Available online at www.sciencedirect.com
ScienceDirect
Lithos 97 (2007) 58–87
LITHOS
www.elsevier.com/locate/lithos

Grenville-age A-type and related magmatism in southern Laurentia, Texas and New Mexico, U.S.A.

Yujia Li [a], Melanie A. Barnes [a], Calvin G. Barnes [a,*], Carol D. Frost [b]

[a] *Department of Geosciences, Texas Tech University, Lubbock, TX 79409-1053, USA*
[b] *Department of Geology and Geophysics, University of Wyoming, Laramie, WY, 82071-3006, USA*

Received 15 November 2005; accepted 4 December 2006
Available online 16 December 2006

Abstract

Large Grenville-age plutons are known to be present in the 1340–1370 Ma basement in Texas and eastern New Mexico, but their distribution and compositional ranges are poorly known. New U–Pb zircon dates (SHRIMP-RG, Stanford University) on subsurface samples have identified widespread presence of compositionally diverse Grenville-age (1070–1110 Ma) plutonic rocks. In the Texas Panhandle, core from a >175 m thick, sill-like gabbroic intrusion yielded a date of 1081±8.3 Ma. *In situ* differentiation of this tholeiitic magma led to a ~7-fold increase in incompatible element concentrations as REE patterns remained essentially flat. Trace element data suggest an E-MORB-like source. To the south, alkali–feldspar granite with A-type affinities was recovered from drill core from the Abilene gravity minimum near Albany, Texas. It yielded a date of 1078 ±23 Ma; similar to undeformed (post-orogenic) granites in the Llano uplift. Further west, an anorthosite xenolith from the Eocene Three Sisters intrusion in El Paso, Texas yielded a date of 1068±30 Ma which is within error of the 1110±19 Ma age determined for the main stage of the nearby A-type Red Bluff granitic suite. Xenoliths from Potrillo maar volcano in the center of the southern Rio Grande rift include monzonitic xenoliths with granulitic texture which yielded dates of ~1072 Ma. In contrast, Potrillo maar xenoliths with igneous textures yielded U–Pb dates of ~27 Ma. Development of the granulitic texture is interpreted to reflect granulite facies metamorphism during Tertiary time (26–27 Ma) on the basis of age zoning and U concentrations in the zircon crystals. Our results show that Grenville-age magmatism in the Texas and New Mexico subsurface was widespread and was coeval with syn- and post-deformation granites in the Llano uplift of central Texas. The compositions of dated samples suggest that mafic magmas were broadly tholeiitic in character and that granitic magmas were "A-type". These magmatic affinities are thought to be associated with crustal extension rather than with subduction. Moreover, the presence of anorthosite xenoliths in the El Paso-Kilbourne Hole region, the broadly tholeiitic character of mafic rocks, and the A-type nature of the granitic rocks are broadly similar to AMCG (Anorthosite–Mangerite–Charnockite–Granite) suites present in the Grenville province of eastern Laurentia.

Keywords: Grenville; Southern Laurentia; U–Pb; A-type; AMCG; Texas; New Mexico

1. Introduction

The Grenville orogen along the eastern margin of Laurentia in North America is characterized by a belt of metamorphism, deformation, and plutonism culminating ~1100 Ma ago. The north-northeast trending

* Corresponding author.
E-mail address: cal.barnes@ttu.edu (C.G. Barnes).

0024-4937/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.lithos.2006.12.010

orogen is exposed for more than 2000 km along the margin of the Canadian Shield in Labrador, Québec and Ontario and records both intracratonic and collisional orogenesis (Davidson, 1986; Rivers et al., 1989). In Labrador, crustal shortening affected older basement rocks in an intracratonic setting (Connelly et al., 1995). In Ontario, island-arc and allochthonous terrane accretion preceded continent–continent collision (Davidson, 1986; Gower et al., 1990; Culotta et al., 1990). Parts of the orogenic belt are exposed in the Appalachian Mountains and the belt continues in the subsurface 3000 km to the southern margin of Laurentia, where it is exposed in Texas and Mexico (Fig. 1).

