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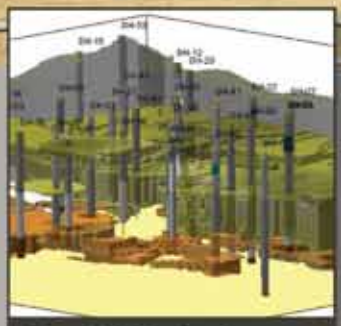

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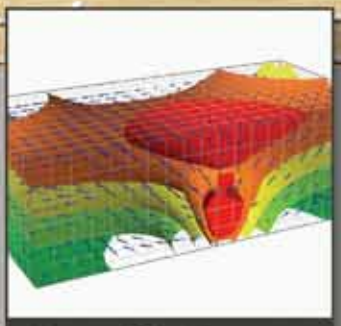

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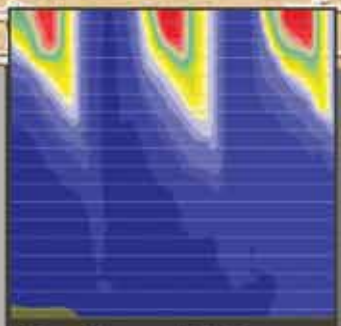

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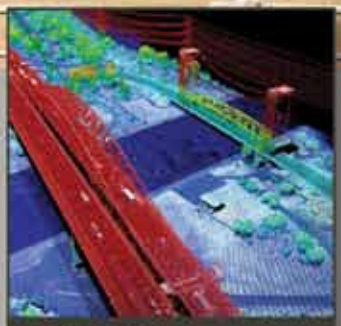

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SCIENCE ARTICLE

Cover: Well-bedded, deep-marine turbidites of the Middle Jurassic Snowshoe Formation in the Suplee-Izee area of eastern Oregon. Inset, detrital zircon grains recovered from a sandstone sample.

Erratum:
The affiliation given for *GSA Today* exceptional reviewer Martha O. Withjack in the Jan. 2012 *GSA Today* (v. 22, no. 1, p. 36) was the Mobil Exploration and Producing Technical Center. This is incorrect. Withjack is a professor at Rutgers University. *GSA Today* regrets this error.

Detrital zircon facies of Cordilleran terranes in western North America

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ABSTRACT

Paleozoic–Mesozoic basins in Cordilleran terranes of western North America contain detrital zircon U-Pb age distributions that vary over 10–100 Ma in a systematic and predictable manner. A minimum of four detrital zircon age distributions, here termed "detrital zircon facies," are present: (1) Paleoproterozoic and Archean facies, chiefly found in Paleozoic and early Mesozoic accretionary complexes, is defined by late Archean–early Proterozoic (ca. 2.7–2.3 Ga) and late Proterozoic ages (ca. 2.0–1.6 Ga) with variable quantities of Paleozoic and early Mesozoic ages. (2) Mixed Proterozoic and Phanerozoic facies is found in Early–Late Jurassic basins and is defined by grains spanning ca. 2.0 Ga–160 Ma, derived from eastern-southwestern Laurentian transcontinental sources and enriched by western U.S. and eastern Mexican early Mesozoic plate-margin magmatism. (3) Triassic and Jurassic facies, found in Late Jurassic–Early Cretaceous basins, is defined by Late Jurassic ages (peak ca. 155 Ma) with a subordinate proportion of Triassic ages (peak ca. 230 Ma). (4) Jurassic and Early Cretaceous facies is found in late Early–early Late Cretaceous marginal basins and is defined by Jurassic and Early Cretaceous ages (ca. 200–130 and ca. 130–100 Ma). Detrital zircon U-Pb ages from terranes of western North America record stages of basin formation during phases of the supercontinent cycle and reflect second-order variability in the tectonic setting of an active continental plate margin. At this temporal and spatial scale, the integrated evolution of orogenic, erosion, and sediment-transport systems controls sediment provenance.

INTRODUCTION

On a global time-integrated scale, detrital zircon U-Pb age distributions reflect episodic magmatic accretion of continental crust (i.e., first-order scale, 100–1000 Ma, e.g., Condie and Aster, 2009). At an order of magnitude finer scale (i.e., second-order, 10–100 Ma, 100,000 km^2 of rock), detrital zircon U-Pb age distributions in continental-margin basins should reflect the long-term distribution of orogenic belts, long-lived Andean-type magmatic arcs, and continental sediment-dispersal systems (e.g., Leeder, 1988; Patchett et al., 1999). Supporting evidence for this scale of tectonic control on sedimentary provenance in the ancient rock record exists, but is generally sparse and typically does not document transitional stages of paleotectonics (e.g., Rainbird et al., 1992; Riggs et al., 1996; Dickinson and Gehrels, 2003; Tyrrell et al., 2007; Druschke et al., 2011).

In this paper, my objectives are to use detrital zircon U-Pb data in terranes of western North America to (1) assess long-term provenance links to the Laurentian craton, (2) identify multi-stage sediment sources through time, and (3) emphasize second-order scale observation in detrital zircon U-Pb age studies. I suggest that this observational scale is critical for understanding changes in tectonic setting along active plate margins, as has been shown for neodymium isotopic values in continental sedimentary rocks (Patchett et al., 1999). In western North America, analysis of the detrital zircon record at this scale elucidates the transition from a marginal-basin regime (i.e., Karig, 1974; Tarney et al., 1981) during most of Paleozoic and early Mesozoic time, to an Andean-type integrated margin by Late Mesozoic time (i.e., McClelland et al., 1992; Saleeby and Busby-Spera, 1992; Dickinson et al., 1996; DeCelles, 2004) and argues against models invoking exotic ribbon continents (e.g., Johnston, 2008; Hildebrand, 2009).

DETRITAL ZIRCON AGE DISTRIBUTIONS IN WESTERN NORTH AMERICA

Over the past ~20 years, the application of U-Pb geochronology to detrital zircon grains has yielded significant insight concerning sediment sources to western North American basins. In particular, terranes of western North America have been extensively studied using detrital zircon U-Pb ages with numerous contrasting interpretations (e.g., Ross and Bowring, 1990; Miller and Saleeby, 1995; Gehrels and Kapp, 1998; Gehrels et al., 2000; Brown and Gehrels, 2007; Wright and Wyld, 2007; Grove et al., 2008; Scherer and Ernst, 2008; Snow and Ernst, 2008; Piercey and Colpron, 2009; LaMaskin et al., 2011).

Here, I compile published and new detrital zircon U-Pb ages from pre-Devonian–early Late Cretaceous, arc-related basins in terranes of western North America. The compilation includes terranes with sufficient available data from west of the $^{87/86}Sr_i$ = 0.706 line (Armstrong et al., 1977), from the southern California Coast Range to the Yukon-Tanana terrane in the north. My compilation, observations, and interpretations are specific to the time frame in this geographic range only; they are not intended to be a comprehensive review of Cordilleran provenance and tectonics, but rather, to serve as a starting point for continued investigation at this scale.

The overwhelming fundamental observation from the data is that regardless of interpreted terrane association, at a stratigraphic scale of 10–100 Ma, distinct age distributions are present in the same stratigraphic order along strike of the western North American margin. I recognize a minimum of four distinct detrital zircon age distributions in pre-Devonian–early Late Cretaceous clastic sedimentary successions in western North America. These age distributions vary systematically

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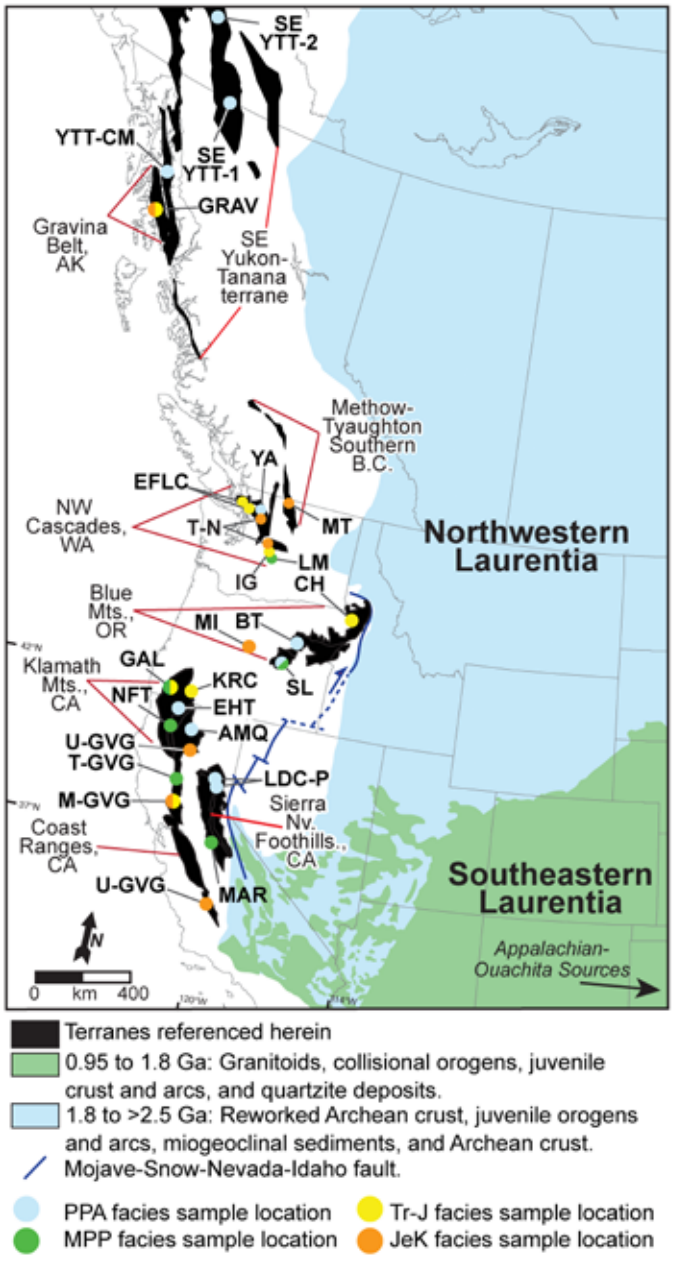

Figure 1. Map illustrating present-day location of terranes discussed in this paper, age distribution of Laurentian Precambrian crust, and detrital zircon sample locations: SEYTT—Southeastern Yukon-Tanana terrane; YTT-CM—Yukon-Tanana terrane in Coast Mountains; GRAV—Gravina Belt; MT—Methow-Tyaughton; EFLC—Easton-Fidalgo-Lummi-Constitution; YA—Yellow Aster; IG—Ingalls Graywacke; T-N—Tonga-Nooksack; LM—Lookout Mountain; CH—Coon Hollow; BT—Baker terrane; MI—Mitchell Inlier; SL—Snowshoe and Lonesome fms.; KRC—Klamath River Conglomerate; GAL—Galice; AMQ—Antelope Mountain Quartzite; EHT—Eastern Hayfork terrane; NFT—North Fork terrane; U-GVG—Upper Great Valley Group; T-GVG—"Tithonian" Great Valley Group; LDC-P—Lang-Duncan-Culberton allochthons and Picayune Valley Fm.; M-GVG—Middle Great Valley Group; MAR—Mariposa; JEK—Jurassic–Early Cretaceous; MPP—Mixed Proterozoic and Phanerozoic; and PPA—Paleoproterozoic and Archean. See Table DR1 for specific data sources[1]. Adapted from Gehrels (2001); Wyld and Wright (2001); DeGraaff-Surpless et al. (2002); Wyld et al. (2006); Brown and Gehrels (2007); Nelson and Gehrels (2007); base modified from Whitmeyer and Karlstrom (2007).

based on the depositional age and tectonic setting of the basin (cf. Gehrels, 2003).

1. Paleoproterozoic and Archean distribution (PPA; Figs. 1 and 2A) is defined by an age distribution of late Archean–early Proterozoic (ca. 2.7–2.3 Ga) and late Proterozoic ages (ca. 2.0–1.6 Ga), with variable quantities of Paleozoic and Early Mesozoic ages dependent on depositional age of the rocks. The majority of samples do not include Mesoproterozoic ages (ca. 1.5–1.0 Ga). PPA is dominant in Paleozoic rocks from California to Alaska, in terranes typically defined as subduction-accretionary complexes or subduction mélange.

2. Mixed Proterozoic and Phanerozoic distribution (MPP; Figs. 1 and 2B) is defined by a multimodal age distribution spanning 2.0–0.16 Ga, including distinct age ranges of (1) late Paleoproterozoic (ca. 2.0–1.6 Ga); (2) Mesoproterozoic (ca. 1.5–1.0 Ga); (3) Neoproterozoic (ca. 0.8–0.6 Ga); (4) early Paleozoic (ca. 0.5–0.35); (5) late Paleozoic (ca. 350–250 Ma); and (6) early Mesozoic (ca. 250–160 Ma). MPP is present in Early–Late Jurassic samples, typically in forearc/intra-arc basins in terranes defined as island-arc complexes.

3. Triassic and Jurassic distribution (TrJ; Figs. 1 and 3A) is defined by a dominant Middle–Late Jurassic (ca. 175–145 Ma) age distribution, with variable quantities of Triassic ages (ca. 250–220 Ma), and a general lack of Precambrian ages. (Note that Fig. 3A is truncated at 300 Ma.) TrJ is present in samples from an extensive belt of Late Jurassic–Early Cretaceous basins that has long been recognized as correlative but of unclear tectonic setting (i.e., Cowan and Brandon, 1981; Garver, 1988; McClelland et al., 1992; Miller and Saleeby, 1995).

