Cretaceous partial melting, deformation, and exhumation of the Potters Pond migmatite domain, west-central Idaho

William J. Montz and Seth C. Kruckenberg
DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCES, BOSTON COLLEGE, CHESTNUT HILL, MASSACHUSETTS 02167, USA

ABSTRACT

The Potters Pond migmatite domain (PPMD) is a heterogeneous zone of migmatites located ~10 km southwest of Cascade, Idaho, within the western Idaho shear zone (WISZ). The PPMD is the only known exposure of migmatites within the WISZ over its ~300 km length, occurring where the shear zone orientation changes from 024° south to 005° north of the migmatite domain. Structural mapping within the PPMD has identified multiple generations of migmatite with varied structural fabrics. Leucosome layers were sampled from distinct migmatite localities and morphologies (e.g., metatexite and diatexite) to determine the timing and duration of partial melting in the PPMD. U-Pb age determinations of zircon by means of laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) document two periods of protracted migmatite crystallization during the Early and Late Cretaceous. Early Cretaceous (ca. 145–128 Ma) migmatite crystallization ages are coeval with the collision and suturing of oceanic terranes of the Blue Mountains province with North America and the formation of the Salmon River suture zone (SRSZ). Migmatite crystallization ages from ca. 104–90 Ma are associated with Late Cretaceous dextral transpression in the WISZ. Field observations and geochronology of crosscutting leucosome relationships are interpreted to record deep crustal deformation and anatexis associated with formation of the SRSZ, subsequently overprinted by solid-state deformation and renewed anatexis during the evolution of the WISZ. These data are the first direct evidence of the synmetamorphic fabric related to the SRSZ east of the initial Sr 0.706 isopleth and indicate that the WISZ is a temporally distinct overprinting structure.

INTRODUCTION

The western margin of Laurentia is marked by the accretion of multiple oceanic terranes. The broad zone of arc-continent collision in western Idaho is known as the Salmon River suture zone (SRSZ), which juxtaposes the island arc terranes of the Blue Mountains on the west with the North American craton to the east (e.g., Hamilton, 1963; Lund and Snee, 1988). Estimates on the timing of this accretion vary from Early Cretaceous (Getty et al., 1993) to Late Jurassic (LaMaskin et al., 2015). Sometime after accretion of the island arc terranes to this margin, the Salmon River suture zone was affected by the western Idaho shear zone (WISZ) (Lund and Snee, 1988; Manduca et al., 1993; McClelland et al., 2000; Giorgis et al., 2005). The western Idaho shear zone records dextral transpressional deformation (e.g., Giorgis and Tikoff, 2004; Giorgis et al., 2008, 2016). Current estimates for timing indicate that deformation ceased at ca. 90 Ma (Giorgis et al., 2008).

A major debate has centered on the timing relation between the Salmon River suture zone and the western Idaho shear zone: There are two main interpretations. The first option is that there is temporal continuity between suturing and the transpressional deformation. This interpretation is implicit in the work of Selverstone et al. (1992) and Snee et al. (1995), and it is explicit in Gray et al. (2012). The second option is that the western Idaho shear zone is a distinctly younger feature that overprints the Salmon River suture zone. This interpretation of spatially overlapping structures was initially proposed for both the western Idaho shear zone and the Coast shear zone of Britain Columbia and Alaska by McClelland et al. (2000), and it was subsequently supported by Tikoff et al. (2001), Giorgis et al. (2008), and Blake et al. (2009). At present, the data support either option, depending on the interpretation of fabrics to U-Pb zircon ages in specific plutonic units (e.g., Gray et al., 2012; Braudy et al., 2016).

We studied a newly mapped migmatite domain associated with the western Idaho shear zone on West Mountain (Braudy, 2013; Braudy et al., 2016). Migmatites, representing former partially molten rocks and magmas (e.g., Sawyer, 2008; Vanderhaeghe, 2009), have been shown by numerous studies to provide critical constraints on tectonic evolution. Partial melt migration is intrinsically linked to deformation (e.g., Brown and Solar, 1998; Weinberg and Mark, 2008), and, as such, migmatites—particularly in shear zones—inform on the timescales and interaction of crustal melting and deformation processes. Our study leverages combined structural mapping and U-Pb geochronology in this newly recognized migmatite domain—herein referred to as the Potters Pond migmatite domain (PPMD)—to determine the timing and duration of partial melting and the deformation history recorded in the Potters Pond migmatites. We demonstrate that migmatites comprising the Potters Pond migmatite domain record two protracted periods of migmatite crystallization in the Early Cretaceous (ca. 145–128 Ma) and Late Cretaceous (ca. 104–90 Ma). We interpret these ages to record deep crustal deformation and anatexis during formation of the Salmon River suture zone and western Idaho shear zone, respectively. These data show that the Salmon River suture zone and western Idaho shear zone occurred as two temporally distinct events and offer the first direct evidence that Late Cretaceous mylonites of the western Idaho shear zone have overprinted Early Cretaceous synmetamorphic...
structures associated with the Salmon River suture zone. The U-Pb zircon age distribution also indicates partial melting of both Blue Mountain and North American sources. As such, a sliver of Blue Mountain terrain must exist east of the western Idaho shear zone at this location, consistent with the interpretation of Braudy et al. (2016). Further, our U-Pb geochronology results are the first clear evidence from south of the Orofino area (e.g., Woodrat Mountain shear zone; Lewis et al., 2007, 2014; Schmidt et al., 2016) that deformation associated with suturing affected the North American side of the western Idaho shear zone.

GEOLOGIC BACKGROUND

The western Idaho shear zone is a steeply dipping, roughly northsouth–striking, high-strain zone that follows the initial Sr 0.706 isopleth (Armstrong et al., 1977) for over 300 km along the western margin of the Idaho batholith (Manduca et al., 1993; McClelland et al., 2000; Tikoff et al., 2001; Giorgis et al., 2016) (Fig. 1). The initial Sr 0.706 isopleth marks the boundary between cratonic North American crust (87Sr/86Sr > 0.706) and accreted oceanic crust (87Sr/86Sr < 0.706). The western Idaho shear zone lies at one of the many subvertical plate boundaries within the North American Cordillera. Although this subvertical boundary was originally thought to reflect the accretion of oceanic terranes with continental North America (e.g., Selverstone et al., 1992), it is potentially better considered as a transpressional modification of that accretionary boundary (e.g., McClelland et al., 2000). Giorgis et al. (2008), in an attempt to build consensus about regional nomenclature, separated the accretionary Salmon River suture zone from the shearing modification of that boundary by the western Idaho shear zone.

