– SECTION C –

THE PROBLEM, SIGNIFICANCE, AND METAMORPHIC IMPLICATIONS OF 60 MILLION YEARS OF POLYPHASE STAUROLITE GROWTH

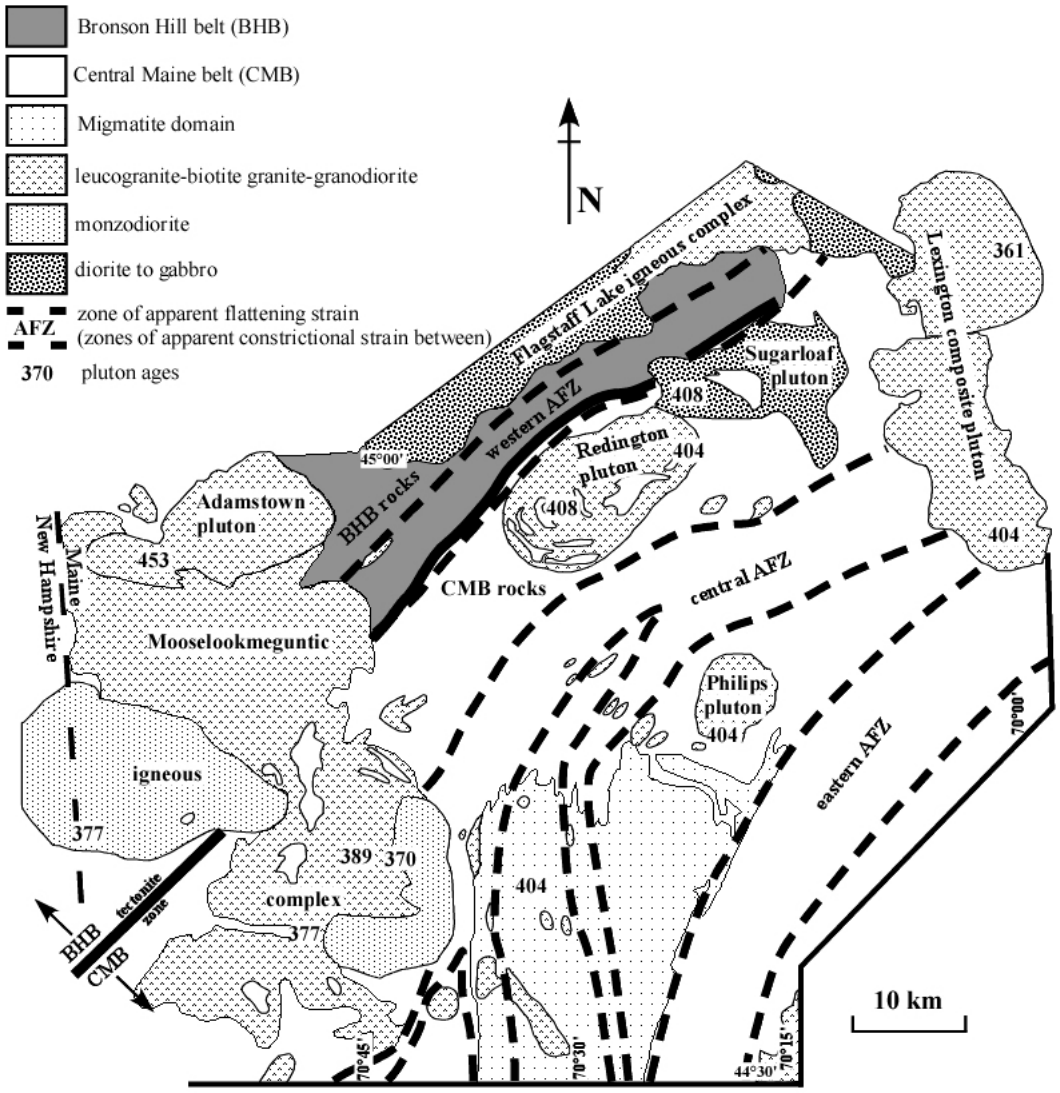

Figure 1. Simplified geological map of the west central Maine showing the major structural features, pluton intrusions, and their crystalization ages. Modified after Tomascak et al. (2005).

