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Barremian rift-related turbidites and alkaline volcanism in southern Mexico and their role in the opening of the Gulf of Mexico

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ABSTRACT

The Chivillas Formation is the easternmost record of Mesozoic marine volcanism in Mexico. It consists of thick intervals of pillow lavas interbedded with siliciclastic turbidites, and debrites, containing clasts derived from metamorphic, sedimentary and volcanic sources. Clast composition and detrital zircon geochronology indicate a continental provenance, with sources located south of the studied rocks. Detrital zircon ages range from 1573 ± 60 to 125 ± 1.6 Ma. The probability curves have peaks at 124 to 130 Ma (mean 126 Ma); 188 Ma and 921–1236 Ma (the latter with peaks at ~1022 and ~1157 Ma). Subordinate peaks at 277, 419 and 535 Ma are also present. We interpret the youngest zircon population ~126 Ma (Barremian), as the maximum depositional age. Other peaks suggest Grenvillian-type basement and Permo-Triassic arc sources. Late Jurassic detrital zircons were probably derived from the Sierra de Juárez Mylonitic belt. Pillow lavas are mostly alkaline basalts, with SiO_2 46%–53%, and alkali oxide ($K_2O + Na_2O$) 5–8 wt.%; all samples have low-TiO_2 (<1.6 wt.%) and low V (180–242 ppm), with Ti/V between 30 and 50. $^{206}Pb/^{204}Pb$ isotopic ratios are 18.6–20.5, and $^{208}Pb/^{204}Pb$ are 38.4–40.3, within OIB and MORB ranges. Initial $\varepsilon Nd(126)$ are 0.3 to 4.1, and T_{DM} are 632–1520 Ma. Lava compositions are similar to alkaline basalts along the margins of the Atlantic Ocean, particularly to basalts from the Central Atlantic Magmatic Province (CAMP), and to the Cretaceous Peri-Atlantic Alkaline Pulse (PAAP). Volcano-sedimentary rocks from Chivillas Formation probably formed in a subsiding marine rift basin, at a ridge–transform intersection. This basin received sediments transported throughout longitudinal canyons along the major Jurassic–Cretaceous strike–slip fault. In this model, extension of the rift basin was controlled by right-lateral displacement of the strike–slip fault, which acted as a transform fault at this time. This rift is interpreted as a segment of the rift system of the Gulf of Mexico.

1. Introduction

Alkaline magmatism associated with the breakup of Pangea initiated in the Early Mesozoic (McHone, 2000), forming a large continental igneous province (CAMP) with its highest peak of volcanism at about 200 Ma (Marzoli et al., 1999). Rifting continued, and although the continents were moving away from the active ridges, sporadic alkaline magmatism occurred in the widely separated continental margins around Atlantic Ocean, with peaks of larger-widespread volumes at ~125 Ma and ~85–80 Ma (Epp and Smoot, 1989; McHone, 2000; Janney and Castillo, 2001; Matton and Jébrak, 2009). The Gulf of Mexico was part of this rifting process, beginning in the Triassic, and ending around Berriasian time (Marton and Buffler, 1994; Pindell, 1994; Bird et al., 2005). The presence of oceanic crust has been inferred on the basis of geophysical data (Bird et al., 2005), but field evidence of syn-rift volcanism has not been previously reported. In this paper we describe for the first time alkaline volcanic rocks and associated sedimentary rocks in the continental margin of the Gulf of Mexico (Chivillas Formation), and we discuss their relationship with the rift history of the Gulf of Mexico.

The Chivillas Formation crops out east from Tehuacán City (Puebla State) in the Zongolica Range, approximately at N18°30′ latitude and W97°22′ longitude (Figs. 1 and 2). The Chivillas Formation was described as a Tithonian–Valanginian marine clastic sequence, interbedded with pillow basalts (Alzaga and Pano, 1989). It was previously interpreted, on the basis of its rock-association, as an intracratonic basin related to the opening of the Caribbean Sea (Carfantan, 1981; Dickinson and Lawton, 2001), or as marginal or backarc basin linked to the tectonic evolution of the Pacific (Delgado-Argote, 1988; Alzaga and Pano, 1989). This paper is the first detailed

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