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Paleoenvironment and paleoecology of a Late Paleocene high-latitude terrestrial succession, Arkose Ridge Formation at Box Canyon, southern Talkeetna Mountains, Alaska

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ABSTRACT

Paleogene sedimentary rocks of the Arkose Ridge Formation (Talkeetna Mountains, Alaska) preserve a record of a fluvial–lacustrine depositional environment and its forested ecosystem in an active basin among the convergent margin tectonic processes that shaped southern Alaska. An ~800 m measured succession at Box Canyon indicates braid-plain deposition with predominantly gravelly deposits low in the exposure to sandy and muddy facies associations below an overlying lava flow sequence. U–Pb geochronology on zircons from a tuff and a sandstone within the measured section, as well as an Ar/Ar date from the overlying lava constrain the age of the sedimentary succession to between ~59 Ma and 48 Ma. Fossil plant remains occur throughout the Arkose Ridge Formation as poorly-preserved coalified woody debris and fragmentary leaf impressions. At Box Canyon, however, a thin lacustrine depositional lens of rhythmically laminated mudrocks yielded fish fossils and a well-preserved floral assemblage including foliage and reproductive organs representing conifers, sphenopsids, monocots, and dicots. Leaf physiognomic methods to estimate paleoclimate were applied to the dicot leaf collection and indicate warm temperate paleotemperatures (~11–15 ± ~4 °C MAT) and elevated paleoprecipitation (~120 cm/yr MAP) estimates as compared to modern conditions; results that are parallel with previously published estimates from the partly coeval Chickaloon Formation deposited in more distal depositional environments in the same basin. The low abundance of leaf herbivory in the Box Canyon dicot assemblage (~9% of leaves damaged) is also similar to the results from assemblages in the meander-plain depositional systems of the Chickaloon. This new suite of data informs models of the tectonostratigraphic evolution of southern Alaska and the developing understanding of terrestrial paleoecology and paleoclimate at high latitudes during the Late Paleocene–Early Eocene greenhouse climate phase.

1. Introduction

Marine and continental successions preserve abundant and diverse evidence of a period of globally warm greenhouse conditions during the Late Paleocene and into the Early Eocene (Kennett and Stott, 1991; Zachos et al., 2001, 2008; Tripati and Elderfield, 2005; Sluijs et al., 2006; Weijers et al., 2007; McInerney and Wing, 2011). Throughout North America, Paleocene and Eocene fossil leaf assemblages have been analyzed for paleoclimatic estimates by leaf physiognomic approaches (e.g., Wilf, 1997; Wilf et al., 1998; Peppe et al., 2011; Yang et al., 2011), and most indicate relatively warmer and wetter conditions at their respective localities compared to modern day (e.g., Wing and Greenwood, 1993; Wing, 1998; Fricke and Wing, 2004; Greenwood et al., 2010; Smith et al., 2011). Many studies have also shown a positive correlation between mean annual temperature (MAT) and the frequency and diversity of leaf damage by insects (Wilf and Labandeira, 1999; Wilf, 2000; Wing et al., 2005; Currano et al., 2008, 2010; Smith, 2008; Currano, 2009). High-latitude Paleocene–Eocene North American basins and their paleofloras remain understudied in these regards. More work in reconstructing the environment and ecology of fossilized forested ecosystems in sub-polar and polar regions is necessary to understand climate/biosphere dynamics during the prevailing global greenhouse climatic conditions at the time. The results have potential implications for how we understand modern ecosystem states and dynamics in these particularly sensitive regions to modern global climate change (Holland and Bitz, 2003; IPCC, 2007).

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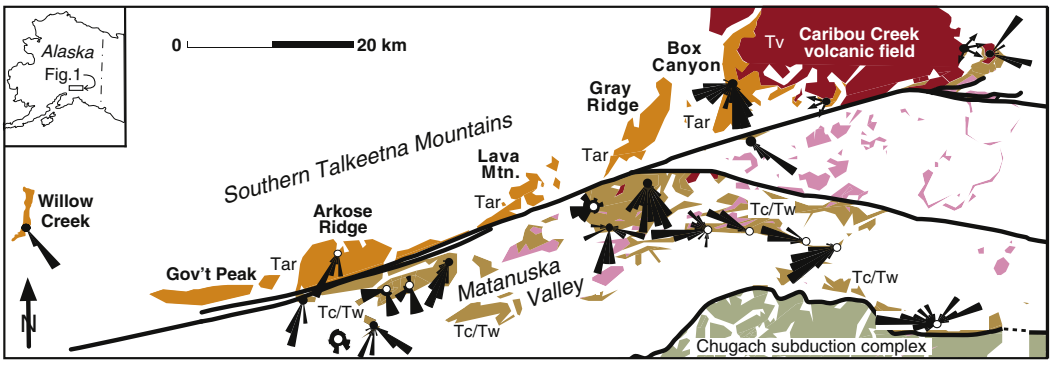

Fig. 1. Geologic map showing Arkose Ridge Formation measured stratigraphic section locations and paleocurrent data. This study focuses on Paleocene sedimentary and volcanic strata exposed north (orange-Tar) of the Castle Mountain fault at Box Canyon, and to a lesser extent, at Lava Mountain and Gray Ridge. Abbreviations: Tar — Paleocene Arkose Ridge Formation, Tc/Tw — Paleocene–Eocene Chickaloon and Wishbone Formations, Tv — Eocene Caribou Creek volcanic.
Rose diagrams represent structurally restored paleocurrent azimuths from Clardy (1974), Little (1988), Trop et al. (2003), Cole et al. (2006), and Donaghy (2012).

