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Supplemental Material

Text: Methods and Results

Table S1. Previous Geochronology

Table S2. Description and Location of Samples used for Geochronology

Appendix 1. Zircon U-Pb SIMS Isotope Data and Ages

Appendix 2. Monazite Th-Pb SIMS Isotope Data and Ages

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Figure S1. Representative CL images of zircon with selected sample numbers, analysis spots, and U-Pb SIMS dates. Upper left panel: magmatic zircon from pre-transpressional infrastructure plutons. Upper right panel: leucopegmatite. Lower left panel: diorite-tonalite suite (four on left) and Ragged Hill gneiss. Lower right panel includes miscellaneous samples re-dated by LA-ICP-MS U-Pb geochronology with sample numbers.

Figure S2. Representative Th-U-Y X-ray maps of monazite dated by SIMS with location of analysis spots. White boxes outline sillimanite inclusions in monazite.

METHODS

Sample Preparation

Zircon and monazite were separated from ~1 kg hand-samples and concentrated via standard methods. Zircon and monazite grains were mounted in epoxy with grains of age standard AS3 and 554, respectively. Mounts were ground to expose the approximate cores of grains. All zircons were examined via backscattered electron (BSE) and cathodoluminescence (CL) imaging before analysis in order to characterize zoning and growth patterns, to guide location of the ion beam, and to provide a basis for age interpretation. Monazite analyzed by SIMS were single grains concentrated from the 50–125 or 125–250 micron sieve fractions. Grains were imaged by low contrast BSE on the CAMECA SX50 before analysis. Selected grains were mapped by elemental X-ray wavelength dispersive spectrometry and/or imaged via high contrast BSE on the JEOL IT100 SEM (the instrument was acquired after dating occurred) following SIMS analysis to characterize compositional zoning and document the location of the ion beam with regard to growth zones. This approach is not optimum for relating SIMS Th-Pb dates to metamorphism and deformation. However, most samples yield consistent age populations that may be related to monazite growth events in the context of prograde and retrograde metamorphic reactions.

SIMS geochronology

Zircon U-Pb secondary ion mass spectrometry (SIMS) was completed on the CAMECA ims1270 ion microprobe at the UCLA Keck facility following Schmitt et al. (2003). Zircon U-Pb analysis was completed in three, three-day analytical sessions (October, 2014; June, 2015; April 2016). The zircon age standard was AS3 (accepted age of 1099 ± 1 Ma; Paces and Miller, 1993; Schmitz et al., 2003). Four to five standard grains were analyzed at the beginning of each session and then every sixth grain. Analysis of standard AS3 for each session yielded concordant U-Pb dates of 1092 ± 3 , 1099 ± 2 , and 1091 ± 3 Ma, respectively. The latter date is 0.1% low relative to the accepted age, however no correction was made to the dates of samples. Zircon analysis was conducted on grains of one size fraction (usually 150–250 or 50–150 microns). The O⁻ primary beam size was ~20 microns in longest dimension.

Monazite analysis was conducted during two two-day sessions (November, 2015 on the ims1270; March, 2019 on the ims1290) and employed the ^{232}Th - ^{208}Pb system, in order to take advantage of the high Th concentration of monazite, which yields high radiogenic Pb contents, permits shorter counting times to achieve the desired precision, and can produce a smaller O⁻ primary beam for greater spatial resolution (ca. 10 μm). The 554 monazite standard was used (accepted age = 45 ± 1 Ma; Harrison et al., 1995). The mean age for monazite standard 554 for the single monazite session was 45 ± 2 Ma. Analytical methods are described in Catlos et al. (2002) and Hietpas et al. (2011). A common lead correction was applied based on the concentration of measured ^{204}Pb , yielding proportions of radiogenic Pb typically >99%. A drawback of using the ^{232}Th - ^{208}Pb is that lead loss and discordance cannot be assessed. Compositional and age zoning in monazite may be complex (e.g., Spear and Pyle, 2002; Kohn et al., 2005), so that beam location is critical to accurate interpretation of dating. Monazite grains were imaged via BSE before SIMS analysis and selected grains were mapped via wavelength dispersive spectrometry (WDS) following analysis to compare spot locations with potential compositional or age zones.

Monazite from the same sample of Coys Hill granite dated here by zircon U-Pb SIMS (PE12–21A) was dated in March 2019 at UCLA on the CAMECA ims1290 using the same methods and standard as above.

LA-ICP-MS U-Pb Geochronology

Zircon from selected samples originally analyzed via SIMS that yielded suspect ages, consisted of less than ten analysis spots, or that had complex zircon growth textures suggestive of two generations of zircon was recently re-analyzed via laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) at the Arizona Laserchron Center following the methods of Pullen et al. (2018). The age standards used were FC1 (same as AS3), SL, and R33.

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RESULTS

Detailed Sample Characteristics and Dates

P14-001: very fine-grained S>L tectonite of the western Monson body at the western contact with Ammonoosuc amphibolite in the Mount Dumlplin high strain zone (Fig. 2). The sample was collected within 2 m of the contact. Its identification as a Monson orthogneiss equivalent is based simply on composition and location. Zircons are prismatic/euhedral with aspect ratios of 2:1–3:1 (Fig. S1). The weighted mean ^{206}Pb - ^{238}U date is 477 ± 11 Ma (MSWD = 0.7; Fig. 6A), interpreted as the crystallization age of the igneous protolith. This age is ~20 m.y. older than the accepted age of the western Monson orthogneiss ($454 \pm 3/-2$ Ma, Table 1: Tucker and Robinson, 1990).