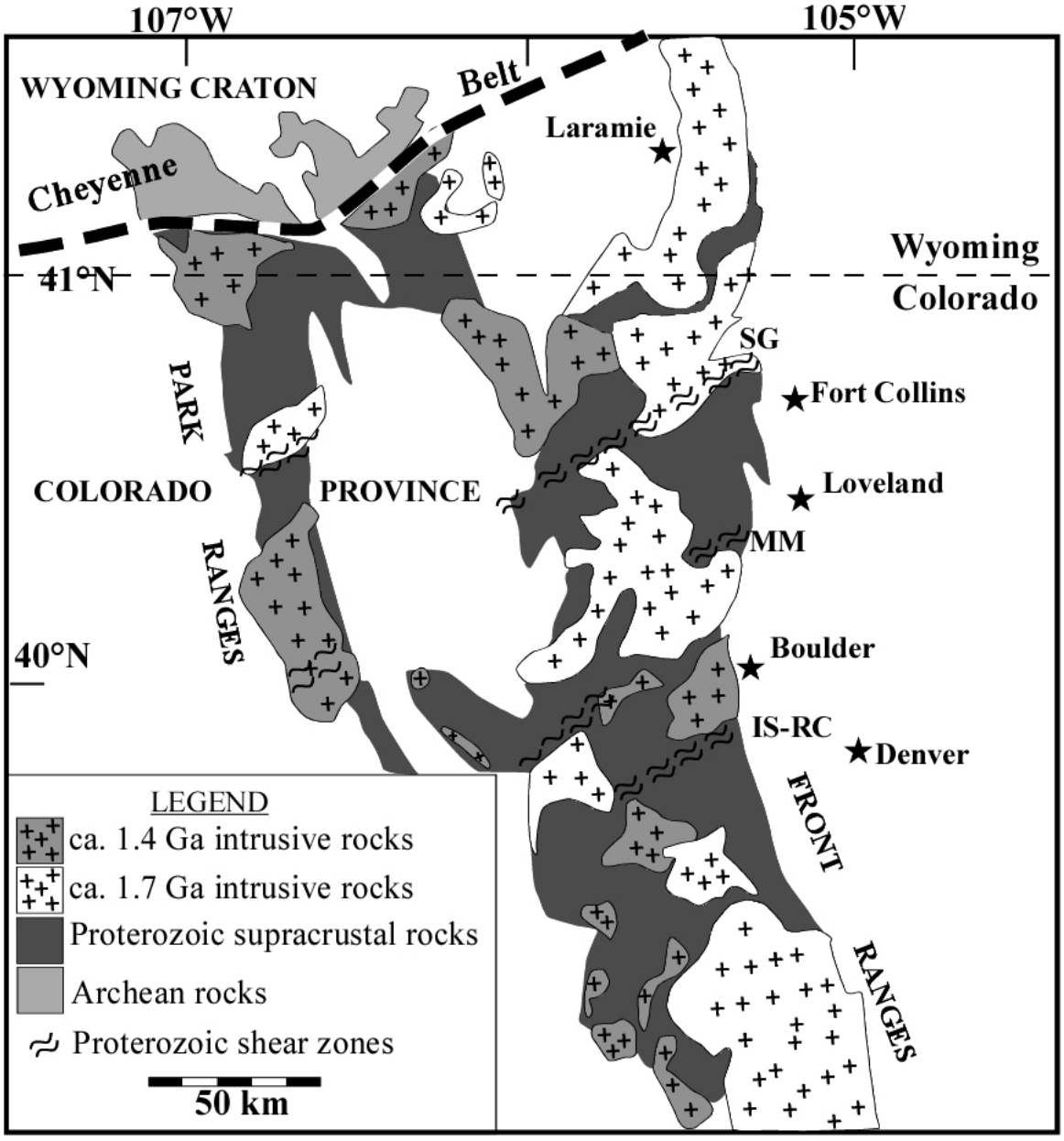

Figure 2. Simplified geological map showing the juxtaposition of the Proterozoic Colorado province rocks against the Archean Wyoming craton along the Cheyenne belt suture and the distribution of Proterozoic suprcrustal rocks, intrusions, and shear zones (after Selverstone et al., 1997). SG - Skin Gulch shear zone, MM - Moose Mountain shear zone, IS-RC - Idaho Springs-Ralston Creek shear zone.

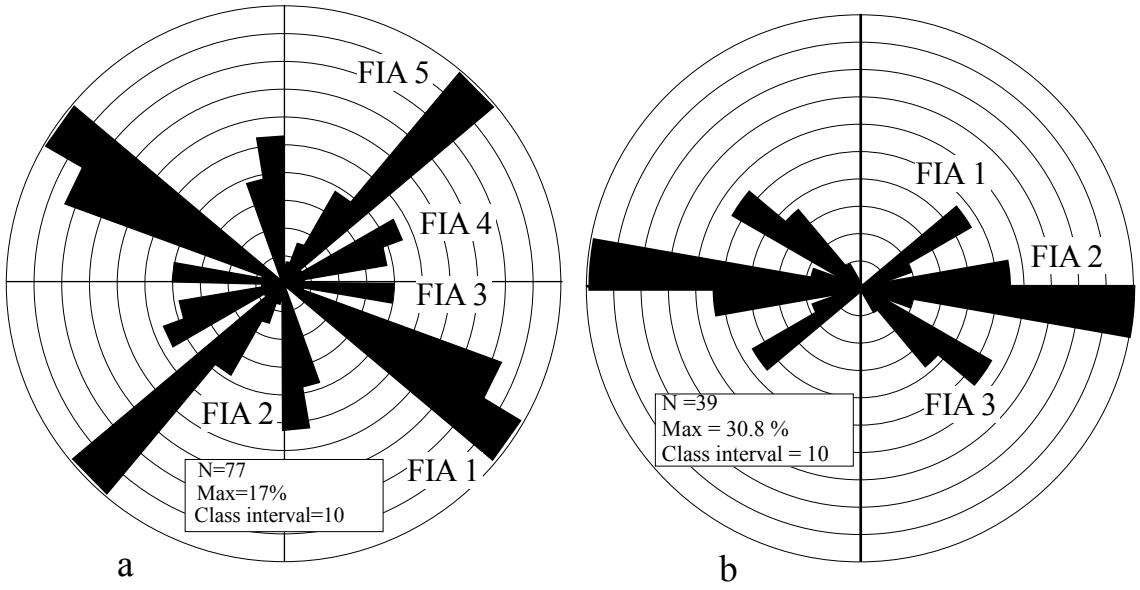

Figure 3. Equal-area rose diagrams showing the trends of FIAs measured in staurolite porphyroblasts from Western Maine (a) and Colorado Front Range (b).

