- SECTION B -

70 MILLION YEARS OF TECTONO-METAMORPHISM REVEALED BY STAUROLITE GROWTH ADJACENT TO THE MOOSELOOKMEGUNTIC PLUTON

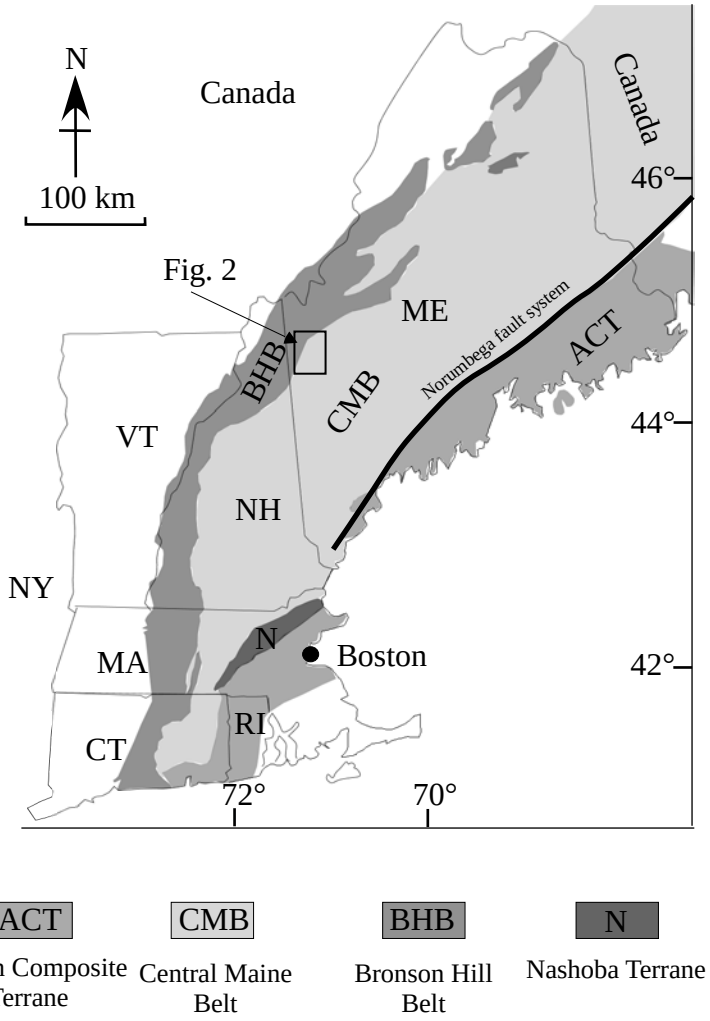


Figure 1. Simplified map of New England showing the major structural units.

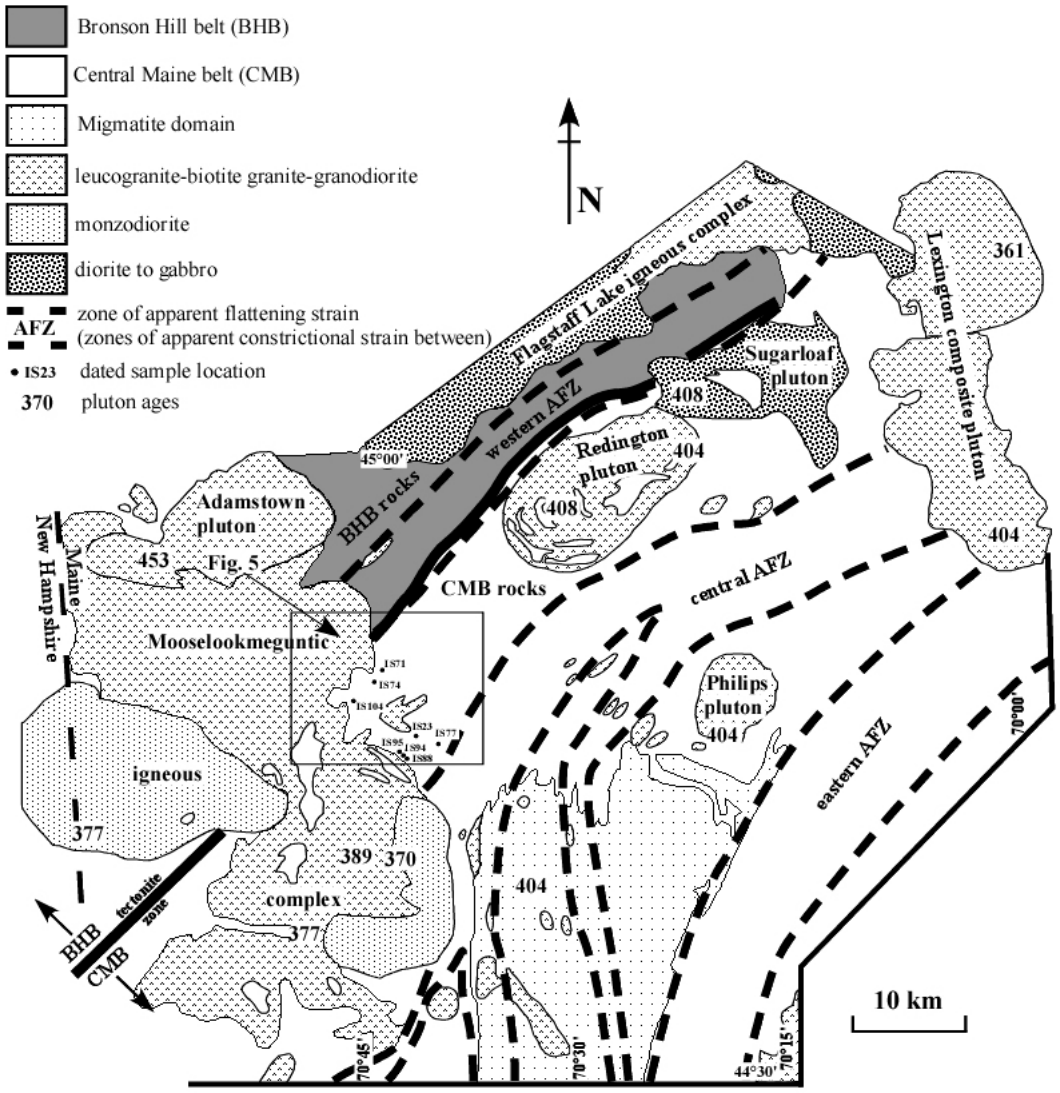


Figure 2. Simplified geological map of west-central Maine showing the major structural features. Modified after Tomascak et al. (2005).

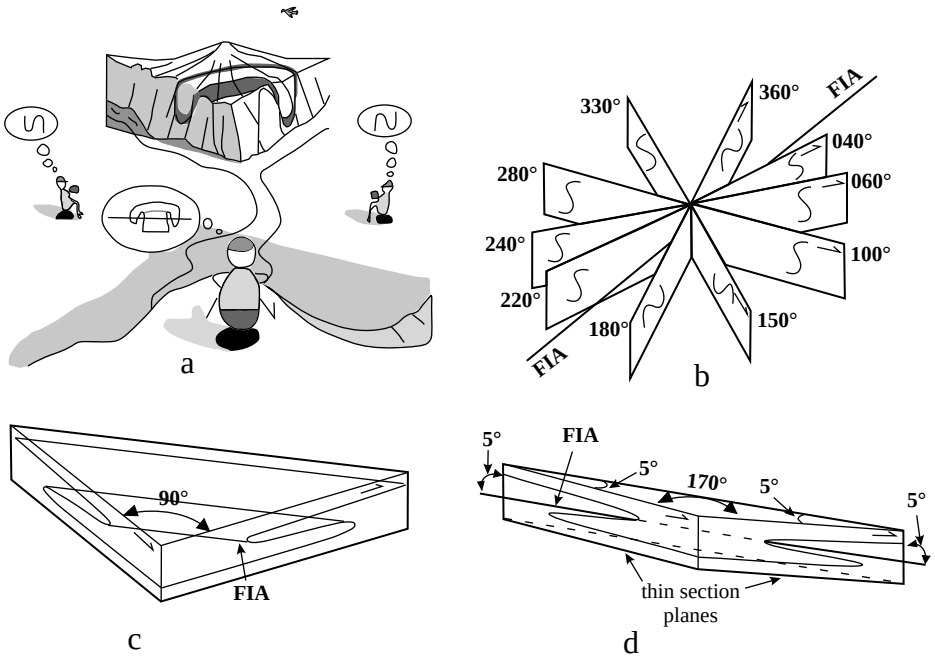


Figure 3. Sketch illustrating the principle behind FIA measurement (after Bell et al., 2004). a) The geologists to either side see the opposite asymmetry for same fold in a cliff face. They have no idea of its trend in 3-D. The geologist in the centre sees the fold on both cliff faces and knows it must trend from one to the other. b) Shows the asymmetry on a series of differently-striking vertical sections. The asymmetry flips across the compass when viewed in the same direction. (c) Shows asymmetry of a sigmoid axis in two sections cut 90° apart. (d) Shows the sigmoid axis of (c) in two sections cut 10° apart lying on either side of the axis. The switch in asymmetry between them defines the location of the axis within a 10° range.

Sample	FIA 1		FIA 2		FIA 3		FIA 4		FIA 5	
no.	St	Grt	St	Grt	St	Grt	St	Grt	St	Grt
IS2		125					75			
IS4	125	125	165r							
IS5	125c	120			95r					
IS7a	125	115								
IS7b									15	40
IS8									45	45
IS9b		120					65			
IS10		115							30	
IS11		120							35	
IS12				145					35	
IS13		125								
IS14		120							40	
IS17	125	125					75			
IS18			165	165						
IS19				165	95					
IS20			165	165						
IS21			175	175						
IS23					95	95				
IS24								75	45	
IS25		120							45	
IS26								75		
IS27							75	75		
IS28a										35
IS28b		130							25	
IS29		115								
IS30	120	115								
IS33								65		
IS34								85		
IS35		125								
IS36								75		
IS37								65		
IS42	115	125								
IS43	110	125								
IS45								75		
IS46				175						
IS47	115	125								
IS49	110	125								
IS50				175						
IS52	110	125								
IS53								75		
IS54	115	115								
IS55			175	175						
IS56			175c	175					45r	
IS57	120	110								
IS59				165						
IS60								75		
IS61								75		
IS62				160						
IS63				160						
IS64				170						
IS65								75		
IS66	125	125								
IS67								65	40	
IS68	125	115								
IS69								65		

Sample	FIA 1		FIA 2		FIA 3		FIA 4		FIA 5	
no.	St	Grt	St	Grt	St	Grt	St	Grt	St	Grt
IS70										25
IS71									40	45
IS72				175			65			
IS73			165p	165					45	
IS74							75p	75	40	
IS77			170c	170					45r	
IS78									55	
IS79	110									
IS81										45
IS82							65			
IS83	120	110								
IS84	125									
IS85							65c	65	35r	
IS86	115c						75r			
IS87	115									
IS88					100c				45r	
IS89	115	115								
IS90	130c	120	165r							
IS91					100c		85m		45r	
IS92a			170							
IS92b	125									
IS93			165	165						
IS94					90c	100	65m		25r	
IS95					95c	95	65m		35r	
IS96								65		
IS99								70		
IS101				155						
IS102									45	45
IS103	120	125								
IS104	115	120								

Table 2. A list of FIA measurements for garnet and staurolite porphyroblasts. c – core-inclusion trails; m –median-inclusion trails; r – rim-inclusion trails; p – pre-FIA.