In western Idaho, the tectonic history begins with the Late Jurassic–Early Cretaceous collision of the oceanic terranes of the Blue Mountains province with the North American craton (Avé Lallemant, 1995; Vallier, 1995; Gray and Oldow, 2005). Initial collision and suturing began at ca. 144 Ma and was active through ca. 128 Ma (Selverstone et al., 1992; Getty et al., 1993), forming the Salmon River suture zone in west-central Idaho (Lund and Snee, 1988). Following suturing, intrusive suites were emplaced in western Idaho with ages that generally decrease from west to east. In the area around McCall, Idaho, where there is great exposure of the western Idaho shear zone, these intrusive suites are the Hazard Creek complex, Little Goose Creek complex, and Payette River tonalite. Rocks of the westernmost unit, the Hazard Creek complex, have two main compositions: an older generation of tonalitic to quartz dioritic orthogneiss and a younger generation of deformed tonalite and trondhjemite (Manduca et al., 1993). U-Pb zircon ages indicate emplacement and deformation of the Hazard Creek complex was ongoing by ca. 118 ± 5 Ma and concluded by ca. 114.4 ± 2.2 Ma (Manduca et al., 1993; Unruh et al., 2008). East of the Hazard Creek complex lies the Little Goose Creek complex, an intrusion composed primarily of porphyritic granodiorite and granite orthogneiss. The Little Goose Creek complex was emplaced between ca. 110 ± 5 and 105 ± 1.5 Ma (Manduca et al., 1993; Giorgis et al., 2008; Unruh et al., 2008). The youngest intrusion is the Payette River tonalite and was emplaced between 91.5 ± 1.1 and 89.7 ± 1.2 Ma (Giorgis et al., 2008). The Payette River tonalite is characterized by coarse-grained hornblende and the presence of mafic enclaves.

The western Idaho shear zone is located within the Salmon River suture zone and is the present-day boundary between accreted oceanic arc terranes and cratonic North America. Deformation is best characterized in the McCall region, where it affects the easternmost portion of the Hazard Creek unit and all of the Little Goose Creek complex. The Payette River tonalite is interpreted as a syntectonic, steeply dipping sill associated with the western Idaho shear zone (e.g., Manduca et al., 1993). The shear zone has been described as far south as the Owyhee Mountains (Benford et al., 2010) and extends north through McCall and Riggins (Giorgis et al., 2008; Blake et al., 2009; Giorgis et al., 2016) before stopping at a younger shear zone near Orofino (McClelland and Oldow, 2007).

The characteristic fabric observed throughout the western Idaho shear zone is a steeply dipping, N- to NNE-trending foliation (e.g., McClelland et al., 2000; Giorgis et al., 2008; Benford et al., 2010). Tikoff et al. (2001) noted that western Idaho shear zone fabrics restore to a vertical orientation when Miocene–present faulting is reconstructed. Thus, dextral transpression is thought to be responsible for the deformation associated with the western Idaho shear zone (e.g., McClelland et al., 2000; Giorgis et al., 2008).
Cretaceous partial melting, deformation, and exhumation of the Potters Pond migmatite domain | THEMED ISSUE

Migmatites are classified based on increasing granitic fraction and continuity of the former solid framework, and they are subdivided into metatexites (former partially molten rocks) and diatexites (former magmas) (Mehnert, 1968; Brown, 1973; Wickham, 1987; Sawyer, 1994; Vanderhaeghe, 2009). Metatexites comprise gneisses and schists with a continuous foliation enclosing leucosome (i.e., segregated partial melt), whereas diatexites are dominated by granite enclosing enclaves, selvages, and/or crystals in suspension (e.g., Sawyer, 2008; Vanderhaeghe, 2009). Migmatites within the Potters Pond migmatite domain are structurally and compositionally heterogeneous, consisting primarily of stromatic and folded metatexite, interlayered or intruded by heterogeneous diatexite (Fig. 2).

Metatexite is volumetrically minor in the Potters Pond migmatite domain, consisting of planar and folded domains of stromatic metatexite (Figs. 3A and 3B), entrained blocks of transposed amphibolite, and foliated granodioritic to tonalitic gneisses. Paleosome layers are locally boudinaged and enveloped by leucosome, which are in turn folded by tight to open folds on the cm to m scale (Fig. 3A). A solid-state foliation is observed in stromatic metatexites, defined by domains of stretched quartz aligned parallel to a variably developed transposition foliation. Throughout the Potters Pond migmatite domain, stromatic metatexite forms anastomosing domains and regions that are either invariably cut by discordant layers of cm to m scale magmatic-textured leucosome or leucocratic veins, or deformed and intruded by voluminous bodies of heterogeneous diatexite (Fig. 2).

Heterogeneous diatexite is the dominant migmatitic variety exposed throughout the Potters Pond migmatite domain (Fig. 2). This leucocratic diatexite is characterized by a well-developed synmagmatic layering (i.e., magmatic) layering (Figs. 3C–3E) defined by biotite schlieren and/or schollen of amphibolite, tonalite, and, rarely, granulite envelopes by granitic...
Figure 3. Representative field photographs of migmatites in the Potters Pond migmatite domain. (A) Folded stromatic metatexite. (B) Planar stromatic metatexite. (C and D) Wispy biotite schlieren characteristic of diatexite in the Potters Pond migmatite domain. (E) Leucosome and melanosome layers in diatexite. (F) Nebulitic-structured diatexite containing abundant garnet within neosome. (G) Agmatic-textured migmatite. Note that biotite- and hornblende-bearing leucosomes lack garnet.
to granodioritic neosome. Diatexite within the Potters Pond migmatite domain is further subdivided into schlieren-structured (Fig. 3D), melanocratic, and neblicitic-structured varieties. Schlieren-structured diatexite is distinguishable by a “wisy” synmigmatitic foliation and abundant layers of segregated leucosome (Figs. 3C–3E). This morphology contrasts melanocratic varieties, which are characterized by a higher modal abundance of biotite, planar synmigmatitic layering, and locally boudined leucosome oriented parallel to a magmatic to subsolidus foliation. Garnet is abundant in diatexite, though not observed everywhere. In melanocratic diatexite, garnet is typically fine grained and dispersed throughout the neosome. In both schlieren-structured and melanocratic diatexite, coarse-grained garnets are concentrated along leucosome-melanosome margins. Leucocratic neblicitic-structured diatexite is distinguished by voluminous, granitic to granodioritic neosome with a swirl to cryptic synmigmatitic foliation and faint leucosomes commonly containing clusters of large garnets up to 2 cm in diameter (Fig. 3F). Schlieren- and neblicitic-structured diatexite lenses tend to form large intrusive bodies on the m to km scale throughout the Potters Pond migmatite domain, whereas melanocratic diatexites form tabular bodies in the southwestern area of the migmatite domain (Fig. 2).

