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Geochemistry and Sm–Nd isotopic systematics of Ediacaran–Ordovician, sedimentary and bimodal igneous rocks in the western Acatlán Complex, southern Mexico: Evidence for rifting on the southern margin of the Rheic Ocean

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ABSTRACT

Ordovician igneous rocks in the western Acatlán Complex (Olinalá area) of southern Mexico include a bimodal igneous suite that intrudes quartzites and gneisses of the Zacango Unit, and all these rocks were polydeformed and metamorphosed in the amphibolite facies during the Devono-Carboniferous. The Ordovician igneous rocks consist of the penecontemporaneous amphibolites, megacrystic granitoids and leucogranite, the latter dated at ca. 464 Ma. Geochemical and Sm–Nd data indicate that the amphibolites have a differentiated tholeiitic signature, and that its mafic protoliths formed in an extensional setting transitional between within-plate and ocean floor. The amphibolites are variably contaminated by a Mesoproterozoic crustal source, inferred to be the Oaxacan basement exposed in the adjacent terrane. The most primitive samples have εNdt ($t = 465$ Ma) values significantly below that of the contemporary depleted mantle and were probably derived from the sub-continental lithospheric mantle. The megacrystic granites were most probably derived by partial melting of an arc crustal source (similar to the Oaxacan Complex) and triggered by the ascent of mafic magma from the lithospheric mantle. Sm–Nd isotopic signatures suggest that metasedimentary rocks from Zacango Unit were derived from adjacent Oaxacan Complex. Trace elements relationships (e.g. La/Th *vs.* Hf) and REE patterns suggest provenance in felsic-intermediate igneous rocks with a calc-alkaline signature. The Ordovician bimodal magmatism is inferred to have resulted from rifting on the southern flank of the Rheic Ocean and is an expression of a major rifting event that occurred along much of the northern Gondwanan margin in the Ordovician.

1. Introduction

The evolution of the Acatlán Complex (= Mixteca terrane) of southern Mexico has important implications for Paleozoic continental reconstructions and has been the focus of considerable debate about the ocean in which the rocks originated: Iapetus, Rheic and/or paleo-Pacific (e.g. Ortega-Gutiérrez et al., 1999; Keppie and Ramos, 1999; Talavera-Mendoza et al., 2005; Nance et al., 2006, 2007; Vega-Granillo et al., 2007; Keppie et al., 2008a). A N–S belt of high-pressure rocks divides the Acatlán Complex into eastern and western parts (Fig. 1), and as such rocks are generally inferred to mark a suture zone of a closed oceanic basin (Maruyama et al., 1996), Ortega-Gutiérrez (1981) inferred that they represent the vestiges of the Iapetus Ocean (i.e. a suture) between Laurentia and Gondwana. On the other hand, Keppie et al. (2008a) suggested that the high-pressure rocks were extruded into the Acatlán Complex implying that the high-pressure rocks do not represent a suture zone. Recently published igneous geochemical data for the eastern Acatlán Complex indicate that the only Paleozoic arc-related igneous activity occurred in the Permian, with Ordovician and Carboniferous rocks being rift-related (Malone et al., 2002; Keppie et al., 2008a,b; Morales-Gámez et al., 2008). Although most of the geochemical data available for the western Acatlán Complex have been interpreted as arc-related (Ramírez-Espinoza, 2001; Talavera-Mendoza et al., 2005; Vega-Granillo et al., 2007), they are limited in scope and the ages of the rocks analyzed are uncertain. Remapping of the Olinalá area in the western Acatlán Complex supplemented by extensive geochronological dating (Ortega-Obregón et al., 2009) provides a firm foundation for the geochemical data of igneous and metasedimentary rocks presented in this paper. These new data indicate that the Ordovician igneous suites are bimodal, rift-related, and that the metasedimentary units were derived directly from the adjacent Mesoproterozoic (ca. 1 Ga) Oaxacan Complex. These results constrain

