

CONSTRAINING THE PROVENANCE OF MIDDLE CENOZOIC FLUVIAL
SANDSTONE IN THE CENTRAL ROCKY MOUNTAINS USING
DETRITAL ZIRCON U-PB GEOCHRONOLOGY AND
SANDSTONE PETROGRAPHY

by

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Abstract

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The University of Texas at Arlington, 2014

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Detrital zircon U-Pb geochronology and sandstone petrography are studied to constrain the provenance of middle Cenozoic fluvial sandstone in the Central Rocky Mountains. Petrographic point counting of 12 sandstone samples show immature compositions, and combined recycled orogen provenance of the proximal Laramide uplifts and magmatic arc provenance of the distal middle Cenozoic magmatism in western and southwestern North America. A total of 670 detrital zircon U-Pb ages show a 17-44 Ma population, derived from the distal middle Cenozoic magmatism, and populations of 45-218 Ma, 220-708 Ma, 948-1326 Ma, 1332-1816 Ma, and 1825-3314 Ma, derived or recycled from the Precambrian basement cores and the Phanerozoic sedimentary rocks on the flanks of the local Laramide uplifts. Detrital zircon U-Pb geochronology also yield

maximum depositional ages between 37.8 ± 1.1 Ma and 27.3 ± 1.1 Ma for seven sandstone samples. These ages are generally consistent with the available radiometric ages of tuff beds and magnetostratigraphic ages.

Table of Contents

Acknowledgements.....	iii
Abstract.....	iv
List of Illustrations.....	viii
List of Tables	ix
Chapter 1 Introduction.....	1
Geologic Setting	4
Regional Tectonics.....	4
Stratigraphy From Archean To Early Cenozoic	6
Samples And Age Constraints	6
Wasatch Formation	7
White River Formation\Group.....	12
Arikaree Formation\Group.....	13
Browns Park Formation	13
Chapter 2 Methods.....	15
Sandstone Petrography	15
Detrital Zircon U-Pb Geochronology	16
Chapter 3 Results	19
Sandstone Petrography Results.....	19
Detrital Zircon Results.....	21
Chapter 4 Discussion	29

Sandstone Petrography Interpretation.....	29
Detrital Zircon Interpretation.....	30
Major Populations	30
Minor Populations.....	33
Maximum Depositional Age And Chronostratigraphy.....	35
Comparison Of Provenance Data Of The Fluvial Sandstone	37
Implications For Paleogeography	38
Conclusions.....	39
Appendix A Sandstone Petrography Raw Point Counts.....	42
Appendix B Detrital Zircon U-Pb Raw Data	44
References.....	71
Biographical Information.....	89

List of Illustrations

Figure 1-1 Geologic map of North America (A) and study area (B).....	3
Figure 1-2 Chronostratigraphy of the studied strata.	8
Figure 1-3 Chronostratigraphic correlation of the studied sections.....	9
Figure 3-1 Ternary diagrams showing modal framework grain composition of the 12 studied samples.....	21
Figure 3-2 Cumulative probability plot for the studied samples.	22
Figure 3-3 Detrital zircon U/Pb concordia diagram of the studied samples.....	23
Figure 3-4 Normalized probability plot.	24
Figure 3-5 Relative abundance chart of the eight samples.	25
Figure 3-6 Probability of zircon grains of Group F for all samples.....	26
Figure 3-7 Maximum depositional ages of the eight-studied sample.	28

List of Tables

Table 1-1 Sample Location and Age Constraints	10
Table 2-1 Point Count Classification.....	16
Table 3-1 Modal Petrographic Data.....	20
Table 3-2 Zircon Population Ages with Number of Analysis, and Relative Percentage.....	25
Table 3-3 Kolmogorov-Smirnoff Test Results for All Samples	27

Chapter 1

Introduction

The Central Rocky Mountains are an extensive area of high elevation and high relief in Wyoming and its nearby area with mountain peaks as high as 4 km and intervening basins of approximately 1.5 km. The region was in the foreland basin of the thin-skinned Sevier fold-and-thrust belt during the late Jurassic to early Cretaceous, and was partitioned by the thick-skinned Laramide orogeny into a sequence of Precambrian basement-cored uplifts and intermontane basins during the latest Cretaceous to early Eocene (Figure 1-1A) (e.g. Dickinson and Snyder, 1978; DeCelles, 2004; Fan et al., 2011). The tectonic process of the Laramide orogeny has been relatively well studied because the Paleocene and early Eocene fluvial and lacustrine sedimentary rocks are well preserved in the intermontane basins (e.g. Thomas, 1949; Love, 1960; Dickinson et al., 1988; Fan and Carrapa, 2014). However, the middle and upper Cenozoic strata in the Central Rocky Mountains have multiple depositional hiatus, and the total thickness varies between 30 m and 3650 m (e.g. Love, 1960; McMillian et al., 2006; Lillegraven, 1993; Cather et al., 2012). The discontinuity of the middle and late Cenozoic deposition precludes solid regional chronostratigraphic correlation and the reconstruction of paleogeography.

Our current understanding to the paleogeography of the Central Rocky Mountains during the middle and late Cenozoic can be generally placed into two

categories. One view suggests that the Central Rocky Mountains experienced continuous subsidence and sedimentation during the Oligocene-late Miocene based on the thickness of the preserved, but isolated post-Laramide basin fill (McMillian et al., 2006). The other view suggests that the Central Rocky Mountains experienced uplift during the late Eocene based on the widespread hiatus of ~42-36 Ma old in Wyoming (Cather et al., 2012). The first view predicts that the Laramide basement-cored uplifts were almost covered, and the provenance of the middle and upper Cenozoic sedimentary rocks is older Phanerozoic sedimentary rocks and the syndepositional middle Cenozoic magmatism in western North America. The last view predicts that the Laramide uplifts experienced erosion during the middle Cenozoic, and the Precambrian rocks contributed detritus to the middle and upper Cenozoic sedimentary rocks.

Here I study the sandstone petrography and detrital zircon U-Pb geochronology of Oligocene and early Miocene fluvial sandstones in the Central Rocky Mountains and adjacent Great Plains in order to constrain the sediment provenance and the maximum depositional ages of the strata. Data collected in this work improve our understanding of the paleogeography of the Central Rocky Mountains during the middle and late Cenozoic.

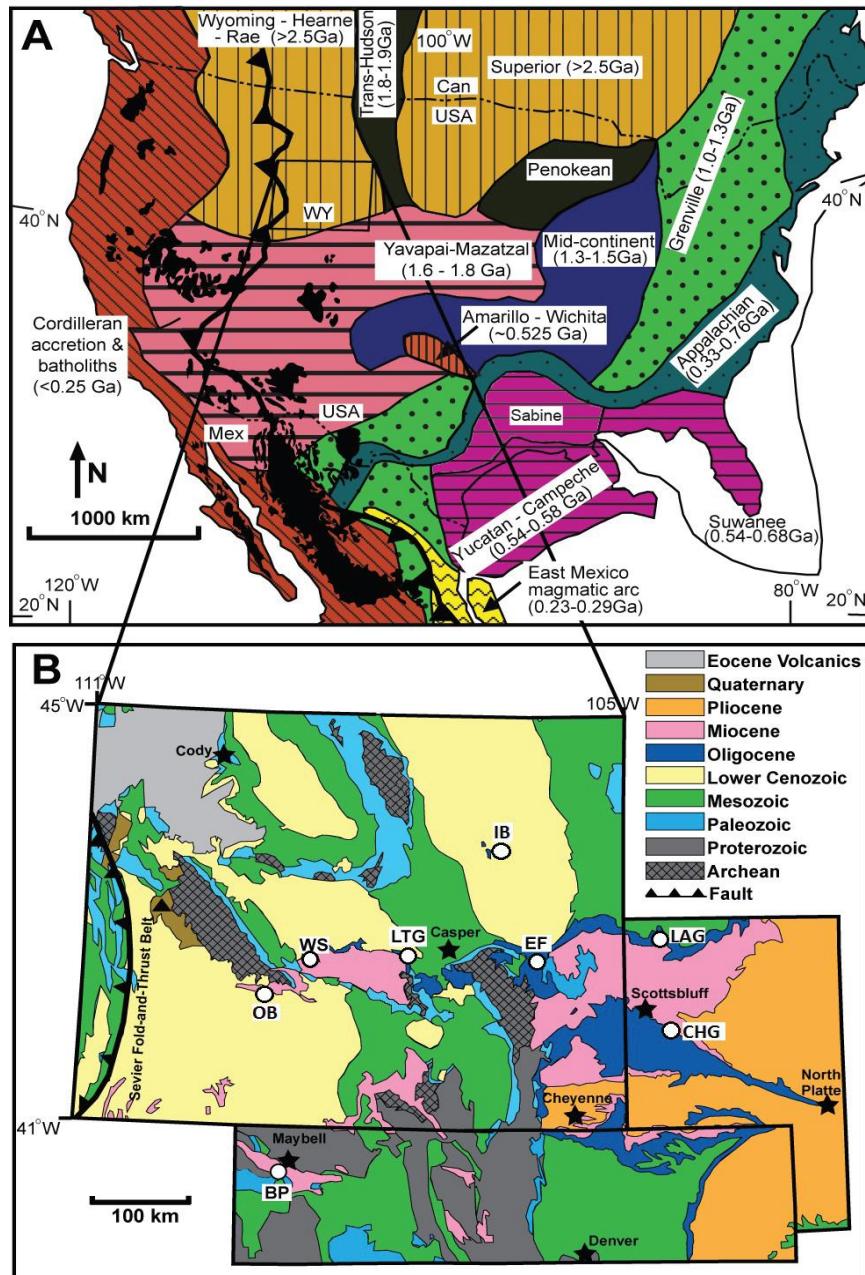


Figure 1-1 Geologic map of North America (A) and study area (B). Major zircon provenances (after Dickinson and Gehrels, 2009; Mackey et al., 2012) (A) and the study area of the Central Rocky Mountains and adjacent Great Plains (B). Black area in (A) represent Cenozoic volcanic fields (after Best et al., 2013) and white dots in (B) represent sample locations. Modified from Rowley (2013).

Geologic Setting

Regional Tectonics

The exposed cores of the mountain ranges in the Central Rocky Mountains are composed of Archean volcanic and metamorphic rocks and Paleoproterozoic metasedimentary rocks (e.g. Frost et al., 2000; Whitmeyer and Karlstrom, 2007) (Figure 1-1A). The Paleoproterozoic basement was sutured to the Archean Wyoming Craton at 1.8-1.6 Ga along the Cheyenne belt in southeastern Wyoming and northern Colorado (Whitmeyer and Karlstrom, 2007; Amato et al., 2008). The continent subsequently experienced multiple continent-continent collisions, including the addition of a Mesoproterozoic craton at 1.55-1.35 Ga and the addition of the Greenville provenance (1.3-0.9 Ga), which resulted in the formation of supercontinent Rodinia (Dickinson, 2004; Whitmeyer and Karlstrom, 2007). Following the breakup of Rodinia (780-550 Ma), the continents of Laurentia and Gondwana collided to form the Appalachian and Ancestral Rocky Mountains on the supercontinent of Pangea (723-385 Ma) (Dickinson et al., 1983; Dickinson and Gehrels, 2003, 2009; Dickinson, 2004). Following the breakup of Pangea, the Antler-Sonoma allochthons were accreted onto the North American continent as accretionary prisms (385-225 Ma) (Dickinson et al., 1983; Dickinson, 2004). Starting in the Late Triassic (~220 Ma), the subduction of the Farallon oceanic plate underneath the western North America continent formed the Cordillera magmatic arc (DeCelles, 2004).

Subduction of the Farallon plate continued into the Cretaceous, and caused crustal shortening and thickening behind the magmatic arc, which formed the Sevier fold-and-thrust belt (~145-75 Ma) and an associated foreland basin in Montana, Wyoming, Colorado, and Utah (Dickinson et al., 1988; DeCelles, 2004). The foreland basin was covered by the Western Interior Seaway during most of its existence until the Maastrichtian (Martin, 1965; Dickinson et al., 1988). From the Maastrichtian to the middle-late Eocene (75-40 Ma), the Laramide orogeny exhumed the Precambrian crystalline basement rock and formed the basement-cored ranges and intermontane basins in the Central Rocky Mountains (Thomas, 1949; Love, 1960; Dickinson et al., 1988). From the middle Eocene (~50 Ma) on, volcanism in the western North America was very active and provided large volumes of volcaniclastics (Love, 1960; Steidtmann et al., 1989). During the Oligocene, the establishment of a major drainage system in Wyoming with an eastward flow caused extensive erosion of the high mountains in the Central Rocky Mountains (Love, 1960). Both the intermontane basins and intervening mountain ranges in the Central Rocky Mountains experienced dynamic uplift caused by mantle upwelling associated with the opening of the Rio Grande Rift during the late Miocene (Heller et al., 2003; McMillian et al., 2006). Pliocene global cooling and seasonal melting of glacier and snow may have played a large role in excavating the upper Cenozoic strata (Pelletier, 2009).

Stratigraphy From Archean To Early Cenozoic

Archean granitic crystalline rocks are exposed on most of the Laramide ranges in Wyoming (Love and Christiansen, 1985). Neoproterozoic metasedimentary rocks are exposed on the Uinta Mountains in northeast Utah and the Black Hills in South Dakota (Love and Christiansen, 1985). Paleozoic carbonate and lower Mesozoic siliciclastic sedimentary rocks, with thicknesses of 1.5-2 km, are exposed along the flanks of the Laramide uplifts bounding the intermontane basins (Thomas, 1949; Love and Christiansen, 1985; DeCelles, 2004). The lower Mesozoic sedimentary rocks include sandstone, shale, and carbonate deposited in eolian, fluvial, and marine environments (Condra and Reed, 1943; Picard, 1993; Snocke, 1993). Cretaceous sedimentary rocks include fluvial and marginal-marine conglomerate, sandstone, siltstone, and shale, with minor amounts of marine carbonates. These rocks are exposed along the flanks of the Laramide uplifts (Love and Christiansen, 1985) (Figure 1-1B). During the latest Cretaceous-early Cenozoic, Laramide intermontane basins were filled with fluvial and lacustrine conglomerate, sandstone, siltstone and shale that are generally quartzolithic to feldspathic (Dickinson et al., 1988).

Samples And Age Constraints

I collected ten sandstone samples from the Oligocene and Miocene strata in the Central Rocky Mountains and the adjacent Great Plains and two samples from the early Eocene Wasatch Formation in the Pumpkin Buttes, Powder River

Basin for detrital zircon U-Pb geochronology and sandstone petrography studies.

Table 1 is a list of the samples with the location and age constraints, Figure 1-2 is the generalized chronostratigraphy of the studied area, and Figure 1-3 is the chronostratigraphic relationship of the sampled stratigraphic sections.

Wasatch Formation

The Wasatch Formation has an estimated thickness of over 600 m in the Pumpkin Buttes, Powder River Basin (Love, 1952; Sharp and White, 1956; Zeller and Stephens, 1968). The formation is of lacustrine and fluvial depositional environment and contains interlayered purple, grey, and brown claystone and carbonaceous shale, thin coal beds, and light yellow and tan sandstone and conglomerate (Love, 1952; Sharp and White, 1956; Zeller and Stephens, 1968). The sandstone is typically poorly sorted, fine- to coarse-grained, and calcite cemented. The coarse-grained sandstone and conglomerates contain trough cross-stratifications (Love, 1952; Sharp and White, 1956; Zeller and Stephens, 1969; Love and Christiansen, 1985). The Wasatch Formation in the Pumpkin Buttes area is of early Eocene age based on the study of vertebrate, leaves, pelecypod, and gastropod fossils (Love, 1952; Zeller and Stephens, 1969). The formation has no radiometric or magnetostratigraphic ages in the Pumpkin Buttes area. My samples were collected from unit 6 of the measured section Ll-66 following Love (1952).

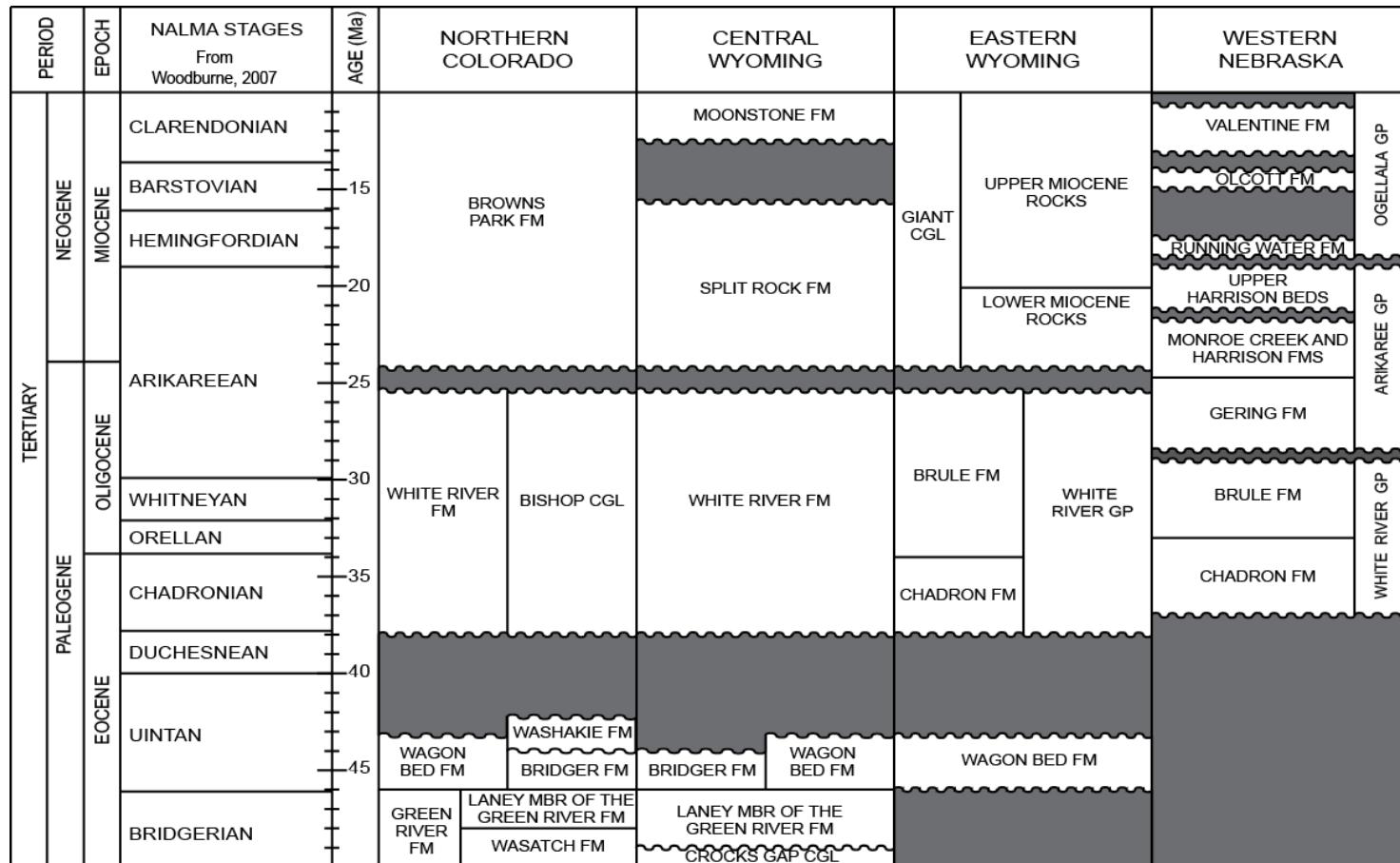


Figure 1-2 Chronostratigraphy of the studied strata.

Northern Colorado: Modified from AAPG COSUNA CSD 535 COL14; Central Wyoming: Modified from AAPG COSUNA CSD 535 COL 9; Eastern Wyoming: Modified from AAPG COSUNA CSD 540 COL 10; Western Nebraska: Modified from Swinehart et al., 1985

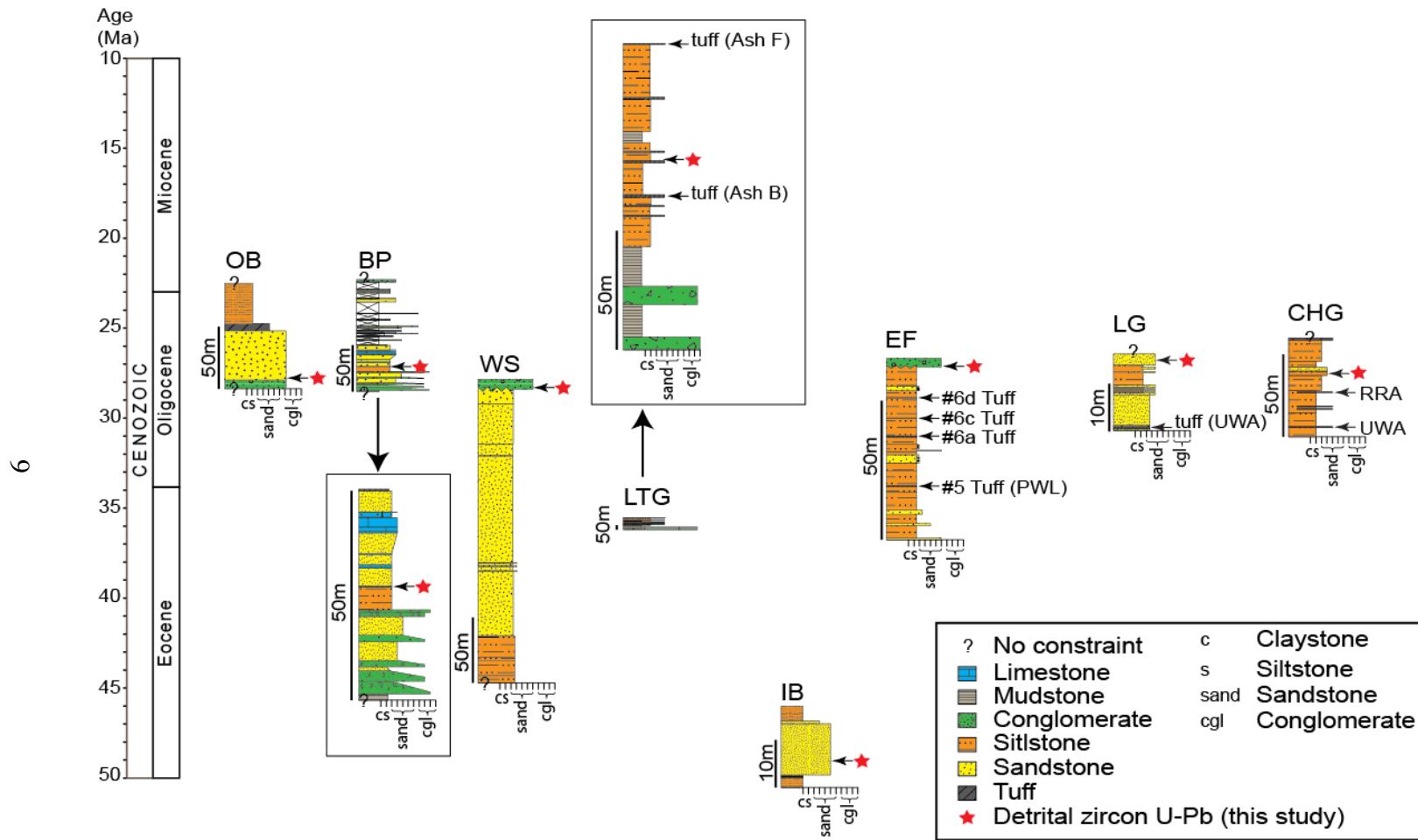


Figure 1-3 Chronostratigraphic correlation of the studied sections.

Table 1-1 Sample Location and Age Constraints

Sample Name	Formation Name	GPS Location		Age Constraint				
		Lat. (°N)	Long. (°W)	NALMA	Radiometric age (Ma)	Magnetostratigraphy (Ma)	Max Depo. Age (Ma)	Number of zircons
IB-Base	Wasatch	43.728	-105.867	Early to Middle Wasatchian (Lillegraven, 1993)	No Constraints	No Constraints	74.2 ± 2.1	6
LTG-80	White River	42.648	-106.758	Middle Chadronian (Emry, 1973, 1992; Swisher and Prothero, 1990; Prothero and Emry, 2004)	40Ar/39Ar age Ash B: 35.92 ± 0.34 [biotite] and 35.97 ± 0.45 [anor]; Ash F: 35.72 ± 0.38 [biotite] and 35.81 ± 0.09 [anor] (Swisher and Prothero, 1990)	Chrons C15n-C15r [34.7-35.7] (Prothero and Emry, 2004)	37.8 ± 1.0	6
LG-30SS	Brule	42.823	-103.585	Orellan (Swisher and Prothero, 1990)	40Ar/39Ar age LWA: 31.85 ± 0.01 [biotite], 31.81 ± 0.03 [anor], 31.67 ± 0.16 [plag]; UWA: 30.58 ± 0.18 [biotite] (Swisher and Prothero, 1990)	Chrons C13r [33.7-34.7] (Prothero and Emry, 2004)	34.7 ± 0.5	10

Table 1-1 *Continued*

Sample Name	Formation Name	GPS Location		Age Constraint				
		Lat. (°N)	Long. (°W)	NALMA	Radiometric age (Ma)	Magnetostratigraphy (Ma)	Max Depo. Age (Ma)	Number of zircons
EF-2TopCg ^[1]	White River	42.709	-105.360	Late Whitneyan to Early Arikareean (Evanoff, 1990)	40Ar/39Ar dates: tuff 5 equivalent to PWL: 33.91 ± 0.1 [biotite] (Swisher and Prothero, 1990); 40Ar/39Ar dates: tuff 5 33.6 ± 1.2 ; tuff 6a: 31.24 ± 0.06 ; tuff 7: 30.7 ± 0.6 ; High Precision Zircon U-Pb dates: tuff 5: 34.0 ± 0.2 ; tuff 6a: 31.2 ± 0.1 ; tuff 7: 32.9 ± 0.2 (Scott and Bowring, 2000)	No Constraints	33.6 ± 0.7	6
CHG-18	Gering	41.597	-103.118	Arikareean (Swisher and Prothero, 1990; Lillegraven, 1993)	40Ar/39Ar dates RRA: 28.59 ± 0.96 [biotite]; UWA: 30.58 ± 0.61 [biotite] (Swisher and Prothero, 1990)	No Constraints	32.8 ± 3.0	3
WS-225	White River	42.623	-108.275	Chadronian to Orellan (Van Houten, 1964)	No Constraints	Chrons C13r-C15r [34-35.3] (Prothero and Sanchez, 2004)	28.3 ± 1.1	4
OB-Base	Arikaree	42.262	-108.768	Arikareean (Lillegraven, 1993)	Zircon Fission-Track ages 27.4 ± 3.1 and 28.2 ± 3.1 (Steidtmann and Middleton, 1986)	No Constraints	27.8 ± 0.7	15
BP-27	Browns Park	40.610	-108.330	Hemingfordian to Early Clarendonian (Honey and Izett, 1988)	Zircon fission track age 9.9 ± 0.4 (Naser et al., 1980); K-AR age 24.0 ± 0.8 [biotite] (Izett, 1975);	No Constraints	27.3 ± 1.0	5

White River Formation\Group

The White River Formation ranges from 30 m to 245 m thick in Wyoming (Condra and Reed, 1943; Love, 1952; Sharp and White, 1956; Emry, 1973; Evanoff, 1990). The formation transits from interlayered tuffaceous arkosic conglomerate, sandstone, siltstone, and mudstone deposited in fluvial depositional environments to massive, fine-grained sandstone deposited in eolian environment (Van Houten, 1964; Emry, 1973, 1975; Evanoff, 1990). Fluvial sandstone samples were collected from the WS, LTG, and EF sections. The LTG and EF sections contain multiple ash beds that have been dated as latest Eocene-early Oligocene based on anorthoclase and biotite $^{40}\text{Ar}/^{39}\text{Ar}$ radiometric dating (Swisher and Prothero, 1990; Scott and Bowring, 2000).

The White River Group in western Nebraska is equivalent to the White River Formation in Wyoming. The group consists of the Chadron and Brule formations (LaGarry, 1998). The older Chadron Formation contains a basal unit of fine- to coarse-grained sandstone with minor amount of conglomerate and an upper unit of interlayered siltstone and claystone (Condra and Reed, 1943; Swinehart et al., 1985). Samples of the LG section were collected from the basal sandstone and the ages are estimated to be earliest Oligocene based on mammal fossils and anorthoclase, biotite, and plagioclase $^{40}\text{Ar}/^{39}\text{Ar}$ radiometric dating of ash beds (Van Houten, 1964, Emry, 1973; Swisher and Prothero, 1990, LaGarry, 1998).

Arikaree Formation\Group

The thickness of the Arikaree Formation ranges from 46 m to 243 m in the Oregon Buttes area (Vondra et al., 1969; Zeller and Stephens, 1969). The formation is of fluvial depositional environment and contains a basal conglomerate unit and an upper unit of interlayered tuffaceous sandstone, siltstone, ash, and moss-agate (Zeller and Stephens, 1969). Samples of the OB sections were collected from measured section 6 following Zeller and Stephens (1969), and the ages are estimated to be Oligocene based on zircon fission-track dating (Steidtmann and Middleton, 1986).

The Arikaree Group in western Nebraska is equivalent to the Arikaree Formation in Wyoming. The group consists of the Gering Formation, Monroe Creek Formation, and Harrison Formation (Condra and Reed, 1943; Vondra et al., 1969). The older Gering Formation contains interlayered fine- to coarse-grained, well- to poorly-sorted sandstone, siltstone, and conglomerate with occasional cross-stratification (Condra and Reed, 1943; Vondra et al., 1969). Samples of the CHG section were collected from the basal sandstone and the ages are estimated to be Miocene based on mammal fossils (Condra and Reed, 1943).

Browns Park Formation

The Browns Park Formation distributed in northwestern Colorado is estimated to have a thickness of more than 555 m (Hansen, 1986; Honey and Izett, 1988). The Formation contains a basal conglomerate and an upper unit of

interlayered planar- to cross-stratified, fine- to medium- grained sandstone, siltstone, mudstone, and ash deposited in eolian and fluvial depositional environments (Hansen, 1986, Honey and Izett, 1988). Samples of the BP section were collected from a measured section west of Craig, Colorado (Majie Fan, unpublished data), and the ages are estimated to be Miocene based on biotite K-Ar and zircon fission-track dating (Izett et al., 1970; Naeser et al., 1980).

Chapter 2

Methods

Sandstone Petrography

Standard thin sections of 12 sandstone samples were examined using a Leica polarizing petrographic microscope. Nine slides were stained for potassium-feldspar and plagioclase identification and three slides were not stained. At least 350 grains in eight of the samples were counted to create modal compositions by using the Gazzi-Dickinson point counting method (Ingersoll et al., 1984; Dickinson, 1985). This method only counts grains larger than silt size (>0.0625 mm). 250 or less grains were counted for the four remaining samples because the grain sizes of most grains are smaller than <0.0625 mm. These four samples include LTG-156 (88 grains), CHG-5 base (170 grains), LG-25WB (34 grains), and WS-230 (250 grains). Framework grains are categorized based on the parameters in Table 2-1 and raw point count data are provided in Appendix A. The data are plotted on a sandstone classification QtFL ternary diagram following Folk (1974, 1980), a QmFLt and QmPK ternary diagram that focuses on source rock to identify potential provenance following Dickinson and Suczek (1979), Dickinson et al. (1979; 1983), and Dickinson (1985) (Figure 3-1).