We distinguish the previously described migmatite units from agmatic-textured migmatite. This unit is characterized by blocks of fine-grained biotite-rich tonalitic paleosome injected by randomly oriented leucosome containing abundant hornblende and biotite, and lacking garnet (Fig. 3G). Zones of agmatic-textured migmatite occur along the western margin of the Potters Pond migmatite domain and form discontinuous lenses within both schlieren-structured diatexite and melanocratic diatexite. These lenses become more elongate in the northern parts of the Potters Pond migmatite domain (Fig. 2).

The dominant orientation of synmigmatitic layering and leucosome orientation within the Potters Pond migmatite domain varies from 000° to 020° (Fig. 4). This pattern is the expected fabric orientation within the western Idaho shear zone based on mapping by Braudy et al. (2016), who documented a solid-state fabric orientation of 005° north of the Potters Pond migmatite domain and 024° south of the domain. A second population of leucosome orientations trends 050°. The relationship between 000°–020° and 050° fabrics varies spatially. In some localities, synmigmatitic layering trending 020° is crosscut by leucosomes oriented 050°, where elsewhere discordant 050° leucosomes become parallel with 020° synmigmatitic layering or merge with leucosomes trending 020°. Lineations, where present, either pitch down dip or pitch steeply to the south.

Evidence for melt-present deformation is abundant within the Potters Pond migmatite domain; in all migmatite varieties, leucosome accumulation is associated with dilatant structural sites (Fig. 5). For example, asymmetric blocks of paleosome within diatexite preserve leucosome in pressure shadows associated with rotation during dextral shearing (Fig. 5A). Similarly, leucosome is preserved in boudin necks within metatexite (Figs. 5B and 5C), flanking structures associated with folded migmatite layers (Fig. 5D), and in the hinge zones of rootless folds in diatexite (Fig. 5E). These structural relationships attest to the role of melt-present deformation in the Potters Pond migmatite domain (e.g., McLellan, 1988; Brown, 1994; Brown and Solar, 1998; Sawyer, 2001; Marchildon and Brown, 2002, 2003; Holness, 2008). We note, however, that the deformation within the migmatite domain was variable through time as evidenced by multiple periods of migmatite formation and changes in deformation conditions (e.g., melt-present versus solid state).

More explicitly, based on map- and outcrop-scale structural relationships, the Potters Pond migmatites record a polyphase deformation history (Figs. 2 and 6). For example, migmatization and melt-present deformation recorded in stromatic metatexite and melanocratic diatexite domains show evidence of overprinting subsolidus deformation (Fig. 6C), as described previously. These early-formed structural features are, in turn, cut and deformed by a younger generation of migmatites (Figs. 6B and 6C) that form the volumetrically distinct regions of magmatically deformed heterogeneous diatexite (Fig. 6D) that characterizes much of the Potters Pond migmatite domain. These relationships clearly show that the Potters Pond migmatite domain records at least two distinct phases of crustal anatexis resulting in migmatite formation, with deformation conditions (i.e., melt-present versus solid-state) being variable through time.

GECHRONOLOGY

Lu-Hf ages of ca. 110–99 Ma are interpreted to reflect multiple generations of garnet growth during migmatite formation in the Potters Pond migmatite domain (Wilford, 2012; Braudy et al., 2016). This interpretation is in agreement with the structural record of polyphase partial melting in the Potters Pond migmatite domain, as described previously. However, the timing and duration of migmatite crystallization remains unknown. We present new zircon and monazite U-Pb data from structurally and compositionally distinct migmatites in the Potters Pond migmatite domain in order to characterize the timing and duration of partial melting and its relationship to different stages of the tectonic evolution of western Idaho.

Analytical Methods

Seven samples were selected for U-Pb isotopic analysis from structurally and compositionally distinct migmatite localities. Sampling focused

Figure 4. Lower-hemisphere equal-area net plots of (A) poles to symmigmatitic layering; (B) poles to solid-state foliation; (C) lineation; and (D) fold hinges measured from migmatites in the Potters Pond migmatite domain. Both symmigmatitic layering and solid-state foliation trend dominantly toward ~015°, and lineation is typically down dip. Orientation of fold hinges generally corresponds to lineation orientation.
Figure 5. Evidence of melt-present deformation is recorded by migmatites in the Potters Pond migmatite domain. During deformation, partial melt preferentially accumulates in dilatant structural sites: (A) Leucosome accumulation in the pressure shadow of paleosome blocks rotated during dextral shearing. (B) Accumulation of leucosome in boudin necks of paleosome layers within stromatic metatexite. (C) Leucosome preserved in boudin necks and shear bands within boudins. (D) Leucosome associated with flanking structures in folded metatexite. (E) Accumulation of leucocratic neosome in the hinge of rootless folds in schlieren-structured diatexite. (F) Leucosome accumulation in dilatant structural sites associated with high-strain domain within the Potters Pond migmatites.
Cretaceous partial melting, deformation, and exhumation of the Potters Pond migmatite domain

on structural settings in which the crystallization ages of leucosome would provide further constraints on the relationships between melt-present and solid-state deformation histories. Zircon and monazite grains were isolated using standard crushing and mineral separation procedures and were dated by laser ablation inductively coupled plasma mass spectrometer (LA-ICP-MS) U-Pb methods. All analyses were conducted at the Arizona Laser-Chron Center (Tucson, Arizona), where zircon analyses were conducted on a Thermo Element2 single-collector ICP-MS, and monazite analyses were conducted on a Nu Plasma multicollector ICP-MS. Crystallization ages from rim overgrowths and new zircon growth attributed to migmatite crystallization were calculated using the weighted-mean $^{206}\text{Pb}/^{238}\text{U}$ ages of clustered populations of data. Analyses with a large uncertainties (>10%) and excessive discordance (>20%) or reverse discordance (>5%) were discarded. Additional details of the analytical method and data tables containing analytical results are provided in the Data Repository.$^{1}$

Results of U-Pb Zircon Analyses

Boudinaged Leucosome within Melanocratic Diatexite (14WM39a)