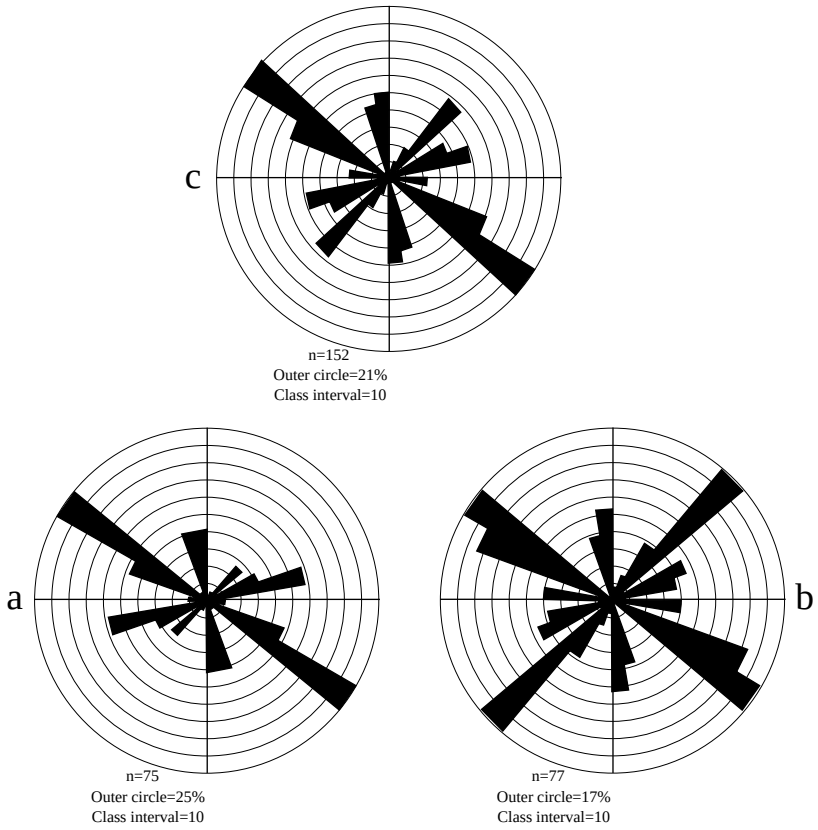
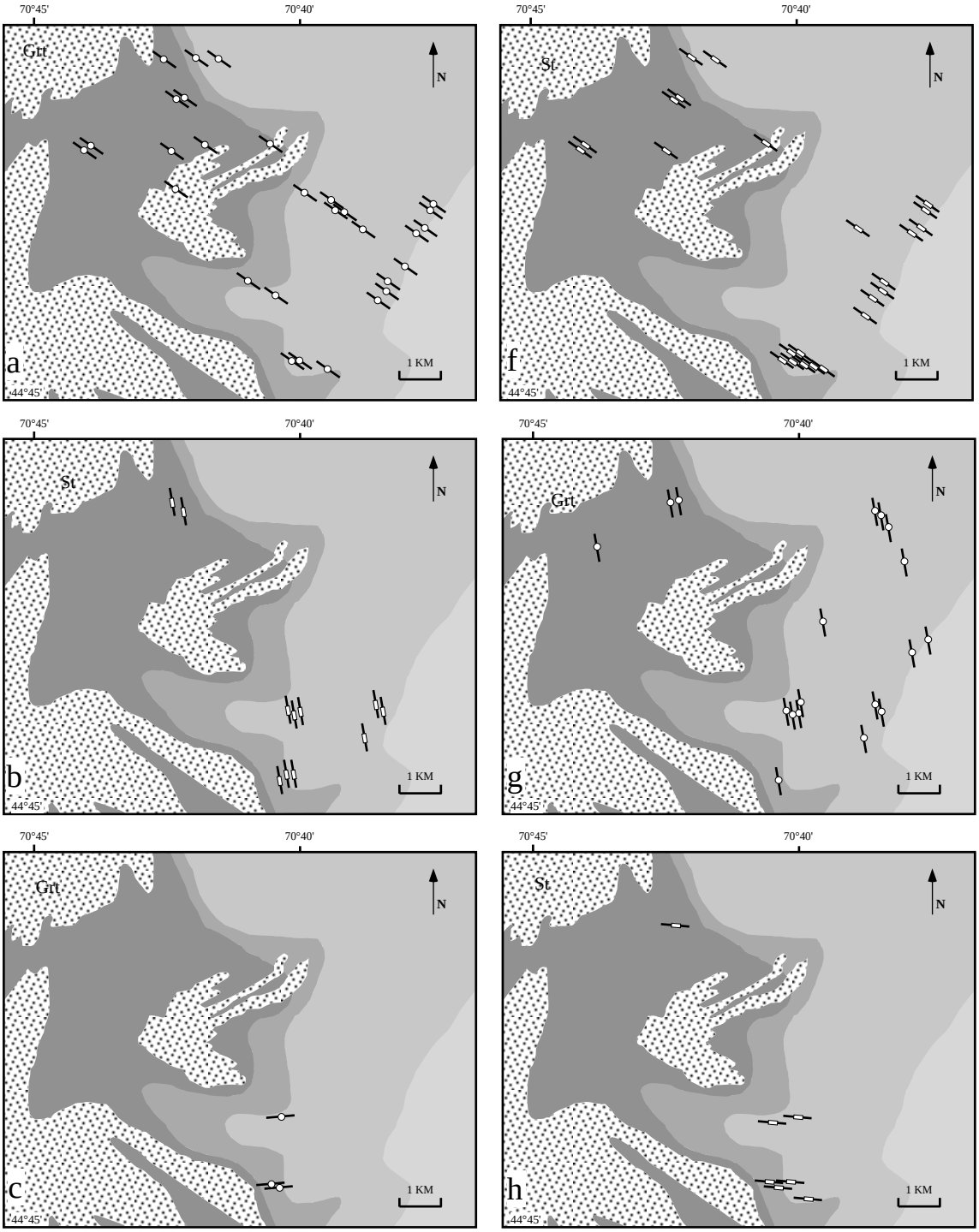


Figure 4. Equal-area rose diagrams of the FIAs in garnet (a), staurolite (b), and combined (c) garnet and staurolite porphyroblasts.



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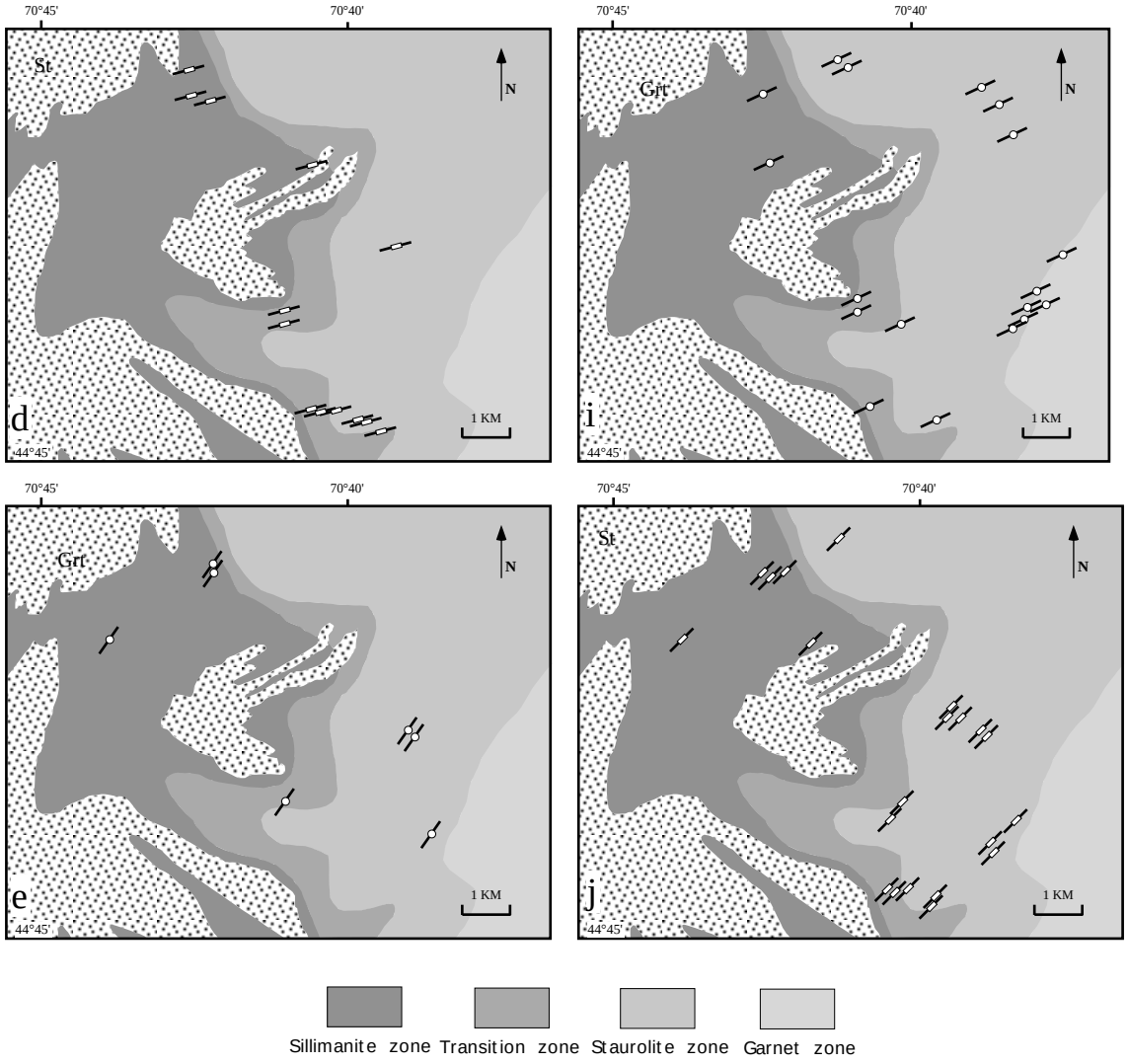


Figure 5. Simplified geological map of the study area showing the distribution of FIA trends based on sample location.

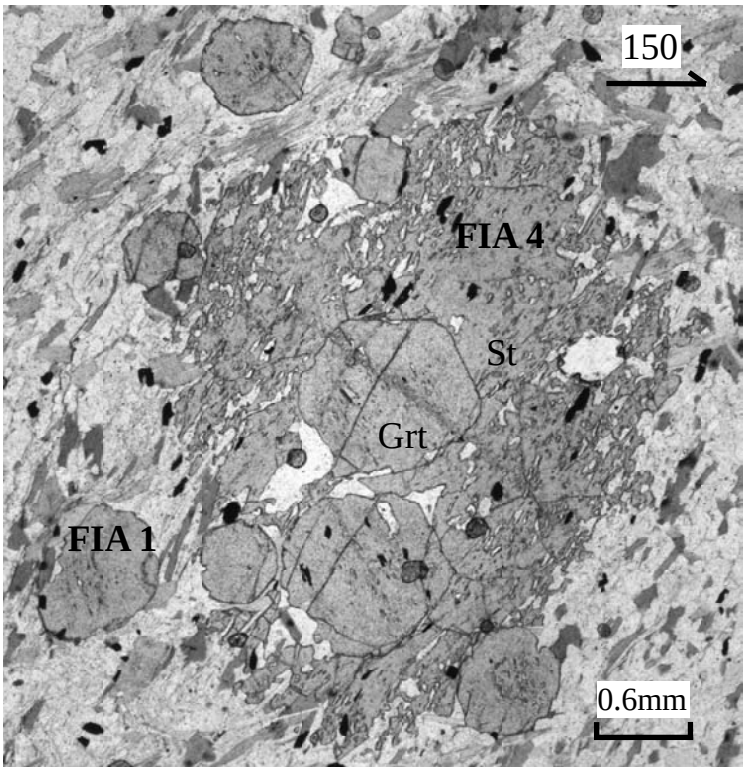


Figure 6. Photomicrograph showing the relationship between garnet and staurolite porphyroblast from sample IS2. Inclusion trails in garnet porphyroblasts contain FIA 1and are truncated by the inclusion trails in the staurolite porphyroblast that contains FIA 4.

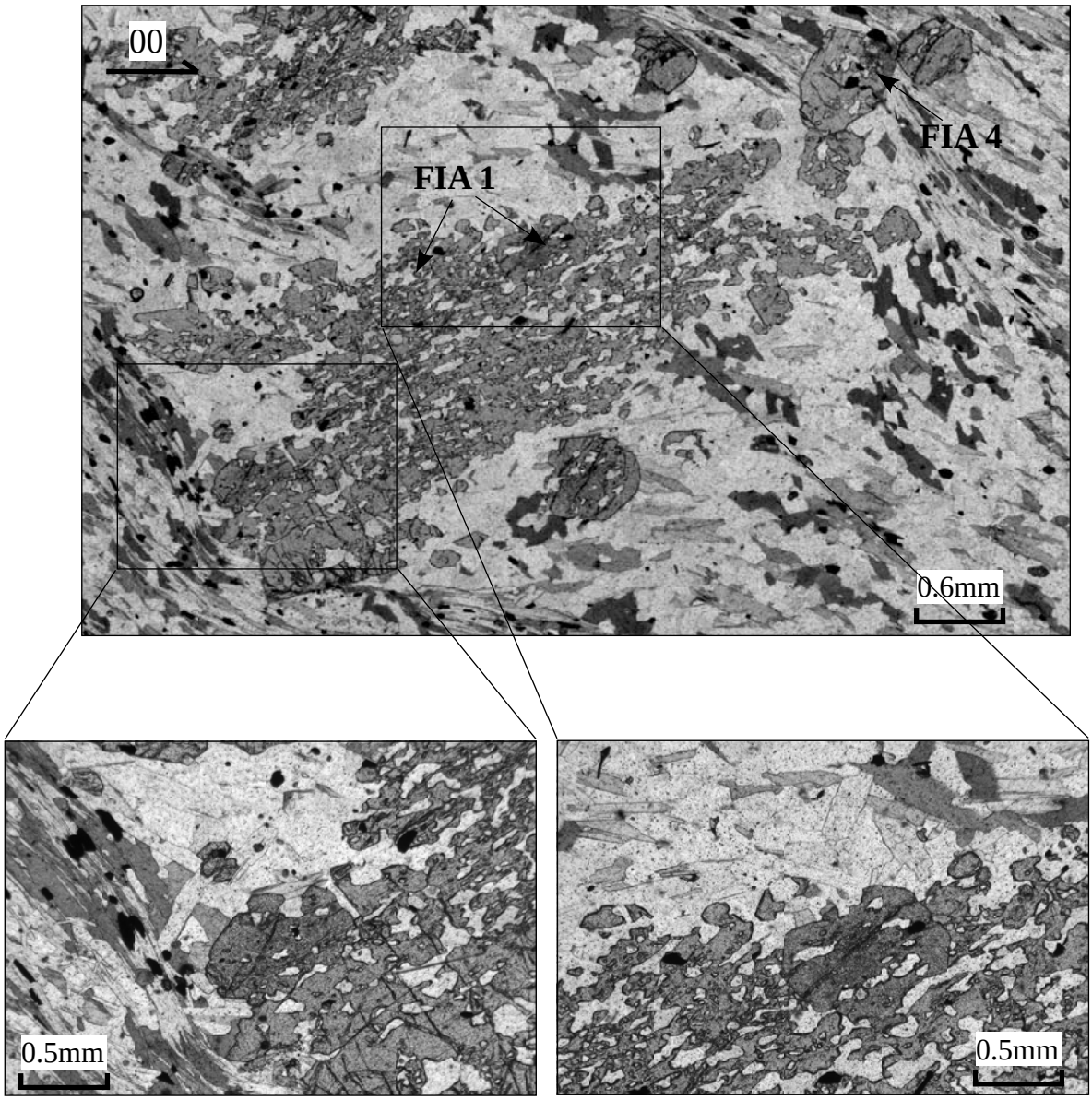


Figure 7. Photomicrograph showing the relationship between garnet and staurolite porphyroblasts from sample IS17. The inclusion trails in garnet are similar and continuous with the inclusion trails from the staurolite core. They both contain FIA1. Staurolite porphyroblasts from this sample usually have a rim growth that contains FIA 4.