4. Jurassic and Early Cretaceous distribution (JeK; Figs. 1 and 3B) is defined by an approximately bimodal age distribution of Jurassic–Early Cretaceous (ca. 200–130 Ma) and Early Cretaceous ages (ca. 130–100 Ma). JeK is found in samples from late Early–early Late Cretaceous basins, generally recognized as the forearc of the western North American Andean-style margin (i.e., Great Valley forearc) (Ingersoll, 1979; Degraaff-Surpless et al., 2002; Brown and Gehrels, 2007; Jacobson et al., 2011).

DISCUSSION

The compilation presented here shows sequential regularity in distinct detrital zircon U-Pb ages at a scale of 10–100 Ma. The detrital zircon age distributions represent a definable aspect of large bodies of rock, are observation based, and allow for distinction between adjacent units. As such, they are here designated "detrital zircon facies." The age ranges present in a given detrital zircon facies (i.e., their recognition criteria) relate directly to known regional source areas of both primary *and* recycled grains. In the following sections, I review each detrital zircon facies and implications for development of the western Laurentian margin (Fig. 4).

Paleozoic–Early Mesozoic Time

The provenance of PPA facies is either (1) crystalline sources in northwestern Laurentia (Gehrels et al., 1995, 2000), (2) rifted and translated crustal fragments of the Precambrian–Paleozoic

[1]GSA supplemental data item 2012079, Table DR1: Data sources, is available online at www.geosociety.org/pubs/ft2012.htm. You can also request a copy from *GSA Today*, P.O. Box 9140, Boulder, CO 80301-9140, USA; gsatoday@geosociety.org.

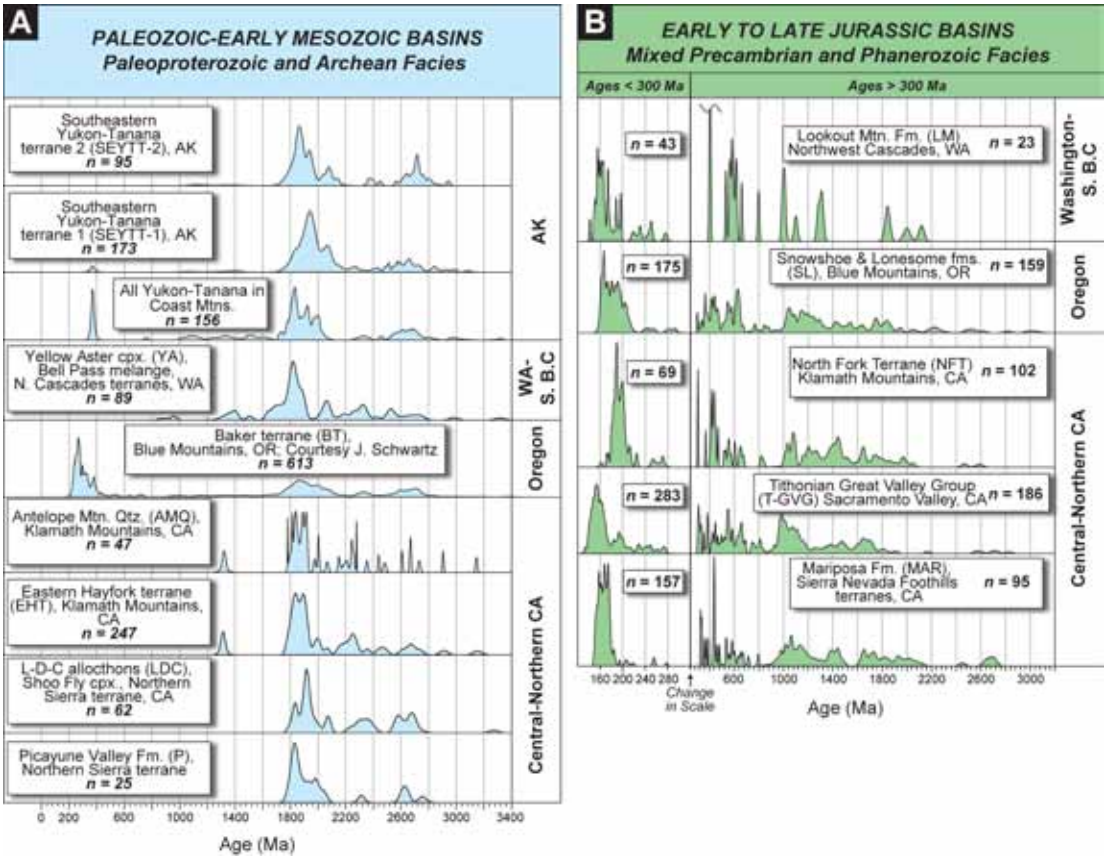

Figure 2. Detrital zircon U-Pb age data from (A) Paleozoic–Mesozoic subduction-accretionary complexes and (B) Early to Late Jurassic basins in island-arc complexes. Specific data sources are shown in Table DR1 (see footnote 1).

northwestern Laurentian miogeocline (Nelson and Gehrels, 2007; cf. Bradley et al., 2007; Beranek et al., 2010a), or (3) originally peri-Gondwanan/Avalonian crust that was tectonically emplaced along the southern Laurentian margin in early–mid-Paleozoic time and subsequently translated along the plate margin in mid–late Paleozoic time (Wright and Wyld, 2006; Grove et al., 2008). Thus, rocks bearing PPA facies may reflect sediment derivation from northwestern Laurentian sources enhanced by plate-margin magmatism or multicycle sediment reworking and tectonic translation of crustal fragments allochthonous to western North America.

Regardless of the ultimate source of age-characteristic zircon grains, PPA facies sand was present in arc-basin complexes on the western North American plate margin by mid-Paleozoic time (Harding et al., 2000; Spurlin et al., 2000; cf. Lindsley-Griffin et al., 2006), and was subsequently recycled along the margin (Fig. 4) (e.g., Scherer et al., 2010; LaMaskin et al., 2011). Noteworthy, non-PPA age distributions in Paleozoic accretionary-subduction complexes of the Klamath Mountains and Sierra Nevada may represent exotic crust, structurally intercalated with PPA-bearing rocks, or may suggest other explanations (e.g., Harding et al., 2000; Wright and Wyld, 2007; Grove et al., 2008).

Early–Late Jurassic Time

The age distribution in MPP facies represents transcontinental sand shed from the greater Ouachita-Appalachian orogeny and enriched by southwestern Laurentian sources, as well as early Mesozoic, plate-margin magmatism in the western U.S. and eastern Mexico (Fig. 4; cf. Dickinson and Gehrels, 2003, 2009; Rahl et al., 2003). The presence of a transcontinental signature in each of these Early–Late Jurassic basins (Fig. 2B; cf. Izsak et al., 2007; Dickinson and Gehrels, 2008a, 2009; LaMaskin et al., 2011) suggests proximity to North America and the modern southwestern U.S. in early Mesozoic time, and that active orogenic structures and the plate-margin arc itself were not barriers to sediment transfer from the craton to the arc.

Existing data suggest that these transcontinental sediments were not incorporated into western North American peripheral-arc systems until Early Jurassic time (Fig. 4; ca. 190–185 Ma, Klamath Mountains, North Fork terrane) (Scherer and Ernst, 2008). It is not clear why transcontinental sediment was not delivered to arc-basin systems of the western U.S. during late Paleozoic time coincident with onset of the Alleghanian orogeny in eastern Laurentia (Hatcher, 2010). Additional data is needed from rocks of Late Paleozoic–Early Jurassic age to assess the timing of delivery of transcontinental sands to plate-margin basins and the transition from PPA to MPP facies.

Despite interpretations of a forearc setting for most Early–Late Jurassic basins (e.g., Dickinson, 1979; MacDonald, 2006; Scherer and Ernst, 2008; Snow and Ernst, 2008), MPP facies may also represent deposition (1) in a flexural basin adjacent to the uplifted western Nevadan back-arc basin (i.e., Jurassic Luning-fencemaker fold-thrust belt) (Wyld, 2002; Dorsey and LaMaskin, 2007; LaMaskin et al., 2011); (2) in extensional basins along the northward-deepening plate-margin arc (e.g., Busby-Spera, 1988; Barth et al., 2004; Dickinson and Gehrels, 2009; LaMaskin et al., 2011); or (3) in suprasubduction zone basins during arc extension and subsequent closure (e.g., Snoke, 1977; Harper, 1980; Hacker et al., 1995). Along-strike variability in modern southeast Pacific active margins suggests that these alternatives are not mutually

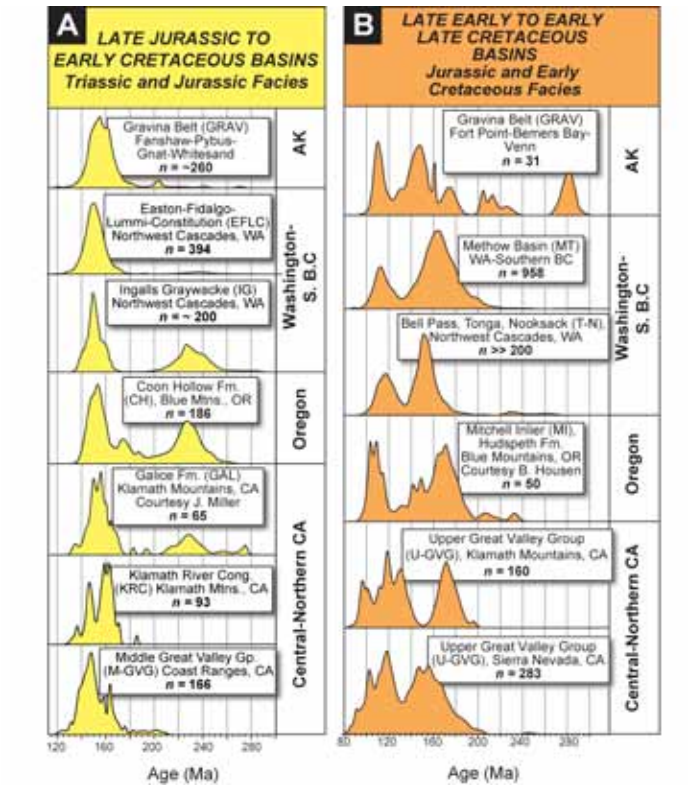

Figure 3. Detrital zircon U-Pb age data from (A) Late Jurassic–Early Cretaceous basins and (B) late Early to early Late Cretaceous basins. Specific data sources are shown in Table DR1 (see footnote 1).

exclusive. Proposed Cretaceous dextral-transpressive shear along the Mojave-Snow-Nevada-Idaho shear zone would have resulted in northern displacement of these originally southwestern U.S. basins (Wyld and Wright, 2001).

Late Jurassic–Early Cretaceous Time

In Late Jurassic–Early Cretaceous basins bearing TrJ facies, the paucity, or complete absence, of Precambrian zircon grains, in conjunction with a voluminous record of Middle–Late Jurassic magmatism, is interpreted to represent initial isolation of basins from the Laurentian craton due to nascent construction of the Andean-type margin (Figs. 3A and 4). Where Precambrian ages *are* present, age distributions mimic underlying MPP facies. A decrease in the relative abundance of Precambrian grains as compared to older samples discussed here may also simply represent an overwhelming *increase* in Mesozoic grains; however, for large sample sizes (e.g., Methow basin), Precambrian grains are not represented, suggesting that the decrease is not due to simple dilution.

The stratigraphic transition from MPP to TrJ facies is interpreted to record stepwise growth of orogenic highlands, as sediment pathways that were connected to the craton were cut off and new ones established along the rising plate margin. I propose that the transition from MPP to TrJ facies illustrates that, despite retro-arc thrusting and associated elevation gain during Middle Jurassic time (Wyld, 2002; Fuentes et al., 2009), there was not a contiguous mountain belt (i.e., topographically integrated) along the Pacific margin until Late Jurassic–Early Cretaceous time. According to this model, continental-scale drainage patterns in the western U.S. were reversed between Late Jurassic–Early Cretaceous time and transcontinental sands no longer entered western U.S. marginal basins. Instead, sediment sources to marginal basins became restricted to active arc and older igneous basement rocks in the now high-standing continental-margin, Andean-type arc.

The presence of TrJ facies in rocks as old as ca. 153–150 Ma (Fig. 4; Galice Formation, Klamath Mountains Province; Miller et al., 2003; Saleeby et al., 1982) suggests that plate reorganization from a complex, marginal-basin regime to an Andean-style margin may have initiated in middle Late Jurassic time (cf. Miller and Saleeby, 1995; Dumitru et al., 2010). A continuous basinal record of this Late Jurassic tectonic reorganization may be found in the western Klamath Mountains, where the Galice Formation includes both a transcontinental MPP facies (i.e., Izsak, et al., 2007) and a TrJ facies (i.e., Miller et al., 2003). Syndepositional, suprasubduction compression of the Galice basin in the western Klamath Mountains (Snoke, 1977; Wyld and Wright, 1988; Harper et al., 1994) may represent the earliest manifestation of plate reorganization. This compilation of detrital zircon U-Pb age data supports the idea of a "common origin for coeval strata on differing basement terranes" (Miller and Saleeby, 1995, p. 18,057), suggesting along-strike integration of disparate substrate crust by Late Jurassic time.

Late Early–Early Late Cretaceous Time

In late Early–early Late Cretaceous basins containing JeK facies, the general lack of Precambrian zircon grains represents continued isolation of marginal basins from the craton by the high-standing Andean-style margin (Figs. 3B and 4). Considering the analytical precision of SHRIMP (sensitive high-resolution ion microprobe) and LA-ICPMS (laser-ablation–inductively coupled plasma mass spectroscopy) methods, the nearly bimodal age distribution is a clear record of the two main magmatic phases of the Mesozoic Andean-type arc (i.e., Late Jurassic and Late Cretaceous; Ducea, 2001; Irwin and Wooden, 2001; Irwin, 2003). Any true differences in age modes and variance represent expected variability in the timing of arc magmatism along the Andean-type arc.