Table 2-1 Point Count Classification

Symbol	Description
C	Chert
Qm	Monocrystalline Quartz
Qp	Polycrystalline Quartz
Qt	Total Quartz (C + Qm + Qp)
K	Alkali Feldspar
P	Plagioclase
F	Total Feldspar (K + P)
Lss	Siltstone Lithic
Lsh	Mudstone Lithic
Lc	Carbonate Lithic
Lm	Metamorphic Lithics
Lvi	Volcanic Lithics (mafic and felsic)
Lvv	Vitric Volcanic Lithics
Lv	Total Volcanic Lithics (Lvi + Lvv)
Ls	Total Sedimentary Lithics (Lss + Lsh + Lc + C)
Lt	Total Lithics (Ls + Lv + Lm + Qp)
L	Total non-quartzose Lithics (Ls + Lc + Lv)
Acc	Accessory Minerals

Note: Accessory Minerals: biotite, chlorite, hematite, hornblende, glauconite, magnetite, and zircon

Detrital Zircon U-Pb Geochronology

Eight sandstone samples were processed for detrital zircon U-Pb geochronology study. Following crushing and grinding of the bulk samples, zircons were separated using a washing pan, a Frantz magnetic separator, and heavy liquids. Zircon grains were analyzed on a laser ablation-inductively coupled plasma-mass spectrometer (LA-ICP-MS) at the University of Arizona

LaserChron Center following the method outlined by Gehrels (2011). A minimum of 100 randomly selected zircon grains from each sample were analyzed. The ages and concentrations of two mineral standards (R33 and SL2) were measured after every five-sample analysis for checking and correcting of isotope ratios (Gehrels et al., 2008). A Photon Machines Analyte G2 excimer laser with a spot diameter of 30 μm for large grains and 25 μm for smaller grains was used to ablate each selected zircon 12 to 15 μm in depth. The ablated material was transported into the Nu HR ICPMS plasma source using helium as a carrier gas and then entered a flight tube where Faraday detectors measure the isotopes. The Faraday detectors measure ^{238}U , ^{235}U , ^{206}Pb , ^{207}Pb , ^{204}Pb , and Thorium and Mercury isotopes (Dickinson and Gehrels, 2009; Gehrels, 2011).

Age determinations of zircons are based on $^{206}\text{Pb}/^{238}\text{U}$ ratios for grains younger than 1000 Ma and $^{206}\text{Pb}/^{207}\text{Pb}$ ratios for grains older than 1000 Ma (Dickinson and Gehrels, 2009). Discordance of zircon U-Pb ages occurs due to Pb loss, inheritance, and overgrowths. Individual grain ages were filtered by 30% discordance. Broader discordance tolerances were used for younger grains due to the inherent inaccuracy in the measurement of $^{207}\text{Pb}^*$ in young grains, which often exceeds the analytical uncertainty of the measurement. Age groups were determined by identifying three or more grains with overlapping $^{206}\text{Pb}^*/^{238}\text{U}$ or $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ages in the aggregated data set. After filtering the data for discordance, the concordant data were used to generate concordia diagrams

(Figure 3-3) and cumulative and normalized probability (Figure 3-2 and Figure 3-4) using Isoplot version 4.15 (Ludwig, 2012). The weighted average of three or more overlapping youngest zircon ages of the eight samples were obtained to constrain the maximum age of deposition. The weighted mean age, uncertainty and MSWD were considered to objectively determine the appropriate age clusters, with a MSWD value of one indicative of the degree of scatter being consistent with analytical precision (Gehrels, 2009 and 2010). Raw data is included in Appendix B.

Chapter 3

Results

Sandstone Petrography Results

Sand grains in the studied samples range from well to poorly sorted, very fine- to coarse-grained, round to sub-angular. The samples are cemented predominantly by micritic calcite with minor amount of spar. Sandstone framework grains include polycrystalline and monocrystalline quartz, potassium-feldspar, plagioclase, and sedimentary, volcanic, and metamorphic lithic fragments. Primary accessory minerals include biotite, chlorite, hematite, hornblende, glauconite, and zircon. Based on Folk's (1974, 1980) classification, five samples are litharenite, five sample are feldspathic litharenite, one is lithic arkose, and one is arkose (Figure 3-1). On average, the two early Eocene IB samples contain 57% total quartz, 36% total non-quartzose lithics, and 10% of feldspar, and the 10 Oligocene-Miocene samples contain 40% total quartz, 39% total non-quartzose lithics, and 18% feldspar. On QmFLt plot, samples are in the range of recycled orogeny and magmatic arc categories. The sandstone samples have low K/P ratios with feldspars predominately plagioclase. Lithics are primarily sedimentary and volcanic, with sedimentary lithics varying between 0.0% and 44% and volcanic lithics varying between 5.5% and 31.2% (Table 3-1). Overall, the composition of the early Eocene IB sample is more mature than the Oligocene-Miocene samples.

Table 3-1 Modal Petrographic Data

Sample	C (%)	Qp (%)	Qm (%)	K (%)	P (%)	Lss (%)	Lsh (%)	Lc (%)	Lvi (%)	Lv v (%)	Ac c (%)
IB-Base	9.8	15.9	29.3	0.0	5.4	13. 9	5.4	4.9	6.9	0.0	8.5
IB-3	4.8	15.8	38.7	9.4	5.7	6.6	3.9	0.0	10. 1	0.0	5.0
LTG-80	7.7	7.2	34.4	4.6	17. 7	2.0	9.2	2.2	9.2	0.0	5.9
LTG-156	3.4	2.3	20.5	1.1	10. 2	25. 0	12. 5	0.0	12. 5	4.5	8.0
CHG-5 base	5.4	10.3	28.4	0.0	16. 0	7.2	9.8	0.0	5.9	4.6	12. 4
CHG-2 base	11.2	6.5	20.0	0.0	10. 0	0.0	10. 6	0.0	27. 1	4.1	10. 6
LG-25WB	11.8	2.9	29.4	0.0	5.9	8.8	2.9	0.0	8.8	20. 6	8.8
EF- 2TopCgl	7.3	5.6	28.5	6.5	24. 4	0.0	0.0	0.0	19. 4	0.0	8.2
WS-225	10.5	8.1	40.9	0.0	15. 3	0.0	5.7	0.0	4.6	0.9	14. 0
WS-230	4.0	2.4	13.2	0.0	8.4	44. 0	0.0	0.0	10. 4	1.2	16. 4
OB-Base	10.4	4.8	18.6	3.3	13. 0	7.4	4.8	0.0	20. 7	0.0	17. 0
BP-27	8.5	3.3	29.7	3.9	41. 5	0.0	0.0	0.0	5.5	0.0	7.6

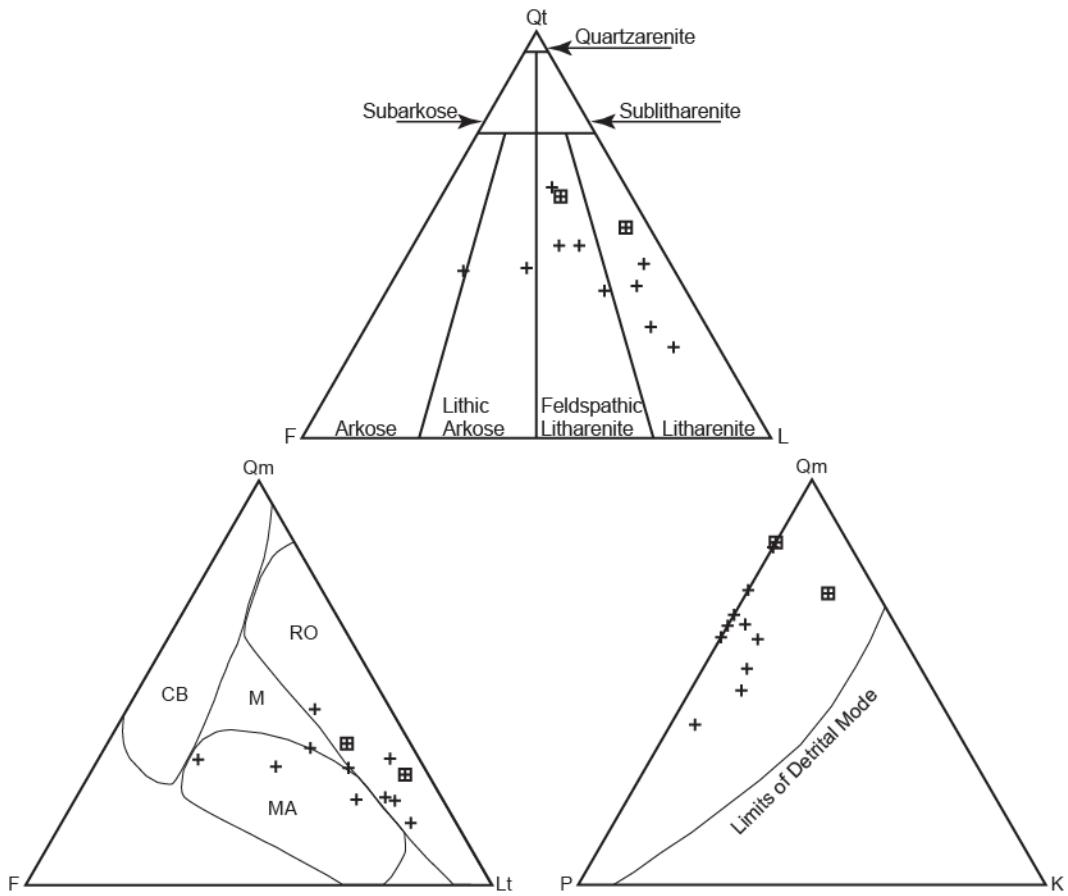


Figure 3-1 Ternary diagrams showing modal framework grain composition of the 12 studied samples. Cross symbol represents Oligocene-Miocene samples and Square with cross symbol represents Eocene samples. CB – Continental Block, M – Mixed, MA – Magmatic Arc, and RO – Recycled Orogen. Data are listed in Table 3-1.

Detrital Zircon Results

A total of 150 analyses were filtered from further analysis, including 68 grains for high ^{204}Pb , 42 grains for high $^{206}\text{Pb}/^{238}\text{U}$ error, 16 grains for low $^{206}\text{Pb}/^{204}\text{Pb}$ error, 15 grains for reverse discordance, seven grains for discordance, and two grains for high $^{206}\text{Pb}/^{237}\text{U}$ error. The cumulative probability plot and

concordance diagram of the remaining 670 zircon grains of the eight samples are shown in Figure 3-2 and Figure 3-3. These zircons have ages varying between 25.5 Ma and 3321.9 Ma and are classified into six major age populations (A- F). Group F (44-24 Ma) is of 11.5%, Group (220-45 Ma) is of 7.3%, Group D (708-225 Ma) is of 5.4%, Group C (1326-900 Ma) is of 15.7%, Group B (1820-1332 Ma) is of 42.1%, and Group A (3400-1825 Ma) is of 18.1% of the total grains (Table 3-2). A chart showing the percent abundance for each sample is shown in Figure 3-5 and probability of zircon grains for Group F in Figure 3-6.

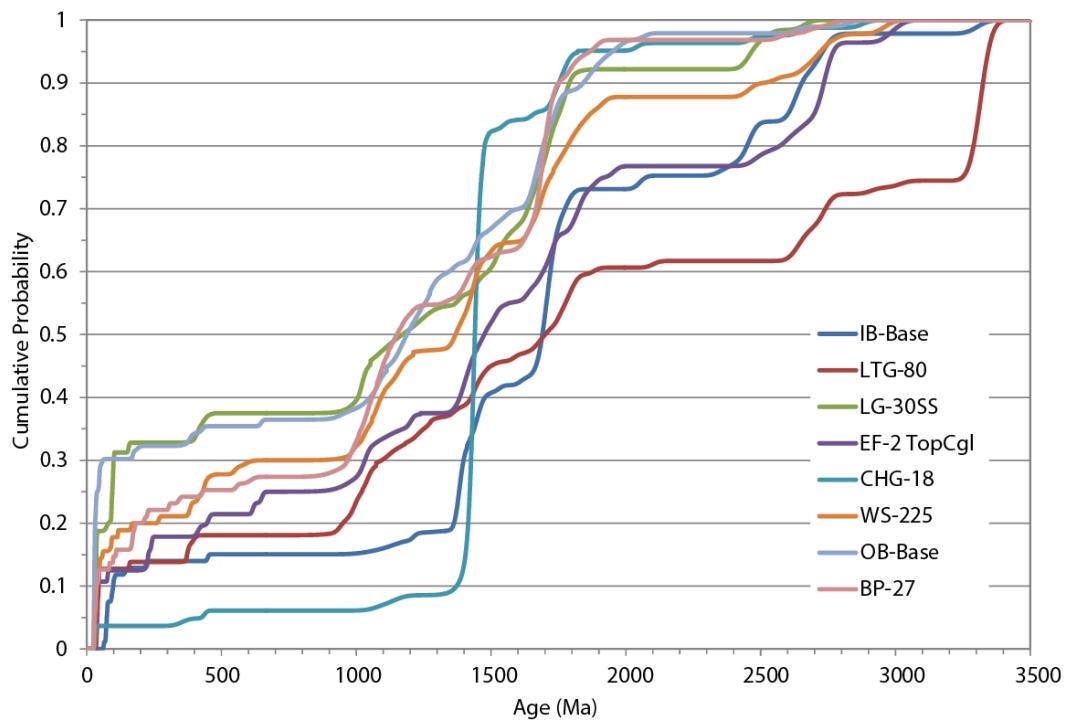


Figure 3-2 Cumulative probability plot for the studied samples.

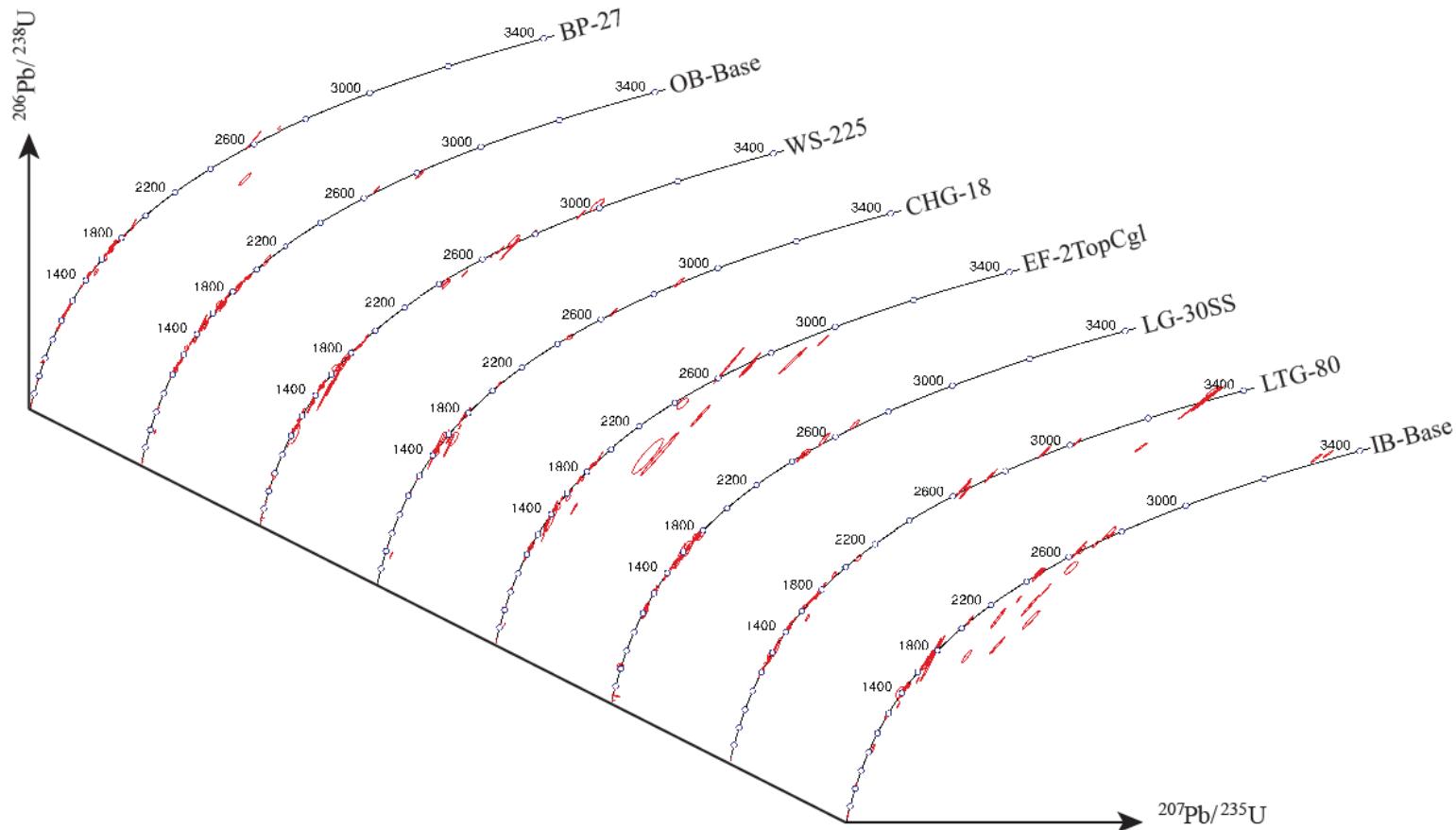


Figure 3-3 Detrital zircon U/Pb concordia diagram of the studied samples.
Red error ellipses are plotted at the 2σ uncertainty. Rejected grains are not included.

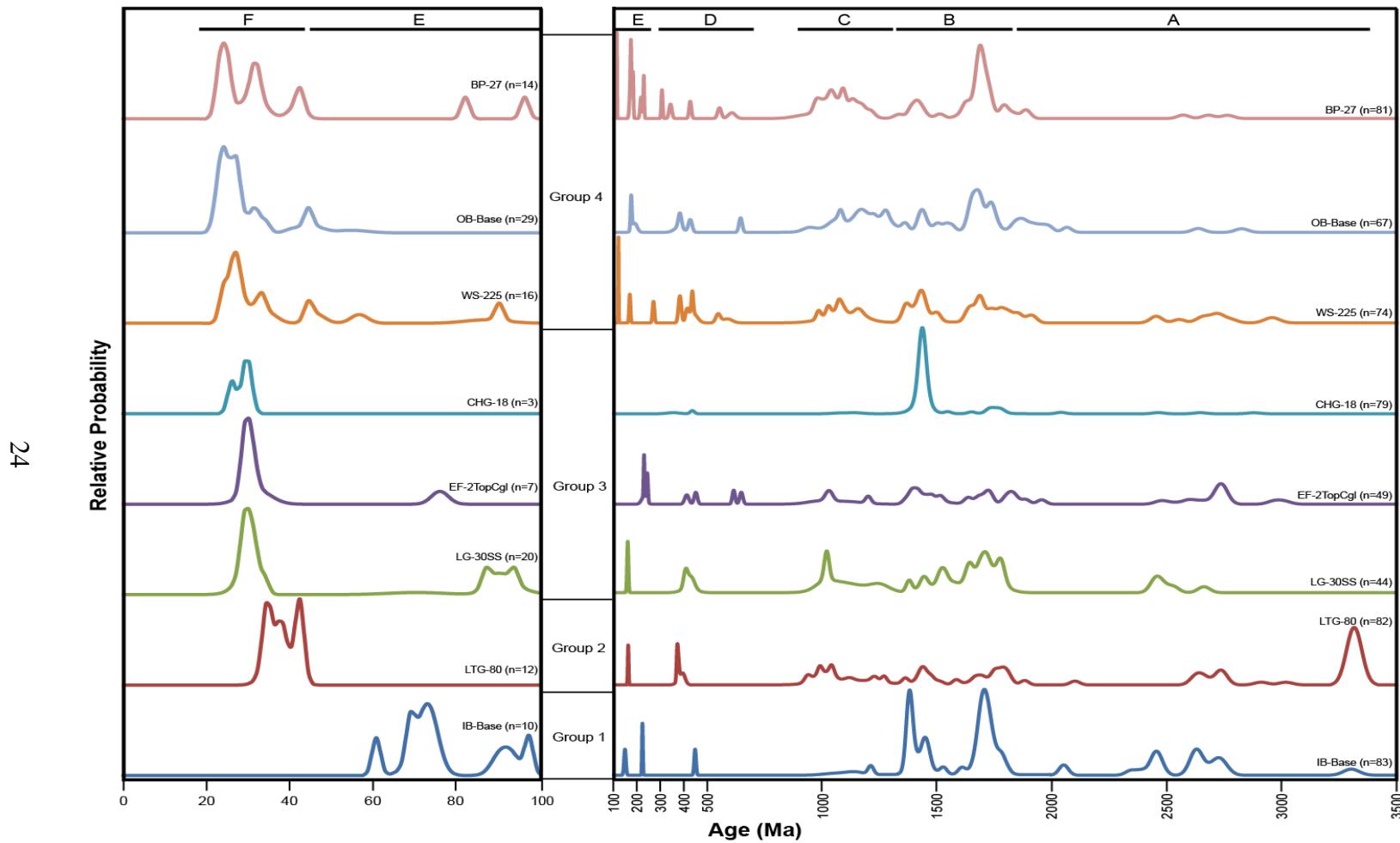


Figure 3-4 Normalized probability plot.
A-F define age groups discussed in text.

Table 3-2 Zircon Population Ages with Number of Analysis, and Relative Percentage.

Group	Age Range (Ma)	Total Number of Grains	Relative Percentage
F	44-24	77	11.5
E	220-45	49	7.3
D	708-225	36	5.4
C	1326-900	105	15.7
B	1820-1332	282	42.1

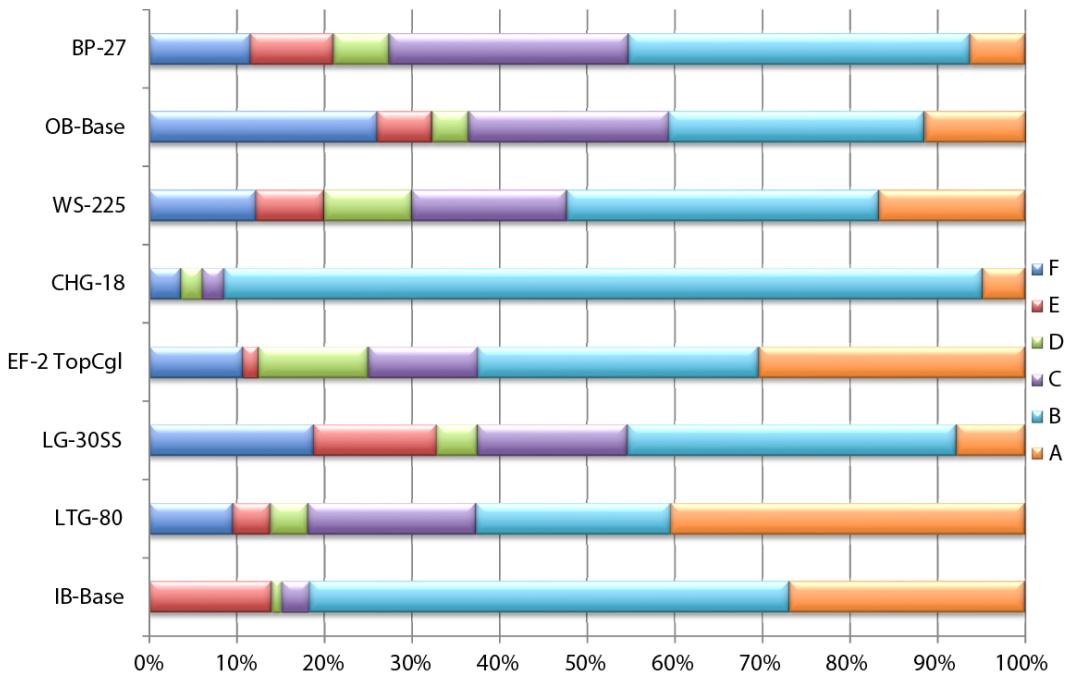


Figure 3-5 Relative abundance chart of the eight samples.

A	3400-1825	121	18.1

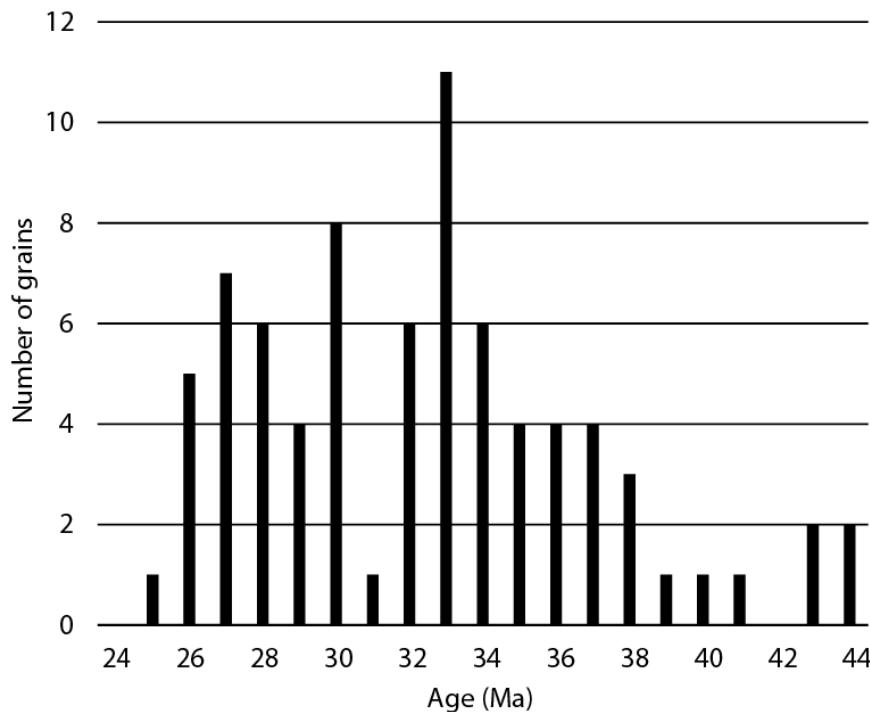


Figure 3-6 Probability of zircon grains of Group F for all samples.

The maximum depositional ages of the eight samples are calculated from the weighted mean of more than three youngest grains, and reported with a MSWD (Figure 3-7). The eight samples are subdivided into four groups based on the maximum depositional age. Group 1 includes IB-Base only, which has a maximum depositional age (74.2 ± 2.2 Ma, $n=6$, MSWD=0.6) that is at least 15 Ma older than the estimated depositional age. Group 2 is of late Eocene age, and only includes LTG-80 which has a maximum depositional age of 37.8 ± 1.1 Ma ($n=6$, MSWD=0.8). Group 3 is of early Oligocene age, and includes LG-30SS, EF-2TopCgl, and CHG-18. LG-30SS has a maximum depositional age of 34.7 ± 0.6 ($n=10$, MSWD=0.8), EF-2TopCgl has a maximum depositional age of 33.6 ± 0.8

(n=6, MSWD=0.7), and CHG-18 has a maximum depositional age of 32.8 ± 1.1 Ma (n=3, MSWD = 1.9). Group 4 is of late Oligocene age, and includes WS-225, OB-Base, and BP-27. WS-225 has a maximum depositional age of 28.3 ± 1.2 Ma (n=4, MSWD=0.9), OB-Base has a maximum depositional age of 27.8 ± 0.8 Ma (n=15, MSWD=0.9), and BP-27 which has a maximum depositional age of 27.3 ± 1.1 (n=5, MSWD=0.8).

The Kolmogorov-Smirnoff (K-S) test shows the statistical relationship among my samples (Table 3-3). P-values ≤ 0.05 indicates the grain populations of two compared samples were from different sources with $\geq 95\%$ confidence, thus the provenances of the two samples are statistically distinguishable. Samples LTG-80 and CHG-18 do not match any other samples based on this test. Samples IB-Base only matches sample EF-2TopCgl with a P-value of 0.18, and the rest of the samples have P-values between 0.05 and 0.73.

Table 3-3 Kolmogorov-Smirnoff Test Results for All Samples

	IB- Base	LTG- 80	LG- 30SS	EF- 2TopCgl	CHG- 18	WS- 225	OB- Base	BP- 27
IB-Base	0.00		0.00	0.18	0.00	0.00	0.00	0.00
LTG-80	0.00		0.00	0.02	0.00	0.00	0.00	0.00
LG-30SS	0.00	0.00		0.05	0.00	0.45	0.73	0.23
EF- 2TopCgl	0.18	0.02	0.05		0.00	0.46	0.05	0.02
CHG-18	0.00	0.00	0.00	0.00		0.00	0.00	0.00
WS-225	0.00	0.00	0.45	0.46	0.00		0.23	0.41
OB-Base	0.00	0.00	0.73	0.05	0.00	0.23		0.11
BP-27	0.00	0.00	0.23	0.02	0.00	0.41	0.11	

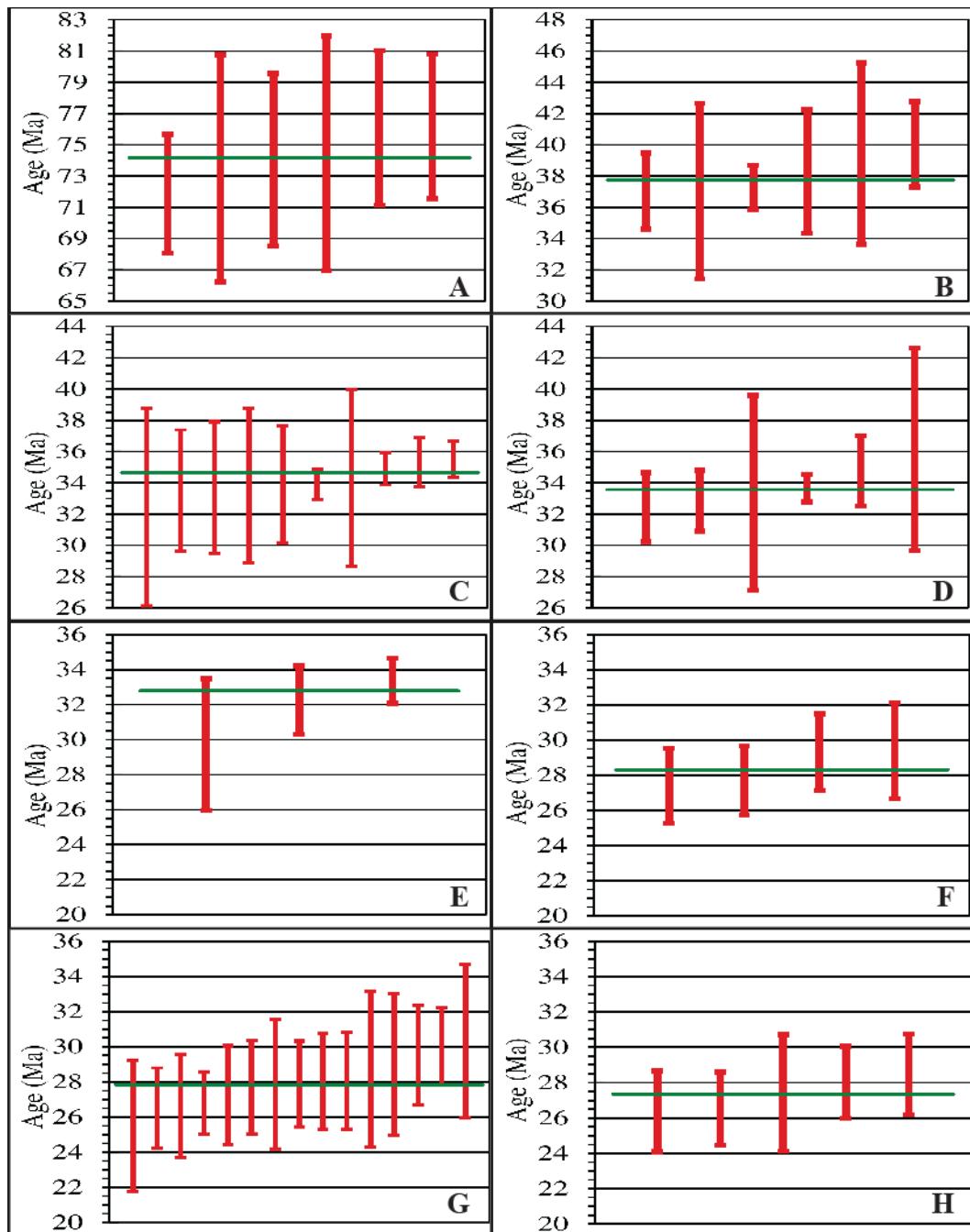


Figure 3-7 Maximum depositional ages of the eight-studied sample.
 A-H represent IB-Base, LTG-80, LG-30SS, EF-2TopCgl, CHG-18, WS-225, OB-Base, and BP-27. See text for maximum depositional age, MSWD, and number of grains.

