DETRITAL-ZIRCON POPULATIONS AND PROVENANCE OF MESOPROTEROZOIC STRATA OF EAST-CENTRAL IDAHO, U.S.A.: CORRELATION WITH BELT SUPERGROUP OF SOUTHWEST MONTANA

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ABSTRACT: Mesoproterozoic strata from east-central Idaho and the Belt Supergroup of southwest Montana (eight new samples) contain several age groupings of detrital zircon grains: from old to young: a) Laurentian grains older than 1.85 Ga, b) a flood of 1655 to 1790 Ma Paleoproterozoic grains; b) non-North American zircon populations (ca. 1510 to 1625 Ma) with no known source on Laurentia, and c) syn-Belt grains, with groupings at 1480 Ma (syn-lower Prichard) and 1450 Ma (upper Piegan Group). The 1450 Ma = grain age population overlaps a 1454 ± 9 Ma fallout tuff in Glacier National Park.

Strata of the Yellowjacket, Hoodoo, Apple Creek, and western Gunsight formations of Idaho all contain the 1450 Ma population, sparse non-North American grains, and dominant Paleoproterozoic populations at 1670 to 1790 Ma. This detrital-zircon signature is comparable to that of the Wallace Formation of the Belt Supergroup. The Swauger Quartzite in Idaho and the eastern Gunsight Formation at the ca. 900 Ma Beaverhead impact site in southwest Montana contain 1710 and 1780 Ma zircon populations identical to those of the Missoula Group of the Belt Supergroup.

The E member of the lower Belt Prichard Formation from Plains, Montana, contains a population of syndeositional zircons at 1479 ± 19 Ma. Like the Revett Formation of the Ravalli Group, the E member contains Mesoproterozoic non-North American detrital-zircon populations as well as Paleoproterozoic grains at 1750 to 1790 Ma.

The thick east-central Idaho Mesoproterozoic section was deposited after 1450 Ma, with deposition of the 10 km thickness from the lower Yellowjacket Formation through the Gunsight Formation spanning only 10 to 20 My. Given this very high rate of deposition, previous correlations of the Apple Creek Formation with the Piegan Group are permissible if problematic. However, previous correlations of the eastern Gunsight and Swauger formations with the Missoula Group are supported. Their detrital-zircon grain populations are identical.

INTRODUCTION

The purpose of this study is to compare new detrital-zircon age populations from Mesoproterozoic rocks of east-central Idaho with new and previously determined populations from the classic Belt Supergroup in Montana and northern Idaho. We present age data from detrital-zircon samples from the Yellowjacket Formation, Hoodoo Quartzite, Apple Creek, and western Gunsight formations of the Lemhi Group, and the Swauger Formation of east-central Idaho. We include one sample of shatter-cone-bearing strata, mapped as eastern Gunsight Formation by Ruppel (1994), from the Beaverhead impact site in southwest Montana (Figs. 1, 2). From the main Belt basin, we report new data from the Prichard Formation, member E, from near Plains, Montana.

Geochronology of volcanic zircons in tuffs and detrital zircons in sandstones constrains temporal correlation and tectonic models for Proterozoic basins (Ross et al., 1991; Ross et al., 1992; Ross and Villeneuve, 2003), in particular the Belt basin, within the pre-Rodinia, Siberia-Laurentia-Australia troika of Sears and Price (2003). Similarly to recent work in the Mesoproterozoic McArthur Basin of northern Australia (Jackson et al., 2000; Jackson and Southgate, 2000), zircon geochronology of the Belt Supergroup (Evans et al., 2000) has provided a chronostratigraphic and tectonic framework not available with other types of data.

REGIONAL GEOLOGIC SETTING

In ascending stratigraphic order (Fig. 2, Column A-B), the Belt Supergroup consists of (1) the lower Belt Prichard Formation (a west-derived deep-water distal clastic wedge), (2) the Ravalli Group (a west-derived fluvial system), (3) the cyclic carbonate-siliciclastic Piegan Group (containing the Helena and overlying Wallace formations and representing a complex transgressive-to-regressive cycle in the Belt basin (Winston, this volume), and (4) the Missoula Group (a south-derived fluvial succession) (Harrison et al., 1974; Link et al., 1993). The Belt Supergroup was deposited in a rapidly subsiding, fault-bounded basin that overlies re-worked Archean crust within the Paleoproterozoic Great Falls tectonic zone and, to the north, the Archean Medicine Hat block (O'Neill and Lopez, 1985; Foster and Fanning, 1997) (Fig. 1). Most of the supply of fine-grained siliciclastic sediment to the Belt basin came from the south and southwest (Frost and Winston, 1987; Winston and Link, 1993).

In east-central Idaho, fine-grained unfossiliferous Mesoproterozoic strata of the Yellowjacket Formation and Hoodoo Quartzite, plus Apple Creek and western Gunsight formations of the Lemhi Group, and overlying Swauger Formation, amount to a 10 km thickness of sedimentary rock in Cretaceous thrust sheets of the Salmon River, Lemhi, and Beaverhead Mountains (Evans and Green, 2003) (Figs. 1 and 2). The stratigraphic affinities and structural relations of these rocks have been problematic since

Ruppel (1975) first noted the similarities between carbonate-siliciclastic cycles in the Apple Creek Formation at Yellow Lake in the central Lemhi Range (Fig. 1; Fig. 2, Column E) and the Helena Formation of the Belt Supergroup. In general, sedimentary structures and bedding geometry are identical between the Lemhi Group and the Belt Supergroup. Winston et al. (1999) made lithostratigraphic correlations, interpreted the Hoodoo Quartzite as a subaerial alluvial apron, and interpreted

Recent work by U.S. Geological Survey personnel (Tysdal, 2003; Evans and Green, 2003; Lund, 2004; Tysdal et al., 2005) does not incorporate the east-central Idaho strata in the Belt Supergroup, nor does it propose stratigraphic correlations. Tysdal (2000a, 2003) inferred a tidal marine depositional setting for the Hoodoo Quartzite and a turbidite depositional setting for the structurally overlying Apple Creek Formation, inferring open connection to the world ocean during deposition of both successions.

FIG. 2.—Generalized stratigraphic columns of Mesoproterozoic Belt Supergroup and strata of east-central Idaho. Stratigraphic positions of detrital-zircon samples are shown. Names of faults: BDF, Bloody Dick fault; BG-CCF, Brushy Gulch-Cow Creek fault; CF, Cabin fault; HCF, Hawley Creek fault; ILF, Iron Lake fault; LPF, Lem Peak fault; ML-BDF, Miner Lake-Beaverhead Divide Fault; PCF, Poison Creek fault; SRF, Salmon River normal fault. Sediment types and rock descriptions used in the key are after Link et al. (1993), Tysdal (2000a, 2000b), Tysdal et al. (2003), and Tysdal et al. (2005).

Age of Belt Supergroup

Recent geochronology of the Belt Supergroup, summarized in Figure 2, Column A-B, constrains deposition to between 1470 and 1400 Ma (Anderson and Davis, 1995; Doughty and Chamberlain, 1996; Evans et al., 2000), a far shorter time interval than previous interpretations (1500 to 800 Ma; Obradovich and Pterman, 1968). Significant age constraints are: syndepositional 1470 Ma mafic sills intruding unlithified sediments of the lower Prichard Formation (Sears et al., 1998; Schandl and Davis, 2001) and three SHRIMP U-Pb ages from upper Belt Supergroup strata in northern Montana (Evans et al., 2000). These include 1454 ± 9 Ma for a tuff in the upper Piegan Group of Glacier National Park*, 1443 ± 7 for a felsic flow at the top of the overlying Purcell lava (lower Missoula Group Snowslip Formation), and 1401 ± 6 Ma for a tuff in the lower Libby or uppermost Bonner Formation of the uppermost Missoula Group.

Syn-Belt Faulting and Tectonic Setting

Models for subsidence of the Belt Basin (Sears et al., 1998; Sears and Price, 2000, 2003) involve an initial continental rift and subsequent tectonic load produced by basalt sills that intruded partly lithified turbidites of the Prichard Formation around 1470 Ma. The Prichard Formation, the Ravalli Group, and the bulk of the Piegan Group were deposited in only 25 My, between 1470 and about 1445 Ma. The uppermost Piegan Group and Missoula Group were deposited over a longer, perhaps 45 My interval, with the youngest strata at about 1400 Ma (Fig. 1).

Pointing to initially rapid but slowing subsidence rates, the presence of significant growth faults against Laurentian metamorphic basement to the south and east, and the thick west-derived fine-grained Lower Belt sediment with a non-Laurentian source, Ross and Villeneuve (2003) proposed that the Belt basin formed in an extensional domain on the western part of Laurentia, inboard of a transpressional tectonic zone. Such a basin setting is analogous to the present day Black and Caspian seas.

There was intrabasinal faulting, volcanism, and basin reorganization ca. 1445 Ma, recorded in the lower Missoula Group that contains at least one unconformity, and also contains bimodal lavas (1443 ± 7 Ma; Evans et al., 2000) in the Snowslip Formation. This suggests basin reorganization. A change in plate motion is recorded by the Bonner disturbance, a jump in the North American paleomagnetic polar-wander path as recorded in sedimentary rocks of the upper Missoula Group (Elston and Link, 1993; Elston et al., 2002).

Lemhi Group deposition in east-central Idaho ended prior to 1370 Ma augen gneiss that intrudes Apple Creek and Gunsight formations at Blackbird and Shoup west of Salmon (Yag in Fig. 1) (Doughty and Chamberlain, 1996; Lund and Tysdal, this volume). Coeval intrusions are found in northern Idaho (Lewis et al., this volume).

REGIONAL GEOLOGY

The Mesoproterozoic strata of east-central Idaho were deposited above crust of the northeast-striking 1860 to 1720 Ma Great Falls Tectonic Zone, which formed as the Archean Wyoming and Medicine Hat cratons collided and stabilized (Fig. 1) (O'Neill and

Lopez, 1985; O'Neill, 1988; Mogk et al., 1992; Mueller et al., 2002; Mueller et al., 2005). The term Big Sky orogeny is used for 1780 to 1720 Ma plate collision along the Great Falls zone in the Tobacco Root Mountains, during which juvenile Proterozoic mafic crust was thrust southward over the Dillon Block of the Archean Wyoming Province (Burger, 2004; Harms et al., 2004).

In southwest Montana, the southeast edge of the Belt basin is the east-trending Perry line (Fig. 1, Map A), which was a down-to-the-north synsedimentary normal fault during deposition of the lower Belt LaHood Formation (McManus, 1963; McTeague and Schmitt, 2003). South of the Perry line are Archean and Paleoproterozoic metamorphic rocks of the Dillon block, including the Great Falls Tectonic Zone. The Perry line extends westward from the syndepositional Volcano Valley Fault in the Helena embayment of the main Belt Basin (Fig. 1A) (Winston, 1986).

Mesozoic and Cenozoic Deformation

The crust of central Idaho was overthickened during the Mesozoic Cordilleran orogeny by east-dipping subduction, formation of a magmatic arc, and east-vergent thrust faulting. South of the Salmon River, the Late Cretaceous Atlanta lobe of the Idaho batholith (100 to 80 Ma) (Lewis et al., 1987) intruded Proterozoic and Phanerozoic strata. Cretaceous thrust faults strike north-westward into the magmatic belt (Sipp, 1987). In Tertiary time, the area was multiply extended through changing extension directions (Dover, 1981, 1983; Wust, 1986; O'Neill and Pavlis, 1988; Janecke, 1994; Janecke et al., 1998; Janecke et al., 1999; Janecke et al., 2001).

MESOPROTEROZOIC STRATIGRAPHY OF EAST-CENTRAL IDAHO AND THE BEAVERHEAD MOUNTAINS

Distribution of Stratigraphic Units

The distribution of formations and the structural geometry from the Salmon River Mountains east to the Montana border is significantly revised (Tysdal 2000a, 2000b; Tysdal et al., 2003) as shown on the geologic maps of the Salmon (Evans and Green, 2003) and Payette (Lund, 2004) National Forests and simplified in Figure 1. The Yellowjacket Formation and overlying Hoodoo Formation and argillaceous quartzite crop out in a regional thrust sheet west of the Iron Lake Fault (Fig. 1B, Stratigraphic column, Fig. 3). Units of the Lemhi Group plus Swauger Formation crop out on several thrust sheets east of the Iron Lake Fault (Tysdal, 2002). These thrusts are parallel to the Hawley Creek Thrust of the Beaverhead Mountains to the southeast (Lucchitta, 1966; Sipp, 1987, 1988; Rodgers and Janecke, 1992; Janecke et al., 2000). In the west, Yellowjacket, Hoodoo, and Lemhi Group units are recognized as pendants across the Idaho Batholith (Lund, 2004).

In the east, in southwest Montana, the steeply dipping Miner Lake-Beaverhead Divide shear zone (Ruppel and Lopez, 1984) separates strongly tectonized and mylonitic Lemhi Group (O'Neill et al., 2005) on the west from less-deformed pebbly sandstone assigned to the Missoula Group, undivided (Evans and Green, 2003). These coarse-grained rocks lie unconformably on 2.4 Ga basement at Ayers Canyon, east of the Beaverhead Divide-Miner Lake Fault (McGonigle, 1993) (Figs. 1, 2). Tysdal et al. (2005) tentatively assigned these rocks to the Gunsight Formation.

Farther east is the Bloody Dick fault zone (Fig. 1A), which strikes southeast into the Cabin Thrust (Fig. 2). East of that fault are Missoula Group strata of the Big Hole Divide area (Ruppel et al., 1993; Tysdal et al., 2005).

*Footnote: At the time it was dated, Evans et al. (2000) placed the Glacier Park tuff in the Helena Formation. Winston, (2003; this volume) places it in the upper Wallace Formation. By either interpretation, the tuff is near the top of the Piegan Group. However, the zircons may be reworked rather than the ash being a primary fallout tuff.

Distinction of Yellowjacket Formation from Apple Creek Formation

In the Salmon River and Beaverhead Mountains, the stratigraphy of the Yellowjacket Formation and the Lemhi Group (Fig. 2) has recently been clarified with major revision by restricting the name Yellowjacket Formation to strata stratigraphically below the Hoodoo Quartzite (Fig. 3). Mineralized strata in the Blackbird mining district and rocks formerly mapped as Yellowjacket Formation in the northeastern Salmon River and Beaverhead Mountains (Ruppel et al., 1993) are included in the Apple Creek Formation (Tysdal, 2000a, 2000b, 2003) (Figs. 2, 3).

These definitions corroborate and extend stratigraphic conclusions previously made independently (Winston et al., 1999). Stratigraphic and structural models from pre-1990 that invoke the "Salmon River" or "Lemhi" arches and the "Medicine Lodge thrust fault" (Harrison et al., 1974; Armstrong, 1975; Ruppel, 1975, 1986; Ruppel and Lopez, 1984) have been rejected on structural and stratigraphic grounds (Evans and Zartman, 1990; Evans, 1998; Winston et al., 1999; Tysdal, 2002; Link et al., 2003; Lund, 2004).

Lemhi Group Stratigraphy Across East-Central Idaho

Lemhi Range Type Area.—

The Lemhi Group was defined in the Lemhi Range (Fig. 1), where it contains the fine-grained, mainly siliciclastic Inyo Creek, West Fork, Big Creek, Apple Creek, and Gunsight formations (Fig. 2, Column E) (Ruppel, 1975). These are overlain by the coarser-grained Swauger Formation. Locally the Lawson Creek Formation lies at the top of the succession (Hobbs, 1980).