CONCLUSIONS AND IMPLICATIONS

In western North America, detrital zircon U-Pb age distributions vary in a systematic and predictable manner and are interpreted to reflect second-order variability in the tectonic setting of an active plate margin. I suggest that at a second-order, 10–100 Ma scale, detrital zircon ages are governed by plate-tectonic setting, in a similar manner to controls on neodymium isotopic values from continental sedimentary rocks (Patchett et al., 1999). At the second-order scale, the integrated evolution of orogenic, erosion, and sediment-transport systems controls detrital zircon U-Pb age distributions and, accordingly, sediment provenance.

Critical evaluation of the model presented here, and integration with rapidly emerging data sets from the miogeocline and interior of the western U.S. and Canada (e.g., Dickinson and Gehrels, 2008a, 2008b, 2009; Scherer et al., 2008; Dickinson et al., 2010; Beranek et al., 2010b; Druschke et al., 2011; Fuentes et al., 2010; Leier and Gehrels, 2011) from tectonically enigmatic thin-skinned sheets such as the Roberts Mountain and Golconda allochthons (e.g., Riley et al.,

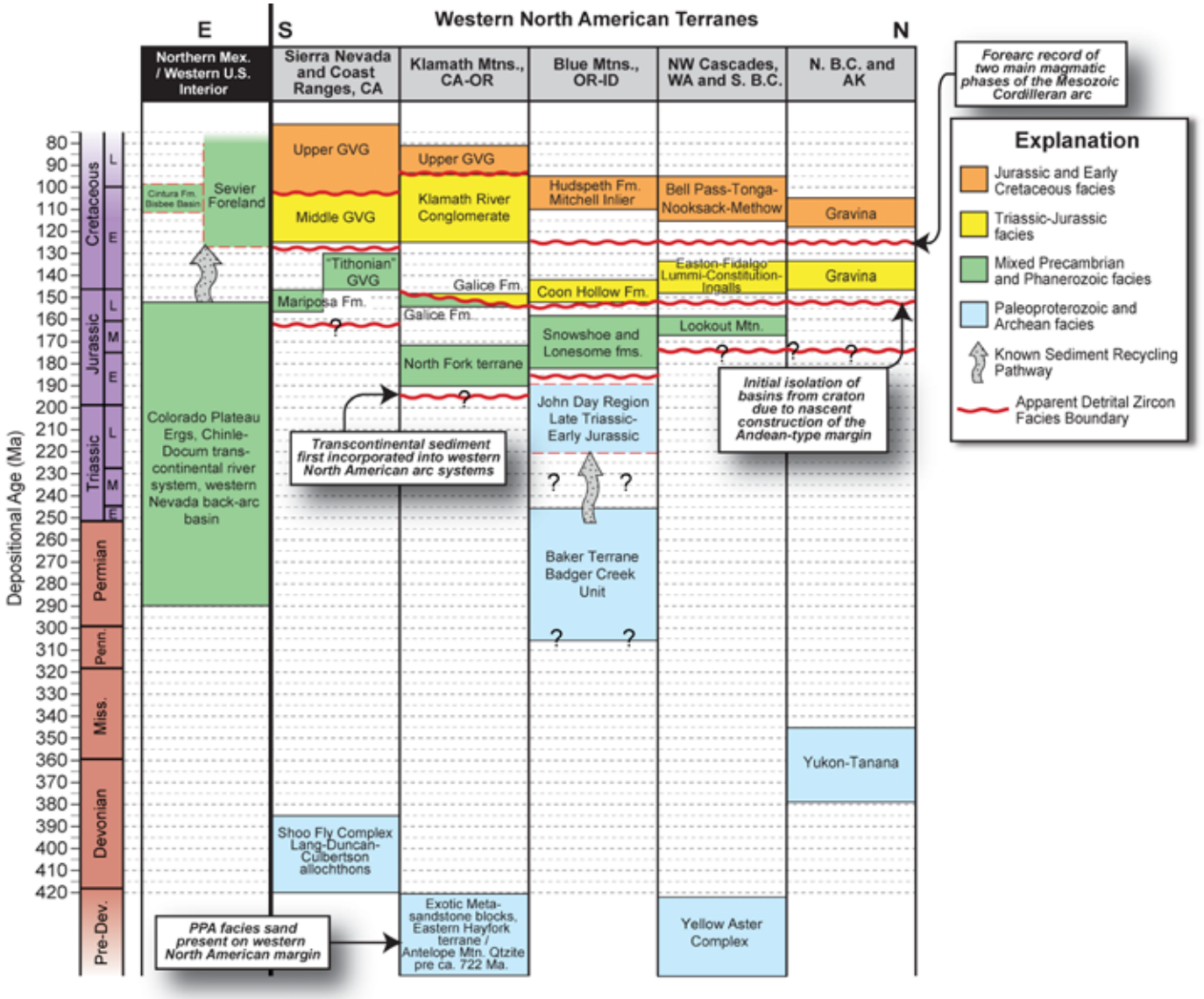

Figure 4. Chronostratigraphic distribution of detrital zircon facies in western North American terranes, as well as referenced samples from the western U.S. interior. GVG—Great Valley Group; PPA—Paleoproterozoic and Archean. Specific data sources are shown in Table DR1 (see footnote 1).

2000; Gehrels et al., 2000; Wright and Wyld, 2006), and roof pendants within the Sierra Nevada batholith (e.g., Memeti et al., 2010), may help resolve the affinity of numerous western Laurentian basins through time. Continued integration of data sets will lead to a better understanding of the pace, areal extent, and along-strike variability of North American plate-margin tectonics with inference for global plate-tectonic processes.

The model proposed here unifies a large data set collected over thousands of kilometers and representing hundreds of millions of years of sedimentation, sets forth predictions for new data collection, and is inherently testable both regionally and on other continents. Identification of age distributions that *do not* fit the model presented here is critical and may point to a truly allochthonous origin for rocks within western North America (e.g., Harding et al., 2000; Wright and Wyld, 2007; Grove et al., 2008). A global evaluation of detrital zircon U-Pb age distributions at this scale may provide important information for understanding the pace and spatial scale of crustal growth via arc and terrane accretion.

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GSA DIVISION AWARDS

Deadline: 15 March

The **Limnogeology Division** *Israel C. Russell Award* recognizes lifetime achievement in Limnogeology through contributions in research, teaching, and service. Nominations should consist of a letter describing the nominee's accomplishments in the field of limnogeology (broadly defined to include limnogeology, limnology, and paleolimnology), service to students and teaching, and contributions to GSA, as well as that person's CV. Send nomination materials electronically to David Finkelstein, Limnogeology Division chair, at dfink@geo.umass.edu. Nominees need not be members of the Division or of GSA, but he or she must have made valuable contributions to the Society.

Deadline: 2 April

Quaternary Geology and Geomorphology Division *Farouk El-Baz Award for Desert Research*. Submit nominations of colleagues who have demonstrated excellence in desert geomorphology research to Jim O'Connor, U.S. Geological Survey, 2130 SW 5th Ave., Portland, OR 97201, USA; oconnor@usgs.gov. Nominations should include (1) a statement of the significance of the nominee's research; (2) a curriculum vitae; (3) letters of support; and (4) copies of no more than five of the nominee's most significant publications related to desert research. Please submit via e-mail; hardcopy submission must be previously approved.

STUDENT GRANTS, AWARDS & SCHOLARSHIPS

Deadline: 15 March

Antoinette Lierman Medlin Scholarship in Coal Geology: GSA's Coal Geology Division offers two scholarships: (1) Financial support of ~US$2,000 for one year for full-time students involved in coal geology research; and (2) a field study award of ~US$1,500. In addition, recipients may receive a stipend to present their results at the 2012 or 2013 GSA Annual Meeting. Students may apply for both awards but may receive only one. To apply, send five copies of the following to Margo Corum, USGS Eastern Energy Resources Science Center, 12201 Sunrise Valley Dr., Reston, VA 20192-0002, USA; mcorum@usgs.gov: (1) a cover letter indicating the award(s) sought; (2) a concise (five or fewer double-spaced pages, incl. references) statement of objectives and methods and an explanation of how the scholarship funds will be used to enhance the project; and (3) a letter of recommendation from the student's advisor that includes a statement of financial need and the amount and nature of other available funding for the research/field study.

Deadline: 1 May

History and Philosophy of Geology Student Award: The GSA History and Philosophy of Geology Division offers a US$1000 award for proposals from students for presentations at a future GSA Annual Meeting. The topic of the proposed presentation may be, but is not limited to, (1) the history of geology; (2) a literature review of ideas for a technical work or thesis/dissertation; or (3) some imaginative aspect of the history of geology we have not thought of before. The application and guidelines are online at **http://gsahist.org/HoGaward/awards.htm.** If you have questions, please contact the Division secretary-treasurer, Jane P. Davidson, jdhexen@unr.edu.

2012 JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

Deadline: 31 March

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. **Please send *nominations* to** GSA Grants, Awards, and Recognition, P.O. Box 9140, Boulder, CO 80301-9140, USA. Find information on nomination criteria and the basis for selection at **www.geosociety.org/awards/fryhow.htm.**

THE GEOLOGICAL SOCIETY OF AMERICA®

GSA FOUNDATION

Formation of the Sierra Nevada Batholith: Magmatic and Tectonic Processes and Their Tempos, Sierra Nevada, California

CONVENERS

Scott R. Paterson, *Department of Earth Sciences, University of Southern California, Los Angeles, California 90089-0740, USA, paterson@usc.edu*

Jade Lackey, *Pomona College, Claremont, California 91711, USA*

Vali Memeti, *Department of Earth Sciences, University of Southern California, Los Angeles, California 90089-0740, USA*

Robert B. Miller *and* ***Jonathan S. Miller,*** *Department of Geology, San José State University, San José, California 95192-0102, USA*

Roland Mundil, *Berkeley Geochronology Center, Berkeley, California 94709, USA*

Keith D. Putirka, *Department of Earth and Environmental Sciences, California State University, Fresno, California 93740, USA*

Cosponsored by GSA Mineralogy, Geochemistry, Petrology, and Volcanology (MGPV) Division and AGU Volcanology, Geochemistry, and Petrology Section.

OVERVIEW

The evolution of continental margin orogens and magmatic arcs involves non–steady-state processes of subduction, orogeny, magmatism, exhumation, and erosion/redeposition. Recent studies have begun to examine the tempo of cyclic volumetric addition rates to arcs of plutonic and volcanic materials, driven by feedbacks between these processes both at the scale of arcs and single magmatic or volcanic systems. A full evaluation of these arc tempos requires the development and syntheses of large databases with high-precision temporal control. One arc, where a number of research groups have been actively developing and synthesizing high-precision databases, is the Sierra Nevada, California, USA. This Field Forum will bring researchers together to share and discuss various data sets while examining components of the Mesozoic arc. Our goal is to foster cross-disciplinary discussions, leading to a better understanding of the components of batholith formation; the tectonic controls on the tempo of arc development; and the significance of important new field, geochronologic, and geochemical databases.

FIELD EXCURSIONS

The field program will focus on a west to east transect through the central Sierra Nevada to examine both volcanic and plutonic components of the Mesozoic arc, regional tectonics, and the characteristics of the underlying basement units. Specific targets will include the following:

1. The ca. 151 Ma Guadalupe Igneous complex, a tilted plutonic section that exposes from top to bottom a volcanic section, granophyres, a mingled granite to dioritic section, a large sequence of high-Mg, layered gabbros, and a potential underlying, vertically sheeted feeder zone.
2. The ca. 124–105 Ma, ~80 × 40 km, tonalitic-granodioritic Fine Gold intrusive complex. This incrementally constructed complex intrudes across a fundamental basement suture (Foothills suture) between oceanic and displaced passive margin basement in the Sierras and thus allows us to examine issues of incremental chamber construction, magma-wall rock interactions, and the isotopic and geochemical systematics across a major basement suture.
3. Plutons west of the Tuolumne batholith: The ca. 102–100 Ma Yosemite Valley Intrusive Suite (El Capitan/Mount Hoffman granodiorite, Taft Granite, and isolated mafic bodies), and ca. 98–95 Ma Yosemite Creek–Sentinel plutons. New mapping, structural analysis, and a growing database of geochemistry (elemental and isotopic whole rock, minerals) and U/Pb geochronology suggest that these plutons grew via numerous increments that produced superficially very different plutons with differing scales of heterogeneity. The new data should allow us to speculate on why/how the resulting differences arose.
4. The ca. 95–85 Ma Tuolumne intrusive complex, an ~1100 km^2, incrementally constructed, internally zoned complex that has been extensively studied over the past 10 years by a number of research groups. New data sets abound, including (a) extensive

1:10,000 scale mapping, (b) detailed structural studies and strain analyses, (c) whole rock and single mineral element geochemistry and a range of isotopic studies, (d) high-precision CA-TIMS U/Pb zircon and ^{40}Ar-^{39}Ar geochronology, and (e) thermobarometry of plutons and host rocks. Models for the construction of this intrusive complex and interpretation of these data sets remain controversial, and our focus will be on the presentation of new data sets and discussion of the proposed growth models.

5. A nearly vertically tilted section through the Triassic to Cretaceous volcanic sequence that was constructed above the Mesozoic plutons and is now exposed in the Saddlebag pendant located along the eastern margin of the Tuolumne intrusive complex. New results will also be presented from studies of this volcanic section to the north (Virginia Canyon area) and south (Ritter Range pendant).
6. There are also a number of new arc-scale data sets being developed and synthesized, including (a) new mapping in a number of pendants and plutons, (b) extensive structural data, (c) strain analyses in both the central and southern Sierras, (d) CA-TIMS and LA-ICPMS ages of plutons and volcanic rocks plus LA-ICPMS detrital zircon ages from metasedimentary and volcaniclastic units, (e) geochemical and isotopic (Sr_i, ε_{Nd}, Pb, O, Hf) analyses and regional syntheses, and (f) syntheses attempting to combine all of the above with regional tectonics. Where appropriate, we will present these new syntheses with the goal of discussing tempos at various scales.