EB13-1: migmatitic Bt-Opx-Plag-Qtz (Fig. 3) granulite-facies tonalitic orthogneiss of the East Brookfield (MA) quadrangle (Walker, 2011). This unit is mapped along strike to the southwest as the Lead Mine Pond Gneiss (mapped as “Neoproterozoic to Ordovician?”), which is interpreted to be basement on which the Silurian Rangeley Formation was deposited (Berry, 1989). However, this interpretation has not been geochronologically tested. Zircons are bimodal in character – either euhedral, elongate (3:1 aspect ratio), dark in CL with faint oscillatory zoning or more equant (2:1–1.5: 1), euhedral, bright in CL with oscillatory zoning (Fig. S1). Analyses are concordant within error (Fig. 6B). The date for each zircon CL population is 444 ± 15 Ma (MSWD = 0.5) and 466 ± 6 Ma (MSWD = 1.1). The latter date is interpreted as the crystallization age of the igneous protolith and the younger date is the age of migmatization during Taconian metamorphism.

H06-2: western body of Monson orthogneiss. This is a tonalitic orthogneiss with thin-section scale compositional banding defined by alternating layers containing variable Hbl + Bt versus Pl. The weighted mean date of 452 ± 5 (MSWD = 0.8; Fig. 5C) is interpreted to be a crystallization age. This age is consistent with the zircon U-Pb TIMS age of the western Monson orthogneiss and spatially related, compositionally similar granitic orthogneiss bodies in the Bronson Hill Zone of Massachusetts and New Hampshire cited above.

WF15-1: The Hedgehog Hill, granulite-facies quartz diorite orthogneiss of the Westford (CT) quadrangle (“Devonian Hedgehog Hill foliated quartz diorite” map unit of Peper and Pease, 1975) is correlated with the foliated quartz diorite in Wales quadrangle to the north (Seiders, 1976) that was also dated (WA14-001, below). It is massive in outcrop but weakly foliated in thin section (Fig. 4). The foliation is defined by dynamically recrystallized folia of biotite and orthopyroxene that wrap plagioclase grains exhibiting deformation twinning. Zircon grains are stubby to elongate (Fig. S1) but all analyses define a single age mode. The weighted mean ^{206}Pb - ^{238}U date of 420 ± 7 (MSWD = 0.7; Fig. 5D) is interpreted as the crystallization age of the plutonic protolith.

WA12-1: The granodioritic to tonalitic Ragged Hill orthogneiss (Field, 1975) exhibits two age modes corresponding to zircon cores and rims (Fig. S1) at 410 ± 15 and 367 ± 12

(MSWD = 0.3 and 0.4 respectively; Fig. 5E). The former is interpreted as the crystallization age of the plutonic protolith and the latter is interpreted as a metamorphic age.

TEMP15-1: This is a narrow (~100 m wide) tonalitic orthogneiss body within Rangeley paragneiss just east of the steeply dipping contact with the Hardwick Tonalite. It yields a weighted mean ^{206}Pb - ^{238}U date of 397 ± 7 (MSWD = 0.5; Fig. 5F) interpreted as the crystallization age of the plutonic protolith.

PE12-21: The Coys Hill granite is mapped as an extreme southern extension of the Cardigan pluton of the Kinsman Qtz-monzonite suite of New Hampshire (Robinson et al., 1986; Clark and Lyons, 1986). The Coys Hill granite is a megacrystic Kfs-Pl-Qtz-Bt-Grt, protomylonitic orthogneiss (O'Brien, 2009). Zircons are uniformly elongate (5:1–10:1) and consist of mostly oscillatory zoned centers with light gray, unzoned overgrowths of variable thickness but generally too narrow to target for SIMS analysis. An initial SIMS analysis of 30 spots on 30 grains for a sample from southeastern Petersham quadrangle yielded mostly concordant analyses and a weighted mean ^{206}Pb - ^{238}U age of 384 ± 4 Ma with an MSWD (0.9) consistent with a single population of dates. However, this age is significantly younger than the zircon U-Pb TIMS age of 396 ± 2 Ma for the Coys Hill granite in northern Massachusetts (Robinson et al., 1998).

The possibility that the initial SIMS age is too young due to slight Pb loss from regional metamorphism or strain related to ductile deformation (Reddy et al., 2006) led us to re-date the Coys Hill granite. The original zircon concentrate, and zircon from a sample of the Coys Hill from Winchendon quadrangle and a third sample from the type locality in Palmer quadrangle, were dated by zircon U-Pb LA-ICP-MS analysis. Zircon grains are consistent among the three samples, being mostly elongate and oscillatory zoned, some with thin light gray unzoned overgrowths (Fig. S1). Cores were targeted for analysis. All three samples yield a date of 395 ± 2 Ma (Fig. 5G), identical to the TIMS age but with higher and more variable MSWD (1.3–3.2) potentially indicating more than one age population. We accept the LA-ICP-MS age for sample PE12-21 as the intrusive age of the Coys Hill granite.