The principal reference section for the Apple Creek Formation is west of Yellow Lake (Fig. 2, Column E; Golden Trout Lake of Ruppel, 1975). The Apple Creek Formation here consists of three units, a lower green and purple mudrock, with sparse mudcracks (360 m), a medial green, fine sandy interval with lenticular and even couplets of silt to clay (> 140 m), and an upper carbonate-bearing cyclic unit over 360 m thick (Winston et al., 1999). This upper mixed siliciclastic and carbonate unit contains about 55 meter-scale cycles (parasequences) in a thickness of about 300 m. The lower half-cycles contain green uncracked lenticular couplets, and the upper half-cycles contain purple mudcracked even couplets.

The strongest lithostratigraphic tie between the Lemhi Group and the Belt Supergroup is between

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FIG. 3.—Generalized Mesoproterozoic stratigraphy, Salmon River Mountains, central Idaho. Stratigraphic column across the Iron Lake Fault shows locations of several detrital zircon samples. Modified from Link et al. (2003) with descriptions of Evans and Green (2003).

this upper carbonate unit of the Apple Creek Formation type section at Yellow Lake (Column E of Fig. 2) and cyclic strata in the Piegan Group. Tysdal (2000a, 2003) found the Yellow Lake facies to be only locally developed in the Apple Creek Formation in the northern Lemhi Range, and thus designated the type section as "not typical". There is ongoing controversy over the identification and extent of the Apple Creek and overlying Gunsight formations in different thrust sheets in the Beaverhead Mountains (J.M. O'Neill, written communication, April 2006).

Apple Creek Diamictite.—

Strata included in the Apple Creek Formation change character significantly across thrust faults in east-central Idaho. North of the type area, in the northern Lemhi Range on the Poison Creek thrust sheet, east of the Lem Peak Fault, the Apple Creek Formation thickens abruptly (Column D, Fig. 2) (Tysdal, 2000a, Tysdal et al., 2003). On the eastern, basinal side of the Lem Peak Fault the Apple Creek contains fine siltite and mass-flow diamictite, likely generated by syndimentary mass flow across a syndepositional fault (Tietbohl, 1986).

Blackbird Mining District.—

To the north, on the Poison Creek thrust sheet in the Salmon River Mountains (Column D of Fig. 2), the Apple Creek Formation contains fine, coarse, and banded siltite units. Prominent sedimentary structures include dark-colored lenticular and undulating couplets, oscillation ripples, crinkle cracks, and hummocky cross bedding (Winston et al., 1999; Link et al., 2003). In the Blackbird district, hummocky cross-bedded "pinch and swell" quartzite and siltite forms the uppermost part of the formation.

Cobalt-copper deposits in the upper part of the banded siltite unit form a resource in the Blackbird mining district (Fig. 1, Map B). These beds are interpreted to have been deposited in an extensional basin, locally subjected to sediment-hosted, possibly syngenetic mineralization from hydrothermal vents (Hahn and Hughes, 1984; Nash and Hahn, 1989; Tysdal and Desborough, 1997; Lund and Tysdal, this volume).

In the Blackbird district, the overlying western Gunsight Formation contains purple to medium gray, tabular flat-laminated, climbing-ripple-bearing sandstone with even uncracked and mudcracked couplets, representing fluvial deposition. The Gunsight is overlain by lighter-colored and locally coarser-grained sandstones of the Swauger Formation.

The Swauger Formation generally consists of coarse- to fine-grained feldspathic arenite. It is correlated with Mt. Shields Formation member 2 of the Belt Supergroup by Farooqui (1994). Winston et al. (1999, p. 17) interpreted the Swauger to be the southern part of an immense north-thinning alluvial sand wedge that extended northward to beyond the Canadian border and contains both the Mount Shields and Bonner formations.

Yellowjacket District, West of Iron Lake Fault.—

Westward, on the Iron Lake sheet (Column C, Fig. 2), the Yellowjacket Formation, the overlying Hoodoo Quartzite and unnamed argillaceous quartzite (Yaq) are recognized in the Yellowjacket mining district (Ekren, 1988) and west across the Middle Fork of the Salmon River in the Payette National Forest (Lund, 2004). A traverse of the thickest (2700 m) exposed section of Yellowjacket Formation at the reference locality (Ross, 1934), south of Yellowjacket Creek (Fig. 1, Map B), can be divided into six informal units (Fig. 3). The upper part of the section locally

contains scapolite, which is interpreted to represent metamorphosed carbonate (possibly dolomite) and evaporite minerals (Tysdal and Desborough, 1997; Tysdal, 2000b). Structural repetition within the section cannot be excluded.

The Hoodoo Quartzite is a cliff-forming quartz arenite marker unit above the Yellowjacket Formation. It is recognized from the Yellowjacket mining district west across the Middle Fork Salmon River to Taylor Ranch on Big Creek in the Payette National Forest (Fig. 1) (Lund, 2004).

Winston et al. (1999) describe the rocks of the Yellowjacket area as part of a general east-dipping homoclinal section below the Apple Creek Formation, following map interpretations of Ekren (1988). Tysdal (2000b) emphasizes the Iron Lake fault as bounding a regional thrust sheet and does not relate the Yellowjacket, Hoodoo, and argillaceous quartzite units to the Apple Creek Formation east of the fault.

Lemhi Group in the Beaverhead Mountains.—

In the Beaverhead Mountains, east of the Poison Creek thrust fault, and west of the Miner Lake-Beaverhead Divide fault, the Apple Creek and the overlying Gunsight formations are mapped (Evans and Green, 2003). East of the Miner Lake shear zone is a very thick (> 5000 m) conglomeratic trough- and planar cross-bedded sandstone mapped as undifferentiated Missoula Group by Evans and Green (2003). These strata coarsen southward, toward a basal unconformity at Ayers Canyon (Fig. 1, Map B) above Paleoproterozoic rocks of the Great Falls Tectonic Zone (M'Gonigle, 1993, 1994).

At the Beaverhead Impact locality in the southeastern Beaverhead Mountains (Column F in Fig. 2) fine-grained ripple cross-laminated Gunsight Formation contains shattercones from a meteorite impact that occurred near 900 Ma (Ruppel, 1994; Kellogg et al., 2003). Skipp and Link (1992) interpreted pebbly quartzite in this area to be Cambrian and Neoproterozoic Wilbert Formation, though the strata at the shattercone locality must be Mesoproterozoic because the unit bears 900 Ma deformation features.

STUDIES OF DETRITAL ZIRCONS

We present eight new detrital-zircon data sets. Table 1 contains the location of each sample. Table 2 contains a summary of the major grain age populations. Data tables are presented in Table 3, located after the references.

Detrital-zircon studies of Belt-Purcell Supergroup strata in Montana and British Columbia were initiated by Ross et al. (1992), with new data synthesized by Ross and Villeneuve (2003). Ross and colleagues recognized several detrital-zircon populations in the Belt-Purcell Supergroup. These are the same populations that we recognize in our samples (Table 2). Cathodoluminescence images of grains from these various populations are shown in Figure 4. The populations include (A) Archean and Paleoproterozoic magmatic and metamorphic grains older than 1800 Ma, having multiple possible source areas within Laurentia to the east, (B) voluminous mainly magmatic Paleoproterozoic grains, 1650 to 1820 Ma, that may have come from within Laurentia and/or other Paleoproterozoic orogenic belts, (C) magmatic grains from 1510 to 1620 Ma that are "non-North American" and may ultimately have come from Australia, and (D) magmatic grains from 1400 to 1470 Ma that are syn-Belt Supergroup. These syn-Belt grains may have been derived from midcontinent A-type magmatism within Laurentia (Anderson 1989; Frost and Frost, 1997; Frost et al., 1998; Anderson and Morrison, 2005) and/or from volcanism in western parts of the Belt basin (Ross and Villeneuve, 2003).

TABLE 1.—Sample locations for detrital zircon samples. GPS precision is ± 10 m, in NAD 27 UTM coordinates.

# on Figs. 1, 2, 5	Sample Number	Sample Location	Easting	Northing
1	BB-31	E member, Prichard Fm., Plains, MT	11T 666010	5242488
2	13PL01	Lowest sand in Yellowjacket Fm. type area, ID	11T 694548	4991514
3	95ITz234	Hoodoo Quartzite, Quartzite Mountain, ID	11T 700942	4992942
4	02RL888	Hoodoo Quartzite, Taylor Ranch, Big Creek, ID	11T 669732	4996421
5	SS95-19a	Banded siltite unit, Apple Creek Fm., Drillcore, Blackbird District, ID	11T 707450	5000600
6	39PL02	Lower Gunsight Fm., Haynes Stellite Mine, Blackbird District, ID	11T 694548	4998522
7	23PL92	Eastern Gunsight Fm., Beaverhead Impact site, MT	12T 345171	4942018
8	95ITz101	Swauger Quartzite, Salmon River north of Challis, ID	12T 264654	4968551

The flood of Paleoproterozoic 1655 to 1820 Ma zircon grains defines the zircon population of the upper and middle parts of the Belt Supergroup. These grains have multiple possible source areas. The most proximal is the Great Falls Tectonic Zone within the Big Sky orogen, southeast of the Belt Basin (Fig. 1, Map A) (Harms et al., 2004). Distal possible source areas include the complex of orogenic belts on the southern margin of the Wyoming Province, including the rocks deformed in the 1780 Ma Medicine Bow orogeny of Chamberlain (1988), the 1650–1800 Ma juvenile arcs of the Yavapai and Mazatzal provinces of northern Arizona (Karlstrom and Bowring, 1988, 1993), and evolved arcs of the > 1800 Ma Mojave Province (Barth et al., 2000; Duebendorfer et al., 2001). In the reconstruction of Sears and Price (2003), these orogenic belts form the eastern part of the Ullkan–Colorado magmatic belt, which crosses from Laurentia into northern Siberia (see Fig. 14 of this paper).

A non-Laurentian source for some of the Paleoproterozoic zircon grains is also possible, inasmuch as 1650 to 1800 Ma magmatism is also found in Siberia and northern Australia (Ross and Villeneuve, 2003).

Hand-Picked Versus Random Grain Selection

Ross and Villeneuve (2003) analyzed between 18 and 34 hand-picked zircons per sample, in order to sample every population of grains based on morphology, and used both TIMS and, later, SHRIMP analyses. We analyzed about 60 random grains per sample using the SHRIMP; the 60 grain sample is based on Dodson et al. (1988). Concerns have been raised about statistical reproducibility of small, non-random sample protocols (Vermeesch, 2004). In our experience (cf. Link et al., 2005) it is the more prominent age groupings (or peaks) on detrital zircon age spectra that are the key to characterizing provenance and sources. Without considerably more analyses (perhaps 117 grains as indicated by Vermeesch, 2004), one or even two grains in an isolated population can be considered to be simply background noise and not of a significant geological meaning.

Methods of This Study

Detrital-zircon samples were collected from 2–5 kg grab samples from medium- and fine-grained sandstones (including rocks mapped as “quartzites”). A heavy-mineral concentrate was prepared from the total rock using standard crushing, washing, heavy liquid (Sp. Gr. 2.96 and 3.3), and paramagnetic procedures. The zircon-rich heavy-mineral concentrates were poured onto

double-sided tape, mounted in epoxy together with chips of the reference zircons (FC1, and SL13), sectioned approximately in half, and polished. Reflected-light and transmitted-light photomicrographs were prepared for all zircons. Cathodoluminescence (CL) scanning electron microscope (SEM) images were prepared for all zircon grains and used to decipher the internal structures of the sectioned grains. Some of these grain types are shown in Figure 4.

The U–Th–Pb analyses were made using SHRIMP I or SHRIMP RG at the Research School of Earth Sciences, The Australian National University, Canberra, Australia. For each sample, zircons on the mount were analyzed sequentially and randomly until a total of at least 60 grains for each sample was reached. Each analysis consisted of four scans through the mass range, with a reference zircon analyzed for every five unknown zircon analyses (Williams, 1998, and references therein). The data have been reduced using the SQUID Excel Macro of Ludwig (2001).

Pb/U ratios have been normalized relative to the value of 0.01859 for the FC1 reference zircon, equivalent to an age of 1099 Ma (see Paces and Miller, 1993). Uncertainties given for individual analyses (ratios and ages) are at the one-sigma level; however, the uncertainties in calculated weighted mean $^{207}\text{Pb}/^{206}\text{Pb}$ ages are reported as 95% confidence limits. Tera and Wasserburg (1972) and Wetherill concordia plots, probability-density plots with stacked histograms ($^{207}\text{Pb}/^{206}\text{Pb}$ ages), and weighted mean $^{207}\text{Pb}/^{206}\text{Pb}$ age calculations were carried out using ISOPLOT/EX (Ludwig, 2003). Using the “Mixture Modeling” algorithm of Sambridge and Compston (1994), via ISOPLOT/EX, approximate age populations were unmixed to assist in the definition of various groupings.

Analyses that are greater than 10% discordant were not included in the histograms and probability density plots shown as Figures 4 through 12. On the Wetherill concordia plots for those figures, the discordant grains are shown as filled circles.

DISCUSSION OF SPECIFIC DETRITAL-ZIRCON SAMPLES

Prichard Formation (Sample #1; BB31; Fig. 5)

Sample BB-31 is a medium-grained sandstone from the E member of the Prichard Formation (Fig. 1A), collected from its best-described section, near Plains, Montana (Cressman, 1989). Sixty-three grains were analyzed. The probability-density plot is in Figure 5, and the data are in Table 3A.

TABLE 2.—Summary of age populations for all samples in this paper, plus Revett and Wallace formations, and Missoula Group samples of Ross et al. (1991), Ross et al. (1992), and Ross and Villeneuve (2003).

Population age (Ma)	Syn-Belt grains		Non-North American grains			Paleoproterozoic grains					
	1450	1480	1500	1550	1610-1615	1655-1670	1680-1690	1710-1725	1740-1760	1775-1790	1820
Prichard and Ravalli Groups											
Prichard Fm. BB31		1479 ± 19 Ma		1550	1615				1750		
Revett Fm.			1500		1610					1790	
Piegan and Lemhi Groups and Yellowjacket Formation											
Yellowjacket Fm 13PL01	1454 ± 9 Ma					1675		1720			
Hoodoo Qzte, 95ITz234	1448 ± 10 Ma					1670			1750	1790	
Hoodoo Qzte., Big Creek 02RL888	1445 ± 12 Ma						1690	1725		1775	
Apple Creek Fm. SS95-19	1446 ± 35 Ma						1680		1740		1820
western Gunsight Fm. 39PL02							1685			1780	
Wallace Fm.				1540			1680		1750		
Missoula Group, Swauger and Eastern Gunsight Formations											
eastern Gunsight Fm.-Beaverhead Impact 23PL92						1655	1690		1740		
Swauger Fm. 95ITz101							1680	1720	1760		
Missoula Gp.								1710		1780	

Italic entries are from Ross' work, and include TIMS analyses with smaller error than SHRIMP analyses. The listed age populations are statistically possible given ages of detrital zircons in each sample. However, they may not reflect distinct empirical populations of grains.