Sample 14WM39a is sourced from granodioritic leucosome within a domain of melanocratic diatexite northwest of Blue Lake (Fig. 2). At this locality, the host melanocratic diatexite is characterized by planar synmigmatitic layering and a strong mineral lineation. The sampled leucosome is boudinaged, forming rough dextral sigmoidal shapes that pinch and swell parallel to synmigmatitic layering (Fig. 6A). Garnet is preferentially found along the contact of the leucosome with the surrounding melanocratic diatexite. A strong solid-state fabric that conforms to the shape of the boudins is observed for a few centimeters in the surrounding rock. Zircon grains in sample 14WM39a are euhedral to subhedral and range in size from 150 to 300 $\mu$m (Fig. 7). Oscillatory-zoned cores are commonly resorbed. Five- to 20-$\mu$m-wide rim overgrowths surround core domains. Fifty locations on 32 zircon grains were analyzed in sample 14WM39a, yielding $^{206}\text{Pb}/^{238}\text{U}$ ages from ca. 153–103 Ma. Thirty-nine of these analyses yield a statistical age of 136.8 ± 0.9 Ma (mean square of

---

1GSA Data Repository Item 2017042, analytical data tables containing results of U-Pb zircon and monazite geochronology, is available at www.geosociety.org/datarepository/2017, or on request from editing@geosociety.org.
Schlieren-Structured Diatexite (13WM25)

Sample 13WM25 is from a diatexite pavement north of, and adjacent to, Blue Lake with intermittent zones of metatexite a few meters thick. The sample was taken from a schlieren-structured, biotite granodiorite diatexite characterized by a strong migmatic texture, well-developed synmigmatic foliation (243/79°W with a lineation pitching 80° from the S), and centimeter-scale leucosomes that alternate with thinner melanosome layers. Garnet is abundant in both the leucosome and melanosome. The zircon population in this sample consists of subhedral to anhedral grains that form elongate to equant crystals 100–200 μm long (Fig. 8). The morphology of core domains exhibits large variability, with anhedral to euhedral cores that are homogeneous or irregularly zoned. Rarely, cores display oscillatory zoning. Rim overgrowths are 10–70 μm wide and exhibit convoluted zoning. Fifty spots on 30 zircon grains were analyzed in sample 13WM20. The major-oxide analyses yield extreme variability in 206Pb/238U ages, ranging from ca. 384–96 Ma. The three youngest analyses yield a mean 206Pb/238U age of 96.8 ± 5.5 Ma (MSWD = 2.3). The next youngest group of three analyses yield a mean age of 109.7 ± 1.9 Ma (MSWD = 0.3).

Schlieren-Structured Diatexite (13WM30)

Sample 13WM30 is from a large body of granodioritic diatexite located near the southern margin of the Potters Pond migmatite domain west of Blue Lake (Fig. 2). Biotite schlieren and tonalitic blocks are scattered throughout the outcrop, which has a pervasive magmatic synmigmatic foliation. The outcrop from which this sample is sourced is >100 m², forming a large concordant intrusive body of diatexites surrounded on three sides by stromatic metatexite. The surrounding metatexite is partially deformed in the solid state, as evidenced by stretched quartz and feldspar porphyroclasts, and locally has a near-mylohnitic fabric. This solid-state foliation conforms to the boundary of the granodioritic diatexite, striking parallel to the contact, suggesting that the diatexite body was emplaced into, and deformed, the surrounding metatexite. The zircon population from this sample consists of euhedral to subhedral grains 200–300 μm long. Internal structure is uniform throughout the zircon population, with light cores displaying indistinct oscillatory zoning (Fig. 9). Light rim overgrowths are separated from the core domains by dark, oscillatory-zoned mantles of variable thickness. We analyzed both core and rim domains of 30 grains for a total of 50 analyses in sample 13WM30. The majority of analyses (N = 47) have Cretaceous 206Pb/238U ages ranging from ca. 142–91 Ma. While 34 of the analyses yield 206Pb/238U ages ranging from ca. 108–91 Ma, 23 analyses define a statistical age of 100.3 ± 0.9 Ma (MSWD = 1.8).

Agmatic-Textured Migmatite (14WM115)

Sample 14WM115 was collected near the northwestern margin of the Potters Pond migmatite domain from a large lens-shaped outcrop of agmatic migmatite. Zircon crystals from this sample are typically 300–400 μm long and have length to width ratios of <5:1 (Fig. 10). Internal structure is variable, with core domains displaying a range of zoning patterns including unzoned, sector-zoned, and oscillatory-zoned cores. Rim overgrowths display wavy subhedral overgrowths and commonly lack distinct zoning. We analyzed 28 zircon grains with 38 individual spot analyses from sample 14WM115. All 38 analyses give Cretaceous weighted deviates [MSWD] = 1.4). Three younger grains have 206Pb/238U ages as young as ca. 103 Ma.
Cretaceous partial melting, deformation, and exhumation of the Potters Pond migmatite domain

Figure 8. (A) Cathodoluminescence images of representative zircon grains dated using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for sample 13WM25 (schlieren-structured diatexite). Small numbers refer to spot number in Table DR1. Larger numbers are $^{206}$Pb/$^{238}$U ages in Ma for individual spot analyses (see Table DR1 for corresponding error on spot analyses). (B) Probability density plots with stacked histogram of $^{206}$Pb/$^{238}$U ages (in Ma) from zircon in sample 13WM25. Light-gray bars represent rim analyses, and dark-gray bars represent core analyses. (C) Weighted-mean $^{206}$Pb/$^{238}$U age calculation and uncertainty are given at 95% confidence limits. Light- and dark-gray bars represent rim and core analyses, respectively. Plots and calculations based on Isoplot of Ludwig (2003).