PRELIMINARY AGENDA

Sat., 1 Sept.: Meet at San Francisco International Airport and drive to Oakhurst, California. Welcoming meal and overview presentation.

Sun., 2 Sept.: Field trip to Guadalupe Igneous complex; evening discussions.

Mon., 3 Sept.: Field trip to Fine Gold intrusive complex; evening discussions.

Tues., 4 Sept.: Field trip across Yosemite Valley Intrusive Suite; travel to Mammoth; evening discussions.

Wed., 5 Sept.: Field trip to Tuolumne batholith; evening discussions.

Thurs., 6 Sept.: Field trip to Triassic–Cretaceous volcanic arc section; evening discussions.

Fri., 7 Sept.: Return trip to Oakhurst, regional overview, and summary discussions.

Sat., 8 Sept.: Depature: Return to San Francisco International Airport by 1 p.m.

TRANSPORTATION

GSA requires all participants to take group transportation while on the Field Forum. Personal vehicles are not permitted and are not covered by GSA insurance. We encourage participants who drive to the Field Forum to leave personal vehicles in Oakhurst, California. Vans will be available to pick up (1 Sept. before 2 p.m.) and return (8 Sept. by 1 p.m.) participants to the San Francisco International Airport. The daily field excursions will involve road stops and short (≤3 km) hikes at high elevations.

ESTIMATED COSTS

Registration fees for students and recent postdoctoral researchers at U.S. institutions will be partially subsidized through NSF funds. The registration fee will cover lodging for seven nights (double occupancy), transportation during the Field Forum, and all meals (except dinner on two nights). There will be one unplanned night in each of the two towns so that participants can visit a local restaurant, hopefully in smaller groups with other participants.

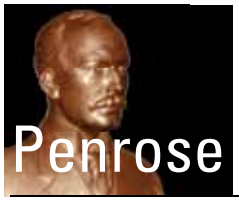
Airfare is not included, and participants must make their own travel arrangements. At the time of this printing, registration fees were not finalized. Please see the GSA website for registration fees and updated information at **http://www.geosociety.org/penrose/**.

APPLICATIONS AND REGISTRATION

Application deadline: **1 May 2012**

There will be a maximum of 54 participants. Participants will have to commit to attending the full seven days of the conference. To apply, please submit a vitae and short statement including any potential presentation (posters only), requests for registration subsidy (students and early postdocs only), and any other information pertinent to the Field Forum, to Scott Paterson (paterson@usc.edu). Please feel free to contact Paterson with any questions that arise.

View of central Sierra Nevada batholith, looking south from the May Lake area in Yosemite National Park. Yosemite Valley Intrusive Suite (day 4) to the right, Tuolumne intrusive complex (day 5) in center, and metavolcanic rocks (day 6) in far distance in left center. Photo courtesy Scott Paterson.



Comparative evolution of past and present accretionary orogens: Central Asia and the Circum-Pacific Urumqi, Xinjiang Uygur Autonomous Region, China

CONVENERS

Alfred Kröner, *Beijing SHRIMP Center, Chinese Academy of Geological Sciences, Beijing, China; and Institut für Geowissenschaften, Universität Mainz, Germany*

Robert J. Stern, *Geosciences Dept., University of Texas at Dallas, Richardson, Texas, USA*

Bor-Ming Jahn, *Dept. of Geosciences, National Taiwan University, Taipei, Taiwan*

Wenjiao Xiao, *State Key Laboratory of Lithospheric Evolution, Institute of Geology & Geophysics, Chinese Academy of Sciences, Beijing, China*

Lifei Zhang, *Dept. of Earth & Space Sciences, Peking University, Beijing, China*

Robert Hall, *SE Asia Research Group, Dept. of Earth Sciences, Royal Holloway University of London, UK*

Alexander Kotov, *Institute of Precambrian Geology and Geochronology, Russian Academy of Sciences, Saint Petersburg, Russia*

Reimar Seltmann, *Center for Russian and Central EurAsian Mineral Studies (CERCAMS), Dept. of Mineralogy, Natural History Museum, London, UK*

ORGANIZING COMMITTEE

Q. Wang, A. Kröner, C. Lan, W. Lin, B. Wang, W. Xiao, Y. Yao, L. Zhang

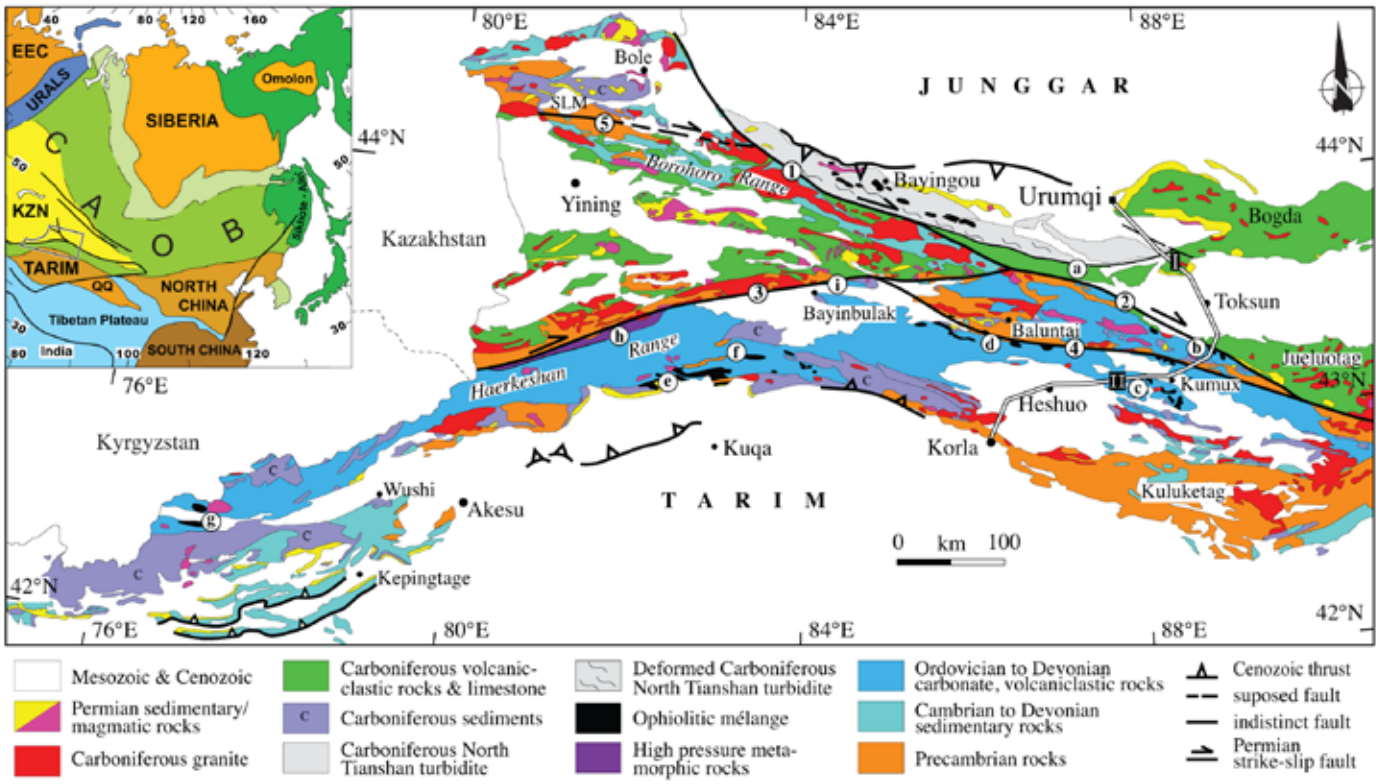
INTRODUCTION

The Central Asian Orogenic Belt (CAOB, also known as Altaids) is one of the largest accretionary orogens on Earth and evolved over some 800 million years, from the latest Mesoproterozoic to the early Triassic. It contains a record of geodynamic processes during a major episode of Neoproterozoic to Paleozoic continental growth. There has been much discussion about its evolution over the past 20 years, and models range from a single, giant arc system to accretion of multiple arc–backarc systems. The CAOB crust appears to comprise long chains of arcs and slices of older continental crust that extend for several hundreds to thousands of kilometers. Amalgamation of these linear crustal elements and their interactions with continental margins generated considerable Phanerozoic continental growth. Its large size, from the Pacific to the Urals, and its extent across six countries (China, Mongolia, Russia, Kazakhstan, Kyrgyzstan, and Uzbekistan) and many more language barriers have complicated orogen-wide comparisons, correlations, and understanding. Current tectonic models mostly see analogues with modern accretionary orogens. In view of the discovery of world-class mineral deposits, a wealth of new age and isotopic data, and much-improved possibilities for international cooperation, it was considered timely to discuss and compare the formation of the CAOB with that of modern accretionary orogens, such as the multiple arc terranes of the circum-Pacific in Indonesia, Melanesia, Taiwan, Japan, Alaska, and California. We hope that the multidisciplinary in-depth comparisons on which the conference was based will spur research and stimulate thinking about the tectono-magmatic evolution of the CAOB and lead to new concepts for accretionary orogeny in general and new strategies for finding mineral deposits. The conference brought together Asian, Russian, and Western geoscientists, and many issues about accretionary orogeny were addressed from the viewpoint of different expertise and methodologies, especially process-oriented comparisons between ongoing orogeny in the circum-Pacific region and geological observations in the CAOB. This conference provided a clearer path for future research in Central Asia and generated contacts that should lead to increased international collaboration.

This Penrose Conference was funded by the National Natural Science Foundation of China, the State Key Laboratory of Lithospheric Evolution of the Chinese Academy of Sciences (IGGCAS), National 305 Project Office Xinjiang, Uygur Autonomous Region of China, Chinese Academy of Geological Sciences, State Key Laboratory for Mineral Deposits Research, Nanjing University, Topo-Central-Asia (CC-1/4) Project of the International Lithosphere Program (ILP), the Centre for Russian and Central EurAsian Mineral Studies (CERCAMS) at the Natural History Museum, London, UK, and Gold Fields Corporation Inc. The 60 participants (including 6 students) who attended the conference came from Australia, China, France, Germany, Italy, Japan, Russia, the UK, and the United States.

VENUE

Urumqi, the capital of the Xinjiang Uygur Autonomous Region of China, was chosen as a meeting venue because it is almost in the center of the Central Asian Orogenic Belt and immediately adjacent to the well-exposed and snow-capped Tianshan (Heavenly Mountains), which were visited during the field trip preceding the discussion meeting. Participants assembled the afternoon of 4 September, and after welcome addresses by R. Zhu,



Geological map of the Chinese western Tianshan belt (after Wang et al. 2008; Lin et al., 2009). Numbers in circle refer to the main faults: 1, North Tianshan fault (NTF); 2, Main Tianshan shear zone (MTSZ); 3, Qingbulak-Nalati fault (QNF); 4, Sangshuyuanzi fault; 5, Jinghe fault. Capital letters correspond to localities cited in text: a, Houxia; b, Gangou-Mishigou; c, Yushugou; d, Guluogou-Wuwamen; e, Heiyingshan; f, Kulehu; g, Aheqi; h, Kekesu; i, Nalati. Roman letters stand for the excursion sections: I, Houxia section; II, Aiweiergou section; III, Gangou section; IV, Yushugou section; V, Cedaya section; VI, Duku road section. Inset shows location of the Tianshan Belt in Central Asia (modified from Jahn, 2004). Abbreviations: CAOB, Central Asian Orogenic Belt; EEC, Eastern European Craton; KZN, Kazakhstan; QQ, Qaidam-Qinling.

Geological map of the Chinese western Tianshan belt showing major tectonic units and excursion route for the Penrose Conference (after Wang et al., 2008, and our excursion guidebook).

director of IGGCAS, and B. Wang, Director of the National 305 Project Office, L. Shu of Nanjing University introduced the geology of the field trip with an overview talk on "Tectonic evolution of the Chinese Tianshan," which was followed by H. Hou's presentation of a seismic profile across the Tianshan titled, "Fine crustal structure beneath the junction of the western part of the southwest Tianshan Mountains and Tarim Basin, China."

FIELD TRIP AND PRESENTATIONS

The six-day Penrose Conference was divided into two parts. The first, from 5 to 7 September, was a three-day field trip across the Chinese Tianshan from Urumqi via Heshuo to Korla, which visited the well-exposed Central Tianshan Carboniferous Suture Zone, a Paleozoic ophiolitic mélange, and a northern Tianshan Permian pull-apart basin. Details of the outcrops visited as well as general models for the tectonic evolution of the Chinese Tianshan were presented in a guidebook, compiled by W. Lin of IGGCAS, and the book, along with an abstract volume of keynote lectures, is available online (ftp://penrose:penroseiggcas@159.226.119.207). During the evenings, participants discussed the geology visited and tectonic models for the Chinese and Kyrgyz Tianshan.

The second part, from 8 to 10 September, was a discussion session in the Mingyuan Newtimes Hotel in Urumqi, where all participants stayed. This meeting was held in a large hall, whose walls displayed 19 posters on geological and geophysical features of Central Asia, which were discussed during breaks. The first day was devoted to 18 overview presentations and discussions of accretionary orogens in the Circum-Pacific and the evolution of different parts of the CAOB, chaired by R. Seltmann, A. Kröner, R.J. Stern, and L. Zhang. The discussion centered on some fundamental problems, such as how to define continental (cratonic?) crust, how much really new and juvenile crust is produced in accretionary orogens, the life of an intra-oceanic arc and how to recognize it in a later orogen, and whether retreating orogens formed as a result of subduction rollback, such as the Tasmanides of eastern Australia and the ongoing evolution of the South Pacific east of Australia, are viable models for the CAOB.