Chapter 4

Discussion

Sandstone Petrography Interpretation

Sandstone samples have framework grain composition in the range of recycled orogen and magmatic arc categories (Figure 3-1 QmFLt) (Dickinson and Suczek, 1979). Source of recycled orogen in the study area includes the Laramide basement-cored uplifts that contain Archean and Proterozoic basement rocks, and Phanerozoic sedimentary rocks (Love and Christiansen, 1985). The magmatic arc source includes the middle Cenozoic magmatism in western and southwestern North America (e.g. McIntosh et al., 1992; Ferrari et al., 2007; Best et al., 2013). The high content of feldspar and lithics show that these Eocene-early Miocene fluvial sandstone samples have low maturity. Sedimentary lithic grains were recycled from the Phanerozoic strata distributed along the flanks of the Laramide uplifts. The volcanic lithic grains, particularly volcanic glass, were sourced from young volcanic eruptions in western and southwestern North America (e.g. McIntosh et al., 1992; Ferrari et al., 2007; Best et al., 2013). The abundance of monocrystalline quartz was the result of recycling of the underlying quartzose units, specifically the Mesozoic sandstones including the Triassic and Jurassic eolianites (Dickinson and Gehrels, 2003). The polycrystalline quartz grains were mainly derived from the Precambrian crystalline basement cores, which experienced metamorphosis before the Cambrian (Love and Christiansen, 1985).

The chert grains were recycled from the Paleozoic and Mesozoic marine limestone units (Love and Christiansen, 1985). The feldspar grains can be derived from both the Precambrian basement and middle Cenozoic magmatism. The Precambrian basement is predominantly granite and gneiss (Love and Christiansen, 1985), thus should provide plagioclase to the sandstone. The middle Cenozoic magmatism are both mafic and felsic (Walker, D., 2014), thus is the provenance of both plagioclase and K-feldspar. The low K/P ratio suggest that the feldspar grains were derived mainly from the middle Cenozoic magmatism. The overall sandstone compositions suggest that the sand grains in the middle Cenozoic fluvial sandstone were derived from proximal basin-bounding Laramide uplifts consisting of Phanerozoic sedimentary strata and Precambrian crystalline basement, and distal middle Cenozoic magmatism in the western and southwestern U.S.A..

Detrital Zircon Interpretation

Major Populations

Major zircon populations include Groups A, B, and C. Sources of Group A are the Archean Wyoming craton, Hearne, Rae, and Superior provenances (> 2500 Ma) and the Paleoproterozoic Trans-Hudson (1900-1800 Ma), and Penokean (~1850 Ma) provenances (Figure 1-1A) (e.g. Frost et al., 2000; Dickinson and Gehrels, 2009). The study area lies above the Archean Wyoming craton, which was exposed in the cores of the Laramide ranges during the Laramide orogeny

(Whitmeyer and Karlstrom, 2007). Therefore, grains of Archean age may be directly from the Laramide ranges. Most of the studied samples have low abundance of Archean zircons (<21.5%), suggesting direct zircon contribution from the Archean basement rocks is small. Sample LTG-80 has a small zircon population of ~3300 Ma (Figure 3-4). This sample was collected from the edge of the Granite Mountains, and the zircon grains may be directly from erosion of Archean basement. Hearne, Rae, and Superior provenances are exposed in northeastern to northwestern North America (Dickinson and Gehrels, 2003; Whitmeyer and Karlstrom, 2007). The Trans-Hudson and Penokean provenances were formed when the Archean Wyoming craton, Hearne, Rae, and Superior provenances collided and are exposed in northeastern to north-central North America (Hoffman, 1988; Ross and Villeneuve, 2003; Whitmeyer and Karlstrom, 2007). Although these sources are not exposed in the study area, Phanerozoic siliciclastic rocks in western U.S.A. commonly contain zircons of Group A (e.g., Dickinson and Gehrels, 2003; LaMaskin, 2010; May et al., 2013), suggesting the zircon grains of Group A must have been predominantly derived from the erosion of the Phanerozoic sedimentary rocks.

Group B has original sources in the Yavapai-Mazatzal orogeny (1820-1600 Ma), the Gawler craton (1590-1500 Ma), and granite-rhyolite province of midcontinent North America (1500-1332 Ma) (Van Schmus et al., 1992; 1996; Doughty et al., 1998; Karlstrom et al., 2004; Whitmeyer and Karlstrom, 2007;

Amato et al., 2008). The Yavapai-Mazatzal provenance was sutured to the Archean Wyoming craton along the Cheyenne belt during the Paleoproterozoic, and was exposed along the Rocky Mountains, but in the states south of Wyoming, by the Laramide orogeny and Ancestral Rocky Mountains orogeny (Condie, 1982; Hoffman, 1989; Dickinson and Gehrels, 2003; Karlstrom et al., 2004). Grains of this provenance were abundant in the upper Paleozoic strata because there were denuded from the basement-cores of the Ancestral Rocky Mountains during the Pennsylvanian-early Permian (Dickinson and Gehrels, 2003; Gehrels et al., 2011). Although the Gawler craton is in Australia today (Fanning et al., 1988), zircon grains of the same age as the Gawler craton have been found throughout western North America and were likely recycled from the Mesoproterozoic sedimentary rocks (Stewart et al., 2001; Nourse et al., 2005; Gleason et al., 2007; Gehrels et al., 2011; Mackey et al., 2012). Early Mesoproterozoic anrogenic magmatism is characterized by scattered plutons in midcontinent North America and are exposed in western Colorado by the Ancestral Rocky Mountains orogeny (Hoffman, 1989; Van Schumus et al., 1996; Nourse et al., 2005; Jones et al., 2013). These grains must have been recycled from the Phanerozoic sedimentary rocks distributed along the flanks of the Laramide ranges and in the intermontane basins (e.g. Dickinson and Gehrels, 2009; May et al., 2013).

The source of Group C (1326-900 Ma) is originally the Greenville basement with small contributions from the Pikes Peak batholith (1100-1000 Ma)

(Anderson, 1983; Dickinson, 2004; Moecher and Samson, 2006; Dickinson and Gehrels, 2009; Dickinson et al., 2012). The Greenville basement provided large quantities of zircons, which were recycled into the Phanerozoic sedimentary rocks in North America (Moecher and Samson, 2006; Dickinson, 2008; Dickinson and Gehrels, 2009; May et al., 2013). Grains in Group C were recycled from the Phanerozoic sedimentary rocks.

Minor Populations

Minor populations include Groups D, E, and F. The sources for Group D are the Appalachian-Ouachita orogenic terranes (723-225 Ma), Antler-Sonoma orogenies (461-225 Ma) in western North America (Dickinson et al., 1983; Dickinson, 2004) and Permian-Triassic magmatic arc provenance (284-232 Ma) in Mexico (Torres et al, 1999; Eriksson et al., 2003; Dickinson and Gehrels, 2009). The Appalachian-Ouachita terranes are distributed in eastern and southern North America, including the Avalonian-Carolinian (640-580 Ma), Potomac (500 Ma), Taconian (500-430 Ma), Acadian (400-350 Ma), and Alleghanian (325-265 Ma) tectonomagmatic units (Hatcher, 1989; Goldberg and Dallmeyer, 1997; Eriksson et al., 2003), and the Suwannee, Sabine, Yucatan-Campeche peri-Gondwana terranes (680-540 Ma) (e.g., Thomas et al., 2004). The grains in Group D must be recycled from the Phanerozoic sedimentary rocks.

The source of Group E is the Cordilleran Magmatic Arc (220-45 Ma) in western North America (Armstrong and Ward, 1993; Dickinson and Lawton,

2001; Dickinson and Gehrels, 2003). In western North America, the Sierra Nevada pluton recorded two major magmatic events during the Jurassic (190-140 Ma) and the Cretaceous (125-85 Ma) (Kauffman, 1985; Armstrong and Ward, 1993). Intermittent igneous activity occurred between 80 and 45 Ma were caused by the low-angle subduction of the Farallon oceanic plate underneath the western U.S.A. (Dickinson and Snyder, 1978; Chadwick, 1981). Grains of these ages were particularly deposited as pure volcanic ash beds in the Mesozoic strata (Kauffman, 1985; Armstrong and Ward, 1993). Grains in this group were recycled from the Mesozoic and lower Cenozoic sedimentary rocks.

The source of Group F (44-24 Ma) is the middle Cenozoic magmatism in western and southwestern North America (e.g. McIntosh et al., 1992; Ferrari et al., 2007; Best et al., 2013). In the northern part of the Great Basin, igneous activity began ~44 Ma then began migrating southeast until ~15 Ma (Best and Christiansen, 1991). The Marysvale volcanic field (32-22 Ma) in Utah is one of the largest volcanic fields in the United States (Cunningham et al., 2007). Volcanism was also active in western Colorado during 35-20 Ma, and the peak volcanisms was in 29-26 Ma (Lipman, 2007). The Mogollon-Dital volcanic field (36.2-24.3 Ma) in Arizona and New Mexico and the Sierra Madre Occidental volcanic field (32-20 Ma) in Mexico (McIntosh et al., 1992; Ferrari et al., 2007) may also contribute zircons of this age group. The grains for Group F must be

recycled from the late Eocene-Oligocene sedimentary rocks and directly derived from ash fall.

Maximum Depositional Age And Chronostratigraphy

The chronostratigraphic correlations of the middle Cenozoic strata in the central Rockies has traditionally relied on radiometric ages of pure ash beds, magnetostratigraphic studies, and mammal fossil ages. The maximum zircon U-Pb depositional ages presented in this thesis confirm the available depositional ages of most of the studied strata, and improves the chronostratigraphy of the other studied strata.

The maximum depositional ages of the LTG-80, LG-30SS, EF-2TopCgl, CHG-18, OB-Base, and BP-27 samples are generally consistent with the existing radiometric and or magnetostratigraphic ages. The maximum depositional ages of the LTG-80 sample is ~2 Ma younger than the reported radiometric ages for the underlying Ash B and ~2 Ma older than the overlying Ash F (Swisher and Prothero, 1990). The maximum depositional age of the LG-30SS sample is ~4 Ma older than the underlying Upper Whitneyan Ash, and consistent with the C13r chron (Swisher and Prothero, 1990; Prothero and Emry, 2004). The maximum depositional age of the EF sample is ~2 Ma younger than the underlying Tuff 6a and 1-3 Ma older than the overlying Tuff 7 (Swisher and Prothero, 1990; Scott and Bowring, 2000). Although the maximum depositional age of the CHG-18 sample is ~4 Ma older than the underlying RRA ash (28.59 ± 0.96 Ma), its

youngest zircon is 29.7 ± 1.9 Ma, comparable to the underlying RRA ash (Swisher and Prothero, 1990). The maximum depositional age of the OB sample is nearly identical to zircon fission track age of 27.4 ± 3.1 Ma reported by Steidtmann and Middleton (1986), suggesting the Arikaree Formation in the Oregon Butte area was of latest Oligocene age. Although Zeller and Stephens (1969) reported that the Formation is of Miocene age based on mammal fossils, Steidtmann and Middleton (1986) argued that the fossils were not in place. The maximal depositional age of the BP-27 sample is ~3 Ma older than the reported biotite K-AR age of 24.0 ± 0.8 Ma by Izett (1975), suggesting the deposition of the Browns Park Formation started as early as the latest Oligocene.

The maximal depositional age of the WS-225 sample is 28.3 ± 1.1 Ma, which is ~6 Ma younger than the magnetostratigraphic age (34-35 Ma) reported by Prothero and Sanchez (2004). The youngest zircon in this sample is 27.4 ± 1.1 Ma old. This sample is collected from a coarse-grained conglomerate with abundant volcanic clasts and erosional base, thus representing the basal Split Rock Formation (e.g. Van Houten, 1964). The IB sample has a maximal depositional age of 74.2 ± 2.1 Ma. Love (1960) inferred that the strata in the Pumpkin Buttes area in the southern Powder River Basin is of Wasatchian age, and Wegemann (1917) published mammal fossils of early Eocene ages. The Absaroka Volcanic Field was active during 51-42 Ma (Armstrong and Ward, 1993), and zircons of this age present in most of the samples I studied (Figure 3-

4). Therefore the fact that the IB sample does not have any zircons of this age suggests the depositional age of the strata underlying the White River Formation in the Pumpkin Butte area is of early Eocene age, between 55.5 - 51 Ma.

Comparison Of Provenance Data Of The Fluvial Sandstone

The detrital zircon U-Pb data presented in this thesis show that the provenances of the middle Cenozoic fluvial sandstones in the Central Rocky Mountains and its adjacent Great Plains are generally similar to each other, with the exception of the LTG-80 and CHG-18 samples. K-S test was conducted to the seven middle Cenozoic fluvial sandstone samples to identify similarities and differences (Table 3-3). The LTG-80 sample has a large amount of (38.3%) of Archean age zircons. The K-S test shows that the LTG-80 sample only closely match the EF sample ($P\text{-value}=0.02$). Both of the samples were collected from the eastside of the Granite Mountains, which is a major Archean basement-cored uplift (Figure 1-1B). The abundant Archean zircons must be derived directly from the Granite Mountains. This inference is consistent with a previous paleoflow study that demonstrate the Oligocene drainage system in central Wyoming was eastward (Clark, 1975). The K-S test of the CHG-18 sample to other samples yields P -values of 0.00. This sample does not match the other samples because zircons from Group B make up to ~87% of the total grains, and the grains were originally derived from the midcontinent granite-rhyolite provinces (85.9% of Group B) with minor contributions (12.7% of Group B) from the Yavapai-

Mazatzal orogeny. The large portions of Group B zircons may be derived from the Colorado Rocky Mountains because several recent studies have suggested that the Colorado Rocky Mountains has major midcontinent granite-rhyolite terranes that were exposed during the Ancestral Rocky Mountain orogeny (Van Schmus et al., 1992; 1996; Dickinson and Gehrels, 2003; Karlstrom et al., 2004; Whitmeyer and Karlstrom, 2007; Jones et al., 2013). The provenance of the CHG-18 sample suggest the stream system that deposited the sandstone may be draining the Colorado Rocky Mountains and flow northeastward.

Implications For Paleogeography

The middle Cenozoic deposition in the Central Rocky Mountains is discontinuous with several hiatuses. The strata are also poorly preserved, making the regional stratigraphic correlation and reconstruction of paleogeography difficult. Current interpretations of the middle Cenozoic paleogeography in the Central Rocky Mountains include two views. The first view is continuous subsidence of the Laramide intermontane basins until 8-6 Ma (McMillian et al., 2006), while the second view suggests uplift during the late Eocene based on a widespread hiatus of ~42-36 Ma (Cather et al., 2012). The first view predicts that the Laramide basement-cored uplifts were largely buried by the middle and late Cenozoic sedimentary rocks, and could not be a major source of the middle Cenozoic sandstone. Detrital zircon U-Pb geochronology and sandstone petrography presented in this study show that abundant sand grains were directly

derived from the Precambrian cores of the local Laramide uplifts and recycled from the range-bounding Phanerozoic sedimentary rocks. Particularly, sample LTG-80 has ~38.3 % of Archean Grains, suggesting the Laramide uplifts were exposed for denudation during the middle Cenozoic time.

The only sample in the western Great Plains, CHG-18, has 86.6% of zircon grains of 1820-1332 Ma old. The zircon compositions of this sample are different from other samples in the Central Rocky Mountains in this study. The 1820-1332 Ma zircon population include zircons mainly formed in the Yavapai-Mazatzal orogeny (1820-1600 Ma), and granite-rhyolite province of midcontinent North America (1500-1332 Ma), both are exposed in the Colorado Rocky Mountains. Therefore, the sand grains of sample CHG-18 must be transported from the Colorado Rocky Mountains in a river system similar to the modern South Platte River. However, this river drained northern Nebraska during the middle Cenozoic, suggesting the drainage of the Platte River has shifted southward during the late Cenozoic.

Conclusions

Sandstone petrography studies of 12 middle Cenozoic fluvial sandstone samples in the Central Rocky Mountains yield average modal compositions of Qm₂₈ F₁₇ Lt₅₄ and Qt₄₃ F₁₇ L₄₀. The samples have low K/P ratio and high Lv abundance. The sand grains were derived from recycled orogen provenance of the

local Laramide uplifts and magmatic arc provenance of the distal middle Cenozoic magmatism in western and southwestern U.S.A..

Detrital zircon U-Pb geochronology of eight sandstone samples constrains the provenance and improves the chronostratigraphy of the middle Cenozoic strata. The zircons grains include primary populations derived from the Archean Wyoming craton, Hearne, Rae, and Superior provenances, Yavapai-Mazatzal orogeny, midcontinent magmatism, and the Greenville basement, and minor populations derived from the Appalachian-Ouachita orogenic terranes, Antler-Sonoma orogenic terranes, Permian-Triassic magmatic arc provenances, Cordilleran Magmatic arc, and middle Cenozoic middle Cenozoic magmatism in western and southwestern U.S.A.. The zircon grains older than middle Cenozoic age were predominantly recycled from the Laramide uplifts, with some samples have zircons directly derived from the Archean basement outcropped in the cores of the Laramide uplifts. Therefore, both sandstone petrography and zircon U-Pb geochronology indicate that the Cenozoic fluvial sandstones in the Central Rocky Mountains have combined provenances of local Laramide uplifts and distal middle Cenozoic magmatism.

The high abundance of Precambrian zircons, particularly occurrence of Archean zircons in the samples close to the Laramide uplifts, suggests that the Laramide uplifts were not covered during the middle Cenozoic and were the major feeders of the sediments deposited in the intermontane basins in the Central

Rocky Mountains and in the adjacent Great Plains. Therefore, my data does not support the view that the Central Rocky Mountains experienced continuous subsidence and sedimentation during the Oligocene-late Miocene.

Appendix A
Sandstone Petrography Raw Point Counts

Sample	C	Qp	Qm	K	P	Lss	Lsh	Lc	Lm	Lvi	Lvv	Acc	Total
IB-Base	44	71	131	0	24	62	24	22	0	31	0	38	447
IB-3	22	72	177	43	26	30	18	0	0	46	0	23	457
LTG-80	35	33	157	21	81	9	42	10	0	42	0	27	457
LTG-156	3	2	18	1	9	22	11	0	0	11	4	7	88
CHG-2 base	21	40	110	0	62	28	38	0	0	23	18	48	388
CHG-5 base	19	11	34	0	17	0	18	0	0	46	7	18	170
LG-25WB	4	1	10	0	2	3	1	0	0	3	7	3	34
EF-2TopCgl	34	26	132	30	113	0	0	0	0	90	0	38	463
WS-225	48	37	187	0	70	0	26	0	0	21	4	64	457
WS-230	10	6	33	0	21	110	0	0	0	26	3	41	250
OB-Base	54	25	96	17	67	38	25	0	0	107	0	88	517
BP-27	39	15	136	18	190	0	0	0	0	25	0	35	458

Appendix B
Detrital Zircon U-Pb Raw Data

Analysis	U (ppm)	Isotopic Ratios						Apparent ages (Ma)								
		206Pb 204Pb	U/Th	206Pb*	±	207Pb*	±	206Pb*	±	Err	206Pb*	±	207Pb*	±	206Pb*	±
BP-27																
1	230.9	2882.2	0.95	17.7	33.3	0.0	34.1	0.0	7.1	0.21	33.0	2.3	39.8	13.3	470.9	756.9
2	38.3	19998.9	1.15	13.4	3.3	1.8	3.9	0.2	2.1	0.54	1013.5	19.9	1030.2	25.5	1065.9	66.7
3	187.2	102677.4	3.18	13.1	1.5	2.0	2.0	0.2	1.4	0.68	1109.2	14.0	1107.8	13.5	1105.2	29.2
4	105.1	122467.5	2.03	8.9	0.6	5.1	1.5	0.3	1.4	0.91	1822.3	21.9	1829.0	12.9	1836.7	11.7
5	113.1	241097.3	1.86	9.5	0.9	4.3	1.3	0.3	1.0	0.73	1683.8	14.4	1701.3	10.9	1722.9	16.5
6	179.8	130562.2	4.10	10.0	0.5	3.9	1.6	0.3	1.5	0.96	1613.5	21.5	1620.2	12.8	1628.9	8.5
7	210.1	146338.1	2.34	12.9	0.7	2.0	1.5	0.2	1.3	0.89	1114.0	13.8	1120.4	10.3	1132.8	13.9
8	208.3	293877.7	1.58	19.8	9.4	0.2	9.7	0.0	2.5	0.26	168.5	4.1	171.9	15.3	218.0	217.0
9	17.5	21179.1	0.96	13.6	14.3	1.8	14.7	0.2	3.5	0.24	1040.0	33.4	1037.7	95.8	1032.7	289.9
10	45.0	76023.8	1.39	10.1	1.5	3.5	2.4	0.3	1.9	0.78	1478.9	24.5	1532.0	18.9	1606.1	28.2
11	279.1	5427.7	1.10	22.7	13.4	0.0	14.0	0.0	4.3	0.31	45.5	1.9	42.7	5.9	-111.7	330.0
12	348.8	2137.5	1.77	19.1	13.2	0.0	14.0	0.0	4.8	0.34	44.2	2.1	49.2	6.7	299.5	302.4
13	81.6	112640.0	1.63	11.2	1.3	3.0	1.6	0.2	0.8	0.53	1415.0	10.6	1413.6	12.1	1411.6	25.7
14	404.8	236758.0	2.13	14.0	0.6	1.5	3.5	0.2	3.4	0.98	932.8	29.9	945.3	21.6	974.4	12.8
15	205.8	32142.0	1.19	13.5	1.3	1.7	1.8	0.2	1.3	0.71	1001.9	11.9	1012.7	11.5	1036.2	25.6
16	467.9	6921.7	1.24	25.8	41.3	0.0	41.5	0.0	3.7	0.09	28.0	1.0	23.4	9.6	-428.4	1125.0
17	574.5	10260.2	1.09	26.6	29.8	0.0	30.1	0.0	3.9	0.13	26.5	1.0	21.5	6.4	-509.4	809.7
18	30.0	22441.1	0.67	9.8	2.5	4.0	2.8	0.3	1.2	0.42	1608.3	16.7	1630.7	22.6	1659.6	46.7
19	197.1	55365.4	1.63	21.0	6.2	0.2	6.3	0.0	1.3	0.20	179.1	2.2	172.5	10.0	83.0	147.2
20	38.5	19370.7	1.83	13.6	3.8	1.8	4.0	0.2	1.4	0.34	1054.0	13.4	1044.2	26.1	1023.8	76.0
21	152.3	117979.0	3.23	13.5	1.3	1.8	1.7	0.2	1.1	0.63	1035.9	10.1	1040.7	11.0	1050.9	26.5
22	225.7	76182.5	2.33	14.3	2.6	1.5	2.7	0.2	1.0	0.36	916.9	8.4	917.8	16.6	920.0	52.6
23	209.5	143327.9	0.93	9.5	0.4	4.3	1.1	0.3	1.0	0.92	1679.1	14.4	1695.9	8.7	1716.7	7.6
24	173.3	377741.6	0.84	9.9	0.5	4.1	1.2	0.3	1.2	0.92	1644.0	16.8	1646.9	10.2	1650.5	8.8
25	232.7	62839.8	2.10	13.8	0.9	1.7	1.4	0.2	1.1	0.80	1011.2	10.6	1007.8	9.1	1000.3	17.6
26	130.4	360540.3	2.37	12.6	0.8	2.2	1.2	0.2	0.9	0.74	1174.4	9.5	1175.9	8.3	1178.6	15.8
27	102.9	2126.9	2.58	16.2	44.8	0.0	49.5	0.0	21.1	0.43	34.7	7.3	45.6	22.1	667.8	1009.0
28	128.7	107765.2	2.53	13.7	1.9	1.7	2.2	0.2	1.1	0.51	1014.7	10.8	1015.1	14.4	1015.9	39.1

29	280.1	259333.5	2.41	9.5	0.3	4.4	1.5	0.3	1.5	0.98	1705.0	22.5	1707.5	12.7	1710.5	5.9
30	54.7	160940.1	0.96	9.4	1.0	4.4	1.4	0.3	1.1	0.74	1687.7	15.7	1706.9	11.9	1730.5	17.8
31	470.8	10107.8	3.17	19.9	17.8	0.0	18.2	0.0	3.5	0.19	34.6	1.2	37.3	6.6	210.6	416.1
32	297.9	282396.9	2.56	9.4	0.3	4.6	1.5	0.3	1.5	0.98	1744.8	22.2	1740.9	12.4	1736.2	5.5
33	142.3	64623.9	1.29	9.7	0.6	4.2	1.3	0.3	1.1	0.87	1678.7	16.4	1677.6	10.5	1676.2	11.6
34	609.0	9437.2	3.07	22.6	17.8	0.0	18.0	0.0	2.2	0.12	35.8	0.8	33.8	6.0	-101.5	440.9
35	65.7	32709.1	2.20	12.6	2.3	2.2	2.9	0.2	1.8	0.61	1178.0	19.3	1178.8	20.3	1180.3	45.5
36	104.2	63297.3	2.48	12.8	1.9	2.1	2.3	0.2	1.2	0.53	1139.4	12.6	1141.4	15.6	1145.3	38.4
37	373.0	13605.2	1.60	21.9	13.2	0.1	13.4	0.0	2.3	0.17	84.6	2.0	81.3	10.5	-17.6	321.3
38	69.9	38026.1	4.11	9.6	1.5	4.3	1.8	0.3	1.0	0.55	1692.2	15.1	1699.0	15.1	1707.4	28.1
39	81.9	163228.4	0.71	5.5	0.4	13.3	0.6	0.5	0.5	0.83	2732.2	11.8	2703.4	6.0	2681.9	5.8
40	192.2	219263.6	2.32	9.7	0.4	4.3	0.9	0.3	0.9	0.90	1701.4	12.8	1693.4	7.8	1683.6	7.6
41	54.4	10624.4	1.89	18.1	10.9	0.7	11.0	0.1	1.7	0.15	555.6	8.9	530.5	45.5	423.5	243.4
42	73.9	87036.8	1.34	9.7	0.7	4.3	1.4	0.3	1.2	0.86	1687.3	17.5	1684.6	11.3	1681.2	13.1
43	194.2	3282.5	1.84	21.9	42.5	0.0	42.8	0.0	5.6	0.13	36.3	2.0	35.5	15.0	-15.2	1069.5
44	150.2	134438.2	0.87	9.5	0.5	4.5	1.9	0.3	1.8	0.96	1745.2	28.0	1735.4	15.8	1723.5	9.3
45	409.2	3991.0	1.54	27.5	43.4	0.0	43.8	0.0	6.0	0.14	27.3	1.6	21.4	9.3	-599.3	1226.8
46	122.0	156041.4	1.85	5.8	0.1	11.9	2.8	0.5	2.8	1.00	2629.2	61.3	2597.1	26.6	2572.1	2.1
47	98.7	90351.7	1.50	9.6	0.7	4.5	1.8	0.3	1.7	0.92	1755.4	25.9	1728.8	15.2	1696.8	13.2
48	140.9	1739.4	0.85	14.8	70.6	0.0	75.3	0.0	26.3	0.35	25.9	6.8	37.4	27.6	853.8	1713.2
49	854.2	99618.3	2.40	19.8	1.6	0.2	2.1	0.0	1.3	0.61	225.6	2.8	224.9	4.2	218.0	38.2
50	58.2	48524.6	1.40	9.6	1.6	4.3	2.2	0.3	1.6	0.70	1704.1	23.2	1698.7	18.2	1692.0	29.0
51	301.9	129926.3	2.18	13.5	0.6	1.8	1.5	0.2	1.4	0.91	1063.1	13.7	1056.5	10.1	1042.8	12.9
52	134.9	47560.9	2.74	9.7	0.7	4.4	1.2	0.3	1.0	0.83	1734.6	15.2	1714.0	10.0	1689.0	12.5
53	278.4	19115.2	1.13	20.3	4.6	0.2	5.5	0.0	3.1	0.56	168.9	5.1	168.3	8.5	159.5	107.1
54	240.6	107258.6	1.53	17.8	3.7	0.5	3.9	0.1	1.4	0.35	423.3	5.7	428.5	13.7	456.8	81.1
55	527.5	52423.8	1.81	20.0	3.4	0.2	3.9	0.0	1.9	0.49	211.9	4.0	210.1	7.4	190.1	79.2
56	124.9	91583.0	2.02	13.4	1.8	1.8	2.1	0.2	1.1	0.52	1056.4	10.5	1057.3	13.6	1059.3	35.5
57	609.7	39408.5	1.30	20.2	3.4	0.2	3.7	0.0	1.5	0.41	168.2	2.6	168.1	5.8	166.6	79.0
58	647.5	15247.7	0.65	21.2	22.4	0.0	22.8	0.0	4.3	0.19	26.1	1.1	26.5	6.0	62.4	539.3
59	159.2	101974.6	1.80	13.5	1.2	1.8	1.6	0.2	1.1	0.67	1049.9	10.5	1047.1	10.5	1041.3	23.9
60	69.2	17702.5	1.69	16.3	6.4	0.8	7.0	0.1	2.7	0.39	603.9	15.5	615.1	32.2	656.4	138.3