Early Neo-Acadian Leucopegmatite Suite

Leucopegmatite zircon grains tend to be elongate (4:1) and prismatic, dark and oscillatory zoned in CL (Fig. S1). Some grains exhibit xenocrysts and others contain overgrowths. Rims were analyzed when present and thick enough for the ion beam.

OR12-1: folded leucopegmatite in the northernmost end of the eastern Monson orthogneiss body (Fig. 3F). Zircon grains are elongate (5:1) with dark oscillatory zoning (Fig. S1). Analyses tend toward reverse discordancy (Fig. 6A). A weighted mean date of 365 ± 4 Ma is interpreted as a magmatic crystallization/intrusion age of the pegmatite.

221-6: protomylonitic leucopegmatite vein in eastern Monson orthogneiss. Zircons are uniformly acicular (5:1–10:1 aspect ratios) and prismatic exhibiting dark oscillatory zoned centers with thin bright oscillatory zoned rims (Fig. S1). Analysis of dark core zones yields an age of 369 ± 4 Ma (MSWD = 1.7), interpreted as the intrusive age and the bright rims yield an age of 354 ± 5 Ma (MSWD = 1.5; Fig. 6B), interpreted as a metamorphic age.

WD14-001, -002B, and -002C: leucopegmatites all intruding the western Monson orthogneiss at its eastern contact with the Partridge Formation within the Greenwich Syncline (Fig. 2). The leucopegmatites are 0.5 m-thick planar bodies aligned parallel to the steeply dipping foliation in the enclosing orthogneiss and parallel to the axial plane of the syncline. U-Pb analyses are generally reversely discordant. Weighted mean ^{206}Pb / ^{238}U ages are 366 ± 5 (MSWD = 0.1; Fig. 6C) for oscillatory zoned cores (Fig. S1) in -001; 351 ± 5 (MSWD = 0.8) for thick

oscillatory zoned regions of grains that represent the greatest volume of zircon growth in –002B (Fig. 6D); and 369 ± 5 Ma (MSWD = 0.3) for dark oscillatory zoned zircon overgrowths on metamict cores that represent the greatest volume of zircon growth in –002C (Fig. 6E). Some core analyses are scattered to older ages (Fig. 6D, E) consistent with inheritance evident from xenocrystic cores (Fig. S1).

FHM-104: sheared leucopegmatite in western Monson orthogneiss. Zircons consist of bright, oscillatory-zoned, variably resorbed inherited cores and dark, oscillatory to sector-zoned overgrowths (Fig. S1). Cores yield dates of ca. 430–470 with a single date of 1200 Ma, consistent with inheritance. The dark overgrowths yield an age of 357 ± 6 (MSWD = 0.8; Fig. 6F), interpreted to be the crystallization age of the pegmatite.

EB14-001: flattened, boudinaged leucopegmatite in Rangeley paragneiss. Zircons are prismatic, equant to stubby (2:1) with dark sector-zoned cores, oscillatory-zoned overgrowths, and bright unzoned rims that embay and overgrow interior zones (Fig. S1). Cores and rims were of sufficient size to accommodate the beam. Cores and rims yield dates of 364 ± 6 (MSWD = 0.3) and 355 ± 7 (MSWD = 0.7), respectively. The older date is interpreted as a crystallization age and the rim date is a metamorphic age.

EB14-002B: isoclinally folded, 0.25 m-thick leucopegmatite layer with an axial plane parallel to the foliation of the enclosing migmatitic Rangeley paragneiss (Fig. 3A) and fold axis parallel to the horizontal lineation in the gneiss defined by acicular sillimanite. A weighted mean ^{206}Pb - ^{238}U age of 367 ± 5 Ma is obtained for oscillatory zoned centers of grains and interpreted as the crystallization age of the leucopegmatite.

EB14-003: 0.25 m-thick, foliation-parallel, boudinaged, leucopegmatite layer in the Paxton Fm. A weighted mean age for analyses from the centers of stubby grains is 366 ± 5 Ma (MSWD = 0.6; Fig. 6H) and is interpreted as the crystallization age of the leucopegmatite.

SB10-1: folded leucopegmatite within the Walker Mtn. orthogneiss (Fig. 4G). Zircons are blocky (1.5:1–2:1) and consist of thick, dark, oscillatory zoned overgrowths that constitute the greatest volume of zircon, on xenocrystic or antecrystic cores (Fig. S1). The zircon U-Pb SHRIMP weighted mean age is 353 ± 3 Ma (MSWD = 1.0; Fig. 6I) is obtained for the generation of zircon overgrowth and is interpreted as the crystallization age.

Paragneiss

WA15-4: This is a sample of Rangeley Fm. Qtz-Kfs-Pl-Crd-Bt-Sil paragneiss from the region of the highest-grade zone of the central Massachusetts granulite-facies high (Fig. 2B, 2C; Schumacher et al., 1989). The Rangeley at this locality is in contact with a dated quartz diorite described below (WA14-001: 362 ± 2 Ma). The foliation is defined by parallelism of biotite, sillimanite, and elongate cordierite aggregates and K-feldspar porphyroblasts (Fig. 4D). Other samples at this locality contain garnet. This sample exhibits none of the retrograde reaction or fabric overprinting characteristic of other Rangeley paragneiss samples dated here. Zircon grains consist of anhedral cores of variable brightness and zoning style (Fig. S1). Zircon cores are mantled by dark, unzoned overgrowths. The variation in zoning of zircon cores is typical of that observed in a detrital zircon sample. The overgrowths are interpreted to be metamorphic.