The next two days were devoted to the following discussion themes, which were introduced by keynote presentations and followed by shorter topical contributions on aspects of the CAOB.

Theme 1: Ophiolites and oceanic crust; group leaders: J.W. Shervais and T. Kusky; overview talk by J.W. Shervais: "Supra-subduction zone (SSZ) ophiolites: The fore-arc connection and implications for orogenic belts." Much discussion was devoted to how to recognize upper and lower plate ophiolites, backarc versus forearc origins of ophiolites, the significance of ophiolitic mélanges, and that mafic/ultramafic rocks do not necessarily

mark sutures. T. Kusky briefly explained the differences between modern and ancient ophiolites and oceanic crust formed in different tectonic settings, and how the modern concept of ophiolites differs from the classic 1970s "Penrose" definition. This topic led to much discussion, especially about how to interpret ancient xenocrystic zircons found in some young oceanic crust and ophiolites.

Theme 2: Metamorphic rocks; group leaders: M. Brown and L. Zhang; overview talk by M. Brown: "Metamorphism in accretionary orogens." This talk generated hot debate about whether ridge subduction was the primary source of heat for high-temperature/low-pressure metamorphic belts such as those present in Japan, Alaska, and parts of the CAOB.

Theme 3: Magmatism, plumes, and ore deposits; group leaders: W. Collins and Y. Xu; overview talk by A. Wurst: "Au-Cu porphyry deposits in accretionary orogens—Comparing the Central Asian Orogenic Belt (CAOB) and modern examples." Much of the debate centered on whether a plume was responsible for widespread Permian magmatism in the CAOB or whether the magmatism was associated with other processes, such as slab breakoff following collision.

Theme 4: Structures, subduction kinematics, and geophysical data; group leaders: K. Schulmann, W. Xiao, and W. Mooney; overview talk by R. Glen: "The SW Pacific and the Tasmanides of Eastern Australia: Possible analogues of the CAOB?" This talk led to a lengthy discussion on subduction kinematics, structural criteria, and seismic observations pertaining to accretionary orogens and particularly the CAOB.

Theme 5: Paleogeography and sedimentary basins; group leaders: Q. Wang and L. Teng; overview talk by Q. Wang: "The Carboniferous Junggar Basin in northwest China exemplifying basin evolution in the CAOB." Much of the discussion centered on the nature and composition of the crust beneath the Junggar basin as well as the sedimentary records of the nearby accretionary terranes.

Theme 6: Isotopes and continental growth; group leaders: B.-M. Jahn and B.F. Windley: overview talks by Windley on "What we have learnt (and not learnt) from the Central Asian Orogenic Belt since Sengör et al. (1993)"; Jahn on "Distinct crustal development of SW and NE Japan—Sr-Nd isotopic evidence and tectonic implications"; and E. Belousova on "Hf isotopes in zircons from the CAOB: Crustal evolution history and tectonic significance." The ensuing discussion and talks on isotopic data touched many aspects of crustal evolution in Central Asia, such as the proportion of juvenile crust in Central Asia and whether the "Baikalian" event (late Neoproterozoic) in Siberia is a separate orogeny or part of CAOB evolution. Jahn's conclusion that SW Japan is not really juvenile may have important implications for considering Japan as a model for the CAOB.

The final discussion of the conference stressed that researchers working in the CAOB should place more emphasis on detailed field mapping and structural analysis and not consider any one particular accretionary orogen of the circum-Pacific as the only model for CAOB evolution. Participants emphasized that the following topics require future study: How to recognize the subduction of an ancient oceanic ridge. Are the western and southern Pacific good analogues for the evolution of the CAOB? Was subduction in the southern Tianshan southward or northward?

Most presentations from the conference are available at ftp://penrose:penroseiggcas@159.226.119.207. A themed issue of *Lithosphere* papers derived from research presented at the conference is in preparation, and R. Hall (London), B.-M. Jahn (Taipei), J. Wakabayashi (Fresno), and W. Xiao (Beijing) volunteered to be guest editors.

Participants: Dmitriy Alexeiev, Robin Armstrong, Elena Belousova, Georgiy Biske, Michael Brown, Keda Cai, Ke Chen, Dominique Clouzel, William Collins, Jun Gao, Dmitry Gladkochub, Richard (Dick) Glen, Longlong Gou, Robert Hall, Dengfa He, Hesheng Hou, Bor-ming Jahn, Ping Jian, Yingde Jiang, Alexander Kotov, Victor Kovach, Alfred Kröner, Timothy Kusky, Wei Lin, Xiaoping Long, Zeng Lü, Huadong Ma, Alekandr Mikolaichuk, Walter Mooney, Onno Oncken, Scott Paterson, Minghua Ren, Inna Safonova, Karel Schulmann, Reimar Seltmann, Inga Sevastianova, John W. Shervais, Liangshu Shu, Robert J. Stern, Yoshihiko Tabata, Louis Teng, Ying Tong, Dondov Tumurkhuu, John Wakabayashi, Koji Wakita, Bo Wan, Bo Wang, Kuo-Lung Wang, Qingchen Wang, Tao Wang, Simon Wilde, Brian F. Windley, Andrew Wurst, Wenjiao Xiao, Yigang Xu, Chao Yuan, Lifei Zhang, Shjihong Zhang, and Rixiang Zhu.

REFERENCE CITED

Wang, B., Faure, M., Shu, L., Cluzel, D., Charvet, J., De Jong, K., and Chen, Y., 2008, Paleozoic tectonic evolution of the Yili Block, Western Chinese Tianshan: Bulletin de la Société Géologique de France, v. 179, p. 483–490.

Group photograph at end of field trip in Baiyanggou section, southern Bogda Mountains.

2012 Section Meeting Mentor Programs

Plan now to attend a Shlemon and/or a Mann Mentor luncheon at your 2012 Section Meeting to chat one-on-one with professional geoscientists. These volunteers will answer your questions and share insights on how to get a job after graduation.

Lunches served at these events are FREE. Students will receive lunch tickets with their registration badge. These events are very popular, and space is limited, so try to arrive early to ensure your participation.

The John Mann Mentors in Applied Hydrogeology Program is designed to acquaint undergraduate, graduate, and recent graduate students with careers in applied hydrogeology through mentoring opportunities with practicing professionals. The Roy J. Shlemon Mentor Program in Applied Geoscience is designed to acquaint advanced undergraduate and beginning graduate students with careers in applied geoscience. For further information, contact Jennifer Nocerino at jnocerino@geosociety.org.

SOUTH-CENTRAL SECTION MEETING
8–9 March • Alpine, Texas, USA
Shlemon Mentors Luncheon: Thurs., 8 March
Mann Mentors Luncheon: Fri., 9 March

Big Bend, Alpine, Texas. Photo courtesy USGS.

NORTHEASTERN SECTION MEETING
18–20 March • Hartford, Connecticut, USA
Shlemon Mentors Luncheons: Sun. & Mon., 18 & 19 March
Mann Mentors Luncheon: Tues., 20 March

Boudins in metaigneous rocks, Tolland, Connecticut. Photo by Tim Byrne.

CORDILLERAN SECTION MEETING
29–31 March • Querétaro, México
Shlemon Mentors Luncheon: Thurs., 29 March
Mann Mentors Luncheon: Fri., 30 March

Spectacular skies over Querétaro, México. Photo by Michelangelo Martini.

SOUTHEASTERN SECTION MEETING
1–2 April • Asheville, North Carolina, USA
Shlemon Mentors Luncheon: Sun., 1 April
Mann Mentors Luncheon: Mon., 2 April

Looking Glass Rock. Photo courtesy Blair Tormey.

NORTH-CENTRAL SECTION MEETING
23–24 April • Dayton, Ohio, USA
Shlemon Mentors Luncheon: Mon., 23 April
Mann Mentors Luncheon: Tues., 24 April

Wright Flyer with crowd. Photo courtesy Dayton Montgomery County and Visitors Bureau.

ROCKY MOUNTAIN SECTION MEETING
9–11 May • Albuquerque, New Mexico, USA
Shlemon Mentors Luncheon: Thurs., 10 May
Mann Mentors Luncheon: Fri., 11 May

Petroglyph National Monument. Credit: Petroglyph National Monument.

STUDENTS—*Mark Your Calendars!*

THE GEOLOGICAL SOCIETY OF AMERICA®

ROCKY MOUNTAIN

64th Annual Meeting of the Rocky Mountain Section, GSA
Albuquerque, New Mexico, USA
9–11 May 2012

www.geosociety.org/Sections/rm/2012mtg/

Rio Geo Fiesta!

LOCATION

Albuquerque is situated along the Rio Grande, near the juncture of five physiographic provinces: the southern Rocky Mountains, the Great Plains, the Colorado Plateau, the Rio Grande Rift, and the Basin and Range. Theme sessions and field trips reflect a full range of geologic topics, and something for all interests and disciplines, including one-day trips to local outcrops and multiday trips to spectacular exposures and geologic problems. The meeting venue, Hotel Albuquerque at Oldtown, is a unique blend of Native American, Mexican, Spanish, and Western cultural traditions situated in historic Old Town. Meeting participants and guests can discover more than 400 years of history and native New Mexican heritage in easy walking distance from the hotel. Adjacent to the hotel are over 150 shops, restaurants and art galleries, including the New Mexico Museum of Natural History and Science.

REGISTRATION

Early registration deadline: 9 April 2012
Cancellation deadline: 16 April 2012

Register online at www.geosociety.org/Sections/rm/2012mtg/. For further information or if you need special accommodations, please contact the general chair, Laura Crossey, at lcrossey@unm.edu. Onsite registration and badge pickup will be at Hotel Albuquerque beginning Tuesday, 8 May, at 4 p.m.

REGISTRATION FEES (all fees are in U.S. dollars)

	EARLY		STANDARD	
	Full Mtg.	**One Day**	**Full Mtg.**	**One Day**
Professional Member	$170	$100	$190	$100
Professional Nonmember	$190	$120	$210	$130
Professional Member 70+	$100	$80	$130	$100
Student Member	$65	$50	$80	$60
Student Nonmember	$90	$65	$110	$80
K–12 Teacher	$50	$30	$60	$35
Guest or Spouse	$50	n/a	$60	n/a
Short Course/Field Trip Only	$35	n/a	$45	n/a

ACCOMMODATIONS

Hotel registration deadline: 16 April 2012

A block of rooms has been reserved at Hotel Albuquerque at Oldtown, located at 800 Rio Grande Blvd. NW Albuquerque, New Mexico 87104, USA, +1-866-505-7829. The meeting rate is US$129 per night plus tax.

THEME SESSIONS

Session descriptions and leader contact information are online at **www.geosociety.org/Sections/rm/2012mtg/techprog.htm.**

1. **Geoscience Education: Current Practice and Research (Oral and Poster).** Steve Semken, Arizona State University; Matt Nyman, University of New Mexico.
2. **Undergraduate Research in the Rocky Mountains (Posters).** David Mogk, Montana State University; Darrell Henry, Louisiana State University; Paul Mueller, University of Florida; David Foster, University of Florida.
3. **Geologic Mapping in the Digital Era: Integrating Research, Modern Mapping Techniques and Map Products (Posters).** Mike Timmons, New Mexico Bureau of Geology and Mineral Resources.
4. **Water Quality and Biogeochemistry before and after the Los Conchas Fire, Jemez Mountains, New Mexico.** Cliff Dahm, University of New Mexico; Jon Chorover, University of Arizona.
5. **Arsenic, Uranium and Radionuclides: Geology and Health Impacts in the Southwest and Rocky Mountains.** Malcolm Siegel, University of New Mexico.
6. **Hydrogeology of the Sierra Blanca, Sacramento Mountains, and Tularosa Basin, New Mexico.** Geoffrey Rawling, New Mexico Bureau of Geology and Mineral Resources; Mike Darr, USGS New Mexico Water Science Center.
7. **Surface to Groundwater Interactions in New Mexico and Southern Colorado.** Mark Person, Emily Woolsey, New Mexico Institute of Technology.
8. **Multidisciplinary Studies of the Rio Grande Rift: Basins, Volcanism, Geophysics, and Hydrogeology.** S.D. Connell, D.J. Koning, New Mexico Bureau of Geology and Mineral Resources; V.J.S. Grauch, U.S. Geological Survey.
9. **Cenozoic Landscape Evolution in the Rocky Mountains and Colorado Plateau: Deciphering the Interplay between Mantle Buoyancy and Surface Processes.** Eric Kirby, Pennsylvania State University; Andres Aslan, Colorado Mesa University.
10. **Deep Lithospheric Structure of the Rocky Mountain Region.** Rick Aster, New Mexico Institute of Technology; Jolante van Wijk, University of Houston.
11. **Advances in Our Understanding of Paleogene Climate and Vegetative Change in the North American Mid-Continent and Rocky Mountain Region.** Grant Boardman, University of Nebraska; William Lukens, Temple University.
12. **Basin-Scale Sedimentology and Stratigraphy of Continental Strata in the Rocky Mountain Region.** Gary Weissmann, University of New Mexico; Kate Zeigler, New Mexico Highlands University; Kevin Hobbs, University of New Mexico.