FIA 1

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
1	0.501	0.455	4.910	1.470	**1735**	**68**	C75 St M1 1
2	0.423	0.369	4.190	1.420	**1739**	**77**	C75 St M1 2
3	0.378	0.394	3.490	1.540	**1746**	**85**	C75 St M1 3
4	0.344	0.369	3.180	1.490	**1732**	**90**	C75 St M1 4
5	0.351	0.383	3.140	1.520	**1759**	**90**	C75 St M1 5
6	0.342	0.371	3.100	1.510	**1749**	**91**	C75 St M1 6
7	0.323	0.283	3.070	1.430	**1786**	**100**	C75 St M1 7
8	0.348	0.334	3.070	1.470	**1836**	**97**	C75 St M1 8
9	0.326	0.328	3.060	1.460	**1742**	**95**	C75 St M1 9
10	0.318	0.326	3.020	1.480	**1724**	**95**	C75 St M1 10
11	0.313	0.289	3.010	1.410	**1751**	**100**	C75 St M1 11
12	0.328	0.330	2.970	1.460	**1783**	**98**	C75 St M1 12
13	0.310	0.286	2.970	1.410	**1758**	**101**	C75 St M1 13
14	0.300	0.312	2.840	1.420	**1717**	**100**	C75 St M1 14
15	0.298	0.296	2.700	1.400	**1788**	**106**	C75 St M1 15
16	0.288	0.292	2.450	1.440	**1852**	**113**	C75 St M1 16
17	0.265	0.251	2.380	1.400	**1823**	**120**	C75 St M1 17
18	0.244	0.254	2.230	1.370	**1759**	**123**	C75 St M1 18
19	0.442	0.366	4.330	1.380	**1773**	**78**	C75 St M 2 1
20	0.390	0.463	3.380	1.158	**1748**	**83**	C75 St M 2 2
21	0.338	0.288	3.380	1.280	**1738**	**94**	C75 St M 2 3
22	0.312	0.310	2.920	1.340	**1753**	**102**	C75 St M 2 4
23	0.337	0.431	2.880	1.059	**1723**	**92**	C75 St M 2 5
24	0.315	0.360	2.800	1.197	**1744**	**99**	C75 St M 2 6
25	0.302	0.293	2.750	1.269	**1795**	**107**	C75 St M 2 7
26	0.266	0.243	2.390	1.122	**1839**	**124**	C75 St M 2 8
27	0.249	0.296	2.090	0.948	**1786**	**125**	C75 St M 2 9
28	0.442	0.386	4.310	1.360	**1759**	**77**	C84 St M3 1
29	0.434	0.404	4.200	1.360	**1742**	**77**	C84 St M3 2
30	0.396	0.457	3.520	1.650	**1738**	**82**	C84 St M3 3
31	0.398	0.513	3.430	1.600	**1711**	**79**	C84 St M3 4
32	0.352	0.361	3.240	1.360	**1758**	**92**	C84 St M3 5
33	0.377	0.468	3.020	1.610	**1809**	**88**	C84 St M3 6
34	0.339	0.435	2.740	1.570	**1780**	**95**	C84 St M3 7
35	0.305	0.335	2.720	1.520	**1758**	**102**	C84 St M3 8
36	0.288	0.309	2.560	1.320	**1777**	**109**	C84 St M3 9
37	0.281	0.284	2.560	1.290	**1773**	**111**	C84 St M3 10
38	0.268	0.289	2.310	1.320	**1804**	**118**	C84 St M3 11
39	0.251	0.311	2.100	1.300	**1764**	**121**	C84 St M3 12
40	0.258	0.331	2.090	1.340	**1776**	**118**	C84 St M3 13
41	0.239	0.297	2.020	1.340	**1749**	**124**	C84 St M3 14
42	0.237	0.284	2.010	1.340	**1765**	**127**	C84 St M3 15
43	0.241	0.311	1.960	1.310	**1772**	**125**	C84 St M3 16

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
44	0.231	0.309	1.880	1.340	**1749**	**128**	C84 St M3 17
45	0.417	0.566	3.240	1.620	**1784**	**80**	C84 St3 M4 1
46	0.301	0.382	2.560	1.390	**1734**	**101**	C84 St3 M4 2
47	0.288	0.377	2.520	1.360	**1688**	**101**	C84 St3 M4 3
48	0.283	0.330	2.470	1.340	**1752**	**108**	C84 St3 M4 4
49	0.272	0.312	2.380	1.430	**1758**	**113**	C84 St3 M4 5
50	0.264	0.297	2.200	1.300	**1820**	**121**	C84 St3 M4 6
51	0.246	0.223	2.140	1.250	**1885**	**135**	C84 St3 M4 7
52	0.515	0.320	5.650	0.988	**1722**	**67**	65A St M5 1
53	0.442	0.366	4.330	1.380	**1773**	**78**	65A St M5 2
54	0.390	0.463	3.380	1.158	**1748**	**83**	65A St M5 3
55	0.338	0.288	3.380	1.280	**1738**	**94**	65A St M5 4
56	0.312	0.310	2.920	1.340	**1753**	**102**	65A St M5 7
57	0.337	0.431	2.880	1.059	**1723**	**92**	65A St M5 8
58	0.315	0.360	2.800	1.197	**1744**	**99**	65A St M5 9
59	0.302	0.293	2.750	1.269	**1795**	**107**	65A St M5 10
60	0.266	0.243	2.390	1.122	**1839**	**124**	65A St M5 11
61	0.249	0.296	2.090	0.948	**1786**	**125**	65A St M5 12

