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Neoproterozoic diamictite-cap carbonate succession and $\delta^{13}C$ chemostratigraphy from eastern Sonora, Mexico

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Abstract

Despite the occurrence of Neoproterozoic strata throughout the southwestern U.S. and Sonora, Mexico, glacial units overlain by enigmatic cap carbonates have not been well-documented south of Death Valley, California. Here, we describe in detail the first glaciogenic diamictite and cap carbonate succession from Mexico, found in the Cerro Las Bolas Group. The diamictite is exposed near Sahuaripa, Sonora, and is overlain by a 5 m thick very finely-laminated dolostone with soft sediment folds. Carbon isotopic chemostratigraphy of the finely-laminated dolostone reveals a negative $\delta^{13}C$ anomaly (down to −3.2‰ PDB) characteristic of cap carbonates worldwide. Carbon isotopic values rise to +10‰ across ~400 m of section in overlying carbonates of the Mina el Mezquite and Monteso Formations. The pattern recorded here is mostly characteristic of post-Sturtian (ca. ≤700 Ma), but pre-Marinoan (ca. ≥635 Ma) time. However, the Cerro Las Bolas Group shares ambiguity common to most Neoproterozoic successions: it lacks useful radiometric age constraints and biostratigraphically useful fossils, and its $\delta^{13}C$ signature is oscillatory and therefore somewhat equivocal.

Keywords: Neoproterozoic; Chemostratigraphy; Mexico; Sonora; Cap carbonate

1. Introduction

Many Neoproterozoic stratigraphic successions contain glacial deposits capped by enigmatic carbonate strata termed ‘cap carbonates’ (e.g., Kennedy, 1996; Kaufman et al., 1997; Hoffman et al., 1998a,b; Kennedy et al., 1998; Prave, 1999; James et al., 2001; Kennedy et al., 2001; Hoffman and Schrag, 2002; Corsetti and Kaufman, 2003; Rodrigues-Nogueira et al., 2003; Halverson et al., 2004; Lorentz et al., 2004; Porter et al., 2004; Xiao et al., 2004). Cap carbonates record negative $\delta^{13}C$ anomalies and many contain unusual carbonate fabrics such as seafloor-precipitated crystal fans and tubestones. This glacial-cap carbonate pattern and concomitant $\delta^{13}C$ anomaly is noted in almost every Neoproterozoic basin around the world and is thought by many to result from low-latitude glaciation and its aftermath. The fact that cap carbonates are also found in siliciclastic-dominated successions suggests that a global marine increase in the saturation state of calcium carbonate occurred and was associated with major perturbations in the carbon cycle. Although the source of the alkalinity, the causation of the negative $\delta^{13}C$

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anomalies, and the origin of the uncommon carbonate fabrics is the source of much debate, chemostratigraphic studies have used this repetitive lithostratigraphic and chemostratigraphic pattern to attempt regional and global correlations between poorly fossiliferous or radiometrically unconstrained Neoproterozoic successions (cf. Kennedy et al., 1998).

In western North America, the glacial-cap carbonate archetype is discontinuously exposed from the Death Valley region northward to the Mackenzie Mountains in northwestern Canada (Stewart and Suczek, 1977; Link et al., 1993; James et al., 2001; Lorentz et al., 2002; Corsetti and Kaufman, 2003; Lorentz et al., 2004). Despite widespread occurrence of Neoproterozoic strata south and east of Death Valley (Stewart et al., 1984, 2002; Stewart and Poole, 2002), glacial deposits and associated cap carbonates have not been recognized. Here, we describe in thin diamictite-carbonate couplet in the Sahuaripa area of southeastern Sonora (Fig. 1), examine its $\delta^{13}C$ profile, and discuss its significance with respect to the Neoproterozoic history of North America and elsewhere (see also Corsetti et al., 2001; Stewart et al., 2002). Southeastern Sonora resides at a critical crossroads with respect to Neoproterozoic plate reconstructions (Stewart et al., 2002) and thus the documentation of glacial-cap carbonate and concomitant chemostratigraphic profiles may provide additional paleogeographic and chronostratigraphic constraints for this region.