The majority of the detrital zircon ages are in the range ca. 1550 to ca. 1615 Ma, with another significant grouping between ca. 1750 Ma and ca. 1790 Ma. Three grains define the youngest population at 1479 ± 19 Ma (weighted mean $^{207}\text{Pb}/^{206}\text{Pb}$ ages). This constrains the maximum age for the lower Prichard Formation in one of its thickest sections. There are scattered older grains, with the oldest grain at ca. 2565 Ma.

The detrital-zircon age spectrum recorded for this sample is similar to those reported in previous studies from the Prichard Formation (Ross et al., 1992; Ross and Villeneuve, 2003). Cressman (1989) recognized that the Prichard was a vast turbidite fan system, with a fluvial point source on the southwest side of the Belt Basin. Ross et al. (1992) recognized the presence of 1510 to 1625 Ma grains in the Prichard and also their value as a non-North American provenance indicator. Suggestions for possible sources of the grains include derivation from North Queensland, Australia (Blewett et al., 1998; Sears and Price, 2003) or the Gawler

Craton of South Australia (Ross et al., 1992). Whilst both of these sources may have provided the ca. 1550–1615 Ma zircons, provenance from the Gawler Craton is more likely because it also contains an abundant 1740–1800 Ma zircon component (Daly et al., 1998). However, it should be noted that there is no prominent source in Australia for the sparse ca. 1490–1520 Ma grains.

Yellowjacket Formation (Sample #2; 13PL01; Fig. 6)

We sampled the lowest sand bed in the Yellowjacket Formation southeast of Yellowjacket Lake, east of the Bighorn Crag pluton. Sample 13PL01 is a banded rock, composed of fine sand and silt couplets, and is petrographically a quartz arenite. The zircon grains are mostly less than 100 microns in length. Sixty-two grains were analyzed, with a number of repeat analyses carried out to cross check the U-Pb data for the younger grains. Data are in Table 3B. There are a number of grains analyzed that

FIG. 4.—Cathodoluminescence images of detrital zircon grains from the several age populations in the Belt Supergroup. A) Prichard Fm., non-North American magmatic grains (1530 to 1625 Ma). B) Yellowjacket Fm., Paleoproterozoic and syn-Belt magmatic grains. C) Hoodoo Quartzite, 2478 and 1764 Ma metamorphic grains; 1787 and 1484 (syn-Prichard) magmatic grains. D) Gunsight Fm. Beaverhead Impact Paleoproterozoic magmatic grains of the 1650–1780 Ma flood (2, 5, 10) and intermediate older 1877 Ma grain (3).

yield significantly discordant U-Pb data, and these are shown as shaded on the Wetherill plot and have been excluded from Fig. 6B. The majority of grains analyzed have ages in the Paleoproterozoic at 1600–1800 Ma, with a significant younger peak at 1450 Ma and scattered older grains ranging to ca. 2585 Ma. The dominant Paleoproterozoic age groupings are ca. 1675 and ca. 1720 Ma. Six grains form a coherent group with a weighted mean age of 1454 ± 9 Ma, which is a maximum constraint on the depositional age (Fig. 6A). These age populations are fundamentally different from those of the Prichard Formation ("the Yellowjacket is not the Prichard"; Winston et al., 1999). Paleoproterozoic populations flood the Yellowjacket. The non-North American populations, which dominate the Prichard, are nearly absent (Table 2).

Hoodoo Quartzite (Sample # 3; 951Tz234; Fig. 7; and Sample #4; 02RL888; Fig. 8)

We analyzed detrital zircons from two samples of strata included in the Hoodoo Quartzite. They have comparable age populations. Sample 951Tz234 of the Hoodoo was collected by R.G. Tysdal from west of Quartzite Mountain, stratigraphically above the Yellowjacket sample. Sixty grains were analyzed (Fig. 7; Table 3C). A second Hoodoo sample (02RL888) is from near Taylor Ranch on Big Creek, a tributary to the Middle Fork of the Salmon River. This is the westernmost sample location, in an area where the Mesoproterozoic strata are totally surrounded by younger intrusive rocks and stratigraphic relations are uncertain. Sixty-three grains were analyzed (Fig. 8; Table 3D).

FIG. 5.—Ages of detrital zircons in sample BB31, Prichard Formation. A) Wetherill plot with enlargement of 1400 to 1800 Ma, and plot of youngest grain group. Filled ellipses are discordant analyses that were not used in the probability–age plot. B) Probability–age plot with major age populations listed.

Both samples contain a population of ca. 1450 grains (1448 ± 10 Ma and 1445 ± 10 Ma) and a ca. 1670–1890 Ma population. Other peaks are at 1725, 1750, 1775, and 1790 Ma. The distinction of these peaks within the Paleoproterozoic flood is rather arbitrary. There are scattered older grains ranging to ca. 2700 Ma.

Apple Creek Formation (Sample #5; SS95-19; Fig. 9)

We sampled a banded siltite unit of the Apple Creek Formation from mineralized drill core in the Blackbird mining district (drillhole from the Sunshine Prospect of Formation Capital Inc., collected by Bill Scales). The sample is from a subsurface interval containing biotitite thought to be a synsedimentary tuff (Hahn and Hughes, 1984; Nash and Hahn, 1989). To the north, these strata are intruded by 1370 Ma plutons, providing a minimum age (Doughty and Chamberlain, 1996; Evans and Green, 2003; Lund and Tysdal, this volume). Seventy-nine grains were analyzed (Fig. 9; Table 3E). Three syn-Belt grains yield an imprecise weighted mean $^{207}\text{Pb}/^{206}\text{Pb}$ age of 1446 ± 36 Ma. Once again the detrital zircon age spectrum is dominated by Paleoproterozoic components, with major age populations at ca. 1680, 1740, and 1820 Ma. There are scattered older grains ranging to ca. 2665 Ma.

Western Gunsight Formation (Sample #6; 39PL02; Fig. 10)

We sampled flat-laminated iron-stained fine sandstone of the lowermost Gunsight Formation from the Haynes Stellite mine in the Blackbird district, Salmon River Mountains, Idaho. Sixty-one grains were analyzed (Fig. 10; Table 3F). The detrital zircons

mostly have ages in the range 1580–1800 Ma, with populations at 1685, 1725, and 1780 Ma. A single grain with $^{207}\text{Pb}/^{206}\text{Pb}$ date of ca. 1410 Ma is within uncertainty of concordia, but this is a single analysis and so has little geological significance. There are four grains in the 1510–1625 non-North American range, which is generally not present in the east-central Idaho strata. Scattered older grains are also present, with four grains in the range ca. 2455–2545 Ma.

Eastern Gunsight Formation from Beaverhead Impact Site (Sample #7; 23PL92; Fig. 11)

We analyzed zircons from hematitic subarkosic arenite from the Gunsight Formation from the Beaverhead impact locality at Island Butte, in southwest Montana (Hargraves et al., 1990; Hargraves et al., 1994; Fiske et al., 1994; Kellogg et al., 2003). Sixty grains were analyzed, a number in duplicate. The data are shown in Figure 11 and Table 3G. The zircons are coarse grained and mostly have simple oscillatory-zoned igneous internal structures (Fig. 4D).

The Beaverhead impact structure has been dated at 900 Ma or younger by Ar–Ar and U–Pb isotopic studies of brecciated Paleoproterozoic gneiss (Kellogg et al., 2003). A feature of the analyses for this sample is the high degree of discordance. Twenty-six of the 65 areas analyzed are greater than 10% discordant, although it is probable that much of this discordance arises from loss of radiogenic Pb at or near the present day. The calculated radiogenic $^{207}\text{Pb}/^{206}\text{Pb}$ ages for the concordant mostly Paleoproterozoic zircons are interpreted to provide reasonable

FIG. 6.—Detrital zircon ages from sample 13PL01; lowest sandstone in Yellowjacket Formation east of Yellowjacket Lake, Bighorn Crags. **A)** Wetherill plot with enlargement of 1400 to 1800 Ma, and plot of youngest grain group. Filled ellipses are discordant analyses that were not used in the probability-age plot. **B)** Probability-age plot with major age populations listed.

FIG. 7.—Detrital zircon ages from 95ITz234; Hoodoo Quartzite from Quartzite Mountain, collected by R.G. Tysdal and K. Lund, and data run by J. Aleinikoff. **A)** Wetherill plot with enlargement of 1400 to 1800 Ma, and plot of youngest grain group. Filled ellipses are discordant analyses that were not used in the Probability-Age plot. **B)** Probability-Age plot with major age populations listed.

FIG. 8.—Detrital zircon ages from 02RL888; Hoodoo Quartzite from Taylor Ranch on Big Creek, west of the Middle Fork Salmon River, Salmon River Mountains. Sample collected by R. Lewis, Idaho Geological Survey. **A)** Wetherill plot with enlargement of 1400 to 1800 Ma, and plot of youngest grain group. Filled ellipses are discordant analyses that were not used in the probability-age plot. **B)** Probability-age plot with major age populations listed.

FIG. 9.—Detrital-zircon age data from SS95A-19a, banded siltite member of Apple Creek Formation, from Sunline Prospect drill core, Blackbird mining district. **A)** Wetherill plot with enlargement of 1400 to 1800 Ma, and plot of youngest grain group. Filled ellipses are discordant analyses that were not used in the probability-age plot. **B)** Probability-age plot with major age populations listed.

FIG. 10.—Detrital-zircon data from 39PL02, basal western Gunsight Formation, Haynes Stellite Prospect, Blackbird mining district. A) Wetherill plot with enlargement of 1400 to 1800 Ma. Filled ellipses are discordant analyses that were not used in the probability-age plot. B) Probability-age plot with major age populations listed.

FIG. 11.—Detrital-zircon age data from 23PL92, Eastern Gunsight Formation with shattercones, from Island Butte, Beaverhead impact site, Beaverhead Mountains, Montana. A) Wetherill plot with enlargement of 1400 to 1800 Ma. Filled ellipses are discordant analyses that were not used in the probability-age plot. B) Probability-age plot with major age populations listed.

estimates for their primary crystallization. The areas analyzed within the grains are mostly of good clear zircon, and are not metamict. Thus the loss of radiogenic Pb is anomalous in terms of the absence of obvious damage to the zircon crystals. Varying degrees of shock deformation are apparent in zircons affected by shock metamorphism, and transported afterward (Krogh et al., 1993; Kamo and Krogh, 1995; Kamo et al., 1996). The Beaverhead impact zircons show the Pb loss that would be expected, but not the shock-deformation features.

From the probability-density plot of the more concordant analyses it can be seen that the majority lie in the Paleoproterozoic, with groupings at ca. 1655, 1690, and 1740 Ma. There are a few older analyses up to ca. 1960 Ma. Analyses younger than 1600 Ma are all discordant, though it should be noted that two of these have $^{207}\text{Pb}/^{206}\text{Pb}$ dates of about 1450 Ma.

Swauger Formation (Sample #8; 951Tz101; Fig. 12)

The Swauger Formation was sampled along the Salmon River by R.G. Tysdal (U.S.G.S.). Sixty grains were analyzed; the data are shown in Figure 12 and Table 3H. The detrital zircons in this sample contain the same Paleoproterozoic populations as the eastern Gunsight Formation, with groupings at ca. 1680, 1720, and 1760 Ma. Syn-Belt and non-North American grain populations are not present. Scattered older Paleoproterozoic and Archean grains are present.

DISTRIBUTION OF GRAIN POPULATIONS

Table 2 and Figure 13 contain a summary of the grain age populations from our samples in comparison to data from the

Revett and Wallace formations and the Missoula Group (Bonner, Mt. Nelson, and Mt. Shields formations) from Ross et al. (1991), Ross et al. (1992), and Ross and Villeneuve (2003). The previous data are shown on Table 2 in italics.

Lower Belt and Ravalli Group Zircon Populations

The Prichard Formation contains a syndepositional zircon population at 1480 Ma, two non-North American populations at about 1550 and 1615 Ma, and two older groupings, at 1750 and 1790 Ma. The Revett Quartzite of the Ravalli Group (Table 2; data from Ross and Villeneuve, 2003) contains non-North American populations at 1500 and 1610 Ma and a Paleoproterozoic population at 1790 Ma. Facies relations are in accord with these detrital-zircon data and suggest that the Ravalli Group in western Montana had the same source area as the Prichard Formation.

Piegan and Lemhi Group Grain Populations

The Yellowjacket, Hoodoo, Apple Creek, and western Gunsight samples from east-central Idaho have syn-Belt populations at 1450 Ma, multiple populations within the Paleoproterozoic flood of zircons, at 1655–1675 Ma, 1680–1690 Ma, 1710–1725 Ma, 1740–1760 Ma, and 1775–1790 Ma. Only the western Gunsight Formation contains populations in the North American magmatic gap, at 1580 and 1630 Ma. Zircons in the Wallace Formation are comparable (Fig. 13), and contain a non-North American grouping at 1540 Ma, and Paleoproterozoic populations at 1680 and 1750 Ma.

The eastern Gunsight (Beaverhead impact) and Swauger formations contain only the Proterozoic populations, with peaks at

FIG. 12.—Detrital-zircon age data from Sample 951Tz101, Swauger Formation, Salmon River Canyon south of Salmon, Idaho, collected by R.G. Tysdal and analyzed by J. Aleinikoff. A) Wetherill plot with enlargement of 1400 to 1800 Ma. Filled ellipses are discordant analyses that were not used in the probability-age plot. B) Probability-age plot with major age populations listed.

FIG. 13.—Detrital-zircon data from this paper combined with Revett and Wallace Formation data (Ross and Villeneuve, 2003), and the Bonner, Mt. Shields, and Mount Nelson formations of the Missoula Group (Ross et al., 1991; Ross et al., 1992). Minimum and maximum ages on non-North American grains are shown by dashed lines at 1510 and 1625 Ma. The probability-frequency curve for Missoula Group strata is not shown because it covers up histogram data.

1665, 1680–1689, 1720, and 1750–1760 Ma. The Missoula Group contains Paleoproterozoic populations at 1710 and 1780 Ma and lacks younger zircons. Its signature is thus similar to that of the eastern Gunsight and Swauger formations.

TECTONIC MODEL

Our data are consistent with a tectonic scenario (Fig. 14) based on the continental reconstruction of Sears and Price (2003) where western, non-North American source terranes fed the Prichard and Ravalli Groups of the northwestern part of the main Belt basin starting around 1470 Ma. This lower Belt clastic wedge contains Paleoproterozoic zircons with age peaks at 1750 and 1780 Ma, non-North American zircons with peaks at 1500, 1550, and 1610–1615 Ma, and Paleoproterozoic populations at 1750 and 1790 Ma.

A different set of detrital-zircon age populations characterizes the middle Belt Supergroup (Piegan Group) and the Yellowjacket, Apple Creek, and western Gunsight formations.

This clastic wedge mainly lacks the non-North American populations, although a few 1510–1630 Ma grains are present. Further, the unmixed peaks of the Paleoproterozoic flood include younger populations not present in the Prichard Formation, at 1655–1670, 1680–1690, and 1710–1725 Ma.

The Missoula Group lacks syn-Belt and non-North American zircon grains and contains the same Paleoproterozoic populations as the eastern Gunsight and Swauger formations at 1710–1720 Ma, 1740–1760 Ma, and 1780 Ma.