61	92.9	80945.4	1.17	9.7	0.9	4.5	2.7	0.3	2.6	0.94	1755.2	39.8	1723.6	22.8	1685.3	16.8
62	421.9	418159.8	2.48	9.7	0.1	4.3	1.5	0.3	1.5	1.00	1707.1	23.1	1697.5	12.7	1685.7	2.5
63	66.6	120320.5	1.60	9.7	1.0	4.3	1.8	0.3	1.5	0.82	1713.8	22.6	1702.5	15.1	1688.5	19.1
64	200.8	62535.9	1.34	16.8	2.6	0.8	3.1	0.1	1.6	0.54	622.4	9.7	615.1	14.1	588.3	55.9
65	193.3	234645.2	1.35	8.6	0.7	5.5	1.3	0.3	1.2	0.86	1893.3	19.0	1895.2	11.5	1897.2	12.3
66	58.3	28793.6	1.78	12.9	2.4	2.0	3.4	0.2	2.4	0.70	1122.1	24.4	1128.6	23.0	1141.1	48.0
67	408.9	280024.6	1.56	8.7	0.2	5.6	1.5	0.4	1.4	0.99	1936.5	24.0	1909.9	12.5	1881.1	4.0
68	172.0	121763.8	1.55	11.6	1.1	2.7	1.5	0.2	1.0	0.68	1337.5	12.4	1337.2	11.1	1336.8	21.1
69	352.0	8303.6	1.42	29.4	32.7	0.0	34.1	0.0	9.5	0.28	33.9	3.2	24.8	8.4	-790.6	947.1
70	524.9	430003.5	16.92	9.1	0.2	4.8	1.4	0.3	1.4	0.99	1779.5	21.8	1786.3	11.9	1794.3	4.2
71	95.8	102117.7	1.84	13.0	1.8	2.0	2.3	0.2	1.4	0.63	1115.8	14.6	1116.9	15.4	1119.1	35.3
72	136.3	662.8	1.05	4.8	291.1	0.1	291.5	0.0	14.5	0.05	27.7	4.0	117.7	335.7	2879.8	161.2
73	78.6	119190.7	1.71	9.6	1.0	4.3	1.9	0.3	1.6	0.86	1689.1	24.2	1689.7	15.5	1690.5	17.6
74	93.5	113573.7	3.23	9.1	0.7	4.9	1.4	0.3	1.1	0.84	1807.8	17.9	1805.9	11.4	1803.7	13.4
75	67.9	45377.1	1.33	10.6	1.0	3.5	1.5	0.3	1.1	0.73	1520.5	14.9	1517.9	11.8	1514.1	19.3
76	540.0	451420.0	23.95	10.0	0.4	3.9	2.1	0.3	2.1	0.98	1623.9	29.6	1623.9	17.1	1623.8	8.2
77	227.8	46167.6	2.20	18.5	3.6	0.4	4.1	0.1	1.9	0.46	342.2	6.3	346.8	12.0	377.6	81.5
78	88.5	149881.6	1.11	9.7	1.1	4.3	1.9	0.3	1.5	0.81	1697.8	22.7	1693.4	15.5	1687.9	20.3
79	174.7	229072.8	2.55	9.6	0.7	4.4	1.3	0.3	1.1	0.85	1725.1	17.0	1709.9	10.9	1691.3	12.9
80	37.8	35979.8	1.20	9.7	1.5	4.3	1.9	0.3	1.1	0.57	1704.5	16.2	1692.0	15.6	1676.6	28.6
81	118.4	78609.8	1.58	11.1	1.0	3.2	1.4	0.3	1.0	0.73	1464.5	13.5	1452.5	10.8	1434.8	18.2
82	72.7	28951.2	2.17	13.8	1.5	1.8	1.9	0.2	1.2	0.64	1057.5	12.1	1039.9	12.7	1003.1	30.5
83	189.6	2461.9	1.96	26.9	64.6	0.0	66.8	0.0	16.9	0.25	34.2	5.8	27.3	18.0	-547.1	1927.5
84	310.7	330201.9	2.10	9.7	0.4	4.3	1.2	0.3	1.2	0.95	1703.8	17.4	1694.1	10.1	1682.1	7.0
85	563.2	4005.4	1.75	20.5	16.2	0.0	16.7	0.0	4.0	0.24	28.5	1.1	29.8	4.9	137.1	383.7
86	654.7	31882.4	2.03	20.9	3.4	0.1	3.8	0.0	1.7	0.44	109.0	1.8	108.3	3.9	92.9	81.5
87	247.2	127853.6	2.44	13.9	0.9	1.6	3.3	0.2	3.1	0.96	954.0	27.8	963.5	20.3	985.3	18.6
88	101.7	58925.1	1.15	5.2	0.7	11.5	2.3	0.4	2.2	0.96	2312.5	43.7	2561.5	21.9	2765.0	11.1
89	190.2	113887.2	3.31	9.2	0.4	4.8	1.5	0.3	1.5	0.97	1790.9	22.7	1787.3	12.6	1783.2	7.1
90	1333.7	50898.7	2.16	20.7	1.7	0.1	2.0	0.0	0.9	0.45	98.2	0.9	98.7	1.8	110.7	41.2
91	116.4	27309.4	1.57	13.3	1.6	1.9	2.3	0.2	1.7	0.74	1074.4	17.0	1073.7	15.5	1072.4	31.7
92	80.9	57635.9	0.61	11.1	1.6	3.1	2.2	0.2	1.5	0.69	1420.3	19.0	1421.1	16.6	1422.2	30.1

93	504.5	88948.8	0.81	18.9	1.9	0.4	2.3	0.0	1.2	0.53	306.0	3.6	307.9	6.0	322.2	43.3					
94	456.7	228696.6	25.38	13.1	0.3	2.0	1.3	0.2	1.3	0.97	1121.9	13.4	1113.5	9.1	1097.2	6.9					
95	197.8	117915.7	1.95	12.4	0.9	2.3	1.6	0.2	1.3	0.84	1215.3	14.6	1215.2	11.2	1214.9	16.9					
96	94.8	45583.4	3.10	13.6	2.2	1.8	2.7	0.2	1.5	0.56	1044.8	14.4	1039.4	17.5	1028.1	45.3					
97	256.0	388133.3	4.56	9.6	0.3	4.4	1.5	0.3	1.4	0.97	1730.9	21.4	1715.4	12.0	1696.7	6.3					
98	79.8	50168.6	1.80	11.1	1.7	3.1	2.3	0.3	1.6	0.69	1458.3	20.9	1442.8	18.0	1420.0	32.5					
99	183.9	169232.2	2.67	11.2	0.6	3.2	1.0	0.3	0.7	0.78	1472.3	9.8	1448.2	7.4	1412.9	11.6					
100	106.3	41288.7	0.99	14.1	2.7	1.6	3.1	0.2	1.4	0.45	1000.4	12.7	986.6	19.3	956.0	55.8					
101	260.0	281915.8	1.13	11.3	0.8	2.9	1.8	0.2	1.6	0.90	1392.7	20.4	1390.5	13.6	1387.1	14.7					
102	193.4	80840.8	1.36	13.2	0.5	1.9	1.6	0.2	1.5	0.95	1102.1	15.5	1097.7	10.8	1088.9	10.3					
103	183.1	133829.5	2.92	12.8	0.9	2.1	1.7	0.2	1.5	0.86	1166.6	16.0	1162.7	12.1	1155.3	17.7					
	CHG-18																				
1	583.7	304860.6	2.95	11.0	0.3	3.2	1.3	0.3	1.3	0.97	1457.6	16.7	1452.3	10.3	1444.5	6.5					
2	143.3	15221.9	1.65	10.9	1.2	3.2	3.0	0.3	2.8	0.92	1459.1	36.3	1458.7	23.4	1458.1	22.6					
3	48.9	21956.6	2.91	10.9	1.1	3.1	1.8	0.2	1.4	0.78	1433.7	18.4	1441.7	14.1	1453.4	21.7					
4	271.6	157558.1	3.68	10.4	0.4	3.7	3.8	0.3	3.8	0.99	1580.5	53.4	1566.8	30.6	1548.5	7.8					
5	882.5	9985.7	1.32	20.4	15.8	0.0	16.1	0.0	3.0	0.19	32.3	1.0	33.9	5.4	153.9	371.9					
6	416.7	67615.0	2.76	11.0	0.4	3.2	1.8	0.3	1.7	0.97	1462.5	22.7	1457.8	13.8	1450.8	8.4					
7	70.2	43059.5	2.36	11.0	1.2	3.2	2.4	0.3	2.1	0.86	1458.1	27.1	1452.9	18.6	1445.4	23.1					
8	365.0	224581.3	2.99	11.1	0.3	3.2	1.2	0.3	1.2	0.96	1471.8	15.6	1457.1	9.5	1435.7	6.3					
9	43.9	48469.9	0.50	4.8	0.4	16.1	1.3	0.6	1.3	0.96	2890.5	29.8	2884.1	12.8	2879.6	6.2					
10	992.0	11931.8	1.48	9.4	0.4	3.8	6.4	0.3	6.4	1.00	1495.9	85.6	1598.8	51.8	1737.2	6.8					
11	67.3	30029.1	1.87	10.9	1.7	3.2	2.2	0.3	1.5	0.65	1446.4	19.1	1453.7	17.4	1464.3	32.3					
13	164.0	33874.3	1.52	11.0	0.5	3.1	1.6	0.3	1.5	0.96	1444.7	19.3	1442.5	12.0	1439.3	8.7					
14	150.9	85312.5	3.39	11.0	0.9	3.2	2.1	0.3	1.9	0.90	1481.4	25.2	1468.5	16.5	1449.9	17.9					
15	425.1	44114.9	3.15	11.1	0.2	2.9	4.8	0.2	4.8	1.00	1354.6	58.8	1386.3	36.5	1435.4	3.8					
16	44.8	33561.4	1.95	11.1	2.2	3.0	2.4	0.2	1.0	0.42	1411.3	12.7	1415.8	18.2	1422.6	41.4					
17	962.7	13771.7	8.66	10.3	1.4	0.8	7.9	0.1	7.7	0.98	354.4	26.7	571.4	34.4	1566.2	26.7					
18	97.0	110396.1	2.14	11.1	1.9	3.1	2.2	0.2	1.2	0.54	1432.2	15.5	1430.2	17.2	1427.2	36.2					
19	1683.0	1357.0	0.58	9.4	3.8	2.9	14.9	0.2	14.4	0.97	1159.4	153.2	1376.4	113.0	1731.3	70.6					
20	100.1	85711.1	1.46	5.6	0.4	12.6	1.2	0.5	1.1	0.95	2658.9	24.0	2652.1	10.9	2647.0	6.2					
21	71.5	41295.6	2.14	11.1	1.7	3.1	2.4	0.3	1.7	0.71	1453.7	22.4	1440.9	18.7	1422.1	32.7					

22	143.0	145310.2	2.28	11.1	0.8	3.1	1.8	0.2	1.7	0.90	1421.0	21.3	1425.6	14.2	1432.4	15.1
23	107.5	47863.1	1.45	13.2	1.8	1.8	2.7	0.2	2.0	0.74	1016.1	18.7	1037.1	17.5	1081.6	36.3
24	55.2	71471.5	3.58	11.1	2.3	3.1	2.7	0.2	1.3	0.48	1434.5	16.4	1434.2	20.5	1433.6	44.8
25	34.7	17418.4	3.52	10.9	4.5	3.1	4.9	0.2	1.9	0.39	1428.9	24.3	1443.6	37.9	1465.4	86.3
26	431.1	78991.0	2.06	11.0	1.9	3.3	8.2	0.3	8.0	0.97	1497.6	106.4	1477.1	63.7	1447.7	35.3
27	156.5	48383.3	2.10	6.2	1.0	10.3	1.3	0.5	0.8	0.63	2454.4	17.1	2460.0	12.4	2464.7	17.6
28	445.2	440355.9	4.29	11.1	0.3	3.1	1.4	0.3	1.4	0.98	1450.6	18.4	1444.2	11.1	1434.9	5.2
29	768.3	1379.6	1.69	10.8	6.5	3.0	8.4	0.2	5.3	0.63	1350.8	65.0	1402.9	64.0	1483.1	123.1
30	120.1	89939.2	3.11	9.1	0.6	4.9	2.1	0.3	2.0	0.95	1798.7	31.6	1795.0	17.8	1790.6	11.8
31	91.4	1662.4	1.60	8.2	202.2	0.1	204.1	0.0	27.8	0.14	32.3	9.0	82.6	163.3	1988.7	161.3
32	175.4	129159.5	1.20	11.1	0.5	3.1	1.8	0.2	1.7	0.96	1420.1	21.7	1424.1	13.6	1430.1	9.4
33	131.9	71535.9	2.10	11.1	1.0	3.1	2.0	0.3	1.8	0.88	1446.8	23.3	1436.1	15.7	1420.3	18.6
34	91.3	54093.6	2.34	11.1	1.3	3.1	1.7	0.3	1.2	0.68	1445.0	15.3	1440.6	13.3	1434.2	24.1
35	552.8	19799.6	3.18	9.2	0.2	4.4	1.2	0.3	1.2	0.99	1671.9	17.8	1715.6	10.2	1769.5	3.6
36	243.8	11541.7	4.29	10.8	3.8	3.1	6.4	0.2	5.2	0.81	1404.7	65.7	1432.5	49.5	1474.0	72.2
37	375.7	149245.5	1.36	9.5	0.3	4.5	2.1	0.3	2.0	0.99	1726.9	30.9	1724.8	17.1	1722.3	5.3
38	131.9	142129.7	1.52	7.9	0.5	6.5	1.3	0.4	1.2	0.92	2052.8	20.5	2046.6	11.1	2040.3	8.6
39	601.2	578528.1	6.51	11.1	0.2	3.2	0.8	0.3	0.7	0.96	1479.3	9.6	1458.9	5.9	1429.4	4.0
40	370.5	847.8	4.55	11.0	2.0	1.5	8.4	0.1	8.2	0.97	719.5	55.6	920.4	50.8	1438.6	37.4
41	50.4	26956.7	1.51	11.1	1.7	3.1	2.0	0.3	1.1	0.52	1453.7	13.8	1444.8	15.6	1431.7	32.9
42	238.3	11848.3	1.23	11.0	0.8	3.2	2.8	0.3	2.7	0.96	1463.8	34.7	1455.0	21.3	1442.2	14.3
43	60.7	72809.4	2.21	11.3	1.7	3.0	4.0	0.2	3.7	0.90	1422.5	46.7	1412.3	30.8	1396.9	33.1
44	131.8	90489.5	1.83	11.0	1.0	3.2	1.4	0.3	1.1	0.74	1459.6	13.7	1454.8	11.0	1447.9	18.2
45	174.7	104354.4	2.99	11.0	0.8	3.2	1.4	0.3	1.1	0.80	1465.0	14.8	1456.1	10.9	1443.1	16.1
46	196.9	133227.0	1.86	11.1	0.5	3.1	1.7	0.3	1.6	0.95	1447.7	20.7	1440.5	12.9	1429.8	10.0
47	1329.2	1179184.4	2.13	11.1	0.1	3.2	1.3	0.3	1.3	0.99	1461.4	17.1	1450.2	10.1	1433.8	2.8
48	121.2	50366.9	2.37	11.1	1.0	3.1	1.4	0.3	1.1	0.74	1452.2	13.8	1441.7	11.0	1426.1	18.4
49	3313.5	1804.2	3.75	6.2	1.4	2.6	18.9	0.1	18.9	1.00	722.5	129.2	1311.6	140.4	2470.0	23.0
50	80.9	105802.8	2.39	11.0	1.4	3.1	1.8	0.3	1.1	0.61	1442.6	14.3	1443.2	14.0	1444.0	27.3
51	975.3	27154.0	2.72	11.1	0.5	2.9	5.1	0.2	5.1	1.00	1344.4	62.0	1380.0	38.8	1435.5	9.5
52	648.5	8165.3	1.94	22.2	13.1	0.0	13.2	0.0	1.9	0.15	33.4	0.6	32.3	4.2	-48.6	319.8
53	236.3	10002.8	2.63	11.0	0.5	3.0	1.2	0.2	1.1	0.89	1378.6	13.3	1402.3	9.1	1438.4	10.2

54	252.1	171082.7	3.21	11.1	0.6	3.2	1.4	0.3	1.2	0.88	1463.8	16.0	1449.4	10.7	1428.1	12.4
55	298.6	1018.6	1.32	5.8	3.2	7.4	7.4	0.3	6.7	0.90	1738.7	101.9	2158.9	66.5	2586.5	53.9
56	423.5	9637.6	3.12	9.3	3.7	4.1	5.4	0.3	3.9	0.73	1556.9	54.2	1645.3	43.7	1760.0	67.0
57	91.3	55938.4	2.82	11.0	1.2	3.2	1.5	0.3	1.0	0.63	1468.1	12.7	1462.0	12.0	1453.2	23.0
58	341.2	57308.1	1.49	11.0	0.5	3.2	2.1	0.3	2.0	0.97	1461.0	26.3	1453.8	16.0	1443.3	9.7
59	44.5	35146.3	2.07	11.3	2.7	3.1	3.1	0.3	1.5	0.49	1441.8	19.7	1422.4	23.8	1393.5	52.1
60	98.2	897.5	1.13	21.2	47.2	0.0	50.9	0.0	19.2	0.38	31.2	6.0	31.5	15.8	55.5	1185.9
61	88.8	49310.5	2.17	11.1	1.7	3.1	2.3	0.3	1.6	0.68	1455.1	20.6	1444.6	17.8	1429.2	32.3
62	174.4	103071.7	1.13	11.0	0.5	3.2	1.4	0.3	1.4	0.94	1466.5	17.8	1455.6	11.1	1439.8	9.2
63	78.9	39310.8	2.19	12.8	1.6	2.2	2.1	0.2	1.3	0.63	1180.5	14.1	1170.0	14.4	1150.6	32.1
64	167.2	59484.0	3.37	11.0	0.8	3.3	1.4	0.3	1.1	0.80	1488.0	14.7	1469.2	10.7	1442.2	15.6
65	132.5	297633.6	1.48	11.0	1.2	3.2	1.5	0.3	1.0	0.63	1463.0	12.6	1456.0	11.8	1445.9	22.6
66	207.6	129742.1	2.53	11.1	0.8	3.2	1.6	0.3	1.4	0.85	1476.4	18.0	1456.8	12.4	1428.2	16.1
67	133.0	83138.9	1.89	11.0	1.1	3.2	1.7	0.3	1.3	0.75	1474.8	16.8	1459.9	13.2	1438.3	21.7
68	418.6	5740.0	2.49	8.6	2.3	5.3	2.7	0.3	1.4	0.52	1841.0	22.5	1868.4	23.1	1899.1	41.4
69	1853.7	323747.5	1.00	11.0	0.3	2.7	12.6	0.2	12.6	1.00	1248.8	142.8	1322.0	93.3	1442.6	4.9
70	200.2	62608.1	2.71	9.9	0.7	3.8	1.7	0.3	1.5	0.90	1544.4	20.4	1590.1	13.3	1651.2	13.6
71	88.9	69808.0	1.85	11.1	1.2	3.2	1.8	0.3	1.4	0.77	1473.0	18.7	1456.0	14.3	1431.3	22.5
72	312.0	271927.4	3.21	9.2	0.2	4.9	1.0	0.3	1.0	0.98	1829.9	16.1	1804.2	8.7	1774.7	3.4
73	99.1	17733.7	1.13	17.2	3.6	0.6	4.3	0.1	2.2	0.52	437.5	9.3	452.4	15.5	529.0	80.0
74	2390.3	17805.6	2.01	9.4	0.3	2.5	8.6	0.2	8.6	1.00	1027.2	81.9	1285.6	63.0	1748.1	4.8
75	85.8	62978.8	2.28	11.1	1.6	3.4	2.1	0.3	1.4	0.66	1540.6	19.4	1493.5	16.7	1427.3	30.6
76	1153.3	11439.0	2.04	9.4	0.2	2.8	2.4	0.2	2.4	1.00	1144.3	25.5	1365.0	18.4	1729.5	4.4
77	151.5	83049.9	1.33	11.0	1.0	3.1	1.5	0.2	1.1	0.76	1437.7	14.5	1437.6	11.4	1437.5	18.3
78	180.4	122434.8	3.89	11.0	0.9	3.2	1.4	0.3	1.0	0.74	1455.3	13.2	1448.4	10.6	1438.2	17.5
79	166.4	133133.1	2.41	11.1	0.7	3.2	1.3	0.3	1.0	0.84	1467.0	13.8	1451.7	9.7	1429.2	13.1
80	227.6	87060.8	2.71	11.1	0.3	3.1	1.2	0.3	1.1	0.97	1448.2	14.4	1442.5	8.9	1434.2	5.7
81	3251.0	60749.2	1.00	5.7	0.1	12.2	2.7	0.5	2.7	1.00	2641.2	58.3	2623.0	25.3	2609.0	1.6
82	185.1	200051.8	2.55	9.4	0.5	4.7	1.9	0.3	1.8	0.97	1781.3	28.6	1758.6	15.9	1731.8	8.5
83	298.5	110319.0	1.27	11.0	0.7	3.2	0.9	0.3	0.7	0.71	1464.6	8.8	1455.9	7.3	1443.2	12.6
84	676.7	9892.0	1.96	11.0	0.3	3.0	1.4	0.2	1.4	0.98	1389.0	17.1	1410.3	10.7	1442.6	5.9
85	504.6	10666.0	3.25	11.0	0.6	3.1	1.5	0.2	1.4	0.93	1436.6	18.6	1437.7	11.9	1439.3	10.6

51	86	305.3	2184.7	1.82	5.9	52.3	13.3	67.3	0.6	42.3	0.63	2898.8	995.8	2699.6	745.5	2553.7	954.6
	87	222.5	4582.3	2.57	10.3	20.2	3.6	21.7	0.3	7.9	0.36	1528.2	107.5	1549.0	173.9	1577.4	381.8
	88	601.7	9955.4	3.23	10.7	9.3	3.2	12.0	0.3	7.6	0.63	1450.0	98.4	1466.9	93.2	1491.3	176.0
	89	309.2	24638.7	2.75	7.8	43.2	4.7	51.7	0.3	28.5	0.55	1525.2	387.0	1769.8	462.6	2072.0	802.5
	90	414.0	358909.4	5.25	7.9	33.5	7.0	59.1	0.4	48.7	0.82	2161.8	899.6	2110.6	580.6	2061.0	608.9
	91	101.0	40755.2	1.87	11.0	1.3	3.2	2.1	0.3	1.6	0.78	1468.0	21.6	1461.3	16.3	1451.5	25.1
	92	182.8	130844.0	2.74	11.0	0.9	3.2	1.5	0.3	1.2	0.80	1474.9	15.6	1462.5	11.5	1444.4	16.9
	93	478.4	222660.4	4.54	11.1	0.3	3.1	1.4	0.3	1.4	0.98	1450.5	17.6	1443.5	10.7	1433.2	5.6
	94	61.3	31970.1	1.31	11.2	1.3	3.1	2.1	0.3	1.7	0.79	1456.8	21.7	1440.2	16.2	1415.7	24.4
	95	201.2	108127.5	2.44	11.0	0.5	3.1	1.5	0.3	1.4	0.94	1443.8	18.2	1442.1	11.5	1439.4	9.7
	96	201.1	2345.6	2.34	21.9	52.4	0.0	52.8	0.0	6.3	0.12	29.7	1.9	29.2	15.2	-16.4	1353.6
	97	226.7	44171.6	1.82	11.0	0.5	3.1	1.0	0.3	0.9	0.86	1440.9	11.1	1439.3	7.7	1437.0	9.8
	98	624.6	13982.1	4.93	9.3	0.5	3.8	4.7	0.3	4.7	1.00	1459.0	61.3	1583.4	37.8	1753.3	8.2
	99	80.0	113882.5	2.96	11.1	1.6	3.2	2.7	0.3	2.2	0.81	1485.2	29.4	1464.0	21.2	1433.2	30.5
	100	879.9	1339.9	2.33	10.9	1.6	2.6	3.9	0.2	3.5	0.91	1222.3	38.9	1309.8	28.4	1456.1	31.1
	101	413.0	184956.6	2.28	11.0	0.3	3.2	3.5	0.3	3.5	1.00	1481.3	46.5	1463.0	27.4	1436.5	6.6
	102	305.3	183858.8	3.14	11.1	0.5	3.2	1.4	0.3	1.4	0.95	1455.9	17.7	1446.2	11.0	1431.9	8.6
	103	858.5	10412.5	3.40	11.0	0.8	3.2	3.4	0.3	3.4	0.97	1445.3	43.4	1446.7	26.6	1448.7	15.3
	EF- 2TopCgl																
	1	53.2	20995.4	2.68	13.4	5.3	1.8	5.4	0.2	1.2	0.22	1060.9	11.5	1058.5	35.8	1053.7	107.1
	2	3357.7	456.3	7.97	7.0	7.1	1.1	33.1	0.1	32.3	0.98	364.9	114.6	776.9	181.4	2265.3	122.2
	3	105.5	6765.4	7.10	10.0	1.9	1.4	16.3	0.1	16.1	0.99	609.3	93.9	873.4	95.5	1619.7	35.9
	4	1137.5	3347.8	1.99	5.4	0.2	4.2	8.2	0.2	8.2	1.00	976.6	74.6	1667.9	67.6	2696.7	3.0
	5	78.1	1319.3	0.32	41.0	128.8	0.0	130.3	0.0	19.3	0.15	35.5	6.8	18.7	24.1	-1846.6	0.0
	6	416.3	6383.4	1.86	9.7	1.9	3.9	2.6	0.3	1.7	0.67	1560.3	23.7	1608.8	20.6	1672.8	35.1
	7	119.6	2030.8	0.87	9.4	153.3	0.1	154.8	0.0	21.8	0.14	35.5	7.7	79.5	119.0	1747.4	107.1
	8	333.7	163700.1	4.59	9.4	0.5	4.5	2.0	0.3	2.0	0.97	1722.0	29.9	1727.4	17.0	1734.0	9.7
	9	138.9	32037.7	1.76	16.4	3.2	0.9	3.4	0.1	1.2	0.36	650.5	7.6	646.7	16.4	633.3	68.9
	10	100.9	51559.8	0.86	5.2	0.3	13.6	2.1	0.5	2.0	0.99	2684.6	44.6	2720.8	19.4	2747.8	4.9
	11	392.4	294416.9	1.44	11.0	0.4	3.2	1.7	0.3	1.6	0.97	1451.3	21.4	1450.5	13.2	1449.2	8.2
	12	4511.0	138.8	12.98	6.8	6.0	1.1	18.6	0.1	17.6	0.95	344.9	59.2	761.0	100.0	2314.0	103.6
	13	1544.3	1200.3	8.33	6.1	2.4	6.3	17.7	0.3	17.6	0.99	1583.3	246.8	2012.6	156.6	2487.4	41.1

14	2479.8	148.5	5.19	6.7	11.7	1.3	28.7	0.1	26.2	0.91	399.3	101.6	853.6	167.5	2341.2	201.7
15	2165.6	579.3	1.27	6.4	2.7	2.0	31.7	0.1	31.5	1.00	564.7	170.6	1106.9	216.6	2417.6	45.2
16	1894.8	1001.8	2.69	5.9	3.8	2.0	35.0	0.1	34.8	0.99	528.3	176.7	1115.5	241.6	2555.9	63.6
17	1581.7	21435.5	1.69	21.2	6.8	0.0	6.9	0.0	1.3	0.19	33.7	0.4	34.0	2.3	54.6	162.0
18	165.2	176759.0	2.27	11.3	0.6	3.0	3.6	0.2	3.5	0.99	1399.0	44.4	1394.9	27.2	1388.7	11.3
19	2173.1	296.7	4.30	7.0	1.2	3.0	9.3	0.2	9.2	0.99	908.5	78.3	1404.6	71.0	2266.1	20.1
20	545.2	8452.5	1.09	27.3	16.4	0.0	16.7	0.0	3.0	0.18	32.9	1.0	25.9	4.3	-585.6	447.2
21	1794.0	1101.7	4.08	6.0	2.3	3.3	27.1	0.1	27.0	1.00	874.0	221.1	1489.2	215.1	2523.3	38.0
22	1965.8	411.7	5.43	6.2	3.6	2.5	17.1	0.1	16.8	0.98	672.5	107.0	1259.2	124.2	2476.7	60.6
23	1493.1	1520.3	2.75	6.3	0.7	4.1	8.3	0.2	8.3	1.00	1097.7	83.4	1649.2	67.7	2447.1	11.2
24	510.8	23170.9	0.61	11.2	0.7	2.7	4.3	0.2	4.2	0.99	1255.9	48.0	1316.9	31.5	1417.6	12.8
25	1925.5	1245.3	2.39	5.9	2.4	5.7	5.7	0.2	5.2	0.91	1406.6	65.3	1930.2	49.3	2550.8	40.2
26	1926.7	924.0	6.69	4.7	0.8	13.6	6.4	0.5	6.4	0.99	2474.8	130.6	2724.1	60.6	2914.6	12.3
27	1965.4	121.1	2.12	5.4	7.7	5.6	9.9	0.2	6.3	0.63	1264.5	71.9	1909.6	85.4	2707.0	126.6
28	2521.9	380.0	0.20	5.9	5.7	1.8	42.3	0.1	41.9	0.99	481.8	194.8	1047.1	283.7	2544.5	95.5
29	1163.6	15331.3	5.17	5.9	3.1	8.2	8.2	0.4	7.6	0.93	1940.7	127.8	2252.2	74.6	2548.6	52.0
30	3334.7	541.2	26.16	7.4	2.9	4.5	11.2	0.2	10.8	0.97	1396.1	135.4	1728.4	92.9	2158.2	50.3
31	2220.2	907.5	5.52	6.9	3.4	2.9	12.1	0.1	11.6	0.96	884.1	96.2	1392.7	92.2	2289.3	58.9
32	2500.2	127.3	1.69	5.5	4.6	2.2	31.0	0.1	30.6	0.99	534.8	157.1	1176.3	219.0	2682.0	76.5
33	1407.4	5435.1	8.07	5.8	0.6	10.6	14.4	0.4	14.4	1.00	2367.4	285.9	2487.5	134.7	2587.1	10.7
34	528.5	30334.5	3.91	8.3	0.7	4.2	3.6	0.3	3.5	0.98	1456.4	45.5	1673.2	29.3	1956.9	13.2
35	1124.1	3906.4	2.47	5.9	0.6	7.4	14.7	0.3	14.7	1.00	1768.0	228.0	2164.1	132.7	2564.2	9.9
36	2101.4	969.9	4.33	7.2	2.8	1.6	38.0	0.1	37.9	1.00	510.8	186.0	962.6	240.5	2215.0	48.1
37	291.8	293555.4	2.17	8.9	0.2	5.2	1.7	0.3	1.7	0.99	1858.6	27.2	1852.2	14.5	1845.1	4.3
38	1996.1	485.7	2.53	6.0	5.1	2.2	19.9	0.1	19.2	0.97	585.3	107.7	1172.3	139.4	2515.4	86.5
39	211.0	78858.8	1.20	11.3	0.5	2.8	0.9	0.2	0.8	0.82	1344.1	9.2	1365.4	7.0	1398.8	10.1
40	2824.2	1645.6	2.98	10.5	1.0	0.5	5.4	0.0	5.3	0.98	227.9	11.9	394.4	17.7	1541.2	19.2
41	477.3	417483.1	2.78	12.5	0.5	2.2	1.0	0.2	0.8	0.84	1183.7	9.2	1190.3	7.1	1202.4	10.7
42	4407.8	1121242.5	3.80	1.9	4.7	46.8	13.1	0.6	12.3	0.93	3190.6	308.8	3926.7	131.4	NA	NA
43	174.6	246234.3	1.08	5.3	0.1	13.9	1.4	0.5	1.4	1.00	2749.5	31.9	2742.8	13.6	2737.9	2.3
44	4506.8	103.0	12.41	6.8	24.2	1.2	36.9	0.1	27.9	0.75	382.1	103.4	821.9	211.1	2323.6	422.4
45	1129.7	79082.3	3.22	9.7	0.2	4.1	0.8	0.3	0.8	0.96	1624.1	10.9	1650.0	6.5	1683.2	4.2

