0.1	107.954	1733682256832.240	4.4	4.7	84.3	1,269.65	3.19
1497-01C	1.9	0.257	0.01	0.012	0.3	156.129	2899184817815.510	7.4	12.2	97.8	1,636.49	1.60
1497-01D	2	0.238	0.01	0.005	0.6	158.762	4534713772877.330	11.6	23.8	99	1,654.53	1.04
1497-01E	2.1	0.036	0.00	0.002	0.3	160.566	5666335024669.100	14.5	38.3	99.7	1,666.80	1.20
1497-01F	•2.2	0.058	0.00	0.002	0.4	164.278	6982713678205.700	17.9	56.2	99.7	1,691.78	2.50
1497-01G	•2.4	0.135	0.00	0.001	1.3	164.444	3906740025381.770	10	66.2	99.7	1,692.88	1.16
1497-01H	•2.6	0.680	0.00	0.002	3.9	164.212	4379162894437.120	11.2	77.5	99.6	1,691.34	1.54
1497-01I	2.8	1.088	0.00	0.003	5.2	162.459	4297550095588.970	11	88.5	99.5	1,679.58	1.26
1497-01J	3.1	0.561	0.00	0.005	1.6	160.470	2233824718753.880	5.7	94.2	99.1	1,666.15	1.58
1497-01K	3.5	0.815	0.00	0.005	2.1	160.945	1156952469577.390	3	97.2	99	1,669.37	2.24
1497-01L	4.5	1.089	0.00	0.006	2.5	125.108	1095498196904.790	2.8	100	98.6	1,408.98	47.06
Integ. Age											1,650.00	7.00
(•) Plateau Age								39.2			1,692.00	7.00
KFM02A-700. Run ID# 1477-01 (J = 0.009461 ± 0.000029) Biotite:												
1477-01A	3	–0.721	0.00	–0.049	0.2	29.941	6944859434.273	0	0	193	449.96	249.28
1477-01B	3.3	3.911	–0.17	–0.466	–0.1	137.441	2996449717.773	0	0	–1,9042.8	1,502.89	368.04
1477-01C	3.6	–20.669	–1.93	–0.465	0.6	131.498	3155136209.628	0	0	–3,364.2	1,458.25	346.15
1477-01D	4	–0.015	0.01	0.114	0	140.288	8540183643769.520	3.3	3.3	80.7	1,523.89	1.45
1477-01E	4.1	–0.043	0.01	0.019	0	151.993	4359179975133.060	1.7	4.9	96.4	1,607.76	1.44

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1477-01G	4.3	0.018	0.01	0.006	0	156.365	10428428218083.100	4	8.9	98.8	1,638.11	1.09
1477-01H	4.4	0.011	0.01	0.004	0	157.990	11877035214055.500	4.5	13.4	99.2	1,649.26	1.21
1477-01I	4.5	0.014	0.01	0.003	0.1	157.759	6569859926209.610	2.5	15.9	99.4	1,647.68	1.36
1477-01J	•4.6	0.008	0.01	0.002	0	158.288	16387747974099.000	6.3	22.2	99.6	1,651.30	0.87
1477-01K	•4.7	–0.001	0.01	0.002	0	158.421	15879180360273.500	6.1	28.3	99.7	1,652.21	1.31
1477-01L	•4.8	–0.006	0.01	0.002	0	158.355	7643065647651.460	2.9	31.2	99.6	1,651.76	1.28
1477-01M	•4.9	0.022	0.01	0.002	0.1	158.947	10011917183895.300	3.8	35	99.6	1,655.80	1.45
1477-01N	•5.0	0.001	0.01	0.002	0	158.257	6650402809363.950	2.5	37.5	99.7	1,651.09	1.29
1477-01O	•5.1	0.014	0.01	0.001	0.3	158.740	8171202056906.160	3.1	40.6	99.9	1,654.39	1.37
1477-01Q	•5.6	0.008	0.01	0.001	0.1	158.817	16159900192050.000	6.2	46.8	99.8	1,654.91	1.60
1477-01R	•6.0	0.011	0.01	0.001	0.1	158.400	17858977370407.300	6.8	53.6	99.8	1,652.06	1.36
1477-01S	•6.5	0.000	0.01	0.001	0	158.707	16951621345516.400	6.5	60.1	99.9	1,654.16	1.13
1477-01T	•7.2	–0.016	0.01	0.000	–0.9	158.420	7411967832766.820	2.8	62.9	100	1,652.20	1.29
1477-01U	•8.0	–0.003	0.01	0.001	–0.1	158.543	24354950033284.300	9.3	72.2	99.9	1,653.04	0.96
1477-01X	•10.5	0.005	0.01	0.001	0.1	158.537	22373361011709.500	8.5	80.8	99.8	1,653.00	1.11
1477-01Y	•13.0	0.019	0.01	0.002	0.1	158.513	19689563711606.700	7.5	88.3	99.6	1,652.84	1.18
1477-01Z	•16.0	0.012	0.01	0.001	0.1	158.602	21646569294715.500	8.3	96.5	99.7	1,653.44	1.08
1477-01AA	•18.0	0.021	0.01	0.002	0.2	158.195	9095592298078.310	3.5	100	99.7	1,650.67	1.37
Integ. Age											1,647.00	7.00
(•) Plateau Age								84.1			1,653.00	7.00
KFM02A-700. Run ID# 1498-01 (J = 0.009461 ± 0.000029) Biotite:												
1498-01A	1.7	108.192	0.01	0.997	1.5	187.474	36440765633.139	0	0	38.3	1,840.48	33.95
1498-01B	1.8	2.774	0.01	0.169	0.2	128.138	1453940216592.190	2	2	72	1,432.51	3.08
1498-01C	1.9	0.235	0.00	0.019	0.2	156.997	12542189701293.800	17.1	19.2	96.6	1,642.45	0.87
1498-01D	•2.0	0.292	0.01	0.003	1.3	158.289	12388542572047.100	16.9	36.1	99.4	1,651.31	0.75
1498-01E	•2.1	0.117	0.01	0.001	1.3	158.569	10938429842872.000	15	51.1	99.8	1,653.22	0.86
1498-01F	•2.2	0.106	0.01	0.002	0.6	158.619	13206504128673.500	18.1	69.1	99.5	1,653.56	0.75
1498-01G	•2.4	0.365	0.01	0.003	1.5	158.118	7878669114577.170	10.8	79.9	99.4	1,650.14	0.97
1498-01H	2.6	0.091	0.01	0.004	0.3	157.013	6259506175844.310	8.6	88.5	99.2	1,642.57	1.05

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1498-01I	2.8	0.154	0.01	0.003	0.7	158.394	3632496487031.830	5	93.4	99.4	1,652.02	1.29
1498-01J	3.1	0.632	0.01	0.005	1.9	157.595	2157369735241.410	2.9	96.4	99.2	1,646.55	1.59
1498-01K	3.5	0.275	0.01	0.003	1.1	159.391	2638643084774.720	3.6	100	99.4	1,658.82	1.28
Integ. Age											1,646.00	7.00
(•) Plateau Age								60.7			1,652.00	7.00
KFM02A-1000. Run ID# 1483-01 (J = 0.009461 ± 0.000029) Biotite:												
1483-01B	•1.9	0.359	0.02	0.002	2.7	156.679	3138517253856.680	21.3	21.3	99.7	1,640.27	1.31
1483-01C	•2.1	0.091	0.01	0.001	1.5	156.428	6470505130911.350	43.8	65.1	99.8	1,638.54	1.88
1483-01D	•2.2	0.085	0.01	0.001	0.9	156.612	2224657197493.320	15.1	80.1	99.8	1,639.81	1.88
1483-01E	•2.3	0.720	0.02	0.001	9.4	157.260	570957371979.126	3.9	84	99.8	1,644.26	3.07
1483-01F	•2.5	2.209	0.02	0.002	16.6	156.886	766032535504.343	5.2	89.2	99.7	1,641.70	3.22
1483-01G	•2.7	0.552	0.01	0.002	3.4	156.510	638416488994.214	4.3	93.5	99.6	1,639.11	3.07
1483-01H	•2.9	1.284	0.01	0.000	186.9	156.765	350327745463.120	2.4	95.9	100	1,640.86	4.11
1483-01I	•3.3	9.455	0.04	0.007	18.4	156.727	246948866051.706	1.7	97.6	98.9	1,640.60	5.70
1483-01J	•3.7	0.812	0.01	0.005	2	157.182	361268647704.324	2.4	100	99	1,643.73	3.92
Integ. Age											1,640.00	7.00
(•) Plateau Age								100			1,640.00	7.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

5.3.2 KFM03A

This near-vertical borehole intersects the bedrock in the south-eastern part of the candidate area, inside the tectonic lens in structural domain 1 (Figure 1-1). In the same manner as KFM02A, it is intersected by several gently dipping fracture zones /SKB 2005/.

KFM03A-150 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 147.00–147.41 m borehole length interval (adjusted). The $^{40}Ar/^{39}Ar$ step-heating spectrum did not yield an interpretable age (Figure 5-21). However, the oldest step of 1,724 ± 3 is similar to the age of the biotite from KFM02A-100.

KFM03A-836 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 836.27–836.70 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,660 ± 7 Ma (Figure 5-22). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C). A second split was analysed which did not yield a good analytical age (Figure 5-23).

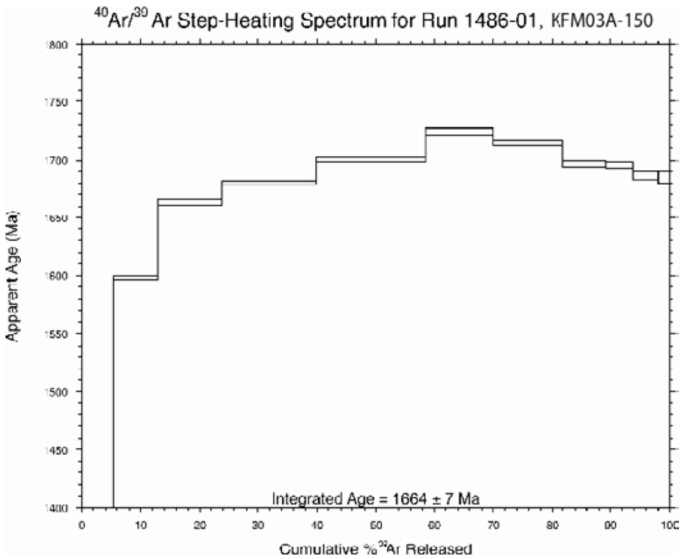


Figure 5-21. KFM03A-150 biotite.

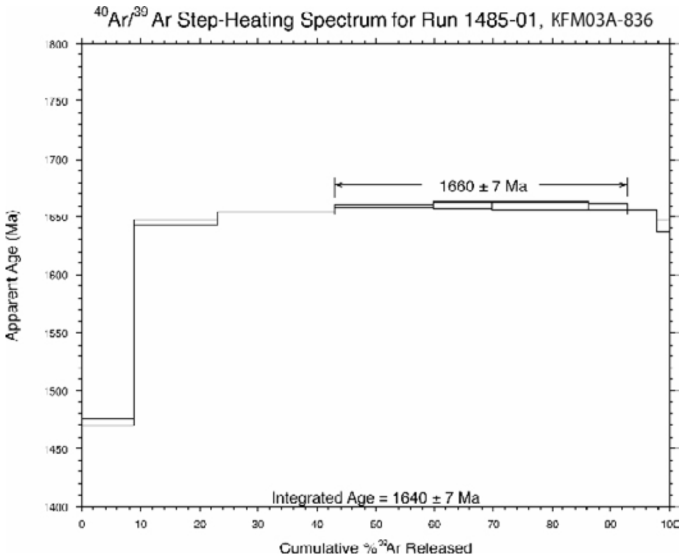


Figure 5-22. KFM03A-836 biotite.

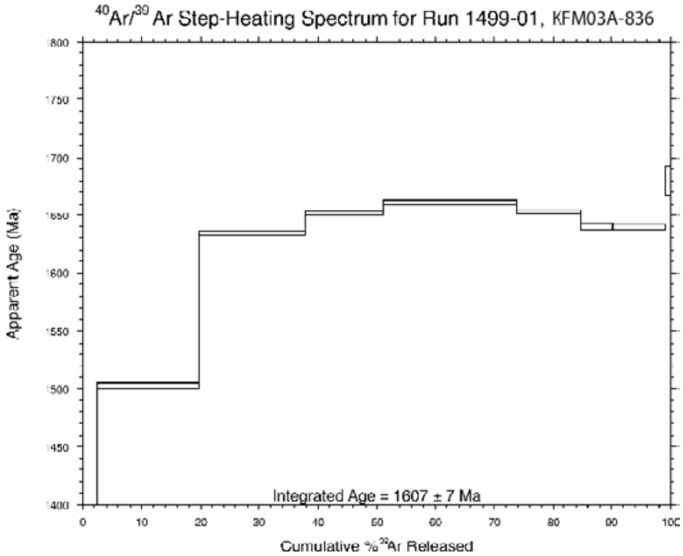


Figure 5-23. *KFM03A-836 biotite.*

KFM03A-1000 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite-granodiorite at the 996.93–997.35 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,669 ± 7 Ma (Figure 5-24). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

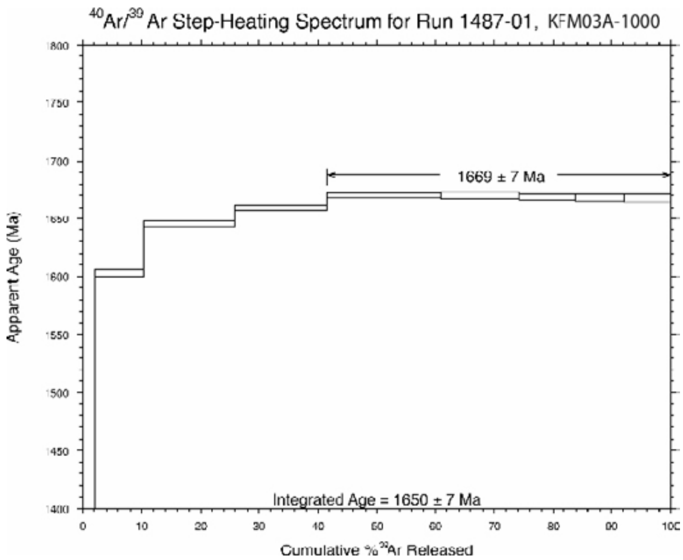


Figure 5-24. *KFM03A-1000 biotite.*

Table 5-4. $^{40}Ar/^{39}Ar$ data from borehole KFM03A.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM03A-150. Run ID# 1486-01 (J = 0.009461 ± 0.000029) Biotite:												
1486-01A	1.7	1.676	0.04	0.586	0	60.985	73740020099.257	0.2	0.2	26	821.78	18.39
1486-01B	1.8	–0.388	0.03	0.076	0	94.881	2209747903627.530	5.3	5.5	80.8	1,155.74	1.46
1486-01C	1.9	–0.285	0.03	0.018	0	150.660	3138296048471.320	7.5	13	96.6	1,598.40	1.03
1486-01D	2	0.093	0.04	0.004	0.3	160.105	4601766976152.670	11	24	99.3	1,663.68	1.22
1486-01E	2.1	0.030	0.04	0.001	0.3	162.613	6635808214103.540	15.9	39.9	99.8	1,680.61	0.82
1486-01F	2.2	0.007	0.04	0.001	0.1	165.599	7807035710297.480	18.7	58.6	99.8	1,700.58	0.87
1486-01G	2.4	0.204	0.03	0.002	1.6	169.179	4810502617398.970	11.5	70.1	99.7	1,724.23	1.43
1486-01H	2.6	0.028	0.03	0.002	0.2	167.755	4971211744856.890	11.9	82	99.7	1,714.87	1.27
1486-01I	2.8	–0.752	0.03	0.002	0	165.005	2999029119502.140	7.2	89.2	99.6	1,696.63	1.31
1486-01J	3.1	–0.069	0.04	0.003	0	164.847	1938519690806.410	4.6	93.8	99.5	1,695.58	1.66
1486-01K	3.5	0.124	0.04	0.003	0.5	163.496	1783143434003.670	4.3	98.1	99.4	1,686.55	1.65
1486-01L	4.5	0.046	0.04	0.003	0.2	163.279	806149235243.193	1.9	100	99.4	1,685.09	2.50
Integ. Age											1,662.00	7.00
KFM03A-836. Run ID# 1485-01 (J = 0.009461 ± 0.000029) Biotite:												
1485-01A	1.7	–1.915	0.08	0.422	0	68.380	16689920636.469	0	0	35.4	900.09	63.99
1485-01B	1.8	0.111	0.95	0.027	0.1	133.343	4747905498752.090	8.8	8.8	94.4	1,472.23	1.47
1485-01C	1.9	0.035	0.98	0.004	0.1	157.313	7701526091392.200	14.2	23	99.4	1,644.63	0.87
1485-01D	2	0.063	0.02	0.001	0.6	158.571	10744402836308.800	19.8	42.8	99.7	1,653.23	0.90
1485-01E	•2.1	0.003	0.01	0.001	0.1	159.530	9237729184631.660	17	59.8	99.8	1,659.77	0.81
1485-01F	•2.2	0.018	0.98	0.002	0.1	159.643	5447442350193.450	10	69.9	99.7	1,660.53	1.38
1485-01G	•2.4	0.211	0.98	0.003	1.1	159.523	8926018646220.020	16.5	86.3	99.6	1,659.72	1.80
1485-01H	•2.6	0.114	0.02	0.004	0.4	159.522	3562284460952.600	6.6	92.9	99.4	1,659.72	1.32
1485-01I	2.8	0.273	0.02	0.003	1.2	158.693	2727073105932.910	5	97.9	99.4	1,654.06	1.31
1485-01J	3.1	0.389	0.01	0.005	1	156.936	1122842225853.700	2.1	100	99	1,642.04	2.29
Integ. Age											1,640.00	7.00
(•) Plateau Age								50.1			1,660.00	7.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM03A-836. Run ID# 1499-01 (J = 0.009461 ± 0.000029) Biotite:												
1499-01A	1.7	5.687	0.05	1.679	0	112.149	101936568872.075	0.2	0.2	18.4	1,304.73	30.72
1499-01B	1.8	0.497	0.01	0.110	0.1	54.908	1389185351135.110	2.3	2.5	62.9	754.78	2.17
1499-01C	1.9	0.088	0.01	0.033	0	137.304	10203564344921.900	17.2	19.7	93.4	1,501.88	1.13
1499-01D	2	0.064	0.01	0.002	0.5	155.796	10783057713251.800	18.1	37.8	99.7	1,634.19	0.85
1499-01E	2.1	0.088	0.01	0.001	1.4	158.343	7830853308807.200	13.2	51	99.8	1,651.67	0.88
1499-01F	2.2	0.174	0.00	0.001	2	159.783	13611829970287.400	22.9	73.8	99.8	1,661.48	0.81
1499-01G	2.4	0.737	0.01	0.002	4.5	158.520	6491715063975.940	10.9	84.8	99.6	1,652.88	1.03
1499-01H	2.6	0.775	0.01	0.003	3.6	156.635	3253547784832.580	5.5	90.2	99.5	1,639.97	1.41
1499-01I	2.8	1.981	0.00	0.002	12.4	156.540	5183112058073.840	8.7	98.9	99.6	1,639.32	1.33
1499-01J	3.1	14.365	0.02	0.013	15.6	164.374	80877257643.623	0.1	99.1	98.1	1,692.42	38.83
1499-01K	4.5	1.868	0.01	0.005	5.7	162.511	547840880939.661	0.9	100	99.2	1,679.93	6.49
Integ. Age											1,607.00	7.00
KFM03A-1000. Run ID# 1487-01 (J = 0.009461 ± 0.000029) Biotite:												
1487-01A	1.7	–20.129	-0.10	0.341	0	179.871	5172377277.366	0	0	64.1	1,793.08	220.77
1487-01B	1.8	–3.180	0.02	0.074	0	103.043	614785165435.539	2.1	2.1	82.3	1,227.70	3.17
1487-01C	1.9	0.062	0.02	0.020	0	151.309	2419453690038.610	8.2	10.3	96.2	1,602.96	1.38
1487-01D	2	0.049	0.40	0.003	0.2	157.388	4572651609730.890	15.5	25.9	99.5	1,645.14	1.10
1487-01E	2.1	0.002	0.40	0.001	0	159.570	4599553085223.180	15.6	41.5	99.8	1,660.04	1.06
1487-01F	•2.2	0.051	0.98	0.001	0.6	161.036	5738285368341.920	19.5	61	99.8	1,669.98	0.95
1487-01G	•2.4	0.021	0.02	0.002	0.2	161.115	3873972103353.570	13.2	74.2	99.7	1,670.52	1.48
1487-01H	•2.6	–0.437	0.02	0.002	0	160.828	2861785282580.330	9.7	83.9	99.7	1,668.57	1.36
1487-01I	•2.8	–1.181	0.02	0.001	0	160.832	2400526745694.130	8.2	92.1	99.7	1,668.60	1.52
1487-01J	•3.1	0.066	0.02	0.002	0.4	160.726	2325392270885.490	7.9	100	99.6	1,667.89	1.60
1487-01K	3.5	–11.715	0.12	0.145	0	132.985	12473716005.685	0	100	75.5	1,469.52	79.15
Integ. Age											1,650.00	7.00
(•) Plateau Age								58.5			1,669.00	7.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau. i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

5.3.3 KFM04A

Drill site KFM04A is located north-east of and close to the Eckarfjärden deformation zone (Figure 1-1). The upper part of the borehole lies outside the tectonic lens and contains highly deformed rocks belonging to structural domain 2. Samples chosen for analysis from this part of the borehole have been taken from this part of the borehole along sections affected by strong ductile strain. They are classified as a ductile shear zone by the mapping team.

KFM04A-395 biotite

$^{40}Ar/^{39}Ar$ biotite sample from muscovite-bearing, highly strained rocks at the 394.84–395.07 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,685 ± 5 Ma (Figure 5-25). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

KFM04A-427 biotite

$^{40}Ar/^{39}Ar$ biotite sample from muscovite-bearing, highly strained rocks at the 427.40–427.65 m borehole length interval (adjusted). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,666 ± 5 Ma (Figure 5-26). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

KFM04A-395 muscovite

$^{40}Ar/^{39}Ar$ muscovite sample from muscovite-bearing, highly strained rocks at the 394.84–395.07 m borehole length interval (adjusted). The forced-fit age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,753 ± 4 Ma (Figure 5-27). The age is interpreted as the age of cooling below the closure temperature of muscovite (c. 350°C). A second split was analysed (Figure 5-28), but was not considered for analytical reasons (poor temperature split and low gas yields).