CONCLUSIONS

Our data yield several specific stratigraphic and tectonic conclusions:

1. The Yellowjacket Formation is younger than 1454 ± 9 Ma. The Yellowjacket contains a different set of detrital-zircon age populations than the lower Belt Prichard Formation (Winston et al., 1999), lacking major non-North American grain popu-

FIG. 14.—Tectonic synthesis map showing Laurentian Paleoproterozoic age terranes (Karlstrom et al., 2001; Ross and Villeneuve, 2003), possible positions of Siberia and Australia (after Sears and Price, 2003, and Sears, this volume), and proposed big-river transport of lower and upper Belt Supergroup grain populations. The circled DB refers to pebbly Missoula Group strata overlying Paleoproterozoic gneiss of the Dillon Block, Great Falls tectonic zone in the Beaverhead Range. This was a proximal source for at least some of the Paleoproterozoic zircon populations. Non-North American grains in lower Belt Supergroup may have come from North Queensland, Australia. The bulk of Paleoproterozoic Laurentian grains are shown as coming from the Yavapai and Mazatzal provinces.

lations. Instead, the Yellowjacket contains the same Paleoproterozoic flood of grains as the Hoodoo Quartzite west of the Iron Lake Fault, and the Apple Creek and western Gunsight formations east of that fault.

2. The Hoodoo Quartzite, which stratigraphically overlies the Yellowjacket, is younger than 1448 ± 10 Ma or 1445 ± 12 Ma, and has basically the same grain populations as the Yellowjacket. The two Hoodoo samples, from widely separated locations, contain the same sets of detrital-zircon grain populations, suggesting that the formation designation is viable.
3. East of the Iron Lake Fault, the Apple Creek Formation in the Blackbird Mining District is younger than 1446 ± 35 Ma and contains detrital-zircon grain populations similar to those of the Yellowjacket and Hoodoo formations west of the fault. The 1450 Ma grain population in Yellowjacket, Hoodoo, and Apple Creek Formation strata overlaps the age for the 1454 ± 9 Ma tuff in the upper Piegan Group in Glacier National Park. Because this tuff is near the top of the Piegan Group, the Yellowjacket, Hoodoo, and Apple Creek formations must be coeval with or younger than the bulk of the Helena and Wallace formations.
4. The correlation of the upper Apple Creek Formation with the upper Piegan Group, first proposed by Ruppel (1975), and supported by Winston et al. (1999), and the presence of ca. 1450 Ma zircons in the Yellowjacket, Hoodoo, and Apple Creek strata of east-central Idaho, requires deposition of these strata in about 10 My (between about 1455 and 1445 Ma). Evidence for rapid deposition includes normal faulting that produced the Apple Creek diamictite, presence of rift-related sedimentary exhalative copper-cobalt mineralization in the Blackbird district, and the cyclic sedimentology with no reported stratigraphic sequence boundaries in the Apple Creek and Gunsight formations. If the 55-meter-scale carbonate-siliciclastic cycles of the upper unit of the Apple Creek Formation at Yellow Lake represent fifth-order parasequences with ca. 10^4 year duration (Vail et al., 1977), then that 300 m of strata could have accumulated in 0.55 million years. Extrapolation of this maximum sedimentation rate of 300 m per 550,000 years to the 10 km total east-central Idaho section yields a minimum depositional span of 18 My, which is of the same scale as the precision on the U-Pb ages.
5. The stratigraphic tie between the Lemhi Group and the Belt Supergroup remains a matter of discussion among the authors. Physical continuity cannot be established, because the area is so broken by thrust faults. The similar detrital-zircon populations suggest a common source but do not demonstrate physical continuity at the time of deposition.
6. The eastern Gunsight and Swauger formations and the Missoula Group contain the same Proterozoic grain populations but lack syn-Belt grains. The correlation of those units seems reasonable. At least some of the sand in the undifferentiated Missoula Group or Gunsight Formation east of the Miner Lake-Beaverhead Divide fault zone came from proximal sources in the Dillon block of southwest Montana (shown as circled DB in Fig. 14) (Tysdal et al., 2005).
7. The great volume of the Paleoproterozoic zircon grain populations, the predominance of concentrically zoned magmatic zircons, and the generally fine-grained nature of the sand in

the Lemhi Group suggest that voluminous distal sources supplied the bulk of the grains. These sources may have included juvenile crust of Colorado, Utah, and Arizona, south of the Cheyenne Belt. The proposed transport systems are shown with large arrows in Figure 14.

Further study of zircons in the Belt Supergroup and Mesoproterozoic strata of east-central Idaho will test our hypotheses and better define the isotopic character of zircon populations of known age. Such data could demonstrate the Laurentian or exotic affinity of the several detrital-zircon age populations.

ACKNOWLEDGMENTS

This research was supported by National Science Foundation grant EAR 0125756, by an Idaho State University Faculty Research Committee grant to P.K. Link, and by the Mineral Resources Program, U.S. Geological Survey. The work was initiated while Link was on sabbatical leave at Australian National University in 2002–2003. The assistance of many people at Research School of Earth Sciences is gratefully acknowledged. We received willing and generous help in mineral separation from Kaleb Scarberry at Idaho State University, Rich Friedman and Jim Mortensen at University of British Columbia, and Ezra Yacob at U.S.G.S. The manuscript was reviewed and drastically improved by comments from Don Winston, Russ Burmester, Gerry Ross, Karl Evans, Art Bookstrom, and J. Michael O'Neill.

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TABLE 3A.—Summary of SHRIMP U-Pb zircon results for sample BB31.

Grain.	U spot	Th (ppm)	Th/U	²⁰⁶ Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				ρ	Age (Ma)				% Disc	
							²³⁸ U/ ²⁰⁶ Pb	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±	±	²⁰⁷ Pb/ ²³⁵ U	±	²⁰⁶ Pb/ ²³⁸ U		±	±	±	±		
1.1	2675	164	0.06	684.0	0.000367	0.59	3.360	0.035	0.1029	0.0002	0.0030	3.990	0.049	0.0079	0.0006	0.840	1670	15	1584	12	-5
2.1	390	189	0.49	100.4	0.000026	0.04	3.334	0.037	0.0994	0.0005	0.0033	4.095	0.051	0.0991	0.0006	0.893	1690	16	1606	10	-5
3.1	199	110	0.55	55.7	0.000011	0.02	3.077	0.036	0.1086	0.0007	0.0038	4.857	0.066	0.1084	0.0007	0.866	1814	19	1773	12	-2
4.1	480	58	0.12	133.1	0.000011	0.02	3.100	0.034	0.1096	0.0005	0.0035	4.866	0.058	0.1094	0.0005	0.925	1802	17	1790	8	-1
5.1	341	31	0.09	86.6	0.000025	0.04	3.383	0.045	0.0977	0.0005	0.0039	3.976	0.057	0.0976	0.0005	0.929	1669	20	1578	10	-6
6.1	177	244	1.38	45.4	0.000039	0.06	3.355	0.040	0.1022	0.0008	0.0036	4.174	0.061	0.1016	0.0008	0.827	1681	18	1654	15	-2
7.1	330	168	0.51	73.5	0.000094	0.15	3.899	0.042	0.0940	0.0005	0.0028	3.308	0.042	0.0927	0.0006	0.859	1483	15	1482	12	0
8.1	179	53	0.30	43.0	0.000025	0.04	3.576	0.043	0.0972	0.0007	0.0033	3.733	0.053	0.0969	0.0007	0.840	1589	17	1565	14	-2
9.1	114	72	0.63	29.4	0.000016	0.03	3.334	0.043	0.1008	0.0009	0.0039	4.160	0.065	0.1006	0.0009	0.829	1691	19	1636	16	-3
10.1	22	13	0.59	5.4	0.000293	0.47	3.465	0.066	0.1010	0.0018	0.0055	3.991	0.105	0.1004	0.0018	0.719	1633	30	1631	34	0
11.1	546	88	0.16	143.9	-	<0.01	3.258	0.035	0.1049	0.0004	0.0033	4.457	0.050	0.1053	0.0004	0.947	1726	16	1719	7	0
12.1	179	88	0.49	43.7	-	<0.01	3.520	0.043	0.0993	0.0007	0.0035	3.899	0.055	0.0993	0.0007	0.863	1612	18	1611	13	0
13.1	187	189	1.01	51.3	0.000043	0.07	3.124	0.038	0.1076	0.0008	0.0039	4.718	0.067	0.1070	0.0008	0.855	1789	19	1749	13	-2
14.1	586	373	0.64	138.9	0.000029	0.05	3.624	0.054	0.0992	0.0006	0.0041	3.758	0.061	0.0988	0.0007	0.911	1570	21	1602	13	2
15.1	109	75	0.69	23.5	0.000134	0.22	3.971	0.094	0.0936	0.0008	0.0060	3.178	0.085	0.0917	0.0011	0.888	1445	31	1462	23	1
16.1	345	319	0.92	83.4	-	<0.01	3.554	0.039	0.0992	0.0005	0.0031	3.860	0.046	0.0995	0.0005	0.907	1599	15	1614	9	1
17.1	193	133	0.69	59.5	0.000022	0.03	2.788	0.032	0.1205	0.0007	0.0041	5.941	0.076	0.1202	0.0007	0.899	1975	20	1959	10	-1
18.1	227	301	1.33	95.4	0.000013	0.02	2.045	0.024	0.1710	0.0008	0.0057	11.518	0.143	0.1709	0.0008	0.934	2566	25	2566	7	0
19.1	343	271	0.79	80.5	0.000050	0.08	3.655	0.042	0.0989	0.0006	0.0031	3.702	0.049	0.0982	0.0006	0.874	1558	16	1590	12	2
20.1	248	101	0.41	64.9	0.000010	0.02	3.281	0.039	0.1069	0.0011	0.0036	4.485	0.071	0.1067	0.0011	0.745	1715	18	1744	19	2
21.1	398	346	0.87	94.9	0.000043	0.07	3.600	0.044	0.0959	0.0006	0.0034	3.646	0.051	0.0953	0.0006	0.874	1579	17	1534	13	-3
22.1	103	66	0.64	25.8	0.000139	0.22	3.425	0.049	0.1080	0.0012	0.0042	4.263	0.083	0.1061	0.0014	0.743	1648	21	1734	24	5
23.1	235	116	0.49	63.2	0.000031	0.05	3.197	0.038	0.1107	0.0007	0.0037	4.754	0.064	0.1103	0.0007	0.872	1753	18	1804	12	3
24.1	292	72	0.25	80.5	0.000097	0.15	3.118	0.036	0.1098	0.0006	0.0037	4.789	0.065	0.1085	0.0008	0.836	1791	18	1774	14	-1
25.1	289	262	0.91	62.5	0.000214	0.35	3.980	0.046	0.0957	0.0006	0.0029	3.200	0.049	0.0927	0.0010	0.745	1441	15	1481	19	3
26.1	192	129	0.67	52.5	-	<0.01	3.142	0.043	0.1098	0.0009	0.0043	4.819	0.077	0.1098	0.0009	0.847	1781	21	1796	16	1
27.1	154	207	1.34	39	0.000004	0.01	3.440	0.041	0.1008	0.0007	0.0035	4.038	0.056	0.1008	0.0007	0.867	1645	17	1638	13	0
28.1	485	138	0.28	119	-	<0.01	3.502	0.039	0.0978	0.0004	0.0032	3.851	0.046	0.0978	0.0004	0.937	1619	16	1583	8	-2
29.1	176	56	0.32	43.2	0.001040	1.69	3.507	0.042	0.1048	0.0010	0.0034	3.809	0.069	0.0977	0.0013	0.664	1605	18	1581	25	-1
30.1	140	134	0.96	33.2	-	<0.01	3.618	0.045	0.0991	0.0009	0.0035	3.796	0.057	0.0996	0.0009	0.824	1574	17	1616	16	3
31.1	249	163	0.65	66.5	0.000018	0.03	3.217	0.037	0.1067	0.0007	0.0036	4.559	0.060	0.1064	0.0007	0.773	1744	18	1739	12	0
32.1	84	65	0.78	21.2	0.000113	0.18	3.403	0.048	0.1003	0.0011	0.0041	4.131	0.075	0.1018	0.0012	0.778	1663	23	1657	21	0
33.1	216	301	1.40	55	0.000012	0.02	3.384	0.039	0.0994	0.0006	0.0034	4.045	0.053	0.0993	0.0006	0.887	1669	17	1611	11	-4
34.1	484	73	0.15	124.8	-	<0.01	3.332	0.036	0.1076	0.0005	0.0033	4.456	0.054	0.1077	0.0005	0.907	1692	16	1761	9	4
35.1	257	117	0.45	60.0	0.000037	0.06	3.682	0.042	0.0999	0.0006	0.0031	3.721	0.050	0.0994	0.0007	0.853	1548	16	1613	13	4
36.1	546	341	0.63	123.2	0.000012	0.02	3.810	0.069	0.0963	0.0005	0.0048	3.480	0.066	0.0962	0.0005	0.960	1502	24	1551	10	3
37.1	522	226	0.43	136.2	0.000015	0.02	3.290	0.036	0.1070	0.0005	0.0033	4.473	0.053	0.1068	0.0005	0.917	1711	16	1745	9	2
38.1	84	51	0.61	20.6	0.000087	0.14	3.498	0.049	0.1004	0.0011	0.0040	3.904	0.074	0.0992	0.0013	0.736	1619	20	1609	24	-1
39.1	231	133	0.58	59.3	0.000018	0.03	3.350	0.045	0.1089	0.0008	0.0040	4.471	0.068	0.1087	0.0008	0.883	1684	20	1777	13	5
40.1	192	140	0.73	44.1	0.000056	0.09	3.744	0.048	0.0955	0.0010	0.0034	3.485	0.060	0.0947	0.0011	0.738	1525	17	1522	22	0
41.1	450	49	0.11	109.6	0.000023	0.04	3.531	0.039	0.1001	0.0005	0.0031	3.895	0.047	0.0998	0.0005	0.905	1607	16	1620	10	1
42.1	86	157	1.84	20.3	0.000135	0.22	3.621	0.053	0.1015	0.0013	0.0040	3.787	0.076	0.0996	0.0014	0.729	1569	20	1618	26	3
43.1	198	214	1.08	45.9	0.000066	0.11	3.708	0.045	0.0959	0.0008	0.0033	3.576	0.052	0.0962	0.0008	0.834	1540	20	1551	15	1
44.1	186	95	0.51	44.7	0.000261	0.42	3.567	0.045	0.1010	0.0008	0.0035	3.766	0.058	0.0978	0.0009	0.818	1588	19	1583	17	0
45.1	129	97	0.75	31.1	0.000070	0.11	3.558	0.047	0.0996	0.0009	0.0037	3.818	0.065	0.0986	0.0011	0.771	1595	19	1599	20	0
46.1	335	80	0.24	87.4	0.000014	0.02	3.297	0.038	0.1067	0.0006	0.0035	4.455	0.058	0.1066	0.0006	0.894	1707	17	1741	11	2
47.1	456	359	0.79	119.2	0.000070	0.11	3.286	0.038	0.1011	0.0005	0.0035	4.849	0.089	0.1138	0.0016	0.621	1736	19	1861	26	7
48.1	716	535	0.75	169.1	0.000025	0.04	3.637	0.039	0.0955	0.0004	0.0029	3.840	0.041	0.0959	0.0004	0.939	1567	16	1547	7	-1
49.1	374	50	0.13	90.0	0.000019	0.03	3.5.														

TABLE 3B.—Summary of SHRIMP U-Pb zircon results for sample 13PL01.