The core of the southern Grenville orogen is exposed in the Llano uplift and consists of polydeformed metavolcanic, metaplutonic, and metasedimentary rocks (1360–1232 Ma) which were assembled during the Grenville (~1.1 Ga) continent–continent collisional event. These rocks record an early eclogite facies event followed by moderate- to high-pressure, upper amphibolite to lower granulite facies metamorphism (Walker, 1992; Mosher, 1993; Reese, 1995; Roback, 1996; Carlson, 1998; Mosher, 1998; Wilkerson et al., 1998; Reese and Mosher, 2004). They were then intruded by ~1119 to 1070 Ma syn-tectonic to post-tectonic, 'Grenville-age' granitic magmas, typically at shallow levels of emplacement, as represented by the ~1.08 Ga Enchanted Rock batholith (Reed, 1995; Reed et al., 1995). The Grenville orogen is also exposed in west Texas near Van Horn, where polydeformed supracrustal and minor intrusive rocks of the Carrizo Mountain Group (1380–1327 Ma, Roths, 1993; Grimes and Mosher, 2003; Grimes and Copeland, 2004) are thrust onto Mesoproterozoic carbonate and volcaniclastic rocks (Allamoore and Tumbledown Formations; 1256–1253 Ma and 1243 Ma, respectively) and syn-orogenic conglomerates and sandstones (Hazel Formation, 1100–1080 Ma) along the west–northwest-trending Streeruwitz thrust (King and Flawn, 1953; Mosher, 1998; Bickford et al., 2000). This thrust marks the northernmost expression of Grenville deformation in Texas (Mosher, 1998). Granite and rhyolite boulders from the conglomerate of the Hazel Formation have petrographic affinities to the Thunderbird group and Red Bluff granitic suite in the Franklin Mountains (see below), and were dated at

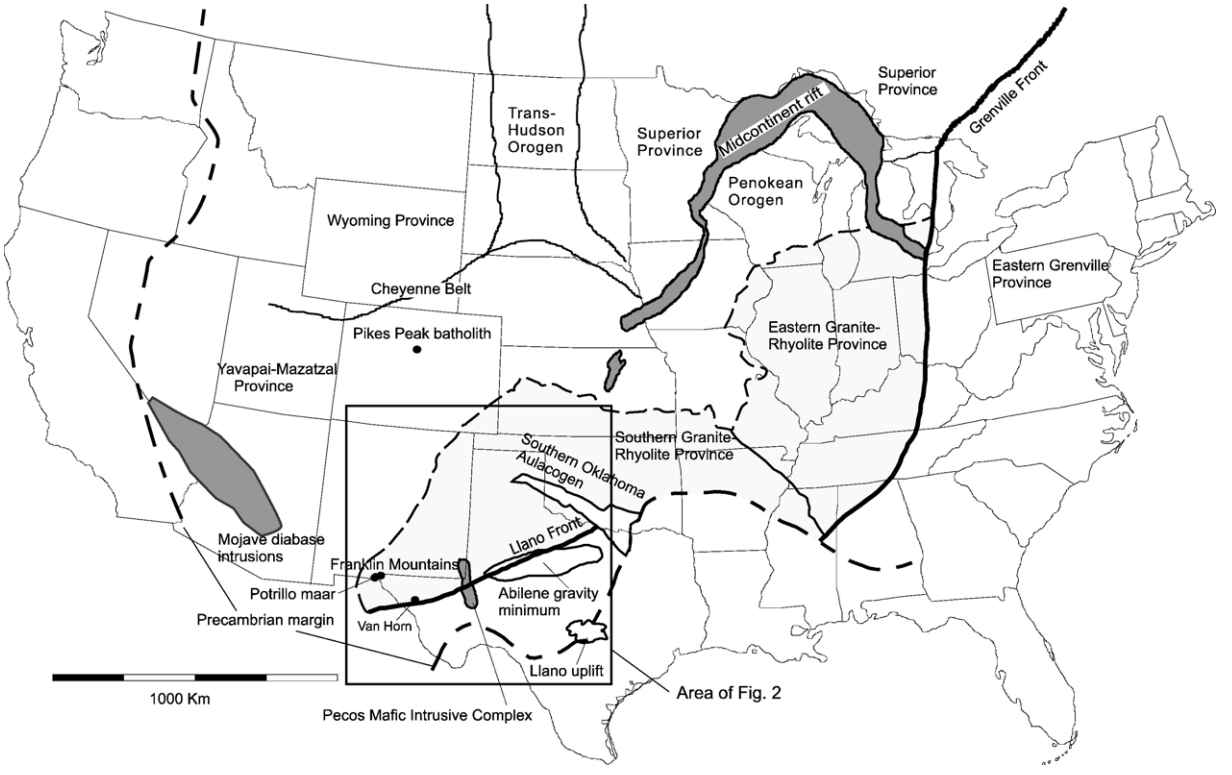

Fig. 1. Geological map of Precambrian crustal provinces in central North America (dark gray regions show the distribution of ~1.1 Ga mafic magmatism (after Barnes et al., 2002).