Precambrian Research 251 (2014) 102–117

Contents lists available at ScienceDirect

Precambrian Research

journal homepage: www.elsevier.com/locate/precamres

Detrital zircon provenance and paleogeography of the Pahrump Group and overlying strata, Death Valley, California

Robert C. Mahon[a,*], Carol M. Dehler[b], Paul K. Link[a], Karl E. Karlstrom[c], George E. Gehrels[d]

[a] Idaho State University, Department of Geosciences, 921 South 8th Avenue, Stop 8072, Pocatello, ID 83209-8072, United States
[b] Utah State University, Department of Geology, 4505 Old Main Hill, Logan, UT 84322-4505, United States
[c] University of New Mexico, Department of Earth and Planetary Sciences, MSCO3-2040, Albuquerque, NM 87131, United States
[d] University of Arizona, Department of Geosciences, 1040 East 4th Street, Tucson, AZ 85721, United States

ARTICLE INFO

Article history:
Received 21 January 2014
Received in revised form 28 April 2014
Accepted 9 June 2014
Available online 19 June 2014

Keywords:
Rodinia
Proterozoic
Pahrump Group
Death Valley
Detrital zircon
Snowball Earth

ABSTRACT

The Mesoproterozoic and Neoproterozoic Pahrump Group of Death Valley, California spans ca. 1300–635 Ma and provides a >500 million-year record of geologic events in southwestern Laurentia. The strata analyzed include preserved sequences separated by unconformities recording syn-Rodinia basin development (Crystal Spring Formation); Rodinia stability; regional extension culminating in Neoproterozoic rifting of the Laurentian margin of Rodinia (Horse Thief Springs through Johnnie Formations); and multiple phases of glacial sedimentation and subsequent cap carbonate deposition (Kingston Peak Formation and Noonday Dolomite). U-Pb detrital zircon analyses were conducted on samples from the entire Pahrump Group and the Noonday Dolomite in the southeastern Death Valley region (20 samples, 1945 grains) to further constrain hypotheses for regional basin development during the development of the southwestern Laurentian margin.

Our interpretation of provenance data expands upon and clarifies previous models defining a series of tectonostratigraphic units including: (A) the <1400 Ma basal conglomerate of the Crystal Spring Formation, comprised of metasedimentary quartzite clasts, and exhibiting a unimodal detrital zircon sample distribution at 1690 Ma with northerly source; (B) the ca. 1320–1080 Ma Crystal Spring Formation exhibiting unimodal zircon distributions derived from southerly, local Paleoproterozoic basement sources punctuated by a ca. 300 Ma duration unconformity; (C) the ca. 780–740 Ma sequence of the Horse Thief Springs Formation, Beck Spring Dolomite, and KP1 unit of Kingston Peak Formation deposited in a marine basin with mixed southwestern Laurentian provenance; (D) a ca. 710–635 Ma glaciogenic sequence (KP2-KP4 members of Kingston Peak Formation), recording the onset of Rodinia rifting, and Sturtian and Marinoan "Snowball Earth" intervals with provenance data suggesting derivation from erosion and recycling of older Pahrump Group strata; (E) the ca. 635 Ma cap dolostone of the Sentinel Peak Member of the Noonday Dolomite, representing post-glacial drainage reorganization with more regional provenance; followed by (F) the <635 Ma strata of the Radcliff Member of the Noonday Dolomite, showing a marked shift to bimodal age distributions, indicating derivation from local basement sources. These data synthesize and complement previous provenance studies from overlying units and result in the addition of ca. 500 Ma of new provenance analysis for the southwestern Laurentian margin.

1. Introduction

Many questions remain unanswered with respect to paleocontinental reconstructions during the 'life cycle' of the supercontinent Rodinia (ca. 1200–600 Ma; e.g. Li et al., 2008), including a lack of well-defined piercing points and an incomplete understanding of the paleogeographic evolution of rifted margins (e.g. Sears and Price, 1978, 2003; Rainbird et al., 1996; Karlstrom et al., 2001; Piper, 2011). Links between the breakup of Rodinia and

* Corresponding author. Present address: University of Wyoming, Department of Geology and Geophysics, Dept. 3006, 1000 University Avenue, Laramie, WY 82071, United States. Tel.: +1 406 241 1026.
E-mail address: rmahon1@uwyo.edu (R.C. Mahon).