Grain. spot	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				ρ	Age (Ma)	% Disc					
							²³⁸ U/ ²⁰⁶ Pb	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±	²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁷ Pb/ ²³⁸ U	±								
1.1	556	56	0.10	147	0.000011	0.02	3.240	0.036	0.1048	0.0004	0.3086	0.0035	4.455	0.054	0.1047	0.0005	0.932	1734	17	1709	8	-1
2.1	157	161	1.03	33	0.000052	0.08	4.047	0.049	0.0924	0.0008	0.2469	0.0030	3.121	0.046	0.0917	0.0008	0.810	1422	15	1461	17	3
2.1	218	242	1.11	47	0.000043	0.07	3.957	0.064	0.0923	0.0007	0.2526	0.0041	3.194	0.058	0.0917	0.0008	0.890	1452	21	1462	16	1
3.1	364	190	0.52	92	0.000016	0.03	3.408	0.038	0.1047	0.0006	0.2934	0.0032	4.224	0.053	0.1044	0.0006	0.872	1658	18	1704	11	3
4.1	341	95	0.28	83	0.000006	0.01	3.534	0.040	0.1054	0.0005	0.2829	0.0032	4.111	0.051	0.1054	0.0005	0.919	1606	16	1721	9	7
5.1	1573	630	0.40	396	0.000008	0.01	3.408	0.036	0.1029	0.0002	0.2934	0.0031	4.157	0.045	0.1028	0.0003	0.974	1659	15	1675	5	1
6.1	372	109	0.29	94	0.000001	0.00	3.397	0.039	0.1044	0.0005	0.2944	0.0034	4.238	0.053	0.1044	0.0005	0.917	1663	17	1704	9	2
7.1	284	179	0.63	61	0.000025	0.04	4.031	0.045	0.0917	0.0006	0.2480	0.0028	3.123	0.041	0.0913	0.0006	0.859	1428	14	1454	13	2
7.1	380	233	0.61	80	0.000018	0.03	4.068	0.046	0.0919	0.0006	0.2457	0.0028	3.106	0.040	0.0917	0.0006	0.874	1416	14	1461	12	3
7.2	1355	257	0.19	229	0.000021	0.03	5.085	0.055	0.0978	0.0003	0.1966	0.0021	2.844	0.030	0.0975	0.0003	0.955	1157	11	1577	6	36
8.1	984	147	0.15	279	-	<0.01	3.025	0.047	0.1060	0.0017	0.3306	0.0051	4.837	0.107	0.1061	0.0017	0.697	1841	25	1734	29	-6
9.1	406	13	0.03	110	-	<0.01	3.170	0.035	0.1042	0.0004	0.3154	0.0034	4.533	0.053	0.1042	0.0004	0.930	1767	17	1700	8	-4
10.1	271	47	0.17	71	0.000008	0.01	3.268	0.053	0.1061	0.0006	0.3059	0.0050	4.473	0.076	0.1060	0.0006	0.948	1721	24	1732	10	1
11.1	666	228	0.34	191	0.000007	0.01	3.000	0.032	0.1060	0.0004	0.3333	0.0036	4.869	0.056	0.1059	0.0004	0.941	1855	17	1731	7	-7
12.1	180	95	0.53	48	0.000005	0.01	3.246	0.037	0.1051	0.0007	0.3080	0.0036	4.462	0.059	0.1051	0.0007	0.865	1731	17	1715	12	-1
13.1	198	92	0.46	51	0.000053	0.08	3.327	0.041	0.1044	0.0008	0.3003	0.0037	4.292	0.063	0.1036	0.0008	0.842	1693	18	1690	14	0
14.1	228	54	0.24	61	0.000032	0.05	3.208	0.036	0.1035	0.0006	0.3115	0.0035	4.426	0.056	0.1030	0.0006	0.893	1748	17	1680	10	-4
15.1	1007	180	0.18	251	0.000003	0.01	3.444	0.036	0.1023	0.0003	0.2904	0.0031	4.092	0.045	0.1022	0.0003	0.961	1643	15	1665	6	1
16.1	677	283	0.42	166	0.000017	0.03	3.509	0.038	0.1037	0.0004	0.2849	0.0030	4.064	0.046	0.1034	0.0004	0.947	1616	15	1687	7	4
17.1	283	66	0.23	78	0.000002	<0.01	3.103	0.035	0.1050	0.0006	0.3223	0.0037	4.662	0.060	0.1049	0.0006	0.881	1801	18	1713	11	-5
18.1	123	36	0.29	35	-	<0.01	2.985	0.038	0.1055	0.0008	0.3351	0.0043	4.887	0.073	0.1058	0.0008	0.861	1863	21	1727	14	-7
19.1	414	62	0.15	109	-	<0.01	3.256	0.036	0.1052	0.0005	0.3072	0.0034	4.462	0.054	0.1054	0.0005	0.909	1727	17	1721	9	0
20.1	190	105	0.55	45	0.000026	0.04	3.608	0.044	0.1027	0.0008	0.2770	0.0034	3.910	0.056	0.1024	0.0008	0.844	1576	17	1668	14	5
21.1	334	142	0.42	69	0.000018	0.03	4.158	0.062	0.0993	0.0007	0.2404	0.0036	3.283	0.054	0.0990	0.0007	0.906	1389	19	1606	13	14
22.1	405	100	0.25	76	0.000018	0.03	4.566	0.051	0.0970	0.0005	0.2190	0.0025	2.920	0.037	0.0967	0.0006	0.879	1276	13	1562	11	22
23.1	277	115	0.42	71	-	<0.01	3.364	0.038	0.1042	0.0006	0.2974	0.0033	4.279	0.054	0.1044	0.0006	0.883	1678	17	1703	11	1
24.1	357	108	0.30	82	0.000027	0.04	3.738	0.041	0.1019	0.0005	0.2674	0.0029	3.743	0.045	0.1015	0.0005	0.904	1527	15	1652	10	8
25.1	449	120	0.27	115	0.000061	0.10	3.362	0.037	0.1057	0.0004	0.2971	0.0032	4.298	0.052	0.1049	0.0005	0.903	1677	16	1713	10	2
26.1	352	145	0.41	79	-	<0.01	3.841	0.043	0.1060	0.0006	0.2804	0.0029	3.808	0.049	0.1061	0.0006	0.885	1492	15	1733	11	16
27.1	642	32	0.05	171	0.000009	0.01	3.235	0.035	0.1036	0.0004	0.3091	0.0033	4.409	0.050	0.1034	0.0004	0.946	1736	16	1687	7	-3
28.1	221	102	0.46	90	0.000024	0.03	2.109	0.024	0.1593	0.0008	0.4739	0.0054	10.390	0.130	0.1590	0.0008	0.908	2501	24	2445	9	-2
29.1	1316	160	0.12	287	0.000005	0.01	3.935	0.045	0.0913	0.0003	0.2541	0.0029	3.195	0.038	0.0912	0.0003	0.981	1460	15	1450	6	-1
30.1	284	58	0.20	79	0.000011	0.02	3.084	0.035	0.1093	0.0006	0.3242	0.0037	4.877	0.061	0.1091	0.0006	0.901	1810	18	1784	10	-1
31.1	393	124	0.32	106	0.000013	0.02	3.192	0.035	0.1099	0.0005	0.3132	0.0034	4.736	0.056	0.1097	0.0005	0.924	1756	17	1794	8	2
32.1	846	42	0.05	225	-	<0.01	3.233	0.035	0.1060	0.0006	0.3093	0.0033	4.524	0.054	0.1061	0.0006	0.899	1737	16	1733	10	0
33.1	146	64	0.44	30	0.000110	0.17	4.199	0.053	0.1025	0.0008	0.2378	0.0030	3.312	0.052	0.1010	0.0009	0.807	1375	16	1643	17	20
34.1	222	30	0.14	51	-	<0.01	3.762	0.043	0.1086	0.0007	0.2659	0.0031	3.985	0.052	0.1087	0.0007	0.877	1520	16	1778	11	17
36.1	132	88	0.66	29	-	<0.01	3.886	0.047	0.1019	0.0010	0.2573	0.0031	3.617	0.056	0.1019	0.0010	0.780	1476	16	1660	18	12
37.1	996	371	0.37	273	0.000004	0.01	3.128	0.033	0.1103	0.0003	0.3196	0.0034	4.858	0.053	0.1102	0.0003	0.970	1788	16	1803	5	1
38.1	359	247	0.69	94	0.000019	0.03	3.272	0.038	0.1055	0.0004	0.3055	0.0035	4.433	0.055	0.1052	0.0005	0.936	1719	17	1719	8	0
39.1	72	29	0.40	18	0.000037	0.06	3.347	0.044	0.1074	0.0010	0.2986	0.0039	4.399	0.073	0.1069	0.0011	0.793	1684	20	1747	18	4
40.1	970	133	0.14	263	0.000002	<0.01	3.174	0.034	0.1050	0.0004	0.3150	0.0034	4.559	0.051	0.1050	0.0004	0.949	1765	16	1714	7	-3
41.1	115	76	0.66	32	0.000123	0.19	3.067	0.038	0.1054	0.0009	0.3254	0.0040	4.654	0.075	0.1037	0.0011	0.776	1816	20	1692	19	-7
42.1	807	55	0.07	185	0.000007	0.01	3.740	0.042	0.1033	0.0003	0.2673	0.0030	3.802	0.044	0.1032	0.0004	0.956	1527	15	1682	6	10
43.1	146	53	0.36	56	0.000002	<0.01	2.230	0.028	0.1602	0.0008	0.4485	0.0056	9.905	0.133	0.1602	0.0009	0.919	2389	25	2458	9	3
44.1	399	64	0.16	98	0.000017	0.03	3.502	0.040	0.1020	0.0005	0.2855	0.0033	4.006	0.050	0.1018	0.0005	0.918	1619	16	1657	9	2
45.1	1091	176	0.16	279	-	<0.01	3.362	0.037	0.1024	0.0003	0.2975											

TABLE 3C.—Summary of SHRIMP U-Pb zircon results for sample 95ITz234.

Grain.	U spot	Th (ppm)	Th/U (ppm)	²⁰⁶ Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				Age (Ma)				%																																																																																																																																																																																																																																													
							²³⁸ U/ ²⁰⁶ Pb	²³⁵ U/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁸ U	²⁰⁷ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U		²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U	²⁰⁶ Pb/ ²⁰⁷ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁶ Pb/ ²³⁵ U

TABLE 3D.—Summary of SHRIMP U-Pb zircon results for sample 02RL888.

Grain. spot	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				ρ	²⁰⁶ Pb/ ²³⁸ U	Age (Ma)				% Disc	
							²³⁸ U/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁷ Pb/ ²³⁵ U	²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁶ Pb/ ²³⁸ U	²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁶ Pb/ ²³⁸ U			²⁰⁷ Pb/ ²⁰⁶ Pb	²⁰⁶ Pb/ ²³⁸ U				
1.1	346	157	0.45	90	0.000021	0.03	3.296	0.038	0.1054	0.0005	0.3033	0.0035	4.396	0.055	0.1051	0.0005	0.922	1708	17	1716	9	1
2.1	253	38	0.15	68	0.000017	0.03	3.214	0.053	0.1083	0.0006	0.3110	0.0052	4.633	0.081	0.1080	0.0006	0.949	1746	25	1767	10	1
3.1	264	129	0.49	78	0.000004	0.01	2.915	0.035	0.1140	0.0005	0.3430	0.0041	5.390	0.070	0.1140	0.0006	0.928	1901	20	1864	9	-2
4.1	861	2063	2.40	190	0.000005	0.01	3.896	0.042	0.0933	0.0004	0.2567	0.0027	3.301	0.038	0.0933	0.0004	0.937	1473	14	1494	8	1
5.1	232	163	0.70	51	0.000055	0.09	3.904	0.047	0.0990	0.0008	0.2559	0.0031	3.469	0.050	0.0983	0.0008	0.832	1469	16	1592	15	8
6.1	591	67	0.11	153	0.000021	0.03	3.329	0.038	0.1039	0.0004	0.3003	0.0035	4.290	0.053	0.1036	0.0005	0.925	1693	17	1690	9	0
7.1	208	78	0.38	55	0.000060	0.09	3.277	0.040	0.1036	0.0007	0.3049	0.0038	4.323	0.062	0.1028	0.0008	0.855	1715	19	1676	14	-2
8.1	199	84	0.42	55	0.000009	0.01	3.090	0.038	0.1084	0.0007	0.3236	0.0040	4.832	0.068	0.1083	0.0007	0.878	1807	19	1771	12	-2
9.1	745	152	0.20	199	0.000006	0.01	3.216	0.036	0.1059	0.0004	0.3109	0.0035	4.538	0.054	0.1059	0.0004	0.949	1745	17	1729	7	-1
10.1	175	63	0.36	37	-	<0.01	4.108	0.058	0.1099	0.0010	0.2434	0.0034	3.689	0.062	0.1099	0.0010	0.834	1404	18	1798	17	22
11.1	237	76	0.32	65	0.000044	0.07	3.130	0.047	0.1092	0.0006	0.3193	0.0048	4.782	0.079	0.1086	0.0007	0.915	1786	24	1777	12	-1
12.1	995	153	0.15	280	0.000018	0.03	3.051	0.035	0.1059	0.0003	0.3277	0.0038	4.772	0.058	0.1056	0.0004	0.960	1827	18	1725	6	-6
13.1	274	80	0.29	73	0.000062	0.10	3.214	0.038	0.1049	0.0006	0.3109	0.0037	4.460	0.060	0.1040	0.0007	0.884	1745	18	1698	12	-3
14.1	368	195	0.53	94	0.000019	0.03	3.375	0.041	0.1082	0.0005	0.2962	0.0036	4.407	0.057	0.1079	0.0005	0.928	1673	18	1764	9	5
15.1	165	90	0.55	46	-	<0.01	3.083	0.039	0.1090	0.0008	0.3245	0.0041	4.887	0.072	0.1092	0.0009	0.848	1811	20	1787	14	-1
16.1	366	98	0.27	92	0.000052	0.08	3.432	0.039	0.1059	0.0005	0.2911	0.0033	4.223	0.053	0.1052	0.0006	0.908	1647	17	1718	10	4
17.1	983	160	0.16	276	0.000017	0.03	3.057	0.034	0.1136	0.0003	0.3270	0.0036	5.111	0.059	0.1134	0.0003	0.965	1824	18	1854	5	2
18.1	533	27	0.05	129	0.000014	0.02	3.535	0.040	0.1023	0.0004	0.2828	0.0032	3.983	0.050	0.1021	0.0005	0.919	1606	16	1663	9	3
19.1	148	44	0.30	38	0.000050	0.08	3.302	0.048	0.1054	0.0008	0.3026	0.0044	4.369	0.074	0.1047	0.0009	0.865	1704	22	1709	16	0
20.1	181	75	0.41	47	0.000007	0.01	3.335	0.053	0.1073	0.0009	0.2998	0.0047	4.432	0.079	0.1072	0.0009	0.890	1690	23	1753	15	4
21.1	210	91	0.44	55	0.000052	0.08	3.253	0.039	0.1072	0.0007	0.3072	0.0037	4.510	0.063	0.1065	0.0008	0.860	1727	18	1740	13	1
22.1	142	83	0.58	30	0.000050	0.08	4.053	0.053	0.0929	0.0009	0.2465	0.0032	3.135	0.052	0.0922	0.0009	0.786	1420	17	1472	19	4
23.1	917	209	0.23	258	0.000007	0.01	3.058	0.034	0.1109	0.0003	0.3270	0.0036	4.995	0.057	0.1108	0.0003	0.965	1824	18	1813	5	-1
24.1	726	34	0.05	206	0.000043	0.07	3.024	0.034	0.1059	0.0004	0.3305	0.0037	4.800	0.058	0.1053	0.0004	0.942	1841	18	1720	7	-7
25.1	103	56	0.54	38	-	<0.01	2.316	0.031	0.1614	0.0011	0.4322	0.0057	9.659	0.146	0.1621	0.0012	0.874	2316	26	2478	12	7
26.1	289	244	0.85	62	0.000007	0.01	3.997	0.046	0.0912	0.0006	0.2501	0.0029	3.142	0.044	0.0911	0.0007	0.836	1439	15	1449	15	1
27.1	484	175	0.36	141	0.000011	0.02	2.950	0.034	0.1087	0.0004	0.3389	0.0039	5.071	0.062	0.1085	0.0005	0.935	1881	19	1775	8	-6
28.1	295	123	0.42	74	0.000085	0.14	3.427	0.040	0.1032	0.0007	0.2914	0.0034	4.100	0.056	0.1020	0.0007	0.848	1649	17	1661	13	1
29.1	58	48	0.84	14	0.000096	0.15	3.627	0.058	0.1011	0.0015	0.2753	0.0044	3.787	0.083	0.0998	0.0015	0.734	1568	22	1620	28	3
30.1	388	143	0.37	102	0.000036	0.06	3.264	0.038	0.1048	0.0005	0.3062	0.0036	4.404	0.056	0.1043	0.0005	0.912	1722	18	1702	10	-1
31.1	566	92	0.16	153	0.000013	0.02	3.179	0.037	0.1071	0.0004	0.3145	0.0036	4.637	0.057	0.1069	0.0005	0.934	1763	18	1748	8	-1
32.1	446	41	0.09	119	-	<0.01	3.229	0.038	0.1050	0.0005	0.3097	0.0036	4.487	0.057	0.1051	0.0005	0.928	1739	18	1716	9	-1
33.1	231	51	0.22	48	0.000340	0.54	4.111	0.052	0.1071	0.0014	0.2420	0.0031	3.417	0.076	0.1024	0.0019	0.575	1397	16	1669	34	16
34.1	733	99	0.14	207	0.000019	0.03	3.039	0.034	0.1105	0.0004	0.3292	0.0037	5.026	0.059	0.1107	0.0004	0.958	1834	18	1812	6	-1
35.1	378	197	0.52	97	0.000002	<0.01	3.340	0.039	0.1015	0.0005	0.2994	0.0035	4.189	0.053	0.1015	0.0005	0.923	1688	17	1651	9	-2
36.1	1419	8	0.01	373	0.000028	0.05	3.273	0.036	0.1010	0.0003	0.3054	0.0034	4.235	0.049	0.1006	0.0003	0.966	1718	17	1635	6	-5
37.1	365	172	0.47	88	0.000096	0.15	3.556	0.043	0.0971	0.0006	0.2808	0.0034	3.709	0.053	0.0958	0.0008	0.834	1595	17	1544	15	-3
38.1	293	46	0.16	80	0.000073	0.11	3.147	0.038	0.1088	0.0006	0.3175	0.0038	4.739	0.063	0.1082	0.0006	0.904	1778	19	1770	10	0
39.1	308	97	0.31	60	0.000131	0.20	4.381	0.066	0.1232	0.0029	0.2244	0.0034	3.397	0.117	0.1098	0.0034	0.433	1305	19	1796	57	27
40.1	152	67	0.44	43	0.000065	0.10	3.043	0.040	0.1094	0.0009	0.3283	0.0043	4.914	0.076	0.1086	0.0009	0.849	1830	21	1776	15	-3
41.1	554	218	0.39	155	0.000029	0.05	3.069	0.036	0.1099	0.0005	0.3257	0.0038	4.918	0.062	0.1095	0.0005	0.929	1817	18	1791	8	-1
42.1	782	252	0.32	210	0.000046	0.07	3.197	0.036	0.1067	0.0004	0.3126	0.0036	4.573	0.055	0.1061	0.0004	0.943	1753	17	1734	7	-1
43.1	134	140	1.05	33	0.000041	0.06	3.461	0.047	0.1040	0.0010	0.2887	0.0039	4.118	0.069	0.1034	0.0010	0.807	1635	20	1687	18	3
44.1	330	108	0.33	96	0.000062	0.10	2.955	0.037	0.1113	0.0006	0.3381	0.0042	5.152	0.071	0.1105	0.0006	0.907	1878	20	1808	10	-4
45.1	1021	432	0.42	274	0.000050	0.08	3.204	0.037	0.1042	0.0004	0.3119	0.0036	4.451	0.054	0.1035	0.0004	0.945	1750	18	1688	7	-4
46.1	450	96	0.21	138	0.000062	0.09	2.800	0.														