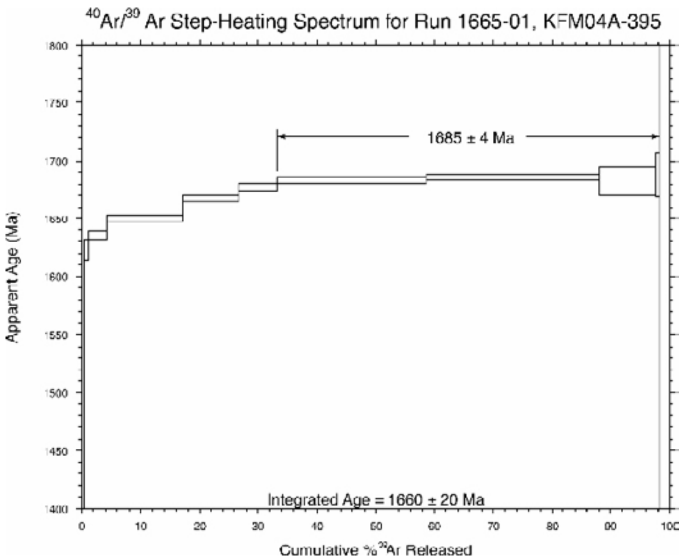


__Figure 5-25.__ KFM04A-395 biotite.

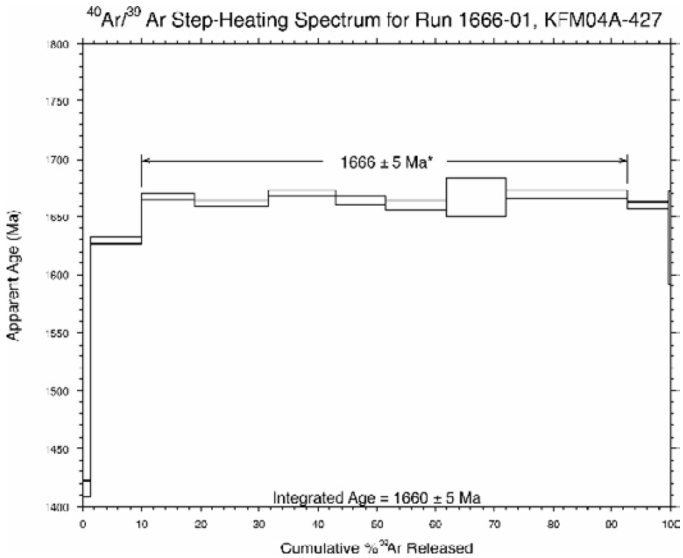


Figure 5-26. *KFM04A-427 biotite.*

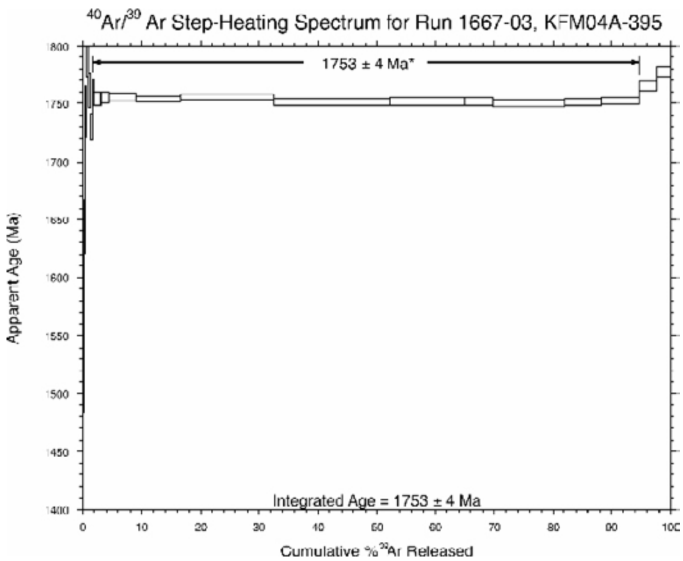


Figure 5-27. *KFM04A-395 muscovite*

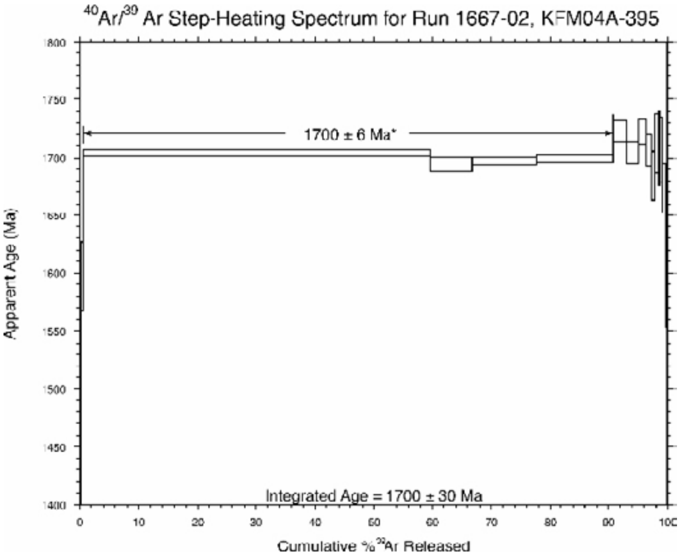


Figure 5-28. *KFM04A-395 muscovite.*

KFM04A-427 muscovite

$^{40}Ar/^{39}Ar$ muscovite sample from muscovite-bearing, highly strained rocks at the 427.40–427.65 m borehole length interval (adjusted). Three splits of this sample were analyzed. One $^{40}Ar/^{39}Ar$ step-heating spectrum yields a plateau age of 1,731 ± 5 Ma (Figure 5-29). A second split yields a plateau age of 1,688 ± 5 (Figure 5-30). A third split yields a forced-fit age of 1,719 ± 5 Ma (Figure 5-31). A mean age of 1,725 Ma has been estimated to represent the best age of this sample. It is based on the average values for splits 1 and 3 and is interpreted as dating cooling below the closure temperature of muscovite (c. 350°C). Split 2 was not included, due to the poor temperature splits and the presence of older ages in the last steps of the sample, consistent with the older ages from splits 1 and 3.

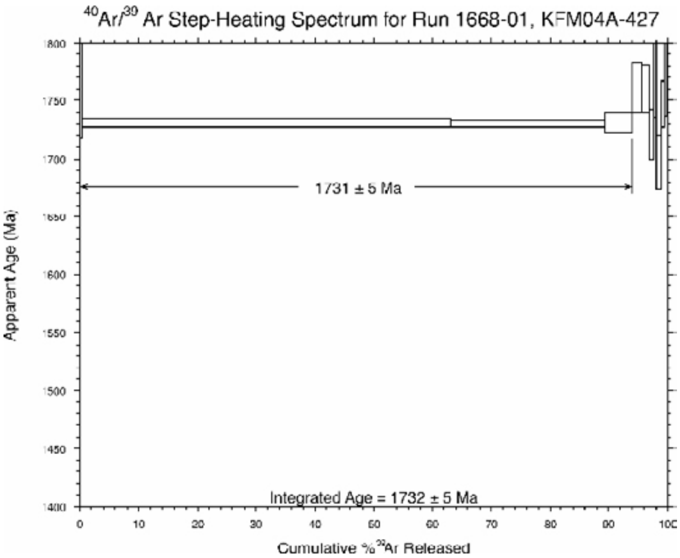


Figure 5-29. *KFM04A-427 muscovite.*

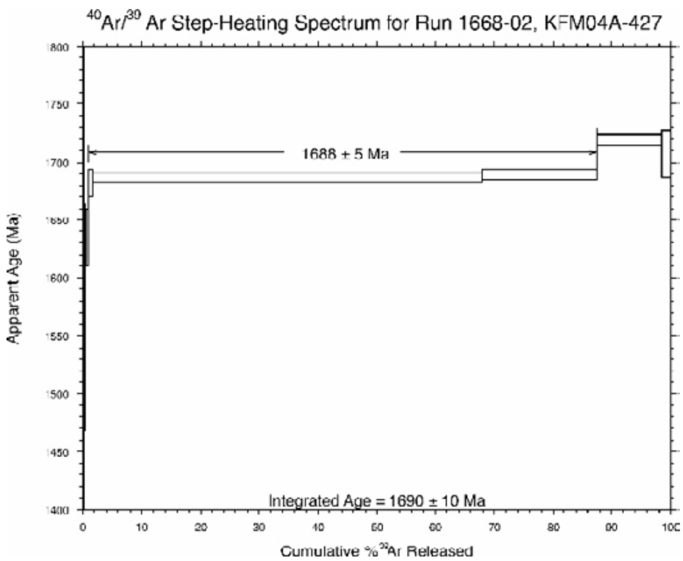


Figure 5-30. *KFM04A-427 muscovite.*

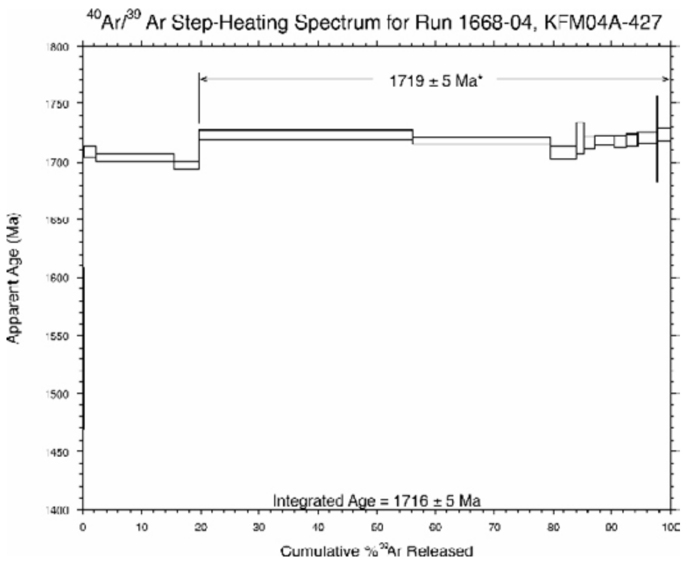


Figure 5-31. *KFM04A-427 muscovite.*

Table 5-5. $^{40}Ar/^{39}Ar$ biotite and muscovite data from borehole KFM04A.

Sample/Run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM04A-395, Run ID# 1665-01 (J = 0.01064 ± 0.00002) Biotite:												
1665-01A	1.4	1.135	–0.05	0.1836	0.1	83.102	1.2792E+11	0.1	0.1	60.5	1,142.89	13.36
1665-01B	1.5	0.240	–0.04	0.0064	0.5	60.773	2.8816E+11	0.3	0.4	97	899.75	6.46
1665-01C	1.6	0.018	–0.02	0.0081	0	137.045	5.9432E+11	0.6	1.1	98.3	1,622.61	4.53
1665-01D	1.7	0.034	0.00	0.0135	0	138.659	2.9716E+12	3.1	4.2	97.2	1,635.17	1.91
1665-01E	1.8	0.017	0.00	0.0067	0	140.578	1.2321E+13	12.9	17.1	98.6	1,649.99	1.44
1665-01F	1.9	0.019	0.00	0.0013	0.2	142.890	9.1900E+12	9.6	26.7	99.7	1,667.69	1.19
1665-01G	2	0.012	0.00	0.0005	0.4	144.189	6.2535E+12	6.6	33.3	99.9	1,677.55	1.49
1665-01H	•2.2	0.011	0.00	0.0011	0.1	144.958	2.4232E+13	25.4	58.7	99.8	1,683.36	1.25
1665-01I	•2.5	0.009	0.00	0.0010	0.1	145.299	2.8045E+13	29.4	88	99.8	1,685.94	1.08
1665-01J	•3.0	0.008	0.00	0.0002	0.5	144.833	9.1986E+12	9.6	97.7	100	1,682.42	5.95
1665-01K	•3.7	0.169	0.01	0.0017	1.4	145.513	5.3451E+11	0.6	98.2	99.7	1,687.56	9.22
1665-01L	4.5	0.383	0.01	0.0052	1	176.300	6.4437E+10	0.1	98.3	99.1	1,905.72	66.77
1665-01M	6	–0.046	–0.03	0.0001	–5.4	4.637	1.6068E+12	1.7	100	99.2	86.89	58.25
Integ. Age=											1,660.00	20.00
(•) Plateau Age =								65			1,685.00	4.00
KFM04A-395, Run ID# 1667-02 (J = 0.01064 ± 0.00002) Muscovite:												
1667-02A	1.3	5.500	0.33	0.0686	1.1	94.724	1.5708E+10	0.1	0.1	82.5	1,257.57	118.02
1667-02B	1.4	2.716	0.11	0.0426	0.9	108.071	1.8593E+10	0.1	0.1	89.6	1,380.85	77.90
1667-02C	1.5	0.185	0.10	0.0122	0.2	93.841	5.2277E+10	0.2	0.3	96.3	1,249.11	29.44
1667-02D	1.6	0.291	0.02	0.0107	0.4	133.717	9.552E+10	0.3	0.6	97.7	1,596.44	14.92
1667-02E	•1.9	0.006	0.00	0.0011	0.1	147.690	1.8168E+13	59	59.6	99.8	1,703.88	1.39
1667-02F	•2.0	0.007	0.00	0.0004	0.2	146.405	2.1813E+12	7.1	66.7	99.9	1,694.26	3.05
1667-02G	•2.1	0.013	0.01	0.0002	0.8	146.807	3.4083E+12	11.1	77.8	100	1,697.27	1.68
1667-02H	•2.2	0.017	0.01	0.0008	0.3	147.028	3.9766E+12	12.9	90.7	99.8	1,698.93	1.75
1667-02I	2.3	0.132	0.00	0.0016	1.1	150.153	7.1222E+11	2.3	93	99.7	1,722.17	4.62
1667-02J	2.4	0.264	0.00	0.0071	0.5	147.701	6.0432E+11	2	95	98.6	1,703.96	4.52
1667-02K	2.5	0.248	0.00	0.0056	0.6	150.129	4.1214E+11	1.3	96.3	98.9	1,721.99	5.46
1667-02L	2.6	0.355	0.01	0.0051	1	148.024	3.282E+11	1.1	97.4	99	1,706.37	6.64

Sample/Run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^*/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^*$[d]	Age (Ma)	± 2σ
1667-02M	2.7	0.064	0.00	0.0111	0.1	145.081	1.6342E+11	0.5	97.9	97.8	1,684.29	10.62
1667-02N	2.8	0.730	0.01	0.0076	1.3	148.851	1.4273E+11	0.5	98.4	98.5	1,712.52	12.61
1667-02O	3	0.447	0.00	0.0052	1.2	148.304	9.9768E+10	0.3	98.7	99	1,708.46	16.06
1667-02P	3.3	0.768	0.00	0.0002	61.6	148.091	1.254E+11	0.4	99.1	100	1,706.87	13.88
1667-02Q	3.7	0.286	0.02	0.0065	0.6	143.609	1.6097E+11	0.5	99.6	98.7	1,673.15	10.74
1667-02R	4.1	0.717	0.09	0.0267	0.4	136.269	4.5408E+10	0.1	99.8	94.5	1,616.54	31.71
1667-02S	4.5	1.450	0.05	0.0176	1.1	129.939	3.1068E+10	0.1	99.9	96.2	1,566.25	122.34
1667-02T	5	–2.710	0.01	–0.0334	1.1	166.776	2.2074E+10	0.1	100	106.2	1,841.01	1,8334.30
1667-02U	7	–1.708	0.01	–0.0234	1	136.217	1.1494E+10	0	100	105.3	1,616.13	121.80
Integ. Age=											1,700	30
(•) Plateau Age =								90.1			1,700	6
KFM04A-395, Run ID# 1667-03 (J = 0.01064 ± 0.00002) Muscovite:												
1667-03A	1.3	2.775	–0.13	–0.0489	–0.8	31.361	-6.877E+09	0	0	186.9	519.47	287.12
1667-03B	1.4	–71.673	0.07	0.2807	–3.5	9.681	8341707543	0	0	10.4	176.88	241.59
1667-03C	1.5	–1.430	0.03	0.1455	–0.1	104.848	3.1981E+10	0	0	70.9	1,351.85	65.07
1667-03D	1.6	6.612	0.44	0.1783	0.5	74.157	2.1566E+10	0	0	58.5	1,049.38	79.50
1667-03E	1.7	2.246	0.13	0.0860	0.4	134.620	7.2817E+10	0.1	0.1	84.2	1,603.57	24.01
1667-03F	1.8	0.574	0.06	0.0667	0.1	111.161	4.0354E+10	0	0.1	85	1,408.24	37.55
1667-03G	1.9	1.091	0.09	0.0463	0.3	112.556	6.6558E+10	0.1	0.2	89.2	1,420.46	23.78
1667-03H	2	4.625	0.09	0.0406	1.6	116.570	6.9341E+10	0.1	0.2	90.8	1,455.19	23.90
1667-03I	2.1	1.057	0.02	0.0199	0.7	139.793	1.8525E+11	0.1	0.4	96	1,643.94	11.74
1667-03J	2.1	0.477	0.00	0.0162	0.4	153.002	1.7521E+11	0.1	0.5	97	1,743.10	11.13
1667-03K	2.2	0.172	0.00	0.0137	0.2	155.175	1.3522E+11	0.1	0.6	97.5	1,758.90	13.03
1667-03L	2.2	0.069	0.01	0.0054	0.2	159.224	3.1202E+11	0.2	0.9	99	1,787.99	7.60
1667-03M	2.3	0.124	0.03	0.0011	1.5	157.173	1.8781E+11	0.1	1	99.8	1,773.31	10.59
1667-03N	2.3	0.074	0.01	0.0033	0.3	155.498	3.1559E+11	0.3	1.3	99.4	1,761.24	7.26
1667-03O	2.4	0.150	0.02	0.0052	0.4	151.996	1.5548E+11	0.1	1.4	99	1,735.73	12.01
1667-03P	2.4	0.298	0.00	0.0137	0.3	151.271	3.5434E+11	0.3	1.7	97.4	1,730.41	5.62
1667-03Q	•2.5	0.317	0.02	0.0338	0.1	155.268	4.1355E+11	0.3	2	94	1,759.58	5.63
1667-03R	•2.5	0.256	0.00	0.0346	0.1	154.548	1.3385E+12	1.1	3.1	93.8	1,754.36	2.94
1667-03S	•2.6	0.185	0.01	0.0142	0.2	154.650	1.6591E+12	1.3	4.4	97.4	1,755.09	2.60

Sample/Run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1667-03T	•2.6	0.070	0.00	0.0037	0.3	154.759	5.9657E+12	4.7	9.1	99.3	1,755.89	1.78
1667-03U	•2.7	0.065	0.00	0.0035	0.3	154.483	9.4287E+12	7.5	16.6	99.3	1,753.89	1.26
1667-03V	•2.7	0.022	0.00	0.0011	0.3	154.711	2.0012E+13	15.9	32.4	99.8	1,755.54	1.24
1667-03X	•2.8	0.003	0.00	0.0005	0.1	154.136	2.5136E+13	19.9	52.3	99.9	1,751.37	1.37
1667-03Y	•2.9	0.028	0.00	0.0005	0.7	154.127	1.5864E+13	12.6	64.9	99.9	1,751.30	1.74
1667-03Z	•3.0	0.028	0.00	0.0014	0.3	154.224	6.0885E+12	4.8	69.7	99.7	1,752.00	1.68
1667-03AA	•3.2	0.017	0.00	0.0009	0.3	153.967	1.5731E+13	12.5	82.2	99.8	1,750.13	1.59
1667-03AB	•3.5	0.037	0.00	0.0003	–1.6	154.128	7.7554E+12	6.1	88.3	99.9	1,751.31	1.65
1667-03AC	•4.0	0.024	0.00	0.0000	12.4	154.240	7.9778E+12	6.3	94.7	100	1,752.12	1.51
1667-03AD	5	0.049	0.01	0.0006	1.1	156.032	3.7739E+12	3	97.7	99.9	1,765.10	1.95
1667-03AE	8	0.008	0.01	0.0003	0.4	157.688	2.957E+12	2.3	100	99.9	1,777.01	2.24
Integ. Age=											1,753	4
(•) Plateau Age =								93			1,753	4
KFM04A-427, Run ID# 1666-01 (J = 0.01064 ± 0.00002) Biotite:												
1666-01A	1.4	0.057	0.00	0.0939	0	111.937	1.3260E+12	1.4	1.4	80.1	1,415.05	3.53
1666-01B	1.5	0.020	0.00	0.0057	0	137.910	7.8880E+12	8.5	9.9	98.8	1,629.35	1.42
1666-01C	•1.6	0.028	0.00	0.0022	0.2	142.928	8.2068E+12	8.8	18.8	99.5	1,667.98	1.27
1666-01D	•1.7	0.015	0.00	0.0050	0	142.188	1.1842E+13	12.8	31.5	99	1,662.33	1.21
1666-01E	•1.8	0.011	0.01	0.0044	0	143.293	1.0603E+13	11.4	42.9	99.1	1,670.75	1.28
1666-01F	•1.9	0.026	0.00	0.0021	0.2	142.513	7.7743E+12	8.4	51.3	99.6	1,664.81	1.71
1666-01G	•2.0	0.018	0.00	0.0016	0.1	141.938	9.7729E+12	10.5	61.8	99.7	1,660.42	2.00
1666-01H	•2.2	0.003	0.00	0.0005	0.1	142.811	9.3157E+12	10	71.9	99.9	1,667.08	8.51
1666-01I	•2.5	0.009	0.00	0.0017	0.1	143.212	1.9246E+13	20.7	92.6	99.7	1,670.13	1.69
1666-01J	3	0.042	0.00	0.0013	0.5	141.940	6.5630E+12	7.1	99.7	99.7	1,660.43	1.53
1666-01K	3.7	1.523	0.05	0.0156	1.3	138.185	2.9500E+11	0.3	100	96.8	1,631.49	20.18
Integ. Age=											1,660.00	5.00
(•) Plateau Age =								82.7			1666.00	5.00

Sample/Run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM04A-427, Run ID# 1668-01 (J = 0.01064 ± 0.00002) Muscovite:												
1668-01A	•1.3	0.455	–0.07	0.0681	0.1	155.987	1.3279E+11	0.4	0.4	88.6	1,764.77	23.54
1668-01B	•1.4	0.006	0.00	0.0049	0	151.347	1.9155E+13	62.6	63	99.1	1,730.97	1.87
1668-01C	•1.5	0.000	0.00	0.0008	0	151.204	8.0395E+12	26.3	89.3	99.8	1,729.92	1.51
1668-01D	•1.6	0.001	–0.01	0.0009	0	151.433	1.4553E+12	4.8	94.1	99.8	1,731.60	4.16
1668-01E	1.7	0.005	0.01	0.0033	0	155.473	4.4281E+11	1.4	95.5	99.4	1,761.06	10.59
1668-01F	1.8	0.049	0.01	0.0019	0.4	155.358	4.2338E+11	1.4	96.9	99.6	1,760.23	10.31
1668-01G	1.9	0.485	0.02	0.0095	0.7	149.985	2.3793E+11	0.8	97.7	98.2	1,720.93	10.93
1668-01H	2	0.026	0.00	0.0021	0.2	157.452	1.1804E+11	0.4	98.1	99.6	1,775.32	19.68
1668-01I	2.2	0.302	0.02	0.0065	0.6	146.788	2.3029E+11	0.8	98.8	98.7	1,697.13	11.38
1668-01J	2.5	–0.154	0.01	0.0011	–1.9	153.545	2.0464E+11	0.7	99.5	99.8	1,747.06	9.99
1668-01K	3	–0.549	0.00	0.0056	–1.4	157.115	1.0484E+11	0.3	99.8	98.9	1,772.90	18.02
1668-01L	4	–2.558	-0.03	0.0049	–7.2	167.548	4.7808E+10	0.2	100	99.1	1,846.34	36.24
Integ. Age=											1,732.00	5.00
(•) Plateau Age =								94.1			1,731.00	5.00
KFM04A-427, Run ID# 1668-02 (J = 0.01064 ± 0.00002) Muscovite:												
1668-02A	1.3	1.030	–0.11	0.1796	0.1	121.713	2.3972E+10	0.1	0.1	69.6	1,498.72	91.42
1668-02B	1.3	–3.241	–0.16	–0.0248	1.8	29.666	2.3263E+10	0.1	0.1	132	494.91	3,608.22
1668-02C	1.4	0.722	0.00	0.0364	0.3	142.183	5.4941E+10	0.1	0.2	93	1,662.29	40.25
1668-02D	1.4	8.437	0.41	0.0855	1.4	134.952	1.1211E+10	0	0.2	84.4	1,606.19	123.70
1668-02E	1.4	3.997	0.12	0.0156	3.5	129.846	3.0470E+10	0.1	0.3	96.7	1,565.50	49.22
1668-02F	1.5	1.181	0.05	0.0138	1.2	139.063	1.5305E+11	0.3	0.6	97.2	1,638.30	11.06
1668-02G	1.5	0.247	0.05	0.0232	0.1	138.592	1.2796E+11	0.3	0.9	95.3	1,634.65	12.60
1668-02H	•1.6	0.072	0.01	0.0082	0.1	144.744	3.9340E+11	0.9	1.8	98.4	1,681.75	5.71
1668-02I	•1.8	0.010	0.00	0.0007	0.2	145.377	3.0574E+13	66.1	67.9	99.9	1,686.53	1.97
1668-02J	•2.1	0.017	0.00	0.0008	0.3	145.770	9.0486E+12	19.6	87.5	99.8	1,689.48	2.07
1668-02K	2.5	0.003	0.00	0.0003	0.2	149.778	5.0447E+12	10.9	98.4	100	1,719.39	2.46
1668-02L	4	0.116	0.00	0.0035	0.5	148.086	7.4678E+11	1.6	100	99.3	1,706.83	9.95
Integ. Age=											1,690.00	10.00
(•) Plateau Age =								86.6			1688.00	5.00

Sample/Run ID#[a]	Power (W)	Ca/K	Cl/K	^{36}Ar/^{39}Ar	%^{36}Ar(Ca)[b]	^{40}Ar*/^{39}Ar	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%^{40}Ar*[d]	Age (Ma)	± 2σ
KFM04A-427, Run ID# 1668-04 (J = 0.01064 ± 0.00002) Muscovite:												
1668-04A	1.4	0.870	0.01	0.0391	0.3	122.804	2.1363E+11	0.2	0.2	91.4	1,507.83	19.80
1668-04B	1.5	0.859	0.04	0.0187	0.6	145.728	9.3478E+10	0.1	0.3	96.4	1,689.17	40.16
1668-04C	1.5	0.010	–0.01	0.0051	0	148.306	2.4961E+12	2.1	2.3	99	1,708.47	2.27
1668-04D	1.6	0.034	0.00	0.0001	4.7	147.607	1.5859E+13	13.1	15.4	100	1,703.26	1.33
1668-04E	1.6	0.111	0.00	0.0004	4.1	146.835	5.2380E+12	4.3	19.7	99.9	1,697.49	1.67
1668-04F	•1.6	0.039	0.00	0.0008	0.6	150.230	4.4354E+13	36.5	56.2	99.8	1,722.74	1.80
1668-04G	•1.7	0.024	0.00	0.0000	10.9	149.580	2.8125E+13	23.2	79.4	100	1,717.93	1.48
1668-04H	•1.7	0.095	0.00	0.0006	2.3	148.189	5.7421E+12	4.7	84.1	99.9	1,707.60	2.66
1668-04I	•1.8	0.205	–0.01	0.0016	1.8	149.874	1.4644E+12	1.2	85.3	99.7	1,720.11	6.71
1668-04J	•1.8	0.173	–0.01	0.0009	2.6	149.414	2.1837E+12	1.8	87.1	99.8	1,716.70	2.83
1668-04K	•1.9	0.096	–0.01	0.0003	4.2	149.649	4.0541E+12	3.3	90.5	99.9	1,718.44	2.07
1668-04L	•2.0	0.206	–0.01	0.0014	2	149.544	2.3981E+12	2	92.4	99.7	1,717.66	2.69
1668-04M	•2.1	0.119	–0.01	0.0008	2	149.678	2.4922E+12	2.1	94.5	99.8	1,718.66	2.79
1668-04N	•2.2	0.042	0.00	0.0004	1.3	149.954	3.8882E+12	3.2	97.7	99.9	1,720.70	2.28
1668-04O	•2.4	0.122	0.02	0.0012	1.4	149.787	1.9525E+11	0.2	97.9	99.8	1,719.46	18.38
1668-04P	•3.0	0.013	–0.01	0.0007	0.3	150.294	2.5979E+12	2.1	100	99.9	1,723.21	2.79
Integ. Age=											1,716.00	5.00
(•) Plateau Age =								80.3			1,719.00	5.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar)

[c] Percentage ^{39}Ar released during each step

[d] Percentage of measured ^{40}Ar that is radiogenic

5.3.4 KFM06A and KFM06B

Drill site 6 is situated in the north-western part of the candidate area, inside but close to the north-eastern border of the tectonic lens in structural domain 1 (Figure 1-1). Gently dipping fracture zones intersect KFM06B and the upper part of KFM06A. Borehole KFM06A is also intersected by several steeply dipping fracture zones at different depths along the borehole.