46	289.6	16674.8	1.33	5.3	0.3	13.4	2.0	0.5	2.0	0.99	2662.2	42.6	2707.3	18.6	2741.2	4.5	
47	100.1	57741.9	1.31	5.3	0.4	13.4	1.0	0.5	1.0	0.94	2663.5	21.1	2706.7	9.7	2739.0	5.9	
48	1440.2	1382.8	6.87	9.5	2.1	1.9	14.8	0.1	14.7	0.99	791.1	109.1	1077.3	98.6	1713.3	39.0	
49	550.6	9426.3	1.91	23.9	23.3	0.0	23.5	0.0	3.2	0.14	34.8	1.1	31.2	7.2	-233.7	593.1	
50	1389.8	13547.8	20.88	6.2	1.7	10.0	2.5	0.4	1.8	0.72	2392.4	35.7	2437.9	22.9	2476.1	29.0	
51	239.5	189168.8	2.35	11.1	0.7	3.2	3.6	0.3	3.5	0.98	1468.7	45.9	1449.7	27.5	1422.0	12.9	
52	675.2	17755.6	3.09	10.8	0.3	2.5	2.5	0.2	2.5	0.99	1165.2	26.3	1279.7	18.1	1477.5	5.6	
53	1488.9	1357.4	2.77	5.5	0.5	7.6	7.1	0.3	7.1	1.00	1701.6	106.4	2187.7	64.1	2680.8	9.1	
54	2579.3	530.6	2.27	6.6	5.8	1.0	25.7	0.0	25.0	0.97	306.1	74.9	711.0	132.1	2360.6	98.9	
55	1592.9	941.6	1.56	6.1	0.6	3.0	6.4	0.1	6.3	1.00	809.1	48.1	1409.0	48.4	2487.0	10.0	
56	1343.3	356.9	3.72	5.9	1.7	3.7	8.7	0.2	8.5	0.98	941.0	74.8	1563.8	69.6	2549.0	29.0	
57	2406.2	157.5	2.11	6.2	5.5	2.7	15.9	0.1	14.9	0.94	724.6	102.4	1317.6	118.1	2478.8	93.4	
58	3134.3	119.2	3.99	6.5	7.5	1.0	19.3	0.0	17.8	0.92	298.5	52.0	703.7	98.4	2379.9	127.3	
59	4306.6	402.5	6.00	7.5	3.2	1.3	19.9	0.1	19.6	0.99	430.5	81.6	834.3	113.4	2149.0	55.9	
60	1010.4	68978.9	2.71	19.6	1.5	0.3	1.9	0.0	1.1	0.60	227.8	2.5	228.6	3.9	236.9	35.1	
61	1758.3	1025.6	3.40	6.3	1.4	4.1	7.4	0.2	7.3	0.98	1109.4	74.1	1651.6	60.4	2432.5	23.2	
62	1207.0	20662.3	13.22	5.7	0.3	12.5	5.2	0.5	5.2	1.00	2703.6	115.4	2644.7	49.2	2599.9	4.4	
63	1627.8	636.7	29.34	6.9	2.1	1.8	13.5	0.1	13.4	0.99	561.1	71.8	1054.1	88.8	2293.4	35.4	
64	37.7	17482.8	0.43	13.3	4.7	1.9	5.1	0.2	2.0	0.40	1074.9	20.0	1073.5	33.7	1070.7	93.8	
65	433.9	76920.5	1.76	13.6	0.8	1.7	1.6	0.2	1.5	0.89	1020.2	13.8	1024.0	10.6	1032.3	15.5	
66	2898.9	193.0	0.90	6.2	5.0	0.9	39.9	0.0	39.6	0.99	267.0	103.5	669.8	198.0	2457.9	83.8	
67	90.4	51953.9	1.84	13.1	3.3	2.0	4.0	0.2	2.2	0.56	1107.0	22.7	1107.8	26.8	1109.4	65.7	
68	166.0	132939.8	1.82	9.0	0.6	5.1	0.9	0.3	0.7	0.77	1854.6	11.4	1841.1	7.9	1825.9	10.7	
69	259.9	1573.1	2.15	17.3	28.9	0.0	30.2	0.0	9.0	0.30	36.1	3.2	44.4	13.1	516.1	646.3	
70	1730.5	1153.8	7.44	5.3	6.5	7.6	11.2	0.3	9.1	0.81	1645.1	132.8	2179.6	101.1	2729.1	107.8	
71	463.8	79669.0	1.62	19.4	2.1	0.3	2.5	0.0	1.3	0.53	241.1	3.2	243.5	5.5	266.4	49.2	
72	723.6	50984.8	9.53	10.8	2.3	3.0	8.3	0.2	7.9	0.96	1351.1	96.8	1405.2	62.9	1488.1	42.9	
73	218.8	431640.5	1.23	5.3	0.1	14.1	0.7	0.5	0.7	0.99	2779.1	16.5	2753.9	7.0	2735.5	2.1	
74	109.6	76550.6	0.86	5.3	0.2	13.9	1.0	0.5	1.0	0.98	2761.2	23.1	2746.1	9.9	2734.9	3.2	
75	280.0	17949.7	1.46	4.5	0.2	17.5	1.4	0.6	1.4	0.99	2898.1	33.5	2965.3	13.9	3011.3	3.0	
76	208.6	101969.1	1.98	9.9	0.8	3.9	1.9	0.3	1.8	0.92	1601.3	25.0	1616.3	15.6	1635.8	14.3	
77	1479.6	26268.7	7.69	5.6	0.9	8.8	9.3	0.4	9.3	1.00	1959.5	156.3	2318.8	85.0	2652.1	14.9	

54	78	451.9	728962.2	5.48	9.5	0.2	4.4	1.5	0.3	1.5	0.99	1716.6	22.9	1715.0	12.7	1713.0	3.9
	79	226.6	3028.0	1.04	30.7	45.6	0.0	46.6	0.0	9.4	0.20	33.4	3.1	23.4	10.8	-912.6	1386.9
	80	246.3	14961.4	2.27	16.4	2.0	0.8	2.1	0.1	0.7	0.32	617.8	4.0	623.5	9.9	644.2	43.2
	81	143.4	104021.7	2.05	8.7	0.3	5.5	3.2	0.3	3.2	1.00	1914.8	53.1	1901.5	27.7	1887.1	5.1
	82	88.7	16173.6	1.90	17.8	8.6	0.5	8.9	0.1	2.5	0.28	413.2	9.9	420.6	30.7	461.4	190.0
	83	333.1	11377.7	1.92	22.4	11.4	0.1	11.8	0.0	2.8	0.24	78.1	2.2	73.5	8.4	-71.0	280.2
	84	164.2	69304.2	1.37	11.5	0.9	2.7	3.8	0.2	3.7	0.97	1298.8	43.8	1324.8	28.3	1367.0	16.5
	85	36.3	34268.5	1.84	10.6	3.0	3.3	3.4	0.3	1.5	0.44	1467.5	19.3	1489.5	26.2	1520.9	56.8
	86	1954.2	388.2	3.65	6.2	2.5	2.6	19.2	0.1	19.1	0.99	721.2	130.1	1308.3	142.4	2465.9	42.7
	87	1396.7	1836.6	7.75	5.9	0.6	6.9	1.7	0.3	1.6	0.95	1674.5	24.3	2097.2	15.4	2542.1	9.4
	88	3865.4	106.1	2.71	5.7	6.2	1.1	14.9	0.0	13.6	0.91	292.6	38.9	762.0	80.3	2602.1	104.1
	89	2211.5	426.1	1.59	6.8	1.3	1.4	17.3	0.1	17.3	1.00	440.6	73.5	899.3	103.7	2300.4	22.6
	90	1137.6	3872.8	12.15	9.7	0.9	2.0	10.7	0.1	10.6	1.00	866.5	86.3	1129.9	73.0	1678.4	16.9
	91	1948.8	906.4	6.08	7.3	5.2	1.9	70.3	0.1	70.1	1.00	612.8	410.3	1074.1	503.5	2186.1	90.5
	92	3132.5	151.3	4.48	7.0	2.6	1.3	14.4	0.1	14.1	0.98	410.1	56.1	843.2	82.4	2263.1	45.7
	93	233.0	176257.6	1.20	9.0	0.5	5.1	1.8	0.3	1.7	0.96	1851.3	27.9	1836.9	15.4	1820.7	9.7
	94	174.0	131384.6	0.82	10.6	0.5	3.5	1.7	0.3	1.6	0.95	1546.6	22.1	1533.9	13.3	1516.6	9.7
	95	186.5	399918.0	2.95	9.4	0.5	4.5	0.9	0.3	0.8	0.85	1723.3	11.6	1725.9	7.5	1728.9	8.7
	96	99.7	35616.9	2.02	13.9	2.2	1.6	2.8	0.2	1.7	0.62	956.9	15.5	964.1	17.6	980.5	45.3
	97	711.6	13083.0	1.31	21.9	20.5	0.0	20.8	0.0	3.4	0.16	32.4	1.1	31.8	6.5	-19.4	501.6
	98	321.7	8401.5	1.61	17.4	3.0	0.6	3.4	0.1	1.7	0.48	452.2	7.2	461.3	12.7	506.9	66.3
	99	705.8	174240.9	4.62	9.1	0.2	4.7	1.0	0.3	1.0	0.98	1732.7	14.9	1761.9	8.4	1796.6	3.7
	100	731.3	2102.6	1.63	5.7	1.8	5.0	44.4	0.2	44.3	1.00	1226.3	495.8	1824.9	394.4	2598.6	29.7
	101	190.1	137193.4	3.25	13.6	0.9	1.7	1.9	0.2	1.7	0.88	1022.0	15.7	1024.7	12.1	1030.5	17.8
	102	287.3	5476.5	1.99	5.4	0.5	11.0	3.8	0.4	3.8	0.99	2292.6	73.5	2523.4	35.7	2714.7	7.5
	103	485.1	18455.2	1.54	4.6	0.4	15.9	3.9	0.5	3.8	1.00	2741.9	85.6	2873.1	36.8	2966.5	5.8
	IB-Base																
1	545.2	31026.4	1.29	21.6	9.1	0.1	9.4	0.0	2.5	0.27	64.0	1.6	62.7	5.7	15.3	217.9	
2	134.0	94858.2	2.73	11.0	0.4	3.2	0.8	0.3	0.6	0.81	1450.2	8.0	1448.6	5.9	1446.3	8.4	
3	135.9	214301.3	1.26	5.3	0.2	13.9	0.8	0.5	0.8	0.97	2761.2	18.6	2741.0	8.0	2726.1	3.1	
4	390.8	116755.5	4.09	11.4	0.4	2.9	0.9	0.2	0.8	0.90	1391.9	9.6	1388.9	6.5	1384.4	7.3	
5	241.8	219323.6	1.87	9.6	0.3	4.4	1.7	0.3	1.7	0.98	1720.6	25.4	1711.0	14.2	1699.3	6.3	

6	127.3	180027.7	2.04	5.4	0.4	13.4	1.1	0.5	1.0	0.93	2699.4	22.1	2706.4	10.2	2711.6	6.5
7	189.6	282116.2	2.00	9.5	0.4	4.4	1.0	0.3	0.9	0.92	1707.6	13.4	1713.5	8.0	1720.8	6.7
8	1308.6	416211.9	7.70	11.3	0.1	2.9	1.5	0.2	1.5	1.00	1373.3	18.4	1378.9	11.3	1387.6	2.5
9	83.3	89827.0	1.30	3.7	0.2	25.8	0.8	0.7	0.8	0.98	3378.2	21.4	3338.1	8.1	3314.2	2.8
10	1334.0	17129.1	1.82	18.6	16.0	0.2	16.2	0.0	2.9	0.18	144.8	4.1	158.4	23.8	366.2	362.0
11	146.0	73816.2	2.11	9.7	0.5	4.3	2.1	0.3	2.0	0.97	1701.0	30.4	1695.4	17.2	1688.4	9.1
12	270.0	324364.0	2.09	9.5	0.4	4.4	1.0	0.3	1.0	0.93	1705.5	14.6	1711.0	8.6	1717.7	6.9
13	695.6	33459.7	1.61	20.7	3.8	0.1	3.9	0.0	0.9	0.23	99.1	0.9	99.6	3.7	111.1	88.9
14	159.3	160032.3	2.68	11.4	0.7	3.0	2.4	0.2	2.3	0.95	1408.1	28.7	1398.5	18.1	1383.9	14.1
15	842.2	2527.7	1.83	5.7	1.2	8.3	25.5	0.3	25.4	1.00	1887.8	416.9	2264.2	234.9	2624.0	19.8
16	169.9	58072.6	1.98	10.4	1.5	1.8	8.6	0.1	8.5	0.99	820.8	65.5	1047.9	56.4	1557.5	27.4
17	122.3	122147.1	0.86	11.3	1.0	3.0	1.6	0.2	1.2	0.76	1400.7	15.0	1397.5	11.9	1392.5	19.7
18	787.5	4350.9	2.33	5.3	0.8	9.9	3.8	0.4	3.7	0.98	2074.0	65.9	2421.9	35.1	2728.8	13.9
19	403.2	289837.9	1.74	7.9	0.1	6.7	1.2	0.4	1.2	0.99	2089.2	21.0	2072.3	10.4	2055.5	2.5
20	15.4	25395.4	2.23	11.6	6.2	2.9	7.2	0.2	3.6	0.50	1408.7	45.6	1383.4	54.2	1344.5	119.8
21	250.4	139456.5	1.83	12.4	0.6	2.3	0.8	0.2	0.5	0.62	1213.4	5.5	1213.6	5.7	1214.0	12.3
22	108.4	18546.6	1.05	17.9	5.5	0.6	5.7	0.1	1.1	0.20	449.0	4.8	449.6	20.5	452.7	123.2
23	3024.8	18845.1	5.84	10.5	0.4	3.4	1.8	0.3	1.7	0.98	1473.2	22.5	1496.4	13.7	1529.4	7.2
24	500.1	21155.4	1.20	5.5	2.7	13.9	6.3	0.6	5.6	0.90	2839.7	129.7	2744.3	59.4	2674.9	44.8
25	419.0	6911.6	1.52	9.4	1.5	4.4	2.6	0.3	2.2	0.82	1706.7	32.6	1718.3	22.0	1732.5	27.8
26	333.3	553785.0	2.72	5.6	0.1	12.5	0.6	0.5	0.6	0.99	2655.7	12.0	2644.3	5.3	2635.7	1.3
27	473.5	49878.7	2.98	9.6	0.3	3.8	2.0	0.3	2.0	0.99	1520.7	26.7	1595.9	16.1	1696.7	5.6
28	882.1	3402.5	3.38	6.7	1.2	6.4	3.2	0.3	2.9	0.93	1746.4	45.1	2035.9	27.9	2343.5	20.3
29	344.0	5889.5	2.23	10.6	4.6	2.1	14.6	0.2	13.9	0.95	964.0	124.3	1149.9	101.0	1519.5	87.1
30	101.8	112989.6	2.62	11.0	0.6	3.1	1.2	0.2	1.0	0.87	1435.8	13.2	1436.6	9.1	1437.8	11.3
31	215.0	10560.7	1.52	7.9	0.6	6.6	1.4	0.4	1.2	0.91	2057.5	21.7	2053.3	11.9	2049.1	9.9
32	24.2	19626.6	0.74	9.7	2.4	4.2	3.0	0.3	1.8	0.59	1649.8	25.7	1665.3	24.5	1685.0	44.7
33	214.1	22096.9	2.47	10.9	1.5	3.2	1.6	0.3	0.5	0.29	1464.6	6.2	1465.3	12.5	1466.4	29.3
34	317.8	59317.1	2.01	10.9	0.6	2.8	2.4	0.2	2.3	0.97	1289.4	26.8	1356.2	17.7	1463.1	11.6
35	141.4	4374.6	3.83	22.4	29.8	0.1	30.3	0.0	5.1	0.17	74.5	3.8	70.1	20.5	-77.7	743.8
36	261.2	8476.2	2.23	21.1	14.7	0.1	14.9	0.0	2.7	0.18	71.9	1.9	71.8	10.3	70.2	350.3
37	145.1	95953.8	1.04	10.1	0.4	3.9	1.6	0.3	1.5	0.97	1603.6	21.3	1606.3	12.5	1609.7	7.3

38	197.1	151086.2	2.67	9.5	0.5	4.5	0.7	0.3	0.5	0.72	1729.5	7.7	1728.3	5.8	1726.8	8.9
39	1187.2	1168385.3	1.60	11.4	0.2	2.8	1.9	0.2	1.9	0.99	1357.4	22.8	1363.0	14.0	1371.8	3.7
40	1232.4	49712.2	5.80	6.2	0.2	9.2	1.2	0.4	1.2	0.98	2248.3	22.4	2358.9	11.0	2455.9	4.0
41	295.4	1511.1	0.78	5.7	0.6	8.1	4.0	0.3	4.0	0.99	1847.8	63.7	2239.1	36.2	2619.0	9.4
42	52.8	17842.3	0.45	9.7	1.9	4.1	2.2	0.3	1.1	0.51	1649.6	16.4	1663.6	18.0	1681.3	34.9
43	718.1	219064.1	3.08	9.2	0.9	4.3	5.5	0.3	5.5	0.99	1612.0	77.8	1684.9	45.4	1776.8	15.7
44	120.5	79020.3	2.59	10.9	0.6	3.2	0.9	0.3	0.7	0.75	1466.4	9.2	1463.6	7.3	1459.4	11.8
45	125.3	139571.2	1.79	6.2	0.3	10.5	1.2	0.5	1.2	0.98	2478.1	23.7	2476.3	10.9	2474.9	4.4
46	117.7	37411.7	1.59	11.0	1.7	3.1	2.2	0.2	1.5	0.67	1436.7	19.3	1442.3	17.2	1450.4	31.7
47	126.4	97966.9	1.26	9.6	0.7	4.5	2.7	0.3	2.6	0.97	1751.7	39.5	1726.0	22.1	1694.9	12.7
48	286.4	1975.2	0.69	5.7	0.5	9.8	4.0	0.4	4.0	0.99	2197.9	74.9	2418.8	37.3	2610.4	7.6
49	366.8	11379.5	2.26	20.7	11.0	0.1	11.4	0.0	3.1	0.27	76.2	2.3	77.3	8.5	111.0	260.5
50	449.5	3380.3	10.47	5.4	1.2	12.1	2.4	0.5	2.0	0.85	2512.5	41.8	2610.3	22.1	2687.0	20.4
51	2967.1	198741.3	8.99	11.2	0.1	3.1	0.9	0.2	0.9	0.99	1430.9	11.1	1423.6	6.7	1412.7	2.2
52	135.4	7368.6	1.77	25.3	36.9	0.1	37.0	0.0	2.6	0.07	92.9	2.4	77.2	27.5	-386.2	987.9
53	233.5	168110.0	2.34	9.1	0.4	4.9	1.0	0.3	0.9	0.90	1802.6	13.4	1803.4	8.0	1804.3	7.6
54	447.5	469980.4	3.96	9.8	0.5	4.2	3.3	0.3	3.2	0.99	1686.1	48.0	1675.9	26.8	1663.0	8.4
55	704.4	91062.0	22.38	9.2	0.3	5.0	3.3	0.3	3.3	1.00	1865.6	53.2	1827.4	27.9	1784.1	4.6
56	149.4	2386.9	0.67	5.6	1.1	12.6	1.6	0.5	1.2	0.75	2656.2	25.7	2650.5	14.9	2646.2	17.5
57	298.2	168828.9	2.27	11.4	0.3	2.9	1.5	0.2	1.5	0.98	1383.3	18.5	1382.7	11.4	1381.8	5.6
58	814.4	8846.9	1.62	5.6	0.2	10.6	2.3	0.4	2.3	1.00	2326.7	44.1	2491.7	21.0	2629.1	2.8
59	89.6	3017.0	1.58	24.7	26.2	0.1	32.4	0.0	19.0	0.59	102.9	19.4	87.4	27.1	-317.4	682.7
60	404.2	196488.3	3.26	6.3	0.2	10.3	1.8	0.5	1.8	1.00	2468.9	36.1	2461.6	16.3	2455.5	2.8
61	80.7	16981.8	0.87	17.2	5.1	0.8	5.4	0.1	1.5	0.28	625.7	8.9	605.2	24.4	529.1	112.7
62	600.0	1675995.7	2.92	5.2	0.1	14.2	0.9	0.5	0.9	1.00	2768.1	20.2	2763.6	8.6	2760.3	1.4
63	602.9	6423.3	1.11	6.5	0.6	8.1	4.1	0.4	4.0	0.99	2087.9	71.4	2243.7	36.7	2389.1	11.0
64	99.9	56170.8	2.51	12.8	1.9	2.1	2.6	0.2	1.7	0.67	1167.6	18.4	1159.9	17.8	1145.6	38.1
65	131.2	55414.9	2.60	6.7	1.5	9.7	6.3	0.5	6.2	0.97	2496.4	127.8	2408.5	58.5	2334.9	25.2
66	354.0	154414.4	2.75	21.3	9.7	0.1	9.9	0.0	2.2	0.22	95.9	2.1	94.2	8.9	49.4	231.3
67	65.4	104458.1	1.47	6.3	0.6	10.1	1.3	0.5	1.2	0.90	2430.7	23.3	2443.3	11.8	2453.8	9.3
68	113.8	33753.2	0.67	11.3	1.2	3.0	1.6	0.2	1.0	0.64	1408.8	12.7	1405.0	11.9	1399.0	23.1
69	159.0	8627.5	1.10	9.2	0.6	4.6	4.2	0.3	4.1	0.99	1738.1	63.2	1754.6	35.0	1774.2	10.6

70	152.0	7938.3	1.02	6.2	0.3	10.2	1.1	0.5	1.1	0.97	2449.1	22.7	2454.0	10.6	2458.0	4.4
71	35.3	60339.1	0.59	5.3	0.6	14.2	1.5	0.5	1.3	0.92	2801.7	30.7	2764.4	14.0	2737.3	9.7
72	233.9	223015.9	1.93	11.3	0.4	2.9	1.1	0.2	1.1	0.94	1381.4	13.2	1384.0	8.5	1387.9	7.2
73	180.2	104942.5	1.23	11.0	0.8	3.2	2.1	0.3	2.0	0.93	1474.6	26.3	1462.8	16.6	1445.6	14.7
74	191.4	5923.4	1.47	20.9	18.5	0.1	18.8	0.0	3.3	0.17	76.1	2.5	76.5	13.9	89.0	442.7
75	211.1	16209.6	2.12	20.8	10.7	0.1	11.1	0.0	3.1	0.28	103.6	3.2	103.5	10.9	99.8	252.5
76	229.0	8751.5	2.33	20.5	11.3	0.1	11.9	0.0	3.7	0.32	74.0	2.8	76.0	8.7	137.8	265.5
77	171.4	105891.3	1.76	9.7	0.5	4.3	1.1	0.3	1.0	0.90	1692.4	15.3	1690.9	9.5	1689.2	9.4
78	3267.3	157.5	3.14	10.1	21.6	0.4	27.2	0.0	16.6	0.61	190.1	31.0	348.0	80.4	1606.5	407.6
79	238.3	141691.7	1.46	9.6	0.3	4.4	0.8	0.3	0.7	0.90	1720.6	10.5	1712.9	6.4	1703.3	6.1
80	338.0	378200.6	6.32	5.6	0.1	12.7	1.0	0.5	1.0	0.99	2697.9	22.7	2661.0	9.8	2633.0	1.8
81	898.9	554.8	2.22	9.8	3.6	1.9	4.9	0.1	3.3	0.67	826.5	25.3	1090.2	32.6	1663.2	67.3
82	86.2	20780.8	3.28	12.0	12.3	2.0	12.5	0.2	1.9	0.15	1030.6	18.0	1115.5	84.7	1284.9	241.1
83	258.6	226809.5	4.39	11.4	0.7	2.9	1.6	0.2	1.5	0.91	1381.8	18.3	1379.7	12.2	1376.3	13.0
84	103.5	323442.4	1.46	3.7	0.2	25.2	1.0	0.7	1.0	0.98	3350.0	25.4	3314.5	9.7	3293.2	3.5
85	153.3	105558.6	4.80	9.4	0.9	4.7	6.3	0.3	6.2	0.99	1794.8	97.5	1771.8	52.7	1744.7	15.7
86	125.7	563670.3	0.76	9.4	0.6	4.7	1.3	0.3	1.2	0.90	1790.1	18.7	1762.8	11.1	1730.7	10.4
87	257.8	235733.5	2.37	9.5	0.5	4.5	1.5	0.3	1.5	0.95	1739.5	22.3	1727.0	12.7	1711.8	8.6
88	173.5	131805.0	1.03	9.5	0.3	4.4	0.5	0.3	0.4	0.78	1710.6	5.9	1711.5	4.2	1712.5	5.9
89	258.2	261056.8	2.27	9.5	0.3	4.4	1.2	0.3	1.2	0.96	1715.8	18.0	1714.7	10.3	1713.2	6.3
90	634.7	667189.4	6.15	11.4	0.3	2.9	1.8	0.2	1.8	0.99	1403.9	22.5	1394.0	13.7	1378.8	5.2
91	418.4	502435.5	11.64	6.3	0.3	10.2	2.0	0.5	1.9	0.99	2461.6	39.6	2450.1	18.2	2440.5	5.7
92	248.5	29995.6	1.23	9.5	0.6	4.5	2.3	0.3	2.2	0.96	1737.2	33.3	1726.2	18.8	1712.8	11.3
93	150.8	4961.7	1.40	25.7	15.3	0.1	16.1	0.0	5.0	0.31	73.5	3.6	60.6	9.4	-423.8	401.9
94	850.5	90394.0	5.89	5.6	0.1	12.3	0.9	0.5	0.9	0.99	2613.5	19.0	2623.8	8.3	2631.8	1.8
95	206.8	1560.5	2.10	13.4	2.8	1.4	5.5	0.1	4.7	0.86	835.5	36.8	900.6	32.6	1063.9	56.0
96	292.7	291155.3	1.76	9.4	0.2	4.6	0.8	0.3	0.8	0.97	1738.7	11.4	1740.2	6.5	1742.1	3.7
97	247.2	184093.4	1.47	9.7	0.4	4.3	1.5	0.3	1.5	0.97	1698.5	21.7	1691.8	12.4	1683.4	7.1
98	356.3	532145.9	5.73	11.4	0.5	2.9	1.7	0.2	1.6	0.96	1370.0	20.1	1374.9	12.8	1382.7	9.5
99	282.7	264715.7	2.05	9.4	0.4	4.6	1.3	0.3	1.2	0.95	1753.3	18.4	1750.2	10.5	1746.5	7.5
100	327.3	68070.8	1.57	19.4	2.7	0.2	3.0	0.0	1.2	0.40	220.2	2.5	223.6	6.0	259.5	62.7
101	198.6	228702.8	2.49	9.5	0.6	4.5	1.8	0.3	1.7	0.95	1733.0	25.8	1725.6	14.9	1716.6	10.6

	102	209.9	133768.5	2.39	11.4	0.7	2.9	1.3	0.2	1.0	0.83	1385.9	13.0	1384.2	9.6	1381.5	13.7
	103	106.7	201436.3	1.80	9.7	1.0	4.3	1.2	0.3	0.6	0.53	1693.4	9.5	1688.7	9.9	1682.8	18.8
LG-30SS																	
58	1	302.7	2919.4	0.61	14.4	147.2	0.0	147.6	0.0	11.6	0.08	33.1	3.8	48.8	70.4	907.3	686.3
	2	7098.2	180.6	18.83	13.1	14.4	0.5	17.0	0.1	9.0	0.53	324.8	28.4	440.9	60.9	1103.6	290.2
	3	4481.6	154407.0	3.19	20.7	1.9	0.1	2.3	0.0	1.3	0.56	99.2	1.3	99.7	2.2	112.0	44.8
	4	425.9	3926.0	1.78	14.7	182.6	0.0	182.7	0.0	6.3	0.03	33.7	2.1	48.6	87.0	864.4	952.0
	5	505.8	299064.4	6.27	6.3	0.4	10.1	1.7	0.5	1.7	0.98	2437.9	34.7	2442.8	16.1	2447.0	6.2
	6	99.0	42195.6	1.89	12.2	2.9	2.5	3.1	0.2	1.2	0.38	1267.0	13.5	1261.1	22.3	1251.2	55.8
	7	755.8	174799.6	6.69	13.7	0.6	1.8	0.7	0.2	0.5	0.63	1039.9	4.5	1033.5	4.8	1019.9	11.6
	8	387.1	649.7	0.65	11.1	4.0	1.6	9.1	0.1	8.1	0.90	762.5	58.4	955.1	56.2	1429.8	76.9
	9	287.4	156782.4	5.75	9.4	0.7	4.7	1.0	0.3	0.8	0.75	1774.5	11.8	1758.7	8.5	1739.9	12.2
	10	112.3	2291.4	1.66	10.6	159.1	0.2	159.4	0.0	9.7	0.06	75.8	7.3	146.0	220.2	1523.5	293.9
	11	145.9	79448.6	2.73	9.5	1.0	4.5	2.2	0.3	2.0	0.89	1732.7	30.5	1726.1	18.6	1718.0	18.5
	12	574.9	46385.6	1.93	9.9	6.5	2.8	37.8	0.2	37.2	0.99	1178.3	401.1	1351.5	289.7	1637.4	120.1
	13	1886.5	12516.3	1.40	22.1	11.2	0.0	11.5	0.0	2.6	0.23	36.8	1.0	35.6	4.0	-43.8	273.4
	14	42.7	12910.2	1.68	12.6	4.1	2.3	4.8	0.2	2.6	0.53	1208.1	28.2	1197.3	33.8	1177.8	80.5
	15	1818.8	14368.2	1.50	23.7	14.1	0.0	14.2	0.0	1.6	0.12	35.5	0.6	32.2	4.5	-209.9	355.6
	16	543.0	6912.4	1.63	26.7	79.0	0.0	79.1	0.0	3.7	0.05	39.0	1.4	31.2	24.4	-528.4	2544.4
	17	366.7	2274.8	0.52	15.5	88.6	0.0	89.1	0.0	9.7	0.11	32.4	3.1	44.6	38.9	758.0	386.4
	18	84.0	17802.8	1.18	17.5	10.5	0.8	10.6	0.1	1.5	0.14	627.6	9.1	601.1	48.2	502.6	232.0
	19	514.7	24716.5	2.38	9.1	2.1	4.8	3.5	0.3	2.8	0.81	1764.7	43.7	1780.4	29.4	1798.9	37.5
	20	849.6	6681.2	3.97	5.7	0.7	7.4	12.1	0.3	12.1	1.00	1722.0	182.5	2164.8	108.7	2615.7	11.4
	21	86.3	33245.0	2.40	9.3	1.5	4.6	1.9	0.3	1.1	0.60	1735.9	17.4	1746.0	15.8	1758.1	27.7
	22	83.7	910.4	1.61	3.4	277.1	0.3	279.5	0.0	37.1	0.13	41.0	15.2	231.4	657.0	3422.2	562.3
	23	3430.5	313.4	9.52	13.4	4.5	0.3	11.2	0.0	10.2	0.91	211.8	21.3	299.8	29.1	1056.9	91.2
	24	320.0	151686.5	1.56	9.9	0.5	4.1	1.5	0.3	1.4	0.93	1654.6	20.7	1648.7	12.4	1641.3	10.0
	25	2580.2	11430.7	2.47	21.5	11.6	0.0	11.7	0.0	1.5	0.12	34.9	0.5	34.7	4.0	19.8	279.3
	26	1217.3	142791.7	11.27	13.6	0.5	1.7	1.1	0.2	0.9	0.89	1026.9	9.0	1025.9	6.8	1023.6	9.7
	27	294.1	108630.8	2.01	9.7	1.0	4.4	1.7	0.3	1.4	0.82	1747.8	21.1	1717.1	14.0	1679.9	18.0
	28	1030.9	66769.1	1.82	14.2	26.9	0.9	26.9	0.1	1.6	0.06	544.1	8.6	628.9	126.9	947.0	560.3
	29	122.4	12980.8	1.08	6.0	0.6	11.3	2.2	0.5	2.1	0.96	2578.3	45.3	2550.8	20.8	2528.9	10.8