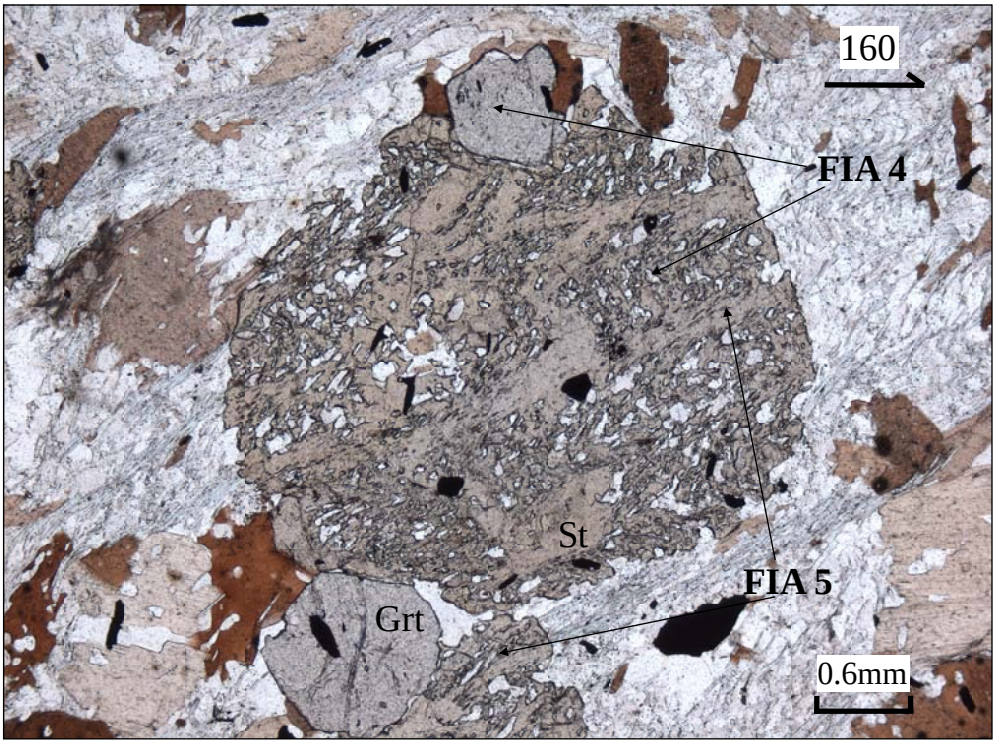


Figure 8. Photomicrograph showing the relationship between staurolite and garnet porphyroblasts from sample IS74. Garnet porphyroblasts grew in the hinge of a crenulation during FIA 4, which was overprinted by staurolite growth during FIA 5.

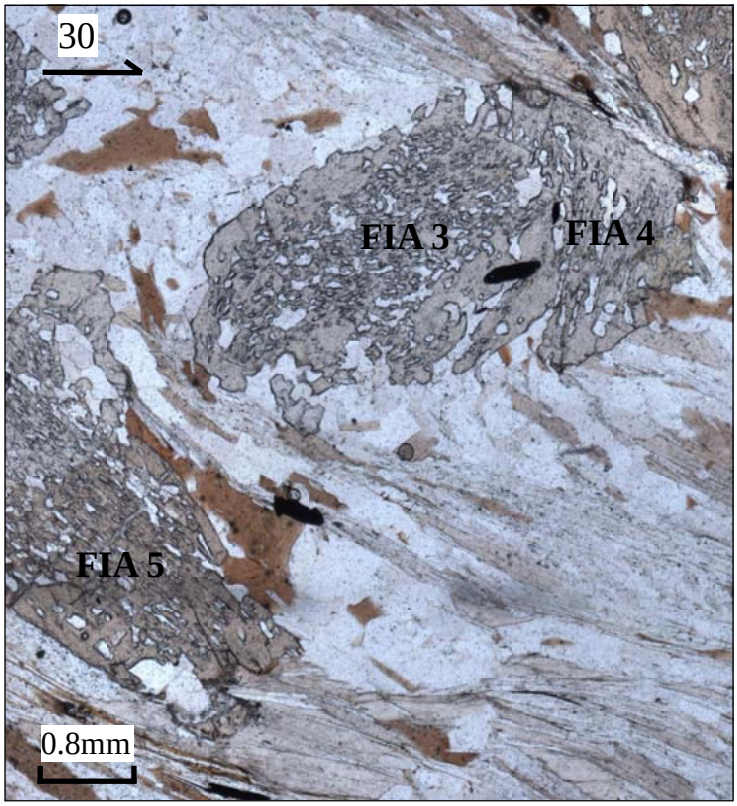


Figure 9. Photomicrograph from sample IS94 showing three generations of staurolite growth which correspond to FIAs 3, 4 and 5. In most cases FIA 5 staurolite overgrew the rim of FIA 4 staurolite, but it is not uncommon to find FIA 5 staurolite overgrowing the latest matrix foliation.

Sample no.	FIA 1		FIA 2		FIA 3		FIA 4		FIA 5	
	Grt	St	Grt	St	Grt	St	Grt	St	Grt	St
IS2	125							75		
IS4	125	125c		165r						
IS5	120	125c				95r				
IS7a	115	125								
IS9b	120							65		
IS10	115									30
IS11	120									35
IS14	120									40
IS17	125	125						75r		
IS25	120									45
IS28b	130									25
IS30	115	120								
IS42	125	115								
IS43	125	110								
IS47	125	115								
IS49	125	110								
IS52	125	110								
IS54	115	115								
IS57	110	120								
IS66	125	125								
IS68	115	125								
IS83	110	120								
IS89	115	115								
IS90	120	130c		165r						
IS103	125	120								
IS104	120	115								
IS12			145							35
IS18			165	165						
IS19			165			95				
IS20			165	165						
IS21			175	175						
IS55			175	175						
IS56			175	175c						45r
IS72			175					65		
IS73			165	165p						45
IS77			170	170c						45
IS93			165	165						
IS23					95	95				
IS94					100	90c		65m		25r
IS95					95	95c		65m		35r
IS24							75			45
IS27							75	75		
IS67							65			40
IS74							75	75p		40
IS85							65	65c		35r
IS7b									40	15
IS8									45	45
IS71									45	40
IS102									45	45

Table 3. FIA measurements for garnet and staurolite porphyroblasts, for only those samples where garnet porphyroblasts were included in staurolite. A clear succession from FIA 1 to FIA 5 can be established in this way.

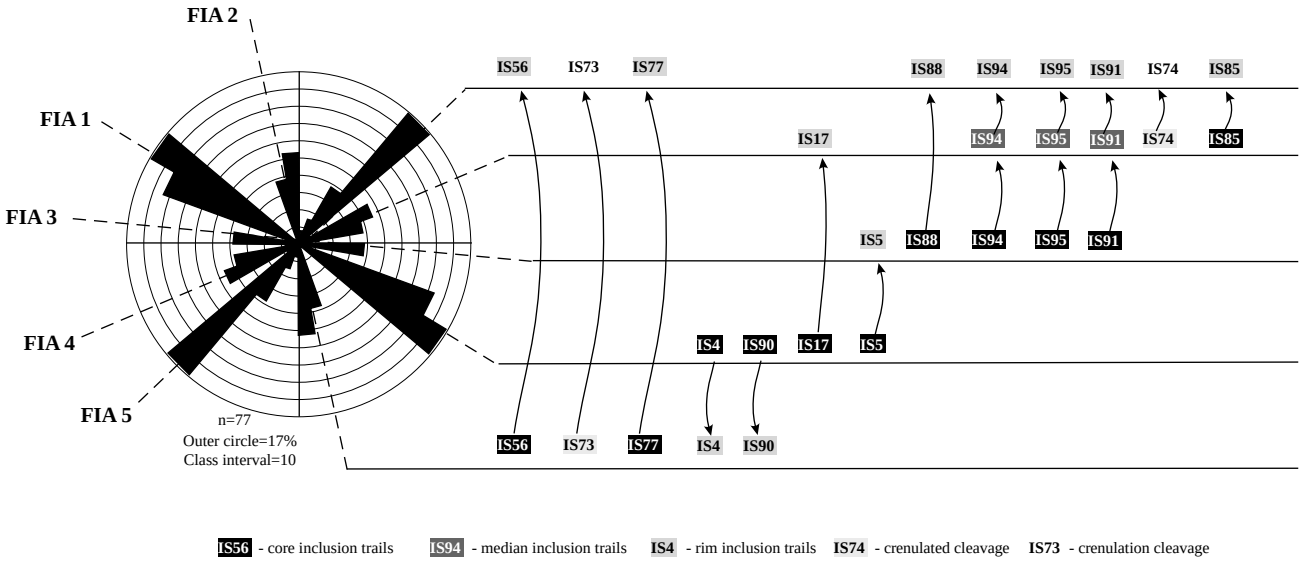


Figure 10. Equal-area rose diagrams of the FIAs in staurolite porphyroblasts illustrating how the relative FIA succession was established. Arrows show core-to-rim changes. A consistent succession is revealed by total combinations of changes.

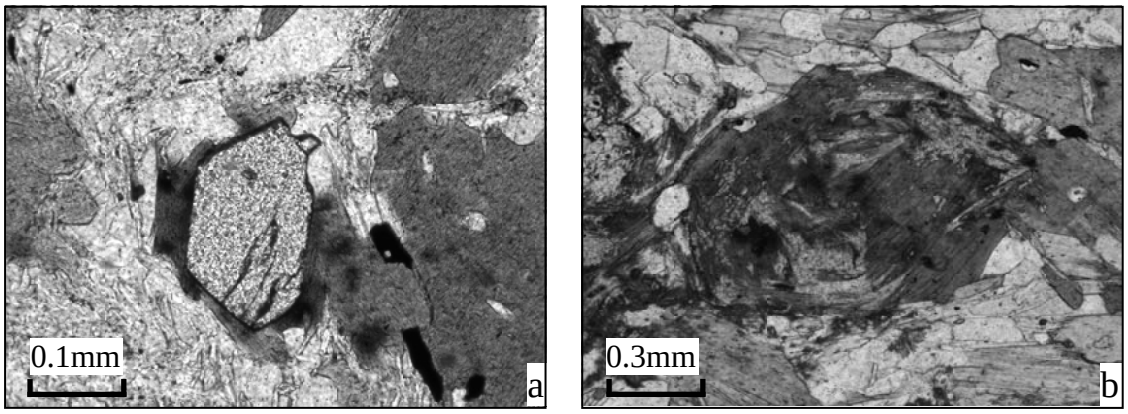


Figure 11. Photomicrographs showing a partially-dissolved garnet that has been replaced by biotite in sample IS71 (a) and a garnet that has been completely replaced by biotite and sillimanite from sample IS104 (b).

Element	X-ray	Crystal	Peak time (secs)	Background time (secs)	Background --/+ (mm)	Standard
P	Kά	TAP-1	20	10	3/4	$^{3}CePO_4$
Pb	Mά	PETJ-2*	180	90	4/6	$^{1}PbSiO_3$
La	Lά	LIFH-3*	10	5	1/4	$^{3}DyPO_4$
U	Mβ	PETJ-4	180	90	3.5/2.5	^{1}U
Th	Mά	PETJ-5	90	45	2.5/3	$^{2}ThO_2$
Y	Lά	TAP-1	60	30	1.25/2	$^{3}YPO_4$
Ce	Lά	LIFH-3*	10	5	1/1	$^{3}GdPO_4$
Ca	Kά	PETJ-5	20	10	1.6/1.6	$^{1}CaSiO_3$
Si	Kά	TAP-1	20	10	5/3	$^{1}PbSiO_3$
Pr	Lβ	LIFH-3*	20	10	1/1	$^{3}SmPO_4$
S	Kά	PETJ-5*	30	15	6/4	$^{1}BaSO_4$
Nd	Lβ	LIFH-3*	10	5	1/1	$^{3}NdPO_4$
Sm	Lβ	LIFH-3*	40	20	1/1	$^{3}PrPO_4$
Gd	Lβ	LIFH-3*	40	20	3.2/3.2	$^{3}CePO_4$
Dy	Lβ	LIFH-3*	40	20	1.6/1.6	$^{3}LaPO_4$

[1] – Astimex, [2] – Taylor, [3] – Pb-free synthetic from Pyle (Rensselaer Polytechnic Institute, USA)
** - sealed Xe detectors*

Table 3. Analytical setup for monazite analyses.