2. Geologic setting

Neoproterozoic strata in Sonora, Mexico can be subdivided into the 1) Caborca succession and equivalents to the northwest, 2) the El Aguila and Las Viboras Groups to the southeast, and 3) the Cerro Las Bolas Group to the far southeast (Stewart et al., 2002; Sour-Tovar et al., 2007). The Caborca succession and equivalents display clear lithostratigraphic similarity to Neoproterozoic–Cambrian Cordilleran miogeoclinal strata of Death Valley, California, and are commonly considered lateral equivalents to the Death Valley/White Inyo successions to the north that formed in response to late Neoproterozoic rifting of North America (Stewart

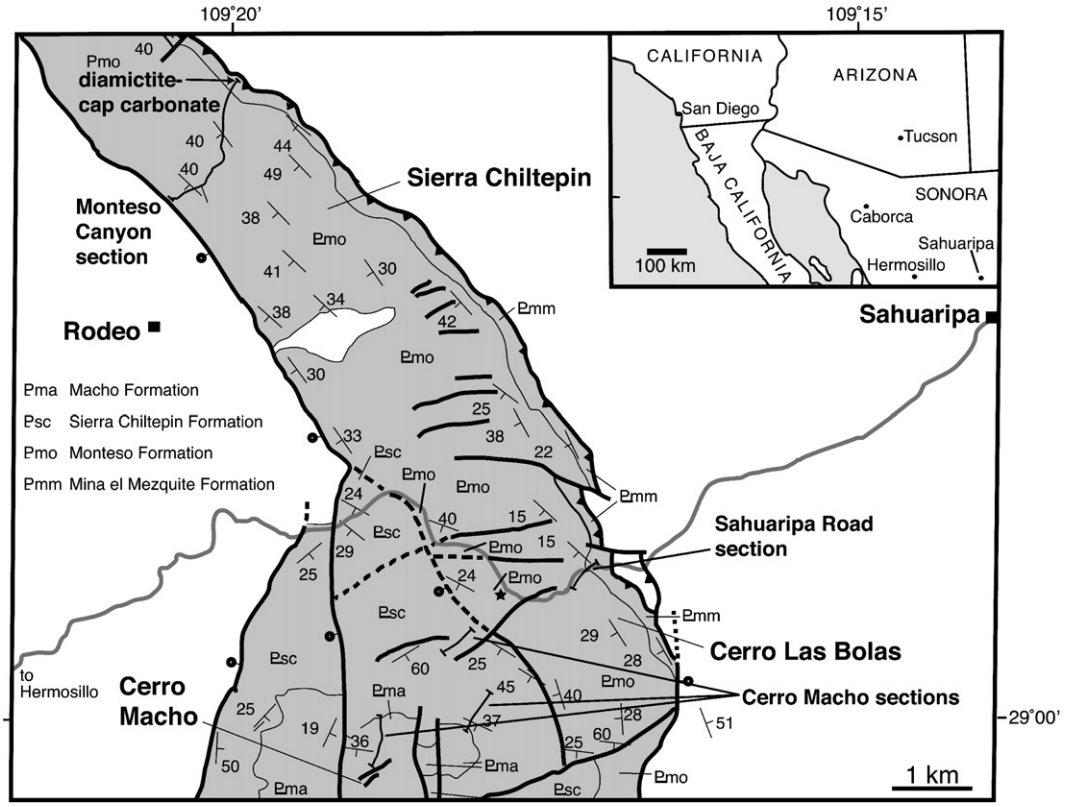

Fig. 1. Location and geologic map for the Sahuaripa area, after Stewart et al. (2002). The shaded area represents the Cerro Las Bolas Group. The stratigraphic sections discussed in the text are shown. The diamictite-cap carbonate units crop out at the northeastern end of Monteso Canyon and were not noted elsewhere in the region.