TABLE 3E.—Summary of SHRIMP U-Pb zircon results for sample SS-95-19A.

Grain spot	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₅₀₀ %	Total Ratios				Radiogenic Ratios				ρ	Age (Ma)						
							²³⁸ U/ ²⁰⁶ Pb	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±	²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁷ Pb/ ²³⁸ U	±		²⁰⁶ Pb/ ²³⁵ U	±	²⁰⁷ Pb/ ²³⁵ U	±	% Disc		
1.1	629	251	0.40	165	0.000014	0.02	3.270	0.035	0.1075	0.0005	0.3057	0.0032	3.922	0.052	0.1073	0.0005	0.921	1720	16	1754	8	-
2.1	684	517	0.76	166	0.000019	0.03	3.494	0.037	0.0997	0.0004	0.2861	0.0030	4.521	0.044	0.0994	0.0004	0.934	1622	15	1613	8	-
3.1	633	247	0.39	177	0.000098	0.15	3.081	0.039	0.1068	0.0007	0.3248	0.0041	4.602	0.067	0.1072	0.0007	0.899	1813	21	1753	11	-
4.1	278	104	0.37	75	0.000250	0.39	3.201	0.043	0.1118	0.0010	0.3112	0.0042	4.650	0.089	0.1084	0.0015	0.702	1747	21	1772	25	1
5.1	6183	1942	0.31	1685	0.000006	0.01	3.153	0.035	0.0999	0.0003	0.3177	0.0035	4.441	0.051	0.1014	0.0003	0.960	1778	18	1650	6	-
6.1	723	169	0.23	190	0.000028	0.04	3.276	0.037	0.1068	0.0005	0.3051	0.0034	4.476	0.055	0.1064	0.0005	0.911	1717	17	1738	9	-
7.1	487	318	0.65	125	0.000083	0.13	3.351	0.039	0.1061	0.0007	0.2980	0.0035	4.314	0.059	0.1050	0.0008	0.852	1681	17	1714	13	-
8.1	678	308	0.45	176	0.000061	0.10	3.318	0.042	0.1013	0.0006	0.3022	0.0038	4.317	0.062	0.1036	0.0007	0.882	1702	20	1690	12	-
9.1	685	263	0.39	153	0.000052	0.08	3.731	0.046	0.1083	0.0008	0.2678	0.0033	3.898	0.057	0.1058	0.0008	0.837	1530	17	1724	15	11
10.1	672	645	0.96	197	-	<0.01	2.934	0.035	0.1144	0.0007	0.3424	0.0041	5.573	0.078	0.1181	0.0008	0.863	1899	23	1927	13	2
11.1	1376	366	0.27	560	-	<0.01	2.109	0.024	0.1637	0.0005	0.4741	0.0054	10.702	0.127	0.1637	0.0005	0.963	2501	24	2494	5	0
12.1	861	366	0.42	228	0.000093	0.15	3.244	0.038	0.1080	0.0008	0.3076	0.0036	4.528	0.062	0.1067	0.0007	0.866	1730	18	1744	12	1
13.1	126	72	0.58	30	-	<0.01	3.555	0.059	0.0985	0.0016	0.2813	0.0047	3.822	0.089	0.0985	0.0016	0.715	1598	24	1597	30	0
14.1	506	202	0.40	134	0.000005	0.01	3.239	0.041	0.1051	0.0008	0.3087	0.0039	4.470	0.066	0.1050	0.0008	0.856	1734	19	1715	14	-1
15.1	328	138	0.42	87	-	<0.01	3.253	0.043	0.1056	0.0010	0.3079	0.0041	4.546	0.081	0.1071	0.0013	0.747	1731	20	1750	22	1
16.1	711	461	0.65	154	0.000041	0.07	3.976	0.045	0.0920	0.0005	0.2514	0.0029	3.170	0.042	0.0915	0.0006	0.866	1446	15	1456	12	-
17.1	602	308	0.51	155	0.000052	0.08	3.331	0.038	0.1062	0.0006	0.3000	0.0034	4.363	0.057	0.1055	0.0007	0.879	1691	17	1723	11	2
18.1	988	528	0.53	273	0.000031	0.05	3.112	0.034	0.1064	0.0005	0.3212	0.0036	4.691	0.058	0.1059	0.0005	0.923	1796	17	1731	8	-4
19.1	501	80	0.16	141	-	<0.01	3.042	0.039	0.1083	0.0008	0.3289	0.0042	4.928	0.075	0.1087	0.0009	0.833	1833	20	1777	15	-3
20.1	1028	326	0.32	335	0.000072	0.11	2.639	0.033	0.1345	0.0007	0.3785	0.0048	6.970	0.097	0.1335	0.0008	0.907	2069	22	2145	10	4
21.1	348	106	0.30	139	-	<0.01	2.151	0.029	0.1608	0.0012	0.4653	0.0062	11.634	0.173	0.1813	0.0012	0.893	2463	27	2665	11	8
22.1	1288	110	0.09	351	0.000004	0.01	3.156	0.034	0.1068	0.0004	0.3169	0.0034	4.665	0.054	0.1068	0.0004	0.944	1774	17	1745	7	-2
23.1	960	389	0.59	176	0.000032	0.05	3.225	0.039	0.1062	0.0007	0.3099	0.0038	4.519	0.064	0.1058	0.0008	0.862	1740	19	1728	13	-1
24.1	366	665	1.82	92	0.000097	0.15	3.412	0.052	0.1008	0.0012	0.2956	0.0045	4.392	0.090	0.1078	0.0015	0.750	1669	33	1762	25	5
25.1	259	218	0.84	61	0.000069	0.11	3.846	0.047	0.1012	0.0009	0.2740	0.0035	3.787	0.060	0.1003	0.0009	0.807	1551	18	1629	17	4
26.1	885	683	0.77	250	0.000007	0.01	3.042	0.038	0.1089	0.0006	0.3299	0.0041	5.076	0.071	0.1116	0.0007	0.896	1836	22	1626	11	-1
27.1	332	226	0.68	86	-	<0.01	3.310	0.045	0.1038	0.0010	0.3022	0.0041	4.339	0.073	0.1041	0.0011	0.798	1702	20	1699	19	0
28.1	656	254	0.39	184	0.000032	0.05	3.073	0.038	0.1048	0.0007	0.3262	0.0040	4.795	0.067	0.1066	0.0007	0.869	1820	20	1742	13	-4
29.1	2080	897	0.43	555	0.000023	0.04	3.217	0.034	0.1060	0.0003	0.3107	0.0033	4.529	0.051	0.1057	0.0004	0.955	1744	16	1727	6	-1
30.1	198	136	0.69	52	0.000040	0.08	3.281	0.053	0.0995	0.0016	0.3062	0.0050	4.354	0.098	0.1031	0.0016	0.721	1722	27	1681	29	-2
31.1	280	41	0.16	68	-	<0.01	3.277	0.046	0.1008	0.0011	0.3053	0.0043	4.253	0.077	0.1010	0.0012	0.776	1718	21	1643	21	-5
31.1	226	37	0.16	57	0.000121	0.19	3.435	0.046	0.1039	0.0010	0.2905	0.0039	4.096	0.071	0.1022	0.0011	0.769	1644	19	1665	20	1
32.1	1007	617	0.61	242	0.000114	0.18	3.573	0.045	0.1007	0.0006	0.2793	0.0035	3.816	0.057	0.0991	0.0008	0.836	1588	18	1607	15	1
33.1	499	197	0.39	141	0.000111	0.17	3.045	0.037	0.1121	0.0006	0.3281	0.0039	5.035	0.067	0.1113	0.0006	0.903	1829	20	1621	10	0
34.1	1736	767	0.44	450	0.000024	0.04	3.313	0.038	0.1034	0.0005	0.3018	0.0034	4.288	0.053	0.1031	0.0005	0.922	1700	17	1689	9	-1
35.1	282	159	0.56	80	0.000073	0.11	3.030	0.045	0.1108	0.0011	0.3305	0.0049	5.110	0.091	0.1121	0.0011	0.830	1841	25	1834	18	0
36.1	566	42	0.07	134	0.000032	0.05	3.622	0.045	0.1035	0.0008	0.2760	0.0035	3.921	0.059	0.1031	0.0008	0.837	1571	17	1680	15	6
37.1	135	92	0.69	35	0.000327	0.52	3.319	0.054	0.1068	0.0018	0.3025	0.0049	4.590	0.107	0.1101	0.0019	0.690	1704	27	1609	31	5
38.1	272	166	0.61	99	0.000078	0.11	2.350	0.029	0.1527	0.0009	0.4251	0.0053	8.889	0.123	0.1517	0.0009	0.897	2284	24	2365	10	3
39.1	803	108	0.13	215	-	<0.01	3.215	0.038	0.1056	0.0006	0.3118	0.0037	4.632	0.062	0.1077	0.0007	0.892	1750	19	1761	11	1
40.1	201	71	0.35	66	-	<0.01	2.628	0.038	0.1283	0.0013	0.3807	0.0055	6.762	0.121	0.1288	0.0013	0.813	2080	26	2082	18	0
41.1	622	352	0.57	168	0.000022	0.03	3.221	0.039	0.1086	0.0007	0.3103	0.0038	4.632	0.064	0.1083	0.0007	0.881	1742	18	1770	12	2
42.1	645	240	0.37	163	0.000037	0.06	3.407	0.041	0.1040	0.0007	0.2933	0.0035	4.184	0.058	0.1035	0.0007	0.871	1658	18	1687	13	2
43.1	252	103	0.41	68	-	<0.01	3.182	0.041	0.1063	0.0009	0.3149	0.0040	4.689	0.072	0.1080	0.0009	0.840	1765	21	1768	15	0
44.1	799	616	0.77	216	0.000020	0.03	3.179	0.040	0.1050	0.0006	0.3159	0.0039	4.730	0.068	0.1086	0.0008	0.872	1770	21	1776	13	0
45.1	1899	511	0.27	482	0.000002	0.00	3.590	0.038	0.1030	0.0003	0.2833	0.0030	4.022	0.045	0.1030	0.0003	0.954	1608	15	1679	6	4
46.1	324	94	0.29	78	0.000025	0.04	3.560	0.044	0.1068	0.0008	0.2808	0.0035	4.114	0.060	0.1063	0.0008	0.844	1595	17	1737	14	8
47.1	476	497	1.04	138	0.000035	0.05	2.956	0.037	0.1124													

TABLE 3F.—Summary of SHRIMP U-Pb zircon results for sample 39PL02.