Seventy spots on cores and rims were targeted for LA-ICP-MS analysis. The dated grains were imaged via CL after analysis assess whether the laser spot fell on cores, overgrowths, overlapped core-overgrowth boundaries, or drilled down into the core (Fig. S1). Cores range in age from 400 to 1900 Ma with a minor age mode at ca. 450 Ma (Fig. 6K). Overgrowth ages range from 365 to 400 Ma. The youngest overgrowth dates for spots fully in the overgrowth approach the age of the adjacent quartz diorite pluton. We thus interpret the range of 365–400

Ma dates to correspond to mixing of a ca. 365 metamorphic age component and an older age component from the relict detrital zircon core of each grain. Monazite U-Pb TIMS ages for Crd-Sil-Kfs-grade Rangeley Fm. paragneisses near our dated sample are ca. 365 Ma (Thomson et al., 1992), supporting our interpretation.

Neo-Acadian Diorite-Tonalite Suite

PI4-008: Diorite of West Warren (Pomeroy, 1977; dark gray, massive to weakly foliated granulite facies Pl-Opx-Qtz-Bt-Grt quartz dioritic orthogneiss (Fig. 4H). Zircon grains are prismatic (3:1–5:1) and oscillatory- to sector- zoned (Fig. S1). Analyses from oscillatory-zoned grain centers yields a weighted mean age of 369 ± 8 Ma (MSWD = 0.7; Fig. 7A).

EB10-26: Walker Mtn. quartz diorite orthogneiss; variably foliated, locally migmatitic Pl-Bt-Hbl-Qtz $\pm$ Grt $\pm$ Cpx $\pm$ Ap orthogneiss (Figs. 3E, 4G). This pluton was originally dated via SHRIMP and yielded an age of 356 ± 4 Ma (MSWD = 0.8) based on analysis of 16 grains (Massey et al., 2017). We re-dated 30 grains from the same 125–250 μ m concentrate via LA-ICP-MS. Zircon grains are fragments of larger zircons and consist of oscillatory zoned regions embayed by medium gray unzoned overgrowths (Fig. S1). The two types of zircon are interpreted to be magmatic and metamorphic, respectively. Dated grains were imaged via CL after analysis. A weighted mean age for the magmatic component is 360 ± 3 Ma (MSWD = 3.1) and the metamorphic component is 352 ± 4 Ma (MSWD = 2.1) (Fig. 7B). We accept the former as the crystallization age of the protolith of the Walker Mtn. orthogneiss.

PE12-10: The Hardwick tonalite is one of the largest plutons in Massachusetts (Fig. 2) and ranges from quartz diorite to tonalite to granodiorite. Although the Hardwick is highly variable in mineralogy and texture, and locally migmatitic (Shearer and Robinson, 1988), the dated sample selected is an equigranular Bt-Hbl tonalite (Fig. 3C). Zircon grains are either elongate (3:1–5:1) or more stubby and prismatic (Fig. S1), both oscillatory zoned. The two varieties of zircon yield ages of 358 ± 5 Ma (MSWD = 1.6) and 352 ± 6 (MSWD = 1.0) (Fig. 7C and 7D). The former is identical to a U-Pb TIMS age (360 ± 1 Ma; Robinson et al., 1998) and is accepted as the crystallization age.

WA14-001: “Foliated quartz diorite” map unit in the Wales (MA-CT) quadrangle of Seiders (1976) and tonalitic gneiss (tg) map unit of Berry (1989). The dated sample is from the same locality as Rangeley paragneiss sample WA15–4 (above). It is a medium gray, banded, migmatitic Pl-Cpx-Hbl-Bt-Qtz tonalitic orthogneiss (Fig. 3D, 4E). The foliation is defined by isoclinally folded Pl-Cpx-Qtz leucosomes and alternating feldspathic and mafic layers. Zircons are elongate and anhedral (“twig-like”) and exhibit two growth generations in CL: a mottled dark to light center with medium gray unzoned overgrowths (Fig. S1). Both generations were initially analyzed by SIMS but there were an insufficient number of ages to discriminate between the two growth zones. A pooled weighted mean of all analyses is 347 ± 8 Ma (MSWD = 1.3). The petrologic evidence is consistent with the diorite having experienced granulite facies metamorphism. Thus the age could be a mix of igneous and metamorphic ages. This sample was reanalyzed via LA-ICP-MS with laser spot locations determined after analysis via CL (Fig. S1). The weighted mean age is 362 ± 2 Ma (Fig. 7F), but with a relatively high MSWD (2.2) suggestive of more than one age population. We accept the latter as the crystallization age with the high MSWD indicative of disturbance of the U-Pb system due to high-grade metamorphism.

PE13-2004: Nichewaug augite-bearing diorite “sill” of Petersham (MA) quadrangle; medium-grained, equigranular, unfoliated Pl-Cpx-Opx-Hbl-Bt-Qtz diorite collected from the center of the ca. 50 m-wide vertical sill. The border phase is weakly foliated and more biotite-rich. Zircon grains are elongate and ragged but oscillatory zoned (Fig. S1). The weighted mean

age is 359 ± 8 Ma (MSWD = 0.9) (Fig. 7E), interpreted as the crystallization age and indistinguishable from the neighboring Hardwick pluton.