http://dx.doi.org/10.1016/j.precamres.2014.06.005
0301-9268/

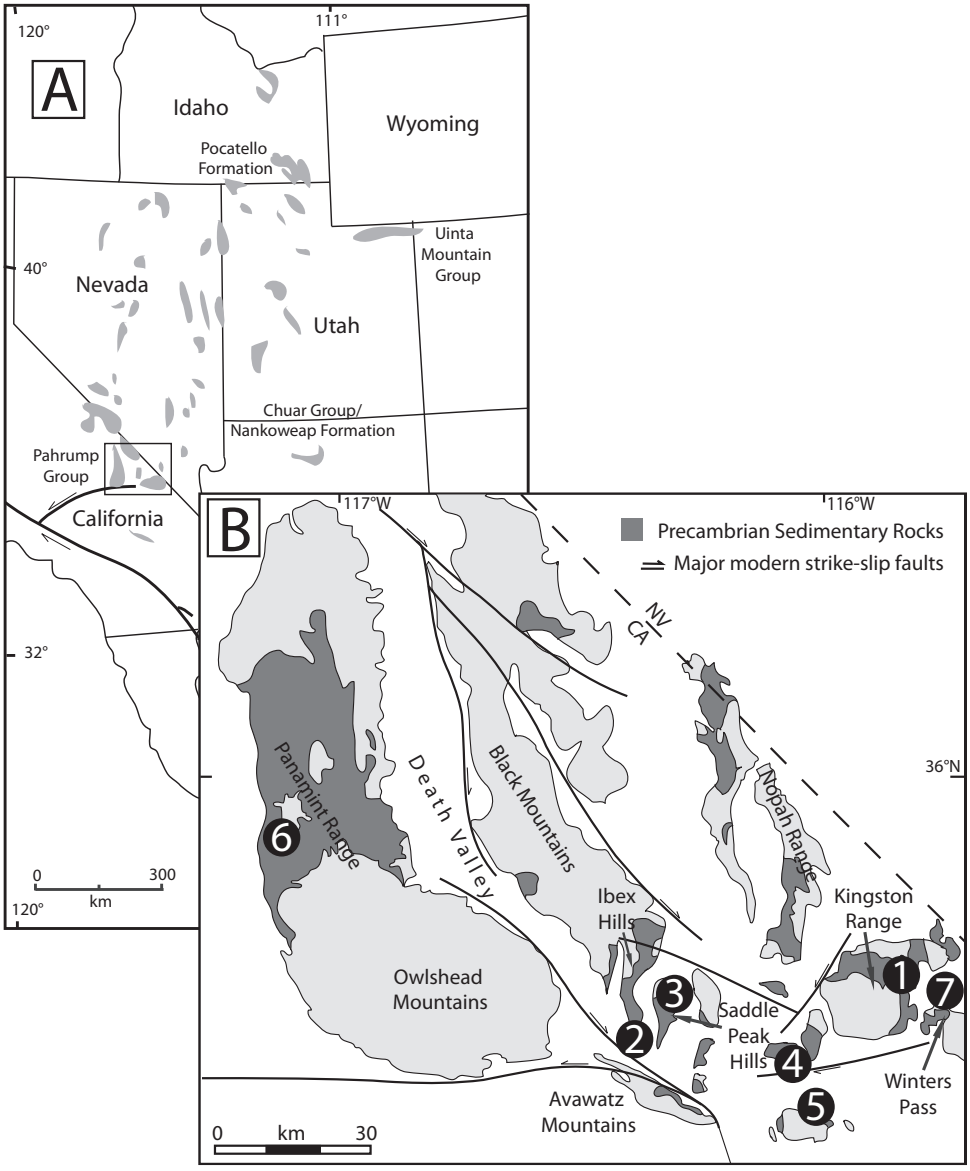

Fig. 1. (A) Map of the southwestern United States showing location and extent of Neoproterozoic sedimentary successions (in gray; modified after Stewart et al., 2001; Lund, 2008). (B) Distribution of Proterozoic sedimentary rocks (dark gray) of the Pahrump Group through Zabriskie Quartzite in the southern Death Valley region. Geology modified from Jennings et al. (1962), Workman et al. (2002) and Petterson (2009). Localities sampled and discussed in text indicated by numbers: 1 – Kingston Range; 2 – southern Ibex Hills/Saratoga Spring; 3 – Saddle Peak Hills; 4 – Alexander Hills; 5 – Silurian Hills; 6 – Redlands Canyon in the southern Panamint Range; 7 – Winters Pass in the Mesquite Mountains.

development of low-latitude glaciations of the late Neoproterozoic also remain uncertain (e.g. Prave, 1999; MacDonald et al., 2013). The Pahrump Group and overlying strata of the Death Valley, California region (Fig. 1) preserve a rich Mesoproterozoic to Cambrian stratigraphic record (see Fig. 2), which captures the time period spanning the growth and decay of Rodinia (Heaman and Grotzinger, 1992; Li et al., 2008; Mahon et al., 2014), and two potentially low-latitude glacial-cap carbonate cycles (Miller, 1985; Link et al., 1994; Prave, 1999; Abolins et al., 2000; Corsetti and Kaufman, 2003).

In this paper, we present new detrital zircon data (20 samples, 1945 grains) from the Pahrump Group (Crystal Spring and Horse Thief Springs Formations, Beck Spring Dolomite, and Kingston Peak Formation) and the overlying Noonday Dolomite, and integrate these data with previously reported zircon ages from underlying basement and overlying Ediacaran and Early Cambrian strata. In light of recent lithostratigraphic, tectonostratigraphic and chronologic investigations (e.g. Mrofka and Kennedy, 2011; Petterson et al., 2011a, 2011b; Verdel et al., 2011; MacDonald et al., 2013; Mahon et al., 2014), our data provide a detailed record of the chronology, provenance and paleogeographic evolution of the ca. 1300–650 Ma time represented (as both preserved sedimentary rock and unconformities) by the Pahrump Group and Noonday Dolomite. The result is the new view that the Pahrump Group records several discrete sedimentation episodes separated by major unconformities, documenting the tectonic evolution within intracratonic Laurentia.

2. Geologic setting

The Pahrump Group (~3 km average thickness) is exposed in numerous ranges across the central and southern Death Valley region, and sits unconformably on 1800–1200 Ma crystalline basement (Wasserburg et al., 1959; Labotka et al., 1980; Barth