30	7.3	2222.8	5.30	12.3	41.1	3.4	41.4	0.3	4.8	0.12	1722.7	73.2	1513.9	337.3	1232.9	842.6
31	1874.9	1176.4	3.20	10.1	3.3	2.7	12.4	0.2	11.9	0.96	1177.6	128.5	1339.9	92.5	1609.3	62.0
32	48.8	5511.9	1.06	23.5	24.3	0.4	25.4	0.1	7.6	0.30	423.4	31.0	340.9	73.7	-189.9	614.4
33	350.9	185292.7	0.68	10.4	1.6	3.7	5.9	0.3	5.7	0.96	1583.0	80.4	1567.3	47.4	1546.2	29.3
34	340.8	3782.5	1.58	12.3	85.3	0.1	86.0	0.0	11.2	0.13	36.0	4.0	61.7	51.5	1225.9	2254.5
35	885.3	5771.2	0.75	21.6	24.3	0.0	24.9	0.0	5.5	0.22	33.9	1.9	33.6	8.2	12.7	591.5
36	321.8	8413.1	1.37	20.0	69.9	0.0	71.3	0.0	14.2	0.20	32.9	4.6	35.2	24.7	191.7	1870.5
37	226.0	54943.7	1.49	10.0	1.1	3.9	1.9	0.3	1.5	0.83	1592.5	21.8	1609.4	15.1	1631.7	19.6
38	521.9	659.1	0.19	9.4	5.6	3.1	8.7	0.2	6.7	0.76	1239.6	75.4	1436.9	67.3	1742.5	103.2
39	114.3	18643.9	1.82	18.1	17.6	0.5	17.9	0.1	3.5	0.19	432.3	14.5	430.1	62.9	418.3	395.3
40	161.4	63214.7	3.71	9.2	1.1	4.7	1.5	0.3	1.0	0.67	1746.0	15.5	1759.2	12.7	1775.0	20.6
41	724.0	14947.7	1.31	22.0	12.1	0.1	12.4	0.0	2.8	0.22	93.5	2.6	88.9	10.5	-32.3	293.2
42	163.0	43002.8	3.17	13.8	2.5	1.8	5.1	0.2	4.4	0.87	1049.4	42.9	1032.8	33.0	998.0	50.8
43	232.0	35346.6	1.06	13.3	3.0	1.7	4.7	0.2	3.6	0.77	990.0	33.1	1018.3	30.2	1079.5	60.6
44	312.1	12869.3	1.50	19.8	14.9	0.2	15.0	0.0	2.1	0.14	156.2	3.2	160.5	22.3	224.0	345.7
45	195.2	991.2	0.75	47.3	114.1	0.0	115.4	0.0	16.8	0.15	36.0	6.0	16.5	18.8	-2396.6	0.0
46	299.5	23176.8	3.10	13.2	4.2	1.8	8.5	0.2	7.4	0.87	1029.2	70.8	1046.6	55.7	1083.1	83.5
47	30.7	5454.1	2.42	15.9	19.5	1.5	19.7	0.2	2.8	0.14	1052.4	27.6	943.9	121.6	698.6	418.6
48	2122.9	846.7	3.00	6.4	5.3	2.8	7.8	0.1	5.7	0.73	787.8	42.3	1360.7	58.5	2427.0	90.4
49	254.5	1656.3	2.75	15.3	135.1	0.1	136.5	0.0	19.1	0.14	37.2	7.1	51.7	68.9	786.7	699.2
50	423.2	50491.6	1.97	9.5	0.5	4.4	1.7	0.3	1.7	0.96	1720.3	24.9	1718.0	14.3	1715.1	8.9
51	786.4	18462.4	1.49	19.5	7.8	0.1	8.1	0.0	2.1	0.26	92.1	1.9	98.4	7.6	253.1	180.0
52	877.8	27772.1	3.15	9.9	3.4	1.1	14.8	0.1	14.4	0.97	475.3	66.2	738.1	78.0	1647.8	62.7
53	219.6	1803.3	0.99	29.7	101.2	0.0	103.1	0.0	19.8	0.19	35.6	7.1	25.8	26.2	-820.5	0.0
54	315.9	2946.2	2.13	25.0	92.3	0.0	92.6	0.0	8.3	0.09	34.3	2.8	29.5	26.9	-349.1	3376.1
55	129.6	1160.2	0.62	10.9	106.9	0.1	111.1	0.0	30.3	0.27	33.5	10.1	64.7	69.8	1459.7	47.2
56	386.2	12646.2	3.40	22.1	14.5	0.1	15.0	0.0	3.9	0.26	96.5	3.7	91.4	13.1	-39.1	353.9
57	92.9	122696.2	1.51	6.2	1.0	10.3	1.8	0.5	1.4	0.82	2460.0	29.5	2458.3	16.3	2456.8	17.0
58	131.1	1910.8	0.97	19.7	50.8	0.1	52.3	0.0	12.3	0.24	70.6	8.6	75.4	38.1	233.1	1250.7
59	518.3	204060.4	2.33	9.2	0.4	4.8	1.3	0.3	1.3	0.96	1803.0	19.9	1792.1	11.1	1779.4	6.8
60	205.4	43054.8	1.85	12.9	3.7	1.8	6.6	0.2	5.5	0.83	1011.9	51.4	1049.6	43.2	1129.0	73.4
61	155.1	2589.1	1.48	18.6	96.6	0.1	97.7	0.0	15.1	0.15	75.3	11.3	84.7	79.6	356.7	729.4

62	546.7	717.0	0.84	5.4	13.5	7.4	24.4	0.3	20.3	0.83	1649.0	295.2	2165.0	221.5	2697.9	224.2
63	592.6	215328.3	4.16	9.5	0.5	4.3	1.0	0.3	0.9	0.90	1682.5	13.7	1694.8	8.5	1710.0	8.4
64	93.9	24442.9	2.10	10.7	1.7	3.3	3.1	0.3	2.6	0.83	1486.8	34.1	1491.5	24.3	1498.2	32.9
65	259.1	81082.4	74.71	11.0	0.9	3.2	1.0	0.3	0.5	0.49	1456.0	6.4	1451.5	7.8	1444.8	16.7
66	329.6	68993.4	1.56	10.0	3.4	4.1	3.9	0.3	1.9	0.48	1669.8	27.7	1652.5	31.9	1630.6	63.5
67	151.8	96682.9	1.88	6.2	0.7	10.5	1.3	0.5	1.1	0.84	2473.1	21.6	2476.4	11.6	2479.1	11.4
68	141.1	17470.3	1.75	13.6	2.6	1.8	2.9	0.2	1.4	0.47	1049.7	13.4	1040.6	19.0	1021.5	52.2
69	226.4	1104.3	1.50	1.9	1227.9	0.4	1227.9	0.0	12.7	0.01	33.1	4.2	315.2	#NUM!	NA	NA
70	333.3	110012.7	2.84	9.2	0.4	4.7	1.1	0.3	1.0	0.92	1761.9	15.4	1769.1	9.1	1777.8	7.8
71	217.8	162622.0	1.78	9.7	0.9	4.1	1.4	0.3	1.1	0.76	1634.7	15.4	1658.6	11.4	1689.1	16.5
72	1699.7	15911.7	1.00	20.4	10.4	0.0	10.5	0.0	1.4	0.13	33.9	0.5	35.6	3.7	152.7	244.1
73	300.6	2625.4	0.45	12.6	135.6	0.1	136.1	0.0	10.9	0.08	33.1	3.6	55.5	73.6	1174.7	413.1
74	175.9	70853.3	0.64	11.0	1.5	3.0	3.3	0.2	2.9	0.89	1402.1	36.3	1418.4	24.9	1442.9	28.7
75	258.5	1671.7	1.85	20.7	106.6	0.0	107.1	0.0	10.0	0.09	30.6	3.1	31.7	33.4	112.6	1002.7
76	200.7	77418.2	1.20	9.6	1.4	4.1	3.9	0.3	3.6	0.93	1625.4	52.2	1655.4	31.9	1693.7	26.0
77	211.2	8103.8	4.95	17.4	9.1	0.5	9.4	0.1	2.3	0.25	408.2	9.1	424.5	32.6	514.3	200.1
78	198.4	1185.8	1.43	25.1	80.5	0.0	81.9	0.0	14.6	0.18	34.1	5.0	29.1	23.5	-366.4	2547.3
79	354.4	3845.2	1.18	19.1	39.4	0.1	41.8	0.0	14.0	0.33	77.8	10.8	85.2	34.2	299.1	932.3
80	204.4	99305.3	0.78	5.5	0.6	13.0	1.4	0.5	1.3	0.90	2698.9	27.7	2678.1	13.2	2662.4	10.2
81	2051.1	14036.6	2.08	20.8	12.9	0.0	14.8	0.0	7.3	0.50	33.8	2.5	34.8	5.1	99.9	305.4
82	201.2	2202.4	1.01	19.6	77.3	0.0	78.6	0.0	14.5	0.18	37.3	5.4	40.6	31.3	240.4	2151.9
83	488.3	5228.2	5.24	25.9	38.8	0.0	46.9	0.0	26.4	0.56	41.4	10.9	34.2	15.8	-448.2	1054.6
84	283.5	183765.4	4.40	13.7	1.7	1.7	5.0	0.2	4.7	0.94	1003.1	43.8	1004.8	32.0	1008.4	34.1
85	325.7	131849.8	1.74	10.6	0.8	3.4	1.4	0.3	1.1	0.80	1510.6	14.9	1512.1	10.9	1514.2	15.7
86	1189.0	12476.2	6.75	21.7	21.7	0.0	21.8	0.0	2.2	0.10	35.3	0.8	34.8	7.4	-2.2	527.5
87	61.7	602.8	0.87	8.2	168.0	0.1	172.7	0.0	40.0	0.23	35.5	14.2	89.8	149.5	1978.8	18.3
88	215.3	73725.6	1.51	12.1	1.9	2.4	2.2	0.2	1.2	0.53	1221.7	13.2	1233.0	16.0	1252.9	37.3
89	134.1	41521.0	0.73	13.4	3.7	1.9	4.0	0.2	1.6	0.41	1067.1	16.2	1066.2	26.6	1064.3	73.9
90	267.0	20458.0	2.17	10.2	1.5	3.6	6.0	0.3	5.8	0.97	1540.7	79.5	1558.4	47.7	1582.5	27.6
91	410.7	11825.2	1.95	20.9	10.1	0.1	11.0	0.0	4.3	0.39	99.0	4.2	98.9	10.3	96.4	239.6
92	993.2	9844.8	1.43	22.1	15.0	0.0	16.1	0.0	5.8	0.36	33.5	1.9	32.4	5.1	-44.7	366.6
93	621.5	248656.9	4.54	11.4	0.6	2.8	1.9	0.2	1.8	0.94	1354.8	21.7	1364.8	14.2	1380.6	12.2

94	313.5	132856.3	1.22	9.9	0.8	4.0	4.3	0.3	4.2	0.98	1607.2	59.6	1625.4	34.6	1648.9	14.3
95	289.0	180863.2	2.92	10.5	0.5	3.4	1.0	0.3	0.9	0.87	1470.0	12.0	1496.5	8.2	1534.4	9.5
96	264.9	92514.4	1.32	22.6	25.2	0.1	25.6	0.0	4.4	0.17	97.2	4.3	89.8	22.0	-101.8	628.6
97	802.9	15990.8	1.43	21.3	13.7	0.1	13.9	0.0	2.6	0.19	96.8	2.5	95.0	12.6	49.0	327.5
98	1093.2	2213.6	0.73	9.5	2.5	2.8	9.1	0.2	8.8	0.96	1154.1	92.6	1366.1	68.6	1715.1	46.6
99	1354.3	186.9	2.17	8.4	20.5	1.3	47.0	0.1	42.3	0.90	484.7	197.4	837.3	274.3	1941.2	370.2
100	362.6	18311.2	1.22	9.3	1.0	4.4	21.1	0.3	21.1	1.00	1690.4	314.3	1721.3	177.1	1759.1	18.5
LTG-80																
1	555.8	17641.0	2.14	23.1	10.0	0.0	10.5	0.0	3.1	0.30	45.5	1.4	42.0	4.3	-151.7	249.0
2	209.7	295314.6	2.83	5.6	0.2	12.4	1.8	0.5	1.8	0.99	2647.7	38.8	2634.9	16.9	2625.0	3.0
3	150.8	344088.6	1.51	3.7	0.1	25.2	1.4	0.7	1.4	1.00	3324.5	36.2	3316.2	13.7	3311.2	2.2
4	745.3	472206.5	1.35	5.5	0.1	12.5	1.4	0.5	1.4	1.00	2621.7	30.3	2646.4	13.2	2665.2	1.6
5	162.7	101798.7	1.20	3.7	0.3	25.8	1.0	0.7	1.0	0.96	3376.1	25.3	3338.8	9.8	3316.5	4.2
6	3133.3	6569.2	4.27	5.8	0.5	4.7	6.0	0.2	6.0	1.00	1161.8	63.9	1761.3	50.4	2571.2	7.6
7	199.0	253479.4	3.03	12.0	0.5	2.5	1.7	0.2	1.6	0.95	1256.6	18.2	1262.1	12.2	1271.5	10.7
8	309.4	342250.4	1.50	9.8	0.4	4.2	1.1	0.3	1.0	0.91	1674.1	14.5	1670.9	8.9	1667.0	8.3
9	220.1	99965.8	2.19	12.3	0.8	2.3	2.0	0.2	1.9	0.92	1211.3	20.5	1218.1	14.4	1230.4	15.9
10	945.6	1939.0	1.84	5.6	1.4	10.6	9.4	0.4	9.3	0.99	2322.2	182.0	2489.5	87.8	2629.0	23.2
11	562.3	7966.0	1.89	24.2	23.2	0.0	23.4	0.0	3.4	0.15	40.0	1.4	35.4	8.1	-266.2	594.3
12	1025.8	17783.6	0.58	21.1	6.0	0.0	6.3	0.0	1.9	0.30	37.3	0.7	37.7	2.3	65.1	143.6
13	103.3	48907.8	3.87	11.1	1.2	3.2	2.4	0.3	2.1	0.87	1470.9	27.1	1453.7	18.3	1428.6	22.3
14	249.6	82207.8	1.33	3.7	0.1	24.5	1.7	0.7	1.7	1.00	3246.6	42.8	3287.9	16.4	3313.3	1.6
15	85.5	39025.8	1.05	13.8	4.4	1.7	4.5	0.2	1.0	0.22	1018.9	9.4	1011.0	29.1	994.1	90.3
16	364.5	111287.9	5.42	13.8	0.5	1.7	1.3	0.2	1.2	0.92	989.8	10.7	990.6	8.0	992.3	10.4
17	719.3	18657.7	8.07	19.8	7.4	0.0	7.9	0.0	2.9	0.37	45.5	1.3	48.9	3.8	219.4	170.5
18	160.1	327797.2	1.32	3.7	0.1	25.3	1.1	0.7	1.1	1.00	3331.2	29.2	3319.1	11.0	3311.7	1.5
19	4398.5	1589.5	3.41	6.4	2.4	3.8	24.1	0.2	23.9	0.99	1050.3	232.1	1594.3	195.8	2413.3	41.0
20	285.9	3776.8	1.89	21.1	32.7	0.0	33.6	0.0	7.6	0.23	37.0	2.8	37.5	12.4	69.6	796.2
21	387.4	37833.8	1.50	18.4	1.7	0.4	2.1	0.1	1.3	0.60	376.0	4.6	376.8	6.6	381.3	37.9
22	99.7	41729.5	4.68	13.7	2.1	1.7	2.9	0.2	1.9	0.68	1017.1	18.2	1017.2	18.4	1017.3	42.9
23	672.1	331211.0	1.87	13.5	0.4	1.8	1.2	0.2	1.1	0.93	1034.3	10.3	1037.1	7.5	1043.1	8.5
24	571.0	7491.9	2.05	23.5	17.4	0.0	31.4	0.0	26.1	0.83	32.8	8.5	29.9	9.2	-195.2	437.5

25	222.1	60908.4	1.16	3.7	0.1	24.8	1.0	0.7	1.0	1.00	3284.5	26.5	3302.2	10.1	3313.0	1.4
26	170.8	215290.8	0.71	5.5	0.3	12.6	1.9	0.5	1.9	0.99	2633.9	40.1	2650.5	17.7	2663.2	5.0
27	775.2	14515.6	1.71	21.1	8.5	0.0	8.7	0.0	1.8	0.21	45.5	0.8	45.9	3.9	65.7	202.7
28	52.0	121489.1	1.39	3.7	0.4	25.8	1.1	0.7	1.0	0.93	3394.5	27.1	3339.3	10.8	3306.3	6.4
29	85.2	18100.8	1.56	17.8	9.5	0.5	9.8	0.1	2.7	0.28	396.9	10.5	405.7	32.9	456.1	210.4
30	66.0	63687.8	3.03	13.8	2.3	1.7	3.5	0.2	2.6	0.76	1016.8	24.5	1013.1	22.1	1005.1	45.9
31	85.2	123066.9	3.19	12.5	1.9	2.1	3.1	0.2	2.4	0.79	1121.4	25.0	1147.3	21.1	1196.6	37.1
32	111.0	105425.5	2.46	8.7	0.8	5.6	1.7	0.4	1.5	0.88	1935.2	24.9	1910.0	14.6	1882.7	14.6
33	45.1	37330.8	3.50	9.9	1.7	4.1	2.1	0.3	1.3	0.60	1649.9	18.7	1647.7	17.3	1644.9	31.4
34	121.7	207605.9	1.80	4.7	0.2	16.8	1.6	0.6	1.6	0.99	2948.5	37.8	2926.3	15.4	2911.1	3.3
35	234.7	137292.7	2.58	11.5	0.8	2.9	1.3	0.2	1.0	0.80	1385.7	12.5	1377.1	9.5	1363.8	14.6
36	67.2	35050.8	1.76	13.9	1.9	1.7	2.1	0.2	0.9	0.41	1018.7	8.2	1008.3	13.6	985.8	39.5
37	119.0	191949.2	1.20	3.7	0.1	25.5	1.0	0.7	1.0	0.99	3353.3	25.0	3328.2	9.4	3313.1	1.8
38	211.2	2637.7	1.43	7.1	20.5	6.2	21.9	0.3	7.7	0.35	1779.2	119.8	2005.7	193.9	2247.8	358.4
39	214.8	157816.1	3.47	9.4	0.3	4.5	0.9	0.3	0.9	0.93	1733.5	13.2	1738.1	7.8	1743.7	6.4
40	124.5	229489.5	1.47	3.7	0.1	25.6	1.2	0.7	1.2	1.00	3356.0	31.4	3330.3	11.8	3314.8	1.9
41	215.4	222923.9	1.12	5.3	0.2	15.2	13.0	0.6	13.0	1.00	2957.7	309.1	2827.1	124.7	2735.3	4.0
42	204.4	3065.0	2.53	21.8	24.1	0.0	24.9	0.0	6.5	0.26	43.7	2.8	42.9	10.5	-5.3	588.3
43	167.2	1108572.7	1.37	3.7	0.2	25.0	1.0	0.7	1.0	0.99	3302.3	24.9	3309.3	9.6	3313.5	2.5
44	340.4	475867.4	1.91	5.6	0.1	12.7	1.5	0.5	1.5	1.00	2697.8	33.9	2656.4	14.5	2625.0	2.1
45	87.6	266544.3	1.29	3.7	0.1	25.6	1.2	0.7	1.2	0.99	3357.9	32.1	3331.9	12.1	3316.3	2.2
46	92.7	94959.9	2.23	10.6	1.2	3.5	1.6	0.3	1.1	0.68	1524.5	14.6	1518.1	12.4	1509.1	21.7
47	93.1	290967.0	1.13	3.7	0.3	25.4	1.6	0.7	1.6	0.98	3334.5	41.8	3322.2	16.0	3314.8	5.3
48	256.4	702955.1	1.52	5.3	0.2	13.9	1.3	0.5	1.2	0.98	2757.7	27.9	2745.0	12.0	2735.6	4.1
49	133.6	229431.7	1.45	10.2	0.9	3.9	1.7	0.3	1.5	0.86	1630.9	21.2	1610.8	13.8	1584.5	16.2
50	138.8	57415.3	3.09	11.0	1.1	3.1	1.8	0.2	1.5	0.81	1429.3	18.9	1435.1	14.0	1443.8	20.5
51	159.1	151250.7	2.96	14.2	0.7	1.6	1.1	0.2	0.8	0.78	960.4	7.6	953.9	6.7	938.9	14.0
52	195.2	379927.5	1.11	3.7	0.1	25.5	1.6	0.7	1.6	1.00	3341.5	41.4	3327.7	15.5	3319.4	1.5
53	177.0	396699.0	1.11	3.7	0.1	25.8	2.1	0.7	2.1	1.00	3369.5	53.9	3339.2	20.1	3321.0	1.9
54	384.9	343092.7	2.65	9.3	0.3	4.7	0.7	0.3	0.7	0.93	1766.9	10.6	1762.5	6.2	1757.4	4.8
55	457.9	67134.5	3.74	18.3	2.2	0.4	2.3	0.1	0.5	0.23	371.4	1.9	375.8	7.2	403.4	50.2
56	122.0	95871.9	2.08	9.7	0.8	4.3	1.3	0.3	1.0	0.78	1698.9	15.3	1694.9	10.8	1690.0	15.0

57	299.3	4063.1	2.05	21.3	33.0	0.0	33.9	0.0	7.4	0.22	39.5	2.9	39.6	13.2	48.5	808.4	
58	126.9	132480.2	1.00	9.3	0.5	4.6	1.4	0.3	1.3	0.92	1756.3	19.8	1754.3	11.6	1751.8	9.7	
59	157.7	324536.3	1.30	3.7	0.1	25.3	1.2	0.7	1.2	0.99	3317.8	31.0	3319.8	11.8	3321.1	2.2	
60	136.2	100432.8	1.62	13.8	2.0	1.7	2.8	0.2	2.0	0.69	998.8	18.1	998.8	18.0	998.9	41.6	
61	465.5	11370.2	1.72	23.6	23.9	0.0	24.2	0.0	3.6	0.15	41.6	1.5	37.7	9.0	-203.4	606.8	
62	118.1	53462.6	0.85	13.0	1.1	2.0	1.8	0.2	1.5	0.81	1128.5	15.4	1125.4	12.5	1119.6	21.3	
63	137.3	214468.5	3.47	9.1	0.5	4.8	1.0	0.3	0.8	0.86	1775.4	12.8	1786.6	8.1	1799.8	9.0	
64	62.0	112733.8	1.36	7.7	1.2	6.9	1.8	0.4	1.3	0.74	2085.6	23.8	2093.6	16.1	2101.4	21.6	
65	97.3	95141.6	2.36	9.0	1.0	4.1	2.1	0.3	1.9	0.88	1541.7	25.5	1662.5	17.4	1818.6	18.6	
66	276.3	26291.3	0.77	19.2	5.2	0.2	5.5	0.0	1.6	0.30	158.8	2.6	167.3	8.5	290.0	119.6	
67	236.4	271420.4	1.85	4.4	0.2	18.5	1.0	0.6	1.0	0.99	3018.5	24.8	3018.7	10.0	3018.8	2.7	
68	86.1	46810.5	2.54	13.6	3.2	1.8	3.7	0.2	1.7	0.47	1073.1	17.1	1056.2	24.0	1021.5	65.3	
69	55.7	29889.5	2.39	12.9	3.0	2.1	4.0	0.2	2.6	0.66	1137.6	27.6	1138.7	27.2	1140.8	59.2	
70	127.4	143878.1	1.01	3.7	0.2	25.7	1.7	0.7	1.7	0.99	3366.5	43.3	3334.1	16.2	3314.8	2.8	
71	181.7	288943.0	1.46	5.3	0.2	13.9	1.5	0.5	1.5	0.99	2750.5	33.8	2742.6	14.4	2736.7	2.7	
72	226.3	6643.7	1.17	30.3	57.6	0.0	57.8	0.0	4.8	0.08	43.7	2.1	30.9	17.6	-877.7	1790.3	
63	73	149.7	43768.9	1.39	3.7	0.2	22.0	1.2	0.6	1.2	0.98	2982.5	29.1	3183.0	12.1	3311.9	3.6
74	129.7	62059.5	3.10	11.0	1.0	3.2	1.6	0.3	1.3	0.78	1452.5	16.4	1446.8	12.4	1438.6	19.1	
75	177.9	141462.9	1.65	9.2	0.4	4.7	0.8	0.3	0.7	0.88	1761.9	10.6	1771.7	6.5	1783.3	6.7	
76	29.1	11313.1	1.70	12.8	5.0	2.1	5.9	0.2	3.1	0.52	1166.3	33.0	1159.5	40.9	1147.0	100.0	
77	171.4	158678.2	1.33	5.3	0.2	13.9	0.8	0.5	0.8	0.98	2757.6	18.0	2745.7	7.8	2737.0	2.9	
78	144.4	192377.8	1.21	3.7	0.2	25.0	0.8	0.7	0.8	0.97	3303.8	21.0	3309.9	8.2	3313.6	3.1	
79	121.7	66692.9	1.17	11.0	0.8	3.3	1.3	0.3	1.0	0.78	1495.7	13.9	1473.5	10.5	1441.7	16.1	
80	113.7	119608.5	1.26	3.7	0.2	25.4	1.4	0.7	1.4	0.99	3333.5	35.7	3323.8	13.5	3317.9	2.6	
81	283.9	3818.8	0.65	32.5	43.0	0.0	43.2	0.0	3.3	0.08	37.0	1.2	24.5	10.5	-1081.7	1350.2	
82	125.2	169725.6	3.06	10.8	0.6	3.2	1.3	0.3	1.1	0.86	1445.9	14.4	1457.9	10.0	1475.5	12.3	
83	166.9	33343.7	2.25	19.4	4.3	0.4	6.2	0.1	4.4	0.72	385.5	16.5	369.0	19.0	266.7	98.3	
84	4152.9	194.3	2.89	7.0	4.7	1.2	20.3	0.1	19.8	0.97	385.6	74.1	805.2	113.5	2256.1	81.0	
85	856.9	1590.0	2.32	5.6	0.3	8.9	5.0	0.4	5.0	1.00	1984.2	85.8	2330.3	45.9	2648.9	4.2	
86	55.5	35915.6	2.88	11.1	2.2	3.1	2.7	0.3	1.6	0.60	1444.8	20.7	1437.9	20.7	1427.7	41.3	
87	247.2	18466.1	1.44	11.9	2.7	2.5	7.1	0.2	6.6	0.92	1256.5	75.0	1271.6	51.6	1297.2	53.2	
88	54.9	49840.5	2.24	13.3	4.5	1.9	4.7	0.2	1.1	0.23	1088.9	10.6	1085.4	31.0	1078.4	91.0	

