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Late thermal evolution of Proterozoic rocks in the northeastern Llano Uplift, central Texas

J.R. Rougvie [a,*], W.D. Carlson [a], P. Copeland [b], J.N. Connelly [a]

[a] *Department of Geological Sciences, University of Texas at Austin, Austin, TX 78712, USA*
[b] *Department of Geosciences, University of Houston, Houston, TX 77204-5503, USA*

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Abstract

The Llano Uplift of central Texas, USA contains large exposures of polydeformed Grenvillian metaigneous and metasedimentary rocks that were intruded by late- to post-orogenic granites. New U–Pb and $^{40}Ar/^{39}Ar$ single mineral ages and Rb–Sr mineral isochrons document the retrograde cooling history that followed Grenville-age metamorphism in the north-central and northeastern Llano Uplift, and explain discrepancies between previous U–Pb crystallization ages and younger determinations based on Rb–Sr and K–Ar isotopic systems. Dating has been carried out in the Valley Spring Gneiss (VSG) and the post-tectonic Lone Grove Pluton (LGP) in three areas of the Llano Uplift, from west to east: VSG rocks in the Babyhead area north of Llano, Texas, yielding hornblende, muscovite and biotite $^{40}Ar/^{39}Ar$ ages and Rb/Sr mineral isochron ages from ~1098 to ~1014 Ma; a sample from the LGP at Petrick Quarry, yielding U–Pb titanite and hornblende and biotite $^{40}Ar/^{39}Ar$ ages from ~1096 to ~1076 Ma; and VSG samples from the Inks Lake area in the eastern Llano Uplift, yielding U–Pb titanite, hornblende and biotite $^{40}Ar/^{39}Ar$, and Rb-Sr mineral isochron ages from ~1087 to ~1029 Ma. Titanite from the Oatman granite to the southwest of these areas yields a U–Pb age of 1119±6 Ma. These ages, combined with closure-temperature estimates, document cooling in the Llano Uplift from ~1100–1000 Ma at rates between 5 and 14°C Ma^{-1}. Although rapid uplift following early high-pressure metamorphism has important regional thermal effects, the cooling rates documented in this study are interpreted to represent the relaxation of local geotherms following local magmatic activity. The low-temperature history documented in this study is probably unrelated to uplift rates. This supports the suggestion that magmatic heating was an important factor in the late high-temperature/low-pressure metamorphism of the Llano region. It further suggests that the late pressure and temperature conditions recorded in the rocks were likely not synchronous across the region.

Keywords: Cooling; Geochronology; Metamorphism; Llano Uplift; Proterozoic

* Corresponding author. Fax: +1 512 471 5766; e-mail: iowa@mail.utexas.edu

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