Supplementary File S1. Analytical Methods and Exploratory Data Analysis

This supplementary file details sample preparation and analytical methods and should be cited as the paper it accompanies:

Attia, S., Paterson, S.R., Saleeby, J., and Cao, W., 2021, Detrital zircon provenance and depositional links of Mesozoic Sierra Nevada intra-arc strata: Geosphere, v. ***xx, n. xx, p. xx-xx, doi: xxxxxxx.xxxx****.*

LASER ABLATION INDUCTIVELY COUPLED MASS SPECTROMETRY (LA-ICPMS) U-PB GEOCHRONOLOGY ANALYSES

Zircon crystals are extracted from samples by traditional methods of crushing and grinding, followed by separation with a Wilfley table, heavy liquids, and a Frantz magnetic separator. Samples are processed such that all zircons are retained in the final heavy mineral fraction. A split of the available grains is incorporated into a 1" epoxy mount together with fragments of Sri Lanka standard zircon. The mounts are sanded down to a depth of ~20 microns, polished, imaged, and cleaned prior to isotopic analysis.

U-Pb geochronology of zircons was conducted by laser ablation multicollector inductively coupled plasma mass spectrometry (LA-MC-ICPMS) at the Arizona LaserChron Center (Gehrels et al., 2008). The analyses involve ablation of zircon with a Photon Machines Analyte G2 Excimer laser (or, prior to May 2011, a New Wave UP193HE Excimer laser) using a spot diameter of 30 microns. The ablated material is carried in helium into the plasma source of a Nu HR ICPMS, which is equipped with a flight tube of sufficient width that U, Th, and Pb isotopes are measured simultaneously. All measurements are made in static mode, using Faraday detectors with 3x1011 ohm resistors for 238U, 232Th, 208Pb-206Pb, and discrete dynode ion counters for 204Pb and 202Hg. Ion yields are ~0.8 mv per ppm. Each analysis consists of one 15-second integration on peaks with the laser off (for backgrounds), 15 one-second integrations with the laser firing, and a 30 second delay to purge the previous sample and prepare for the next analysis.