Monazite Th-Pb Geochronology

Paragneisses

EB14-001B: protomylonitic Rangeley Fm. Qtz-Bt-Grt-Sil-Kfs $\pm$ Ms paragneiss. Textural evidence is consistent with retrograde Bt, Sil, and Ms formation after garnet. Garnet is heavily embayed and resorbed (Fig. 4A). Sillimanite inclusions in garnet are interpreted to be prograde to early retrograde; matrix sillimanite is demonstrably retrograde.

Monazite grains exhibit zones of varying Y, Th, and U (Fig. 8) with no clear correlation of zones with ages. Several monazite grains contain sillimanite inclusions (Fig. 8). Although the probability distribution function cannot resolve two age modes, there appear to be major and minor age modes (Fig. 8A). 26 of the 30 SIMS spots yield a weighted mean ^{232}Th - ^{208}Pb age of 330 ± 4 Ma (MSWD = 0.4; Fig. 8A). Four analyses yield a weighted mean age of 309 ± 10 Ma (MSWD = 0.4; Fig. 8A). The low MSWD values indicate the cited analytical errors ($\sim 3\%$) are overestimates and the two age modes represent two distinct periods of monazite growth in response to retrograde metamorphism.

EB14-002C: migmatitic Rangeley Qtz-Kfs-Bt-Grt-Sil-Pl-Crd paragneiss hosting a dated leucopegmatite layer (367 ± 5 Ma; Fig. 3A). Many garnet porphyroblasts are heavily embayed, resorbed, and enveloped by retrograde Bt+Sil folia, consistent with formation and deformation of the matrix around existing garnet, whereas some garnet overgrows sillimanite implying garnet growth during early deformation (Fig. 4B). Matrix sillimanite defines a conspicuous, shallowly plunging N-S lineation parallel to the hinge line of the dated folded pegmatite layer.

Monazite grains consist of broad low-Y zones around mottled high-Y centers (Fig. S2). Thirty spots on 23 random monazite grains define a broad age distribution with a mean of 339 ± 5 Ma and relatively high MSWD (1.5) (Fig. 8B). Single grains with multiple spots may yield consistent ages (analyses 20–22 and 23–25) or highly disparate ages (analyses 16–19, Fig. S2). These differences and the high MSWD suggest two or more generations of monazite growth constitute the range of ages shown in Figure 8B.

P14-005A: Qtz-Bt-Grt-Sil-Pl-Ms Rangeley Fm. paragneiss with deformed leucosomes (Fig. 3B). Resorbed garnet is enveloped by Bt+Sil folia defining a σ -type asymmetry consistent with syn-deformational retrograde growth (Fig. 4C). Some garnet margins contain sillimanite, suggesting prograde and retrograde garnet growth and stability of sillimanite through the prograde to retrograde path. Monazite consists of high Y (low Th+U) cores with low Y (high Th+U) overgrowths (Fig. S2). Sillimanite inclusions occur in monazite. Ages define two distinct modes at 384 ± 4 (MSWD = 0.4) and 340 ± 6 (MSWD = 0.6) (Fig. 8C). Multiple analysis spots on single grains are generally consistent within error (Fig. S2). The older age is interpreted to be a relict of Acadian metamorphism of the pre-transpressional infrastructure and the younger age corresponds to transpressional deformation.

PE13-2003: Rangeley Fm. Qtz-Pl-Bt-Sil-Grt-Ms paragneiss located between the the Hardwick tonalite and Nichewaug intrusions. Parallelism of retrograde biotite and sillimanite define the matrix foliation, which may envelop resorbed garnet defining a σ -type asymmetry. Some sillimanite grains are fractured and extended parallel to the lineation, and overgrown by fine-grained muscovite. Some monazite grains contain sillimanite inclusions (Fig. S2). Monazite grains consist of zones that are highly heterogeneous (mottled) in Y with high-Y outer bands (Fig. S2). Monazite ages define three modes ($\sim 380, 350, 330$ Ma) that are not resolvable based

on the estimated analytical precision ($1\sigma = 3\%–4\%$; Appendix 2) (Fig. 9D). The weighted mean of all analyses is 349 ± 7 Ma, with an MSWD (1.7) consistent with the presence of multiple age generations.

PE12-21: Monazite is as abundant in the Coys Hill granite as is zircon, and was dated by SIMS at UCLA on the CAMECA ims1290. Monazite grains are complexly zoned (Fig. S2), but dates generally correlate with zones: (1) higher Th+U (lower Y) zones are brighter in gray scale and yield a mean age of 398 ± 4 Ma (MSWD = 0.4); (2) lower Th+U (higher Y) zones yield a mean age of 369 ± 4 (MSWD = 0.4) (Fig. 8E). The older age is within error of the zircon LA-ICP-MS age determined here (395 ± 2 Ma) and of the TIMS U-Pb age of the Coys Hill granite from northern Massachusetts (396 ± 2 Ma, 2σ : Robinson, 2003), interpreted as the crystallization/intrusive age of the Coys Hill. The younger age is interpreted here as a metamorphic age as it is identical to other ages discussed above interpreted to reflect regional metamorphism, and the Coys Hill exhibits mineralogic and textural evidence of regional metamorphism (O'Brien, 2009).