Grain. spot	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				p	Age (Ma)				%		
							²³⁸ U/ ²⁰⁶ Pb	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±	²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁷ Pb/ ²³⁵ U	±		²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±		Disc	
1.1	536	322	0.60	145	-	<0.01	3.166	0.034	0.1089	0.0004	0.3159	0.0034	4.745	0.054	0.1089	0.0004	0.936	1770	17	1782	7	-
2.1	136	90	0.66	34	0.000053	0.08	3.458	0.044	0.1026	0.0009	0.2889	0.0037	4.059	0.066	0.1019	0.0010	0.780	1636	18	1659	19	-
3.1	187	77	0.41	50	0.000029	0.04	3.231	0.038	0.1057	0.0008	0.3094	0.0037	4.492	0.063	0.1053	0.0008	0.842	1738	18	1720	14	-
4.1	335	168	0.50	90	0.000047	0.07	3.181	0.035	0.1059	0.0006	0.3141	0.0035	4.560	0.059	0.1053	0.0007	0.852	1761	17	1720	12	-
5.1	652	318	0.49	181	0.000008	0.01	3.102	0.033	0.1087	0.0004	0.3224	0.0034	4.825	0.054	0.1085	0.0004	0.940	1801	17	1775	7	-
6.1	363	61	0.17	103	0.000023	0.04	3.030	0.033	0.1099	0.0006	0.3301	0.0036	5.009	0.061	0.1100	0.0006	0.907	1839	18	1800	9	-
7.1	3212	457	0.14	756	0.000034	0.05	3.650	0.038	0.0982	0.0002	0.2738	0.0028	3.689	0.039	0.0977	0.0002	0.973	1560	14	1581	5	-
8.1	142	49	0.34	38	-	<0.01	3.219	0.039	0.1052	0.0009	0.3107	0.0038	4.511	0.067	0.1053	0.0009	0.828	1744	19	1719	15	-
9.1	411	76	0.18	116	-	<0.01	3.060	0.033	0.1097	0.0005	0.3269	0.0036	4.954	0.059	0.1099	0.0005	0.910	1823	17	1798	9	-
10.1	589	144	0.24	260	0.000007	0.01	1.947	0.021	0.1646	0.0007	0.5137	0.0056	11.649	0.136	0.1645	0.0007	0.937	2672	24	2502	7	-
11.1	350	81	0.23	92	-	<0.01	3.283	0.037	0.1053	0.0006	0.3047	0.0035	4.425	0.056	0.1054	0.0006	0.904	1714	17	1721	10	0
12.1	483	143	0.30	129	0.000014	0.02	3.216	0.035	0.1060	0.0006	0.3109	0.0034	4.536	0.057	0.1058	0.0006	0.878	1745	17	1729	11	-
13.1	768	154	0.20	249	0.000015	0.02	2.651	0.028	0.1230	0.0004	0.3771	0.0040	6.383	0.071	0.1228	0.0004	0.952	2063	19	1997	6	-
14.1	482	160	0.33	134	0.000002	0.00	3.089	0.035	0.1056	0.0005	0.3237	0.0036	4.712	0.057	0.1056	0.0005	0.923	1808	18	1724	9	-
15.1	329	90	0.27	85	-	<0.01	3.333	0.037	0.1053	0.0006	0.3001	0.0034	4.368	0.055	0.1056	0.0006	0.884	1692	17	1724	11	-
16.1	510	115	0.22	124	0.000021	0.03	3.546	0.038	0.1008	0.0005	0.2819	0.0031	3.905	0.047	0.1005	0.0005	0.910	1601	15	1633	9	2
17.1	246	158	0.64	67	-	<0.01	3.160	0.036	0.1050	0.0007	0.3165	0.0037	4.585	0.061	0.1051	0.0007	0.871	1772	18	1716	12	-
18.1	279	139	0.50	77	0.000090	0.14	3.115	0.034	0.1101	0.0005	0.3205	0.0035	4.810	0.061	0.1088	0.0007	0.864	1792	17	1780	12	-
19.1	314	260	0.83	73	-	<0.01	3.692	0.040	0.1029	0.0005	0.2709	0.0029	3.847	0.046	0.1030	0.0005	0.910	1545	15	1679	9	8
20.1	524	101	0.19	133	-	<0.01	3.385	0.036	0.1024	0.0004	0.2955	0.0031	4.171	0.047	0.1024	0.0004	0.934	1669	16	1668	8	0
21.1	323	47	0.15	79	0.000026	0.04	3.525	0.038	0.1022	0.0005	0.2836	0.0031	3.983	0.049	0.1019	0.0006	0.883	1609	16	1659	11	3
22.1	261	112	0.43	66	0.000109	0.17	3.391	0.040	0.1036	0.0006	0.2944	0.0034	4.143	0.058	0.1021	0.0008	0.830	1663	17	1662	15	0
23.1	99	36	0.37	40	0.000031	0.04	2.094	0.027	0.1691	0.0011	0.4773	0.0060	11.101	0.158	0.1687	0.0011	0.891	2516	26	2545	11	1
24.1	112	53	0.47	30	0.000183	0.29	3.223	0.044	0.1122	0.0011	0.3094	0.0043	4.678	0.096	0.1097	0.0017	0.675	1738	21	1794	27	3
25.1	458	30	0.06	120	0.000037	0.06	3.279	0.035	0.1044	0.0005	0.3048	0.0033	4.366	0.052	0.1039	0.0005	0.905	1715	16	1695	9	-1
26.1	2072	1443	0.70	555	0.000003	<0.01	3.207	0.033	0.1033	0.0002	0.3118	0.0032	4.439	0.047	0.1033	0.0002	0.974	1749	16	1684	4	-4
27.1	227	56	0.25	62	0.000018	0.03	3.124	0.036	0.1096	0.0007	0.3200	0.0037	4.825	0.065	0.1094	0.0008	0.856	1790	18	1789	13	0
28.1	127	57	0.45	37	0.000015	0.02	2.973	0.037	0.1088	0.0009	0.3363	0.0042	5.038	0.079	0.1086	0.0011	0.787	1869	20	1777	18	-5
29.1	228	163	0.71	96	0.000035	0.05	2.043	0.024	0.1605	0.0008	0.4892	0.0056	10.797	0.135	0.1601	0.0008	0.918	2567	24	2456	8	-5
30.1	463	204	0.44	128	0.000070	0.11	3.118	0.034	0.1084	0.0005	0.3209	0.0035	4.812	0.057	0.1088	0.0005	0.923	1794	18	1779	8	-1
31.1	230	193	0.84	59	0.000006	0.01	3.327	0.040	0.1059	0.0007	0.3005	0.0036	4.386	0.060	0.1059	0.0007	0.875	1694	18	1729	12	2
32.1	295	344	1.16	61	0.000033	0.05	4.181	0.047	0.0897	0.0006	0.2390	0.0027	2.940	0.041	0.0892	0.0007	0.817	1382	14	1409	15	2
33.1	788	62	0.08	212	-	<0.01	3.194	0.034	0.1097	0.0004	0.3131	0.0033	4.736	0.053	0.1097	0.0004	0.953	1756	16	1794	6	2
34.1	274	218	0.80	74	0.000014	0.02	3.169	0.036	0.1089	0.0006	0.3155	0.0036	4.730	0.060	0.1087	0.0006	0.898	1768	17	1778	11	1
35.1	214	85	0.40	69	0.000056	0.08	2.678	0.031	0.1251	0.0007	0.3731	0.0043	6.399	0.087	0.1244	0.0009	0.861	2044	20	2020	12	-1
36.1	279	93	0.33	71	0.000027	0.04	3.355	0.038	0.1069	0.0006	0.2979	0.0034	4.376	0.057	0.1065	0.0007	0.868	1681	17	1741	12	3
37.1	847	340	0.40	226	0.000298	0.46	3.223	0.034	0.1175	0.0009	0.3089	0.0033	4.834	0.072	0.1135	0.0012	0.720	1735	16	1856	19	7
38.1	905	640	0.71	234	0.000021	0.03	3.322	0.035	0.1064	0.0004	0.3009	0.0032	4.404	0.049	0.1061	0.0004	0.944	1696	16	1734	7	2
39.1	940	383	0.41	259	0.000018	0.03	3.122	0.033	0.1056	0.0004	0.3202	0.0034	4.650	0.052	0.1053	0.0004	0.948	1791	16	1720	7	-4
40.1	325	155	0.48	80	0.000043	0.07	3.493	0.039	0.1026	0.0006	0.2861	0.0032	4.023	0.052	0.1020	0.0007	0.854	1622	16	1661	13	2
41.1	89	61	0.69	23	0.000002	0.00	3.296	0.046	0.1015	0.0011	0.3034	0.0042	4.243	0.081	0.1014	0.0013	0.727	1708	21	1651	24	-3
42.1	302	199	0.66	78	0.000032	0.05	3.317	0.038	0.1046	0.0006	0.3014	0.0034	4.329	0.056	0.1042	0.0006	0.878	1698	17	1700	11	0
43.1	140	33	0.23	38	0.000059	0.09	3.208	0.040	0.1097	0.0009	0.3114	0.0039	4.675	0.077	0.1089	0.0012	0.761	1748	19	1781	19	2
44.1	131	60	0.46	33	0.000080	0.13	3.352	0.045	0.1056	0.0009	0.2980	0.0040	4.293	0.075	0.1045	0.0012	0.767	1681	20	1706	21	1
45.1	267	78	0.29	79	0.000022	0.03	2.920	0.033	0.1144	0.0007	0.3424	0.0039	5.384	0.070	0.1141	0.0007	0.876	1896	19	1865	11	-2
46.1	181	79	0.44	52	0.000014	0.02	2.985	0.037	0.1124	0.0008	0.3350	0.0042	5.183	0.076	0.1122	0.0009	0.852	1862	20	1836	14	-1
47.1	456	70	0.15	117	0.000021	0.03	3.362	0.038	0.1061	0.0005	0.2973	0.0033	4.339	0.054	0.1058							

TABLE 3G.—Summary of SHRIMP U-Pb zircon results for sample 23PL92.

Grain. spot	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	Total Ratios										Radiogenic Ratios					Age (Ma)					%
					²⁰⁴ Pb/ ²⁰⁶ Pb	f ₂₀₆ %	²³⁸ U/ ²⁰⁶ Pb	²⁰⁷ Pb/ ²⁰⁶ Pb	±	²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁶ Pb/ ²⁰⁷ Pb	±	²⁰⁷ Pb/ ²³⁵ U	±	²⁰⁶ Pb/ ²⁰⁷ Pb	±	ρ	²⁰⁶ Pb/ ²³⁸ U	±	²⁰⁷ Pb/ ²⁰⁶ Pb	±			
					±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±	±				
1.1	488	126	0.26	120.1	0.000169	0.29	3.488	0.038	0.1039	0.0005	0.2859	0.0031	4.002	0.052	0.1015	0.0007	0.838	1621	16	1653	13	1			
2.1	868	360	0.41	215.8	0.000031	0.05	3.454	0.036	0.1067	0.0003	0.2894	0.0030	4.241	0.046	0.1063	0.0003	0.957	1639	15	1737	6	0			
3.1	649	147	0.23	167.9	0.000030	0.05	3.319	0.036	0.1152	0.0004	0.3012	0.0033	4.768	0.054	0.1148	0.0004	0.953	1697	16	1877	6	10			
4.1	183	101	0.55	46.2	0.000166	0.28	3.400	0.040	0.1065	0.0007	0.2933	0.0035	4.216	0.063	0.1043	0.0009	0.798	1658	17	1701	17	3			
5.1	300	85	0.28	78.2	0.000083	0.14	3.297	0.037	0.1049	0.0006	0.3028	0.0034	4.331	0.057	0.1037	0.0007	0.866	1705	17	1692	12	-			
6.1	904	313	0.35	222.2	0.000043	0.07	3.493	0.037	0.1045	0.0003	0.2860	0.0030	4.098	0.046	0.1039	0.0003	0.954	1622	15	1695	6	4			
7.1	2202	40	0.02	248.2	0.000874	1.48	7.624	0.079	0.1125	0.0006	0.1292	0.0013	1.790	0.038	0.1004	0.0019	0.484	783	8	1632	35	52			
8.1	697	271	0.39	74.6	0.000660	1.11	8.019	0.086	0.0928	0.0005	0.1233	0.0013	1.419	0.032	0.0835	0.0016	0.484	750	8	1280	38	41			
9.1	526	142	0.27	105.5	0.000043	0.07	4.286	0.047	0.1064	0.0005	0.2332	0.0025	3.403	0.041	0.1058	0.0005	0.904	1351	13	1729	9	22			
10.1	315	183	0.58	70.2	0.000119	0.20	3.849	0.044	0.1049	0.0007	0.2593	0.0030	3.691	0.054	0.1032	0.0009	0.794	1486	15	1683	16	12			
11.1	380	147	0.39	67.0	0.000092	0.15	4.881	0.056	0.1033	0.0006	0.2045	0.0023	2.877	0.040	0.1020	0.0008	0.827	1200	13	1661	14	28			
12.1	606	261	0.43	142.3	0.000031	0.05	3.658	0.041	0.1589	0.0007	0.2732	0.0030	5.897	0.071	0.1565	0.0007	0.922	1557	15	2419	8	36			
13.1	128	122	0.95	21.1	0.000198	0.33	5.224	0.073	0.1028	0.0012	0.1908	0.0027	2.633	0.060	0.1001	0.0018	0.615	1126	15	1626	34	31			
14.1	550	284	0.52	101.0	0.000053	0.09	4.679	0.051	0.1035	0.0008	0.2135	0.0023	3.024	0.042	0.1027	0.0009	0.795	1248	12	1674	15	25			
15.1	545	300	0.55	126.9	0.000106	0.18	3.692	0.039	0.1048	0.0010	0.2704	0.0029	3.853	0.059	0.1033	0.0011	0.693	1543	15	1685	20	8			
15.2	923	287	0.31	96.7	0.001155	1.95	8.193	0.090	0.0929	0.0012	0.1197	0.0013	1.262	0.051	0.0765	0.0030	0.274	729	8	1108	78	34			
16.1	224	177	0.79	50.6	0.000023	0.04	3.800	0.045	0.0998	0.0007	0.2631	0.0031	3.609	0.052	0.0995	0.0008	0.830	1506	16	1614	15	7			
16.2	125	60	0.48	32.7	0.000304	0.51	3.285	0.045	0.1041	0.0010	0.3063	0.0042	4.603	0.081	0.1090	0.0012	0.779	1722	22	1783	20	3			
17.1	1068	204	0.19	129.9	0.000743	1.26	7.063	0.080	0.0954	0.0005	0.1398	0.0016	1.638	0.041	0.0850	0.0019	0.460	844	9	1314	43	36			
17.2	471	65	0.14	101.8	0.000139	0.24	3.971	0.047	0.0998	0.0008	0.2512	0.0030	3.391	0.053	0.0979	0.0010	0.770	1445	15	1584	19	9			
18.1	208	116	0.56	52.7	0.000015	0.03	3.395	0.039	0.1027	0.0006	0.2945	0.0034	4.163	0.055	0.1025	0.0007	0.873	1664	17	1671	12	0			
18.2	583	157	0.27	96.9	0.000541	0.91	5.175	0.056	0.0987	0.0005	0.1915	0.0021	2.407	0.045	0.0912	0.0014	0.585	1129	11	1450	29	22			
19.1	143	46	0.32	38.3	0.000105	0.18	3.216	0.039	0.1059	0.0007	0.3116	0.0038	4.627	0.066	0.1077	0.0008	0.863	1749	20	1761	13	1			
20.1	1961	482	0.25	210.8	0.000767	1.30	7.993	0.093	0.0968	0.0009	0.1235	0.0015	1.465	0.046	0.0861	0.0025	0.380	751	8	1340	56	44			
21.1	216	109	0.50	56.4	0.000005	0.01	3.294	0.038	0.1012	0.0006	0.3035	0.0035	4.231	0.055	0.1011	0.0008	0.888	1709	17	1644	11	-4			
21.2	530	126	0.24	89.4	0.003500	5.91	5.097	0.065	0.1322	0.0066	0.1846	0.0028	2.111	0.293	0.0829	0.0114	0.108	1092	15	1267	269	14			
22.1	389	322	0.83	106.4	0.000048	0.08	3.141	0.036	0.1061	0.0005	0.3228	0.0037	5.219	0.088	0.1173	0.0014	0.678	1803	20	1915	22	6			
23.1	404	192	0.47	111.2	0.000049	0.08	3.123	0.034	0.1052	0.0005	0.3201	0.0035	4.638	0.055	0.1051	0.0005	0.929	1790	18	1716	8	-4			
24.1	242	208	0.86	44.5	0.001430	2.42	4.676	0.055	0.1150	0.0008	0.2087	0.0025	2.737	0.102	0.0951	0.0034	0.320	1222	13	1530	67	20			
25.1	364	166	0.46	99.4	0.000012	0.02	3.148	0.035	0.1036	0.0005	0.3176	0.0035	4.530	0.054	0.1034	0.0005	0.922	1778	17	1687	9	-5			
26.1	115	54	0.47	35.4	0.000483	0.82	2.801	0.037	0.1156	0.0011	0.3591	0.0048	5.956	0.101	0.1203	0.0013	0.781	1978	24	1960	19	-1			
27.1	195	59	0.30	49.6	0.000056	0.10	3.379	0.040	0.1026	0.0007	0.2955	0.0035	4.152	0.063	0.1019	0.0010	0.781	1670	17	1658	17	-1			
28.1	205	94	0.46	56.0	0.000004	0.01	3.143	0.037	0.1037	0.0006	0.3181	0.0037	4.546	0.061	0.1036	0.0007	0.876	1781	18	1690	12	-5			
29.1	814	246	0.30	134.1	0.000324	0.55	5.214	0.055	0.1089	0.0005	0.1907	0.0020	2.747	0.039	0.1044	0.0010	0.759	1125	11	1705	17	34			
30.1	221	32	0.15	46.2	0.000128	0.22	4.101	0.052	0.1046	0.0008	0.2433	0.0031	3.451	0.056	0.1029	0.0010	0.787	1404	16	1676	19	16			
31.1	1103	374	0.34	240.5	0.000328	0.55	3.940	0.041	0.1081	0.0003	0.2524	0.0026	3.606	0.048	0.1036	0.0008	0.789	1451	14	1690	15	14			
32.1	312	58	0.19	89.9	0.000020	0.03	2.980	0.034	0.1054	0.0006	0.3356	0.0038	4.875	0.062	0.1054	0.0006	0.901	1885	19	1721	10	-8			
33.1	478	60	0.13	125.7	0.000017	0.03	3.267	0.037	0.1067	0.0006	0.3060	0.0035	4.491	0.058	0.1064	0.0006	0.889	1721	17	1739	11	1			
34.1	492	174	0.35	119.7	0.000004	0.01	3.529	0.041	0.1106	0.0007	0.2833	0.0033	4.320	0.056	0.1106	0.0007	0.887	1608	16	1809	11	11			
35.1	348	227	0.65	66.0	0.000081	0.14	4.528	0.056	0.0922	0.0008	0.2206	0.0027	2.770	0.046	0.0911	0.0010	0.745	1285	14	1448	21	11			
36.1	1573	214	0.14	339.0	0.000034	0.06	3.985	0.042	0.1069	0.0004	0.2508	0.0026	3.681	0.042	0.1065	0.0004	0.936	1443	14	1740	7	17			
37.1	794	322	0.41	185.9	0.000085	0.14	3.670	0.041	0.1086	0.0006	0.2721	0.0030	4.032	0.052	0.1075	0.0007	0.868	1551	15	1757	12	12			
38.1	110	29	0.27	31.3	-	<0.01	3.023	0.043	0.1153	0.0011	0.3309	0.0047	5.270	0.092	0.1155	0.0011	0.822	1843	23	1888	18	2			
39.1	1924	122	0.06	364.2	0.000093	0.16	4.539	0.047	0.1027	0.0003	0.2199	0.0023	3.075	0.033	0.1014	0.0004	0.943	1282	12	1650	7	22			
40.1	245	104	0.42	67.6	0.000011	0.02	3.116	0.037	0.1067	0.0007	0.3209	0.0038	4.716	0.068	0.1066										