KFM06B-11 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite at the 11.57–11.77 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,701 ± 5 Ma (Figure 5-32). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

KFM06A-175 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite at the 175.11–175.35 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,674 ± 5 Ma (Figure 5-33). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

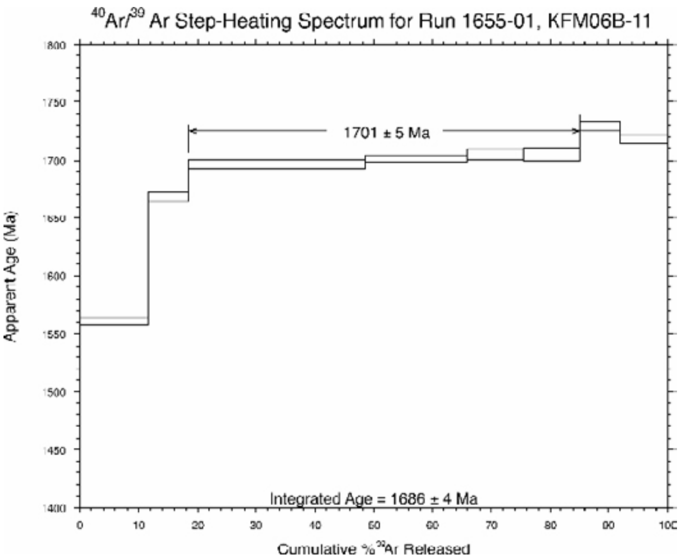


Figure 5-32. KFM06B-11 biotite.

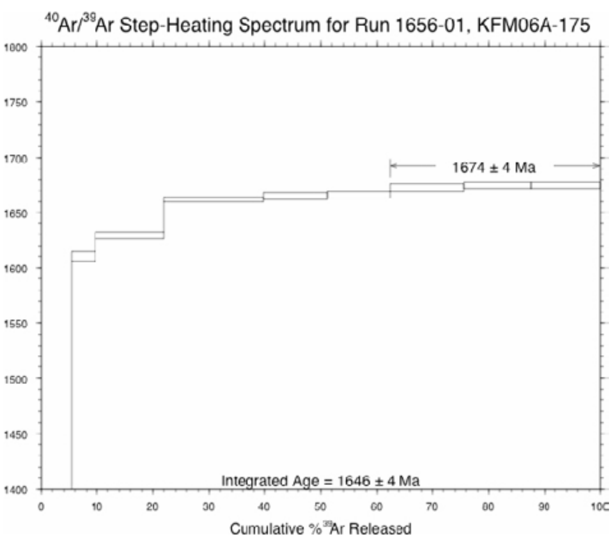


Figure 5-33. KFM06A-175 biotite.

KFM06A-401 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite at the 401.19–401.42 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,689 ± 5 Ma (Figure 5-34). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

KFM06A-577 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a metagranite at the 577.03–577.26 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,682 ± 4 Ma (Figure 5-35). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

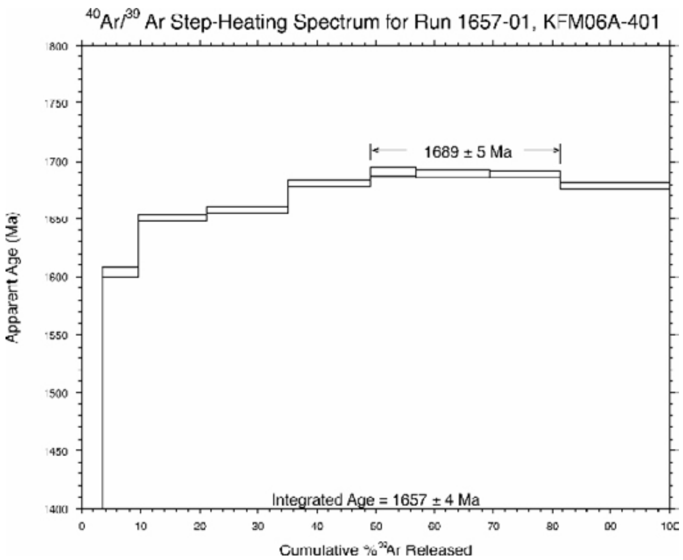


Figure 5-34. *KFM06A-401 biotite.*

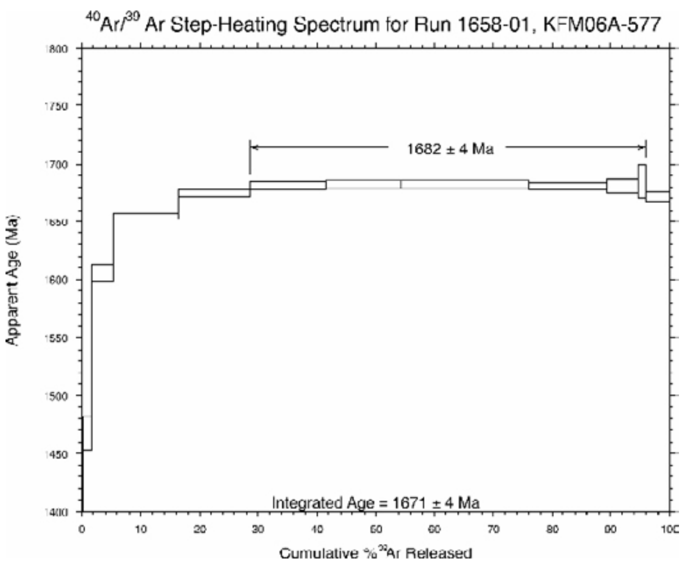


Figure 5-35. *KFM06A-577 biotite.*

KFM06A-709 biotite

$^{40}Ar/^{39}Ar$ biotite sample from a leucocratic granite at the 709.18–709.39 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,692 ± 4 Ma (Figure 5-36). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

KFM06A-993 biotite

$^{40}Ar/^{39}Ar$ biotite sample from metagranite at the 993.0–993.29 m borehole length interval (adjusted). The plateau age defined on the $^{40}Ar/^{39}Ar$ step-heating spectrum diagram is 1,616 ± 4 Ma (Figure 5-37). The age is interpreted as the age of cooling below the closure temperature of biotite (c. 300°C).

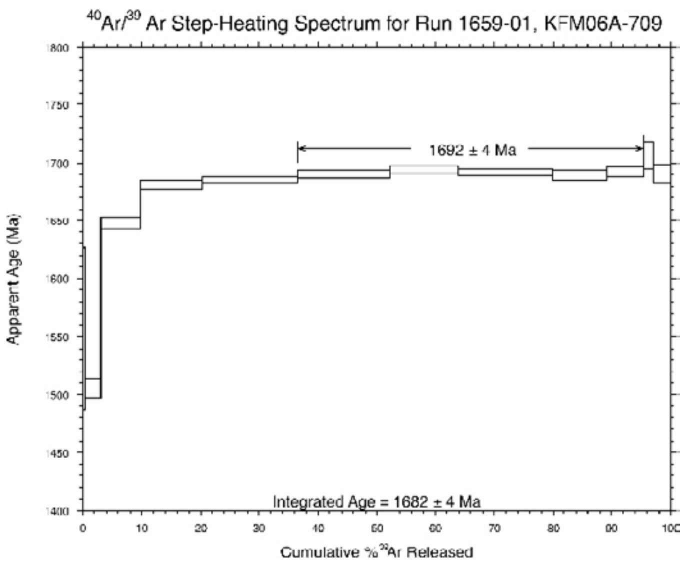


Figure 5-36. KFM06A-709 biotite.

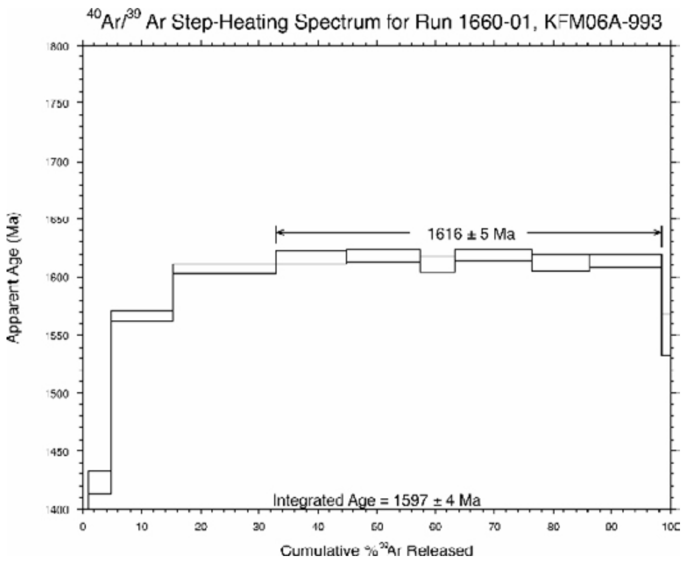


Figure 5-37. KFM06A-993 biotite.

KFM06B-11 K-feldspar

$^{40}Ar/^{39}Ar$ K-feldspar sample from metagranite at the 11.57–11.77 m borehole length interval (adjusted). The $^{40}Ar/^{39}Ar$ step-heating spectrum yields a staircase pattern that is commonly observed in slowly cooled feldspar (Figure 5-38). The age attains a maximum value at 1,490 Ma, which can be interpreted as the minimum age for cooling through approximately 200–225°C.

KFM06A-993 K-feldspar

$^{40}Ar/^{39}Ar$ K-feldspar sample from metagranite taken at the 993.0–993.29 m borehole length interval (adjusted). The $^{40}Ar/^{39}Ar$ step-heating spectrum yields a staircase pattern that is commonly observed in slowly cooled feldspar (Figure 5-39). The age attains a maximum value at 1,500–1,550 Ma, which can be interpreted as the minimum age for cooling through approximately 200–225°C.

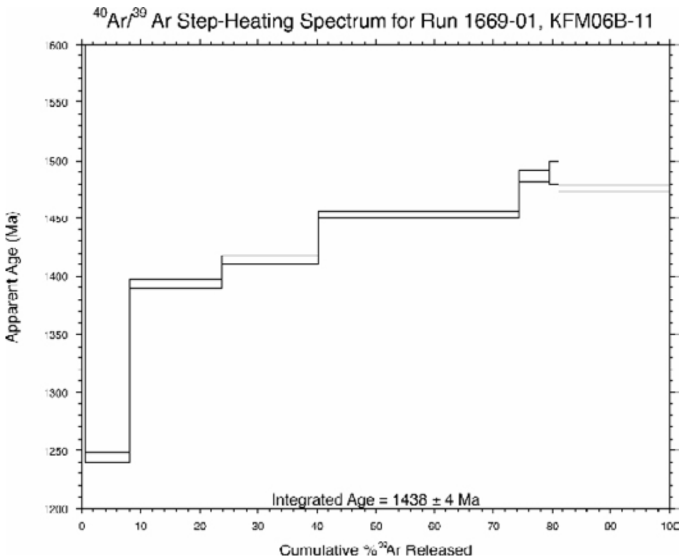


Figure 5-38. KFM06B-11 K-feldspar.

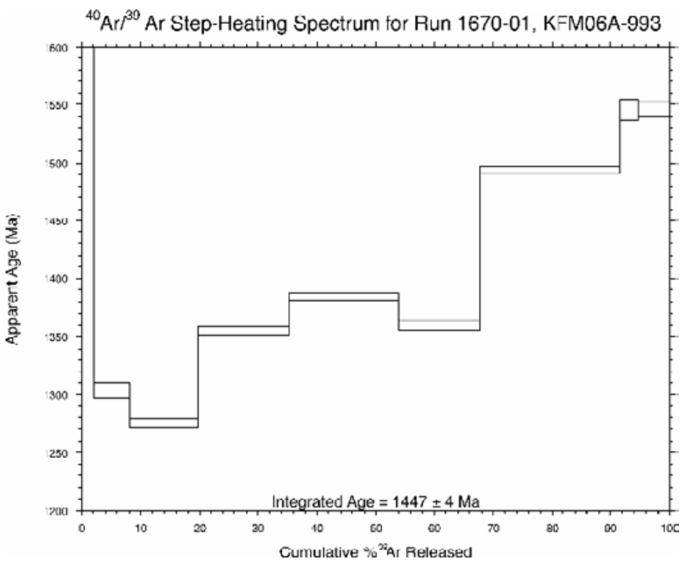


Figure 5-39. KFM06A-993 K-feldspar.

Table 5-6. $^{40}Ar/^{39}Ar$ data for biotite and K-feldspar from KFM06A and KFM06B.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM06B-11. Run ID# 1655-01 (J = 0.01064 ± 0.00002)												
Biotite:												
1655-01A	1.6	0.009	0.06	0.062	0	129.332	6696470712944.860	11.5	11.5	87.6	1,561.35	1.49
1655-01B	1.7	0.061	0.06	0.005	0.2	142.961	4052926742388.790	6.9	18.4	99.1	1,668.23	1.85
1655-01C	•1.8	0.001	0.06	0.002	0	146.765	17620322924080.300	30.2	48.6	99.7	1,696.95	1.97
1655-01D	•1.9	0.002	0.06	0.000	0.3	147.319	10163314499972.300	17.4	65.9	100	1,701.10	1.49
1655-01E	•2.0	0.038	0.06	0.000	1.2	147.803	5505311399861.500	9.4	75.4	99.9	1,704.72	2.34
1655-01F	•2.2	0.002	0.06	0.000	83.9	147.844	5783975212918.010	9.9	85.3	100	1,705.02	2.63
1655-01G	2.5	0.005	0.06	0.000	0.3	151.040	3880530936864.700	6.6	91.9	100	1,728.71	1.85
1655-01H	3	0.090	0.06	0.001	0.9	149.611	4727170821387.860	8.1	100	99.7	1,718.16	1.97
Integ. Age											1,686.00	4.00
(•) Plateau Age								66.9			1,701.00	5.00
KFM06A-175. Run ID# 1656-01 (J = 0.01064 ± 0.00002)												
Biotite:												
1656-01A	1.4	0.355	-0.00	1.785	0	83.567	306041526147.588	0.4	0.4	13.7	1,147.63	22.61
1656-01B	1.5	0.060	0.04	0.212	0	106.221	3607392411053.830	5	5.4	62.9	1,364.26	2.42
1656-01C	1.6	0.000	0.04	0.025	0	135.467	3042852054985.140	4.2	9.6	94.9	1,610.24	2.03
1656-01D	1.7	0.022	0.05	0.011	0	137.887	8867672609010.380	12.3	21.9	97.6	1,629.17	1.39
1656-01E	1.8	0.013	0.05	0.002	0.1	142.167	12903348120743.400	17.9	39.8	99.5	1,662.17	1.12
1656-01F	1.9	0.045	0.05	0.001	0.4	142.478	8226147212437.340	11.4	51.2	99.7	1,664.54	1.63
1656-01G	2	0.005	0.05	0.001	0.1	142.736	7955410292055.790	11	62.2	99.8	1,666.51	1.43
1656-01H	•2.2	0.002	0.05	0.002	0	143.533	9647852132693.850	13.4	75.6	99.6	1,672.58	1.63
1656-01I	•2.5	0.041	0.05	0.002	0.3	143.878	8557075631675.510	11.9	87.5	99.6	1,675.19	1.50
1656-01J	•3.2	0.007	0.05	0.002	0	143.838	9042229845136.640	12.5	100	99.6	1,674.89	1.47
Integ. Age											1,646.00	4.00
(•) Plateau Age								37.8			1,674.00	4.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM06A-401. Run ID# 1657-01 (J = 0.01064 ± 0.00002) Biotite:												
1657-01A	1.4	0.271	0.02	0.742	0	65.067	673583022926.806	1.1	1.1	22.9	949.12	12.07
1657-01B	1.5	0.192	0.02	0.111	0	97.843	1414223692718.600	2.3	3.4	75	1,287.14	4.11
1657-01C	1.6	0.043	0.02	0.030	0	134.646	3746499382549.400	6.1	9.6	93.8	1,603.78	2.07
1657-01D	1.7	0.025	0.02	0.006	0.1	140.716	7135921394502.980	11.7	21.2	98.9	1,651.05	1.47
1657-01E	1.8	0.023	0.03	0.002	0.2	141.682	8433516307872.120	13.8	35	99.6	1,658.46	1.37
1657-01F	1.9	0.022	0.02	0.001	0.5	144.624	8524751036570.030	14	49	99.9	1,680.84	1.53
1657-01G	•2.0	0.015	0.02	0.000	1.1	145.941	4794825625196.300	7.8	56.8	100	1,690.78	1.97
1657-01H	•2.2	0.049	0.02	0.001	0.6	145.706	7724586724107.760	12.6	69.5	99.8	1,689.01	1.71
1657-01I	•2.5	0.184	0.02	0.001	2.1	145.647	7344379509114.080	12	81.5	99.8	1,688.56	1.52
1657-01J	3.2	0.517	0.02	0.001	4.9	144.415	11299570910443.200	18.5	100	99.7	1,679.26	1.38
Integ. Age											1,657.00	4.00
(•) Plateau Age								32.5			1,689.00	5.00
KFM06A-577. Run ID# 1658-01 (J = 0.01064 ± 0.00002) Biotite:												
1658-01A	1.4	1.066	–0.08	11.597	0	77.424	113039226229.330	0.2	0.2	2.2	1,084.10	88.89
1658-01B	1.5	0.053	–0.00	0.877	0	117.990	815386568749.502	1.5	1.7	31.3	1,467.32	7.49
1658-01C	1.6	0.019	0.01	0.161	0	134.837	2028013986118.710	3.7	5.4	73.9	1,605.28	3.80
1658-01D	1.7	0.005	0.02	0.021	0	141.236	6023071756520.930	11	16.4	95.8	1,655.05	1.45
1658-01E	1.8	0.002	0.02	0.004	0	143.829	6721717610341.600	12.3	28.7	99.1	1,674.82	1.81
1658-01F	•1.9	0.004	0.02	0.003	0	144.726	7006272985287.270	12.8	41.5	99.4	1,681.62	1.61
1658-01G	•2.0	0.006	0.02	0.002	0	144.820	7032091134865.440	12.9	54.4	99.5	1,682.33	1.64
1658-01H	•2.2	0.003	0.02	0.001	0	144.851	11744881455409.900	21.5	75.9	99.8	1,682.56	1.72
1658-01I	•2.5	0.038	0.02	0.001	0.4	144.621	7458779771612.480	13.6	89.5	99.7	1,680.82	1.31
1658-01K	•3.5	–0.022	0.01	0.000	0	144.589	2739339264899.800	5	94.5	100	1,680.58	2.92
1658-01L	•4.5	–0.203	-0.00	0.004	0	145.147	742027276049.690	1.4	95.9	99.2	1,684.79	7.17
1658-01M	6	0.028	0.01	0.001	0.3	143.405	2248895796422.510	4.1	100	99.7	1,671.61	2.22
Integ. Age											1,671.00	4.00
(•) Plateau Age								67.2			1,682.00	4.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM06A-709. Run ID# 1659-01 (J = 0.01064 ± 0.00002) Biotite:												
1659-01A	1.4	0.648	–0.13	2.344	0	128.714	85335017918.551	0.3	0.3	15.7	1,556.35	35.04
1659-01B	1.5	0.125	0.01	0.157	0	122.529	809540760216.227	2.8	3	72.5	1,505.54	4.50
1659-01C	1.6	0.055	0.02	0.018	0	140.335	1987539474625.770	6.8	9.8	96.3	1,648.12	2.36
1659-01D	1.7	0.066	0.02	0.003	0.3	144.619	3037081713002.380	10.3	20.1	99.4	1,680.80	2.01
1659-01E	1.8	0.007	0.02	0.001	0.1	145.229	4802040914570.740	16.3	36.4	99.8	1,685.41	1.37
1659-01F	•1.9	0.010	0.02	0.001	0.1	145.895	4642242984223.050	15.8	52.2	99.7	1,690.43	1.59
1659-01G	•2.0	0.005	0.02	0.001	0.1	146.368	3394438411270.060	11.5	63.8	99.9	1,693.98	1.67
1659-01H	•2.2	0.031	0.02	0.001	0.4	146.074	4693369828707.690	16	79.7	99.8	1,691.77	1.57
1659-01I	•2.5	0.061	0.02	0.002	0.5	145.773	2778050636134.680	9.4	89.2	99.7	1,689.51	2.19
1659-01J	•3.0	0.122	0.02	0.001	1.3	146.128	1822776514331.060	6.2	95.4	99.7	1,692.18	2.41
1659-01K	3.5	0.404	–0.01	0.001	5.8	147.992	512649424915.004	1.7	97.1	99.8	1,706.13	5.91
1659-01L	4.5	0.676	0.00	0.002	5	145.922	824156820914.354	2.8	99.9	99.6	1,690.63	3.93
1659-01M	6	2.952	–0.06	0.060	0.7	151.698	26604290489.239	0.1	100	89.5	1,733.55	75.82
Integ. Age											1,682.00	4.00
(•) Plateau Age								58.9			1,692.00	4.00
KFM06A-993. Run ID# 1660-01 (J = 0.01064 ± 0.00002) Biotite:												
1660-01A	1.4	0.503	–0.09	1.065	0	85.362	127987605328.871	0.9	0.9	21.3	1,165.77	21.68
1660-01B	1.5	0.178	–0.01	0.132	0	112.811	576273974221.953	3.9	4.8	74.4	1,422.69	4.90
1660-01C	1.6	0.011	0.01	0.012	0	129.927	1538707751106.410	10.5	15.3	97.3	1,566.16	2.32
1660-01D	1.7	0.010	0.02	0.001	0.1	135.021	2595823032676.860	17.7	33	99.8	1,606.73	1.95
1660-01E	•1.8	0.013	0.01	0.003	0.1	136.229	1723444881244.110	11.7	44.7	99.4	1,616.22	2.95
1660-01F	•1.9	0.014	0.02	0.004	0.1	136.444	1880652214752.510	12.8	57.5	99.2	1,617.91	2.54
1660-01G	•2.0	0.077	0.00	0.005	0.2	135.518	840134991383.321	5.7	63.3	99	1,610.65	3.55
1660-01H	•2.2	0.065	0.02	0.000	61.2	136.510	1915952117844.070	13.1	76.3	100	1,618.43	2.31
1660-01I	•2.5	0.089	0.01	0.003	0.4	135.711	1471135081645.100	10	86.3	99.3	1,612.16	3.56
1660-01J	•3.0	0.193	0.01	0.004	0.7	135.902	1776444439411.930	12.1	98.4	99.2	1,613.67	2.81
1660-01K	4	0.878	0.03	0.004	3.1	127.980	229076419091.764	1.6	100	99.1	1,550.39	8.75
Integ. Age											1,597.00	4.00
(•) Plateau Age								65.5			1,616.00	5.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar moles	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
KFM06B-11. Run ID# 1669-01 (J = 0.01064 ± 0.00002) K-feldspar:												
1669-01A	1.3	11.758	0.38	0.528	0.3	1115.452	29643126148.110	0.1	0.1	87.7	4,609.01	71.47
1669-01B	1.4	0.991	0.03	0.007	2.1	194.811	298231753064.973	0.6	0.6	99	2,025.23	16.64
1669-01C	1.6	0.023	–0.00	0.002	0.1	93.265	3913446876857.940	7.5	8.1	99.3	1,243.57	1.98
1669-01D	1.8	0.059	–0.00	0.001	0.8	109.471	8204835496510.570	15.7	23.8	99.7	1,393.32	2.01
1669-01E	2	0.071	–0.00	0.000	2.1	111.801	8610891630645.260	16.4	40.2	99.9	1,413.86	1.85
1669-01F	0	0.048	–0.00	0.001	0.6	116.310	17934575052412.900	34.2	74.4	99.7	1,452.96	1.69
1669-01G	2.4	0.006	–0.00	0.000	0.9	120.294	2615786082868.310	5	79.4	100	1,486.82	2.36
1669-01H	2.6	0.093	–0.02	0.004	0.3	120.654	961224770740.274	1.8	81.2	99.1	1,489.84	4.84
1669-01I	5	0.039	–0.00	0.002	0.3	119.050	9835886840867.220	18.8	100	99.6	1,476.32	1.52
Integ. Age											1,438.00	4.00
KFM06A-993. Run ID# 1670-01 (J = 0.01064 ± 0.00002) K-feldspar:												
1670-01A	1.4	0.653	0.23	0.039	0.2	353.657	362832823448.039	2.1	2.1	96.8	2,815.91	7.28
1670-01B	1.5	1.306	0.03	0.011	1.7	99.566	992343385564.151	5.9	8	96.9	1,303.28	3.27
1670-01C	1.6	0.393	0.01	0.003	1.7	96.590	1960566896091.420	11.6	19.6	99	1,275.32	1.94
1670-01D	1.7	0.204	0.00	0.001	3.9	105.208	2634621314802.840	15.6	35.2	99.8	1,355.11	1.99
1670-01E	1.8	0.252	0.00	0.001	3.3	108.451	3198554751929.590	18.9	54.1	99.7	1,384.25	1.55
1670-01F	1.9	0.356	0.01	0.002	2.2	105.688	2284101496016.710	13.5	67.6	99.4	1,359.46	2.37
1670-01G	2	0.338	0.01	0.002	1.9	121.085	4049149080628.890	24	91.6	99.4	1,493.47	1.48
1670-01H	2.1	0.294	0.02	0.004	1	127.393	508833905045.907	3	94.6	99	1,545.62	4.29
1670-01I	2.2	0.333	0.02	0.004	1.1	127.412	914705081105.048	5.4	100	99.1	1,545.78	2.97
Integ. Age											1,447.00	4.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

5.4 $^{40}Ar/^{39}Ar$ data – concluding remarks

5.4.1 $^{40}Ar/^{39}Ar$ hornblende surface data

The following preliminary conclusions can be made on the basis of the age-dating results presented here, in combination with the $^{40}Ar/^{39}Ar$ hornblende ages presented in the phase 1 geochronology study /Page et al. 2004/.