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
1	0.107	0.429	4.700	1.430	**414**	**43**	is23-m-1-1
2	0.065	0.251	3.040	1.320	**395**	**64**	is23-m-2-1
3	0.073	0.356	3.320	1.420	**384**	**56**	is23-m-3-1
4	0.084	0.407	3.960	1.350	**373**	**48**	is23-m-4-1
5	0.078	0.410	3.350	1.410	**394**	**54**	is23-m-5-1
6	0.084	0.329	4.440	1.410	**362**	**45**	is23-st1-1
7	0.127	0.433	5.820	1.350	**415**	**38**	is23-st1-2
8	0.062	0.355	2.020	1.540	**463**	**77**	is23-st1-3
9	0.133	0.436	6.320	1.440	**404**	**35**	is23-st2-1

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
10	0.073	0.357	3.840	1.320	**343**	**51**	is71-m-1-1
11	0.119	1.121	3.040	2.020	**365**	**40**	is71-m-2-1
12	0.093	0.895	2.920	1.800	**322**	**44**	is71-m-2-2
13	0.103	0.933	3.110	1.860	**339**	**42**	is71-m-2-3
14	0.093	0.772	2.730	1.920	**356**	**49**	is71-m-2-4
15	0.094	0.843	2.990	1.560	**337**	**45**	is71-m-2-5
16	0.093	0.345	4.500	1.310	**389**	**47**	is71-m-3-1
17	0.143	0.383	8.330	1.320	**352**	**29**	is71-m-4-1
18	0.148	0.400	7.960	1.420	**377**	**30**	is71-m-4-2
19	0.143	0.378	7.470	1.500	**388**	**32**	is71-m-4-3
20	0.162	0.352	9.240	1.300	**368**	**27**	is71-m-4-4
21	0.155	0.330	8.540	1.268	**382**	**30**	is71-m-4-5
22	0.071	0.350	3.920	1.370	**334**	**49**	is71-m-5-3
23	0.080	0.342	3.760	1.400	**388**	**53**	is71-m-6-1
24	0.053	0.266	2.820	1.205	**339**	**66**	is71-m-7-1
25	0.063	0.408	2.930	1.370	**349**	**58**	is71-m-8-1
26	0.071	0.411	3.230	1.340	**366**	**57**	is71-m-8-2
27	0.063	0.288	3.400	1.270	**345**	**58**	is71-m-9-1
28	0.063	0.252	3.770	1.196	**324**	**54**	is71-m-9-2
29	0.086	0.362	4.120	1.350	**385**	**50**	is71-m-9-3
30	0.064	0.304	3.560	1.244	**333**	**54**	is71-m-9-4
31	0.064	0.264	2.780	1.230	**414**	**71**	is71-m-9-5
32	0.053	0.271	2.710	1.246	**349**	**68**	is71-m-9-6
33	0.071	0.264	3.670	1.168	**372**	**56**	is71-m-10-1
34	0.123	0.304	6.960	1.340	**365**	**34**	is71-m-10-2
35	0.070	0.387	3.520	1.410	**346**	**52**	is71-m-11-1
36	0.114	0.323	6.340	1.320	**366**	**37**	is71-st1-1
37	0.078	0.424	3.850	1.560	**353**	**49**	is71-st1-2
38	0.047	0.382	2.070	1.430	**333**	**71**	is71-st1-3
39	0.087	0.501	4.630	1.620	**329**	**40**	is71-st1-4
40	0.078	0.300	4.150	1.310	**360**	**50**	is71-st1-5
41	0.062	0.290	3.140	1.270	**365**	**35**	is71-st2-1
42	0.089	0.308	4.540	1.266	**295**	**59**	is71-st2-2
43	0.100	0.363	5.430	1.223	**321**	**46**	is71-st2-3
44	0.085	0.321	3.810	1.290	**357**	**36**	is71-st2-4
45	0.077	0.405	3.470	1.300	**355**	**54**	is71-st2-5
46	0.124	0.328	5.870	1.390	**319**	**53**	is71-st2-6
47	0.148	0.379	6.830	1.430	**369**	**39**	is71-st2-7
48	0.062	0.383	2.570	1.320	**383**	**35**	is71-st2-8
49	0.113	0.294	5.310	1.247	**318**	**64**	is71-st2-9
50	0.085	0.292	3.910	1.234	**373**	**44**	is71-st2-10
51	0.137	0.370	5.620	1.460	**353**	**54**	is71-st2-11
52	0.091	0.437	3.240	1.550	**379**	**65**	is71-st3-1
53	0.094	0.502	3.130	1.480	**396**	**56**	is71-st3-2
54	0.111	0.495	4.850	1.350	**405**	**56**	is71-st3-3
55	0.099	0.499	3.830	1.490	**353**	**41**	is71-st3-4
56	0.085	0.472	3.620	1.500	**368**	**48**	is71-st4-1
57	0.073	0.403	3.240	1.400	**329**	**48**	is71-st4-2
58	0.079	0.411	3.500	1.460	**318**	**54**	is71-st4-3
59	0.071	0.411	3.590	1.460	**324**	**50**	is71-st4-4
60	0.099	0.438	4.430	1.430	**347**	**55**	is71-st4-5
61	0.099	0.423	3.730	1.570	**397**	**46**	is71-st4-6
62	0.076	0.460	2.590	1.450	**392**	**51**	is71-st5-1
63	0.083	0.422	2.890	1.480	**372**	**62**	is71-st5-2
64	0.069	0.441	2.550	1.440	**390**	**60**	is71-st5-3
65	0.071	0.488	2.780	1.460	**339**	**61**	is71-st5-4
66	0.061	0.426	1.820	1.370	**322**	**57**	is71-st5-5
67	0.068	0.450	2.040	1.350	**341**	**57**	is71-st5-6
68	0.082	0.431	3.560	1.330	**389**	**72**	is71-st5-7
69	0.102	0.450	4.840	1.280	**334**	**52**	is71-st5-8
70	0.113	0.423	5.820	1.280	**331**	**41**	is71-st5-9
71	0.094	0.368	4.000	1.251	**322**	**36**	is71-st5-10
72	0.094	0.394	4.500	1.264	**369**	**51**	is71-st5-11
73	0.111	0.343	5.260	1.241	**328**	**45**	is71-st5-12
74	0.131	0.519	6.620	1.470	**359**	**42**	is71-st5-13
75	0.121	0.615	5.330	1.620	**322**	**32**	is71-st5-14
76	0.097	0.669	3.700	1.600	**339**	**36**	is71-st5-15
77	0.146	0.578	6.550	1.540	**335**	**44**	is71-st5-16
78	0.135	0.417	6.940	1.360	**360**	**33**	is71-st5-17
79	0.104	0.377	4.960	1.390	**336**	**33**	is71-st5-18
80	0.101	0.344	4.850	1.320	**341**	**43**	is71-st5-19
81	0.140	0.517	6.610	1.490	**343**	**44**	is71-st5-20
82	0.124	0.617	4.660	1.630	**350**	**33**	is71-st5-21
83	0.109	0.706	4.190	1.600	**384**	**40**	is71-st5-22
84	0.059	0.353	2.640	1.320	**342**	**40**	is71-st5-23
85	0.084	0.345	4.050	1.300	**297**	**63**	is71-st5-24
86	0.090	0.304	4.730	1.215	**327**	**49**	is71-st5-25
87	0.080	0.340	3.790	1.268	**316**	**44**	is71-st5-26
88	0.126	0.370	6.550	1.340	**329**	**52**	is71-st5-27
89	0.127	0.377	6.430	1.204	**335**	**35**	is71-st5-28
90	0.080	0.401	3.110	1.390	**344**	**35**	is71-st5-29
91	0.066	0.368	2.910	1.350	**365**	**57**	is71-st5-30
92	0.108	0.407	4.520	1.400	**315**	**59**	is71-st5-31
93	0.085	0.431	3.180	1.430	**379**	**46**	is71-st5-32
94	0.091	0.447	4.050	1.410	**376**	**56**	is71-st5-33
95	0.100	0.430	4.010	1.310	**335**	**47**	is71-st5-34
96	0.074	0.422	3.520	1.270	**379**	**49**	is71-st5-35
97	0.077	0.434	3.150	1.340	**365**	**63**	is71-st5-36
98	0.073	0.429	2.640	1.370	**340**	**55**	is71-st5-37
99	0.053	0.445	2.180	1.350	**359**	**63**	is71-st5-38
100	0.077	0.451	2.860	1.360	**351**	**84**	is71-st6-1
101	0.090	0.504	2.950	1.460	**359**	**59**	is71-st6-2
102	0.092	0.546	2.880	1.590	**402**	**57**	is71-st6-3
103	0.065	0.452	2.700	1.410	**400**	**56**	is71-st6-4
104	0.073	0.484	2.860	1.470	**306**	**58**	is71-st6-5
105	0.086	0.519	3.200	1.540	**325**	**56**	is71-st6-6
106	0.098	0.526	3.880	1.078	**354**	**53**	is71-st6-7
107	0.135	0.356	7.030	1.192	**368**	**48**	is71-st6-8
108	0.108	0.266	5.650	1.153	**343**	**33**	is71-st6-9
109	0.159	0.419	8.070	1.360	**339**	**40**	is71-st6-10

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
110	0.169	0.434	8.080	1.400	**352**	**30**	is71-st6-11
111	0.129	0.383	5.980	1.350	**372**	**30**	is71-st6-12
112	0.100	0.440	4.550	1.310	**371**	**38**	is71-st6-13

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
113	0.053	0.350	2.190	1.480	**373**	**73**	is74-m-1-1
114	0.067	0.467	2.580	1.720	**385**	**61**	is74-m-1-2
115	0.050	0.352	2.170	1.420	**355**	**72**	is74-m-1-3
116	0.065	0.378	3.000	1.450	**365**	**59**	is74-m-1-4
117	0.048	0.349	2.420	1.430	**322**	**67**	is74-m-1-5
118	0.054	0.360	2.200	1.340	**380**	**73**	is74-m-1-6
119	0.070	0.339	2.800	1.330	**424**	**67**	is74-m-1-7
120	0.063	0.400	3.220	1.253	**331**	**55**	is74-m-1-8
121	0.093	0.593	4.270	1.510	**353**	**42**	is74-m-1-9
122	0.070	0.487	3.210	1.610	**347**	**52**	is74-m-1-10
123	0.044	0.353	2.060	1.410	**324**	**72**	is74-m-1-11
124	0.076	0.402	3.230	1.310	**395**	**57**	is74-m-1-12
125	0.046	0.426	1.850	1.580	**337**	**73**	is74-m-2-1
126	0.077	0.440	3.970	1.420	**339**	**48**	is74-m-2-2
127	0.058	0.348	2.530	1.400	**376**	**67**	is74-m-3-1
128	0.089	0.505	3.810	1.700	**386**	**48**	is74-m-3-2
129	0.059	0.390	2.890	1.620	**335**	**59**	is74-m-3-3
130	0.086	0.732	2.710	1.840	**397**	**51**	is74-m-4-1
131	0.059	0.444	2.630	1.420	**344**	**60**	is74-m-5-1
132	0.072	0.396	3.340	1.650	**365**	**54**	is74-m-6-1
133	0.071	0.418	3.710	1.370	**331**	**49**	is74-m-6-2
134	0.080	0.394	3.590	1.162	**388**	**54**	is74-m-6-3
135	0.070	0.409	3.210	1.254	**363**	**56**	is74-m-6-4
136	0.092	0.525	4.420	1.300	**355**	**43**	is74-m-6-5
137	0.127	0.459	6.750	0.956	**364**	**34**	is74-m-6-6
138	0.108	0.908	4.170	1.610	**359**	**38**	is74-m-6-7
139	0.044	0.307	2.210	1.219	**322**	**75**	is74-m-7-1
140	0.069	0.430	3.720	1.350	**320**	**49**	is74-m-7-2
141	0.070	0.483	3.120	1.500	**352**	**53**	is74-m-8-1
142	0.124	0.980	4.450	1.650	**384**	**36**	is74-m-8-2
143	0.068	0.426	2.900	1.350	**376**	**60**	is74-m-8-3
144	0.156	0.836	7.330	2.190	**366**	**28**	is74-st1-1
145	0.089	0.424	4.720	1.650	**346**	**43**	is74-st1-2
146	0.069	0.374	3.160	1.530	**372**	**58**	is74-st2-1
147	0.076	0.428	3.470	1.630	**368**	**52**	is74-st3-1
148	0.175	0.638	8.790	1.830	**381**	**27**	is74-st4-1
149	0.110	0.426	5.030	1.470	**405**	**42**	is74-st5-1
150	0.087	0.378	4.210	1.610	**378**	**48**	is74-st5-2
151	0.141	0.471	7.590	1.600	**365**	**30**	is74-st5-3
152	0.055	0.337	2.830	1.310	**332**	**62**	is74-st6-1

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
153	0.105	0.486	3.930	1.280	**447**	**50**	is77-m-1-1
154	0.110	0.271	5.460	1.450	**410**	**43**	is77-m-2-1
155	0.168	0.324	9.110	1.380	**390**	**29**	is77-m-3-1
156	0.202	0.304	10.590	1.530	**412**	**26**	is77-m-4-1
157	0.250	0.336	13.130	1.350	**414**	**22**	is77-m-5-1
158	0.100	0.293	5.190	1.410	**384**	**43**	is77-st1-1
159	0.089	0.270	4.130	1.450	**419**	**52**	is77-st2-1
160	0.100	0.265	4.830	1.470	**414**	**47**	is77-st2-2
161	0.179	0.284	9.280	1.390	**413**	**29**	is77-st3-1
162	0.184	0.344	9.080	1.460	**425**	**29**	is77-st4-1
163	0.088	0.278	4.070	1.370	**415**	**54**	is77-st5-1
164	0.133	0.267	7.140	1.420	**393**	**35**	is77-st5-2
165	0.225	0.321	11.750	1.222	**415**	**24**	is77-st5-3
166	0.145	0.340	7.410	1.129	**401**	**33**	is77-st5-4
167	0.092	0.287	4.960	1.310	**368**	**45**	is77-st6-1
168	0.196	0.360	10.160	1.500	**408**	**26**	is77-st7-1
169	0.038	0.116	1.720	1.350	**425**	**114**	is77-st8-1