MULTIDIMENSIONAL SCALING (MDS) EXPLORATORY DATA ANALYSIS

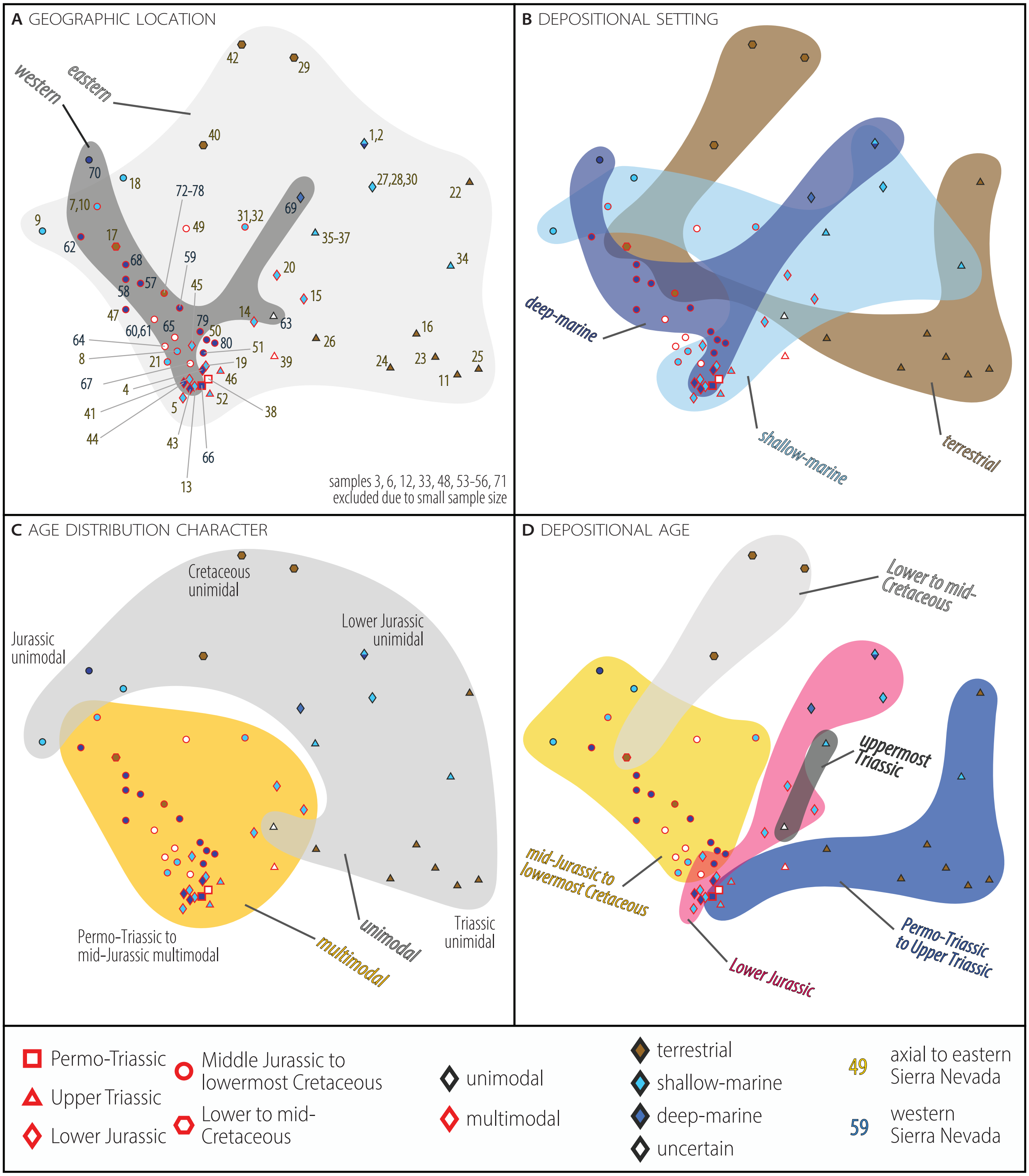
Methods

Multi-dimensional scaling (MDS) uses pairwise dissimilarity between sample detrital age distributions to calculate coordinates for each sample on a map that plots similar detrital zircon sample populations closer together and dissimilar populations farther apart (Vermeesch, 2013; Vermeesch and Garzanti, 2015). The analysis takes an 'N by N' (N=number of input distributions) matrix of pairwise dissimilarities and fits coordinates to each sample such that the pairwise Euclidean distances between sample coordinates minimize misfit with respect to the input dissimilarities. The values plotted on each axis have no meaningful units, the x- and y-axes simply represent the coordinates of each point as computed through MDS. A classic example of MDS is the recreation of a geographic map of major US cities given a matrix of pairwise distances between these cities. MDS finds coordinates for each city that minimize 'strain' between the given and resulting inter-city distances. We have made the following methodological choices in the MDS analysis applied to this compilation: (a) restricting MDS to two dimensions for ease of presentation, (b) combining multiple sample analyses to form composite distributions where appropriate, and (c) calculating pairwise dissimilarity using the Kuiper's test V-value.

Results

MDS results show a dense cloud of multimodal distributions and diffuse arrays of mostly unimodal distributions that together form a pentagonal structure (Fig. 9). Each 'vertex' of this irregular pentagon corresponds to end-member distributions based on depositional age and the character of the distribution (i.e. unimodal vs multimodal). Permo-Triassic samples lie nearest to multimodal Jurassic samples as both are dominated by the spread of pre-300 Ma detrital ages. Sample of Upper Triassic strata form a two-pronged array between a multimodal Triassic end member and unimodal end members. Samples of uppermost Triassic strata overlap with Lower Jurassic strata due to the latest Triassic-aged detrital zircon component present in Lower Jurassic strata. Cretaceous distributions contain significant proportions of mid-Jurassic ages, exemplified by the linear array between the unimodal Cretaceous end member and nearly unimodal Jurassic distributions. MDS results suggest a time-dependent variation in sedimentary provenance within a coherent, interconnected sedimentary network spanning the entire Sierra Nevada.

Figure S1 (next page). Multidimensional scaling results illustrate the structure of compiled detrital zircon U-Pb age data based on pairwise dissimilarity of populations calculated as the Kuiper's test V-value. Colored fields in each panel, depicting different sample groupings, illustrate how depositional age and distribution complexity control sample pairwise dissimilarity rather than depositional setting or sample location. MDS results calculated using the DZmds Matlab application (Saylor et al., 2017). Sample information and abbreviations are given in Table 1.



A GEOGRAPHIC LOCATION
western
eastern
samples 3, 6, 12, 33, 48, 53-56, 71 excluded due to small sample size
B DEPOSITIONAL SETTING
deep-marine
shallow-marine
terrestrial
C AGE DISTRIBUTION CHARACTER
Cretaceous unimidal
Jurassic unimodal
Lower Jurassic unimidal
Permo-Triassic to mid-Jurassic multimodal
multimodal
unimodal
Triassic unimidal
D DEPOSITIONAL AGE
Lower to mid-Cretaceous
uppermost Triassic
mid-Jurassic to lowermost Cretaceous
Lower Jurassic
Permo-Triassic to Upper Triassic
Permo-Triassic
Upper Triassic
Lower Jurassic
Middle Jurassic to lowermost Cretaceous
Lower to mid-Cretaceous
unimodal
multimodal
terrestrial
shallow-marine
deep-marine
uncertain
49 axial to eastern Sierra Nevada
59 western Sierra Nevada

REFERENCES CITED ONLY IN THIS DATA REPOSITORY ITEM

Saylor, J.E., Jordan, J.C., Sundell, K.E., Wang, X., Wang, S., and Deng, T., 2017, Topographic growth of the Jishi Shan and its impact on basin and hydrology evolution, NE Tibetan Plateau: Basin Research, v. 30, n. 3, p. 544-563.

Vermeesch, P., 2013, Multi-sample comparison of detrital age distributions: Chemical Geology, v. 341, p. 140-146.

Vermeesch, P., and Garzanti, E., 2015, Making geological sense of 'Big Data' in sedimentary provenance analysis: Chemical Geology, v. 409, p. 20-27.