A) One older amphibole age of 1,854 ± 7 Ma is present in a sample taken from a tectonic lens, north-east of the Eckarfjärden deformation zone. The age probably reflects the cooling below c. 500°C after crystallisation and penetrative amphibolite facies metamorphism of the Group B rocks in the area. The dated amphibolite is situated within an ultramafic intrusion that acted as a rigid block or small-scale tectonic lens during later deformation. It is suggested that the argon system in amphibole inside the lens was protected from later resetting inside this lens. The interpretation that the temperature reached c. 500°C at 1,854 ± 7 Ma is supported by the existence of an older generation of titanite, at 1,859 ± 2 Ma, that constrains the cooling of the U-Pb titanite system after metamorphism /Page et al. 2004/. Further support is also provided from the 1,864 ± 4 Ma age for the Group C metagranodiorites, which are affected by lower amphibolite facies metamorphic conditions, during the waning stage of the major penetrative ductile deformation event /Page et al. 2004/.

B) Four amphibole ages from samples collected within the major tectonic lens at Forsmark (structural domain 1) fall in the range 1.83–1.82 Ga. These ages can be interpreted to reflect cooling through c. 500°C after some heating event that, perhaps in combination with some dynamic recrystallisation, reset the argon system in these rocks. The presence of a younger titanite generation, dated to between 1.84 and 1.83 Ga /Page et al. 2004/, provides some support to this interpretation. The intrusion of the Group D granite dykes and pegmatites at 1.85 Ga, in association with hot fluids, could potentially have triggered new growth of titanite and added enough heat to raise the temperature of the slowly cooled crust above c. 500°C, so as to reset the argon system in the amphiboles. The 1.84–1.83 Ga tectonothermal event in southern Finland could possibly also be a candidate that affected the Forsmark area enough to cause titanite growth and resetting of the argon system.

C) Amphibole ages ranging from about 1.81 to 1.79 Ga occur consistently along the high-strain belts surrounding the tectonic lens (structural domain 2). They are also present in three samples from within the lens. These ages are interpreted to reflect resetting of the argon system in amphibole in response to a 1.80 Ga tectonothermal event, which can also be seen regionally in central Sweden. Ductile deformation was not penetrative during this event, since all amphiboles within the tectonic lens are not reset at this time. In addition, the Group D granite dykes do not show much deformation after 1.85 Ga in the folded, ductile high-strain zone in the northern part of the tectonic lens.

   It is suggested that sufficient stress was applied to cause dynamic recrystallisation of amphibolite that already had a parallel mineral fabric, but without affecting the rheologically more rigid metagranitoids. More pervasive dynamic recrystallisation in the high-strain zones around the tectonic lens could have been accelerated by a more extensive exposure to fluids, since high-strain zones commonly act as conduits for fluid transport. This can help to explain why all samples from the highly strained belts in structural domain 2 and only a limited number of samples from structural domain 1 inside the tectonic lens yield younger ages.

D) It is suggested that the Forsmark area was situated at mid-crustal levels with a very slow cooling rate that maintained approximately lower amphibolite to upper greenschist facies temperatures between 1,864 ± 4 Ma and 1.80 Ga. During the slow cooling, minor heat pulses (e.g. at 1.85 Ga) could be enough to raise the temperature above the closure tempertaure to reset the argon system in the amphibole, which could be the explanation for the intermediate argon ages. Minor movements in the crust could also have triggered dynamic recrystallisation in some of the amphibolites. The consistently younger argon ages along the high-strain belts and the younger ages in the tectonic lens are most probably related to dynamic recrystallization coupled to late movement along these zones.

5.4.2 $^{40}Ar/^{39}Ar$ biotite surface data

$^{40}Ar/^{39}Ar$ biotite ages range from 1,730 to 1,665 Ma. These ages generally represent cooling below 300°C. A large age spread is to be expected in slowly cooled regions. The affects of younger movement in the brittle regime to explain the variation in ages awaits further evaluation.

5.4.3 $^{40}Ar/^{39}Ar$ biotite, muscovite and K-feldspar borehole data

A) All boreholes show older $^{40}Ar/^{39}Ar$ biotite ages at the top and younger ages at the bottom. Top ages for biotites range from 1,724 to 1,700 Ma, while at the bottom ages range from 1,660 to 1,616 Ma.

B) An uplift rate of 20–30 m/Ma during the c. 1,700–1,600 Ma time interval is obtained in the boreholes where such rates can be estimated. This result is consistent with the results found previously from KFM01A /Page et al. 2004/.

$^{40}Ar/^{39}Ar$ biotite ages - KFM02A

The biotite $^{40}Ar/^{39}Ar$ age-borehole length diagram (Figure 5-40) shows a trend for the lower three age samples that yields an uplift rate of c. 30 m/Ma.

There appears to be a significant break in age between the top sample and the second sample. The gently dipping deformation zone ZFMA3 is located between these two sample sites. The significance of this age break awaits further evaluation.

$^{40}Ar/^{39}Ar$ biotite ages - KFM03A

The biotite $^{40}Ar/^{39}Ar$ age-borehole length diagram (Figure 5-41) also shows younger ages at the bottom and significantly higher ages at the top. Deformation zone ZFMA3 intersects this borehole at a much deeper level and the possibility for a significant step in ages across either this zone or a zone higher up in the borehole (e.g. ZFMA4) is once again apparent.

$^{40}Ar/^{39}Ar$ biotite and K-feldspar ages - KFM06A and KFM06B

The biotite $^{40}Ar/^{39}Ar$ age-borehole length diagram (Figure 5-42) is complex and difficult to interpret, It is noteworthy that borehole KFM06A intersects several steeply dipping fracture zones with both ENE and NNE strike /Carlsten et al. 2005/. Nevertheless, the top and bottom of the borehole yield older and younger ages, respectively, as expected. A possible uplift rate of c. 25 m/Ma can be calculated in the undisturbed 400–600 m section in borehole KFM06A.

K-feldspar dating from KFM06A and KFM06B shows step-heating spectra typical for K-feldspar from slowly cooled regions and demonstrates that the age of the feldspars must be greater than c. 1,500 Ma.

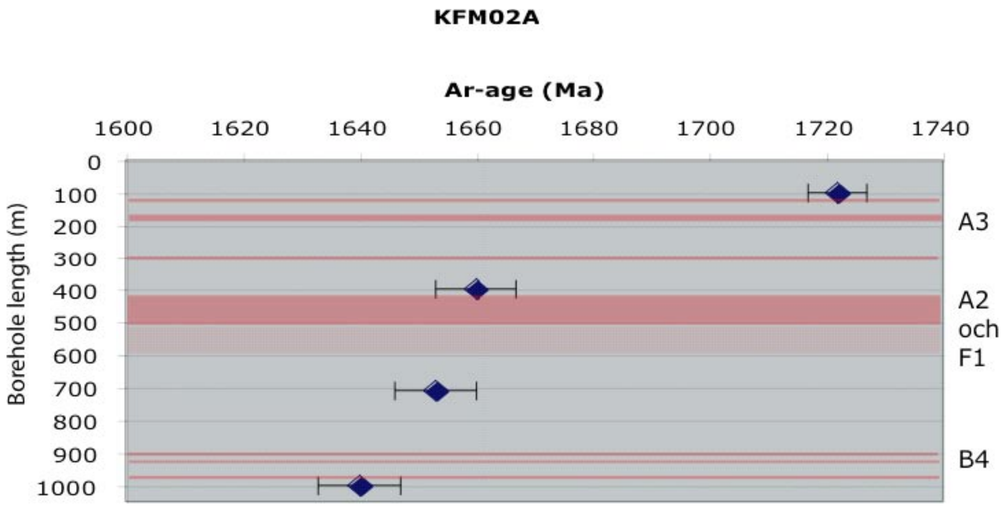


***Figure 5-40.** Biotite KFM02A age-borehole length plot. Some gently dipping fracture zones are marked.*

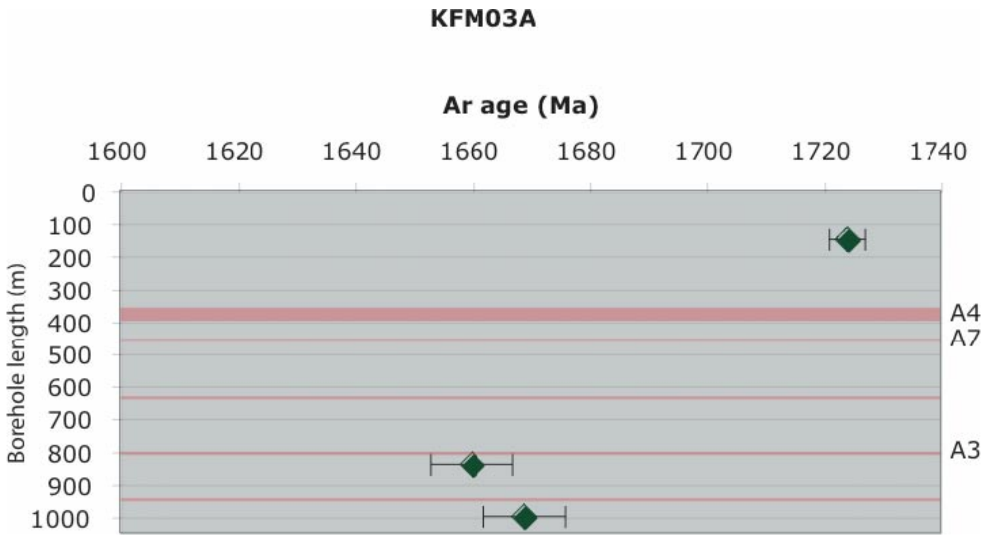


***Figure 5-41.** Biotite KFM03A age-borehole length plot.*

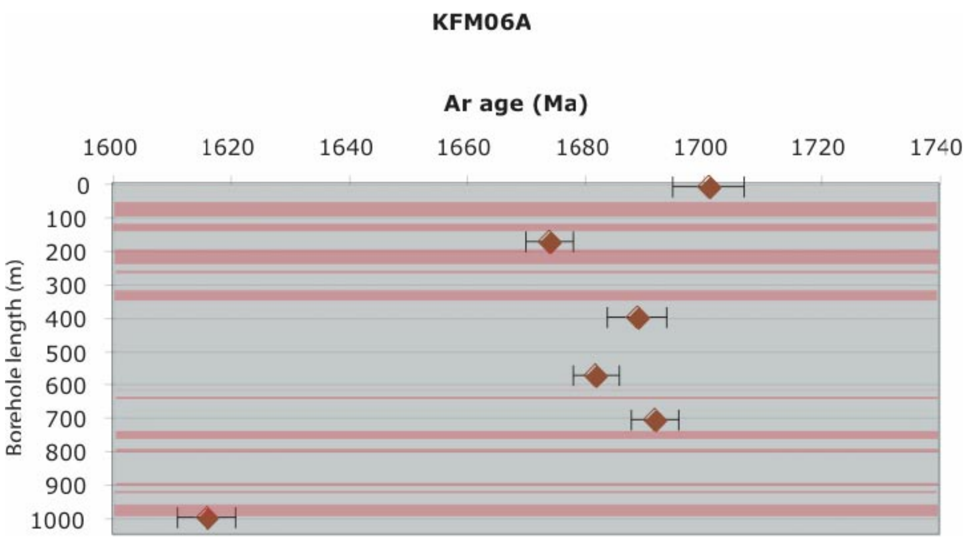


***Figure 5-42.** Biotite KFM06A and KFM06B age-borehole length plot.*

$^{40}Ar/^{39}Ar$ biotite and muscovite ages - KFM04A

Muscovite and biotite pairs (closure temperatures 350 and 300°C, respectively) were analysed from samples taken along two levels in a muscovite-bearing ductile deformation zone from KFM04A (Figure 5-43). These samples provide evidence for slow cooling during the c. 1,750–1,665 time period, with a rate of c. 0.8°C/Ma.

5.5 (U-Th)/He geochronology

When apatite crystallizes. U and Th are incorporated into the crystal lattice. Both isotopes subsequently decay with emission of alpha particles (= ^4He nuclei). Helium is completely mobile in apatite down to a temperature of c. 60–70°C /Farley 2000/, after which it starts to be retained in the crystal. However, helium diffusion continues at lower temperatures, though at progressively slower rates, until complete retention occurs below c. 40°C. This temperature range is referred to as the Helium Partial Retention Zone (HePRZ) and is analogous to the Partial Annealing Zone (PAZ) used in apatite fission-track thermochronology /Gallagher et al. 1998/. Due to its lower temperature sensitivity, the (U-Th)/He method has been used in interdisciplinary fields within geomorphology, landform evolution, structural geology and geodynamics.

The (U-Th)/He data that have been used to calculate the ages presented in this report are listed in Table 5-7. These include age determinations from five surface samples and from several depths along boreholes KFM02A and KFM03A. The means that are mentioned in the text below are weighted means that include the internal errors stated in Table 5-7 and assigned external errors. The uncertainties given with these weighted means are within 95% confidential level. The assigned external errors can be such since there are uncertainties in the correct estimates of the correction factor (F_t) when it comes to old rocks and very slow cooling.

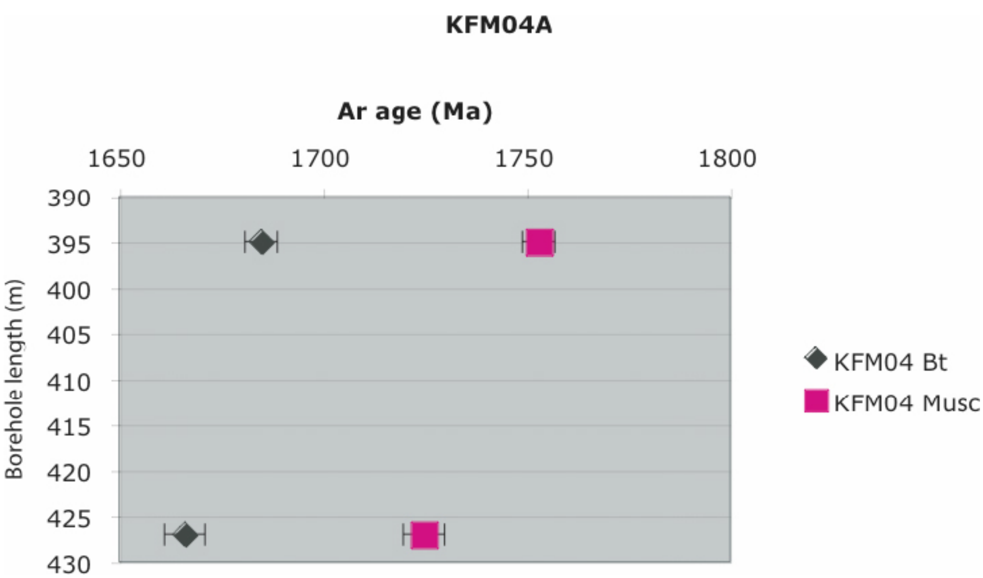


***Figure 5-43.** Biotite and muscovite KFM04A age-borehole length plot.*

Table 5-7. (U-Th)/He data.

Sample[a]	^{238}U (no of atoms)	^{235}U (no of atoms)	^{232}Th (no of atoms)	He (no of atoms)	Ft[b]	Corr. age[c] (Ma)	Error (±2s)
PFM000256	1.08E+11	7.80E+8	5.08E+10	5.66E+10	0.671	530	57
PFM001240p1	2.07E+11	1.50E+9	1.30E+11	1.32E+11	0.698	594	194
PFM001240p2	1.33E+11	9.68E+8	7.24E+10	1.37E+11	0.691	964	102
PFM001240p3	1.98E+11	1.44E+9	1.02E+11	1.45E+11	0.648	752	159
PFM002100p1	1.79E+11	1.30E+9	8.27E+10	1.29E+11	0.770	629	63
PFM002100p2	1.45E+11	1.05E+9	7.84E+10	1.01E+11	0.753	612	101
PFM002207p1	9.32E+10	6.76E+8	7.48E+10	6.71E+10	0.604	751	71
PFM002207p2	9.12E+10	6.62E+8	6.71E+10	5.34E+10	0.535	702	116
PFM002207p3	8.86E+10	6.43E+8	6.33E+10	1.16E+11	0.564	1,444	388
PFM002213p1	4.45E+10	3.23E+8	1.78E+10	1.36E+10	0.621	342	45
PFM002213p2	8.77E+10	6.36E+8	4.52E+10	3.18E+10	0.681	361	30
KFM02A-108p1	9.87E+10	7.16E+8	7.29E+10	4.20E+10	0.629	438	32
KFM02A-108p2	1.13E+11	8.21E+8	5.30E+10	4.28E+10	0.659	392	30
KFM02A-108p3	3.34E+10	2.42E+8	1.98E+10	1.21E+10	0.544	445	34
KFM02A-300p1	1.89E+11	1.37E+9	1.75E+11	1.38E+11	0.682	658	48
KFM02A-300p2	3.40E+11	2.47E+9	3.51E+11	2.10E+11	0.673	556	46
KFM02A-300p3	6.17E+10	4.47E+8	7.10E+10	2.00E+10	0.642	304	23
KFM02A-300p4	3.10E+11	2.25E+9	3.21E+11	1.62E+11	0.687	465	38
KFM02A-300p5	2.24E+11	1.63E+9	2.63E+11	2.01E+11	0.743	704	52
KFM02A-300p6	2.74E+11	1.98E+9	2.78E+11	2.12E+11	0.716	654	49
KFM02A-408p1	1.52E+11	1.10E+9	1.44E+11	6.75E+10	0.660	418	32
KFM02A-408p2	1.67E+11	1.21E+9	1.76E+11	8.80E+10	0.670	478	39
KFM02A-408p3	1.40E+11	1.02E+9	1.46E+11	6.80E+10	0.688	431	31
KFM02A-508p1	9.58E+10	6.95E+8	9.63E+10	6.20E+10	0.737	535	37
KFM02A-508p2	2.08E+11	1.51E+9	1.81E+11	5.45E+10	0.735	227	15
KFM02A-508p3	4.19E+10	3.04E+8	4.39E+10	3.20E+10	0.650	707	52
KFM02A-710p1	1.30E+11	9.44E+8	1.75E+11	3.90E+10	0.712	245	20
KFM02A-710p2	8.00E+10	5.80E+8	1.06E+11	2.60E+10	0.706	269	18
KFM02A-1001p1	2.69E+11	1.95E+9	2.04E+11	1.00E+11	0.722	333	25
KFM02A-1001p2	1.84E+11	1.34E+9	1.19E+11	7.60E+10	0.715	380	26
KFM03A-150p1	6.73E+11	4.88E+9	2.05E+11	3.80E+11	0.781	505	34
KFM03A-150p2	3.27E+11	2.37E+9	8.29E+10	1.10E+11	0.770	313	21
KFM03A-150p3	5.63E+11	4.08E+9	1.16E+11	2.34E+11	0.812	369	27
KFM03A-150p4	4.02E+11	2.91E+9	8.34E+10	1.44E+11	0.787	328	22
KFM03A-440p1	1.77E+11	1.28E+9	1.31E+11	8.40E+10	0.660	464	34
KFM03A-440p2	2.83E+11	2.05E+9	1.78E+11	1.37E+11	0.713	446	31
KFM03A-440p3	2.60E+11	1.89E+9	1.43E+11	1.06E+11	0.714	385	26
KFM03A-640p1	1.81E+11	1.31E+9	1.29E+11	6.26E+10	0.669	338	25
KFM03A-640p2	3.68E+11	2.67E+9	2.52E+11	1.30E+11	0.751	309	22
KFM03A-840p1	2.24E+11	1.62E+9	1.43E+11	7.60E+10	0.739	304	22
KFM03A-840p2	5.06E+11	3.67E+9	3.60E+11	2.20E+11	0.770	367	28
KFM03A-1000p1	1.20E+12	8.74E+9	8.07E+11	4.89E+11	0.809	329	22
KFM03A-1000p2	1.19E+11	8.66E+8	9.84E+10	2.80E+10	0.675	224	16
KFM03A-1000p3	1.08E+12	7.84E+9	5.06E+11	7.27E+9	0.752	6	1
KFM03A-1000p4	3.44E+11	2.49E+9	2.30E+11	1.09E+11	0.744	206	14

[a] p1. pt etc at the end of the sample name refers to splits of same sample.

[b] Ft = alpha-ejection correction factor.

[c] Raw age corrected with respect to F_t.

5.5.1 Surface samples

The surface samples generally show a good reproducibility (Figure 5-44). Three of the five surface samples yield ages from 750 to 530 Ma (sample PFM000256, PFM002100 and PFM002207), whereas one sample yields a slightly younger age (PFM002213; 356 ± 24 Ma). Sample PFM001240 shows a large spread in ages and has large errors (Figure 5-44). The spread may be due to 1) small inclusions in the grains, despite the careful picking or 2) the rock may lie close to a fracture zone where hot fluids can have been transported, which may have altered the apatites. One analysis from sample PFM002207 yields a much too old age (Figure 5-44). This is probably due to small inclusions, most likely of zircon. These samples are disregarded from further discussion.

5.5.2 KFM02A

The ages from borehole KFM02A (Figure 5-45) vary somewhat down the borehole, but, in most cases, are consistent within the individual levels. All borehole lengths mentioned below are adjusted lengths. The 100 m level yields a mean age of 424 ± 38 Ma; the 400 m level yields a mean age of 440 ± 38 Ma; the 700 m level yields a mean age of 258 ± 36 Ma and the 1,000 m level yields a mean age of 356 ± 72 Ma. At levels 300 m and 500 m the ages between individual splits vary too much to give interpretable ages.

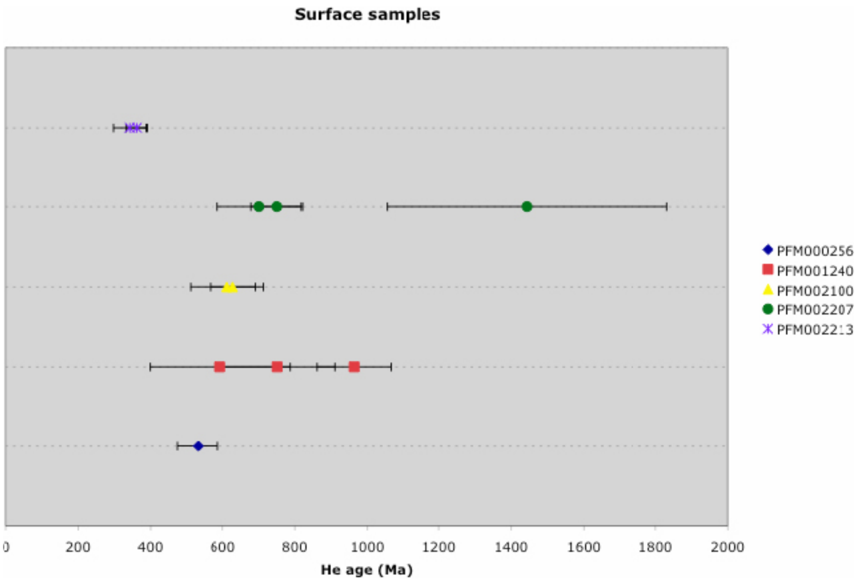


Figure 5-44. *(U-Th)/He surface ages*

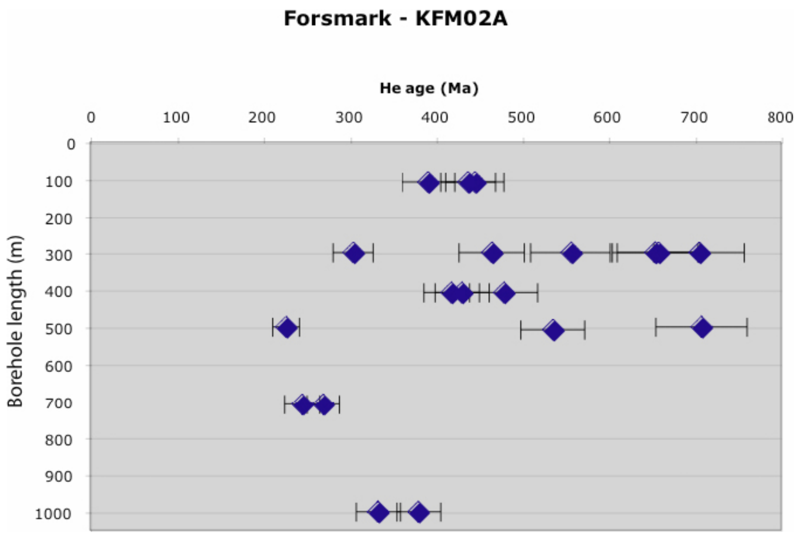


Figure 5-45. *(U-Th)/He age versus borehole length plots KFM02A.*

5.5.3 KFM03A

The ages from borehole KFM03A (Figure 5-46) also vary somewhat at different borehole lengths along the borehole, but are generally consistent within the individual levels. The 150 m level yields a mean age of 320 ± 15 Ma. Two splits (split p1 and p3; Table 5-7) were not included in the calculated mean since a too high portion of He was registered during the reheat-step of the analysis, which usually indicates inclusions. This is, in turn, a general explanation for non-reproducible ages. These two splits are excluded from further interpretation. At 440 m, the mean age is 430 ± 55 Ma, which was calculated on all splits of the sample. The 640 m level yields a mean of 322 ± 43 Ma, level 840 m a mean of 329 ± 96 Ma and the 1,000 m level a mean of 214 ± 27. At 1,000 m, the ages are also variable. The oldest age (329 Ma; split p1 in Table 5-7) was excluded from the mean calculation, since the grain that was analyzed was a fragment rather than a grain. This can yield errors in the age calculation since the formula includes grain dimensions. The very young age (6 Ma; split p3 in Table 5-7) is unrealistic and may have several explanations:
1) The sample has been partly pumped away; 2) It is not an apatite; 3) An incomplete He extraction possibly due to a contact problem, the position of the packet in the sample holder and/or the position of the grain in the packet. These young ages are excluded from further discussion.