RESULTS REFERENCES CITED

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Table S1. Previous Geochronology in the Bronson Hill (BH) and Central Maine (CM) zones (MA, ME, NH, VT)

Zone	Plutons	System	Age (Ma)*	Metaseds.	System	Age(s) (Ma)	Interpretation	References
	Taconian							
BH – MA	Monson orthogneiss east/west bodies	Zrc U-Pb TIMS	443 $\pm$ 3 455 $\pm$ 3	--	--	--	Intrusive age	Tucker & Robinson, 1990
BH-MA-CT	Glastonbury orthogneiss	Zrc U-Pb TIMS/ SHRIMP	451 $\pm$ 2 448 $\pm$ 3	--	--	--	Intrusive age	Aleinikoff et al., 2002
	Silurian							
CV-BH VT-NH	Comerford intrusive suite	Zrc - baddeleyite U-Pb TIMS	419 $\pm$ 1	--	--	--	Intrusive age related to crustal extension	Rankin et al., 2007
	Acadian			--	--	--		
CM-NH	Kinsman Suite NH Plutonic Series	Whole rock Rb-Sr	411 $\pm$ 19 (1 σ)	--	--	--		Lyons & Livingston, 1977
BH-MA	Kinsman Ashuelot pluton	Zrc U-Pb TIMS	403 $\pm$ 3	--	--	--	Intrusive age	Robinson, 2003
CM - ME	Pre, syn-tectonic plutons and conformable sheets	Zrc U-Pb	408-404	--	--	--	Redington, Lexington, Phillips,	Solar et al., 1998
BH-NH	Spaulding tonalite	Zrc U-Pb TIMS	408 $\pm$ 2	--	--	--	Intrusive age	Robinson, 2003
BH-MA	Prescott gabbro	Zrc U-Pb TIMS	412	--	--	--	Intrusive age	Robinson, 2003
CM - NH	Several granitic plutons and pegmatites	Mnz U-Pb	401-395	--	--	--	Acadian plutonism	Eusden & Barreiro, 1988
CM - ME	Post-folding plutons	Hbl ⁴⁰ Ar- ³⁹ Ar	403 $\pm$ 4	--	--	--	Intrusive age	Hubacher & Lux 1987
CMZ-MA	Coys Hill granite	Zrc U-Pb TIMS	396 $\pm$ 2	--	--	--	Intrusive age	Robinson et al., 1998
BH - MA	Belchertown qtz diorite	Zrc U-Pb SIMS	389 $\pm$ 2	--	--	--	Intrusive age	Massey et al., 2017
BH - MA	Partridge Fm. xenolith in Belchertown	Zrc U-Pb SIMS	386 $\pm$ 15	--	--	--	Contact meta. age (intrusion)	Massey et al., 2017
CM-ME	Mooselookmeguntic igneous Complex	Zrc U-Pb	370 $\pm$ 1; 378 $\pm$ 2; 377 $\pm$ 2, 370 $\pm$ 2	--	--	--	2-mica granite; monzodiorite “border facies”	Solar et al. 1998; Moench & Aleinikoff, 2002; Tomascak et al., 2005
CM - ME	Mooselookmeguntic granite	Mnz U-Pb	363	--	--	--		Smith & Barreiro, 1990 (bulk

								monazite U-Pb TIMS)
CM-ME	Mooselookmeguntic	Hbl Ar-Ar	359, 330;				Post emplacement cooling; partial resetting of Hbl	Lux & Guidotti 1985
	Songo	Hbl Ar-Ar	310-305	--	--	--	Complete resetting of Ar systematics by Sebago batholith	
CM - ME	Sebago	Zrc U-Pb	324 $\pm$ 3				Bulk zrc TIMS	Aleinikoff et al. 1985
	Songo	Hbl Ar-Ar	382 $\pm$ 3	--	--	--	Hercyn. Kfs-Sil meta. (M3)	Lux & Aleinikoff 1985
	Songo		~302				Reset by Sebago	Lux et al. 1989
	Neo-Acadian			--	--	--		
CM-NH	Post-tectonic Concord granite suite	Zrc U-Pb TIMS, SIMS	360-350	--	--	--	intrusive age	Harrison et al., 1987; Lyons & Livingston, 1977
CM – MA	Hardwick Hbl tonalite	Zrc U-Pb TIMS	360 $\pm$ 1	--	--	--	intrusive age	Robinson et al., 1998
CM – MA	Hardwick microcline porphyry	Zrc U-Pb TIMS	361 $\pm$ 2	--	--	--	intrusive age	Robinson et al., 1998
CM – MA	Wachusett tonalite	Zrc U-Pb TIMS	359 $\pm$ 1	--	--	--	intrusive age	Robinson et al., 1998
CM – NH	Fitzwilliam granite	Zrc U-Pb TIMS	354 $\pm$ 1	--	--	--	intrusive age	Robinson et al., 1998
CM-MA	Walker Mtn. qtz diorite orthogneiss	Zrc U-Pb SHRIMP II	356 $\pm$ 4	--	--	--	intrusive age	Massey et al., 2017
CM-MA	Folded pegmatite in Walker Mtn. orthogneiss	Zrc U-Pb SHRIMP II	353 $\pm$ 3	--	--	--	intrusive age	Massey et al., 2017
BH-MA	Pegmatite in eastern Monson	Zrc U-Pb TIMS	366 $\pm$ 1	--	--	--	folded, mylonitic	Robinson, 2003
BH-CT	Folded, mylonitic pegmatite in western Monson	Zrc U-Pb SIMS	372 $\pm$ 12c 293 $\pm$ 17r	--	--	--	folded, mylonitic	Massey et al., 2017 (WSSM)
CM-BH	Mylonitic pegmatite sill in Rangeley Fm. in CBSZ	Zrc U-Pb SIMS	370 $\pm$ 12c 356 $\pm$ 13r; 390 $\pm$ 14c 359 $\pm$ 15r	--	--	--	c: intrusive age r: metamorphic age	Massey et al., 2017 (WRH-104)
	Alleghenian			--	--	--		