89	169.2	207131.2	1.62	9.1	0.5	4.9	2.6	0.3	2.6	0.98	1816.9	40.4	1810.6	22.1	1803.4	9.9	
90	203.9	174172.6	1.11	13.5	1.0	1.8	1.3	0.2	0.8	0.60	1050.4	7.6	1048.1	8.5	1043.3	21.1	
91	148.9	424563.5	1.05	3.7	0.2	25.0	1.0	0.7	1.0	0.98	3282.7	24.9	3306.5	9.7	3321.0	3.3	
92	240.0	17375.0	2.51	19.1	39.5	0.0	39.9	0.0	5.2	0.13	38.3	2.0	42.8	16.7	301.4	935.0	
93	173.8	761835.1	1.38	3.7	0.2	25.4	1.1	0.7	1.1	0.99	3332.9	27.9	3324.2	10.6	3318.9	2.4	
94	181.7	401222.4	1.66	5.3	0.3	14.0	0.9	0.5	0.8	0.94	2760.8	18.5	2746.7	8.3	2736.4	4.9	
95	130.0	73673.2	2.23	9.2	0.6	4.6	1.2	0.3	1.0	0.86	1733.7	15.5	1754.0	9.9	1778.3	11.0	
96	189.1	147491.5	0.94	9.5	0.5	4.4	1.4	0.3	1.3	0.92	1711.2	19.5	1710.5	11.6	1709.6	10.1	
97	85.9	173831.0	0.92	3.7	0.3	25.3	2.0	0.7	2.0	0.99	3320.0	52.0	3320.2	19.7	3320.3	4.1	
98	126.3	198413.3	1.32	3.7	0.1	25.3	1.5	0.7	1.5	1.00	3327.6	40.0	3320.8	15.1	3316.7	2.3	
99	309.2	262624.3	2.93	5.6	0.2	12.7	1.1	0.5	1.1	0.99	2688.4	23.4	2659.8	10.1	2638.0	2.7	
100	76.5	30610.1	1.54	13.7	1.8	1.7	2.0	0.2	0.9	0.47	1031.8	9.0	1023.7	13.1	1006.3	36.3	
101	208.2	359258.2	0.93	3.7	0.1	25.4	0.7	0.7	0.7	0.99	3330.5	18.5	3325.1	7.0	3321.9	1.6	
102	141.4	194103.2	1.67	5.3	0.1	14.1	1.3	0.5	1.3	0.99	2777.8	29.6	2754.4	12.5	2737.3	2.4	
103	146.9	332255.5	1.34	3.7	0.2	25.8	0.6	0.7	0.6	0.96	3370.2	15.4	3339.8	5.9	3321.6	2.6	
OB-Base																	
64	1	166.5	122345.0	0.81	8.6	0.5	5.5	1.4	0.3	1.3	0.94	1912.3	21.2	1907.4	11.7	1902.1	8.4
	2	26.4	25556.8	0.77	9.0	2.1	5.0	2.4	0.3	1.2	0.50	1801.6	18.8	1812.9	20.1	1826.0	37.3
	3	248.3	208198.6	2.11	10.5	0.4	3.5	2.0	0.3	2.0	0.98	1530.8	26.8	1534.2	15.8	1538.8	6.8
	4	38.6	19308.3	1.73	13.4	5.9	1.8	6.0	0.2	0.9	0.15	1061.6	8.8	1060.0	39.2	1057.0	118.6
	5	175.2	249424.1	0.59	8.3	0.2	5.8	0.8	0.3	0.7	0.95	1928.4	12.3	1943.3	6.7	1959.2	4.1
	6	218.1	131467.7	2.63	12.1	0.8	2.5	1.3	0.2	1.0	0.75	1259.3	11.1	1262.6	9.3	1268.3	16.5
	7	111.3	64135.9	1.48	11.1	0.9	3.1	1.7	0.2	1.4	0.85	1432.8	18.3	1429.9	12.9	1425.5	17.1
	8	95.6	42735.3	1.59	13.3	1.8	1.8	2.2	0.2	1.2	0.55	1046.4	11.5	1056.7	14.3	1078.0	36.6
	9	446.3	5898.7	1.31	21.9	27.6	0.0	27.9	0.0	3.9	0.14	30.4	1.2	29.8	8.2	-15.7	678.8
	10	185.7	88127.4	2.75	12.3	0.8	2.3	1.4	0.2	1.2	0.83	1215.7	13.1	1220.3	10.1	1228.4	15.5
	11	86.7	17025.5	0.96	18.7	4.9	0.5	5.3	0.1	2.0	0.37	428.5	8.2	415.5	18.0	344.1	110.6
	12	73.3	103319.8	2.69	9.3	1.0	4.4	1.7	0.3	1.4	0.81	1683.7	20.9	1718.9	14.4	1762.1	18.4
	13	255.2	2162.8	1.87	15.0	26.0	0.0	27.0	0.0	7.3	0.27	25.5	1.9	36.4	9.7	833.7	550.1
	14	88.3	1171.0	0.68	6.4	196.3	0.1	196.9	0.0	14.7	0.07	35.3	5.2	114.1	215.7	2422.8	163.6
	15	727.2	6030.9	1.04	20.1	23.0	0.0	23.5	0.0	4.9	0.21	28.0	1.4	30.0	6.9	186.2	541.2
	16	1019.4	22191.4	2.16	21.2	7.1	0.0	7.4	0.0	2.2	0.30	47.9	1.0	48.2	3.5	61.9	169.0

17	42.7	43827.1	0.76	9.9	2.4	4.2	2.9	0.3	1.7	0.59	1687.3	25.3	1667.0	23.8	1641.6	43.7
18	95.2	60370.4	3.52	9.4	0.7	4.8	1.2	0.3	1.0	0.84	1820.9	16.4	1779.9	10.3	1732.2	12.4
19	75.6	9198.8	2.06	18.3	13.2	0.5	13.3	0.1	2.1	0.16	383.9	7.8	386.2	42.9	400.3	296.1
20	133.8	16015.0	3.37	12.6	1.7	2.1	2.1	0.2	1.1	0.55	1152.0	12.1	1159.7	14.3	1174.0	34.1
21	657.1	13479.6	1.52	20.9	15.5	0.0	15.7	0.0	2.5	0.16	30.8	0.8	31.5	4.9	86.9	370.0
22	209.2	265368.3	1.81	9.5	0.4	4.5	1.4	0.3	1.4	0.97	1748.1	20.9	1737.0	11.7	1723.7	6.5
23	186.7	174276.1	2.03	13.2	0.5	1.9	2.1	0.2	2.1	0.97	1092.5	20.9	1089.3	14.3	1082.9	10.2
24	433.2	7075.7	1.23	22.0	20.7	0.0	21.2	0.0	4.8	0.23	29.5	1.4	28.7	6.0	-36.1	506.1
25	96.7	76154.4	2.20	11.6	1.4	2.8	1.8	0.2	1.1	0.61	1343.6	13.6	1343.3	13.6	1342.8	27.9
26	107.3	64643.4	2.31	12.7	2.0	2.2	2.2	0.2	1.1	0.48	1176.5	11.5	1171.7	15.5	1162.8	38.8
27	71.6	95968.4	2.70	7.8	1.0	6.7	2.5	0.4	2.3	0.92	2077.4	40.3	2071.7	21.8	2066.1	17.3
28	916.4	583491.2	3.30	11.6	2.5	0.7	6.2	0.1	5.7	0.91	378.2	20.8	550.0	26.3	1344.7	48.6
29	543.4	5273.0	1.22	26.6	27.3	0.0	27.7	0.0	4.9	0.18	28.1	1.4	22.7	6.2	-511.2	739.5
30	238.8	528110.2	1.78	9.6	0.6	4.2	1.0	0.3	0.8	0.80	1669.6	11.3	1679.7	7.9	1692.3	10.6
31	80.4	88944.5	1.26	12.6	2.1	2.1	2.8	0.2	1.9	0.66	1134.4	19.7	1151.7	19.6	1184.5	42.0
32	284.4	4200.1	1.46	25.4	24.7	0.0	25.2	0.0	4.8	0.19	35.7	1.7	30.2	7.5	-387.1	651.2
33	136.1	2009.4	1.09	2.9	843.9	0.3	844.0	0.0	12.5	0.01	35.1	4.4	237.8	#NUM!	3709.5	273.1
34	73.7	105674.1	1.43	5.0	0.4	14.9	1.4	0.5	1.4	0.97	2790.9	31.3	2811.3	13.6	2826.1	5.9
35	36.1	23682.6	2.38	12.4	3.9	2.3	4.3	0.2	1.6	0.38	1195.5	17.9	1201.4	30.0	1212.2	77.5
36	86.9	70850.3	1.28	11.5	0.8	2.9	1.4	0.2	1.1	0.82	1383.6	13.9	1376.2	10.3	1364.7	15.2
37	52.1	29854.5	1.45	12.4	2.5	2.4	3.0	0.2	1.5	0.51	1269.2	17.6	1247.6	21.3	1210.5	50.1
38	125.5	54425.2	1.38	12.6	1.7	2.2	2.5	0.2	1.9	0.74	1178.2	20.2	1179.0	17.7	1180.5	33.7
39	227.2	316050.0	1.60	11.8	0.9	2.6	1.7	0.2	1.5	0.85	1303.5	17.2	1303.6	12.6	1303.7	17.6
40	42.2	35822.4	1.50	12.6	2.9	2.2	3.2	0.2	1.5	0.46	1195.6	15.9	1192.0	22.5	1185.6	56.3
41	318.0	24676.4	2.17	9.4	0.4	4.3	2.3	0.3	2.2	0.99	1658.8	32.6	1694.4	18.7	1738.7	7.1
42	199.3	9426.2	1.08	17.8	42.5	0.0	42.9	0.0	5.6	0.13	34.2	1.9	41.0	17.2	457.1	985.5
43	71.3	52449.4	0.94	10.8	1.4	3.2	2.0	0.3	1.4	0.73	1456.5	18.9	1465.2	15.4	1477.9	25.9
44	229.7	2621.2	1.18	24.5	37.9	0.0	38.7	0.0	7.7	0.20	28.7	2.2	25.2	9.7	-294.0	998.9
45	122.4	232544.4	2.25	8.7	0.7	5.3	1.4	0.3	1.2	0.86	1870.2	20.2	1872.1	12.4	1874.2	13.5
46	54.1	29247.6	1.02	10.3	0.9	3.4	2.3	0.3	2.1	0.92	1480.5	28.2	1515.8	18.1	1565.5	16.5
47	87.6	118732.6	1.04	9.8	0.9	4.1	1.9	0.3	1.7	0.88	1640.8	24.9	1647.2	15.9	1655.4	17.0
48	192.7	1151.9	1.08	28.2	53.0	0.0	53.7	0.0	9.1	0.17	32.7	3.0	25.0	13.2	-668.3	1555.1

99	49	246.1	3935.5	1.94	21.6	25.7	0.0	26.2	0.0	4.6	0.18	44.1	2.0	43.5	11.1	8.2	628.3
	50	42.5	40819.2	1.88	13.1	4.4	1.8	4.7	0.2	1.8	0.37	1040.3	17.0	1059.5	31.2	1099.3	88.0
	51	214.8	231803.7	2.76	11.0	0.9	3.0	2.3	0.2	2.1	0.92	1405.8	27.1	1419.3	17.9	1439.6	17.7
	52	174.4	40828.9	1.50	9.9	0.5	4.0	1.3	0.3	1.2	0.91	1626.6	17.1	1631.9	10.6	1638.9	10.1
	53	37.7	359999.9	1.03	8.8	1.2	5.2	2.7	0.3	2.4	0.89	1837.6	38.1	1850.9	22.8	1865.8	22.3
	54	139.7	96503.2	5.60	13.4	1.4	1.9	2.9	0.2	2.5	0.87	1090.9	25.1	1082.3	19.1	1065.0	28.5
	55	552.6	13460.5	0.91	23.6	18.8	0.0	19.2	0.0	3.6	0.19	30.0	1.1	27.3	5.2	-205.9	475.6
	56	206.4	208362.4	2.59	11.0	0.9	3.2	8.4	0.3	8.4	0.99	1453.5	108.9	1449.2	65.1	1442.9	17.6
	57	326.5	5630.7	4.78	12.7	1.3	2.1	1.8	0.2	1.4	0.73	1117.2	13.9	1133.9	12.6	1165.9	24.8
	58	150.6	220755.4	3.27	9.4	0.4	4.7	2.2	0.3	2.1	0.98	1786.2	33.1	1765.6	18.2	1741.4	8.2
	59	196.1	129266.5	1.93	9.7	0.5	4.1	1.5	0.3	1.4	0.95	1651.7	20.6	1664.0	12.2	1679.4	8.6
	60	171.4	241208.9	2.28	9.8	0.5	4.2	1.0	0.3	0.8	0.85	1676.8	12.4	1670.3	8.1	1662.1	9.7
	61	245.7	301827.2	2.45	9.5	0.4	4.5	1.7	0.3	1.6	0.96	1740.6	25.0	1735.1	14.1	1728.5	8.2
	62	234.1	19618.0	0.97	20.6	6.4	0.2	6.7	0.0	1.8	0.27	171.0	3.1	167.7	10.4	121.4	152.0
	63	277.0	39014.0	2.44	12.1	2.1	0.3	6.6	0.0	6.3	0.95	186.8	11.6	294.3	16.9	1266.9	41.0
	64	200.1	185568.4	0.86	8.5	0.3	5.7	1.2	0.3	1.2	0.96	1932.8	19.5	1930.7	10.5	1928.3	6.2
	65	608.3	4119.9	0.52	25.5	25.8	0.0	26.4	0.0	5.5	0.21	26.6	1.5	22.5	5.9	-397.7	682.1
	66	267.9	7676.0	2.37	22.4	24.8	0.0	25.0	0.0	3.6	0.14	47.2	1.7	44.9	11.0	-73.9	613.5
	67	415.2	8465.2	1.43	21.3	28.3	0.0	28.7	0.0	4.3	0.15	26.5	1.1	26.7	7.5	42.8	689.3
	68	686.4	8132.2	0.83	21.1	22.2	0.0	22.6	0.0	4.4	0.19	27.9	1.2	28.3	6.3	64.1	533.5
	69	56.8	33234.4	1.23	12.6	2.2	2.1	2.4	0.2	1.0	0.41	1141.2	10.2	1155.6	16.6	1182.6	43.3
	70	195.6	137447.1	2.61	12.0	0.6	2.5	1.1	0.2	0.9	0.81	1264.8	10.0	1271.6	7.8	1282.9	12.4
	71	87.9	23812.7	1.10	13.5	2.7	1.7	3.3	0.2	1.8	0.56	1015.0	17.2	1021.9	21.0	1036.8	54.6
	72	598.4	9913.9	1.74	22.0	32.9	0.0	33.0	0.0	3.3	0.10	26.8	0.9	26.2	8.5	-30.9	815.8
	73	300.6	5131.4	1.32	29.1	34.4	0.0	35.0	0.0	6.6	0.19	27.9	1.8	20.6	7.2	-762.1	991.5
	74	137.2	58729.2	1.37	16.1	2.4	0.9	2.7	0.1	1.3	0.46	647.3	7.8	654.7	13.2	680.3	51.9
	75	445.9	7049.5	0.96	18.5	24.4	0.0	24.9	0.0	5.2	0.21	27.2	1.4	31.5	7.7	369.2	556.6
	76	130.3	4301.3	1.28	25.9	104.2	0.0	104.4	0.0	7.3	0.07	57.5	4.2	47.4	48.4	-438.4	1440.7
	77	713.4	9171.8	2.05	20.6	14.5	0.0	14.9	0.0	3.6	0.24	30.5	1.1	31.8	4.7	129.9	341.5
	78	505.2	14245.3	1.39	20.7	19.9	0.0	20.0	0.0	1.7	0.09	37.5	0.6	38.7	7.6	119.7	473.2
	79	649.9	3486.3	1.71	19.6	18.1	0.0	18.5	0.0	3.6	0.20	30.6	1.1	33.4	6.1	241.7	420.2
	80	58.2	78401.9	1.26	9.7	1.4	4.3	1.9	0.3	1.2	0.64	1686.2	17.7	1684.7	15.4	1682.8	26.8

81	224.9	206067.1	1.39	9.4	0.3	4.5	1.0	0.3	1.0	0.95	1737.0	14.8	1738.5	8.6	1740.3	6.0
82	186.3	138555.8	0.94	9.6	0.6	4.3	1.0	0.3	0.8	0.82	1677.3	12.4	1684.6	8.5	1693.8	11.0
83	309.9	636.1	0.84	14.9	26.7	0.0	27.7	0.0	7.2	0.26	33.7	2.4	48.2	13.0	847.5	565.0
84	148.5	130206.9	2.26	9.9	0.6	4.0	1.2	0.3	1.1	0.88	1613.7	15.1	1630.0	9.8	1651.1	10.8
85	661.9	1095.9	1.78	19.6	18.1	0.0	22.4	0.0	13.1	0.59	24.1	3.2	26.3	5.8	236.4	421.4
86	290.8	3100.5	1.45	18.8	30.3	0.0	31.2	0.0	7.2	0.23	30.3	2.2	34.5	10.6	336.9	701.1
87	128.0	43311.8	2.26	13.4	1.8	1.8	2.4	0.2	1.6	0.67	1016.7	15.4	1029.8	15.8	1057.8	36.7
88	124.0	256209.0	0.78	12.1	1.0	2.4	1.4	0.2	1.0	0.73	1247.0	11.9	1253.4	10.4	1264.5	19.4
89	598.8	5128.7	1.70	22.0	30.6	0.0	31.0	0.0	4.8	0.16	27.7	1.3	27.1	8.3	-27.3	758.0
90	332.5	31776.7	3.37	9.2	0.5	2.2	7.8	0.1	7.8	1.00	884.9	64.4	1180.2	54.5	1771.3	8.9
91	112.0	222075.6	1.14	9.8	0.6	4.2	1.8	0.3	1.7	0.94	1688.5	25.7	1673.9	15.1	1655.7	11.2
92	100.8	99949.2	1.09	8.2	0.6	6.1	1.3	0.4	1.1	0.89	1998.7	19.5	1994.5	11.1	1990.2	10.3
93	63.8	72364.9	1.73	8.9	1.0	5.2	1.6	0.3	1.2	0.76	1851.2	19.0	1846.0	13.3	1840.2	18.5
94	324.8	891.0	2.61	5.5	5.6	11.5	6.9	0.5	4.0	0.58	2408.8	79.8	2560.8	64.2	2683.5	92.8
95	218.2	98287.4	2.98	14.2	1.3	1.6	2.2	0.2	1.7	0.79	976.4	15.5	966.5	13.5	944.0	27.2
96	204.0	319989.3	2.56	10.7	0.4	3.4	1.1	0.3	1.0	0.91	1515.0	13.2	1511.1	8.4	1505.5	8.3
97	293.9	2443.6	0.99	17.2	108.7	0.0	108.9	0.0	7.0	0.06	29.0	2.0	35.9	38.5	529.1	700.8
98	255.9	153184.0	1.65	5.6	0.2	12.6	1.1	0.5	1.1	0.99	2665.4	23.8	2649.8	10.4	2638.0	3.0
99	103.5	109439.5	2.50	11.1	1.0	3.1	2.7	0.3	2.6	0.94	1448.8	33.2	1442.3	21.1	1432.5	18.5
100	252.4	244484.1	5.98	9.7	0.4	4.3	1.5	0.3	1.5	0.97	1688.8	21.9	1686.6	12.5	1683.9	6.8
101	268.0	304064.5	1.98	9.7	0.3	4.2	1.7	0.3	1.6	0.98	1678.6	24.0	1681.0	13.6	1683.9	5.7
102	895.0	23805.6	2.33	21.1	8.0	0.1	9.8	0.0	5.6	0.58	49.3	2.8	49.6	4.7	65.8	190.3
103	17.6	9576.1	1.81	14.0	10.0	1.8	10.6	0.2	3.6	0.34	1072.5	35.1	1041.1	69.0	975.8	203.6
WS-225																
1	595.7	7380.1	0.80	26.5	23.5	0.0	23.6	0.0	2.4	0.10	30.0	0.7	24.3	5.7	-508.8	633.1
2	77.5	168956.6	0.77	6.3	0.8	10.0	1.6	0.5	1.5	0.88	2413.5	29.3	2430.8	15.2	2445.4	13.0
3	2875.9	217.1	2.65	11.9	1.1	0.5	6.3	0.0	6.3	0.99	246.2	15.1	377.6	20.0	1290.4	20.8
4	325.5	4616.6	1.19	22.5	56.6	0.0	57.8	0.0	11.7	0.20	32.1	3.8	30.6	17.4	-83.8	1501.0
5	452.6	55350.5	2.91	5.3	0.2	13.3	2.8	0.5	2.8	1.00	2670.6	61.7	2703.7	26.7	2728.5	3.1
6	437.2	33948.5	5.04	13.3	0.5	1.9	1.1	0.2	1.0	0.90	1073.4	9.9	1073.7	7.4	1074.3	9.9
7	85.6	66726.7	2.78	11.5	0.9	2.8	1.6	0.2	1.3	0.81	1361.7	15.4	1359.7	11.7	1356.6	17.8
8	217.8	104524.7	1.55	12.7	0.9	2.1	1.5	0.2	1.2	0.81	1164.8	13.1	1163.5	10.5	1160.9	17.5

9	427.6	7468.1	1.24	25.0	36.0	0.0	39.2	0.0	15.5	0.40	33.4	5.2	28.6	11.1	-353.8	956.3
10	332.4	140357.6	1.29	13.9	0.5	1.6	1.2	0.2	1.1	0.90	988.5	9.9	987.8	7.6	986.4	10.4
11	409.9	226.1	1.24	13.6	61.9	0.1	62.2	0.0	6.0	0.10	89.7	5.3	135.1	78.8	1030.6	1400.3
12	132.3	134455.5	0.78	8.9	0.5	5.2	1.1	0.3	1.0	0.88	1842.4	15.3	1844.6	9.2	1847.1	9.1
13	102.1	252895.2	0.42	5.1	0.3	14.7	0.7	0.5	0.7	0.94	2816.1	15.6	2796.8	6.9	2782.9	4.2
14	266.5	5081.9	1.33	23.6	21.9	0.0	25.3	0.0	12.6	0.50	31.7	4.0	28.9	7.2	-202.1	555.3
15	3485.6	111.1	18.81	5.6	3.8	1.9	36.3	0.1	36.1	0.99	472.3	164.4	1074.9	245.2	2649.2	62.4
16	436.5	8102.7	2.10	13.3	1.3	1.9	2.3	0.2	1.9	0.83	1089.8	19.4	1085.6	15.5	1077.3	25.7
17	170.3	1180197.5	2.75	4.6	0.1	17.2	1.2	0.6	1.2	0.99	2948.9	27.5	2946.3	11.3	2944.5	2.3
18	193.5	2719.9	1.82	11.2	1.8	2.8	2.0	0.2	1.0	0.49	1325.3	11.8	1360.5	15.1	1416.1	33.6
19	130.5	11848.2	1.53	18.4	8.8	0.3	9.0	0.0	1.7	0.19	268.3	4.4	281.2	22.0	389.5	198.1
20	80.7	32079.4	2.29	12.8	2.5	2.0	2.6	0.2	0.9	0.35	1111.2	9.3	1122.1	17.9	1143.1	49.0
21	210.1	189485.7	10.73	5.5	0.2	12.9	1.2	0.5	1.2	0.99	2673.4	25.5	2671.5	11.1	2670.1	3.2
22	60.9	49735.8	0.99	9.7	1.5	4.2	2.0	0.3	1.3	0.67	1659.7	19.4	1666.9	16.2	1676.0	27.0
23	95.3	96056.8	1.20	5.3	0.3	13.8	1.1	0.5	1.0	0.95	2740.8	22.4	2734.9	10.0	2730.5	5.1
24	526.9	754.3	3.63	18.7	21.4	0.1	21.7	0.0	3.8	0.18	59.9	2.3	67.6	14.2	349.5	488.5
25	159.8	194079.8	0.96	9.8	0.7	4.2	1.5	0.3	1.3	0.90	1681.7	19.7	1668.7	12.1	1652.3	12.1
26	274.5	258125.9	6.10	11.1	0.6	2.9	1.3	0.2	1.2	0.90	1348.3	14.1	1379.9	9.7	1429.1	10.6
27	40.9	37158.6	1.00	9.3	2.4	4.7	2.6	0.3	1.1	0.43	1768.1	17.3	1766.2	22.0	1764.0	43.5
28	60.4	43503.9	3.50	12.8	3.2	2.0	3.3	0.2	0.9	0.26	1101.8	8.7	1116.2	22.3	1144.3	63.1
29	97.8	56102.3	1.31	13.7	2.4	1.7	3.0	0.2	1.8	0.61	990.4	16.8	996.1	19.1	1008.5	48.2
30	155.7	196456.8	2.41	9.7	0.5	4.3	2.1	0.3	2.1	0.98	1708.4	31.4	1699.3	17.7	1688.1	8.6
31	1135.1	12244.5	0.70	19.6	11.4	0.0	12.0	0.0	3.9	0.32	27.4	1.1	30.0	3.6	242.3	262.9
32	549.8	13517.7	1.72	19.9	8.1	0.1	8.4	0.0	2.4	0.28	47.6	1.1	50.9	4.2	209.4	187.1
33	337.5	1674.9	1.81	11.4	1.2	2.6	1.8	0.2	1.4	0.74	1251.9	15.4	1299.7	13.5	1379.6	23.9
34	62.2	44058.4	0.92	5.4	0.7	13.6	2.1	0.5	2.0	0.95	2743.0	44.2	2721.5	19.8	2705.6	11.0
35	173.8	26839.9	1.37	9.7	0.8	3.4	9.3	0.2	9.2	1.00	1398.3	116.1	1515.5	73.1	1683.2	14.0
36	3559.5	6570.9	9.88	13.6	0.2	1.5	1.9	0.1	1.9	1.00	899.1	16.1	937.5	11.8	1028.8	3.4
37	108.6	57862.8	1.86	12.8	2.5	2.1	2.9	0.2	1.5	0.53	1167.0	16.2	1161.9	20.0	1152.4	48.7
38	161.8	243903.2	3.30	8.5	0.4	5.7	1.5	0.4	1.4	0.96	1935.1	23.8	1929.2	12.8	1922.8	7.6
39	239.2	87477.8	0.99	8.8	0.3	5.2	1.5	0.3	1.4	0.98	1847.8	22.9	1854.3	12.4	1861.6	5.2
40	303.9	109055.8	1.52	11.2	0.5	3.0	1.5	0.2	1.4	0.94	1400.4	17.3	1406.9	11.1	1416.8	9.5

69

41	644.7	1438.0	5.88	4.0	4.3	19.0	9.0	0.6	7.9	0.88	2843.1	181.2	3041.2	87.0	3174.8	68.8
42	171.2	43721.6	1.03	18.8	2.7	0.5	4.4	0.1	3.5	0.80	451.7	15.3	433.1	15.5	335.4	60.2
43	476.9	7314.9	1.46	18.6	19.7	0.0	20.1	0.0	3.7	0.19	29.3	1.1	33.7	6.7	357.5	449.0
44	184.4	13554.0	3.46	13.5	1.5	1.7	2.6	0.2	2.1	0.81	1001.6	19.3	1014.1	16.4	1041.1	29.9
45	395.8	392478.4	5.55	9.7	0.2	4.3	1.5	0.3	1.5	0.99	1688.3	22.6	1687.7	12.7	1687.1	3.9
46	326.3	76911.9	0.96	9.2	0.2	4.5	1.0	0.3	1.0	0.97	1694.6	14.8	1734.4	8.5	1782.7	4.3
47	78.2	15608.5	2.62	9.4	0.9	4.1	3.9	0.3	3.8	0.97	1570.1	52.8	1646.8	31.8	1746.1	17.4
48	101.0	3373.5	1.88	10.6	3.1	2.8	11.9	0.2	11.5	0.97	1264.7	132.0	1358.5	89.4	1509.2	58.7
49	45.1	11990.4	1.46	16.4	7.3	0.7	7.5	0.1	1.9	0.25	549.1	10.0	567.3	32.7	640.9	156.8
50	29.4	11286.8	1.13	17.0	15.0	0.8	15.5	0.1	3.8	0.25	589.1	21.4	584.5	68.9	566.8	328.3
51	95.9	74887.7	1.61	10.0	0.9	3.9	1.3	0.3	1.0	0.75	1593.8	14.1	1609.3	10.8	1629.7	16.4
52	334.4	301406.7	3.51	9.1	0.3	4.8	0.6	0.3	0.6	0.88	1753.4	8.5	1777.7	5.3	1806.3	5.5
53	123.2	85600.3	0.93	12.7	1.8	2.2	8.0	0.2	7.8	0.97	1171.3	83.1	1167.7	55.3	1161.1	35.7
54	156.8	64117.7	2.34	13.2	0.7	1.9	1.2	0.2	1.0	0.81	1097.9	10.1	1095.5	8.3	1090.7	14.6
55	18.5	19057.1	0.71	9.8	5.7	4.1	5.9	0.3	1.7	0.29	1662.0	25.4	1663.9	48.5	1666.3	104.9
56	236.0	12372.5	1.00	11.0	0.6	3.0	1.4	0.2	1.2	0.91	1406.1	15.6	1419.0	10.4	1438.5	10.8
57	179.3	4200.3	1.26	23.0	40.5	0.0	41.2	0.0	7.9	0.19	33.7	2.6	31.4	12.8	-142.3	1040.0
58	571.7	94935.9	2.11	18.0	0.9	0.5	1.4	0.1	1.1	0.76	437.1	4.5	437.5	5.0	440.1	20.2
59	1878.0	832.0	1.27	12.1	3.2	0.7	13.9	0.1	13.5	0.97	372.7	48.9	525.1	57.0	1258.0	62.6
60	369.6	6544.4	1.41	23.8	21.8	0.0	22.1	0.0	3.3	0.15	30.3	1.0	27.3	6.0	-226.5	554.9
61	262.1	3838.0	1.33	28.2	54.1	0.0	54.7	0.0	8.4	0.15	34.5	2.9	26.3	14.2	-669.9	1594.0
62	236.4	149821.7	1.35	11.5	0.5	2.8	1.3	0.2	1.2	0.92	1329.2	14.1	1343.5	9.4	1366.4	9.4
63	365.9	23501.7	2.04	21.6	10.3	0.1	10.4	0.0	2.0	0.19	92.5	1.8	89.7	9.0	17.7	247.0
64	217.9	125917.5	3.10	11.3	1.0	2.7	2.5	0.2	2.3	0.91	1298.9	26.7	1332.4	18.5	1386.7	19.6
65	162.1	268436.8	3.62	8.6	0.4	5.4	1.4	0.3	1.3	0.95	1878.0	21.7	1889.2	12.0	1901.5	7.9
66	355.6	227240.9	2.32	6.2	0.8	10.0	1.8	0.5	1.7	0.91	2402.7	33.6	2436.2	17.0	2464.3	13.0
67	212.5	443095.1	1.55	5.9	0.2	11.0	1.2	0.5	1.2	0.99	2483.1	24.5	2522.4	11.2	2554.2	3.3
68	36.4	25617.3	4.67	10.8	3.1	3.3	3.3	0.3	1.3	0.40	1490.7	17.6	1482.8	26.0	1471.5	58.2
69	44.0	18387.4	1.92	13.7	3.9	1.8	4.1	0.2	1.4	0.33	1060.4	13.4	1045.5	27.0	1014.5	79.0
70	432.6	8935.4	1.51	26.8	26.9	0.0	27.1	0.0	3.6	0.13	31.3	1.1	25.1	6.7	-535.7	732.5
71	211.2	10204.8	1.03	9.4	1.0	3.9	8.0	0.3	8.0	0.99	1529.6	108.6	1616.0	65.0	1730.4	17.7
72	317.4	442236.2	1.77	11.0	0.4	3.2	1.4	0.3	1.3	0.95	1461.1	17.0	1456.6	10.7	1450.1	8.6