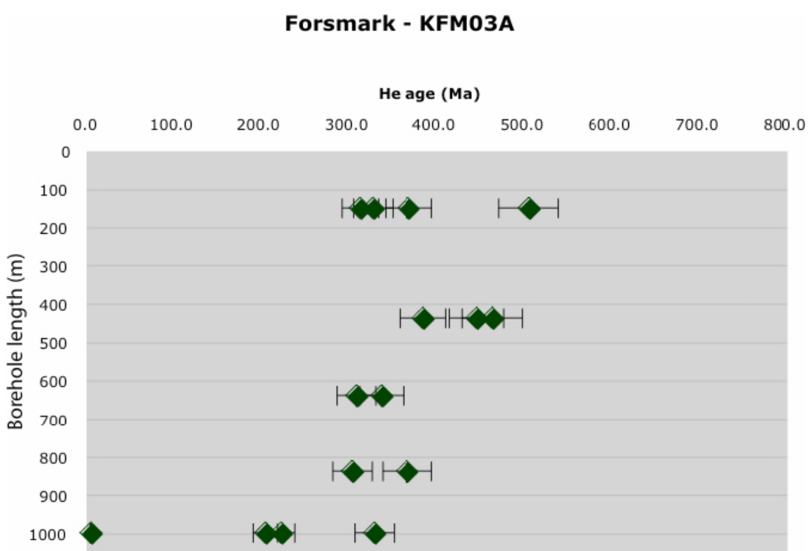


Figure 5-46. *(U-Th)/He age versus borehole length plots KFM03A.*

5.6 (U-Th)/He data - concluding remarks

5.6.1 Surface data

The ages obtained from the surface samples in the Forsmark area generally reproduce well and most range between 750 to 530 Ma. These ages indicate that the rocks in the Forsmark area were cooled below 70°C during this time period, which may be associated with the development of the sub-Cambrian peneplain. The ages also indicate that the bedrock in this area has not been heated over 70°C since that period of time.

5.6.2 KFM02A data

The ages from borehole KFM02A are in the same age range as KFM03A and are also consistent with KFM01A /Page et al. 2004/). However, to draw conclusions from KFM02A on its own is difficult, since this borehole intersects several gently dipping fracture zones. Zones have been described at 110–122 m; 160–184 m; 300–310 m; 415–600 m; 893–905 m; 922–925 m and at 976–982 m /Carlsten et al. 2004a/. The zones at 300–310 m and 415–600 m coincide with the levels where no interpretable He ages were obtained, (Figure 5-47). It is possible that hot fluids were transported along these zones, which generated the inconsistency in He ages. The zones throughout the borehole are situated between the levels from which interpretable He ages are obtained so that no two levels can be interpreted together. It cannot be excluded that there has been some movement along some of the zones after the start of the apatite-He clock, i.e. around or after 250 Ma, which is the youngest age of the borehole. Such offsets may help to explain the irregularity in ages between different levels.

5.6.3 KFM03A data

Even along KFM03A, there are several gently dipping fracture zones; at 356–399 m; at 448–455 m; 638–646 m; 803–816 m; and 942–949 m /Carlsten et al. 2004b/. In KFM03A, there are commonly two interpretable He ages at adjacent levels, giving a possibility to interpret the ages in a better way than the ages from KFM02A. The ages from level 460 m and 640 m can possibly be linked together with a “younging with increasing depth” pattern, as can the ages at 840 m and 1,000 m. If the ages in KFM03A correspond to each other in the above-mentioned way, it is possible that there is an offset between the levels along zone ZFMA3 at c. 810 m (Figure 5-48). If there has been movement along this zone to offset the individual levels, the displacement has to be younger than c. 200 Ma. Furthermore, the rate at which the ages decrease with increasing borehole length can be correlated with the pattern for the lower part of KFM01A /Page et al. 2004/.

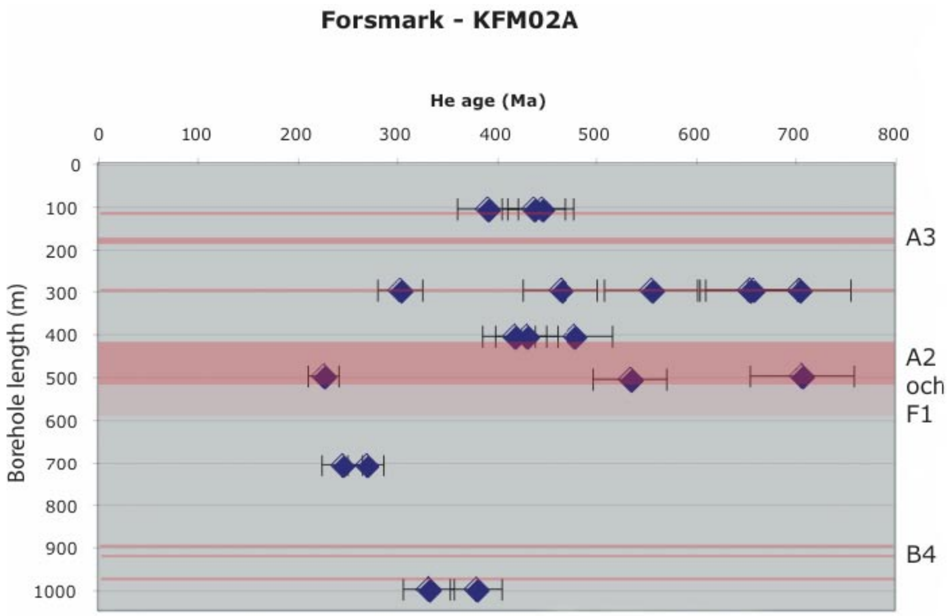


Figure 5-47. *(U-Th)/He age versus borehole length plots in KFM02A. including fracture zones.*

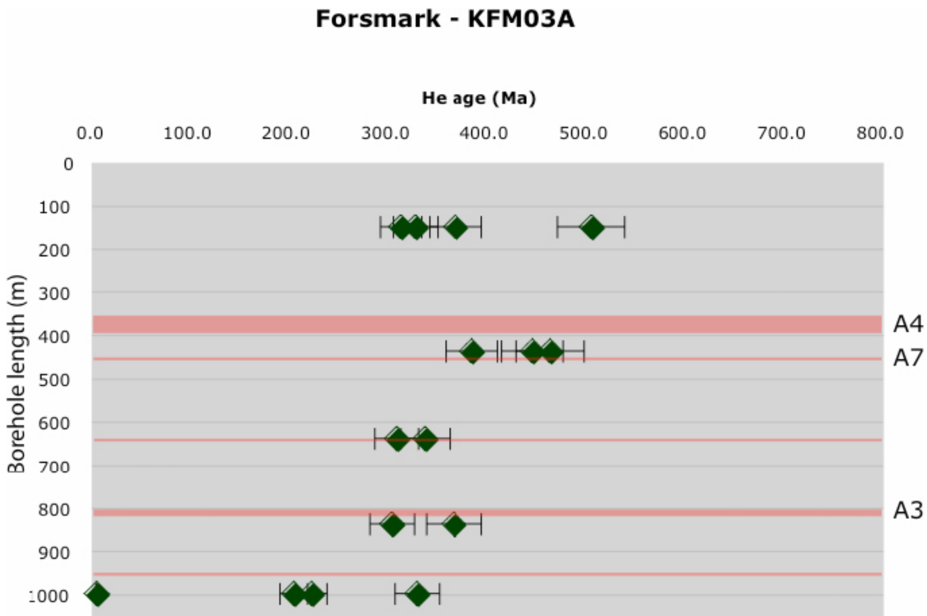


Figure 5-48. *(U-Th)/He age versus borehole length plots in KFM03A. including fracture zones.*

6 Regional $^{40}Ar/^{39}Ar$ hornblende and biotite study

$^{40}Ar/^{39}Ar$ analyses on biotite and hornblende were collected from a wider geographical region, in order to determine the variation in regional cooling ages and, thereby, to more fully understand how the Forsmark area fits into the larger regional geological pattern. Samples were collected along E-W and N-S transects from Forsmark (Figure 2-1). Westward from Forsmark, along the E-W transect, the grade of metamorphism changes from amphibolite- to greenschist-facies. Southwards from Forsmark, along the N-S transect, the grade of metamprphism changes from amphibolite-facies rocks in the Forsmark area to migmatitic, high amphibolite-facies rocks in Sörmland.

The data from the regional geochronological study are presented in a series of tables, each table being placed at the end of the relevant section: Table 6-1 $^{40}Ar/^{39}Ar$ hornblende. Table 6-2 $^{40}Ar/^{39}Ar$ biotite. Step-heating spectra for the $^{40}Ar/^{39}Ar$ data are given for each sample. The samples and results are presented from west to east towards Forsmark along the E-W transect, and from north to south away from Forsmark along the N-S transect.

6.1 $^{40}Ar/^{39}Ar$ hornblende ages along E-W transect

PFM007048A

The sample was collected from a foliated amphibolite in a mixed metagabbro and amphibolite outcrop. The plateau age (Figure 6-1), 1,784 ± 4 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

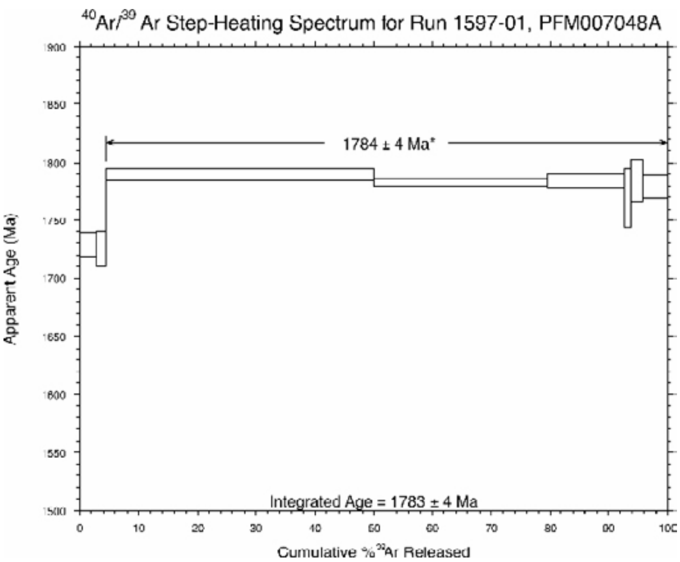


Figure 6-1. $^{40}Ar/^{39}Ar$ *step-heating spectrum for sample PFM007048A.*

PFM007049A

The sample was collected from a metagabbro. The plateau age (Figure 6-2), 1,805 ± 5 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

PFM007051A

The sample was collected from a fine-grained, foliated amphibolite. Two splits were analysed. The plateau age in the better analytical split (Figure 6-3), 1,813 ± 4 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C). The second split did not yield a statistical plateau, but gave a forced fit age of 1,824 ± 4 Ma (Figure 6-4).

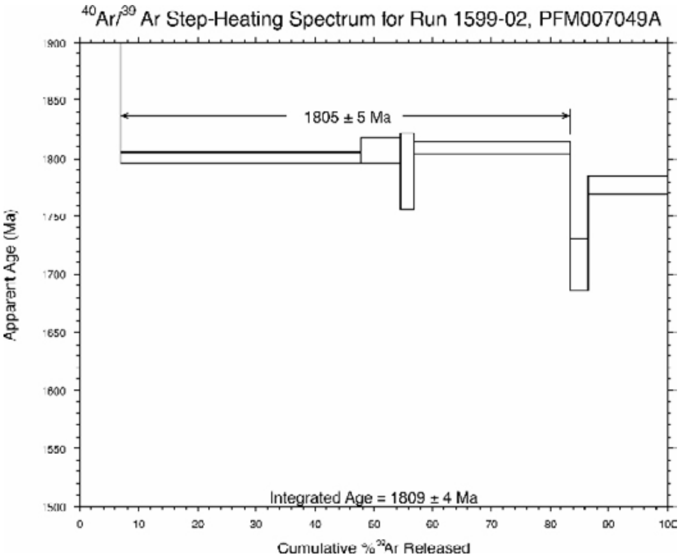


Figure 6-2. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007049A.*

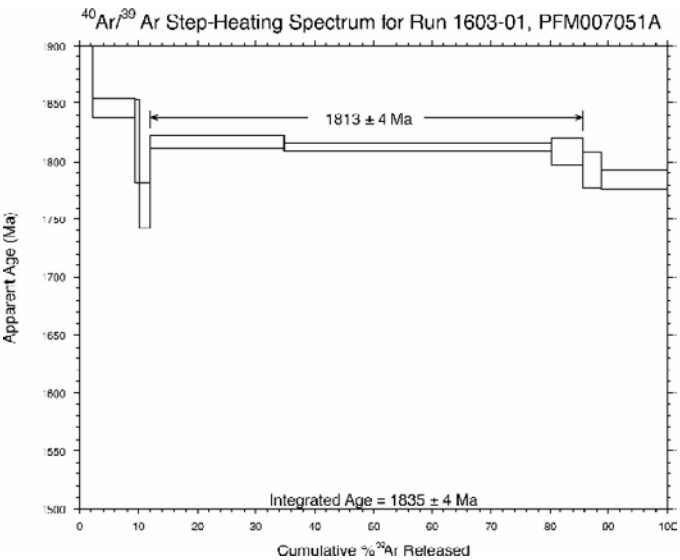


Figure 6-3. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007051A.*

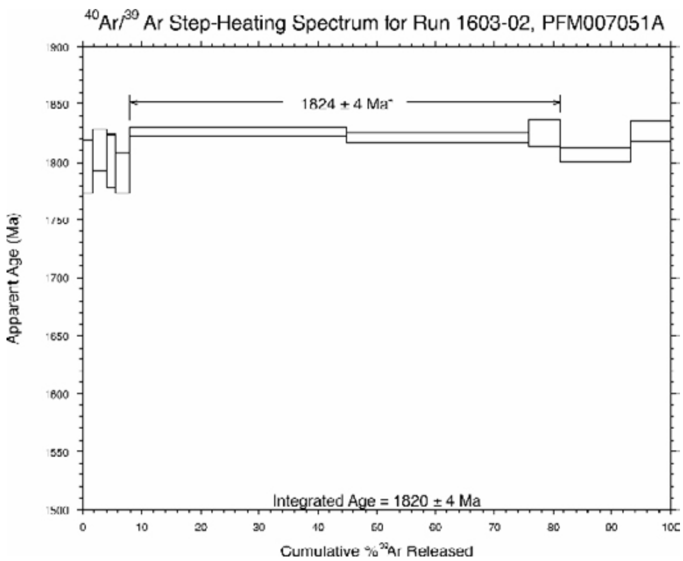


Figure 6-4. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007051A second-split.*

PFM007053A

The sample was collected from a fine-grained metagabbro. The plateau age (Figure 6-5), 1,776 ± 9 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C). However, due to an extremely small analytical signal, this age is considered to be less reliable.

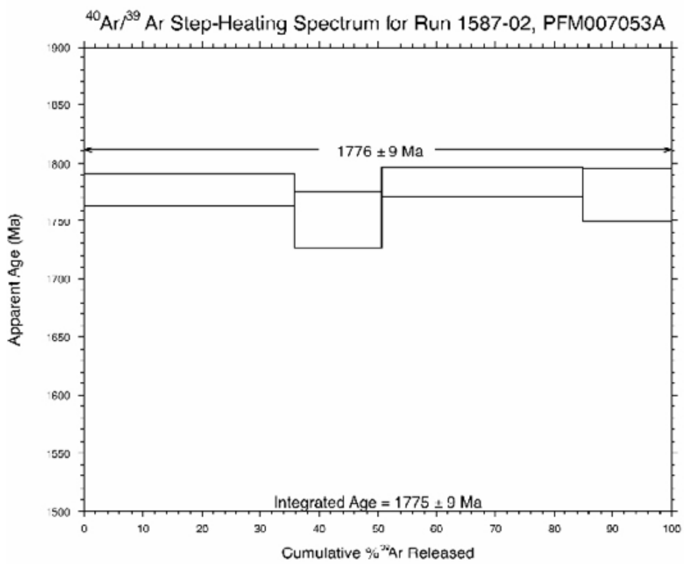


Figure 6-5. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007053A.*

PFM007054A

The sample was collected from a medium-grained metagabbro. The forced-fit age (Figure 6-6), 1,800 ± 8 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

PFM007059A

The sample was taken from an amphibolite. The plateau age (Figure 6-7), 1,870 ± 5 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

PFM007061A

The sample was collected from a coarse-grained gabbro-diorite. Two splits of this sample were analysed (Figures 6-8 and 6-9). Both ages are consistent within error and yield plateau ages of 1,836 ± 4 Ma (Figure 6-8) and 1,841 ± 4 Ma (Figure 6-9). These ages are interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

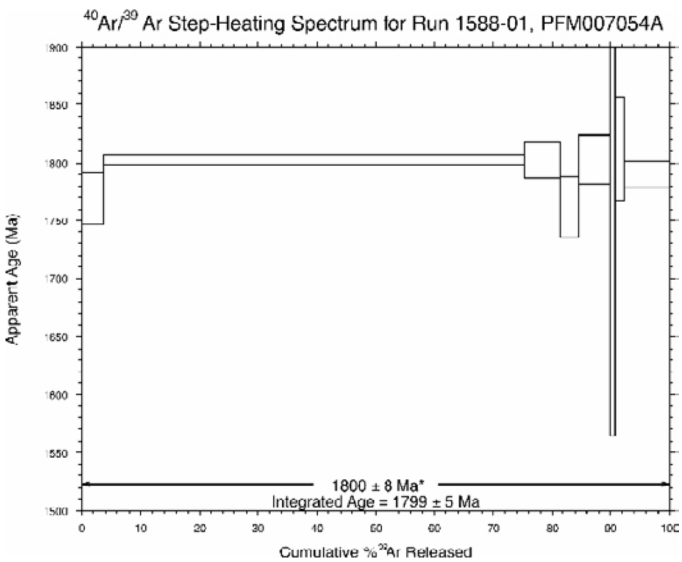


Figure 6-6. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007054A.*

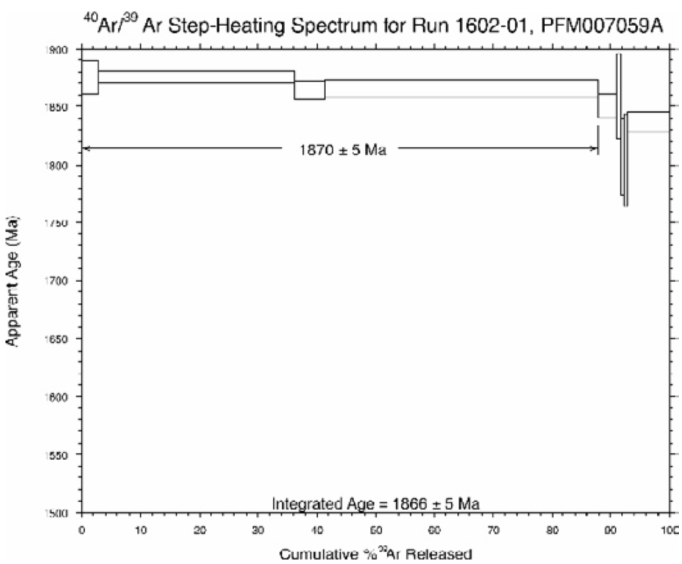


Figure 6-7. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007059A.*

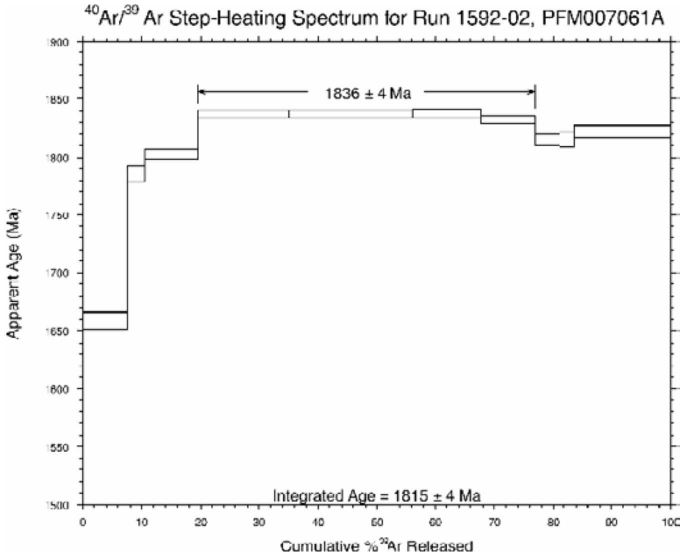


Figure 6-8. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007061A.*

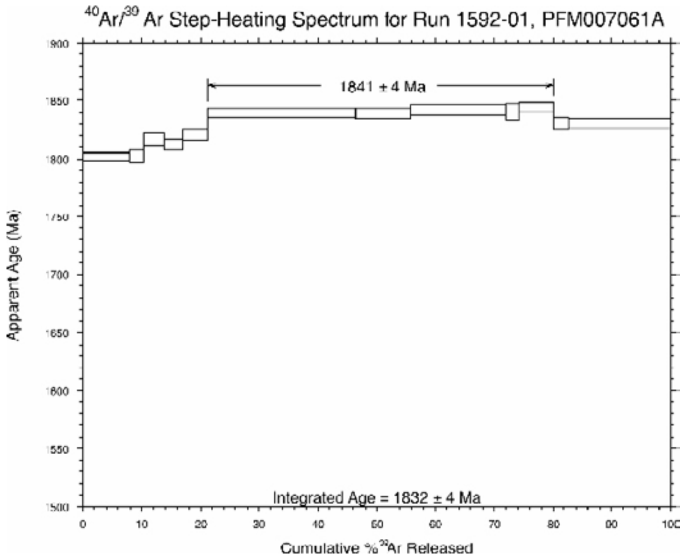


Figure 6-9. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007061A.*

6.2 $^{40}Ar/^{39}Ar$ hornblende ages along N-S transect

PFM007062A

The sample was collected from an amphibolite, which is probably xenolithic in character. The plateau age (Figure 6-10), 1,853 ± 4 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

PFM007064A

The sample was collected from an amphibolite. The plateau age (Figure 6-11), 1,851 ± 4 Ma, is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

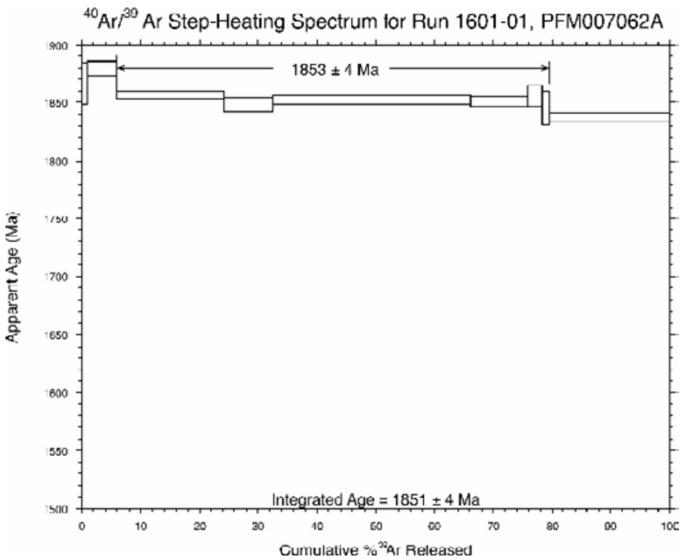


Figure 6-10. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007062A.