Figure 9. (A) Cathodoluminescence images of representative zircon grains dated using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for sample 13WM30 (schlieren-structured diatexite). Small numbers refer to spot number in Table DR1. Larger numbers are $^{206}$Pb/$^{238}$U ages in Ma for individual spot analyses (see Table DR1 for corresponding error on spot analyses). (B) Probability density plots with stacked histogram of $^{206}$Pb/$^{238}$U ages (in Ma) from zircon in sample 13WM30. Light-gray bars represent rim analyses, and dark-gray bars represent core analyses. (C) Weighted-mean $^{206}$Pb/$^{238}$U age calculation and uncertainty are given at 95% confidence limits. Light- and dark-gray bars represent rim and core analyses, respectively. Plots and calculations based on Isoplot of Ludwig (2003).
Nebulitic-Structured Diatexite (14WM58)

Sample 14WM58 is from a large, homogeneous body of massive to nebulitic-structured diatexite. At this outcrop locality, the diatexite is composed almost entirely of neosome (i.e., essentially anatectic granite) containing no remnants of paleosome and only small (2-cm-long) pervasive wispy biotite aggregates. Variably sized garnet (2 mm to 2 cm in diameter) is distributed densely throughout the diatexite body. Zircon crystals in this sample are characterized by euhedral to subhedral elongate crystals, ranging from 200 to 500 μm in length (Fig. 11). Core domains commonly display oscillatory zoning. Rim overgrowths also exhibit oscillatory zoning and are separated from the cores by a thin, dark cathodoluminescence band. A total of 50 analyses on 30 grains were analyzed in this sample. The zircon population in sample 14WM58 yielded \(^{206}\text{Pb}/^{238}\text{U}\) ages ranging from ca. 146–93 Ma, with the remaining 30 analyses extending into the Early Cretaceous as far back as ca. 116 Ma. Twenty-three of the Late Cretaceous analyses yield a statistically relevant age of 93.3 ± 0.7 Ma (MSWD = 1.4). Five younger populations consisting of nine rim analyses give Late Cretaceous \(^{206}\text{Pb}/^{238}\text{U}\) ages ranging from ca. 100–84 Ma, with the remaining ten analyses extending into the Early Cretaceous.

Discordant Leucosome in Stromatic Metatexite (14WM37a)

Sample 14WM37a is from a discordant leucosome that cuts across an outcrop of folded and stromatic metatexite (Fig. 6B). The sampled leucosome cuts the metatexite layering at a high angle and merges with a layer-parallel leucosome 1 m to the north, before cutting across a larger diatexite body of granodioritic composition. This diatexite contains delicate magmatic structures (e.g., rootless folds) and has a weak and pervasive solid-state fabric. Equant to elongate zircon grains in this sample are 100–300 μm long and range from euhedral to subhedral crystals (Fig. 12). Internal structure is variable, but grains typically exhibit sector and oscillatory-zoned euhedral to subhedral cores. Some grains display an oscillatory-zoned mantle surrounded by a light rim overgrowth. A few of the sector-zoned grains lack overgrowths that are distinguishable from the core domains. We analyzed 50 individual spots on 30 zircon grains in sample 14WM37a. Forty-seven of these analyses give Late Cretaceous \(^{206}\text{Pb}/^{238}\text{U}\) ages ranging from ca. 100–84 Ma, with the remaining ten analyses extending into the Early Cretaceous as far back as ca. 116 Ma. Twenty-three of the Late Cretaceous analyses yield a statistically relevant age of 93.3 ± 0.7 Ma (MSWD = 1.4). Five younger populations consisting of nine rim analyses give a mean \(^{206}\text{Pb}/^{238}\text{U}\) age of 93.3 ± 0.7 Ma (MSWD = 1.4). Five younger populations consisting of nine rim analyses give a mean \(^{206}\text{Pb}/^{238}\text{U}\) age of 93.3 ± 0.7 Ma (MSWD = 1.4). Five younger populations consisting of nine rim analyses give a mean \(^{206}\text{Pb}/^{238}\text{U}\) age of 93.3 ± 0.7 Ma (MSWD = 1.4).
Figure 11. (A) Cathodoluminescence images of representative zircon grains dated using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for sample 14WM58 (Nebulitic-structured diatexite). Small numbers refer to spot number in Table DR1. Larger numbers are \(^{206}\text{Pb}/^{238}\text{U}\) ages in Ma for individual spot analyses (see Table DR1 for corresponding error on spot analyses). (B) Probability density plots with stacked histogram of \(^{206}\text{Pb}/^{238}\text{U}\) ages (in Ma) from zircon in sample 14WM58. Light-gray bars represent rim analyses, and dark-gray bars represent core analyses. (C) Weighted-mean \(^{206}\text{Pb}/^{238}\text{U}\) age calculation and uncertainty is given at 95% confidence limits. Light- and dark-gray bars represent rim and core analyses, respectively. Plots and calculations based on Isoplot of Ludwig (2003).

Figure 12. (A) Cathodoluminescence images of representative zircon grains dated using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for sample 14WM37a (discordant leucosome in stromatic metatexite). Small numbers refer to spot number in Table DR1. Larger numbers are \(^{206}\text{Pb}/^{238}\text{U}\) ages in Ma for individual spot analyses (see Table DR1 for corresponding error on spot analyses). (B) Probability density plots with stacked histogram of \(^{206}\text{Pb}/^{238}\text{U}\) ages (in Ma) from zircon in sample 14WM37a. Light-gray bars represent rim analyses, and dark-gray bars represent core analyses. (C) Weighted-mean \(^{206}\text{Pb}/^{238}\text{U}\) age calculation and uncertainty are given at 95% confidence limits. Light- and dark-gray bars represent rim and core analyses, respectively. Plots and calculations based on Isoplot of Ludwig (2003).
Results of U-Pb Monazite Analyses

Fourteen monazite grains from sample 13WM24 were analyzed for a total of 19 analyses (Figs. 14A and 14B). The majority of the grains yield either discordant ages or negative $^{208}\text{Pb}/^{232}\text{Th}$ ages and have therefore been discarded. Eight analyses on five grains yield acceptable results with $^{206}\text{Pb}/^{238}\text{U}$ ages ranging from ca. 105–90 Ma. The grains from which these analyses were taken do not appear zoned, and ages show no correlation to their location in the monazite grains. The eight analyses yield a mean $^{206}\text{Pb}/^{238}\text{U}$ age of 97.7 ± 2.3 Ma (MSWD = 1.3).

Twenty-four monazite grains from sample 13WM25 were analyzed for a total of 30 analyses (Figs. 14C and 14D). Almost all of the analyses (N = 29) give Late Cretaceous $^{206}\text{Pb}/^{238}\text{U}$ ages ranging from ca. 99–85 Ma and show no correlation to spot location in monazite grains. A single analysis yields an Early Cretaceous age of ca. 106 Ma. The young cluster of 29 analyses gives a mean $^{206}\text{Pb}/^{238}\text{U}$ age of 91.6 ± 2.3 Ma (MSWD = 1.7).

Twenty-seven individual spots were analyzed on monazite grains in sample 13WM30 (Figs. 14E and 14F). All 27 analyses yield Late Cretaceous $^{206}\text{Pb}/^{238}\text{U}$ ages ranging from ca. 100–85 Ma and have a weighted-mean $^{206}\text{Pb}/^{238}\text{U}$ age of 90.3 ± 1.6 Ma (MSWD = 2.2).