CM - ME	Sebago Batholith	Monazite U-Pb TIMS	293±2	--	--	--	intrusive age	Tomaschak et al. 1996
		Zrc U-Pb TIMS	296±3					Foord et al. 1995
	Metamorphism							
CM - NH	--	--	--	Sil-Dev Rangeley to Littleton	Mnz U-Pb TIMS	402-384	Acadian regional metamorphism	Eusden & Barreiro, 1988
CM-ME	--	--	--	Carrabas- sett Fm.	Mnz U-Pb TIMS	403±6	Contact meta.	Wing et al., 2003
CM-ME	--	--	--	Waterville Fm.	Mnz Th-Pb SIMS	364±4 343±9	Buchan meta. Retrograde meta.	Wing et al., 2003
CM-MA, CT	--	--	--	Rangeley Fm.	Mnz U-Pb TIMS	363±1 367±2	Regional meta.	Thomson et al., 1992
BH-NH	--	--	--	Rangeley Fm.	Mnz Th-Pb SIMS Th-U-Pb EPMA	400±10 381±8 372±6 352±14	Regional meta. related to Acadian plutons or delamination	Pyle et al. 2005
BH – NH, CT	--	--	--	Littleton Fm.	Mnz Th-Pb SIMS, Th-U-Pb EPMA	Continuum of ages ca. 400- 260	Regional meta. +/- deformation	Spear et al., 2007
CV-VT	--	--	--	Gile Mtn. Fm.	Mnz Th-Pb SIMS	353±9	Regional meta.	Wing et al., 2003
BH- MA	xenolith in Belchertown diorite	--	--	Partridge Fm.	Mnz Th-Pb SIMS	349±7	Regional meta.	Massey et al., 2017
CM-BH MA	--	--	--	Rangeley Fm. in CBSZ	Mnz Th-Pb SIMS	373±10c 353±12 343±9 330±7r	Peak regional and retrograde meta.	Massey et al., 2017
CM-BH MA	--	--	--	Rangeley Fm. in CBSZ	Mnz U-Th- Pb EPMA	439±6	Core of detrital mnz included in Grt	Massey et al., 2017
	--	--	--			433±6/ 365±8	Core/rim of detrital mnz included in Pl in leucosome	
	--	--	--			386±6/ 392±6/ 333±6	Core/overgrowth/ rim of matrix mnz	
BH-MA MDHSZ	--	--	--	Partridge Fm.	Mnz U-Th- Pb EPMA	386±6/ 392±6/ 333±6	Core/overgrowth/ rim of matrix mnz	Massey et al., 2017
	--	--	--	Partridge Fm.	Mnz U-Th- Pb EPMA	385±7	Inclusion in Grt	Massey et al., 2017

	--	--	--	Partridge Fm.	Mnz U-Th- Pb EPMA	393±8 374±5 366±4 347±7	Cores of matrix mnz	Massey et al., 2017
	--	--	--	Partridge Fm.	Mnz U-Th- Pb EPMA	340±6 309±8 308±5 296±6	Rims of matrix mnz	Massey et al., 2017

*: ages 2σ except where noted. Abbreviations: c: core; r: rim; BH: Bronson Hill zone; CM: Central Maine zone; CV: Connecticut Valley zone;
 CBSZ: Conant Brook Shear Zone; MDHSZ: Mount Dumlupning Mnz: monazite; SIMS: secondary ion mass spectrometry; EPMA: electron probe micro-analysis; TIMS: thermal
 ionization mass spectrometry.