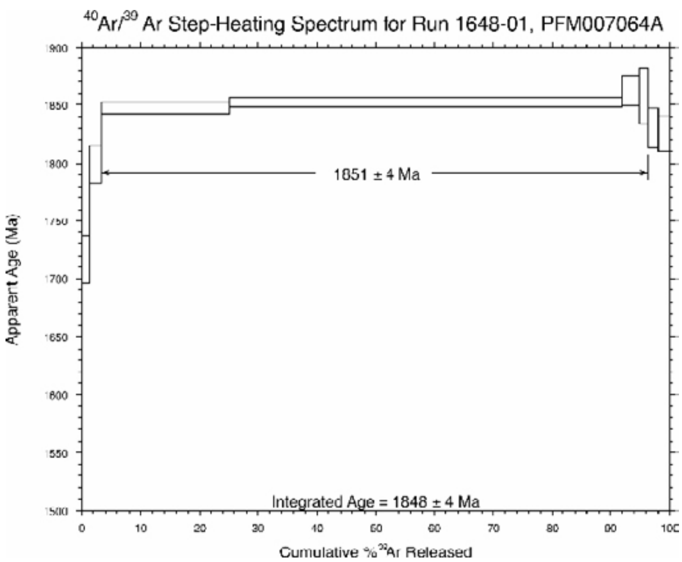


Figure 6-11. $^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007064A.

PFM007066A

The sample was collected from a coarse to medium-grained gabbro-diorite. Two splits of hornblende were analysed. The plateau age of 1,811 ± 1 Ma (Figure 6-12) is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C). The other split did not yield an interpretable release spectrum (Figure 6-13).

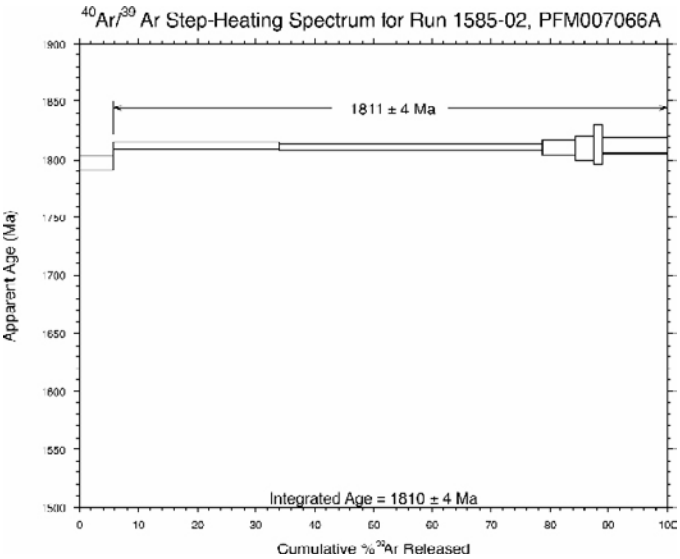


Figure 6-12. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007066A.*

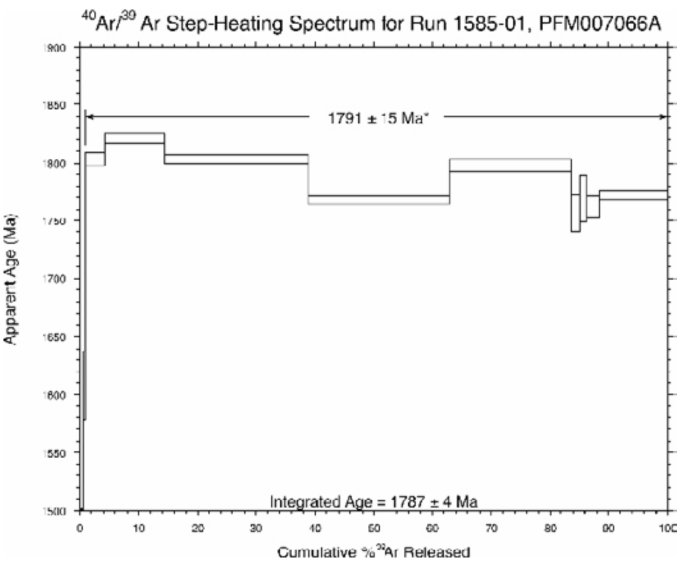


Figure 6-13. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007066A.*

PFM007068A

The sample was collected from a fine- to medium-grained amphibolite xenolith in a pegmatitic granite. The plateau age, 1,770 ± 3 Ma (Figure 6-14), is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

PFM007072A

The sample was collected from an amphibolite. The plateau age, 1,757 ± 4 Ma (Figure 6-15), is interpreted as dating the cooling below the closure temperature of hornblende (c. 500°C).

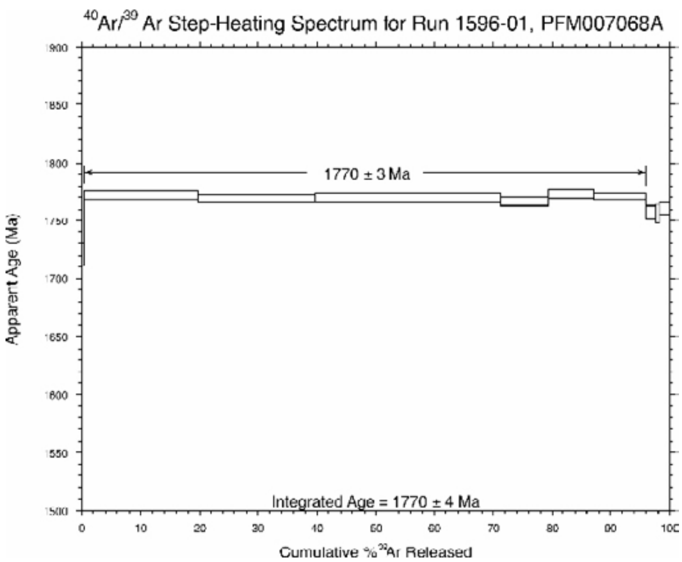


Figure 6-14. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007068A.*

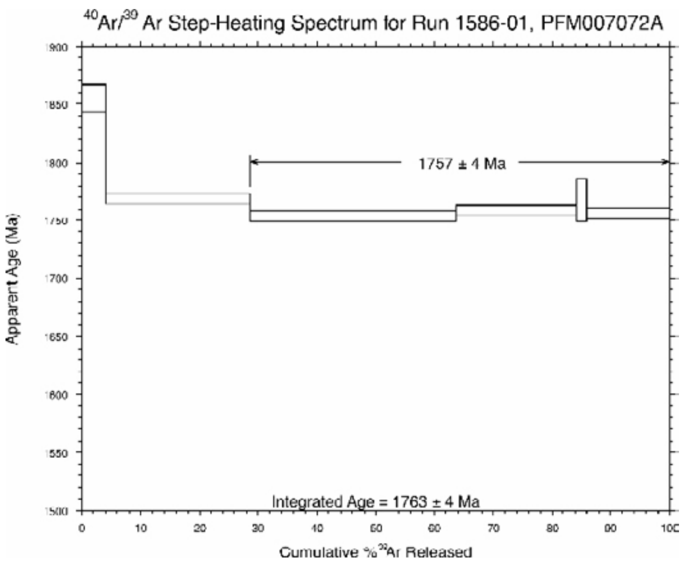


Figure 6-15. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007072A.*

Table 6-1. $^{40}Ar/^{39}Ar$ regional hornblende data.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM007048A. Run ID# 1597-01 (J = 0.01067 ± 0.000015):												
1597-01B	1.9	9.120	0.08	0.005	23.8	150.632	0.010	2.8	2.8	99.2	1,728.83	5.21
1597-01C	2	3.852	0.12	0.018	2.9	150.145	0.006	1.6	4.4	96.6	1,725.23	7.62
1597-01D	•2.1	5.141	0.16	0.005	14.9	159.002	0.162	45.5	49.9	99.3	1,789.60	2.49
1597-01E	•2.1	6.532	0.16	0.003	27.8	158.086	0.105	29.5	79.4	99.6	1,783.04	1.41
1597-01F	•2.2	3.844	0.15	0.004	11.9	158.204	0.047	13.3	92.7	99.3	1,783.89	3.07
1597-01G	•2.2	0.750	0.10	0.015	0.7	156.223	0.004	1.2	93.9	97.2	1,769.65	12.70
1597-01H	•2.3	6.105	0.09	0.008	11	158.275	0.006	1.8	95.7	98.7	1,784.40	8.93
1597-01K	•3.2	1.253	0.14	0.003	6.9	157.500	0.015	4.3	100	99.6	1,778.84	4.91
Integ. Age											1,783.00	4.00
(•) Plateau Age								95.6			1,784.00	4.00
PFM007049A. Run ID# 1599-02 (J = 0.01067 ± 0.000015):												
1599-02A	2	26.578	0.54	0.160	2.3	184.206	0.005	6.9	6.9	79.8	1,961.10	6.80
1599-02B	•2.1	42.801	0.54	0.010	60.2	160.545	0.028	40.8	47.7	99.3	1,800.58	2.46
1599-02C	•2.2	36.011	0.52	0.000	1,138.8	161.443	0.005	7	54.7	100.9	1,806.94	5.59
1599-02D	•2.3	36.383	0.42	0.049	10.2	158.946	0.001	2.1	56.8	92.3	1,789.20	16.21
1599-02E	•2.4	47.667	0.48	0.006	102.7	161.781	0.018	26.6	83.4	100	1,809.33	2.46
1599-02G	2.6	44.441	0.53	0.024	25.1	147.787	0.002	3	86.5	96.4	1,707.71	11.38
1599-02H	3.2	50.721	0.52	0.012	56	157.268	0.009	13.5	100	99	1,777.18	3.79
Integ. Age											1,809.00	4.00
(•) Plateau Age								76.6			1,805.00	5.00
PFM007051A. Run ID# 1603-01 (J = 0.01067 ± 0.000015):												
1603-01A	1.8	0.010	0.02	0.009	0	306.406	0.005	2.4	2.4	99.1	2,618.55	7.85
1603-01B	1.9	6.096	0.16	0.003	25.8	166.965	0.016	7	9.3	99.6	1,845.56	4.16
1603-01C	2	8.671	0.04	0.039	3.1	162.974	0.002	0.8	10.2	93.6	1,817.73	17.68
1603-01D	2	7.601	0.12	0.031	3.3	155.177	0.004	1.7	11.9	94.5	1,762.08	10.13
1603-01E	•2.0	7.294	0.16	0.004	28.4	162.825	0.052	22.9	34.8	99.5	1,816.68	2.88
1603-01F	•2.1	8.088	0.17	0.002	66.6	162.184	0.103	45.4	80.2	99.9	1,812.17	1.76

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1603-01G	•2.1	9.266	0.13	0.001	140.2	161.645	0.013	5.7	85.8	100.1	1,808.37	5.80
1603-01H	2.2	7.612	0.12	0.000	234.6	159.344	0.007	3	88.8	100.1	1,792.03	7.63
1603-01I	0	8.858	0.17	0.005	23.3	158.294	0.025	11.2	100	99.3	1,784.53	4.08
Integ. Age											1,835.00	4.00
(•) Plateau Age								74			1,813.00	4.00
PFM007051A. Run ID# 1603-02 (J = 0.01067 ± 0.000015):												
1603-02C	2	1.290	0.21	0.009	1.9	159.956	0.004	1.6	1.6	98.4	1,796.40	11.51
1603-02D	2	0.760	0.21	0.008	1.3	161.891	0.005	2.3	4	98.6	1,810.11	8.89
1603-02E	2.1	0.094	0.19	0.006	0.2	160.579	0.004	1.6	5.6	99	1,800.82	11.62
1603-02F	2.1	0.410	0.19	0.011	0.5	159.085	0.005	2.3	7.9	98.1	1,790.19	8.58
1603-02G	•2.2	0.021	0.17	0.002	0.2	164.179	0.084	37	44.8	99.7	1,826.18	1.70
1603-02H	•2.3	0.005	0.17	0.000	1	163.412	0.070	31	75.8	100	1,820.81	1.94
1603-02I	•2.3	0.031	0.15	0.001	0.7	163.993	0.012	5.5	81.3	99.9	1,824.88	5.96
1603-02J	2.5	0.265	0.18	0.003	1.3	161.347	0.027	12.1	93.3	99.5	1,806.26	2.86
1603-02K	3.2	0.934	0.19	0.005	2.8	164.267	0.015	6.7	100	99.2	1,826.80	4.23
Integ. Age											1,820.00	2.40
(•) Plateau Age								73.4			1,824.00	4.00
PFM007053A. Run ID# 1587-02 (J = 0.01067 ± 0.000015):												
1587-02I	•2.2	32.531	0.55	0.021	21.7	157.231	0.004	35.7	35.7	97	1,776.91	6.84
1587-02J	•2.2	27.023	0.47	0.021	17.7	153.634	0.001	14.9	50.7	96.7	1,750.87	12.27
1587-02L	•2.3	39.353	0.61	0.022	24.4	158.243	0.003	34.3	85	96.9	1,784.17	6.35
1587-02Y	•3.2	37.451	0.48	0.010	53.4	156.602	0.002	15	100	99.2	1,772.38	11.74
Integ. Age											1,775.00	9.00
(•) Plateau Age								100			1,776.00	9.00
PFM007054A. Run ID# 1588-01 (J = 0.01067 ± 0.000015):												
1588-01C	•2.0	27.744	0.52	0.024	16.2	156.073	0.004	3.7	3.7	96.4	1,768.57	11.35
1588-01D	•2.1	33.912	0.69	0.009	53.7	160.766	0.081	71.4	75.1	99.3	1,802.14	1.94
1588-01E	•2.1	30.027	0.58	0.008	53.9	160.842	0.007	6.5	81.6	99.4	1,802.69	7.87
1588-01G	•2.2	37.251	0.64	0.003	186.3	155.052	0.003	3	84.6	100.5	1,761.17	13.22

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1588-01H	•2.3	34.700	0.69	0.005	103.9	160.832	0.006	5.4	90	100	1,802.61	10.51
1588-01I	•2.3	35.343	0.42	0.008	58.3	154.009	0.001	0.9	90.8	99.3	1,753.60	94.39
1588-01J	•2.5	34.567	0.56	0.012	40.9	162.128	0.002	1.5	92.3	98.7	1,811.77	22.09
1588-01K	•0.0	32.864	0.63	0.010	47.6	159.111	0.009	7.7	100	99.1	1,790.38	5.74
Integ. Age											1,799.00	5.00
(•) Plateau Age								100			1,800.00	8.00
PFM007059A. Run ID# 1602-01 (J = 0.01067 ± 0.000015):												
1602-01D	•2.1	0.009	0.12	0.001	0.2	171.268	0.009	2.9	2.9	99.9	1,875.10	7.01
1602-01E	•2.2	0.084	0.15	0.003	0.4	171.256	0.101	33.3	36.2	99.5	1,875.02	2.81
1602-01F	°•2.2	0.095	0.14	0.006	0.2	169.636	0.016	5.2	41.4	99	1,863.96	4.09
1602-01G	°•2.3	0.069	0.15	0.003	0.3	169.866	0.141	46.5	87.9	99.5	1,865.53	3.56
1602-01H	°2.3	0.032	0.15	0.007	0.1	167.658	0.009	3	90.9	98.9	1,850.35	5.12
1602-01I	2.3	0.065	0.12	0.005	0.2	169.014	0.002	0.8	91.7	99.2	1,859.69	18.44
1602-01J	2.4	0.025	0.04	0.046	0	161.386	0.002	0.6	92.3	92.2	1,806.54	16.32
1602-01K	2.6	0.393	0.06	0.064	0.1	161.012	0.002	0.6	92.9	89.5	1,803.89	19.63
1602-01L	2.8	0.004	0.14	0.007	0	165.695	0.022	7.1	100	98.7	1,836.75	4.42
Integ. Age											1,866.00	5.00
(•) Plateau Age								87.9			1,870.00	5.00
(°) Plateau Age								54.7			1,862.00	6.00
PFM007061A. Run ID# 1592-01 (J = 0.01067 ± 0.000015):												
1592-01A	2	0.452	0.03	0.016	0.4	160.689	0.136	7.9	7.9	97.1	1,801.60	1.75
1592-01B	2.1	0.606	0.02	0.002	3.7	160.730	0.042	2.4	10.4	99.6	1,801.89	2.50
1592-01C	2.1	0.950	0.03	0.002	6.1	162.820	0.061	3.6	13.9	99.6	1,816.65	2.96
1592-01D	2.2	1.892	0.05	0.003	8.7	162.180	0.052	3	16.9	99.5	1,812.15	2.38
1592-01E	2.2	2.384	0.05	0.001	26	163.417	0.073	4.3	21.2	99.8	1,820.84	2.23
1592-01F	•2.3	9.759	0.19	0.002	56.7	166.117	0.432	25.2	46.3	99.8	1,839.69	2.02
1592-01G	•2.3	6.194	0.13	0.002	48.8	166.014	0.162	9.4	55.8	99.8	1,838.97	2.12
1592-01H	•2.4	9.264	0.18	0.002	60.7	166.466	0.279	16.3	72	99.9	1,842.11	2.21
1592-01I	•2.4	3.452	0.07	0.002	22.7	166.161	0.039	2.3	74.3	99.7	1,839.99	3.59

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1592-01J	•2.5	5.005	0.10	0.003	26.2	166.794	0.097	5.6	79.9	99.7	1,844.38	2.05
1592-01K	2.5	6.197	0.11	0.003	32.3	164.762	0.047	2.7	82.6	99.7	1,830.25	2.89
1592-01L	2.6	6.341	0.11	0.002	43.5	164.774	0.298	17.4	100	99.8	1,830.33	2.37
Integ. Age											1,832.00	4.00
(•) Plateau Age								58.7			1,841.00	4.00
PFM007061A. Run ID# 1592-02 (J = 0.01067 ± 0.000015):												
1592-02A	2	1.066	0.04	0.021	0.7	141.298	0.041	7.5	7.5	95.8	1,658.57	3.46
1592-02B	2.1	0.779	0.04	0.003	4.1	158.492	0.017	3.2	10.6	99.5	1,785.95	3.47
1592-02C	2.2	4.772	0.14	0.002	29.1	160.859	0.049	8.9	19.5	99.7	1,802.81	1.98
1592-02D	•2.3	9.124	0.21	0.003	48.6	165.734	0.085	15.5	35	99.8	1,837.03	1.55
1592-02E	•2.3	7.482	0.19	0.002	52.5	165.712	0.116	21.1	56.1	99.8	1,836.87	1.67
1592-02F	•2.4	8.175	0.21	0.002	48	165.766	0.064	11.6	67.7	99.8	1,837.25	1.95
1592-02G	•2.4	6.682	0.19	0.002	45.2	165.063	0.051	9.3	76.9	99.8	1,832.35	1.63
1592-02H	2.5	6.486	0.17	0.002	36.9	162.633	0.023	4.2	81.1	99.7	1,815.33	2.50
1592-02I	2.8	9.345	0.18	0.004	32.3	162.606	0.014	2.6	83.7	99.5	1,815.14	3.37
1592-02J	3.6	8.167	0.17	0.002	53.6	163.574	0.089	16.3	100	99.8	1,821.95	2.49
Integ. Age											1,815.00	4.00
(•) Plateau Age								57.4			1,836.00	4.00
PFM007062A. Run ID# 1601-01 (J = 0.01067 ± 0.000015):												
1601-01D	2.1	0.045	0.13	0.014	0	169.985	0.005	0.9	0.9	97.6	1,866.34	8.81
1601-01E	2.2	0.003	0.17	0.005	0	171.807	0.025	5	6	99.2	1,878.76	3.26
1601-01F	•2.3	0.014	0.18	0.003	0.1	168.577	0.092	18.3	24.3	99.6	1,856.69	1.73
1601-01G	•2.3	0.005	0.18	0.003	0	167.362	0.041	8.1	32.4	99.4	1,848.31	2.74
1601-01H	•2.3	0.109	0.17	0.002	0.7	167.900	0.169	33.8	66.2	99.6	1,852.02	2.09
1601-01J	•2.5	0.013	0.14	0.002	0.1	167.669	0.047	9.5	75.7	99.7	1,850.43	2.21
1601-01K	•2.5	0.064	0.12	0.004	0.2	168.386	0.013	2.5	78.2	99.3	1,855.37	4.73
1601-01L	•2.6	0.013	0.11	0.004	0	166.939	0.006	1.3	79.5	99.3	1,845.38	7.34
1601-01O	0	0.016	0.18	0.004	0.1	165.798	0.103	20.5	100	99.4	1,837.47	1.89
Integ. Age											1,851.00	4.00
(•) Plateau Age								73.5			1,853.00	4.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM007064A. Run ID# 1648-01 (J = 0.01067 ± 0.000015):												
1648-01C	1.9	5.010	0.08	0.022	3.2	148.998	0.002	1.3	1.3	96	1,716.73	10.40
1648-01D	2	10.694	0.15	0.009	17.2	160.366	0.003	1.9	3.2	98.7	1,799.31	8.10
1648-01E	•2.1	11.244	0.17	0.006	26.7	167.185	0.034	22	25.2	99.3	1,847.09	2.44
1648-01F	•2.2	9.234	0.17	0.003	42.3	167.904	0.103	66.8	92	99.7	1,852.05	1.85
1648-01G	•2.2	9.686	0.16	0.006	23.7	169.375	0.004	2.8	94.8	99.3	1,862.17	6.26
1648-01H	•2.3	11.101	0.17	0.015	10.5	168.698	0.002	1.5	96.3	97.8	1,857.51	11.77
1648-01J	2.5	16.086	0.16	0.014	16.2	164.693	0.003	1.9	98.2	98	1,829.77	8.54
1648-01K	2.6	12.284	0.17	0.014	12.2	164.109	0.003	1.8	100	97.8	1,825.69	7.56
Integ. Age											1,848.00	4.00
(•) Plateau Age								93.1			1,851.00	4.00
PFM007066A. Run ID# 1585-01 (J = 0.01067 ± 0.000015):												
1585-01G	2.2	6.592	0.08	0.023	3.9	119.559	0.006	0.5	0.5	94.8	1,483.47	8.73
1585-01H	2.3	8.062	0.19	0.014	7.9	134.757	0.004	0.4	0.9	97.2	1,607.65	14.74
1585-01I	•2.3	8.368	0.27	0.004	29.6	160.887	0.038	3.3	4.2	99.5	1,803.00	2.64
1585-01J	•2.4	5.146	0.32	0.002	29.4	163.369	0.120	10.3	14.5	99.7	1,820.50	1.95
1585-01K	•2.4	6.821	0.31	0.002	42.5	160.858	0.282	24.3	38.8	99.8	1,802.79	1.69
1585-01L	•0.0	6.415	0.29	0.002	45.2	154.768	0.279	24	62.8	99.8	1,759.11	2.04
1585-01M	•2.5	6.619	0.32	0.002	44.4	160.146	0.243	20.9	83.8	99.8	1,797.75	2.63
1585-01N	•2.5	8.814	0.24	0.009	13.7	151.769	0.016	1.4	85.1	98.5	1,737.21	8.41
1585-01O	•2.6	9.207	0.22	0.004	34.5	156.097	0.014	1.2	86.3	99.5	1,768.74	9.92
1585-01P	•2.8	10.420	0.27	0.002	67.8	155.170	0.025	2.1	88.5	99.9	1,762.03	4.44
1585-01Q	•3.0	7.055	0.31	0.003	34	156.542	0.134	11.5	100	99.6	1,771.95	1.91
Integ. Age											1,785.00	4.00
(•) Plateau Age								99.1			1790.00	16.00
PFM007066A. Run ID# 1585-02 (J = 0.01067 ± 0.000015):												
1585-02A	1.9	0.018	0.33	0.034	0	160.030	0.024	5.7	5.7	94.1	1796.92	3.16
1585-02B	•2.0	0.021	0.34	0.002	0.1	162.131	0.120	28.3	34	99.6	1811.79	1.77
1585-02C	•2.1	0.003	0.34	0.002	0	161.906	0.189	44.5	78.6	99.7	1810.21	1.46
1585-02D	•2.1	0.018	0.36	0.001	0.4	161.974	0.025	5.8	84.4	99.9	1810.69	3.23

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol-14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1585-02E	•2.2	0.391	0.38	0.008	0.7	161.858	0.013	3.2	87.6	98.6	1809.87	5.11
1585-02F	•2.3	0.067	0.34	0.001	1.1	162.254	0.007	1.5	89.1	99.9	1812.66	8.68
1585-02G	•2.5	0.039	0.34	0.003	0.2	162.172	0.046	10.9	100	99.5	1812.08	3.28
Integ. Age											1810.20	1.00
(•) Plateau Age								94.3			1810.90	1.00
PFM007068A. Run ID# 1596-01 (J = 0.01067 ± 0.000015):												
1596-01E	2.2	0.201	0.20	0.034	0.1	149.522	0.012	0.5	0.5	93.8	1720.62	4.95
1596-01F	•2.3	3.943	0.25	0.004	12.8	156.574	0.491	19.2	19.6	99.3	1772.18	1.80
1596-01G	•2.4	5.616	0.25	0.001	68.4	156.187	0.510	19.9	39.6	99.9	1769.39	1.45
1596-01H	•2.4	5.451	0.24	0.002	46.5	156.350	0.808	31.6	71.1	99.8	1770.56	1.89
1596-01I	•2.4	4.769	0.24	0.002	36.8	155.851	0.206	8	79.2	99.8	1766.96	1.76
1596-01J	•2.5	6.213	0.25	0.002	42.4	156.694	0.205	8	87.2	99.8	1773.05	1.94
1596-01K	•2.5	2.961	0.25	0.002	22.3	156.407	0.227	8.9	96	99.7	1770.98	1.57
1596-01L	2.5	5.007	0.23	0.003	23.9	154.470	0.040	1.5	97.6	99.6	1756.95	2.99
1596-01M	2.6	5.110	0.22	0.005	13	154.348	0.017	0.7	98.3	99.1	1756.06	4.32
1596-01N	2.8	5.978	0.23	0.005	17.4	155.062	0.045	1.7	100	99.3	1761.25	2.65
Integ. Age											1770.00	4.00
(•) Plateau Age								95.6			1770.00	3.00
PFM007072A. Run ID# 1586-01 (J = 0.01067 ± 0.000015):												
1586-01A	2.2	14.199	0.00	0.015	13.3	168.356	0.015	4	4	97.8	1855.17	5.65
1586-01B	2.3	8.136	0.01	0.003	32.7	156.133	0.091	24.6	28.6	99.6	1769.00	2.23
1586-01C	•2.4	8.494	0.01	0.003	40.7	154.038	0.129	35	63.6	99.7	1753.81	2.60
1586-01D	•2.4	12.575	0.01	0.003	58	154.800	0.076	20.6	84.2	99.8	1759.35	2.27
1586-01G	•2.6	13.164	0.01	0.001	233.1	155.914	0.007	1.8	86	100.2	1767.42	9.38
1586-01H	•3.6	12.812	0.02	0.002	78.3	154.383	0.052	14	100	99.9	1756.32	2.71
Integ. Age											1763.00	4.00
(•) Plateau Age								71.4			1757.00	4.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

6.3 $^{0}Ar/^{39}Ar$ biotite ages along E-W transect

PFM007048B

Amphibolite with paler, fine-grained biotite-rich bands. The $^{40}Ar/^{39}Ar$ step-heating plateau age is 1,774 ± 5 Ma (Figure 6-16) and is interpreted as dating cooling below c. 300°C.