13. **Detrital Zircon Studies in the Western Interior U.S. and Their Implications for Ancient Landscape Evolution.** Carol Dehler, Utah State University; Mark Pecha, University of Arizona; Timothy Lawton, New Mexico State University.
14. **From the Archean to the Eocene and from the Surface to the Mantle: New Perspectives on Laramide Orogenesis in the Rocky Mountain Region.** Jeff Bader, AECOM Technology Corp.
15. **Exploring Stratigraphic, Geochemical, and Paleobiologic Records in Phanerozoic Marine Systems of the Rocky Mountain Region.** Maya Elrick, University of New Mexico.
16. **Paleoproterozoic Orogeny and Mesoproterozoic Enigmas: Constraints on the Formation, Assembly, and Evolution of the Precambrian Rocks in the Rockies.** Chris Andronicos, Cornell University; Chris Daniel, Bucknell University.
17. **Meteorites and Impact Craters.** Rhian Jones, University of New Mexico; Adrian Brearley, University of New Mexico.
18. **Cenozoic Drainage Evolution and River Incision History of the Colorado Plateau–Rocky Mountain Region.** Richard Young, SUNY Geneseo; Karl Karlstrom, University of New Mexico.
19. **Terrestrial Carbonate Systems: Travertines, Lakes, Soils and Caves.** Laura Crossey, Alexandra Priewisch, University of New Mexico.

FIELD TRIPS

Pre-Meeting

1. **Sedimentation, Tectonics, and Landscape Evolution of the Albuquerque and Española Basins.** Sun.–Tues., 6–8 May; departs Sun., 6 May, 7:30 a.m.; returns Tues., 8 May, 3 p.m. US$190. Min.: 7. Max.: 30. Sean Connell, Dan Koning, New Mexico Bureau of Geology and Mineral Resources; Jason Ricketts, University of New Mexico.
2. **Geology of Mount Taylor, a Large Composite Volcano, West-Central New Mexico.** Mon.–Tues., 7–8 May; departs Mon., 7 May, 8 a.m.; returns Tues., 8 May, 6 p.m. US$130. Min.: 10. Max.: 30. Larry Crumpler, New Mexico Museum of Natural History and Science; Fraser Goff, University of New Mexico.
3. **Dinosaurs That Did Not Die: Field Examination of the Dinosaur-Bearing, Paleocene, Ojo Alamo Sandstone, San Juan Basin, New Mexico.** Mon.–Tues., 7–8 May; departs Mon., 7 May, 8 a.m.; returns Tues., 8 May, 6 p.m. US$170. Min.: 10. Max.: 30. James Fassett, U.S. Geological Survey, retired.
4. **Water Quality, Hydrology, and Biogeochemistry of the Valles Caldera.** Tues., 8 May, 7:30 a.m.–4:30 p.m. US$60. Min.: 15. Max.: 30. Cliff Dahm, Lauren Sherson, University of New Mexico; Robert Parmenter, Valles Caldera National Preserve.

Post-Meeting

5. **A Midcrustal Transect across the Yavapai-Mazatzal Transition Zone: Investigating the Timing and Nature of Paleoproterozoic-Mesoproterozoic Sedimentation, Deformation, and Regional Metamorphism in North-Central New Mexico.** Fri.–Mon., 11–14 May; departs Fri., 11 May, 5:30 p.m.; returns Mon., 14 May, 5 p.m. US$235. Min.: 20. Max.: 30. Christopher Daniel, Bucknell University; Karl Karlstrom, University of New Mexico; Lincoln Hollister, Princeton University.
6. **Shatter Cones and Possible Impact Breccias Associated with the Santa Fe Impact Structure.** Sat., 12 May, 7:45 a.m.–6 p.m. US$65. Min.: 10. Max.: 24. Shawn Wright, Horton Newsom, University of New Mexico; Tim McElvain.
7. **Volcanic, Structural, and Geothermal Evolution of the Valles Caldera.** Sat.–Sun., 12–13 May; departs Sat., 12 May, 8 a.m.; returns Sun., 13 May, 6 p.m. US$230. Min.: 20. Max.: 40. Fraser Goff, University of New Mexico; Jamie Gardner, Consultant.
8. **Albuquerque Volcanoes: A Fissure-Type Eruption at the Center of the Rio Grande Rift.** Sat., 12 May, 8:30 a.m.–1:30 p.m. US$60. Min.: 8 Max.: 22. Jayne Aubele, Larry Crumpler, New Mexico Museum of Natural History and Science.

WORKSHOPS

1. **Facilitating Classroom Innovation in the Geosciences: The TUES and Other NSF Educational Funding Programs, and Strategies for Successful TUES Proposals.** Tues., 8 May, 1–5 p.m. FREE, but you must register to attend. Min.: 5; max.: 30. Jeff Ryan, University of South Florida, ryan@mail.usf.edu; Jill Singer, Buffalo State College, singerjk@buffalostate.edu.

   This half-day workshop will provide current information about new NSF–Division of Undergraduate Education (DUE) funding opportunities to support innovation in geoscience education, focusing on the Transforming Undergraduate Education in STEM (TUES) Program, but including information about other relevant opportunities.

   The project has some funding to help faculty from 2-year colleges or minority-serving institutions attend the workshop; contact the presenters directly for more information.
2. **Active Learning Strategies for Geoscience Teaching.** Fri., 11 May, 1–5 p.m. FREE, but you must register to attend. Min.: 5; max.: 30. Steven Semken, Arizona State University.

   This half-day workshop will help college faculty and secondary-school teachers in the Earth sciences to introduce active-learning strategies into predominantly lecture-based classes. *Participants will be able to apply for funds to defray most of the workshop costs.*

SPECIAL EVENTS

Welcome Reception. Tues., 8 May, 5–7 p.m., Hotel Albuquerque.

GSA Town Hall Meeting. Wed., 9 May, 5:30–6:30 p.m. All meeting attendees are invited to this event to discuss the Society's future. Learn more about GSA and GSA's strategic plan at www.geosociety.org/aboutus/index.htm. Coffee and pastries provided.

A Night at the Museum. *Cosponsored by the New Mexico Museum of Natural History and Science.* This festive event will be held at the nearby New Mexico Museum of Natural History and Science on Thurs., 10 May, 6–8:30 p.m., and includes a public geology–related lecture and access to the museum exhibits.

OPPORTUNITIES FOR STUDENTS

Find more information by clicking on the "Students" tab on the meeting website.

Save Money

- **Travel Grants:** Application deadline: 9 April 2012.
- **Volunteer & Save on Registration:** Student volunteers help make the meeting strong and save money at the same time.

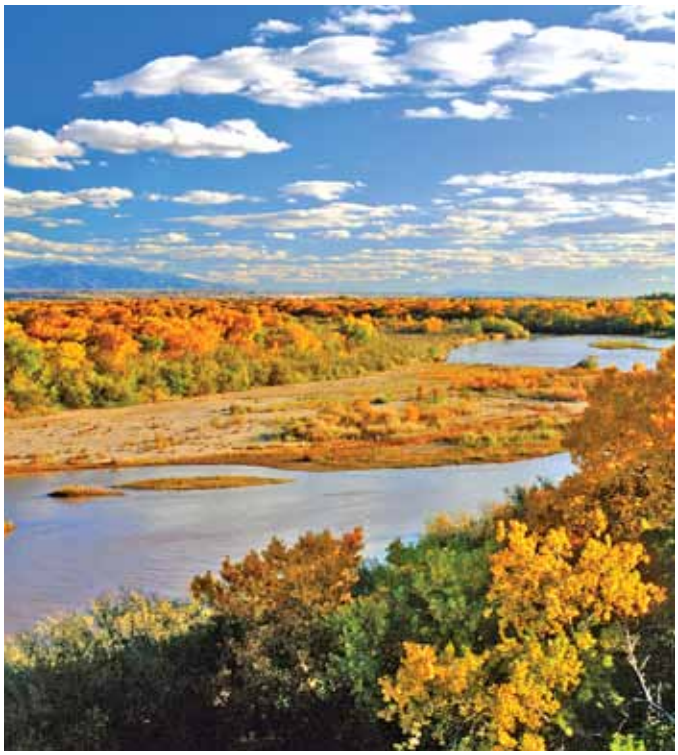
Mentor Luncheons

Cosponsored by the GSA Foundation. Learn more at www.geosociety.org/mentors/ or contact Jennifer Nocerino, jnocerino@geosociety.org.

- **Roy J. Shlemon Mentor Program in Applied Geoscience.** Thurs., 10 May. Students will have the opportunity to discuss career prospects and challenges with professional geoscientists from multiple disciplines over a FREE lunch.
- **John Mann Mentors in Applied Hydrogeology Program.** Fri., 11 May. Students interested in applied hydrogeology or hydrology as a career will have the opportunity to network with professionals in these fields over a FREE lunch.

Student Presentation Awards

Cash prizes will be awarded in the following categories (awards provided by the Rocky Mountain Section): Best Undergrad Oral, Honorable Mention, Undergrad Oral; Best Undergrad Poster, Honorable Mention, Undergrad Poster; Best Grad Oral, Honorable Mention, Grad Oral; Best Grad Poster, Honorable Mention, Grad Poster.



Rio Grande in autumn; photo by Jay Blackwood.

2012

SOUTH-CENTRAL
8–9 March
Alpine, Texas, USA
Local Committee Chair: Kevin Urbanczyk

NORTHEASTERN
18–20 March
Hartford, Connecticut, USA
Local Committee Chair: Jean Crespi

CORDILLERAN
29–31 March
Querétaro, Mexico
Local Committee Chair: Luca Ferrari

SOUTHEASTERN
1–2 April
Asheville, North Carolina, USA
Local Committee Co-Chairs: Blair Tormey; Cheryl Waters-Tormey

NORTH-CENTRAL
23–24 April
Dayton, Ohio, USA
Local Committee Chair: Charles Ciampaglio
Early reg. deadline: 19 Mar. 2012

ROCKY MOUNTAIN
9–11 May
Albuquerque, New Mexico, USA
Local Committee Chair: Laura Crossey
Early reg. deadline: 9 Apr. 2012

GSA Section Meeting Schedule

THE GEOLOGICAL SOCIETY OF AMERICA®

GSA ELECTIONS

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council.

You will receive a postcard with instructions for accessing your electronic ballot via our secure Web site, and biographical information on the nominees will be online for you to review at that time. Paper versions of both the ballot and candidate information will also be available.

Please help continue to shape GSA's future by voting on the nominees listed here.

2012 OFFICER AND COUNCIL NOMINEES

PRESIDENT
(July 2012–June 2013)
George H. Davis
University of Arizona
Tucson, Arizona, USA

VICE PRESIDENT
(July 2012–June 2013)
Suzanne Mahlburg Kay
Cornell University
Ithaca, New York, USA

TREASURER
(July 2012–June 2013)
Jonathan G. Price
Nevada Bureau of Mines & Geology
Reno, Nevada, USA

COUNCILOR POSITION 1
(July 2012–June 2016)
Laurie Brown
University of Massachusetts–Amherst
Amherst, Massachusetts, USA

Isabel P. Montanez
University of California–Davis
Davis, California, USA

COUNCILOR POSITION 2
(July 2012–June 2016)
Marilyn J. Suiter
Arlington, Virginia, USA

Peter J. Vrolijk
ExxonMobil Upstream Research Co.
Houston, Texas, USA

COUNCILOR POSITION 3
(July 2012–June 2016)
Steven G. Driese
Baylor University
Waco, Texas, USA

William W. Simpkins
Iowa State University
Ames, Iowa, USA

Elections begin 10 March; ballots must be submitted electronically or postmarked by 8 April 2012.

THE GEOLOGICAL SOCIETY OF AMERICA®

Help Shape the Future of Geoscience— Serve on a GSA Committee!

2013–2014 COMMITTEE VACANCIES

Deadline to apply or submit nominations: 15 July 2012

If you are looking for the opportunity to work toward a common goal, a way to give back to GSA, networking opportunities, or a place to make a difference, then you should volunteer (or even nominate a fellow GSA Member) to serve on a Society committee or as a GSA representative to another organization. To learn more about the committees and access the nomination form, visit **www.geosociety.org/aboutus/committees/.** You can also download the form and send a hardcopy nomination to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1074; phone +1-303-357-1044 or +1-800-472-1988, ext. 1044; pfistell@geosociety.org. **Terms begin 1 July 2013** (unless otherwise indicated).

COMMITTEE, SECTION, AND DIVISION VOLUNTEERS:

Council Thanks You!

GSA Council acknowledges the many member-volunteers who, over the years, have contributed to the Society and to our science through involvement in the affairs of the GSA. Your time, talent, and expertise help build a solid and lasting Society.