FIA 2

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
62	0.479	0.394	5.030	0.246	**1690**	**69**	C43 10 St M6 1
63	0.586	0.845	4.710	0.612	**1715**	**58**	C43 10 St M6 2
64	0.592	0.808	4.630	1.630	**1774**	**61**	C43 10 St M6 3
65	0.569	0.814	4.580	0.732	**1719**	**60**	C43 10 St M6 4
66	0.563	0.803	4.520	0.654	**1722**	**61**	C43 10 St M6 5
67	0.462	0.549	4.120	1.880	**1718**	**70**	C43 10 St M6 6
68	0.466	0.597	4.080	1.870	**1698**	**69**	C43 10 St M6 7
69	0.464	0.575	4.070	2.080	**1714**	**71**	C43 10 St M6 8
70	0.461	0.588	3.860	0.890	**1749**	**73**	C43 10 St M6 9
71	0.392	0.487	3.420	1.980	**1720**	**80**	C43 10 St M6 10
72	0.349	0.387	3.110	1.800	**1756**	**91**	C43 10 St M6 11
73	0.334	0.432	2.880	1.790	**1711**	**90**	C43 10 St M6 12
74	0.272	0.325	2.440	0.748	**1711**	**110**	C43 10 St M6 13
75	0.268	0.418	1.970	1.670	**1742**	**110**	C43 10 St M6 14
76	0.534	0.349	5.810	0.806	**1718**	**65**	65A St M7 1
77	0.554	0.397	5.660	1.188	**1771**	**66**	65A St M7 2
78	0.501	0.360	5.640	0.974	**1647**	**65**	65A St M7 3
79	0.506	0.363	5.430	0.844	**1709**	**67**	65A St M7 4
80	0.480	0.398	5.110	0.786	**1670**	**68**	65A St M7 5
81	0.477	0.367	5.040	0.711	**1706**	**70**	65A St M7 6
82	0.465	0.351	4.960	0.864	**1702**	**72**	65A St M7 7
83	0.446	0.352	4.680	0.762	**1705**	**74**	65A St M7 8
84	0.398	0.355	4.100	0.687	**1684**	**80**	65A St M7 9
85	0.404	0.348	4.040	0.618	**1732**	**82**	65A St M7 10
86	0.406	0.355	4.030	0.628	**1738**	**81**	65A St M7 11
87	0.384	0.361	3.760	0.567	**1722**	**84**	65A St M7 12
88	0.373	0.378	3.540	0.614	**1727**	**87**	65A St M7 13
89	0.376	0.372	3.530	0.600	**1753**	**87**	65A St M7 14
90	0.368	0.358	3.520	0.751	**1735**	**87**	65A St M7 15
91	0.274	0.275	2.630	0.760	**1719**	**110**	65A St M7 16
92	0.248	0.281	2.280	0.564	**1713**	**119**	65A St M7 17
93	0.753	0.360	8.970	0.554	**1673**	**49**	65A St M8 1
94	0.788	0.449	8.970	0.533	**1695**	**48**	65A St M8 2
95	0.739	0.350	8.660	0.598	**1697**	**51**	65A St M8 3
96	0.756	0.457	8.330	0.675	**1724**	**50**	65A St M8 4
97	0.687	0.485	7.290	0.912	**1728**	**54**	65A St M8 5
98	0.671	0.365	7.270	0.868	**1774**	**57**	65A St M8 6
99	0.632	0.362	7.240	0.778	**1686**	**56**	65A St M8 7
100	0.685	0.502	7.100	0.992	**1746**	**55**	65A St M8 8
101	0.684	0.489	7.070	1.127	**1757**	**56**	65A St M8 9
102	0.621	0.385	6.820	1.066	**1722**	**58**	65A St M8 10
103	0.596	0.354	6.620	1.032	**1717**	**60**	65A St M8 11
104	0.614	0.487	6.550	1.218	**1683**	**57**	65A St M8 12