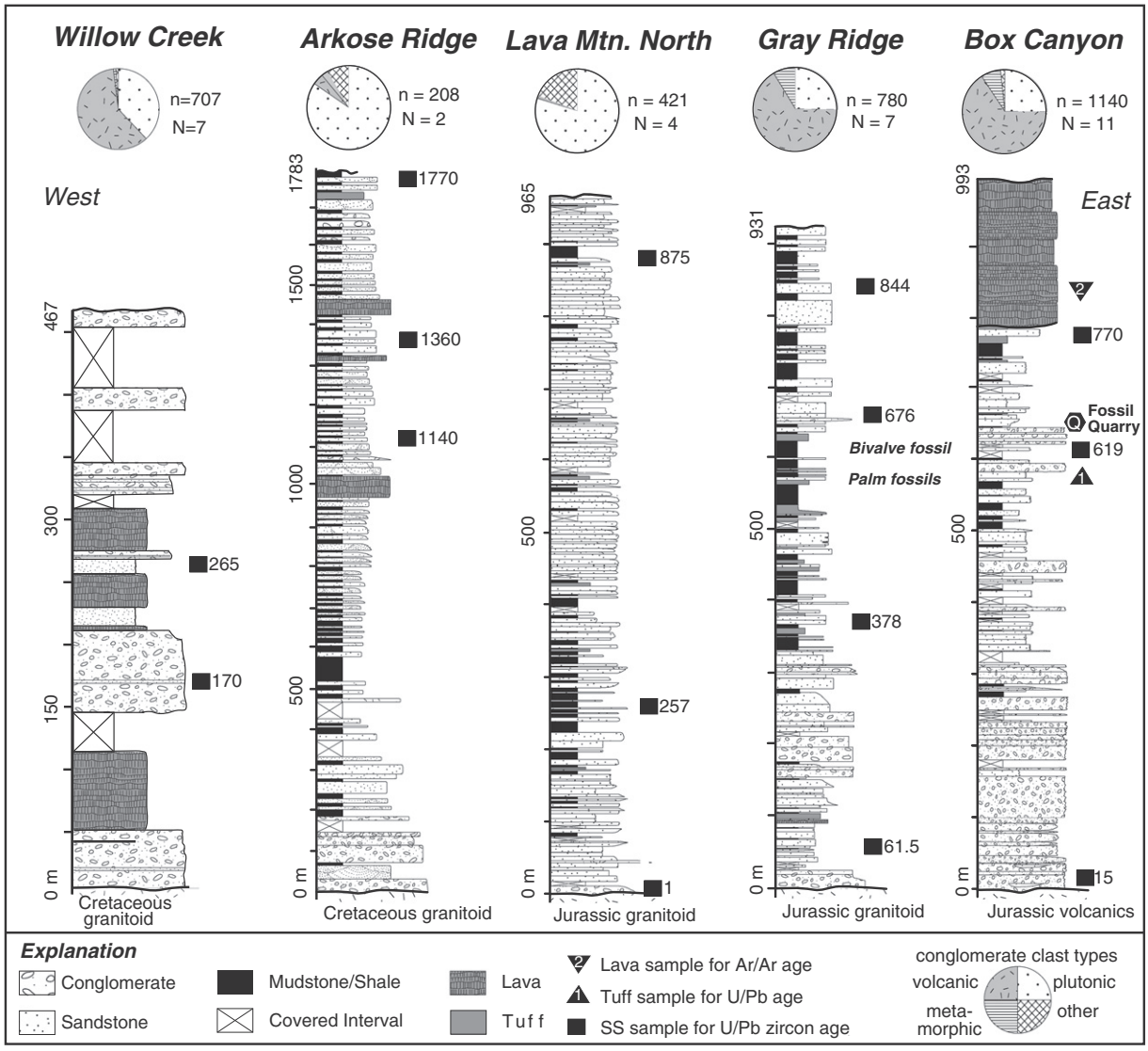

Fig. 2. Generalized logs (in meters) of measured stratigraphic sections of Paleocene sedimentary and volcanic strata exposed in the southern Talkeetna Mountains (see Fig. 1). Tuff ages are U/Pb zircon analyses whereas lava ages are $^{40}Ar/^{39}Ar$ analyses on groundmass. n = total number of clasts counted; N = number of conglomerate beds sampled.
Isotopic ages from tuff and lava are from Idleman et al. (2011). Squares mark position of sandstone samples for detrital geochronologic ages reported by Kortyna et al. (2013) that yield maximum depositional ages consistent with the tuff and lava ages. Pie diagrams above sections show summary of conglomerate clast compositions reported by Kortyna et al. (2013).