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
170	0.191	0.437	10.860	1.400	**367**	**23**	is88-m-1-1
171	0.098	0.382	4.590	1.270	**396**	**45**	is88-m-2-1
172	0.104	0.737	4.530	1.340	**355**	**38**	is88-m-3-1
173	0.255	0.515	14.340	1.460	**376**	**19**	is88-m-3-2
174	0.051	0.372	1.990	1.216	**375**	**74**	is88-m-4-1
175	0.134	0.400	6.950	1.310	**384**	**33**	is88-m-4-2
176	0.056	0.370	1.940	1.270	**419**	**79**	is88-m-5-1
177	0.150	0.476	8.410	1.400	**355**	**27**	is88-m-6-1
178	0.159	0.491	8.650	1.380	**367**	**27**	is88-m-6-2
179	0.143	0.378	7.480	1.320	**389**	**32**	is88-st1-1
180	0.175	0.446	9.250	1.320	**386**	**26**	is88-st1-2
181	0.175	0.463	9.460	1.320	**377**	**26**	is88-st2-1
182	0.156	0.438	8.400	1.320	**374**	**28**	is88-st2-2
183	0.136	0.437	6.700	1.310	**394**	**34**	is88-st2-3
184	0.117	0.422	5.820	1.300	**382**	**37**	is88-st3-1
185	0.197	0.459	10.430	1.290	**390**	**24**	is88-st4-1
186	0.173	0.418	8.870	1.390	**400**	**28**	is88-st4-2
187	0.122	0.384	6.520	1.290	**370**	**34**	is88-st4-3

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
188	0.087	0.682	2.990	1.440	**392**	**49**	is94-m-1-1
189	0.082	0.604	3.200	1.248	**374**	**50**	is94-m-1-2
190	0.089	0.542	3.650	0.947	**389**	**48**	is94-m-1-3
191	0.105	0.512	4.960	0.532	**374**	**41**	is94-m-1-4
192	0.098	0.493	4.970	0.406	**351**	**41**	is94-m-1-5
193	0.120	0.559	5.770	0.466	**374**	**36**	is94-m-1-6
194	0.077	0.398	3.930	0.575	**350**	**49**	is94-m-1-7
195	0.068	0.348	3.440	0.492	**354**	**56**	is94-m-1-8
196	0.088	0.457	4.200	0.633	**364**	**47**	is94-m-1-9
197	0.093	0.448	4.350	0.516	**376**	**46**	is94-m-1-10
198	0.073	0.361	3.120	0.639	**404**	**62**	is94-m-1-11
199	0.096	0.432	4.180	0.392	**403**	**48**	is94-m-1-12
200	0.109	0.500	4.860	0.454	**397**	**42**	is94-m-1-13
201	0.090	0.393	4.410	0.559	**372**	**48**	is94-m-1-14
202	0.085	0.508	4.540	0.501	**324**	**42**	is94-m-1-15
203	0.076	0.445	3.610	0.617	**355**	**51**	is94-m-1-16
204	0.065	0.390	2.690	0.751	**385**	**64**	is94-m-1-17
205	0.061	0.377	2.560	0.745	**379**	**67**	is94-m-1-18
206	0.059	0.345	2.610	0.702	**372**	**67**	is94-m-1-19
207	0.065	0.338	3.460	0.465	**339**	**56**	is94-m-1-20
208	0.064	0.353	3.200	0.373	**346**	**60**	is94-m-1-21
209	0.082	0.375	3.880	0.244	**379**	**52**	is94-m-1-22
210	0.062	0.332	2.410	0.645	**419**	**74**	is94-m-1-23

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
211	0.074	0.393	3.680	0.382	**353**	**53**	is94-m-1-24
212	0.082	0.380	4.270	0.310	**353**	**48**	is94-m-1-25
213	0.083	0.423	4.030	0.251	**363**	**49**	is94-m-1-26
214	0.080	0.410	3.370	0.666	**399**	**56**	is94-m-1-27
215	0.082	0.445	4.130	0.414	**347**	**48**	is94-m-1-28
216	0.106	0.542	5.190	0.475	**359**	**39**	is94-m-1-29
217	0.124	0.571	6.160	0.420	**366**	**35**	is94-m-1-30
218	0.086	0.386	4.040	0.377	**381**	**51**	is94-m-1-31
219	0.090	0.487	4.130	0.333	**374**	**47**	is94-m-1-32
220	0.104	0.584	4.650	0.847	**373**	**41**	is94-m-2-1
221	0.053	0.359	2.650	0.616	**329**	**65**	is94-m-2-2
222	0.066	0.435	2.840	0.781	**364**	**60**	is94-m-2-3
223	0.065	0.489	2.880	0.904	**345**	**56**	is94-m-2-4
224	0.063	0.444	3.190	0.784	**320**	**54**	is94-m-2-5
225	0.073	0.408	3.260	0.692	**376**	**56**	is94-m-2-6
226	0.062	0.377	3.090	1.034	**338**	**57**	is94-m-2-7
227	0.129	0.433	6.420	0.334	**387**	**36**	is94-m-2-8
228	0.098	0.432	5.190	0.432	**350**	**40**	is94-m-2-9
229	0.095	0.509	4.880	0.588	**344**	**40**	is94-m-2-10
230	0.080	0.423	3.810	0.492	**365**	**51**	is94-m-2-11
231	0.087	0.442	3.730	0.755	**396**	**51**	is94-m-2-12
232	0.113	0.523	5.030	0.669	**395**	**41**	is94-m-2-13
233	0.100	0.534	5.370	0.525	**334**	**37**	is94-m-2-14
234	0.120	0.528	5.220	0.447	**407**	**40**	is94-m-2-15
235	0.108	0.612	5.140	0.667	**358**	**38**	is94-m-2-16
236	0.108	0.563	5.020	0.627	**372**	**40**	is94-m-2-17
237	0.115	0.577	5.280	0.692	**378**	**38**	is94-m-2-18
238	0.117	0.526	5.350	0.420	**391**	**39**	is94-m-2-19
239	0.096	0.516	4.810	0.485	**348**	**41**	is94-m-2-20
240	0.112	0.507	5.330	0.514	**380**	**39**	is94-m-2-21
241	0.084	0.389	4.070	0.325	**370**	**51**	is94-m-2-22
242	0.110	0.583	5.280	0.436	**363**	**38**	is94-m-2-23
243	0.117	0.544	5.460	0.432	**383**	**38**	is94-m-2-24
244	0.132	0.594	6.250	0.369	**380**	**34**	is94-m-2-25
245	0.125	0.448	6.040	0.338	**394**	**37**	is94-m-2-26
246	0.154	0.420	8.090	0.062	**385**	**30**	is94-m-3-1
247	0.164	0.450	8.610	0.086	**385**	**28**	is94-m-3-2
248	0.101	0.437	4.880	0.105	**378**	**43**	is94-m-3-3
249	0.092	0.415	4.690	0.131	**359**	**45**	is94-m-3-4
250	0.106	0.397	5.300	0.101	**379**	**42**	is94-m-3-5
251	0.130	0.412	6.300	0.095	**401**	**37**	is94-m-3-6
252	0.084	0.380	4.140	0.115	**371**	**50**	is94-m-3-7
253	0.185	0.441	9.410	0.065	**402**	**27**	is94-m-3-8
254	0.058	0.365	2.510	0.808	**372**	**68**	is94-st1-1
255	0.072	0.426	3.340	0.767	**359**	**55**	is94-st1-2
256	0.082	0.429	3.740	0.647	**378**	**51**	is94-st1-3
257	0.129	0.585	6.160	0.428	**378**	**35**	is94-st1-4
258	0.089	0.429	4.320	0.502	**369**	**48**	is94-st1-5
259	0.104	0.513	5.120	0.635	**361**	**41**	is94-st1-6
260	0.067	0.377	2.980	0.797	**375**	**63**	is94-st1-7
261	0.071	0.389	3.580	0.751	**344**	**54**	is94-st2-1
262	0.089	0.366	4.160	0.735	**392**	**51**	is94-st2-2
263	0.073	0.322	3.690	0.744	**362**	**56**	is94-st2-3
264	0.092	0.330	4.290	0.756	**406**	**51**	is94-st2-4
265	0.055	0.183	2.660	0.928	**396**	**79**	is94-st2-5
266	0.032	0.094	1.990	0.982	**325**	**99**	is94-st2-6
267	0.051	0.165	3.080	0.970	**334**	**67**	is94-st3-1
268	0.065	0.242	3.380	1.170	**367**	**61**	is94-st3-2
269	0.060	0.284	2.990	1.040	**365**	**66**	is94-st3-3
270	0.052	0.231	2.470	1.123	**381**	**78**	is94-st3-4
271	0.032	0.145	1.680	0.853	**354**	**109**	is94-st3-5
272	0.044	0.175	2.240	0.874	**373**	**87**	is94-st3-6
273	0.054	0.122	2.570	1.320	**427**	**83**	is94-st3-7
274	0.068	0.354	2.860	0.770	**401**	**67**	is94-st3-8
275	0.108	0.507	4.730	0.932	**401**	**43**	is94-st3-9
276	0.068	0.331	3.040	0.816	**391**	**65**	is94-st3-10
277	0.086	0.340	4.640	0.597	**355**	**47**	is94-st3-11
278	0.078	0.303	4.220	0.530	**352**	**52**	is94-st3-12
279	0.084	0.303	4.210	0.438	**379**	**53**	is94-st3-13
280	0.116	0.346	5.680	0.353	**402**	**42**	is94-st3-14
281	0.138	0.514	6.920	0.681	**378**	**34**	is94-st3-15
282	0.091	0.366	4.760	0.582	**360**	**46**	is94-st3-16
283	0.085	0.371	4.150	0.864	**375**	**50**	is94-st3-17
284	0.083	0.356	3.660	0.795	**406**	**56**	is94-st3-18
285	0.105	0.387	5.540	0.371	**364**	**41**	is94-st4-1
286	0.083	0.310	3.850	0.577	**401**	**56**	is94-st4-2
287	0.047	0.232	2.540	1.072	**336**	**74**	is94-st4-3
288	0.033	0.103	1.980	0.914	**338**	**101**	is94-st4-4
289	0.074	0.419	3.990	1.470	**329**	**47**	is94-st4-5
290	0.055	0.213	2.660	1.100	**387**	**75**	is94-st4-6
291	0.054	0.293	2.690	0.850	**348**	**70**	is94-st4-7
292	0.071	0.367	3.000	0.837	**399**	**63**	is94-st4-8

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
293	0.060	0.759	0.505	1.920	**385**	**81**	is95-st1-1
294	0.066	0.808	0.739	1.740	**391**	**73**	is95-st1-2
295	0.071	0.461	1.870	1.221	**434**	**78**	is95-st2-1
296	0.155	0.819	6.700	0.726	**358**	**31**	is95-st2-2
297	0.125	0.788	4.790	0.988	**362**	**38**	is95-st2-3
298	0.084	0.380	3.440	1.240	**367**	**56**	is95-st2-4
299	0.115	0.558	4.400	1.460	**382**	**44**	is95-st2-5
300	0.115	0.536	4.970	1.500	**352**	**40**	is95-st2-6
301	0.105	0.431	4.120	1.360	**391**	**48**	is95-st2-7
302	0.083	0.758	1.500	1.790	**421**	**65**	is95-st3-1
303	0.083	0.684	2.250	1.660	**375**	**58**	is95-st3-2
304	0.066	0.792	0.940	1.590	**375**	**71**	is95-st3-3
305	0.081	0.520	3.010	1.244	**352**	**55**	is95-st8-3-1
306	0.165	0.586	7.410	0.546	**384**	**32**	is95-st8-3-2
307	0.060	0.540	1.740	1.420	**338**	**72**	is95-st8-3-3
308	0.082	0.501	3.030	1.029	**364**	**58**	is95-st8-3-4
309	0.073	0.409	2.310	1.174	**409**	**73**	is95-st8-3-5
310	0.062	0.464	1.630	1.400	**393**	**81**	is95-st8-3-6
311	0.074	0.492	2.340	1.189	**386**	**67**	is95-st8-3-7
312	0.073	0.579	2.060	1.400	**374**	**66**	is95-st8-3-8
313	0.126	0.755	5.060	0.724	**361**	**38**	is95-st5-1
314	0.166	0.692	7.950	0.400	**353**	**29**	is95-st5-2
315	0.223	0.576	11.33	0.161	**369**	**24**	is95-st6-1
316	0.201	0.708	8.920	0.261	**394**	**27**	is95-st6-2
317	0.075	0.513	2.950	0.712	**345**	**59**	is95-st6-3
318	0.073	0.461	2.350	0.859	**401**	**70**	is95-st6-4
319	0.073	0.628	2.540	0.817	**333**	**59**	is95-st6-5