Twenty-three monazite grains were analyzed with 33 individual spots in sample 14WM37a (Figs. 14G and 14H). Seven of these analyses exhibited excessive discordance. The remaining 26 analyses give Late Cretaceous $^{206}\text{Pb}/^{238}\text{U}$ ages ranging from ca. 99–85 Ma and have a weighted-mean age of 92.4 ± 0.7 Ma (MSWD = 1.5).

DISCUSSION

Interpretation of the Geochronology Results

Schematic leucosome relationships of sampled migmatite units from the Potters Pond migmatite domain are shown in Figure 15. Field observations suggest that the melanocratic diatexitic (14WM39a) formed during one of the oldest periods of partial melting. It is commonly crosscut by...
Figure 14. Results of monazite analyses, presented as probability density plots with stacked histogram of $^{206}\text{Pb}/^{238}\text{U}$ ages (in Ma), and weighted-mean $^{206}\text{Pb}/^{238}\text{U}$ age calculation of (A and B) sample 13WM24, (C and D) sample 13WM25, (E and F) sample 13WM25, (G and H) sample 14WM37a, (I and J) sample 14WM39a, (K and L) sample 14WM58, and (M and N) sample 14WM115. Light- and dark-gray bars correspond to rim and core analyses. Weighted-mean age calculation and uncertainty are given at the 95% confidence limit. See Table DR2 for corresponding error on individual spot analyses.
The 93.3 ± 0.7 Ma age obtained from zircon in sample 14WM37a agrees with the six youngest analyses composing two peaks at ca. 110 and 97 Ma. Four samples collected for this study (13WM24, 13WM25, 13WM30, and 14WM37a) crosscut the metatexite, and therefore 206Pb/238U zircon ages of these samples are able to provide a minimum age estimate of its crystallization. Sample 13WM25 is the oldest of the four crosscutting samples, and result is within error of the schlieren-structured diatexite age, it suggests hornblende-bearing leucosomes could be either older (i.e., represent large blocks of older migmatite that have been included in younger diatexite) or younger (i.e., represent a formerly tabular migmatite body that has been boudinaged and intruded by new leucocratic veins) than both of these units. However, results of geochronologic analysis place the age of crystallization at ca. 99 Ma. While this result is within error of the schlieren-structured diatexite age, it suggests hornblende-bearing leucosomes may be of intermediate age between the melanocratic diatexite and the schlieren-structured diatexite. This allows for two interpretations: (1) The formation of hornblende-bearing leucosome may represent a change in melting conditions within the Potters Pond migmatite domain—e.g., transitions between dehydration melting and an episode of flux melting responsible for the generation of the hornblende-bearing leucosome. (2) Alternately, changes in the bulk composition of the protolith may have controlled the mineral parageneses found in these distinct hornblende-bearing leucosome. This latter interpretation is supported by the spatial distribution of the agmatic-textured migmatite along the western margin of the Potters Pond migmatite domain, where compositional layering may have favored the formation of hornblende over garnet during anatexis and migmatite crystallization. However, localized discordant leucosome (e.g., 14WM37a), stromatic metatexite, or agmatic-textured migmatite (e.g., 14WM115). Geochronology of the melanocratic diatexite confirms it to be the oldest migmatization episode with nearly all zircons analyzed crystallizing by ca. 137 Ma. These ages are contemporaneous with the Early Cretaceous Salmon River suture zone event. Samples 14WM58 (nebulitic-structured diatexite in the northern portion of the Potters Pond migmatite domain) and 13WM25 (schlieren-structured diatexite that crosscuts stromatic metatexite) also have populations of 206Pb/238U ages correlative with the Salmon River suture zone event (ca. 132 Ma and 131–117 Ma, respectively).

Field observations indicate that the stromatic metatexite is one of the older generations of migmatite in the Potters Pond migmatite domain. Four samples collected for this study (13WM24, 13WM25, 13WM30, and 14WM37a) crosscut the metatexite, and therefore 206Pb/238U zircon ages of these samples are able to provide a minimum age estimate of its formation. Sample 13WM25 is the oldest of the four crosscutting samples, with the six youngest analyses composing two peaks at ca. 110 and 97 Ma. Another six analyses yield a continuum of ages ranging from ca. 131 and 117 Ma, pushing the probable crystallization age of the stromatic metatexite into the Early Cretaceous. This interpretation is further supported by the 100.3 ± 0.92 Ma age obtained from zircon in sample 13WM30 (the body of schlieren-structured diatexite), and structural observations indicating that it was intruded into the stromatic metatexite, causing solid-state deformation to occur in the metatexite along its margins with the diatexite. The 93.3 ± 0.7 Ma age obtained from zircon in sample 14WM37a agrees with observed structural relationships; this discordant leucosome clearly crosscuts both the structural fabrics within the stromatic metatexite and the solid-state foliation and compositional layering in adjacent melanocratic diatexite. Sample 13WM24 yields the youngest zircon age attributed to migmatite crystallization. Given that this sample was sourced from layer-parallel leucosome that merges seamlessly with leucosome accumulated in boudin necks with the stromatic metatexite, we interpret the 92.4 ± 0.7 Ma age to correspond to the last phase of melt-present deformation and migmatite crystallization in the Potters Pond migmatite domain.
flux melting on the margin of the Potters Pond migmatite domain could also explain this spatial distribution, and therefore the origin of this unit remains ambiguous.

Sample 14WM58, the nebulitic-structured diatexite in the northern part of the Potters Pond migmatite domain, shares structural relationships similar to sample 13WM30 (schlieren-structured diatexite); it forms a large intrusive body of magmatically deformed leucocratic diatexite enveloped by stromatic metatexite. It is worth noting that the 95.3 ± 0.94 Ma age obtained from sample 14WM58 is ~5 million years younger than that obtained from sample 13WM30. However, based on their structural and morphological similarities, it is likely that these large migmatite bodies formed coevally during a protracted period of migmatite crystallization.