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
105	0.586	0.346	6.490	1.014	**1722**	**61**	65A St M8 13
106	0.571	0.495	5.740	1.330	**1725**	**62**	65A St M8 14
107	0.460	0.364	4.820	1.159	**1709**	**72**	65A St M8 15
108	0.451	0.365	4.730	1.151	**1700**	**72**	65A St M8 16
109	0.425	0.339	4.390	1.153	**1722**	**78**	65A St M8 17
110	0.762	0.370	8.770	0.522	**1717**	**50**	65A St M9 1
111	0.705	0.408	7.830	0.580	**1725**	**53**	65A St M9 2
112	0.636	0.450	6.800	1.052	**1719**	**57**	65A St M9 3
113	0.525	0.321	5.660	0.860	**1749**	**67**	65A St M9 4
114	0.503	0.328	5.510	0.933	**1710**	**68**	65A St M9 5
115	0.500	0.338	5.440	1.121	**1711**	**68**	65A St M9 6
116	0.471	0.368	5.020	1.106	**1689**	**70**	65A St M9 7
117	0.370	0.336	3.700	1.370	**1714**	**85**	65A St M9 8
118	0.340	0.299	3.450	1.155	**1709**	**92**	65A St M9 9
119	0.342	0.415	2.860	0.995	**1777**	**94**	65A St M9 10
120	0.304	0.319	2.850	1.132	**1725**	**101**	65A St M9 11
121	0.527	0.642	4.610	1.800	**1727**	**64**	C108 St M10 1
122	0.426	0.429	4.100	1.640	**1714**	**76**	C108 St M10 2
123	0.425	0.448	3.900	1.660	**1749**	**77**	C108 St M10 3
124	0.406	0.481	3.620	1.650	**1721**	**78**	C108 St M10 4
125	0.371	0.371	3.530	1.560	**1732**	**85**	C108 St M10 5
126	0.402	0.544	3.420	1.740	**1697**	**77**	C108 St M10 6
127	0.307	0.289	2.950	1.400	**1745**	**100**	C108 St M10 7
128	0.346	0.499	2.840	1.710	**1694**	**87**	C108 St M10 8
129	0.278	0.277	2.660	1.450	**1723**	**108**	C108 St M10 9
130	0.307	0.387	2.530	1.550	**1771**	**101**	C108 St M10 10
131	0.278	0.383	2.260	1.530	**1731**	**106**	C108 St M10 11
132	0.277	0.400	2.150	1.600	**1749**	**106**	C108 St M10 12
133	0.245	0.350	2.060	1.580	**1678**	**114**	C108 St M10 13
134	0.232	0.346	1.930	1.540	**1663**	**118**	C108 St M10 14
135	0.464	0.517	4.200	1.800	**1737**	**71**	C108 St M11 1
136	0.468	0.598	4.110	1.890	**1696**	**68**	C108 St M11 2
137	0.487	0.632	4.100	1.850	**1732**	**67**	C108 St M11 3
138	0.447	0.515	4.090	1.690	**1706**	**72**	C108 St M11 4
139	0.452	0.532	3.970	1.740	**1740**	**73**	C108 St M11 5
140	0.438	0.546	3.690	1.740	**1753**	**74**	C108 St M11 6
141	0.411	0.487	3.660	1.720	**1721**	**77**	C108 St M11 7
142	0.443	0.614	3.660	1.860	**1711**	**71**	C108 St M11 8
143	0.370	0.371	3.610	1.550	**1701**	**83**	C108 St M11 9
144	0.400	0.501	3.320	1.720	**1764**	**81**	C108 St M11 10
145	0.357	0.404	3.310	1.580	**1704**	**86**	C108 St M11 11
146	0.369	0.442	3.250	1.700	**1730**	**84**	C108 St M11 12
147	0.366	0.438	3.250	1.730	**1722**	**84**	C108 St M11 13
148	0.355	0.420	3.200	1.600	**1710**	**87**	C108 St M11 14
149	0.320	0.344	3.100	1.410	**1679**	**93**	C108 St M11 15

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
150	0.321	0.352	2.990	1.490	**1710**	**94**	C108 St M11 16
151	0.327	0.374	2.930	1.550	**1733**	**94**	C108 St M11 17
152	0.333	0.403	2.920	1.560	**1726**	**92**	C108 St M11 18
153	0.281	0.265	2.660	1.430	**1761**	**110**	C108 St M11 19
154	0.261	0.266	2.540	1.360	**1695**	**111**	C108 St M11 20
155	0.273	0.370	2.350	1.560	**1683**	**104**	C108 St M11 21
156	0.250	0.323	2.180	1.430	**1700**	**114**	C108 St M11 22
157	0.255	0.364	2.090	1.510	**1701**	**112**	C108 St M11 23
158	0.544	0.626	4.830	1.820	**1741**	**63**	C75 St M12 1
159	0.520	0.597	4.520	1.830	**1765**	**66**	C75 St M12 2
160	0.485	0.566	4.370	1.790	**1716**	**68**	C75 St M12 3
161	0.488	0.571	4.330	1.770	**1732**	**68**	C75 St M12 4
162	0.422	0.452	3.840	1.590	**1750**	**77**	C75 St M12 5
163	0.360	0.369	3.350	1.420	**1747**	**88**	C75 St M12 6
164	0.345	0.397	3.120	1.530	**1721**	**89**	C75 St M12 7
165	0.312	0.357	2.840	1.490	**1718**	**96**	C75 St M12 8
166	0.409	0.349	4.010	1.490	**1763**	**81**	C75 St M13 1
167	0.409	0.404	3.910	1.550	**1730**	**79**	C75 St M13 2
168	0.375	0.356	3.740	1.560	**1698**	**83**	C75 St M13 3
169	0.397	0.441	3.670	1.520	**1715**	**79**	C75 St M13 4
170	0.364	0.366	3.470	1.540	**1725**	**86**	C75 St M13 5
171	0.324	0.329	3.210	1.530	**1678**	**92**	C75 St M13 6
172	0.331	0.297	3.190	1.430	**1760**	**95**	C75 St M13 7
173	0.320	0.287	3.070	1.390	**1768**	**99**	C75 St M13 8
174	0.596	0.790	5.010	2.250	**1721**	**58**	C117B St M14 1
175	0.359	0.490	2.970	1.630	**1721**	**87**	C117B St M14 2
176	0.318	0.388	2.850	1.690	**1699**	**95**	C117B St M14 3
177	0.294	0.357	2.410	1.520	**1794**	**108**	C117B St M14 4
178	0.266	0.349	2.230	1.650	**1728**	**112**	C117B St M14 5
179	0.245	0.352	1.970	1.670	**1715**	**120**	C117B St M14 6