COMMITTEE	No. of Vacancies	Length of Term
Academic and Applied Geoscience Relations (AM, T/E)	three	3 years
Annual Program (AM, B/E)	two	4 years
	one	2 years
Arthur L. Day Medal Award (T/E)	two	3 years
Diversity in the Geosciences (AM, T/E)	three	3 years
Education (AM, B/E, T/E)	three	4 years
	one	2 years
eGSA (AM, T/E)	two	3 years
Geology and Public Policy (AM, B/E, T/E)	one	3 years
Joint Technical Program (T/E)	three	2 years, starts 1 Dec. 2012
Membership (B/E)	two	3 years
Nominations (B/E, T/E)	two	3 years
Penrose Conferences and Field Forums (T/E)	two	3 years
Penrose Medal Award (T/E)	two	3 years
Professional Development (T/E)	two	3 years
Publications (AM, B/E, T/E)	one	4 years
Research Grants (B/E, C)	six	3 years
Young Scientist Award (Donath Medal) (T/E)	two	3 years

GSA REPRESENTATIVES TO OTHER ORGANIZATIONS	No. of Vacancies	Length of Term
GSA Representative to the GSA and AASG Selection Committee for the John C. Frye Memorial Award in Environmental Geology	one	3 years, starts 1 July 2013
North American Commission on Stratigraphic Nomenclature (NACSN) (AM, possibly B/E)	one	3 years, starts 1 Nov. 2013

AM—Meets at the Annual Meeting • B/E—Meets in Boulder or elsewhere
C—Extensive time commitment required during application review period (15 Feb.–15 Apr. 2013) • T/E—Communicates by phone or electronically

2012 GSA ANNUAL MEETING & EXPOSITION

GEOSCIENCES Investing in the Future

Explore

CHARLOTTE

4–7 NOVEMBER 2012 • CHARLOTTE, NORTH CAROLINA, USA

DATES & DEADLINES

April: First announcement of topical and discipline sessions published in the April/May *GSA Today.*

April: Electronic abstract form posted at **www.geosociety.org.**

June: Second announcement and registration information published in the June *GSA Today.*

5 June: Space request deadline.

14 August: Abstracts due by 11:59 p.m. PDT.

31 August: Technical program finalized.

Early September: Accepted abstracts with links to speakers and titles will be posted at **www.geosociety.org.**

THE GEOLOGICAL SOCIETY OF AMERICA®

2012 MEETING ORGANIZERS

Chair: John Diemer, University of North Carolina at Charlotte, jadiemer@uncc.edu

Technical Program Chair: Richard C. Berg, Illinois Geological Survey, rberg@illinois.edu

Special Session/Short Course Chair: Andy Bobyarchick, UNC Charlotte, arbobyar@uncc.edu

Field Trip Co-Chairs: Missy Eppes, UNC Charlotte, meppes@uncc.edu; Jerry Bartholomew, University of Memphis, jbrthlm1@memphis.edu

K–12 Education Chair: Jake Armour, UNC Charlotte, jarmour@uncc.edu

K–12 Education Co-Chairs: Randy Bechtel, North Carolina Geological Survey, randy.bechtel@ncdenr.gov; Eric Pyle, James Madison University, pyleej@jmu.edu

Special Events/Community Education Chairs: Ken Taylor, North Carolina Geological Survey, Kenneth.b.taylor@ncdenr.gov; John Bender, UNC Charlotte, jfbender@uncc.edu; Scott Hippensteel, UNC Charlotte, shippens@uncc.edu

www.geosociety.org

View to west of Tablerock Mountain (high peak to south) and Hawksbill Mountain (high peak to north) in North Carolina Blue Ridge Mountains. Photo by Andy R. Bobyarchick, 2008.

Kelly A. Kryc

The Best of Times

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us… —Charles Dickens, *A Tale of Two Cities*

This timeless Dickens quote so eloquently captures the dichotomy of many real-world scenarios—and none more so than my brief experience working for Congress as the 2011–2012 GSA-USGS Congressional Science Fellow. I couldn't be more thrilled with the opportunity to serve as a science and technology fellow—regardless of the perceived (or real) challenges of working on the Hill in this particular Congress. I took a circuitous route to the fellowship that involved a decade of school and research, and another decade in science program management. In just four months, I can honestly say that this has been the best job of my life ("it was the best of times…"), and here's why:

As many of my predecessors have described, the fellowships start off with an exceptional two-week orientation facilitated by the American Association for the Advancement of Science (AAAS). I think it is important to note that I was under the complete misconception that it is harder to get a Ph.D. in science than it is to learn how policy gets made in the United States. The term "drinking through a firehose" doesn't even start to describe how much information I have absorbed since starting the fellowship in September. For example, do you know what this means?

Defeating the previous question on the motion to recommit with instructions in order to offer a substitute amendment to the amendment in the nature of a substitute.

Neither do I. But, I hope to by the end of my fellowship year (thanks to the venerable Judy Schneider at the Congressional Research Service for providing the example above). Stay tuned.

The sudden realization that my high school government classes and college political science courses had woefully underprepared me for this endeavor, coupled with a crash-course in ethics, left me a bit unsettled and mildly panicked. This feeling quickly abated, and we thirty-five 2011–2012 Congressional Fellows were set loose upon Congress to start our placement process. This was, by far, the most exhilarating two weeks of my life. I'm not confident I can describe the process to its full credit, but suffice it to say, at no other point in my career do I expect to have the unprecedented access to Hill staff and members of Congress as I did during that process.

Wanting to take full advantage of the opportunity, I interviewed as broadly as possible, which included meeting with people from individual member offices in both the House and the Senate, committee offices in both the House and the Senate, and offices representing both the majority and the minority parties. This year, there was an overwhelming interest by the congressional offices to attract a Fellow to work on energy and environment issues—a perfect alignment with the skill set offered by the four geoscience Fellows (AGU sponsored two Fellows this year, and GSA and AGI both sponsored one)—and an indication of the importance for continued support of the geoscience fellows in the future. Ultimately, I accepted an offer from the Senate Committee on Energy and Natural Resources, working for the majority staff on issues primarily pertaining to the water and power nexus.

In a recent *New York Times* poll, the approval rating of the United States Congress fell to an all-time low of 9% ("it was the worst of times…"). For context, the *Huffington Post* reported that 11% of Americans approve of the "U.S. going communist," 23% approve of banks, and 16% apparently approved of BP during the oil spill (http://www.huffingtonpost.com/2011/11/16/congress-approval-rating-porn-polygamy_n_1098497.html). That said, the Senate Committee on Energy and Natural Resources has managed to stay productive in a time when the full Senate struggles to do so and, from my very brief exposure and limited perspective, serves as a great model for bipartisan cooperation in a difficult and challenging legislative environment.

For example, I have already worked on three oversight hearings, including one field hearing in West Virginia to examine Marcellus Shale Gas development and production, and a Subcommittee on Water and Power hearing on opportunities and challenges to address domestic and global water supply issues. Since I started in September, the full committee has conducted two business meetings to mark-up bills and move them to the Senate's Legislative Calendar for consideration. As an additional highlight, I was able to observe the committee process to consider the nomination of Arunava Majumdar to be Under Secretary of Energy (he was subsequently approved by the full Senate shortly thereafter). All in all, there hasn't been a shortage of things for an eager geologist to dig into. A couple of the things that have piqued my interest thus far, and that I plan to describe to you in more detail in my next report, include marine renewable energy,

industrial efficiency and advanced manufacturing, and the nexus of water and power.

In closing, as we enter another election year, and based on my observations of the Energy and Natural Resources Committee, I choose to remain cautiously optimistic that we are capable of exiting Dickens' "winter of despair" and entering his "spring of hope." My email is listed below and I encourage you to write me directly if you have any questions.

This manuscript is submitted for publication by Kelly A. Kryc, 2011–2012 GSA-USGS Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. G11AP20221. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government. Kryc is serving on the staff of the Senate Committee on Energy and Natural Resources and can be reached at Kelly_Kryc@energy.senate.gov.

THE GEOLOGICAL SOCIETY OF AMERICA®

Get into the Field with GSA and ExxonMobil

ExxonMobil

Bighorn Basin Field Award Field Seminar in the Bighorn Basin of north-central Wyoming emphasizing multidisciplinary integrated basin analysis. This one-week field program covers all costs for awardees and both students and faculty are welcome to apply. *Application deadline: 2 April 2012.*

Field Camp Scholar Award Field award for undergraduate students to attend summer field camp. Seventeen students will be awarded $2,000 each to attend the field camp of their choice based on diversity, economic/financial need, and merit. *Application deadline: 12 March 2012.*

Field Camp Excellence Award One field camp instructor/director will receive an award of $10,000 to assist with their summer field season. This award will be based on safety awareness, diversity, and technical excellence. *Application deadline: 12 March 2012.*

Learn more at

https://rock.geosociety.org/ExxonMobilAward/index.asp

Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org, +1-303-357-1036.

In Memoriam

The Society notes with regret the deaths of the following members (notifications received between 1 November 2011 and 7 February 2012).

Donald A. Brobst
Ann Arbor, Michigan, USA
3 July 2011

Raymond B. Daniels
Midlothian, Virginia, USA
1 June 2009

John A. Elson
Menlo Park, California, USA
Notified 1 Dec. 2011

John D. Fett
Incline Village, Nevada, USA
Notified 5 Jan. 2012

Charles W. Fetter
Hilton Head Island, South Carolina, USA
10 Sept. 2011

Gerald M. Friedman
Bronx, New York, USA
29 Nov. 2011

Ronald Greeley
Tempe, Arizona, USA
27 Oct. 2011

Robert J. Gunthorpe
Flagstaff Hill, South Australia, Australia
20 Apr. 2011

Jerry R. Hassemer
Arvada, Colorado, USA
27 Apr. 2011

Jarod E. Lyman
Sandy, Utah, USA
3 Feb. 2012

Lynn Margulis
Amherst, Massachusetts, USA
22 Nov. 2011

William L. Pickles
Half Moon Bay, California, USA
Notified 30 Dec. 2011

Pierre Saint-Amand
Ridgecrest, California, USA
Notified 15 Dec. 2011

Melvin C. Schroeder
Bryan, Texas, USA
12 Jan. 2011

Hy Seiden
Bakersfield, California, USA
Notified 23 Nov. 2011

Maynard Slaughter
Denver, Colorado, USA
15 Mar. 2011

Harmon R. Taber
West Sacramento, California, USA
11 Feb. 2011

William C. Ward
Boerne, Texas, USA
8 Jan. 2011

Donald W. Watson
Slippery Rock, Pennsylvania, USA
6 Feb. 2011

Robert G. Wiese Jr.
Twinsburg, Ohio, USA
17 Dec. 2011

John M. Wilson
Baltimore, Maryland, USA
1 July 2011

GSA FOUNDATION

Classified Rates—2012

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact advertising@geosociety.org, +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses. To estimate cost, count 54 characters per line, including punctuation and spaces. Actual cost may differ if you use capitals, boldface type, or special characters. Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Positions Open	$8.95	$8.70
Fellowship Opportunities	$8.95	$8.70
Opportunities for Students		
First 25 lines	$0.00	$4.75
Additional lines	$4.75	$4.75

Positions Open

ENVIRONMENTAL SCIENCE AND GIS
ILLINOIS WESLEYAN UNIVERSITY

The Environmental Studies Program at Illinois Wesleyan University invites applications for a one-year teaching post-doctoral position in Environmental Science and GIS for the academic year 2012-2013. The candidate must have a Ph.D. in one of the following areas: earth systems science, environmental geology, global environmental change, environmental geography or a related field. Teaching and research interests that utilize Geographic Information Systems are particularly desirable. Candidates should have received their Ph.D. within the last five years or should receive it no later than 1 Aug. 2012. The regular teaching load at IWU is six course units. The successful candidate will be responsible for teaching five course units and will receive one course unit release for research and writing. Teaching responsibilities include two sections of Introduction to Earth Systems Science with associated labs and two sections of Introduction to Geographic Information Systems (GIS) using ArcGIS. Illinois Wesleyan University is a highly competitive private undergraduate liberal arts university that emphasizes quality teaching and student-faculty research collaboration. To apply for the position, interested applicants should send as PDFs a letter of interest, a current CV, and teaching and research statements to pnoonan@iwu.edu, under the subject heading "Environmental Science Post-doc." In addition, they should arrange for three signed letters of recommendation to be sent to: Abigail Jahiel, Chair, Environmental Studies Program Search Committee, Illinois Wesleyan University, P.O. Box 2900, Bloomington, IL 61702.

Review of applications will begin March 1 and continue until the position is filled. IWU is an equal opportunity employer and welcomes individuals from diverse backgrounds.

FULL-TIME, TENURE TRACK
GEOLOGY INSTRUCTOR,
SANTA MONICA COLLEGE

Santa Monica College is accepting applications for the following Full-Time, Tenure Track position: **Geology Instructor.**

DUTIES: Teach introductory lecture and laboratory courses in Physical Geology, Historical Geology, and Oceanography; conduct field classes; develop new Geology curriculum into areas such as Geospatial Technologies and Sustainability; connect coursework to the Sustainable Technologies Program (STP) within the Earth Science Department; act as lead faculty for the Earth Science Department; review and update Student Learning Outcomes for all current Geology curricula; assist in the development of an Associate of Science degree in accordance with the Geology Transfer Model Curriculum under SB 1440; maintain office hours; participate in development and evaluation of course materials, selection of textbooks, academic and career advisement, staff development programs and college department and faculty organization activities.

MINIMUM QUALIFICATIONS: The minimum qualifications for disciplines on this list is a Master's in geology, geophysics, earth sciences, meteorology, oceanography, or paleontology OR Bachelor's in geology AND Master's in geography, physics, or geochemistry OR the equivalent* OR possession of an appropriate valid California Community College Credential authorizing service in the specified subject area(s).

PREFERRED QUALIFICATIONS: Ph.D. in geology or closely related field however the specialization is open; demonstrated excellence in teaching college level geology; experience in geological fieldwork; experience with the use of technology as a teaching tool; evidence of sensitivity to and understanding of the socio-economic, academic, cultural and ethnic diversity within the community college student population including students with physical and/or learning disabilities as these factors relate to differences in learning styles.

Salary: $45,331–$107,490 (based upon academic preparation and teaching experience).

Apply Online: https:jobs.smc.edu.

All applications and materials must be received by **29 MARCH 2012.**

GEOLOGY INSTRUCTOR
UNIVERSITY OF ARKANSAS AT LITTLE ROCK

The University of Arkansas at Little Rock Dept. of Earth Sciences invites applications for Geology Instructor. Primary teaching responsibilities include introductory geology and possibly courses in the candidate's specialty. Minimum requirement for the position is a M.S. in Geology or a related field. The Department of Earth Sciences, with over 70 undergraduate geology majors, offers a BS in Geology, a Graduate Certificate in Geospatial Technology, and participates in college graduate programs.