TABLE 3H.—Summary of SHRIMP U-Pb zircon results for sample 95ITz101.

Grain.	U spot	U (ppm)	Th (ppm)	Th/U (ppm)	²⁰⁶ Pb/ ²⁰⁶ Pb (ppm)	²⁰⁴ Pb/ ²⁰⁶ Pb %	f ₂₀₆ %	Total Ratios				Radiogenic Ratios				ρ	Age (Ma)				%	
								²³⁸ U/ ²⁰⁶ Pb ±	²⁰⁷ Pb/ ²⁰⁶ Pb ±	²⁰⁶ Pb/ ²³⁸ U ±	²⁰⁷ Pb/ ²³⁵ U ±	²⁰⁷ Pb/ ²⁰⁶ Pb ±	²⁰⁶ Pb/ ²³⁸ U ±	²⁰⁷ Pb/ ²⁰⁶ Pb ±	²⁰⁶ Pb/ ²³⁸ U ±		²⁰⁷ Pb/ ²⁰⁶ Pb ±	Disc				
1.1	219	96	0.44	58	0.000161	0.29	3.274	0.047	0.1076	0.0006	0.3046	0.0044	4.426	0.072	0.1054	0.0008	0.889	1714	22	1721	7	0
2.1	278	135	0.48	73	0.000067	0.12	3.287	0.047	0.1057	0.0005	0.3039	0.0043	4.392	0.067	0.1048	0.0006	0.928	1711	21	1711	5	0
2.2	1049	446	0.43	138	0.000402	0.73	6.549	0.091	0.1013	0.0005	0.1516	0.0021	2.000	0.033	0.0957	0.0008	0.848	910	12	1542	8	41
3.1	70	38	0.55	18	0.000359	0.65	3.302	0.052	0.1071	0.0011	0.3009	0.0049	4.240	0.124	0.1022	0.0025	0.550	1696	24	1665	23	-2
4.1	473	131	0.28	113	0.000041	0.07	3.597	0.050	0.1040	0.0004	0.2778	0.0039	3.963	0.058	0.1035	0.0005	0.949	1580	20	1687	4	6
5.1	162	58	0.35	42	0.000081	0.15	3.304	0.048	0.1065	0.0007	0.3023	0.0044	4.392	0.073	0.1054	0.0008	0.885	1703	22	1721	7	1
6.1	181	91	0.50	46	0.000145	0.26	3.387	0.049	0.1069	0.0007	0.2945	0.0043	4.261	0.073	0.1049	0.0009	0.850	1664	21	1713	8	3
7.1	149	188	1.26	40	0.000085	0.15	3.198	0.047	0.1059	0.0007	0.3122	0.0046	4.507	0.076	0.1047	0.0009	0.873	1751	23	1709	8	-2
8.1	121	42	0.35	31	0.000302	0.55	3.317	0.050	0.1073	0.0012	0.2998	0.0045	4.264	0.086	0.1031	0.0014	0.746	1690	22	1681	12	-1
9.1	1179	98	0.08	296	0.000036	0.07	3.425	0.047	0.1035	0.0003	0.2918	0.0040	4.143	0.059	0.1030	0.0004	0.970	1650	20	1679	3	2
10.1	761	392	0.52	278	0.000066	0.12	2.353	0.035	0.1977	0.0005	0.4246	0.0063	11.528	0.172	0.1969	0.0005	0.985	2281	28	2801	2	19
11.1	276	99	0.36	73	0.000132	0.24	3.245	0.046	0.1074	0.0007	0.3074	0.0044	4.475	0.073	0.1056	0.0008	0.880	1728	22	1724	7	0
12.1	397	99	0.25	171	0.000070	0.13	1.992	0.030	0.1877	0.0007	0.5014	0.0075	12.919	0.200	0.1869	0.0008	0.963	2620	32	2715	3	4
13.1	175	78	0.45	47	0.000149	0.27	3.192	0.043	0.1065	0.0008	0.3125	0.0042	4.500	0.074	0.1045	0.0010	0.824	1753	21	1705	9	-3
14.1	1268	47	0.04	346	0.000025	0.04	3.153	0.045	0.1081	0.0003	0.3170	0.0045	4.708	0.069	0.1077	0.0003	0.978	1775	22	1761	3	-1
15.1	178	73	0.41	52	0.000092	0.17	2.931	0.043	0.1137	0.0008	0.3406	0.0050	5.280	0.087	0.1124	0.0009	0.886	1889	24	1839	7	-3
16.1	199	63	0.32	50	0.000145	0.26	3.383	0.058	0.1060	0.0008	0.2948	0.0051	4.226	0.083	0.1040	0.0010	0.880	1665	25	1696	9	2
17.1	225	52	0.23	50	0.000264	0.48	3.838	0.052	0.1052	0.0008	0.2593	0.0035	3.632	0.063	0.1016	0.0011	0.783	1486	18	1653	10	10
18.1	388	159	0.41	104	0.000067	0.12	3.194	0.043	0.1055	0.0010	0.3127	0.0042	4.507	0.077	0.1045	0.0011	0.798	1754	21	1706	9	-3
19.1	166	54	0.32	47	0.000211	0.38	3.012	0.044	0.1129	0.0009	0.3307	0.0048	5.017	0.103	0.1100	0.0016	0.713	1842	23	1800	13	-2
20.1	890	419	0.47	215	0.000099	0.18	3.562	0.049	0.1053	0.0004	0.2802	0.0039	4.017	0.058	0.1040	0.0004	0.956	1593	20	1696	4	6
21.1	189	225	1.19	52	0.000142	0.26	3.105	0.045	0.1113	0.0008	0.3212	0.0047	4.843	0.081	0.1093	0.0009	0.864	1796	23	1788	8	0
22.1	367	231	0.63	95	0.000086	0.16	3.315	0.051	0.1062	0.0010	0.3012	0.0047	4.360	0.085	0.1050	0.0012	0.796	1697	23	1714	11	-1
23.1	86	42	0.49	44	0.000238	0.43	1.689	0.026	0.2165	0.0013	0.5894	0.0092	17.369	0.296	0.2137	0.0015	0.912	2987	37	2934	6	-2
24.1	465	186	0.40	126	0.000037	0.07	3.164	0.045	0.1078	0.0005	0.3159	0.0045	4.672	0.071	0.1073	0.0005	0.947	1769	22	1754	4	-1
25.1	644	276	0.43	176	0.000055	0.10	3.147	0.044	0.1084	0.0006	0.3174	0.0044	4.714	0.071	0.1077	0.0006	0.919	1777	22	1761	5	-1
26.1	223	157	0.70	81	0.000172	0.31	3.153	0.051	0.1084	0.0007	0.3162	0.0051	4.624	0.085	0.1061	0.0009	0.887	1771	25	1733	8	-2
27.1	237	115	0.48	66	0.000126	0.23	3.075	0.045	0.1092	0.0011	0.3244	0.0048	4.808	0.091	0.1075	0.0013	0.780	1811	23	1757	11	-3
28.1	210	84	0.40	54	0.000119	0.21	3.361	0.046	0.1042	0.0008	0.2969	0.0040	4.197	0.068	0.1025	0.0009	0.836	1676	20	1670	8	0
29.1	164	48	0.29	42	0.000041	0.07	3.349	0.049	0.1064	0.0009	0.2984	0.0043	4.355	0.074	0.1058	0.0009	0.851	1683	22	1729	8	3
30.1	891	429	0.48	192	0.000135	0.24	3.987	0.056	0.1058	0.0004	0.2502	0.0035	3.585	0.054	0.1039	0.0005	0.938	1440	18	1695	5	15
31.1	245	105	0.43	89	0.000051	0.09	2.364	0.035	0.1615	0.0008	0.4226	0.0062	9.372	0.148	0.1608	0.0009	0.936	2272	28	2465	5	8
32.1	392	69	0.18	111	0.000066	0.12	3.034	0.044	0.1108	0.0006	0.3292	0.0048	4.989	0.081	0.1099	0.0008	0.895	1834	23	1798	7	-2
33.1	585	338	0.58	140	0.000176	0.32	3.588	0.050	0.1538	0.0006	0.2778	0.0038	5.806	0.085	0.1516	0.0007	0.945	1580	19	2364	4	33
34.1	149	82	0.55	38	0.000168	0.30	3.343	0.045	0.1077	0.0009	0.2982	0.0041	4.333	0.075	0.1054	0.0011	0.782	1683	20	1721	10	2
35.1	272	122	0.45	75	0.000079	0.14	3.109	0.044	0.1092	0.0007	0.3212	0.0045	4.788	0.075	0.1081	0.0007	0.902	1796	22	1768	6	-2
36.1	116	128	1.10	34	0.000331	0.60	2.968	0.041	0.1179	0.0019	0.3350	0.0047	5.238	0.127	0.1134	0.0022	0.576	1862	23	1855	18	0
37.1	390	107	0.27	110	0.000095	0.17	3.054	0.049	0.1143	0.0006	0.3269	0.0052	5.094	0.086	0.1130	0.0006	0.943	1823	25	1848	5	1
38.1	226	105	0.46	60	0.000110	0.20	3.239	0.044	0.1056	0.0007	0.3081	0.0042	4.424	0.072	0.1041	0.0009	0.838	1731	21	1699	8	-2
39.1	248	149	0.80	67	0.000154	0.28	3.202	0.046	0.1095	0.0006	0.3115	0.0045	4.614	0.075	0.1074	0.0008	0.881	1748	22	1756	7	0
40.1	1033	341	0.33	237	0.000069	0.12	3.742	0.051	0.1077	0.0004	0.2689	0.0036	3.931	0.056	0.1068	0.0004	0.964	1525	19	1746	3	13
41.1	170	113	0.66	33	0.000252	0.45	4.497	0.106	0.1018	0.0011	0.2213	0.0052	3.002	0.083	0.0984	0.0014	0.850	1289	28	1593	14	19
42.1	1497	672	0.45	225	0.000206	0.37	5.715	0.078	0.1004	0.0004	0.1743	0.0024	2.345	0.034	0.0976	0.0005	0.932	1036	13	1578	5	34
43.1	330	142	0.43	85	0.000149	0.27	3.321	0.053	0.1056	0.0006	0.3003	0.0048	4.289	0.077	0.1036	0.0009	0.888	1693	24	1689	8	0
44.1	224	108	0.48	98	0.000070	0.13	1.955	0.028	0.1786	0.0008	0.5108	0.0073	12.521	0.191	0.1778	0.0009	0.941	2660	31	2632	4	-1
45.1	284	123	0.43	74	0.000164	0.30	3.300	0.045	0.1090	0.0007	0.3022	0.0041	4.448	0.071	0.1068	0.0009	0.853	1702	20	1745	8	2
46.1																						