PFM007050A

Fine-grained felsic metavolcanic rock. The $^{40}Ar/^{39}Ar$ step-heating plateau age is 1,694 ± 3 Ma (Figure 6-17) and is interpreted as dating cooling below c. 300°C.

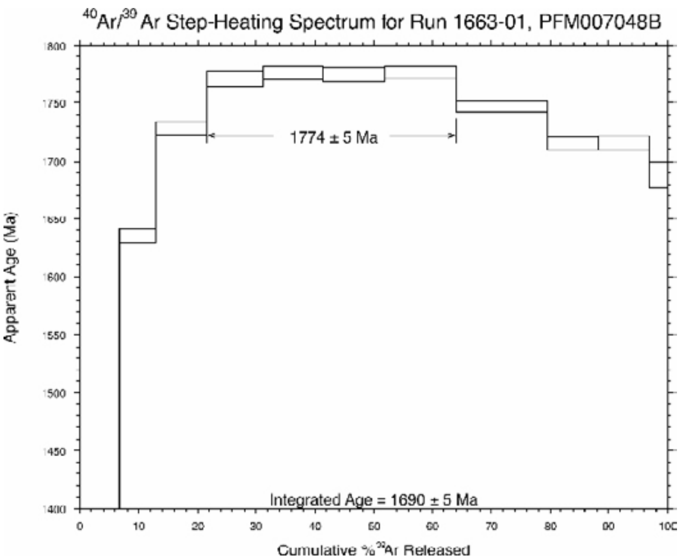
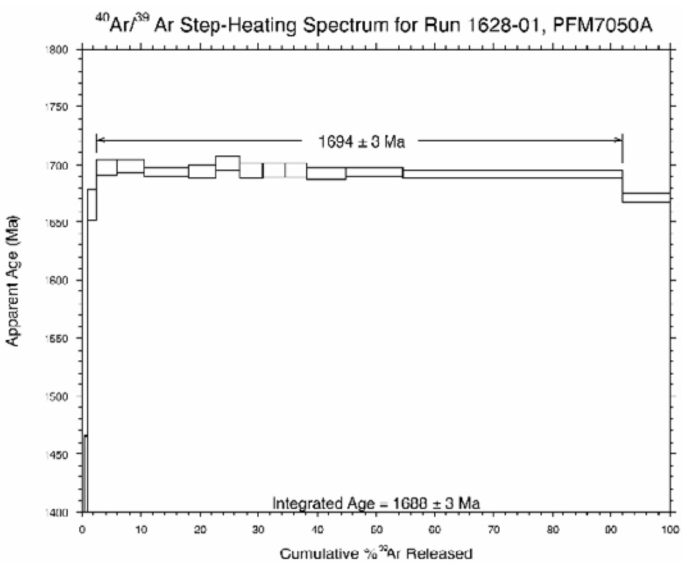


Figure 6-16. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007048B.*



(fig. 6-31)

Figure 6-17. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007050A.*

PFM007052A

Medium-grained homogeneous metatonalite. Two splits of this sample were analysed (Figures 6-18 and 6-19). The $^{40}Ar/^{39}Ar$ step-heating plateau age of 1,724 ± 6 Ma (Figure 6-19) yields the best age and is interpreted as dating cooling below c. 300°C.

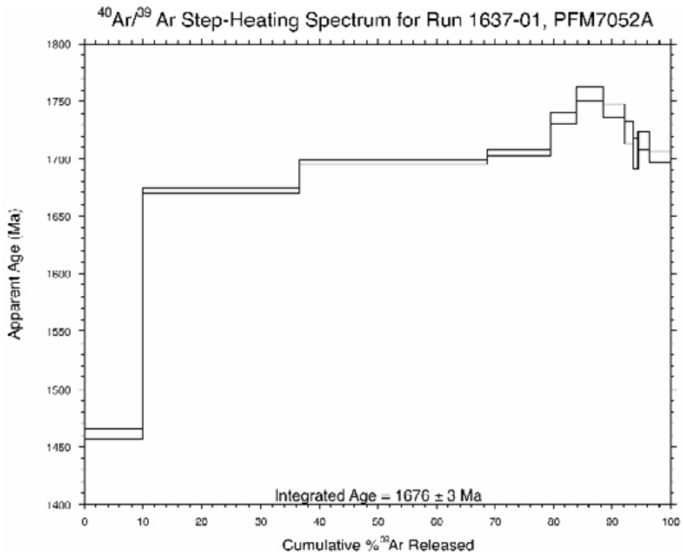


Figure 6-18. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007052A.*

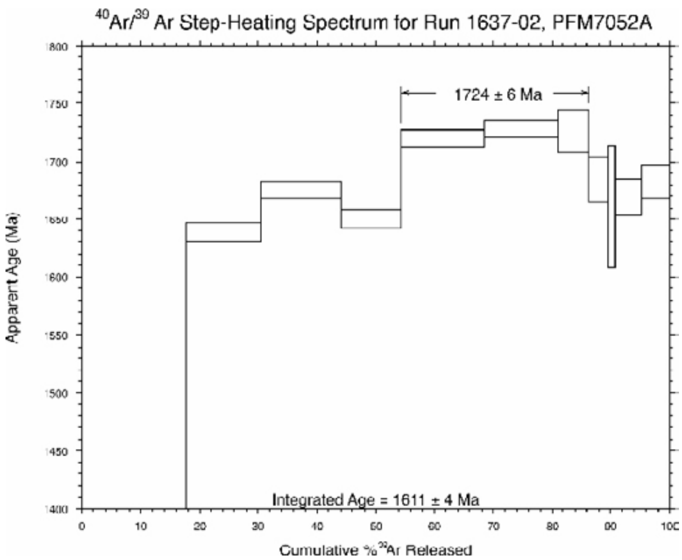


Figure 6-19. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007052A.*

PFM007055A

Pale grey metagranite to granodiorite. The $^{40}Ar/^{39}Ar$ step-heating forced-fit age is 1,739 ± 9 Ma (Figure 6-20) and is interpreted as dating cooling below c. 300°C.

PFM007056A

Coarse-grained metatonalite. Three splits of this sample were analyzed (Figures 6-21, 6-22 and 6-23) The $^{40}Ar/^{39}Ar$ forced-fit age of 1,810 ± 7 Ma (Figure 6-23) is the best analysis and is interpreted as dating cooling below c. 300°C.

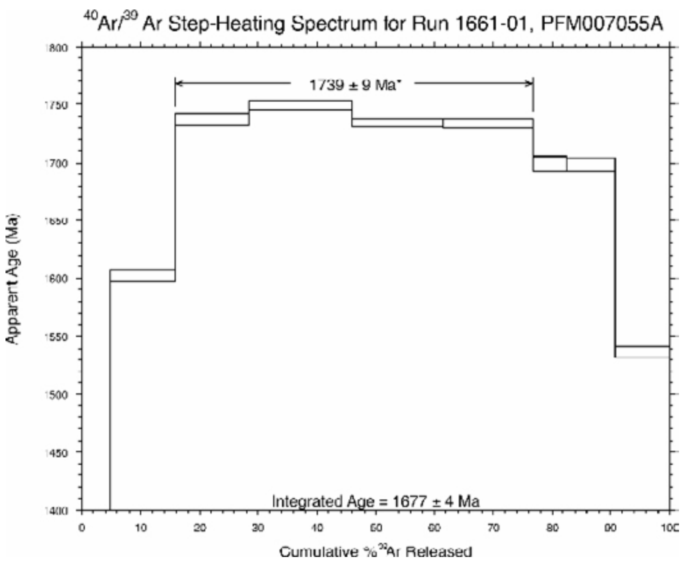


Figure 6-20. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007055A.*

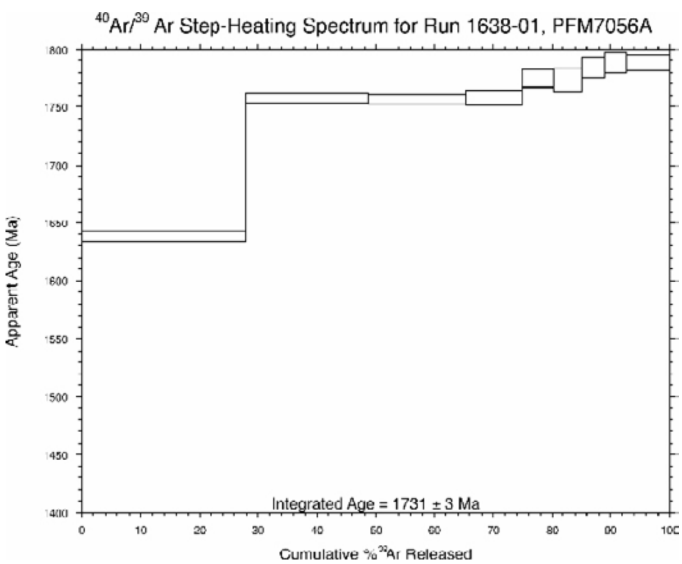


Figure 6-21. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007056A.*

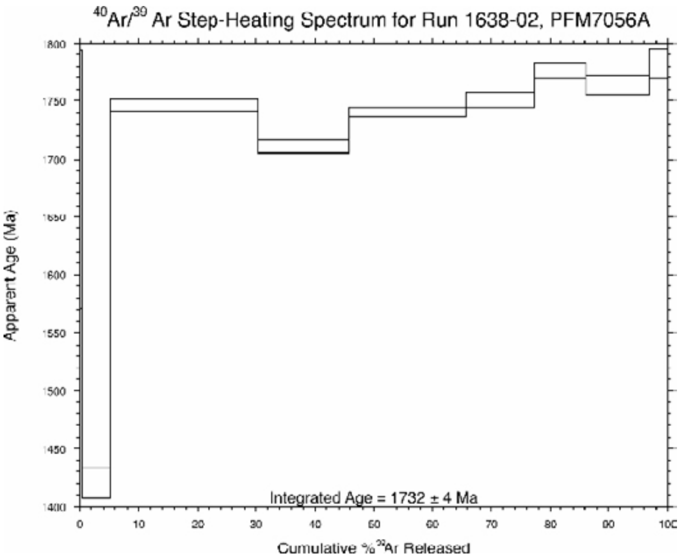


Figure 6-22. *^{40}Ar/^{39}Ar step-heating spectrum for sample PFM007056A.*

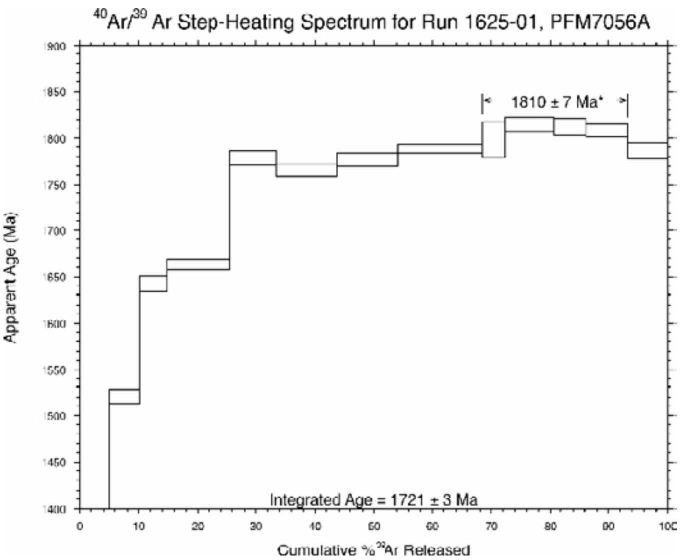


Figure 6-23. *^{40}Ar/^{39}Ar step-heating spectrum for sample PFM007056A.*

PFM007060A

Metagranite. The $^{40}Ar/^{39}Ar$ step-heating forced-fit age is 1,861 ± 4 Ma (Figure 6-24) and is interpreted as dating cooling below c. 300°C.

PFM007061B

Coarse-grained homogeneous metatonalite with biotite. The $^{40}Ar/^{39}Ar$ step-heating plateau age is 1,802 ± 3 Ma (Figure 6-25) and is interpreted as dating cooling below c. 300°C.

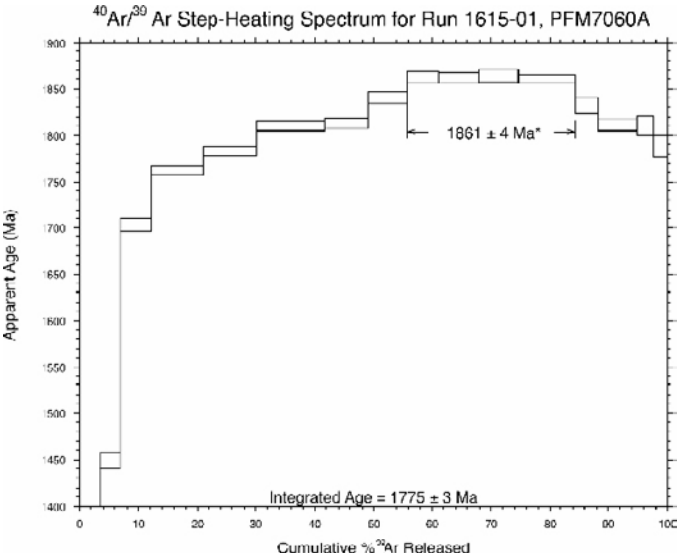


Figure 6-24. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007060A.*

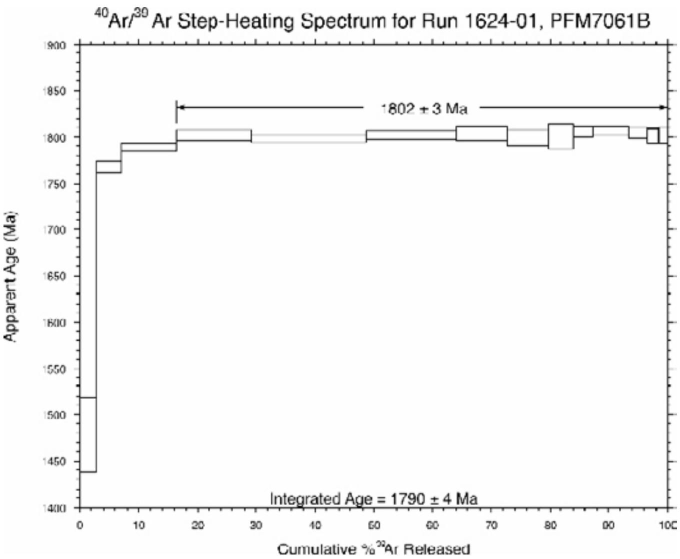


Figure 6-25. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007061B.*

6.4 $^{40}Ar/^{39}Ar$ biotite ages along N-S transect

PFM007069A

Garnet-rich metagranite. The $^{40}Ar/^{39}Ar$ step-heating plateau age is 1,664 ± 3 Ma (Figure 6-26) and is interpreted as dating cooling below c. 300°C.

PFM007073A

Metagranodiorite. The $^{40}Ar/^{39}Ar$ step-heating plateau age is 1494 ± 3 Ma (Figure 6-27) and is interpreted as dating cooling below c. 300°C.

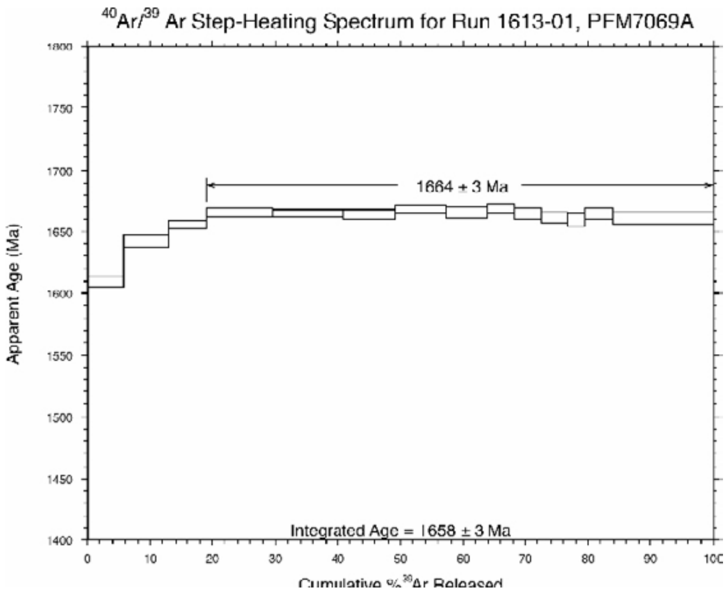


Figure 6-26. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007069A.*

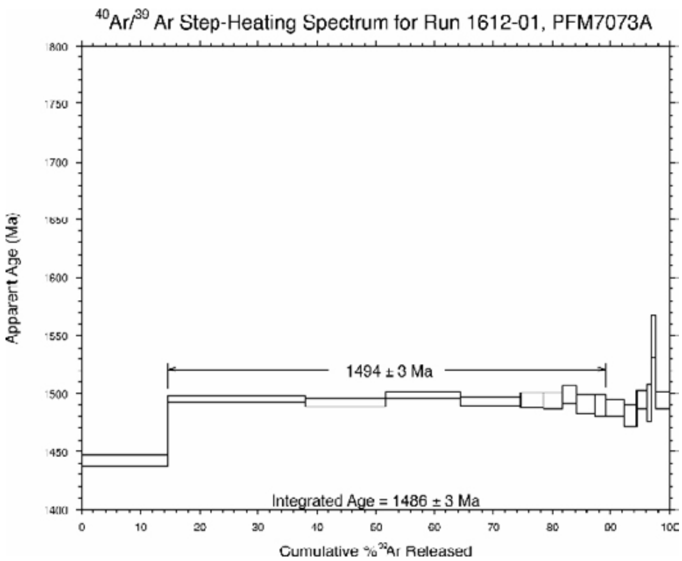


Figure 6-27. *$^{40}Ar/^{39}Ar$ step-heating spectrum for sample PFM007073A.*

Table 6-2. $^{40}Ar/^{39}Ar$ regional biotite data.

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%^{36}Ar(Ca)[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM007048B. Run ID# 1663-01 (J = 0.01064 ± 0.00002):												
1663-01A	1.4	0.298	0.01	0.027	0.2	46.571	0.010	6.7	6.7	85.6	726.09	2.61
1663-01B	1.5	0.021	0.01	0.028	0	138.574	0.009	6.1	12.9	94.4	1,634.51	3.29
1663-01C	1.6	0.031	0.01	0.007	0.1	150.992	0.012	8.7	21.5	98.6	1,728.36	2.84
1663-01D	•1.7	0.028	0.02	0.001	0.3	156.796	0.014	9.6	31.1	99.8	1,770.60	3.25
1663-01E	•1.8	0.058	0.01	0.004	0.2	157.464	0.015	10.3	41.4	99.2	1,775.40	2.81
1663-01F	•1.9	0.016	0.01	0.000	0.9	157.280	0.015	10.4	51.8	100	1,774.08	2.99
1663-01G	•2.0	0.101	0.02	0.003	0.4	157.565	0.017	12.2	64	99.4	1,776.12	2.54
1663-01H	2.2	0.098	0.02	0.003	0.5	153.481	0.022	15.5	79.5	99.5	1,746.59	2.14
1663-01I	2.4	0.071	0.01	0.004	0.2	149.190	0.013	8.8	88.3	99.2	1,715.04	2.81
1663-01J	3	0.115	0.01	0.004	0.4	149.275	0.012	8.7	97	99.2	1,715.67	2.97
1663-01K	4.5	0.060	–0.01	0.005	0.2	145.660	0.004	3	100	99	1,688.66	5.66
Integ. Age											1,690.00	5.00
(•) Plateau Age								42.4			1,774.00	5.00
PFM7050A. Run ID# 1628-01 (J = 0.01067 ± 0.000012):												
1628-01A	2	–1.212	–0.10	0.303	–0.1	95.110	0.003	0.4	0.4	51.5	1,263.81	16.80
1628-01B	2.2	0.746	0.03	0.058	0.2	98.693	0.005	0.6	1	85.3	1,297.72	83.87
1628-01C	2.4	0.119	–0.01	0.014	0.1	142.087	0.013	1.5	2.5	97.2	1,664.62	7.09
1628-01D	•2.6	–0.224	–0.00	0.012	–0.2	146.450	0.029	3.5	6	97.5	1,697.69	3.36
1628-01E	•2.8	0.004	0.00	0.010	0	146.551	0.039	4.7	10.7	98.1	1,698.45	2.73
1628-01F	•3.0	0.003	0.00	0.003	0	145.932	0.061	7.3	18	99.5	1,693.80	2.05
1628-01G	•3.2	0.004	0.00	0.000	0.2	145.908	0.040	4.8	22.8	99.9	1,693.61	2.80
1628-01H	•3.4	0.005	–0.02	0.000	0.4	146.797	0.034	4.1	26.8	100	1,700.29	2.96
1628-01I	•3.6	0.051	0.01	0.001	1.4	146.013	0.032	3.9	30.7	99.9	1,694.41	3.46
1628-01J	•3.9	0.005	–0.00	0.000	0.7	146.067	0.032	3.9	34.6	100	1,694.81	3.16
1628-01K	•4.2	0.032	0.02	0.003	0.2	146.061	0.031	3.7	38.3	99.5	1,694.77	3.22
1628-01L	•4.6	0.003	0.01	0.001	0	145.772	0.054	6.5	44.9	99.7	1,692.59	2.68
1628-01M	•5.0	0.002	0.01	0.002	0	145.927	0.082	9.8	54.7	99.6	1,693.76	2.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1628-01N	•7.0	0.001	0.01	0.002	0	145.561	0.309	37.2	91.9	99.7	1,691.00	1.73
1628-01O	10	0.069	0.01	0.001	0.7	142.930	0.067	8.1	100	99.7	1,671.05	2.06
Integ. Age											1,688.00	3.00
(•) Plateau Age								89.4			1,694.00	3.00
PFM7052A. Run ID# 1637-01 (J = 0.01067 ± 0.000012):												
1637-01A	1.7	0.003	0.03	0.105	0	116.927	0.048	10	10	79	1,461.06	2.20
1637-01B	1.9	0.003	0.03	0.003	0	143.014	0.127	26.6	36.6	99.5	1,671.70	1.30
1637-01C	2.1	0.009	0.03	0.000	0.4	146.302	0.153	32.1	68.7	99.9	1,696.58	1.10
1637-01D	2.3	0.007	0.03	0.001	0.1	147.547	0.051	10.7	79.4	99.8	1,705.91	1.40
1637-01E	2.5	0.055	0.03	0.002	0.4	151.532	0.022	4.5	83.9	99.6	1,735.47	2.47
1637-01F	2.7	0.064	0.03	0.002	0.5	154.404	0.021	4.5	88.4	99.6	1,756.47	3.02
1637-01G	2.9	0.037	0.03	0.000	1.4	152.409	0.018	3.8	92.2	99.9	1,741.91	2.91
1637-01H	3.2	0.075	0.02	0.003	0.3	149.849	0.007	1.5	93.7	99.4	1,723.04	4.92
1637-01I	3.8	0.294	–0.01	0.002	1.7	147.297	0.004	0.8	94.5	99.5	1,704.05	6.77
1637-01J	6	0.025	0.02	0.002	0.2	148.868	0.009	1.8	96.3	99.6	1,715.76	3.93
1637-01K	10	0.335	0.03	0.002	2.6	146.973	0.018	3.7	100	99.6	1,701.62	2.41
Integ. Age											1,676.00	3.00
PFM7052A. Run ID# 1637-02 (J = 0.01067 ± 0.000012):												
1637-02A	1.4	0.014	0.01	0.021	0	90.032	0.010	17.7	17.7	93.5	1,214.64	3.09
1637-02B	1.5	0.011	0.00	0.003	0.1	138.668	0.007	12.9	30.6	99.4	1,638.27	3.81
1637-02C	1.6	0.155	–0.00	0.002	1.1	143.568	0.007	13.4	44	99.6	1,675.91	3.71
1637-02D	1.7	0.134	–0.01	0.002	1.2	140.213	0.006	10.4	54.4	99.7	1,650.22	4.31
1637-02E	•1.8	0.100	0.01	0.003	0.5	149.379	0.008	14.1	68.5	99.5	1,719.56	3.57
1637-02F	•1.9	0.136	0.00	0.002	1.1	150.560	0.007	12.4	80.9	99.7	1,728.30	3.71
1637-02G	•2.0	0.344	0.04	0.005	0.9	150.236	0.003	5.5	86.4	99	1,725.91	9.10
1637-02H	2.2	0.745	0.05	0.004	2.6	144.763	0.002	3.2	89.6	99.2	1,684.97	9.93
1637-02I	2.5	0.438	0.13	0.030	0.2	141.521	0.001	1.1	90.7	94.1	1,660.28	26.22
1637-02J	3	0.236	–0.01	0.013	0.3	142.671	0.003	4.6	95.3	97.5	1,669.08	7.73
1637-02K	4.5	0.886	0.00	0.002	8	144.447	0.003	4.7	100	99.7	1,682.59	7.11