U-Pb ages obtained from all zircon grains analyzed range from ca. 160–84 Ma, with analyses from two samples extending into the Paleozoic and Precambrian. 206Pb/238U ages obtained from rim overgrowths and new zircon growth attributed to migmatite crystallization are dominantly concentrated within two age populations ranging from ca. 145–128 Ma and ca. 104–90 Ma (Fig. 16A). These data are interpreted to suggest that the Potters Pond migmatite domain records two protracted periods of migmatite crystallization. The older age population is correlative to the accretion of ocean arc terranes of the Blue Mountains province with Laurentia and the formation of the Salmon River suture zone (e.g., Silverstone et al., 1992; Getty et al., 1993). The second, younger population of ages coincides with the timing of dextral transpressional deformation along the western Idaho shear zone (e.g., Manduca et al., 1993; Giorgis et al., 2008; Braudy et al., 2016). Mean 206Pb/238U ages from six of the seven monazite-bearing samples fall in a narrow range from ca. 93–90 Ma. The entire suite of monazite analyses (N = 153) yields a mean age of 92.0 ± 0.4 Ma (MSWD = 1.0) (Figs. 16B and 16C). This well-defined age is interpreted to record the initiation of exhumation and cooling of the Potters Pond migmatite domain, and therefore the local section of the western Idaho shear zone, at ca. 92 Ma.

While seven analyses from sample 13WM25 (schlieren-structured diatexite) yield inherited Mesozoic ages ranging from ca. 246–149 Ma offer the possibility of inheritance from oceanic terranes, the remaining analyses all yielded Paleozoic or Precambrian ages. We interpret the bulk of Paleozoic and Precambrian ages as inherited ages from the North American continental crust. However, aside from two cores in sample 13WM24 and two Late Permian cores in sample 13WM30, all other inherited cores are Mesozoic and lack a North American signature. Mesozoic ages have commonly been identified in the Wallowa terrane of the Blue Mountains province (Schwartz et al., 2010, 2011; Kurz et al., 2012), suggesting the Potters Pond migmatites may be derived from a protolith related to oceanic terranes. Consequently, we interpret that there is likely both a Blue Mountain province and cratonic North America protolith for the migmatites comprising the Potters Pond migmatite domain. This interpretation is consistent with that of Braudy et al. (2016) suggesting an eastward extension of the Salmon River suture zone on the cratonic side of the western Idaho shear zone.

**Tectonic Significance**

Evidence of the timing and duration of western Idaho shear zone deformation has been well established by previous studies. Figure 17, in part, shows a visual summary of the data these studies have acquired and interpreted to help constrain the timing of western Idaho shear zone deformation. The initiation of shearing is difficult to constrain. Nearly all of the plutonic rocks of the Little Goose Creek complex have been deformed by the western Idaho shear zone (Manduca et al., 1993). While this observation does not require the age of the Little Goose Creek complex to correspond to the initiation of western Idaho shear zone deformation, an examination of the strain recorded in the Little Goose Creek complex determined that the strain likely accumulated entirely after its intrusion, setting the lower age limit for western Idaho shear zone deformation at ca. 105 Ma (Giorgis et al., 2005, 2008). Slightly younger metaplutonic rocks may indicate that ductile deformation began a few million years later. The ca. 104 Ma Crevice pluton—a correlative of the Little Goose Creek complex (Grey et al., 2012) and the ca. 101 Ma Four Bit Creek tonalite—a weakly deformed tonalite body within the westernmost western Idaho shear zone—suggest deformation may have started as late as 101 Ma. These plutonic rocks have only weak magmatic fabrics and, in the case of the Crevice pluton, strong solid-state fabric at its margins,
Previous Work

Many studies have analyzed zircons from the Payette River tonalite (and correlatives) to determine cessation of ductile deformation in the western Idaho shear zone. Weak solid-state fabric has been observed in western portions of the Payette River tonalite, while eastern portions exhibit a magmatic foliation parallel to the solid-state fabric of the western Idaho shear zone (Manduca et al., 1993; Benford et al., 2010; Braudy et al., 2016). These observations suggest western Idaho shear zone deformation was waning during the emplacement of the Payette River tonalite. U-Pb analysis of zircon from the Payette River tonalite yields ages of 91.5 ± 1.1 Ma and 89.7 ± 1.2 Ma (Giorgis et al., 2008), which agree with previous results (89 ± 5 Ma, Lund and Snee, 1988; 90 ± 5 Ma, Manduca et al., 1993) in other parts and correlatives of the Payette River tonalite (e.g., Whisky Ridge tonalite; Benford et al., 2010). Combined with a 90.0 ± 1.4 Ma undeformed pegmatite that cuts western Idaho shear zone fabric in the Little Goose Creek complex (Giorgis et al., 2008), these data suggest the end of movement on the western Idaho shear zone occurred ca. 90 Ma. New Lu-Hf garnet ages from Braudy et al. (2016) suggest peak metamorphism during western Idaho shear zone deformation occurred at ca. 98 Ma.

Migmatites in the Potters Pond migmatite domain provide an additional record of the timing and duration of western Idaho shear zone deformation. The preservation of melt-present deformation structures throughout the Potters Pond migmatite domain allows us to conclude that deformation was ongoing during migmatization. Moreover, the younger population of zircon ages ranging between ca. 104–90 Ma indicates that migmatite crystallization in the Potters Pond migmatite domain was coeval with the timing of western Idaho shear zone deformation, established by previous studies.

Previous geochronologic studies that attempt to constrain the timing and duration of suturing predating western Idaho shear zone formation focus on rocks from accreted Blue Mountain terranes and the Salmon River belt. Walker (1989) analyzed zircon from calc-alkaline plutons that crosscut folded rocks of the Blue Mountains province. Emplacement ages of these plutons range from ca. 145–120 Ma, giving an early estimate on the initiation of collision. Sm-Nd dating of garnets in amphibolites from the Salmon River belt by Getty et al. (1993) revealed two stages of garnet overgrowth: (1) ca. 144 Ma cores are interpreted to represent the initial collision of oceanic arc terranes with North America, and (2) ca. 128 Ma rim overgrowths record peak metamorphic conditions during underthrusting and burial of the Wallowa terrane (Getty et al., 1993).

The significance of the older population of 206Pb/238U zircon ages from the Potters Pond migmatite domain (ca. 145–128 Ma) is twofold. First, the melt-present deformation structures of the Potters Pond migmatite domain record a period of high-temperature deformation that predates western Idaho shear zone deformation. The preservation of melt-present deformation structures throughout the Potters Pond migmatite domain allows us to conclude that deformation was ongoing during migmatization. Moreover, the younger population of zircon ages ranging between ca. 104–90 Ma indicates that migmatite crystallization in the Potters Pond migmatite domain was coeval with the timing of western Idaho shear zone deformation, established by previous studies.