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
320	0.148	0.781	6.320	0.425	**364**	**33**	is95-st6-6
321	0.059	0.267	2.560	1.249	**356**	**46**	is95-st7-1
322	0.071	0.341	2.520	1.320	**389**	**72**	is95-st7-2
323	0.074	0.351	3.110	1.164	**351**	**62**	is95-st7-3
324	0.071	0.378	2.740	1.420	**355**	**64**	is95-st7-4
325	0.067	0.409	2.400	1.330	**359**	**67**	is95-st7-5
326	0.121	0.478	4.900	1.440	**390**	**42**	is95-st8-1-1
327	0.274	0.588	14.77	0.336	**356**	**19**	is95-st8-1-2
328	0.156	0.487	8.330	0.920	**332**	**28**	is95-st8-1-3
329	0.095	0.426	4.570	1.270	**324**	**43**	is95-st8-1-4
330	0.247	0.530	13.28	0.330	**356**	**21**	is95-st8-1-5
331	0.121	0.463	5.730	1.280	**347**	**37**	is95-st8-1-6
332	0.079	0.533	3.060	0.971	**343**	**55**	is95-st8-1-7
333	0.154	0.679	6.950	1.310	**355**	**31**	is95-st8-1-8
334	0.188	0.521	9.410	0.670	**364**	**26**	is95-st8-1-9
335	0.147	0.556	7.240	0.412	**351**	**32**	is95-st8-1-10
336	0.097	0.560	3.610	1.280	**368**	**49**	is95-st8-2-1
337	0.080	0.399	3.380	1.133	**349**	**55**	is95-st8-2-2
338	0.159	0.697	7.400	0.585	**355**	**30**	is95-st8-2-3
339	0.113	0.552	4.620	0.763	**376**	**43**	is95-st8-2-4
340	0.069	0.465	2.000	1.022	**405**	**75**	is95-st8-2-5
341	0.058	0.464	1.680	1.077	**372**	**78**	is95-st8-2-6
342	0.110	0.761	3.960	1.032	**364**	**43**	is95-st8-2-7
343	0.051	0.359	1.640	1.154	**354**	**87**	is95-st8-2-8
344	0.069	0.501	2.330	1.038	**358**	**65**	is95-st8-2-9
345	0.094	0.599	3.340	1.078	**370**	**51**	is95-st8-2-10
346	0.066	0.327	2.600	1.057	**366**	**70**	is95-st8-2-11
347	0.083	0.381	3.270	1.095	**381**	**58**	is95-st8-2-12
348	0.069	0.531	2.490	1.209	**329**	**59**	is95-st8-2-13

No.	PbO	UO_2	ThO_2	Y_2O_3	Age (Ma)	Error (2σ)	Comments
349	0.144	0.859	6.530	0.373	**365**	**32**	is104-m-1-1
350	0.083	0.768	3.540	0.601	**326**	**45**	is104-m-2-1
351	0.151	0.847	6.500	0.585	**384**	**32**	is104-m-3-1
352	0.080	0.612	3.530	1.330	**342**	**47**	is104-m-4-1
353	0.095	0.693	3.720	1.510	**375**	**44**	is104-m-5-1
354	0.097	1.199	2.250	0.963	**374**	**45**	is104-m-6-1
355	0.106	0.546	4.570	0.566	**395**	**44**	is104-m-7-1
356	0.091	0.969	2.220	1.219	**399**	**51**	is104-m-8-1
357	0.076	0.727	2.730	0.646	**354**	**53**	is104-m-9-1
358	0.075	0.565	3.530	0.360	**329**	**51**	is104-m-10-1
359	0.070	0.541	3.150	0.388	**339**	**55**	is104-m-10-2
360	0.119	1.191	3.960	1.053	**358**	**36**	is104-m-11-1
361	0.122	1.094	3.640	1.009	**399**	**40**	is104-m-11-2
362	0.075	1.058	1.980	1.330	**328**	**47**	is104-m-12-1
363	0.092	0.978	2.350	1.076	**392**	**49**	is104-m-12-2
364	0.049	0.395	2.350	0.587	**317**	**70**	is104-m-13-1
365	0.111	0.612	4.960	0.334	**376**	**41**	is104-m-14-1
366	0.087	0.515	4.340	0.276	**340**	**46**	is104-m-14-2
367	0.079	0.559	3.920	0.483	**326**	**47**	is104-m-15-1
368	0.058	0.463	2.910	0.476	**313**	**59**	is104-m-16-1
369	0.084	0.475	3.580	0.514	**388**	**53**	is104-m-16-2
370	0.113	0.601	5.640	0.512	**352**	**37**	is104-m-17-1
371	0.085	0.534	4.220	0.469	**337**	**46**	is104-m-17-2
372	0.103	0.514	5.030	0.527	**365**	**41**	is104-m-17-3
373	0.086	0.562	3.900	0.545	**354**	**48**	is104-m-17-4
374	0.097	0.672	3.710	1.550	**389**	**46**	is104-m-17-5
375	0.066	0.416	2.860	0.583	**369**	**63**	is104-m-17-6
376	0.079	0.595	3.770	1.015	**329**	**46**	is104-m-17-7
377	0.090	0.630	3.760	1.214	**367**	**46**	is104-m-17-8
378	0.128	0.647	6.010	0.529	**372**	**36**	is104-m-17-9
379	0.075	0.477	3.550	0.511	**347**	**53**	is104-m-17-10
380	0.118	0.638	5.470	0.529	**369**	**38**	is104-m-18-1
381	0.166	0.923	7.630	0.484	**368**	**28**	is104-m-18-2
382	0.202	0.939	9.500	0.256	**380**	**25**	is104-m-19-1
383	0.157	0.632	8.130	0.291	**364**	**29**	is104-m-20-1

Table 4. Monazite chemistry and calculated ages for every analytical spot.

Sample no.	Grain no.	Grain location	FIA	Yttrium statistics							Age (Ma)	
				Mean (%)	Std. error	Median	Mode	Stdev	Variance	Count	Grain	Location
IS23	is23-stx	core	3	1.435	0.040	1.425	N/A	0.079	0.006	4	403±22	403±22
IS71	is71-st1	core	5	1.448	0.062	1.430	N/A	0.140	0.019	5	350±20	350,6±5.2
	is71-st2			1.312	0.024	1.290	N/A	0.080	0.006	11	354±13	
	is71-st3			1.468	0.042	1.485	N/A	0.084	0.007	4	378±26	
	is71-st4			1.470	0.024	1.460	1.460	0.059	0.004	6	349±20	
	is71-st5			1.381	0.018	1.355	1.350	0.113	0.013	38	345,1±7.3	
	is71-st6			1.359	0.041	1.360	1.360	0.149	0.022	13	357±12	
IS74	is74-stx	crenulated cleavege	4	1.647	0.083	1.610	N/A	0.248	0.061	9	371±13	371±13
IS77	is77-st5	core	2	1.285	0.067	1.296	N/A	0.134	0.018	4	407±16	408±10
	is77-stx			1.418	0.023	1.430	N/A	0.065	0.004	8	408±13	
IS88	is88-stx	core	3	1.318	0.010	1.320	1.320	0.030	0.001	9	385±9.7	385±9.7
IS94	is94-st1	median	4	0.655	0.056	0.647	N/A	0.148	0.022	7	371±18	375.9±9.6
	is94-st2			0.816	0.045	0.754	N/A	0.109	0.012	6	376±24	
	is94-st3			0.817	0.061	0.835	N/A	0.258	0.067	18	378±13	
	is94-st4	rim	5	0.899	0.118	0.882	N/A	0.335	0.112	8	363±21	363±21
IS95	is95-st2	median	4	1.214	0.104	1.240	N/A	0.275	0.076	7	369±16	370.2±8
	is95-st8-3			1.175	0.102	1.216	1.400	0.289	0.083	8	376±20	
	is95-st6			0.539	0.121	0.568	N/A	0.298	0.089	6	373±14	
	is95-st7			1.296	0.043	1.320	N/A	0.096	0.009	5	360±27	
	is95-stx			1.403	0.224	1.660	N/A	0.591	0.350	7	368±18	
	is95-st8-1	rim	5	0.894	0.137	0.945	N/A	0.432	0.187	10	353.2±9.1	356.1±7.7
	is95-st8-2			1.040	0.051	1.077	N/A	0.182	0.033	13	363±14	

Table 5. Monazite grain ages, their microstructural location, and yttrium statistics for every grain analyzed from staurolite porphyroblasts.

Sample no.	Grain no.	Grain location	Yttrium statistics							Age (Ma)
			Mean (%)	Std. error	Median	Mode	Stdev	Variance	Count	
IS23	is23-m-x	N/A	1.386	0.022	1.410	N/A	0.048	0.002	5	393±23
IS71	is71-m-2	Crenulation cleavage	1.832	0.077	1.860	N/A	0.172	0.030	5	344±20
	is71-m-4	Crenulated cleavage	1.362	0.043	1.320	N/A	0.096	0.009	5	372±13
	is71-m-9	Crenulation cleavage	1.256	0.021	1.245	N/A	0.052	0.003	6	356±24
	is71-m-x	N/A	1.323	0.025	1.340	1.370	0.079	0.006	10	360±16
IS74	is74-m-1	Crenulation cleavage	1.439	0.038	1.425	N/A	0.131	0.017	12	361±17
	is74-m-6	Crenulated cleavage	1.329	0.092	1.300	N/A	0.244	0.060	7	360±17
	is74-m-x	N/A	1.504	0.051	1.460	1.420	0.177	0.031	12	360±15
IS77	is77-m-x	N/A	1.398	0.043	1.380	N/A	0.096	0.009	5	410±13
IS88	is88-m-x	N/A	1.338	0.026	1.340	1.400	0.079	0.006	9	371±10
IS94	is94-m-1	Crenulation cleavage	0.562	0.046	0.496	N/A	0.259	0.067	32	369.2±8.6
	is94-m-2	Crenulated cleavage	0.585	0.037	0.556	N/A	0.190	0.036	26	369.9±8.3
	is94-m-3	Crenulated cleavage	0.095	0.008	0.098	N/A	0.024	0.001	8	386±12
IS104	is104-m-17	Crenulation cleavage	0.745	0.120	0.537	N/A	0.378	0.143	10	358±14
	is104-m-x	N/A	0.690	0.075	0.566	1.330	0.377	0.142	25	365.1±8.1

Table 6. Monazite grain ages, their microstructural location, and yttrium statistics for every grain analyzed from the matrix.

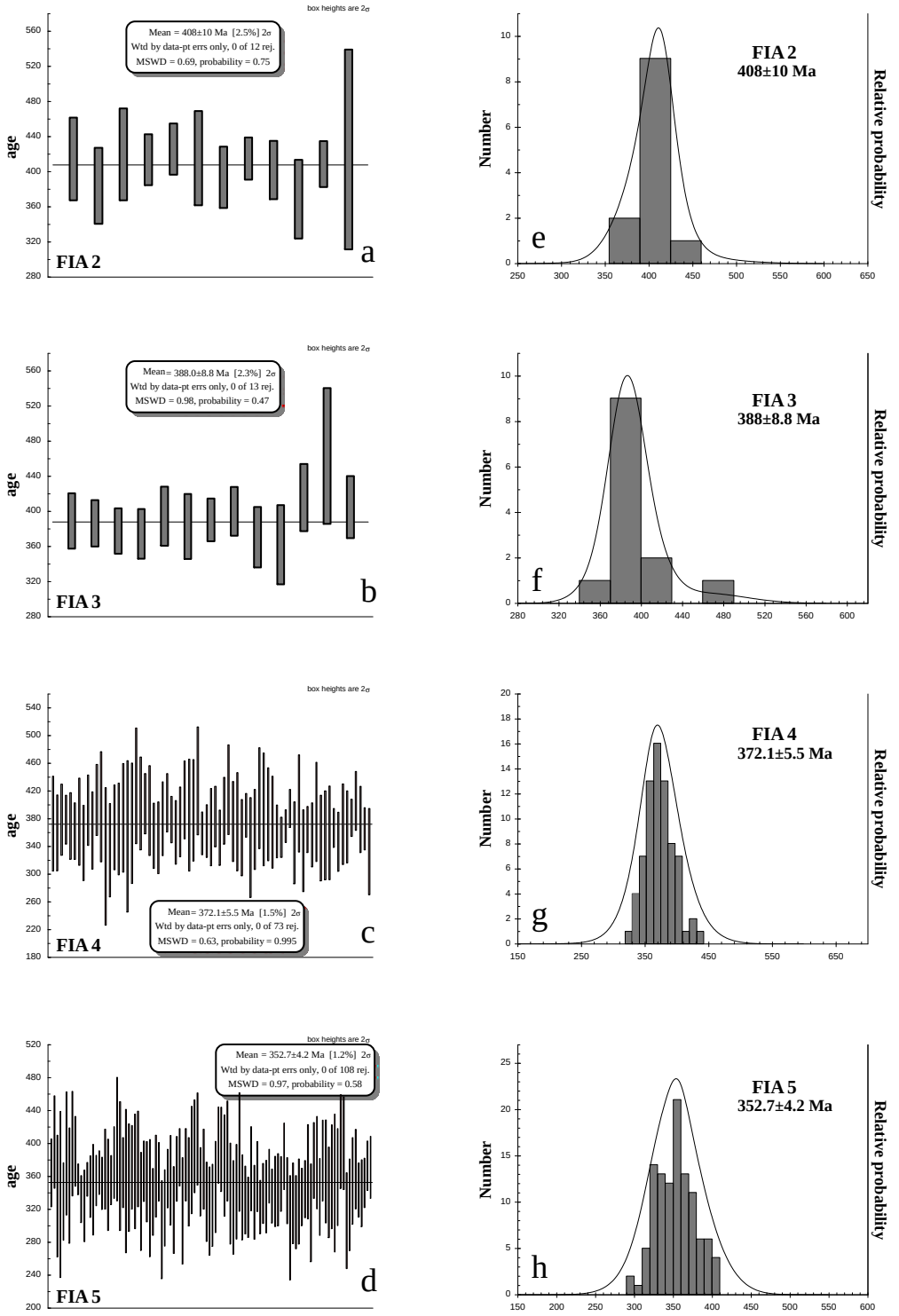


Figure 12. Probability diagrams and monazite ages for FIA set 2 (a and e), for FIA set 3 (b and f), for FIA set 4 (c and g), and for FIA set 5 (d and h).