73	350.8	25159.2	3.60	18.4	2.4	0.5	3.0	0.1	1.8	0.59	381.8	6.7	381.7	9.6	381.2	54.8
74	122.3	153915.5	1.46	10.8	1.1	3.4	2.5	0.3	2.3	0.90	1513.5	30.6	1502.4	19.8	1486.7	20.7
75	230.3	5373.2	1.35	22.7	62.8	0.0	63.2	0.0	7.1	0.11	38.1	2.7	35.9	22.3	-109.2	1709.6
76	117.0	52455.2	0.73	9.9	0.9	4.0	1.1	0.3	0.7	0.61	1636.1	9.6	1640.1	8.8	1645.1	16.0
77	386.6	110739.0	0.97	9.2	0.4	4.7	4.3	0.3	4.2	0.99	1762.1	65.3	1768.4	35.7	1775.9	7.9
78	195.1	3541.4	1.45	17.1	48.4	0.0	49.7	0.0	11.5	0.23	35.0	4.0	43.7	21.3	548.5	1120.4
79	164.9	31785.6	1.58	18.0	4.3	0.5	5.2	0.1	2.9	0.56	434.0	12.4	435.0	18.5	440.2	95.9
80	197.8	3555.0	1.42	24.8	133.0	0.0	133.7	0.0	13.7	0.10	29.4	4.0	25.5	33.7	-327.0	0.0
81	98.4	75352.4	3.31	11.3	1.6	3.0	2.0	0.2	1.2	0.60	1392.8	15.0	1395.7	15.2	1400.1	30.9
82	240.6	50191.6	0.81	18.2	2.6	0.5	3.2	0.1	1.8	0.57	414.1	7.3	412.9	10.9	405.6	58.8
83	959.9	10906.3	1.69	21.0	9.8	0.0	9.9	0.0	1.4	0.14	36.9	0.5	37.5	3.6	75.5	232.7
84	238.4	147673.7	3.83	10.7	0.4	3.4	1.9	0.3	1.8	0.97	1513.2	24.7	1509.7	14.8	1504.9	7.9
85	331.4	209451.0	2.00	9.6	0.4	4.3	2.6	0.3	2.6	0.99	1709.5	38.3	1701.7	21.3	1692.2	6.6
86	27.9	27985.0	1.30	12.5	6.3	1.9	10.6	0.2	8.6	0.80	1019.7	80.8	1076.8	70.7	1194.2	124.7
87	121.8	96917.8	1.62	11.0	1.3	3.2	1.7	0.3	1.2	0.67	1463.6	15.1	1454.9	13.2	1442.3	24.1
88	235.7	3762.3	0.83	24.3	29.4	0.0	29.8	0.0	4.9	0.17	49.4	2.4	43.4	12.7	-274.9	760.8
89	110.8	217605.0	2.26	13.4	2.0	1.8	2.3	0.2	1.0	0.45	1046.3	9.9	1049.9	14.9	1057.4	41.0
90	92.8	2232.5	1.57	-11.6	389.7	-0.1	390.0	0.0	16.1	0.04	31.1	5.0	-59.8	-244.9	NA	NA
91	675.2	15404.0	1.03	21.0	3.3	0.1	3.8	0.0	1.7	0.45	117.0	2.0	115.4	4.1	82.5	79.4
92	46.5	67854.2	3.15	4.6	0.8	18.1	1.7	0.6	1.5	0.88	3025.5	35.4	2994.2	16.0	2973.3	12.8
93	626.2	14917.6	1.27	18.7	11.5	0.0	12.1	0.0	3.6	0.30	27.7	1.0	31.8	3.8	353.1	260.8
94	1177.4	10660.8	2.30	11.1	0.6	3.1	3.8	0.2	3.8	0.99	1435.2	49.0	1434.5	29.6	1433.4	10.9
95	379.9	26948.0	1.75	20.0	5.2	0.2	5.6	0.0	2.1	0.37	165.6	3.4	167.7	8.7	197.2	121.6
96	2208.8	103.4	4.39	9.8	10.2	0.3	10.9	0.0	3.7	0.34	154.1	5.7	298.1	28.2	1666.2	190.0
97	341.0	17216.6	4.55	17.6	3.8	0.5	4.2	0.1	1.8	0.43	385.4	6.7	398.9	13.9	478.4	84.0
98	342.8	2525.0	0.51	8.9	2.7	2.7	6.6	0.2	6.1	0.92	1047.0	58.7	1334.0	49.2	1830.0	48.2
99	519.7	40176.8	0.80	20.2	23.6	0.0	24.0	0.0	4.6	0.19	29.4	1.4	31.2	7.4	176.4	557.0
100	76.1	26857.0	1.53	13.0	3.4	2.1	3.5	0.2	1.0	0.28	1157.8	10.5	1146.6	24.1	1125.4	66.9
101	410.7	434261.1	0.79	5.6	0.1	12.5	0.7	0.5	0.7	0.99	2631.2	14.2	2639.4	6.3	2645.6	1.6
102	208.6	143709.5	1.76	9.0	0.3	4.8	1.3	0.3	1.3	0.96	1763.6	19.5	1788.6	11.0	1817.9	6.3
103	90.8	125944.6	1.50	9.5	1.6	4.3	2.1	0.3	1.4	0.65	1673.7	20.3	1694.2	17.4	1719.7	29.3

References

- Amato, J.M., Boullion, A.O., Serna, A.M., Sanders, A.E., Farmer, G.L., Gehrels, G.E., and Wooden, J.L., 2008, Evolution of the Mazatzal province and the timing of the Mazatzal orogeny: Insights from U-Pb geochronology and geochemistry of igneous and metasedimentary rocks in southern New Mexico: Geological Society of America Bulletin, v. 120, no. 3-4, p. 328-346.
- Anderson, J.L., 1983, Proterozoic anrogenic granite plutonism of North America, in Medaris, L.G., Byers, C.W., Mickelson, D.M., and Shank, W.C., eds., Proterozoic Geology: Selected Papers from an International Proterozoic Symposium: Geological Society of America Memoir 161, p. 133-154.
- Armstrong, R.L., and Ward, P.L., 1993, Late Triassic to earliest Eocene magmatism in the North American Cordillera: Implications for the Western Interior Basin, in Caldwell, W.G.E., and Kauffman, E.G., eds., Evolution of the Western Interior Basin: Geological Association of Canada Special Paper 39, p. 49-72.
- Best, M.G., and Christiansen, E.H., 1991, Limited extension during peak Tertiary volcanism, Great Basin of Nevada and Utah: Journal of Geophysical Research, v. 96, p. 13,509-13,528.
- Best, M.G., Christiansen, E.H., and Gromme, S., 2013, The 36–18 Ma southern Great Basin, USA, ignimbrite province and flareup: Swarms of

- subduction-related supervolcanoes: *Geosphere*, v. 9, p. 260-274, doi:10.1130/GES00870.1.
- Cather, S.M., Chapin, C.E., and Kelley, S.A., 2012, Diachronous episodes of Cenozoic erosion in southwestern North America and their relationship to surface uplift, paleoclimate, paleodrainage and paleoaltimetry: *Geosphere*, v. 8, no. 6, p. 1177-1206.
- Chadwick, R.A., 1981, Chronology and structural setting of volcanism in southwestern and central Montana, *Montana Geological Society Field Conference and Symposium Guidebook to Southwest Montana*, p. 301-310.
- Childs, O.E., Steele, G., Salvador, A., and Lindberg, F.A., 1988, Correlation of stratigraphic units in North America (COSUNA) Project: AAPG, Tulsa, Oklahoma, 20 map sheets.
- Clark, J., 1975, Controls of sedimentation and provenance of sediments in the Oligocene of the central Rocky Mountains, in Curtis, B.F., ed., *Cenozoic history of the southern Rocky Mountains*: Geological Society of America Memoir, v. 144, p. 97-118, doi:10.1130/MEM144-p95.
- Condie, K.C., 1982, Plate-tectonics model for Proterozoic continental accretion in the southwestern United States: *Geology*, v. 10, p. 37-42, doi:10.1130/0091-7613(1982)10<37:PMFPCA>2.0.CO;2.

Condra, G.E., and Reed, E.C., 1943, The Geological Section of Nebraska, Nebraska Geological Survey Bulletin, no. 14, p. 1-82.

Cunningham, C.G., Rowley, P.D., Steven, T.A., and Rye, R.O., 2007, Geologic evolution and mineral resources of the Marysvale volcanic field, west-central Utah, in Willis, G.C., Hylland, M.D., Clark, D.L., and Chidsey, T.C., Jr., eds., Central Utah: Diverse Geology of a Dynamic Landscape: Utah Geological Association Publication 36, p. 143-161.

DeCelles, P.G., 2004, Late Jurassic to Eocene evolution of the Cordilleran thrust belt and foreland basin system, western U.S.A.: American Journal of Science, v. 304, p. 105-168.

Dickinson, W.R., 1985, Interpreting provenance relations from detrital modes of sandstones, in Zuffa, G.C., ed., Provenance of Arenites: Hingham, Massachusetts, D. Reidel Publishing Company, p. 333-361.

Dickinson, W.R., 2004, Evolution of the North American Cordillera: Annual Review of Earth and Planetary Sciences, v. 32, p. 13-45.

Dickinson, W.R., 2008, Impact of differential zircon fertility of granitoid basement rocks in North America on age populations of detrital zircons and implications for granite petrogenesis: Earth and Planetary Science Letters, v. 275, p. 80–92, doi:10.1016/j.epsl.2008.08.003.

Dickinson, W.R., and Gehrels, G.E., 2003, U-Pb ages of detrital zircons from Permian and Jurassic eolian sandstones of the Colorado Plateau, USA:

Paleogeographic implications: Sedimentary Geology, v. 163, p. 29-66,
doi: 10.1016/S0037-0738(03)00158-1.

Dickinson, W.R., and Gehrels, G.E., 2009, U-Pb ages of detrital zircons in Jurassic eolian and associated sandstones of the Colorado Plateau: Evidence for transcontinental dispersal and intraregional recycling of sediment: Geological Society of America Bulletin, v. 121, p. 408-433.

Dickinson, W.R., and Lawton, T.F., 2001, Carboniferous to Cretaceous assembly and fragmentation of Mexico, Geological Society of America Bulletin, v. 113, no. 9, p. 1142-1160, doi:10.1130/0016-7606(2001)113<1142:CTCAAF>2.0.CO;2.

Dickinson, W.R., and Snyder, W.S., 1978, Plate tectonics of the Laramide orogeny, in Matthews, V., ed., Laramide folding associated with basement block faulting in the western United States: Geological Society of America Memoir 151, p. 355-366.

Dickinson, W.R., and Suczek, C., 1979, Plate tectonics and sandstone compositions: The American Association of Petroleum Geologists Bulletin, v. 63, p. 2164-2182.

Dickinson, W.R., Beard, L.S., Brakenridge, G.R., Erjavec, J.L., Ferguson, R. C., Inman, K.F., Knepp, R.A., Lindberg, F.A., and Ryberg, P.T., 1983, Provenance of North American Phanerozoic sandstones in relation to

- tectonic setting: Geological Society of America Bulletin, v. 94, p. 222-235.
- Dickinson, W.R., Klute, M.A., Hayes, M.J., Janecke, S.U., Lundin, E.R., McKittrick, M.A., and Olivares , M.D., 1988, Paleogeographic and paleotectonic setting of Laramide sedimentary basins in the central Rocky Mountain region: Geological Society of America Bulletin, v. 100, p. 1023-1039, doi:10.1130/00167606(1988)100<1023:PAPSOL>2.3.CO;2.
- Dickinson, W. R., T. F. Lawton, M. Pecha, S. J. Davis, G. E. Gehrels, and R. A. Young, 2012, Provenance of the Paleogene Colton Formation (Uinta Basin) and Cretaceous-Paleogene Provenance Evolution in the Utah Foreland: Evidence from U-Pb Ages of Detrital Zircons, Paleocurrent Trends, and Sandstone Petrofacies, Geological Society of America: Geosphere, vol. 8, no. 4, p. 854-880.
- Doughty, P.T., Price, R.A., and Parrish, R.R., 1998, Geology and U-Pb geochronology of Archean basement and Proterozoic cover in the Priest River complex, northwestern United States, and their implications for Cordilleran structure and Precambrian continent reconstructions, Canadian Journal of Earth Sciences, v. 35, p. 39-54, doi:10.1139/cjes-35-1-39.
- Emry, R. J., 1973, Stratigraphy and preliminary biostratigraphy of the Flagstaff Rim Area, Natrona County, Wyoming: Smithsonian contributions to paleobiology, v. 18, p. 1-43.

Emry, R. J., 1975, Revised Tertiary stratigraphy and paleontology of the Western Beaver Divide, Fremont County, Wyoming: Smithsonian contributions to paleobiology, v. 25, p. 1-20.

Eriksson, K.A., Campbell, I.H., Palin, J.M., and Allen, C.M., 2003, Predominance of Grenvillian magmatism recorded in detrital zircons from modern Appalachian rivers: The Journal of Geology, v. 111, p. 707-717, doi:10.1086/378338.

Evanoff, E., 1990a, Late Eocene and early Oligocene paleoclimates as indicated by the sedimentology and nonmarine gastropods of the White River Formation near Douglas, Wyoming, 493 p.

Fan, M., and B. Carrapa, 2014, Late Cretaceous–early Eocene Laramide uplift, exhumation, and basin subsidence in Wyoming: Crustal responses to flat slab subduction, Tectonics, 33, 509-529, doi:10.1002/2012TC003221.

Fan, M., DeCelles, P.G., Gehrels, G. E., Dettman, D.L., and Peyton, S. L., 2011, Sedimentology, detrital zircon geochronology, and stable isotope geochemistry of the lower Eocene strata in the Wind River Basin, central Wyoming: GSA Bulletin, v. 123, no. 5/6, p. 979-996.

Fanning, C. M., Flint, R. B., A. J. Parker, Ludwig, K. R., and Blissett, A. H., 1988, Refined Proterozoic evolution of the Gawler Craton, South Australia, through U-Pb zircon geochronology The early to middle

Proterozoic of Australia Precambrian Research, v. 40-41, p. 363-386,
doi:10.1016/0301-9268(88)90076-9.

Ferrari, L., Valencia-Moreno, M., and Bryan, S., 2007, Magmatism and tectonics
of the Sierra Madre Occidental and its relation with the evolution of the
western margin of North America, in Alaniz-Álvarez, S.A., and Nieto-
Samaniego, Á.F., eds., Geology of México: Celebrating the Centenary of
the Geological Society of México: Geological Society of America Special
Paper 422, p. 1-39.

Folk, R.L., 1974, Petrology of sedimentary rocks: Austin, Texas, Hemphill
Publishing Co., second edition, 182 p.

Folk, R.L., 1980, Petrology of Sedimentary Rocks: Austin, Texas, Hemphill
Publishing Company, 184 p.

Frost, B. R., K. R. Chamberlain, S. Swapp, C. D. Frost, and T. P. Hulsebosch,
2000, Late Archean Structural and Metamorphic History of the Wind
River Range: Evidence for a Long-Lived Active Margin on the Archean
Wyoming Craton, Geological Society of American Bulletin, vol. 112, no.
4, p. 564-578.

Gehrels, G.E., 2011, Detrital Zircon U-Pb Geochronology: Current Methods and
New Opportunities, in Busby, C. and A. Azo, eds., Tectonics of

Sedimentary Basins: Recent Advances, Chichester, UK, John Wiley & Sons.

Gehrels, G.E., Valencia, V., and Ruiz, J., 2008, Enhanced precision, accuracy, efficiency, and spatial resolution of U-Pb ages by laser ablation–multicollector–inductively coupled plasma–mass spectrometry: *Geochemistry Geophysics Geosystems*, v. 9, p. Q03017, doi: 10.1029/2007GC001805.

Gehrels, G.E., Blakey, R., Karlstrom, K.E., Timmons, J.M., Dickinson, B., and Pecha, M., 2011, Detrital zircon U-Pb geochronology of Paleozoic strata in the Grand Canyon, Arizona: *Lithosphere*, v. 3, p. 183-200, doi:10.1130/L121.1.

Gleason, J.D., Gehrels, G.E., Dickinson, W.R., Patchett, P.J., and Kring, D.A., 2007, Laurentian sources for detrital zircon grains in turbidite and deltaic sandstones of the Pennsylvanian Haymond Formation, Marathon assemblage, west Texas, USA: *Journal of Sedimentary Research*, v. 77, p. 888-900, doi:10.2110/jsr.2007.084.

Goldberg, S.A., and Dallmeyer, R.D., 1997, Chronology of Paleozoic metamorphism and deformation in the Blue Ridge thrust complex, North Carolina and Tennessee, *American Journal of Science*, v. 297, p. 488-526.

Hansen, W.R., 1986, Neogene Tectonics and Geomorphology of the Eastern Uinta Mountains in Utah, Colorado, and Wyoming, U.S. Geological Survey Professional Paper, v. 1356, p. 1-78.

Hatcher, R.D., Jr., 1989, Tectonic synthesis of the U.S. Appalachians, in Hatcher, R.D., Jr., et al., eds., The Appalachian-Ouachita orogen in the United States: Boulder, Colorado, Geological Society of America, Geology of North America, v. F-2, p. 511–535.

Heller, P.L., Dueker, K., and McMillan, M.E., 2003, Post-Paleozoic alluvial gravel transport as evidence of continental tilting in the U.S. Cordillera: Geological Society of America Bulletin, v. 115, p. 1122-1132.

Hoffman, P.F., 1988, United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia: Annual Review of Earth and Planetary Sciences, v. 16, p. 543- 603,
doi:10.1146/annurev.ea.16.050188.002551.

Hoffman, P.F., 1989, Speculations on Laurentia's first gigayear (2.0 to 1.0 Ga): Geology, v. 17, p. 135-138, doi:10.1130 /0091-7613(1989)017<0135:SOLSGF>2.3.CO;2.

Honey, J.G., and Izett, G.A., 1988, Paleontology, taphonomy, and stratigraphy of the Browns Park Formation (Oligocene and Miocene) near Maybell, Moffat County, Colorado: U.S. Geological Survey Professional Paper 1358, 52 p.

Ingersoll, R.V., Bullard, T.F., Ford, R.L., Grimm, J.P., Pickle, J.D., and Sares, S.W., 1984, The effect of grain size on detrital modes: A test of the Gazzie-Dickinson point-counting method: *Journal of Sedimentary Petrology*, v. 54, p. 103-116.

Izett, G.A., 1975, Late Cenozoic sedimentation and deformation in northern Colorado and adjoining areas, in Curtis, B.F., ed., Cenozoic history of the Southern Rocky Mountains: Geological Society of America Memoir 144, p. 179-209.

Izett, G. A., Denson, N. M., and Obradovich, J. D., 1970, K-Ar age of the lower part of the Browns Park Formation, northwestern Colorado: U.S. Geological Survey Professional Paper 700-C, p. C150-C152.

Jones, J.V., Shaw, C.A., Allen, J.L., and Housh, T., 2013, U-Pb zircon age constraints on two episodes of Paleoproterozoic magmatism and development of the Grizzly Creek shear zone, White River Uplift, western Colorado, U.S.A., *Rocky Mountain Geology*, v. 48, no. 1, p. 15-39.

Karlstrom, K.E., Amato, J.M., Williams, M.L., Heizler, M.T., Shaw, C.A., Read, A.S., and Bauer,P., 2004, Proterozoic tectonic evolution of the New Mexico region: A synthesis, in Mack, G.H., and Giles, K.A., eds., *The Geology of New Mexico; A Geologic History*: New Mexico Geological Society Special Publication 11, p. 1-34.

Kauffman, E.G., 1985, Cretaceous evolution of the Western Interior Basin of the United States, in Pratt, L.M., Kauffman, E.G., and Zelt, F.B., eds., Fine-grained deposits and biofacies of the Cretaceous Western Interior Seaway: Evidence of cyclic sedimentary processes: Society of Economic Paleontologists and Mineralogists, 1985 Midyear Meeting, Golden, Colorado, Field Trip Guidebook No. 4, p. iv-xiii.

LaGarry, H.E., 1998, Lithostratigraphic revision and redescription of the Brule Formation (White River Group) of northwestern Nebraska, in Terry, D.O., Jr., LaGarry, H.E., and Hunt, R.M., Jr., eds., Depositional Environments, Lithostratigraphy, and Biostratigraphy of the White River and Arikaree Groups (Late Eocene to Early Miocene, North America): Boulder, Colorado, Geological Society of America Special Paper 325, p. 63-92.

LaMaskin, T.A., Vervoort, J.D., Dorsey, R.J., and Wright, J.E., 2011, Early Mesozoic paleogeography and tectonic evolution of the western United States: Insights from detrital zircon U-Pb geochronology, Blue Mountains Province, northeastern Oregon, Geological Society of America Bulletin, v. 123, p. 1939-1965, doi:10.1130/B30260.1.

Lillegraven, J.A., 1993, Correlation of Paleogene strata across Wyoming—a users' guide, in Snee, A.W., Steidtmann, J.R., and Roberts, S.M., eds., Geology of Wyoming: Geological Survey of Wyoming Memoir No. 5, p. 417-477.

Lipman, P.W., 2007, Incremental assembly and prolonged consolidation of Cordilleran magma chambers: Evidence from the Southern Rocky Mountain volcanic field: *Geosphere*, v. 3, no. 1, p. 42-70.

Love, J. D., 1952, Preliminary Report on Uranium Deposits in the Pumpkin Buttes Area Powder River Basin, Wyoming, Geological Survey Circular, vol. 176, p. 1-37.

Love, J. D., 1960, Cenozoic Sedimentation and Crustal Movement in Wyoming, American Journal of Science, Bradley Volume, vol. 258-A, p. 204-214.

Love, J.D., and Christiansen, A.C., 1985, Geologic Map of Wyoming: U.S. Geological Survey, scale 1:500,000.

Ludwig, K. L., 2008, Isoplot 3.70. A geochronological toolkit for Microsoft Excel: Berkeley Geochronology Center Special Publication 4, p. 1-77.

Mackey, G.N., Horton, B.K., and Milliken, K.L., 2012, Provenance of the Paleocene-Eocene Wilcox Group, western Gulf of Mexico basin: Evidence for integrated drainage of the southern Laramide Rocky Mountains and Cordilleran arc: *Geological Society of America Bulletin*, v. 124, no. 5/6, p. 1007-1024.

Martin, C. A., 1965, Denver Basin, *Bulletin of the American Association of Petroleum Geologists*, vol. 49, no. 11, p. 1908-1925.

May, S.R., Gray, G.G., Summa, L.L., Stewart, N.R., Gehrels, G.E., and Pecha, M.E., 2013, Detrital zircon geochronology from the Bighorn Basin,

- Wyoming, USA: Implications for tectonostratigraphic evolution and paleogeography, Geological Society of America Bulletin, v. 125, no. 9-10, p. 1403-1422, doi:10.1130/B30824.1.
- McIntosh, W.C., Chapin, C.E., Ratte, J.C., and Sutter, J.F., 1992, Time-stratigraphic framework for the Eocene-Oligocene Mongollon-Datil volcanic field, southwest New Mexico: Geological Society of America Bulletin, v. 104, p. 851-871.
- McMillan, M.E., Heller, P.L., and Wing, S.L., 2006, History and causes of post-Laramide relief in the Rocky Mountain orogenic plateau: Geological Society of America Bulletin, v. 118, p. 393-405.
- Moecher, D.P., and Samson, S.D., 2006, Differential zircon fertility of source terranes and natural bias in the detrital zircon record: implications for sedimentary provenance analysis: Earth and Planetary Science Letters, v. 247, p. 252-266.
- Naeser, C.W., Izett, G.A., and Obradovich, J.D., 1980, Fission-track and K-Ar ages of natural glasses: U.S. Geological Survey Bulletin, v. 1489, 31 p.
- Nourse, J.A., Premo, W.R., Iriondo, A., and Stahl, E.R., 2005, Contrasting Proterozoic basement complexes near the truncated margin of Laurentia, northwestern Sonora–Arizona international border region, in Anderson, T.H., Nourse, J.A., McKee, J.W., and Steiner, M.B., eds., The Mojave-Sonora Megashear Hypothesis: Development, Assessment, and

- Alternatives: Geological Society of America Special Paper 393, p. 123-182.
- Pelletier, J.D., 2009, The impact of snowmelt on the late Cenozoic landscape of the southern Rocky Mountains, USA: GSA Today, v. 19, p. 4-10, doi: 10.1130/GSATG44A.1.
- Picard, M.D., 1993, The early Mesozoic history of Wyoming, in Snoker, A.W., Steidtmann, J.R., and Roberts, S.M., eds., Geology of Wyoming: The Geological Survey of Wyoming Memoir 5, p. 211-248.
- Prothero, D.R., and Emry, R.J., 2004, The Chadronian, Orellan, and Whitneyan North American Land Mammal Ages, in Woodburne, M.O., eds., Late Cretaceous and Cenozoic Mammals of North America: Biostratigraphy and Geochronology, Columbia University Press, New York, p. 21-43.
- Prothero, D.R., and Sanchez, F., 2004, Magnetic stratigraphy of the middle to upper Eocene section at Beaver Divide, Fremont County, Wyoming. New Mexico Museum of Natural History and Science Bulletin, v. 26, p. 149-152.
- Ross, G.M., and Villeneuve, M.E., 2003, Provenance of the Mesoproterozoic (1.45 Ga) Belt basin (western North America): Another piece in the pre-Rodinia paleogeographic puzzle: Geological Society of America Bulletin, v. 115, p. 1191-1217, doi: 10.1130/B25209.1.

Rowley, Jillian. "Timing, Provenance, and Paleoclimate Implications of the Cenozoic Eolian Deposition in the Central Rocky Mountains, USA." Order No. 1551774 The University of Texas at Arlington, 2013. Ann Arbor: ProQuest. Web. 16 June 2014.

Scott, J., and Bowring, S.A., 2000, High precision U/Pb geochronology of Oligocene tuffs from the White River Formation, Douglas, Wyoming: Society of Vertebrate Paleontology, v. 20, no. 3, p. 69A.

Sharp, W. N. and A. M. White, 1956, Geology of the Pumpkin Buttes Area of the Powder River Basin, Campbell and Johnson Counties, Wyoming, Trace Elements Memorandum Report, vol. 899, p. 1-12.

Snoke, A.W., 1993, Geologic history of Wyoming within the tectonic framework of the North American Cordillera, in Snoke, A.W., Steidtmann, J.R., and Roberts, S.M., eds., Geology of Wyoming: Geological Survey of Wyoming Memoir No. 5, p. 2-56.

Steidtmann, J.R., and Middleton, L.T., 1986, Eocene-Pliocene stratigraphy along the southern margin of the Wind River Range, Wyoming: Revisions and implications from field and fission-track studies, The Mountain Geologist, v. 23, no. 1, p. 19-25.

Steidtmann, J.R., Middleton, L.T., and Schuster, M.W., 1989, Post-Laramide (Oligocene) uplift in the Wind River Range, Wyoming: Geology, v. 17, p. 38-41, doi:10.1130/00917613(1989)017<0038:PLOUIT>2.3.CO;2.

Stewart, J.H., Gehrels, G.E., Barth, A.P., Link, P.K., Christie-Blick, N., and Wrucke, C.T., 2001, Detrital zircon provenance of Mesoproterozoic to Cambrian arenites in the western United States and northwestern Mexico: Geological Society of America Bulletin, v. 113, p. 1343-1356, doi:10.1130/0016-7606(2001)113<1343:DZPOMT>2.0.CO;2.

Swinehart, J.B., Souders, V.L., DeGraw, H.M., and Diffendal, R.F., Jr., 1985, Cenozoic paleogeography of western Nebraska, in Flores, R.M., and Kaplan, S.S., eds., Cenozoic paleogeography of west-central United States: Rocky Mountain Paleogeography Symposium 3, Rocky Mountain Section: Tulsa, Society of Economic Paleontologists and Mineralogists, p. 209-229.

Swisher, C.C., III, and Prothero, D.R., 1990, Single crystal 40Ar/39Ar dating of the Eocene- Oligocene transition in North America: Science, v. 249, p. 760-762.

Thomas, H. D., 1949, Geological History and Geological Structure of Wyoming, The Geological Survey of Wyoming, vol. 42, p. 1-29.

Thomas, W.A., Becker, T.P., Samson, S.D., and Hamilton, M.A., 2004, Detrital zircon evidence of a recycled orogenic foreland provenance for Alleghanian clastic-wedge sandstones: The Journal of Geology, v. 112, p. 23–37.

Torres, R., Ruiz, J., Patchett, P.J., and Grajales, J.M., 1999, Permo-Triassic continental arc in eastern Mexico: Tectonic implications for reconstructions of southern North America, in Bartolini, C., Wilson, J.L., and Lawton, T.F., eds., Mesozoic Sedimentary and Tectonic History of North-Central Mexico: Geological Society of America Special Paper 340, p. 191-196.

Van Houten, F.B., 1964, Tertiary geology of the Beaver Rim area, Fremont and Natrona Counties, Wyoming: U.S. Geological Survey Bulletin, v. 1164, 99 p.

Van Schmus, W.R., Bickford, M.E., Sims, P.K., Anderson, J.L., Shearer, C.K., and Treves, S.B., 1993, Proterozoic geology of the western midcontinent region, in Reed, J.C., Bickford, M.E., Houston, R.S., Link, P.K., Rankin, D.W., Sims, P.K., and Van Schmus, W.R., eds., Precambrian Conterminous U.S.: Geological Society of America, The Geology of North America, v. C-2, p. 239–259.

Van Schmus, W.R., Bickford, M.E., and Turek, A., 1996, Proterozoic geology of the east-central mid-continent basement, in van der Pluijm, B.A., and Catacosinos, P.A., eds., Basement and Basins of Eastern North America: Geological Society of America, Special Paper 308, p. 7–32.

Vondra, C.F., Schultz, C.B., and Stout, T.M., 1969, New Members of the Gering Formation (Miocene) in Western Nebraska, Nebraska Geological Survey Paper, no. 18, p. 1-18.

Walker, D., 2014, NAVDAT: The Western North American Volcanic and Intrusive Rock Database, Retrieved July 31, 2014, from <http://www.navdat.org/>.

Wegemann, C.H., 1917, Wasatch fossils in so-called Fort Union beds of the Powder River Basin, Wyoming: U.S. Geological Survey Professional Paper, no. 108-D.

Whitmeyer, S. J., and Karlstrom, K. E., 2007, Tectonic model for the Proterozoic growth of North America: Geosphere, v. 3, no. 4, p. 220-259.

Woodburn, M.O., 2007, Mammal Ages, Stratigraphy, v. 3, no. 4, p. 229-261.

Zeller, H.D., and Stephens, E.V., 1969, Geology of the Oregon Buttes area Sweetwater, Sublette and Fremont counties southwestern Wyoming, U.S. Geological Survey Bulletin, no. 1256, p. 1-60.

Biographical Information

Alex Mankin is a United States Marine Corps veteran, serving from 1998 to 2007. His job in the Marine Corps was Electro-Optical Ordnance Technician and he was qualified to repair over 455 different pieces of ground based target acquisition devices. A Sergeant in 2003, he was deployed for the war in Iraq as the acting Staff Non-Commissioned Officer in Charge (SNCOIC) of his platoon. He left active duty later that year and in 2005, he was promoted to the rank of Staff Sergeant (E-6) becoming the reserve SNCOIC of a platoon in Waco, TX.

From 2005-2008, Alex worked for a small environmental remediation company as the Field Service Supervisor. In 2008, he left his job to pursue a Mechanical and Aerospace engineering degree at the University of Texas at Arlington. By the end of summer 2009, he realized that he did not like the amount of math required, and switched to Geology at his best friend's recommendation. Alex finished the Bachelors of Science in Geoinformatics at the end of summer 2011 and started working on the Masters of Science in Geology. He is currently employed by a small, but quickly growing, E&P company as the only operations geologist. His future goals are to continue to develop his professional knowledge and skills in the oil and gas industry.