Figure 17. Summary of 206Pb/238U ages of zircon and monazite samples from this study and visualization of geochronologic data collected from other work in the western Idaho shear zone and Salmon River suture zone. Interpretations are derived from past geochronologic data (see corresponding numbered references), as well as new structural observations and U-Pb age determinations for zircon and monazite from the Potters Pond migmatite domain. Further discussion of these interpretations is included in the text.

PPMD—Potters Pond migmatite domain; SRSZ—Salmon River suture zone; WISZ—western Idaho shear zone; HCC—Hazard Creek complex; LGCC—Little Goose Creek complex. References for data are as follows: 1—Lund and Snee, 1988; 2—Walker 1989; 3—Getty et al., 1993; 4—Manduca et al., 1993; 5—Snee et al., 1995; 6—Snee et al., 2005; 7—McClelland and Oldow, 2007; 8—Giorgis et al., 2008; 9—Benford et al., 2010; 10—Grey et al., 2012; 11—Braudy et al., 2016; 12—Mckay, 2011; 13—LaMaskin et al., 2012.
Idaho shear zone deformation. This range of ages correlates well with the proposed timing and duration of suturing presented in previous studies (e.g., Selverstone et al., 1992; Getty et al., 1993) and strengthens the constraints on the timing of deformation related to the Salmon River suture zone. Second, it has been commonly suggested that the western Idaho shear zone is a temporally distinct event that has overprinted symmetamorphic fabric of the Salmon River suture zone (e.g., McClendon et al., 2000; Giorgis et al., 2008). However, no studies have identified direct evidence of overprinting within the western Idaho shear zone, and some studies argue that the Salmon River suture zone and western Idaho shear zone are both parts of a progressive deformation history associated with suturing (e.g., Grey et al., 2012). The Potters Pond migmatite domain records two distinct periods of crustal anatexis and associated high-temperature deformation with a ~25 m.y. gap in which migmatite crystallization is not recorded. Our new U-Pb zircon ages therefore clearly delineate two age populations correlative with the timing of the Salmon River suture zone and western Idaho shear zone structures, suggesting that they formed as a result of distinct events. The preservation of solid-state deformational fabrics that overprint early-formed migmatite units, which are in turn cut by a younger generation of migmatites correlative with the timing of the western Idaho shear zone, indicate that deformation conditions within the Potters Pond migmatite domain must have changed throughout the Cretaceous (i.e., melt-present deformation followed by cooling and solid-state deformation and renewed crustal anatexis and subsequent solid-state deformation during shearing associated with the western Idaho shear zone). Our data therefore offer the first direct evidence that Late Cretaceous mylonites of the western Idaho shear zone have overprinted Early Cretaceous symmetamorphic structures associated with the Salmon River suture zone.

Summary

In summary, our data reveal two periods of partial melt crystallization within the Potters Pond migmatite domain (Figs. 16A and 17). The first period spans from ca. 145–128 Ma and records high-temperature deformation associated with the collision, underthrusting, and suturing of ocean arc terranes of the Blue Mountains province with North America. This timing agrees with metamorphic events dated by Sm-Nd garnet geochronology by Getty et al. (1993).

The second period of partial melting spans from ca. 104–90 Ma and records high-temperature deformation associated with dextral transpression of the western Idaho shear zone. Peak 206Pb/238U zircon ages for this period occur between ca. 98 and 94 Ma, agreeing with the timing of peak western Idaho shear zone metamorphism evidenced by Lu-Hf garnet ages of ca. 98 Ma (Braudy et al., 2016). Crosscutting structural relationships in the Potters Pond migmatite domain provide evidence that melt-present deformational structures associated with the Salmon River suture zone were overprinted by solid-state deformation associated with the first period of deformation. Boudinaged leucosomes within melanocratic diatexite (e.g., sample 14WMM39a; Fig. 6A) yield ages coeval with the Salmon River suture zone and exhibit strong solid-state fabric. This fabric is crosscut by younger migmatites and large diatexite bodies of western Idaho shear zone age that are not deformed in the solid state. A narrow range of monazite ages from ca. 93–90 Ma indicates exhumation of the Potters Pond migmatite domain began by ca. 92 Ma, which agrees with the cessation of western Idaho shear zone deformation by 90 Ma.

CONCLUSIONS

Structural and geochronologic data from the Potters Pond migmatite domain provide additional constraints to timing of deformation in western Idaho and offer new insights into the deformation conditions of the deep crust during Cretaceous deformation. Geochronology of crosscutting migmatite units within the Potters Pond migmatite domain confirms that there have been two episodes of partial melting that record distinct protracted periods of high-temperature, melt-present deformation. The older period of migmatite crystallization corresponds to melting and deformation associated with the Salmon River suture zone (ca. 145–128 Ma); the younger period of migmatite crystallization corresponds to melting and deformation associated with the formation of the western Idaho shear zone (ca. 104–90 Ma). Various crosscutting relationships observed in the field indicate the Potters Pond migmatite domain experienced varying deformation conditions during the Cretaceous. Migmatites contain melt-present structures formed coeval with the Salmon River suture zone. These migmatites were overprinted by solid-state deformation that predates the formation of the western Idaho shear zone during hiatus in migmatite crystallization. During western Idaho shear zone deformation, the Potters Pond migmatite domain experienced renewed crustal anatexis resulting in melt-present deformation in the deep crust while the rest of the western Idaho shear zone experienced solid-state deformation. The changes in deformation conditions experienced by the Potters Pond migmatite domain during Salmon River suture zone contraction and western Idaho shear zone transpression, and the gap in migmatisation recorded by U-Pb geochronology of zircons from the Potters Pond migmatites, provide the first structural and geochronologic evidence that the Salmon River suture zone is distinct from—and has been overprinted by—the western Idaho shear zone. Exhumation of the Potters Pond migmatite domain began by 92 Ma, and western Idaho shear zone deformation had ceased by the time the Potters Pond migmatite domain cooled and reached mid-crustal levels.

ACKNOWLEDGMENTS

This research was supported by a Geological Society of America student research grant to W.J. Montz, research funds from Boston College to S.C. Krukenberg, and by National Science Foundation grant EAR-1338583 in support of the Arizona LaserChron Center. We thank Basil Tikoff for helpful discussions and insightful comments that significantly improved upon early versions of this research. We thank Nicholas Kolokon for assistance in the field and Mark Pechka and the staff at the Arizona LaserChron Center (Tucson, Arizona) for their support in obtaining U-Pb ages in zircon and monazite. Finally, detailed reviews by two anonymous reviewers and editorial comments by Arlo Wellington significantly improved this manuscript and are gratefully acknowledged.

REFERENCES CITED