FIA 3

No.	PbO (%)	UO_2 (%)	ThO_2 (%)	Y_2O_3 (%)	Age (Ma)	Error (2σ)	Comment
180	0.466	0.465	4.530	1.640	**1706**	**71**	C83 St M15 1
181	0.479	0.530	4.470	1.690	**1706**	**70**	C83 St M15 2
182	0.422	0.511	3.890	1.650	**1678**	**75**	C83 St M15 3
183	0.391	0.412	3.770	1.590	**1692**	**81**	C83 St M15 4
184	0.405	0.483	3.680	1.690	**1698**	**79**	C83 St M15 5
185	0.361	0.379	3.630	1.530	**1648**	**84**	C83 St M15 6
186	0.369	0.432	3.450	1.620	**1679**	**83**	C83 St M15 7
187	0.234	0.241	2.470	1.310	**1600**	**117**	C83 St M15 8
188	0.261	0.334	2.410	1.460	**1644**	**109**	C83 St M15 9
189	0.217	0.259	2.020	1.360	**1673**	**130**	C83 St M15 10
190	0.462	0.356	4.880	1.450	**1707**	**72**	C84 St16 1
191	0.393	0.378	3.930	1.440	**1690**	**80**	C84 St16 2
192	0.361	0.341	3.600	1.520	**1701**	**86**	C84 St16 3
193	0.299	0.291	3.120	1.410	**1636**	**96**	C84 St16 4
194	0.308	0.318	3.040	1.350	**1673**	**97**	C84 St16 5
195	0.242	0.256	2.420	1.340	**1654**	**116**	C84 St16 6
196	0.462	0.356	4.880	1.450	**1707**	**72**	C84 St16 7
197	0.393	0.378	3.930	1.440	**1690**	**80**	C84 St16 8
198	0.361	0.341	3.600	1.520	**1701**	**86**	C84 St16 9
199	0.299	0.291	3.120	1.410	**1636**	**96**	C84 St16 10
200	0.308	0.318	3.040	1.350	**1673**	**97**	C84 St16 11
201	0.242	0.256	2.420	1.340	**1654**	**116**	C84 St16 12

Table 1. Electron microprobe analysis and calculated ages for every analytical spot from monazite grains included in staurolite porphyroblasts from Colorado Front Range.