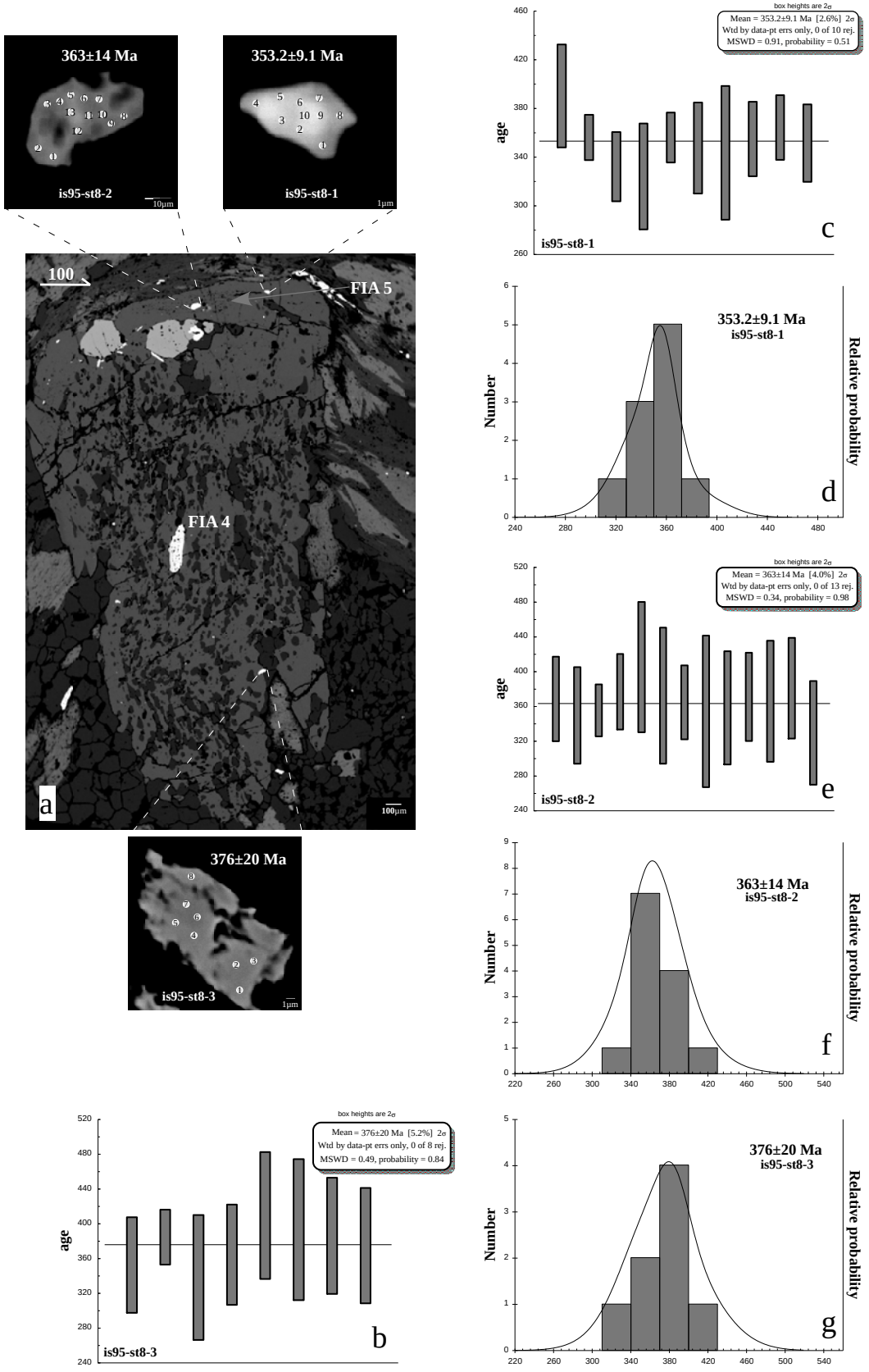


Figure 13. Back-scattered electron image (a) of a staurolite porphyroblast from sample IS95 which has a core containing FIA 4 and a rim overgrowth containing FIA5. The monazite grain from the core (b and g) is older than the monazite grains located in the rim (c, d, e, and f).

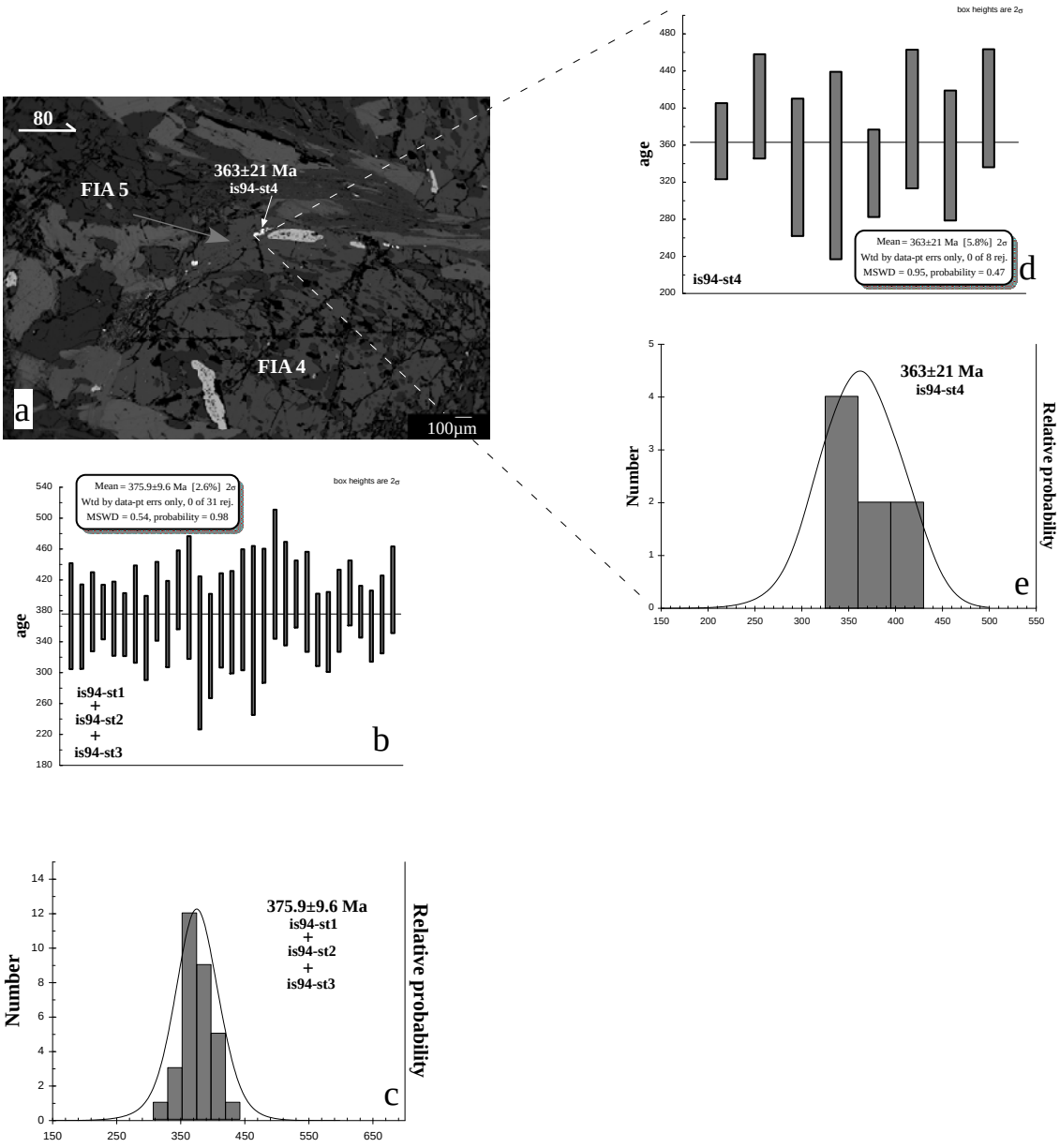


Figure 14. Back-scattered electron image (a) showing the location of the monazite grain is94-st4 from sample IS94 in the rim of a FIA 4 staurolite. The rim inclusion trails contain FIA 5. The age of the monazite grain (d and e) located in the FIA 5 rim is younger than the age of the monazite grains located in FIA 4 staurolites (b and c).

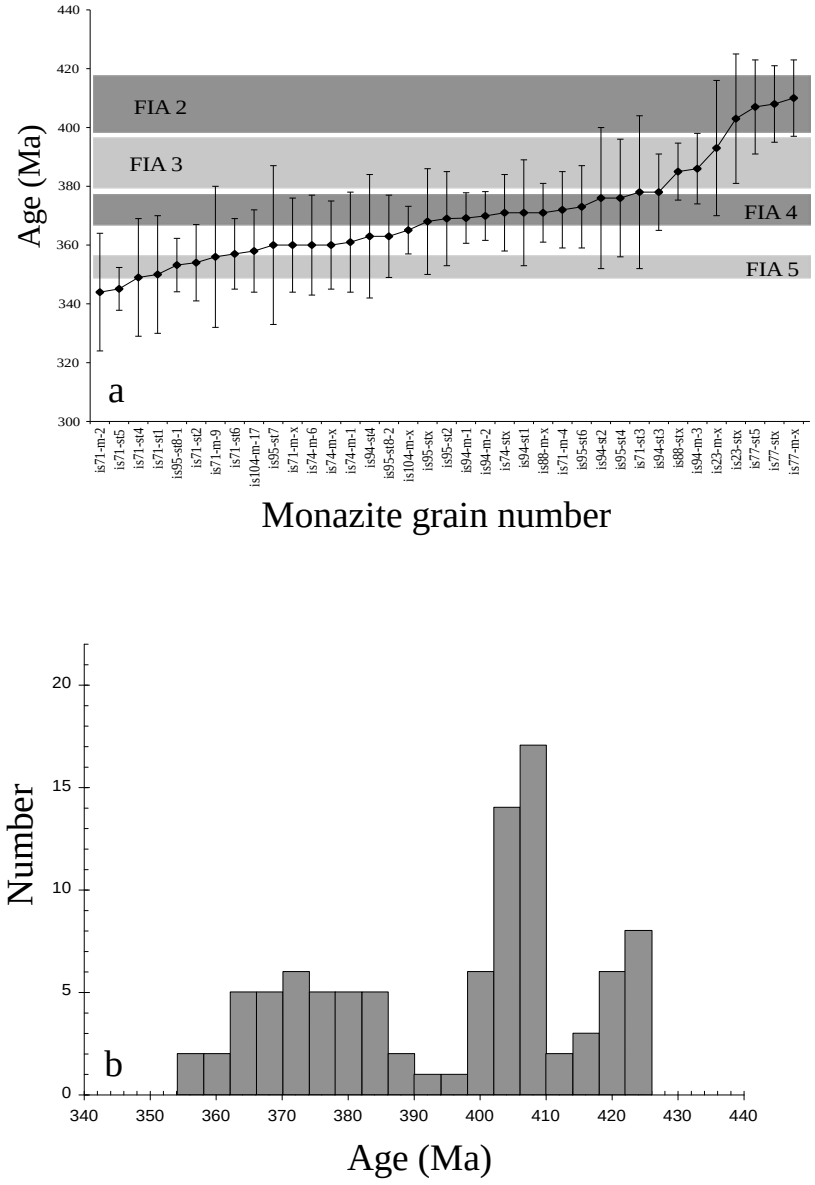


Figure 15. (a) Diagram showing the calculated ages and their errors for every monazite grain included in this study. (b) diagram showing the distribution of the crystallization ages for the plutons located in Maine and adjacent areas.

