Preface

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OVERVIEW

This volume evolved over many decades and benefited from the accessibility of geochronology to field geologists who could then make regional tectonic interpretations using EarthScope data in conjunction with many seasons of fieldwork. We suggest that the reader also look at various Rocky Mountain compendia, specifically Dorr et al. (1977), Schmidt and Perry (1988), Link et al. (1992), Hildebrand (2009), and DeCelles et al. (2015) to see the evolution of thinking on mountain-building in the Cordillera.

Following World War II, the U.S. government, through the efforts of the U.S. Geological Survey, sought the locations and concentrations of various strategic mineral deposits. Cretaceous-aged "titaniferous" (black) sandstones were identified in the Sevier belt foreland and studied in great detail (Houston and Murphy, 1962). These deposits are rich in Ti (rutile, titaniferous illmenite; 30%–60%), Fe (magnetite, hematite; 5%–12%), and U (zircon; <16%), among other strategic elements and minerals. Attempts were made to understand the provenance of these metal-rich deposits by separating zircons by shape and color, then counting α particle emissions per milligram of zircon per hour versus the average Pb concentration. The zircon concentrations for each sample were counted in milligrams (mg) not by the number of zircon grains! Houston and Murphy (1962) reported ages of 750, 135, and 94 Ma for their different zircon pile morphologies. Jack Dorr, who ran the University of Michigan's Camp Davis field camp for many decades, mapped the northern Sevier belt while on horseback and dated many of the synorogenic deposits (Dorr et al., 1977). Dorr also trained many students doing theses in the Sevier belt, including Craddock (in 1981), where Dorr described the importance of understanding the provenance of the Cliff Creek black sand deposit to thrust belt evolution. Malone et

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al. (Chapter 4) first analyzed the composition of garnets in the Jurassic Stump Formation at Cliff Creek in the Prospect thrust sheet and found these garnets were not sourced from the proximal Wind River or Teton Ranges, but somewhere to the west. Eventually, LA-ICPMS (laser-ablation inductively coupled plasma–mass spectrometry) dating of zircons became available, so our "mountain" of Cliff Creek Preuss Formation zircons (Malone et al., Chapter 4, Fig. 5d; this is 3.409 g of zircon from a 2 kg hand sample!) produced a depositional age and westerly, Sierra Nevadan provenance (Malone et al., Chapter 4, Fig. 6A), which supports the Eocene fission track uplift story for the Teton Range of Brown et al. (2017).

This volume also has a focus on the evolution of the crust of the hinterland of the orogen during the orogenic cycle. About a third of the chapers describe the evolution of the crust and basins at metamorphic core complexes. First described in the North American Cordillera, these structures were re-interpreted as extensional structures by the seminal work of Richard Lee Armstrong in his 1972 paper, and have inspired geologists to tackle many aspects of their evolution for the past five decades. This volume includes 14,902 U-Pb ages (mostly LA-ICPMS, with a few ID-TIMS and SHRIMP results), mostly from zircon but a few monazite, xenotime and calcite ages, 339 Lt-Hf ages, as well as a few Ar-Ar ages.

We have organized the volume from oldest to youngest and hinterland (west) to foreland (east), then back to the southwest as the orogen extended. The Sevier orogen started in the Jurassic period (170 Ma; Craddock Affinati et al., Chapter 1), involved intrusion and easterly transport of Cretaceous plutons (Gottlieb et al., Chapter 2) and metamorphism (Hoiland et al., Chapter 7) as the thin-skinned belt evolved, and Sevier synorogenic sediment from the Paris sheet buried the foreland from the early Cretaceous to the Oligocene (Malone et al., 2017a). The Sevier belt was ~700 km wide and was shortened ~50% by eastward thin-skinned thrust translation and by displacement along a lower, west-dipping detachment at 30 km. The Sevier thin-skinned belt records a complex strain history of oblique convergence (Craddock and Malone, Chapter 5). while the timing of thrust motions includes frontal backthrusts and out-of-sequence fault motions (Malone et al., Chapter 4). Laramide crystalline uplifts were along small-offset, oblique faults listric to a detachment at 30 km (Craddock et al., Chapter 6), and the highlands and adjacent basins were buried in synorogenic debris sourced from the west starting in the Jurassic period, and as far west as the Coast Mountain batholith in British Columbia and flowing east to the Mississippi River drainage (Foreman et al., Chapter 3; Welch et al., Chapter 9; Pecha et al., Chapter 10; Sharman et al., Chapter 11). Archean-cored Laramide structures, including lithospheric buckling in the Bighorn Range (Tikoff et al., Chapter 8), were uplifted once and stripped of their post-Archean cover, then uplifted again and Eocene–Oligocene sediment was deposited atop these highlands; this implies that the basins adjacent to Laramide uplifts were filled by sediment sourced from the massive Paris thrust sheet (Malone et al., 2017a) and the topography of the Laramide province is very young. Slab rollback started in the northeast ca. 55 Ma and included the catastrophic volcanically induced Heart Mountain (Malone et al., Chapter 12; 49.19 Ma) and Markagunt slides (Hacker et al., 2014; 22 Ma). The orogenic cycle comes to a close with the actively evolving continental extensional Basin and Range Province. This broad continental rift has zones of relatively minor extension (10%–15%) and areas where high-magnitude extension exhumed the middle-lower crust to the surface as metamorphic core complexes. The links between deformation in the deep crust and basin formation are examined and evaluated in the context of the interactions between the removal of the Farallon oceanic slab and the regional magmatic activity in the Basin and Range and Snake River Plain province (Lund Snee and Miller, Chapter 13; Miller et al., Chapter 14; and Konstantinou, Chapter 15).

DEDICATION AND HISTORY

John (Jack) A. Dorr Jr. (University of Michigan) was instrumental in Craddock's education in the Sevier belt and the value of field mapping, understanding crosscutting relationships, and using mammalian fossils to constrain fault timing. Dave Wiltschko and Ben van der Pluijm (University of Michigan) were pioneers in understanding thrust belt mechanics. Craddock and Malone met on a three-week Lake Superior field course led by Cam Craddock (University of Wisconsin; 1990), and both benefited from Cam's Rocky Mountain field course across South Dakota, Wyoming, Idaho, and Montana. Dave's dissertation on the Heart Mountain slide, directed by Cam, led to an overlap with John Craddock on Wyoming structure problems (beginning in 2000, that led to more than a dozen papers on this topic; see Craddock et al., 2000, and Malone et al., 2017b). Dave was an undergraduate student at Illinois State University (ISU), taking the ISU field course in the Rockies with Skip Nelson in 1988 and later teaching the ISU camp from 1992–present. Brady Foreman was educated at Macalester College with Craddock and began working in the Bighorn Basin under Philip Gingerich (University of Michigan) and later with Paul Heller (University of Wyoming) on Cretaceous and early Paleogene strata. Alex Konstantinou came to Macalester from Cyprus, then was educated at Stanford University with Elizabeth Miller, where he overlapped with the rest of the "Elizabeth Miller band" that contributed to this volume (Gottlieb et al., Chapter 2; Hoiland et al., Chapter 7; Sharman et al., Chapter 11; Lund Snee and Miller, Chapter 13; Miller et al., Chapter 14).

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