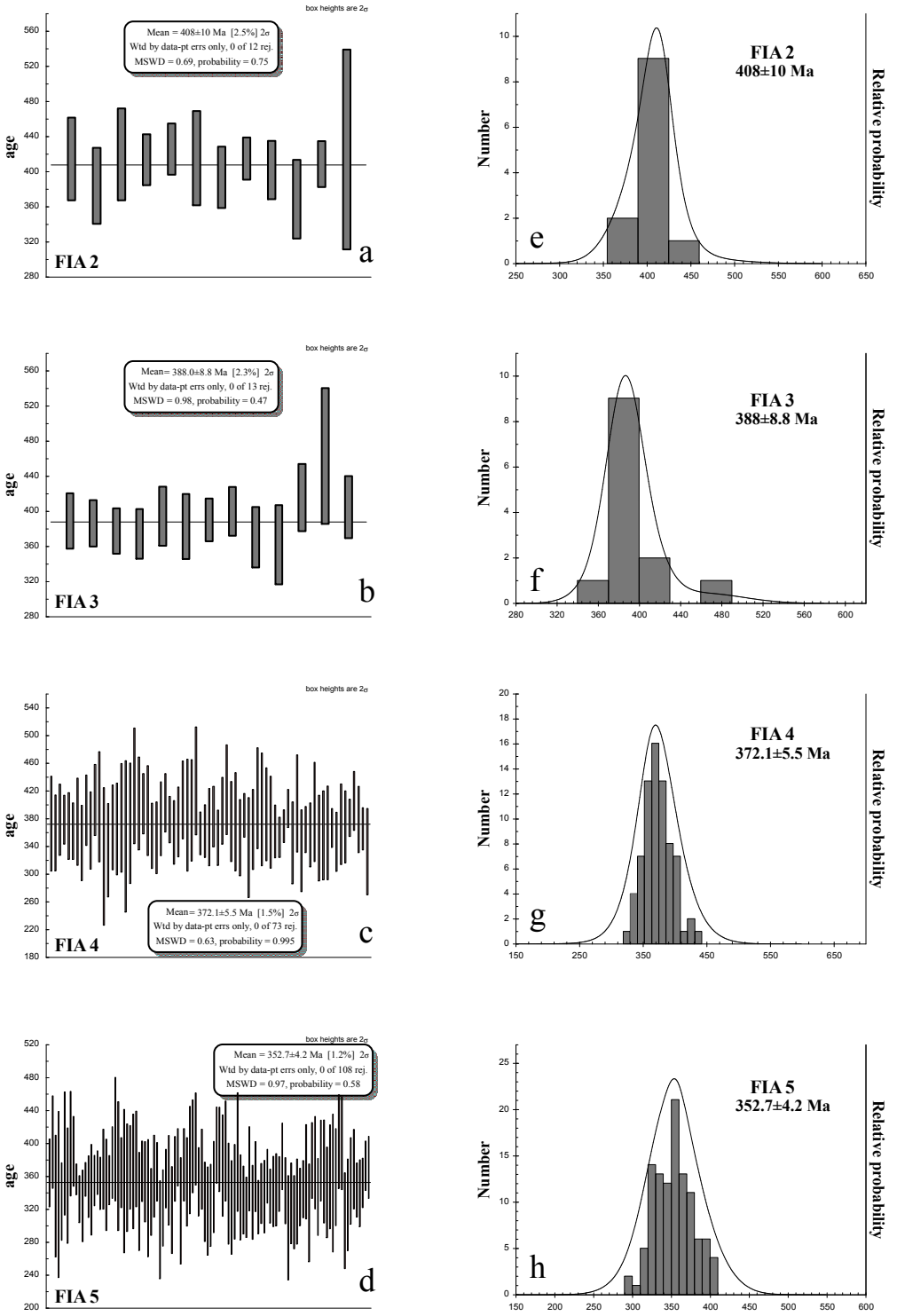

Figure 4. Probability diagrams and monazite ages for FIA set 2 (a and e), FIA set 3 (b and f), FIA set 4 (c and g) and for FIA set 5 (d and h)determined from the monazite inclusions in staurolite porphyroblasts from west-central Maine.

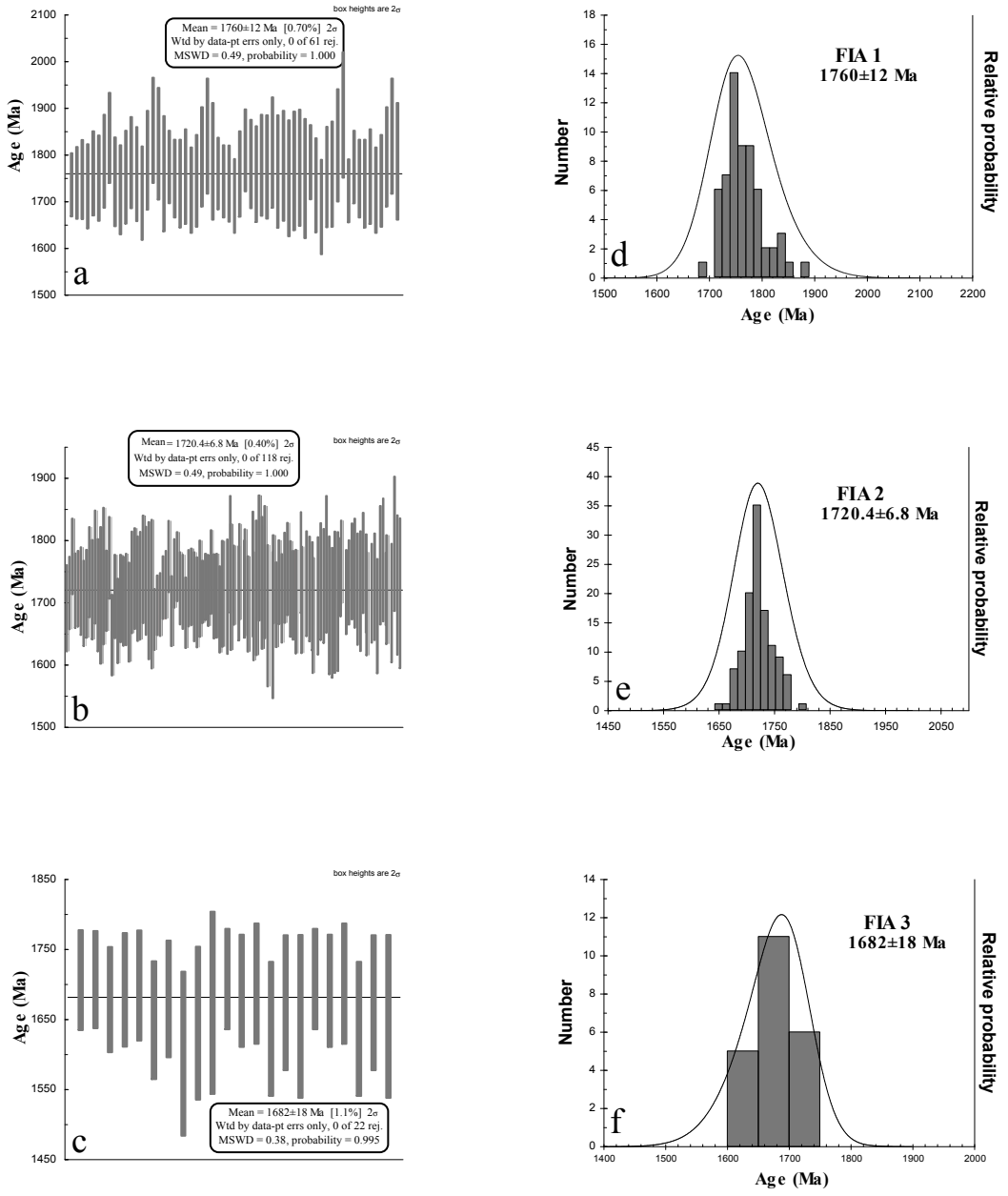

Figure 5. Probability diagrams and monazite ages for FIA set 1 (a and d), FIA set 2 (b and e) and for FIA set 3 (c and f) determined from the monazite inclusions in staurolite porphyroblasts from Colorado Front Range.