Table S2. Description and Location of Samples used for Geochronology

Sample No.	Lithology	Unit Name ¹	Lat. Long.	Mineral Assemblage ³	Textural Details (Photomicrograph)
Pre-transpressional plutons					
EB13-1	dioritic orthogneiss	Lead Mine Pond orthogneiss	42.1474893 -72.1142987	Pl-Bt-Opx-Qtz	migmatitic, folded, 0.1 to 1 meter-scale mafic enclaves (Fig. 4I)
P14-001	tonalitic orthogneiss	Western Monson orthogneiss	42.1924192 -72.3150094	Pl-Qtz-Hbl-Bt-Ep	S>L tectonite
H06-1	tonalitic orthogneiss	Western Monson orthogneiss	42.248231 -72.315682	Pl-Qtz-Bt-Hbl-Ep-Grt	compositional layering defined by varying amount of mafic minerals
PE12-21	granitic gneiss	Coys Hill granite	42.3912826 -72.1245439	Kfs-Pl-Qtz-Bt-Grt	Porphyroclastic, protomylonitic
W12-1	granitic gneiss	Ragged Hill gneiss	42.2894524 -72.1823799	Pl-Qtz-Kfs-Bt-Grt	equigranular, weakly foliated
WF15-1	qtz dioritic orthogneiss	Hedgehog Hill orthogneiss	41.9624701 -72.2353686	Pl- Bt-Opx-Qtz-Ap	protomylonitic (DRQ, deformation twinning in Pl, bending of Bt flakes, weak S-C fabric) (Fig. 4F)
TEMP15-1	tonalitic orthogneiss	none	42.5702199 -72.0708623	Pl-Qtz-Bt-Ms-Grt	equigranular, weakly foliated
Leucopegmatite					
221-6	--	Eastern Monson orthogneiss	42.165098 -72.284698	Pl-Qtz-Bt-Ms ^r	protomylonitic (DRQ, feldspar deformation twins)
EB14-002B	--	Rangeley paragneiss	42.1558952 -72.0830917	Pl-Qtz-Kfs-Grt	folded (field photo in Fig. 3A)
EB14-003	--	Paxton paragneiss	42.1535678 -72.0364463	Pl-Qtz-Kfs-Bt-Grt	folded, boudinaged parallel to fold axis
FHM-104	--	Western Monson orthogneiss	42.0546 -72.3043	Qtz-Pl-Bt-Or-Ms ^r	protomylonitic
OR12-1	--	Eastern Monson orthogneiss	42.5586500 -72.3019464	Pl-Qtz-Kfs	folded (field photo fig. 3F)
SB10-1	--	Walker Mtn. orthogneiss	42.1169702 -72.0758265	Pl-Qtz-Kfs-Bt	folded (field photo fig. 3G)
WD14-001	--	Western Monson orthogneiss	42.2620568 -72.2901624	Pl-Qtz-Kfs	
WD14-002B	--	Western Monson gneiss	42.317112 -72.2942072	Pl-Qtz-Kfs	
WD14-002C	--	Western Monson gneiss	42.317112 -72.2942072	Pl-Qtz-Kfs	

Diorite-tonalite suite					
EB10-26	qz diorite orthogneiss	Walker Mtn. orthogneiss	42.1366329 -72.0645709	Pl-Bt-Hbl-Ap-Qtz	equigranular, unfoliated (outcrop Fig. 3E; thin section Fig. 4G)
P14-008	qtz diorite	Diorite of West Warren	42.1411876 -72.2766532	Pl-Opx-Bt-Qtz-Grt	equigranular, granoblastic (Fig. 4H)
PE12-10	tonalite orthogneiss	Hardwick Tonalite	42.4166892 -72.1962831	Pl-Bt-Hbl+Qtz±Cpx	equigranular, granoblastic (Fig. 3C)
PE13-2004	diorite	Nichewaug sill	42.4966356 -72.2098856	Pl- Cpx-Bt-Qtz-Ilm	equigranular, massive, weak relict diabasic texture
WA14-1	qtz diorite orthogneiss	Foliated Quartz Diorite of Wales quad.	42.1091843 -72.1708400	Pl-Bt-Qtz-Opx-Hbl-Ttn-Ap-Aln	foliation defined by //ism of biotite, elongate opx clusters; folded leucosomes in outcrop; Pl is antiperthite (outcrop Fig. 3D, thin section Fig. 4E)
Pelitic paragneisses					
EB14-001B	metapelite	Paxton Fm.	42.2256742 -72.0219812	Qtz- Bt ^f -Kfs-Grt- Sil ^f	protomylonitic (DRQ), Bt shear bands, Sil+Bt folia wrapping resorbed garnet (Fig. 3A)
EB14-002	metapelite	Rangeley Fm.	42.1558952 -72.0830917	Qtz-Kfs-Bt ^f -Grt-Sil ^f	Sil+Bt folia wrapping resorbed garnet (Fig. 3B)
P14-005A	metapelite	Rangeley Fm.	42.1906555 -72.2751588	Qtz-Bt-Grt-Sil-Pl	Sil+Bt folia wrapping resorbed garnet defining σ clasts (Fig. 3C)
PE13-2003	metapelite	Rangeley Fm.	42.4979260 -72.2109454	Pl-Qtz-Bt-Sil-Grt	foliation defined by alignment of Sil+Bt, Sil+Bt folia wrapping resorbed garnet
WA15-4	metapelite	Rangeley Fm.	42.1091843 -72.1708400	Pl-Kfs-Crd-Sil-Bt	foliation defined by alignment of Sil, Bt, Crd, and elongate Kfs grains (Fig. 3D)

¹: commonly recognized or formal map unit designations usually after Robinson (2003), Robinson et al. (1986, 1992), or Berry (1989), or pegmatite host lithology

²: Assemblage listed in order of abundance

Sample numbers keyed to 7.5 min. quadrangle in which sample was collected: EB: East Brookfield (MA); OR: Orange (MA); P: Palmer (MA); PE: Petersham (MA); T: Templeton (MA); W: Ware (MA); WA: Wales (MA); WD: Windsor Dam (MA); WF: Westford (CT).

Figure S1 Moecher et al.

EB14-001B Rangeley Paragneiss

EB14-002C Rangeley Paragneiss

P14-005 Rangeley Paragneiss

PE13-2003 Rangeley Paragneiss

PE12-13 Coys Hill Granite

Figure S2 Moecher et al.