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
Integ. Age											1,611.00	4.00
(•) Plateau Age								31.9			1,724.00	6.00
PFM007055A. Run ID# 1661-01 (J = 0.01064 ± 0.00002):												
1661-01A	1.3	8.074	0.43	0.164	0.7	61.063	0.000	0.1	0.1	55.9	903.12	88.76
1661-01B	1.5	0.289	0.01	0.007	0.6	86.496	0.009	4.7	4.8	97.8	1,177.14	2.94
1661-01C	1.6	0.144	0.02	0.005	0.4	134.398	0.020	10.9	15.8	98.9	1,601.82	2.62
1661-01E	•1.8	0.002	0.01	0.001	0	152.177	0.023	12.7	28.5	99.7	1,737.07	2.78
1661-01F	•1.9	0.060	0.01	0.002	0.5	153.861	0.032	17.6	46	99.7	1,749.37	1.89
1661-01G	•2.0	0.060	0.01	0.002	0.4	151.816	0.028	15.6	61.6	99.6	1,734.42	1.74
1661-01H	•2.2	0.050	0.01	0.001	0.5	151.723	0.027	15.2	76.8	99.8	1,733.74	2.00
1661-01I	2.4	0.125	–0.01	0.001	1.2	147.012	0.010	5.7	82.6	99.7	1,698.81	3.23
1661-01J	3	0.073	–0.00	0.001	0.9	146.959	0.015	8.2	90.7	99.8	1,698.41	2.90
1661-01K	4.5	0.075	–0.00	0.001	0.7	126.282	0.017	9.3	100	99.7	1,536.54	2.33
Integ. Age											1,677.00	4.00
(•) Plateau Age								61.1			1,739.00	9.00
PFM7056A. Run ID# 1625-01 (J = 0.01067 ± 0.000012):												
1625-01A	1.4	0.384	0.04	3.366	0	78.334	0.002	0.4	0.4	7.3	1,095.96	61.18
1625-01B	1.5	0.166	0.01	0.664	0	48.432	0.005	1.4	1.9	19.8	751.54	16.33
1625-01C	1.6	0.092	0.03	0.327	0	66.315	0.011	3.1	5	40.7	965.32	7.61
1625-01D	1.7	–0.075	0.02	0.113	0	123.916	0.020	5.3	10.3	78.8	1,519.95	4.17
1625-01E	1.8	0.172	0.04	0.056	0	139.265	0.016	4.5	14.7	89.4	1,642.90	4.14
1625-01F	1.9	0.094	0.04	0.033	0	141.865	0.040	10.9	25.6	93.7	1,662.92	2.83
1625-01G	2	–0.261	–0.00	0.000	–14.4	157.401	0.029	7.8	33.4	99.9	1,778.13	3.69
1625-01H	2.1	–0.065	0.02	0.001	–1.2	155.576	0.038	10.3	43.7	99.9	1,764.98	3.35
1625-01I	2.2	0.004	0.02	0.000	0.3	157.155	0.039	10.6	54.3	100	1,776.37	3.16
1625-01J	2.4	0.048	0.04	0.003	0.3	158.748	0.052	14.2	68.4	99.5	1,787.78	2.21
1625-01K	•2.6	0.070	0.04	0.003	0.4	160.274	0.015	4	72.4	99.5	1,798.66	9.50
1625-01L	•2.9	0.022	0.03	0.003	0.1	162.517	0.030	8.1	80.5	99.5	1,814.51	3.93
1625-01M	•3.2	0.054	0.01	0.003	0.2	162.176	0.021	5.7	86.2	99.5	1,812.11	4.06

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1625-01N	•3.8	0.129	0.01	0.004	0.5	161.540	0.026	7	93.2	99.3	1,807.62	3.34
1625-01O	5.5	–0.035	0.01	0.002	–0.2	158.618	0.025	6.8	100	99.6	1,786.85	4.10
Integ. Age											1,721.00	3.00
(•) Plateau Age								24.8			1,810.00	7.00
PFM7056A. Run ID# 1638-01 (J = 0.01067 ± 0.000012):												
1638-01A	1.7	0.002	0.03	0.145	0	138.615	0.032	27.8	27.8	76.4	1,637.85	2.44
1638-01B	1.8	0.005	0.03	0.003	0	154.499	0.024	20.8	48.6	99.4	1,757.16	2.23
1638-01C	1.9	0.007	0.03	0.000	0.7	154.430	0.019	16.7	65.3	100	1,756.66	2.40
1638-01D	2	0.004	0.02	0.003	0	154.556	0.011	9.4	74.8	99.4	1,757.58	3.08
1638-01E	2.1	0.001	0.00	0.002	0	156.912	0.006	5.4	80.2	99.6	1,774.61	4.13
1638-01F	2.2	0.002	0.00	0.003	0	156.713	0.006	4.9	85.1	99.4	1,773.18	4.90
1638-01G	2.4	0.244	–0.00	0.003	1.1	158.173	0.005	3.9	89.1	99.4	1,783.67	4.34
1638-01H	2.8	0.036	–0.01	0.001	0.9	158.927	0.004	3.5	92.6	99.9	1,789.06	4.56
1638-01I	3.5	0.078	0.02	0.003	0.3	158.849	0.009	7.4	100	99.4	1,788.50	3.54
1638-01J	5	48.278	9.80	0.272	2.4	NG	–0.000	0	100	127.6	NG	NG
1638-01K	10	–90.713	1.55	–0.874	1.4	248.473	0.000	0	100	13513.1	2,336.38	1207.92
Integ. Age											1,731.00	3.00
PFM7056A. Run ID# 1638-02 (J = 0.01067 ± 0.000012):												
1638-02A	1.3	2.009	–0.24	2.429	0	144.337	0.000	0.4	0.4	16.7	1,681.75	55.65
1638-02B	1.4	0.193	–0.00	0.306	0	112.237	0.005	4.8	5.2	55.4	1,420.44	6.59
1638-02D	1.6	0.007	0.02	0.001	0.1	152.984	0.025	25.1	30.3	99.8	1,746.12	2.38
1638-02C	1.5	0.066	0.02	0.033	0	148.249	0.016	15.4	45.7	93.9	1,711.16	2.89
1638-02E	1.7	0.069	0.03	0.000	4	152.204	0.020	20	65.8	100	1,740.41	1.95
1638-02F	1.8	0.010	0.02	0.002	0.1	153.655	0.012	11.6	77.3	99.5	1,751.02	3.13
1638-02G	2	0.015	0.01	0.004	0.1	157.027	0.009	8.9	86.2	99.3	1,775.44	3.50
1638-02H	2.4	0.062	0.01	0.005	0.2	155.338	0.011	10.8	97	99.1	1,763.25	4.15
1638-02I	3	0.063	0.02	0.002	0.4	157.928	0.003	3	100	99.6	1,781.91	6.65
1638-02J	4.5	–6.589	0.24	–0.051	1.8	417.421	0.000	0	100	103.7	3,060.31	309.66
Integ. Age											1,732.00	4.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	%$^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	%^{39}Ar[c]	Cum. %^{39}Ar	%$^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM7060A. Run ID# 1615-01 (J = 0.01067 ± 0.000012):												
1615-01A	2	0.243	0.05	0.235	0	43.537	0.019	3.5	3.5	38.5	688.32	4.97
1615-01B	2.2	0.068	0.04	0.049	0	115.484	0.019	3.5	7	88.9	1,448.66	4.30
1615-01C	2.4	0.004	0.05	0.019	0	147.150	0.028	5.2	12.2	96.4	1,702.94	3.42
1615-01D	2.6	0.066	0.05	0.007	0.1	155.162	0.048	8.8	21	98.7	1,761.97	2.58
1615-01E	2.8	0.049	0.05	0.004	0.2	158.077	0.050	9.2	30.2	99.3	1,782.98	2.22
1615-01F	3	0.107	0.05	0.003	0.5	161.854	0.062	11.4	41.6	99.5	1,809.84	2.57
1615-01G	3.2	0.051	0.05	0.002	0.3	162.265	0.040	7.4	49.1	99.6	1,812.74	2.65
1615-01H	3.4	0.003	0.04	0.000	0.3	166.213	0.036	6.6	55.7	100	1,840.36	2.82
1615-01I	•3.6	0.058	0.05	–0.002	–0.4	169.373	0.030	5.6	61.2	100.4	1,862.16	3.11
1615-01J	•3.9	0.014	0.05	0.000	0.7	169.262	0.036	6.6	67.8	99.9	1,861.39	2.89
1615-01K	•4.2	0.027	0.05	0.002	0.2	169.586	0.037	6.9	74.7	99.7	1,863.61	3.26
1615-01L	•4.6	0.098	0.05	0.002	0.6	169.039	0.053	9.8	84.5	99.6	1,859.86	2.18
1615-01M	5	–0.097	0.02	–0.001	1	164.943	0.021	3.9	88.4	100.2	1,831.51	4.16
1615-01N	6	0.191	0.04	0.002	1.7	161.942	0.035	6.4	94.7	99.7	1,810.46	3.02
1615-01O	8	0.578	0.02	0.003	2.3	161.928	0.016	3	97.7	99.4	1,810.36	4.92
1615-01P	10	0.588	0.04	0.003	2.5	158.839	0.013	2.3	100	99.4	1,788.43	5.65
Integ. Age											1,775.00	3.00
(•) Plateau Age								28.8			1,861.00	4.00
PFM7061B. Run ID# 1624-01 (J = 0.01067 ± 0.000012):												
1624-01A	1.5	–0.184	0.05	4.192	0	118.887	0.034	2.9	2.9	8.8	1,477.77	20.09
1624-01B	1.6	–0.189	0.01	0.245	0	155.949	0.048	4.2	7.1	68.3	1,767.67	3.38
1624-01C	1.7	–0.027	0.02	0.087	0	158.885	0.107	9.3	16.4	86.1	1,788.76	2.10
1624-01D	•1.8	0.001	0.02	0.051	0	160.748	0.148	12.8	29.2	91.4	1,802.02	2.62
1624-01E	•1.9	–0.022	0.02	0.021	0	160.212	0.224	19.5	48.7	96.3	1,798.21	2.04
1624-01F	•2.0	–0.018	0.02	0.010	0	160.694	0.178	15.4	64.1	98.3	1,801.64	2.23
1624-01G	•2.1	0.034	0.02	0.009	0	161.000	0.100	8.6	72.8	98.3	1,803.80	3.71
1624-01H	•2.2	0.002	0.02	0.008	0	160.226	0.080	6.9	79.7	98.5	1,798.31	4.22
1624-01I	•2.4	0.061	0.03	0.014	0.1	160.490	0.050	4.3	84	97.5	1,800.19	6.56

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
1624-01J	•2.6	0.074	0.03	0.016	0.1	161.190	0.039	3.4	87.3	97.1	1,805.15	2.62
1624-01K	•2.9	0.026	0.02	0.014	0	161.358	0.071	6.1	93.5	97.6	1,806.34	2.08
1624-01L	•3.2	0.046	0.02	0.014	0	161.042	0.035	3.1	96.5	97.4	1,804.10	2.96
1624-01M	•3.8	0.058	–0.00	0.019	0	160.568	0.021	1.9	98.4	96.6	1,800.74	3.76
1624-01P	•7.0	0.339	0.01	0.028	0.2	160.678	0.019	1.6	100	95.1	1,801.52	4.31
Integ. Age											1,790.00	3.00
(•) Plateau Age								83.6			1,802.00	3.00
PFM7069A. Run ID# 1613-01 (J = 0.01067 ± 0.000012):												
1613-01A	1.7	0.101	–0.17	3.876	0	117.783	0.000	0.1	0.1	9.3	1,468.38	65.01
1613-01B	1.8	–4.835	–0.01	0.434	–0.2	280.017	0.000	0	0.1	68.6	2,495.46	126.58
1613-01C	2	–0.240	–0.18	0.297	0	88.717	0.001	0.1	0.2	50.3	1,201.68	33.01
1613-01D	2.3	28.481	0.72	0.613	0.6	–178.185	0.000	0	0.2	–4810.6	NAN(000).00000	–2323.36
1613-01E	2.5	–0.013	–0.01	0.053	0	134.934	0.026	5.5	5.8	89.7	1,609.05	2.30
1613-01F	2.6	0.001	–0.01	0.008	0	139.202	0.033	7	12.8	98.3	1,642.41	2.43
1613-01G	2.7	0.002	–0.00	0.002	0	140.850	0.029	6.2	19	99.7	1,655.13	1.94
1613-01H	•2.9	0.006	–0.01	0.001	0.1	142.127	0.049	10.5	29.5	99.7	1,664.92	1.79
1613-01I	•3.1	0.004	–0.00	0.001	0.1	142.111	0.054	11.5	41	99.9	1,664.80	1.47
1613-01J	•3.3	0.001	–0.01	0.000	0.3	141.903	0.038	8.2	49.2	100	1,663.21	1.85
1613-01K	•3.5	–0.038	–0.01	–0.001	0.6	142.550	0.038	8.1	57.3	100.2	1,668.16	1.84
1613-01L	•3.7	–0.048	–0.01	–0.001	0.8	142.219	0.031	6.5	63.8	100.2	1,665.63	2.33
1613-01M	•3.9	0.002	–0.02	0.000	0.3	142.660	0.021	4.5	68.3	100	1,669.00	2.30
1613-01N	•4.2	–0.074	–0.01	–0.001	0.9	142.000	0.020	4.2	72.5	100.2	1,663.95	2.22
1613-01O	•4.5	–0.049	–0.01	–0.001	0.7	141.648	0.020	4.3	76.8	100.2	1,661.26	2.20
1613-01P	•4.9	–0.025	–0.01	–0.001	0.3	141.366	0.012	2.7	79.4	100.3	1,659.09	2.89
1613-01Q	•5.5	0.002	–0.01	0.000	0.3	142.013	0.020	4.3	83.8	100	1,664.05	2.07
1613-01R	•12.0	0.001	–0.00	0.001	0	141.521	0.076	16.2	100	99.7	1,660.28	2.56
Integ. Age											1,658.00	3.00
(•) Plateau Age								81			1,664.00	3.00

Sample/run ID#[a]	Power (W)	Ca/K	Cl/K	$^{36}Ar/^{39}Ar$	$\%^{36}Ar(Ca)$[b]	$^{40}Ar^{*}/^{39}Ar$	^{39}Ar (Mol–14)	$\%^{39}Ar$[c]	Cum. $\%^{39}Ar$	$\%^{40}Ar^{*}$[d]	Age (Ma)	± 2σ
PFM7073A. Run ID# 1612-01 (J = 0.01067 ± 0.000012):												
1612-01A	2	0.001	0.00	0.186	0	114.708	0.098	14.8	14.8	67.7	1,441.96	2.39
1612-01B	•2.2	0.002	0.00	0.011	0	120.860	0.157	23.5	38.3	97.5	1,494.44	1.37
1612-01C	•2.4	0.004	0.00	0.008	0	120.569	0.091	13.7	52	98.2	1,491.99	1.99
1612-01D	•2.7	–0.011	0.00	0.005	0	121.330	0.085	12.8	64.8	98.8	1,498.38	1.57
1612-01E	•3.0	0.003	0.00	0.005	0	120.610	0.068	10.3	75.1	98.8	1,492.34	1.96
1612-01F	•3.2	–0.028	–0.01	0.002	–0.2	120.769	0.027	4	79.1	99.5	1,493.67	3.31
1612-01G	•3.4	–0.094	–0.01	0.002	–0.6	120.725	0.023	3.5	82.5	99.5	1,493.30	3.60
1612-01H	•3.6	–0.239	–0.01	0.000	–45.3	121.349	0.016	2.4	84.9	100	1,498.54	3.89
1612-01I	•4.0	–0.111	–0.01	–0.000	4.9	120.461	0.020	3.1	88	100.1	1,491.08	3.87
1612-01J	•4.4	–0.295	–0.03	0.006	–0.7	120.224	0.012	1.9	89.8	98.5	1,489.08	4.53
1612-01K	4.8	–0.038	0.00	0.002	–0.3	120.003	0.021	3.2	93	99.5	1,487.21	3.73
1612-01L	5.2	–0.018	0.00	0.003	–0.1	119.233	0.013	2	95	99.3	1,480.71	4.60
1612-01M	5.6	–0.119	–0.03	–0.004	0.4	120.836	0.012	1.7	96.7	101.1	1,494.23	4.14
1612-01N	6	0.052	–0.03	–0.007	–0.1	120.485	0.006	0.9	97.7	101.8	1,491.28	7.97
1612-02	10	–0.032	–0.01	0.001	–0.4	120.775	0.016	2.3	100	99.7	1,493.72	4.09
Integ. Age											1,486.00	3.00
(•) Plateau Age								75.1			1,494.00	3.00

[a] • indicates steps included in the plateau age; Integ. Age = the age calculated from all steps analysed; (•) Plateau Age = the age calculated from steps that constitute a plateau, i.e. the interpreted true age of the sample.

[b] Percentage of the total ^{36}Ar that are produced from Ca during irradiation (used to correct for atmospheric ^{40}Ar).

[c] Percentage ^{39}Ar released during each step.

[d] Percentage of measured ^{40}Ar that is radiogenic.

6.5 Concluding remarks

A compilation of the results from the regional $^{40}Ar/^{39}Ar$ hornblende and biotite study are shown on Figure 6-28. Although the data set require closer evaluation, a few general observations can be made:

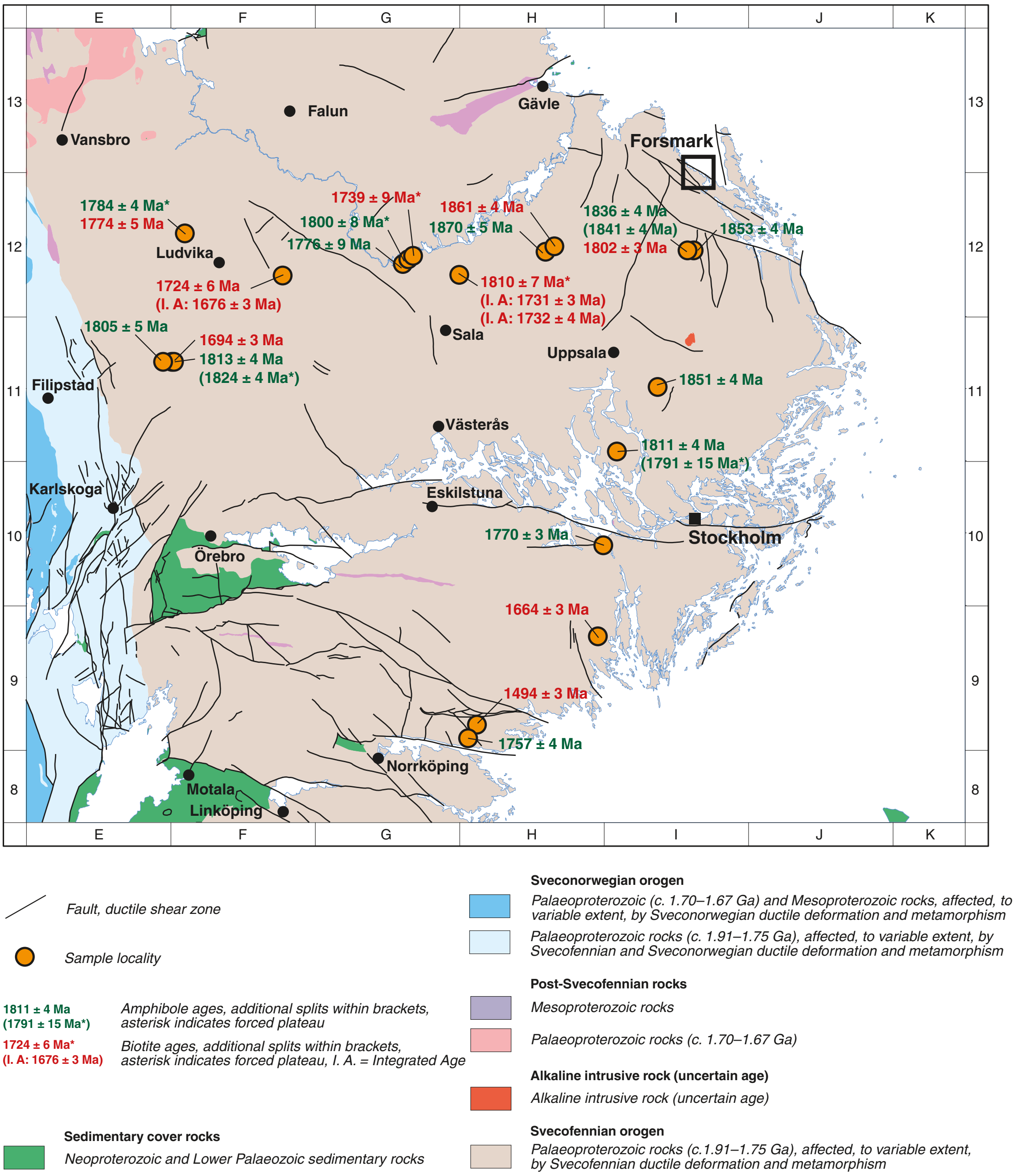


Figure 6-28. *Compilation of regional 40Ar/39Ar hornblende and biotite ages in the Bergslagen area. The Forsmark study area is also shown.*

6.5.1 Regional $^{40}Ar/^{39}Ar$ hornblende study

There is evidence for amphibole cooling ages around 1.85 Ga and even up to 1.87 Ga in the eastern part of Bergslagen close to Forsmark. These may represent cooling after a major regional event, or possibly after crystallisation of the rocks themselves. There are also ages present that correspond both to the 1.83–1.82 Ga and 1.81–1.79 Ga cooling/recrystallisation events at Forsmark. Younger ages in the range 1.78 Ga to 1.76 Ga are also present in the western part of the E-W transect and in the southern part of the N-S transect.

6.5.2 Regional $^{40}Ar/^{39}Ar$ biotite study

There is no distinctive trend in the regional biotite results. However, the biotite cooling ages of samples from the western part of the E-W transect are generally younger (1,774–1,694 Ma), compared to the ages in the central part of the transect (1,810–1,861 Ma). The biotite ages in the central part either overlap with or are significantly older than the ages obtained in the Forsmark study area. Further south towards Norrköping, there is evidence from the biotite data for the affects of a younger c. 1,500 Ma tectonothermal event. This event is of increasing significance in south-eastern Sweden.

7 References

Carlsten S, Petersson J, Stephens M, Mattsson H, Gustafsson J, 2004a. Forsmark site investigation. Geological single-hole interpretation of KFM02A and HFM04-05 (DS2). SKB P-04-117, Svensk Kärnbränslehantering AB.

Carlsten S, Petersson J, Stephens M, Thunehed H, Gustafsson J, 2004b. Forsmark site investigation. Geological single-hole interpretation of KFM03B, KFM03A and HFM06-08 (DS3). SKB P-04-117, Svensk Kärnbränslehantering AB.

Carlsten S, Gustafsson J, Mattsson H J, Petersson J, Stephens M, 2005. Forsmark site investigation. Geological single-hole interpretation of KFM06A and KFM06B. SKB P-05-132, Svensk Kärnbränslehantering AB.

Dalrymple G B, Lanphere MA, 1971. $^{40}Ar/^{39}Ar$ technique of K-Ar dating: a comparison with the conventional technique. Earth Planet. Sci, Lett. 12: 300–308.

Farley K A, 2000. Helium diffusion from apatite: general behavior as illustrated by Durango flourapatite. Journal of Geophysical Research 105: 2,903–2,914.

Gallagher K, Brown R, Christopher J, 1998. Fission-track analysis and its applications to geological problems. Annual Revue of Earth and Planetary Science 26: 519–572.

McDowell F B, McIntosh W C, Farley K A, 2005. A precise $^{40}Ar/3^{9}Ar$ reference age for the Durango apatite (U-Th)/He and fission-track dating standard, Chem. Geol 214: 249–263.

Page L, Hermansson T, Söderlund P, 2004. Forsmark site investigation. Bedrock mapping. U-Pb, $^{40}Ar/^{39}Ar$ and (U-Th)/He geochronology. SKB P-04-126, Svensk Kärnbränslehantering AB.

Renne P R, Swisher C C, Deino A L, Karner D B, Owena T L, DePaolo D J, 1998. Intercalibration of standards, absolute ages and uncertainties in $^{40}Ar/^{39}Ar$ dating. Chem. Geol. 145: 117–152.

SKB 2005. Preliminary site description. Forsmark area – version 1.2. SKB R-05-18, Svensk Kärnbränslehantering AB.

Stephens M B, Lundqvist S, Bergman T, Andersson J, 2003. Forsmark site investigation. Bedrock mapping. Rock types, their petrographic and geochemical characteristics, and a structural analysis of the bedrock based on Stage 1 (2002) surface data. SKB P-03-75, Svensk Kärnbränslehantering AB.