Sample no.	C65A	C68B	C75	C77	C78B	C80	C108	Average
SiO_2	63.07	64.39	63.48	64.20	63.43	64.30	66.25	64.16
TiO_2	0.75	0.66	0.81	0.81	0.67	0.75	0.81	0.75
Al_2O_3	19.46	17.70	18.24	18.33	17.28	18.82	16.84	18.10
Fe_2O_3T	7.42	7.15	8.23	7.90	8.89	7.21	7.40	7.74
MnO	0.08	0.06	0.08	0.10	0.12	0.06	0.08	0.08
MgO	1.40	1.94	1.89	2.11	2.21	1.85	1.82	1.89
CaO	0.41	0.30	0.84	0.69	0.66	0.33	0.66	0.56
Na_2O	0.81	0.88	1.29	0.86	1.11	0.78	0.92	0.95
K_2O	4.62	4.64	3.79	3.40	3.88	4.14	3.57	4.01
P_2O_5	0.11	0.10	0.13	0.14	0.06	0.11	0.13	0.11
l.o.i.	2.34	2.29	1.69	1.93	1.97	2.18	1.72	2.02
Total	100.47	100.11	100.47	100.47	100.28	100.53	100.20	100.36

Table 2. XRF bulk-compositions for samples collected from Colorado Front Range.

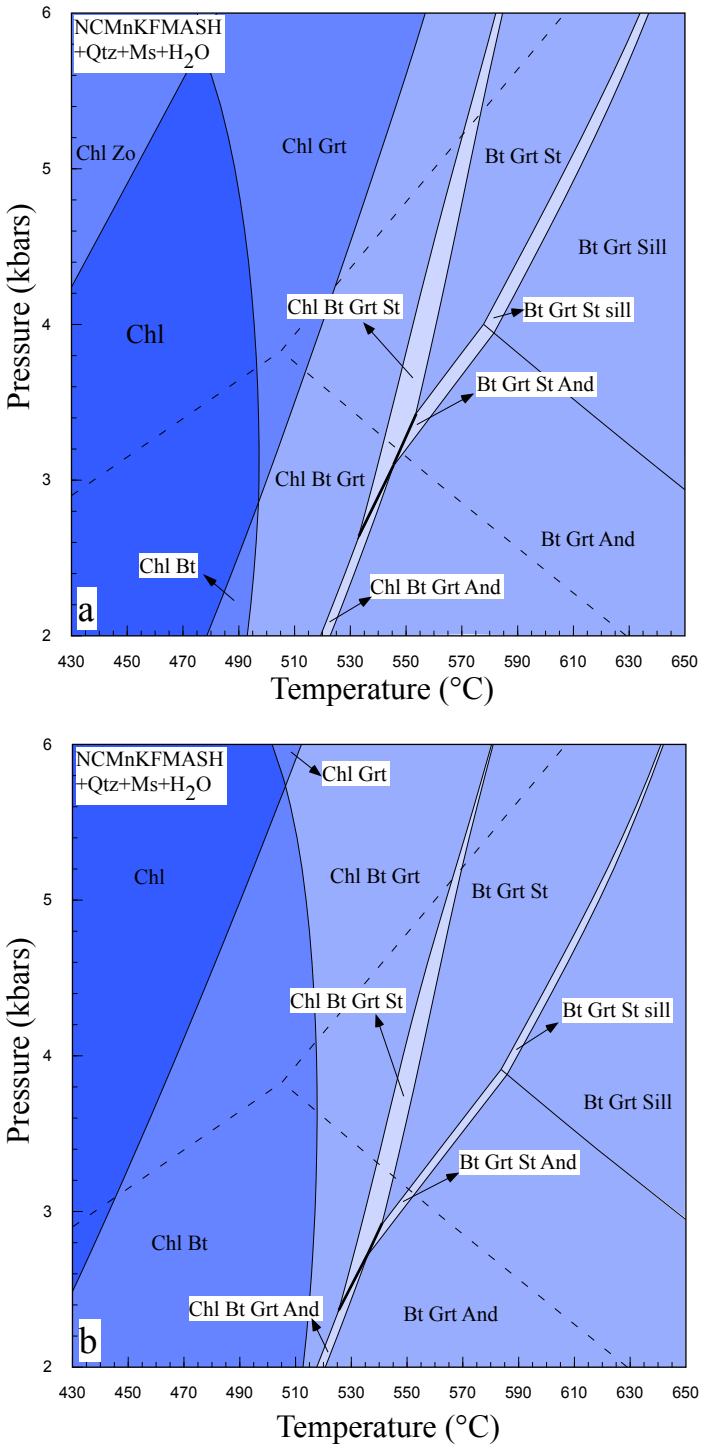

Figure 6. P-T pseudosection modelled in the NCMnKFMASH system for the avergae composition of the pelites from west-central Maine (a) and from Colorado Front Range (b). All assemblages contain plagioclase.