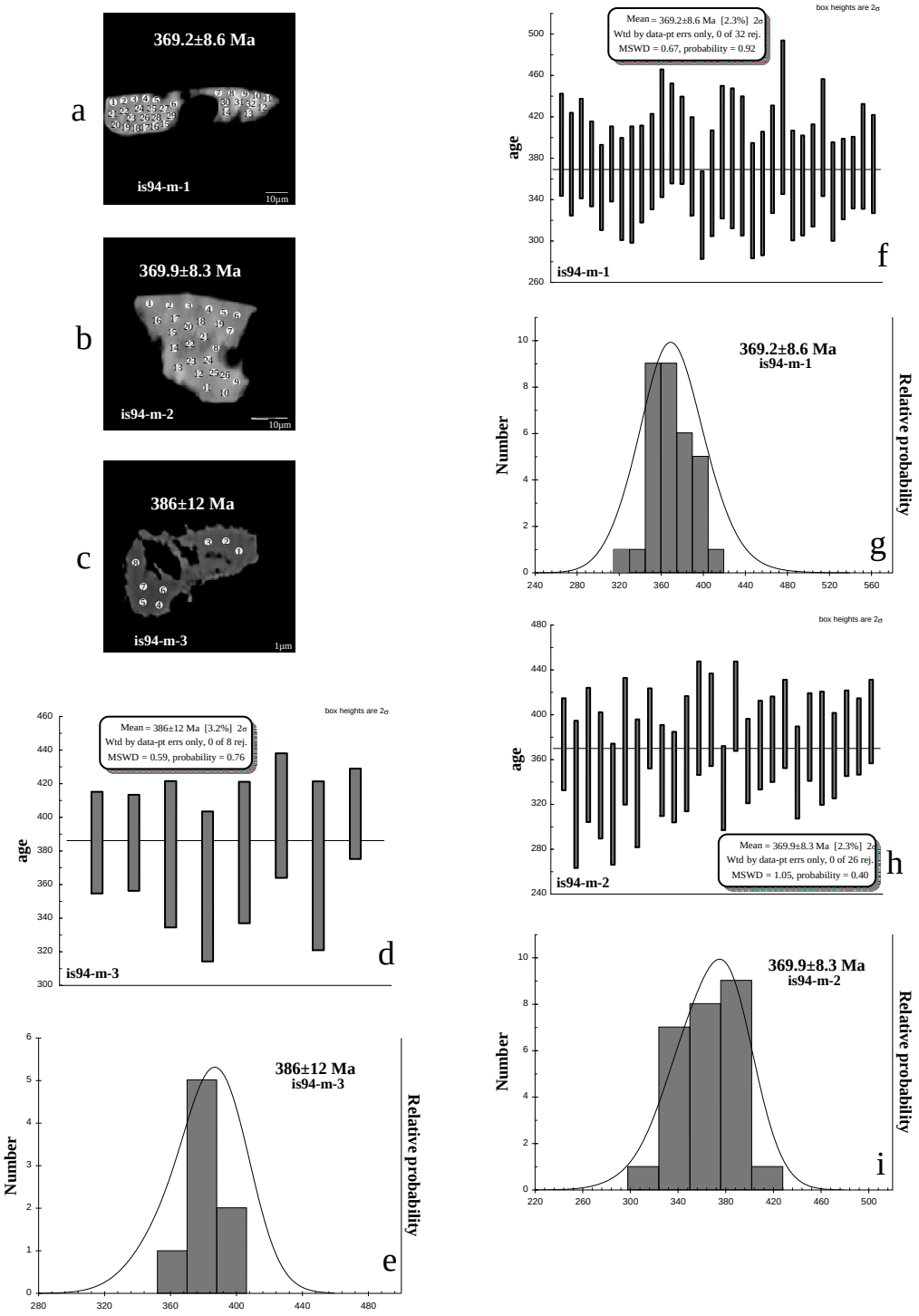


Figure 16. Back-scattered electron images of some of the matrix monazites and their apparent ages.

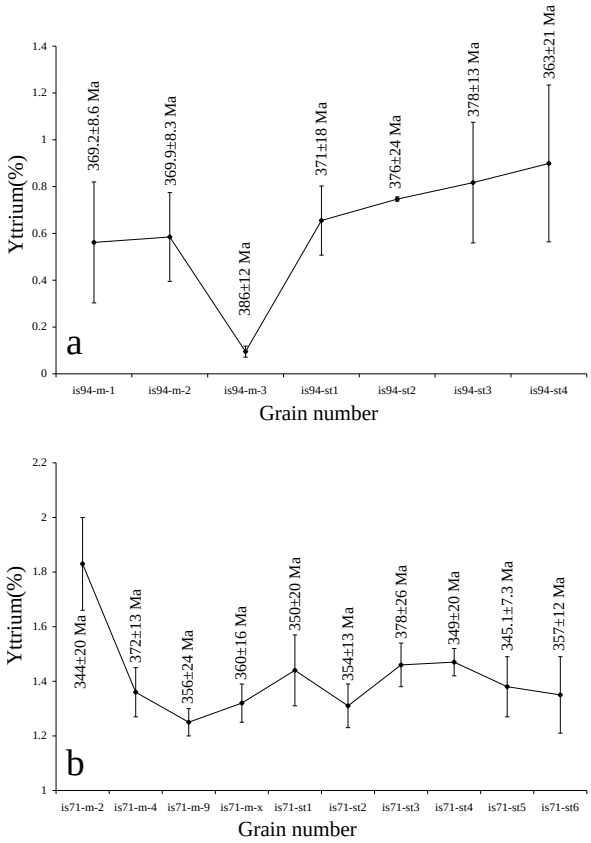


Figure 17. Diagrams showing the relationship between the yttrium content and the monazite grain ages from sample IS94 (a) and IS71 (b).

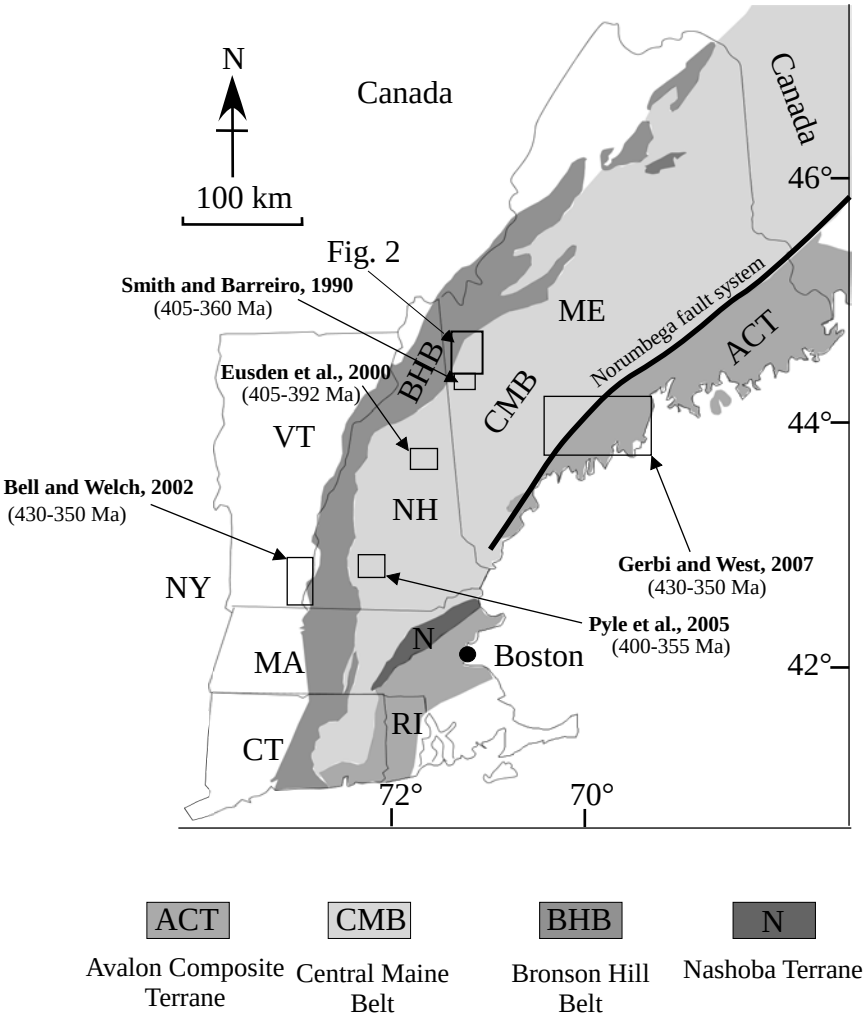
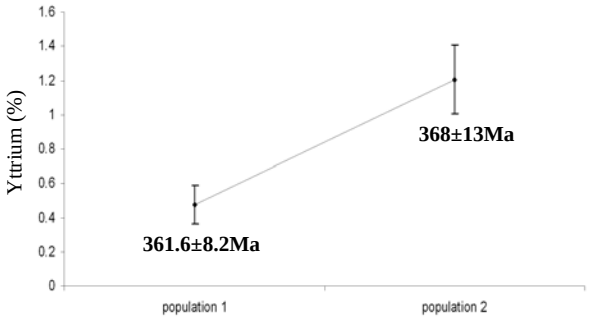


Figure 18. Simplified geological map of the New England showing the location of dated samples and the spread in monazite ages cited in this study.



No.	average	standard error	median	mode	standard deviation	variance	count	Age (Ma)
population 1	0.48	0.02	0.51	N/A	0.11	0.01	24.00	361.6±8.2
population 2	1.21	0.06	1.21	1.33	0.20	0.04	11.00	368±13

Figure 19. Diagram showing the realationship between the yttrium content and monazite ages for sample IS104.

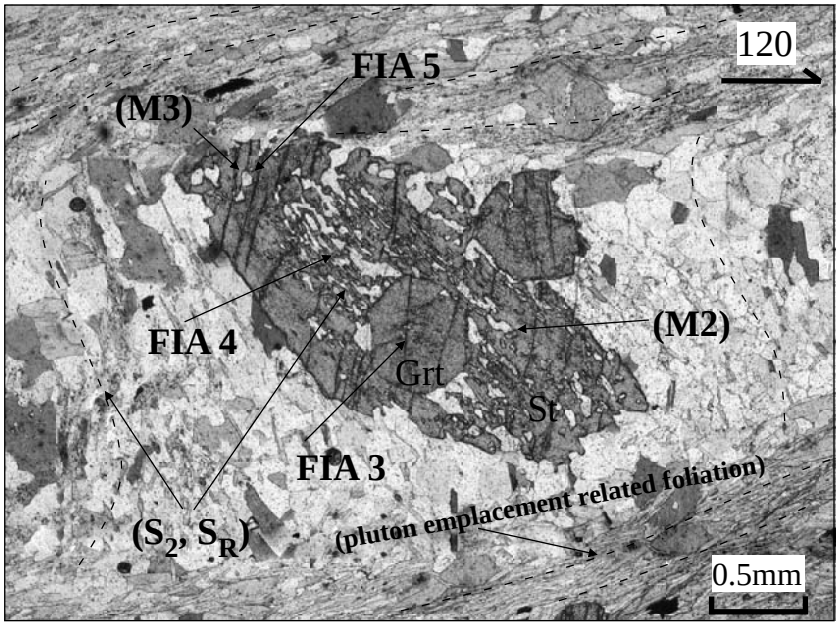


Figure 20. Photomicrograph showing typical microstructural relationships between garnet, staurolite and, matrix from the contact aureole of the Mooselookmeguntic pluton. Note that the inclusion trails in the garnet porphyroblast are restricted to the core of the garnet, and they are oblique to the inclusion trails from the staurolite core. This suggests that the garnet growth occurred in an earlier event compared to that in the core of the staurolite. See text for more details.

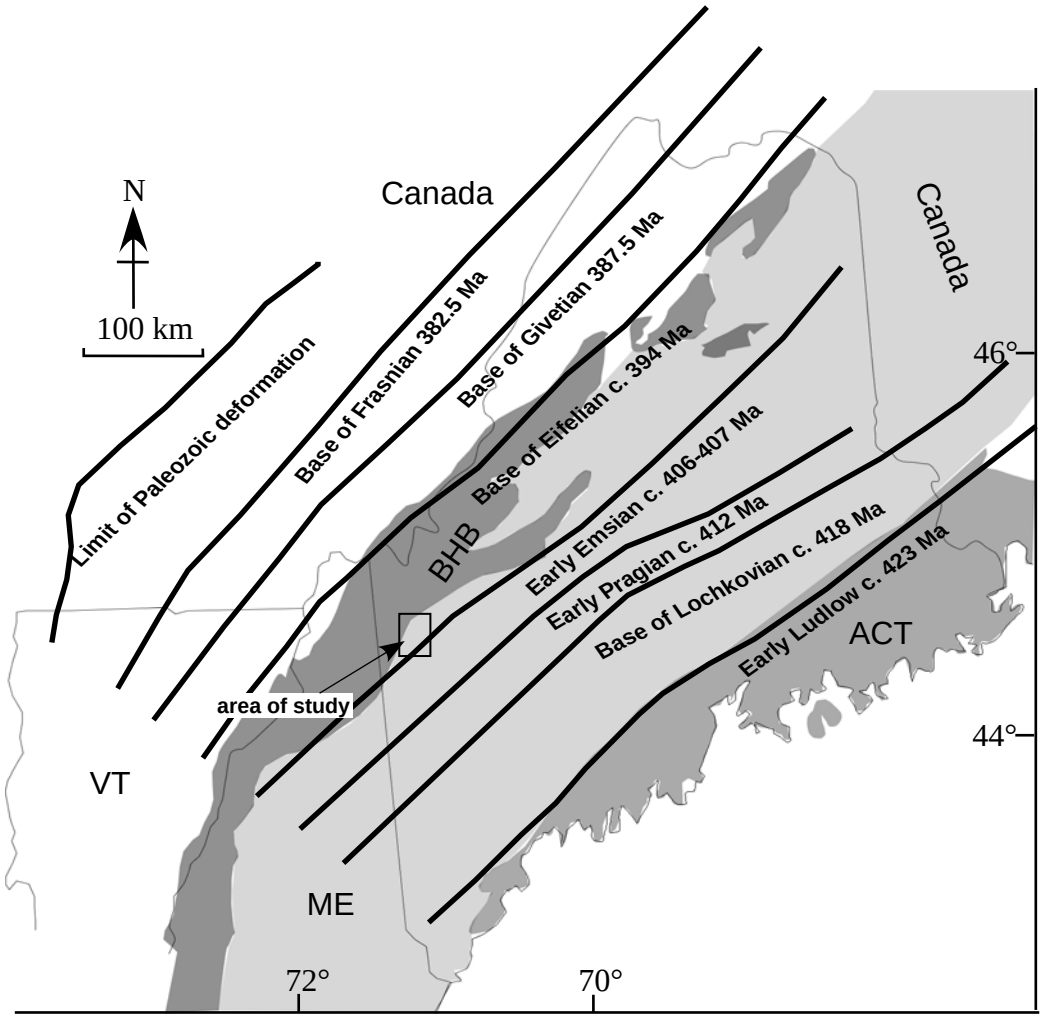


Figure 21. Simplified geological map of Maine and adjacent areas showing location of the orogenic front after Bradley et al., (1998) and location of the study area.