Submit applications electronically in PDF format to jbconnelly@ualr.edu. Please use the subject line Geology Instructor-R97334. Applications should include a cover letter, curriculum vitae, statement of teaching interests and goals, and contact information for at least three professional references. The position begins 15 Aug. 2012. Review of applications will begin 1 March and continue until the position is filled. For more information, please contact Dr. Jeffrey Connelly, Chair, Dept. of Earth Sciences, jbconnelly@ualr.edu.

The University of Arkansas at Little Rock is an equal opportunity, affirmative action employer and actively seeks candidacy of women, minorities and individuals with disabilities. Persons hired must provide proof of legal authority to work in the United States. Under Arkansas law, all applications are subject to disclosure.

ASSISTANT/ASSOCIATE PROFESSOR
SEDIMENTARY PETROLOGY,
STRATIGRAPHY & PALEONTOLOGY,
MIDWESTERN STATE UNIVERSITY

The Dept. of Chemistry, Geosciences, and Physics invites applications for a tenure-track position to begin Fall 2012. We seek candidates with combined expertise in depositional processes, quantitative stratigraphy, and fossil biota. The successful candidate will teach introductory courses, Sedimentology and Stratigraphy, Paleontology, and appropriate upper-level courses. Experience in developing a successful undergraduate research program will be given special consideration. Requirements include a Ph.D. in geosciences, strong interpersonal skills, and publications in refereed journals commensurate with experience. MSU is a comprehensive public university serving over 6,000 students. The Geosciences Program has strong ties with regional petroleum exploration and environmental science communities and is poised for continued growth in the next five years. Send an application letter, CV, statements of teaching and research interests, and the names and contact information of three references to Dr. J.D. Price, Geosciences, Midwestern State University, 3410 Taft Blvd., Wichita Falls, TX 76308, USA; e-mail: jonathan.price@mwsu.edu. Review of applications will begin immediately, and this position will remain open until filled. This position is designated as security sensitive and requires the finalist to complete a criminal background check. EEO/ADAAA compliance employer.

FIELD GEOLOGIST
ENERGY RESOURCES SECTION, ALASKA DIV.
OF GEOLOGICAL & GEOPHYSICAL SURVEYS

The Alaska Division of Geological & Geophysical Surveys is seeking to fill a vacant full-time permanent geologist position in the Energy Resources Section. Field experience mapping bedrock geology in structurally complex fold and thrust belts and strike-slip settings involving sedimentary and crystalline rocks is highly desirable, as well as the ability to apply general stratigraphic and structural principles to improve understanding of complex stratigraphic relations. We are particularly interested in applicants with stratigraphy and sedimentology expertise who have worked with subsurface datasets, including wireline logs and reflection seismic data. Experience in the use of GIS software to manage and interpret geologic data is also highly desirable. The State of Alaska complies with Title I of the Americans with Disabilities Act (ADA). We are an equal opportunity employer and support workplace diversity. The State of Alaska does not sponsor work VISAS for non-U.S. citizens; non-U.S. citizens must have a valid work VISA by the time this position closes in order to be considered. This position will remain open through 31 March 2012. Applications must be submitted through Workplace Alaska.

For further information, see the full job announcement on Workplace Alaska, position number 10-2035: http://notes4.state.ak.us/wa/mainentry.nsf/WebData/1hp1HomePage/?Open.

PETROGRAPHER/CONSULTANT
SIMPSON GUMPERTZ & HEGER (SGH)
WALTHAM, MASS.

Simpson Gumpertz & Heger (SGH) is actively recruiting an experienced candidate for a position as Petrographer/Consultant in our Waltham, Mass.,

office. SGH is a nationally known civil and structural engineering firm that works in all aspects of design, investigation, and rehabilitation of structures. At SGH, petrographers provide front-line collaborative support to our investigative teams as well as for external clients, including other engineering firms. The successful candidate will work on investigations of concrete, masonry, stone, and related construction materials.

Applicants should have at least 10 years of experience with stone and concrete petrography; meet the requirements of ASTM C856 and C295; and understand the use of supplemental testing and analytical techniques such as XRD, IR, SEM/EDS, and chemical testing. Exceptional communication skills, experience in research and investigations, and a demonstrated ability for managing and developing staff are also required skills.

To learn more about SGH and to apply for this position, please visit our website at www.sgh.com or e-mail your resume to Stella Mereves-Carolan, Corporate Recruiter, at smereves-carolan@sgh.com, or apply online at www.sgh.com.

Equal Employment Opportunities Employer.

ASSISTANT PROFESSOR
STRUCTURE, TECTONICS
IDAHO STATE UNIVERSITY

The Dept. of Geosciences at Idaho State University invites applications for an Assistant Professor with expertise in Structural Geology & Tectonics. Applicants are required to have a Ph.D. or ABD, and expertise in field-based Structural Geology or closely related fields.

Applicants with interests in the North American Cordillera or resource and energy exploration are especially encouraged.

The position will be awarded as either tenure-track or visiting depending on applicant qualifications and funding approval. The successful applicant will teach high-quality graduate and undergraduate courses including structural geology, and will participate in ISU's Summer Field Camp. The successful applicant will also supervise graduate students and develop a vigorous, externally-funded research program.

Submit a cover letter describing your interest in the position, current CV, statements of Teaching and Research Interests, and contact information for three professional references, via the ISU Human Resources website (www.isujobs.net). For further information, see http://geology.isu.edu or e-mail Dr. Leif Tapanila at tapaleif@isu.edu.

Review of applications began 13 Feb. 2012, and the position will remain open until filled.

Idaho State University is an AA/EEO Employer. Women, Minorities, and Veterans are encouraged to apply. Idaho State University is committed to an environment of civility, respect, and tolerance within the University community.

GEOLOGY & GEOPHYSICS ASSISTANT PROFESSOR
THE MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

The Missouri University of Science and Technology Dept. of Geological Sciences and Engineering invites applications for a full-time tenure-track position at the assistant professor level in Geology and Geophysics in the area of Neotectonics, Remote-Sensing, and Geodynamics to begin September 2012. The successful candidate will be expected to develop an externally-funded research program integrated with excellence in teaching at both the graduate and undergraduate levels. Teaching responsibilities will include courses in Tectonics and Remote Sensing as well as others in the individual's area of expertise. Specific research subfields of the successful applicant could include active deformation/geodesy/InSAR, morphotectonics/dynamic-topography, and crustal/mantle dynamics that can build on departmental strengths in Mechanical Earth Modeling, Tectonics, Geophysics/Seismology, and Natural Hazard Mitigation. For a full position description including application procedures, visit http://hraadi.mst.edu/hr/employment/geologygeophysics/.

TENURE TRACK POSITION
DEPARTMENT OF GEOLOGICAL SCIENCES
THE UNIVERSITY OF SASKATCHEWAN

Now accepting applications for a tenure-track position at the Assistant Professor level in the broad area of Structural Geology and Tectonics. The department seeks a versatile researcher who takes an integrative approach to elucidating the structural and tectonic evolution of the Earth's crust.

The successful candidate will join a growing department and will be expected to develop a vigorous, externally funded research program, and to participate broadly in undergraduate and graduate student teaching and research, including introductory courses, structural geology, and field schools. The candidate must hold a Ph.D. when appointed, which is expected to be 1 July 2012.

The University of Saskatchewan is located in Saskatoon, Saskatchewan, a city with a diverse and thriving economic base, a vibrant arts community and a full range of leisure opportunities. The University has a reputation for excellence in teaching, research and scholarly activities and offers a full range of undergraduate, graduate, and professional programs to a student population of about 20,000. The university is one of Canada's leading research-intensive universities.

The College of Arts & Science offers a dynamic combination of programs in the humanities and fine arts, the social sciences and the sciences. There are over 8,000 undergraduate and graduate students in the College and 325 faculty, including 14 Canada Research Chairs. The College emphasizes student and faculty research, interdisciplinary programs, community outreach and international opportunities.

The Dept. of Geological Sciences in the Division of Science has 16 full-time faculty, including two Canada Research Chairs and two endowed research chairs, and excellent analytical and computing facilities. For detailed information about the Department, the applicants are encouraged to visit http://artsandscience.usask.ca/geology/.

Applications, including résumé, statement of research interests and teaching philosophy, and three letters of reference, should be sent to: Search Committee, Dept. of Geological Sciences, College of Arts and Science, University of Saskatchewan, 114 Science Place, Saskatoon, SK S7N 5E2, Canada, e-mail: jim.merriam@usask.ca; fax: 306-966-8593

We will begin reviewing applications after 20 April 2012.

The University of Saskatchewan is committed to increasing representation of equity groups (women, people of aboriginal ancestry, visible minorities and/or people with disabilities). Applicants from these groups are encouraged to self-identify in their applications. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

Opportunities for Students

Fellowship Opportunity in IODP for Minority Students at U.S. Universities and Colleges. The Integrated Ocean Drilling Program–U.S. Implementing Organization (IODP-USIO) is currently accepting applications for the **Minorities in Scientific Ocean Drilling Fellowship** (deadline: 30 April). The Fellowship will award $30,000 to an outstanding student whose research is using data and/or materials obtained from scientific ocean drilling, or who is developing technology that will help advance science or engineering in scientific ocean drilling research.

For full details about this unique opportunity, including the application process, visit www.oceanleadership.org/education/diversity/minorities-in-scientific-ocean-drilling-fellowship/.

Philmont Scout Ranch Volunteer Geologist Program

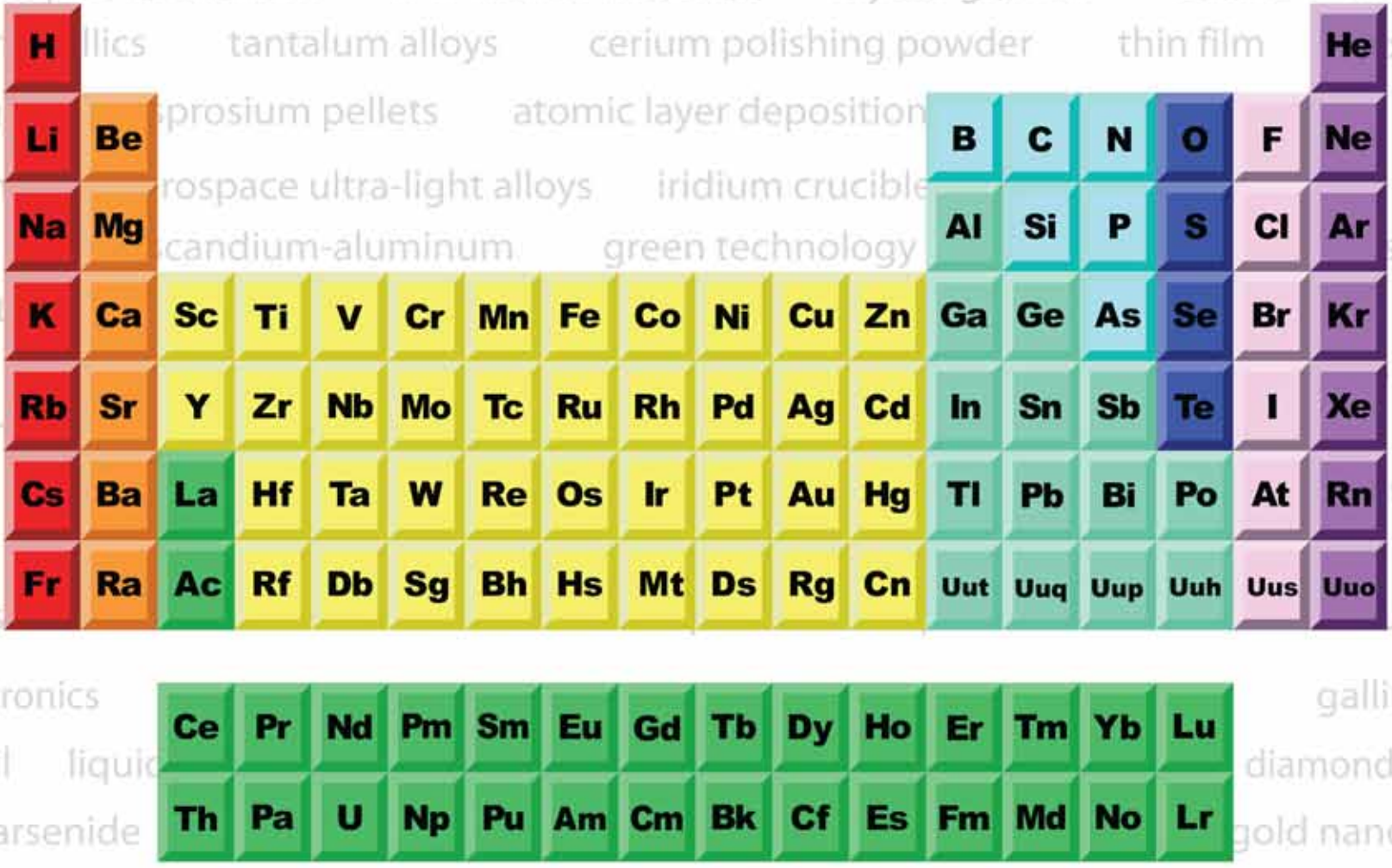
Cimarron, New Mexico, USA

Sponsored by the Rocky Mountain Association of Geologists

Volunteer to teach and demonstrate area geology in back-country New Mexico!

The 2012 season begins on 16 June; last week of the program begins on 12 August.

For more information and to sign up, contact Ed Warner, P.O. Box 480046, Denver, CO 80248-0046, USA, +1-303-331-7737, ewarn@ix.netcom.com. Alternate contact: Bob Horning, P.O. Box 460, Tesuque, NM 87574, USA, +1-505-820-9290, rrhorning@gmail.com.



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