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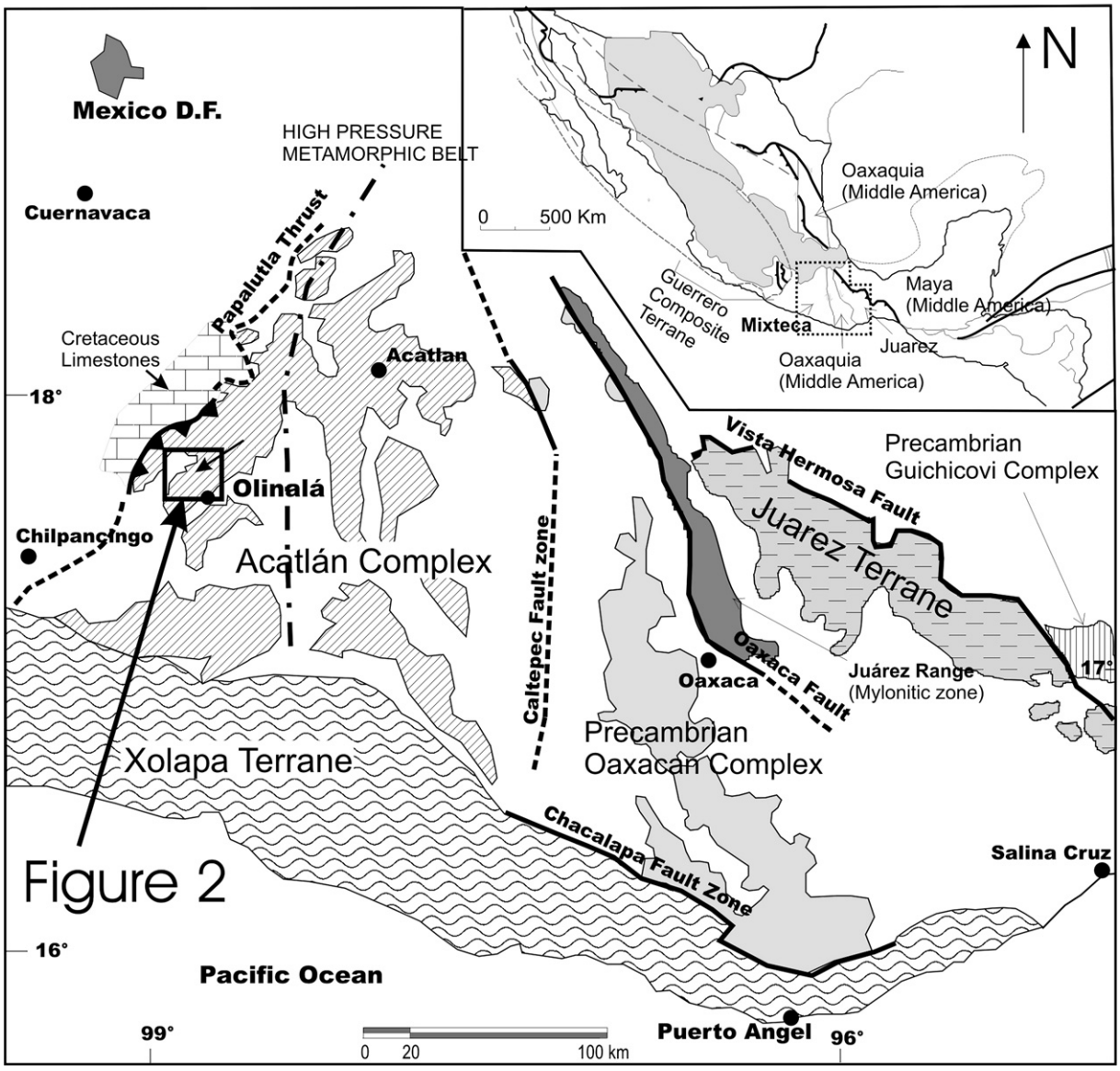

Fig. 1. Terrane map of southern Mexico showing the locations of the Mixteca, Oaxaquia, Guerrero and Cuicateco terranes and the studied area at Olinalá, Guerrero State, Mexico (modified from Keppie et al., 2003). Inset shows terrane map of Middle America (after Keppie, 2004).

the tectonic evolution and paleogeography of the western Acatlán Complex, and test whether the high-pressure belt within the Acatlán Complex represents a suture zone between Laurentia and Gondwana or not.

2. Geological setting

The Acatlán Complex is tectonically juxtaposed on the eastern, southern and western sides against the ca. 1 Ga Oaxacan and Mesozoic Xolapa complexes, and Cretaceous carbonates, respectively (Fig. 1). To the north, the complex is unconformably overlain by Cenozoic rocks of the Trans-Mexican Volcanic Belt. The geology of the Acatlán Complex has recently been reviewed by Keppie et al. (2008a and references therein) and this is summarized here. Detailed mapping and field relationships combined with geochronological studies in the Olinalá region are described in Ortega-Obregón et al. (2009) (Fig. 1). The western Acatlán Complex is predominantly underlain by the polydeformed, high grade Zacango Unit, which is dominated by paragneisses, impure quartzites, and minor schists. The Zacango Unit occurs in several fault blocks, and was deposited between ca. 654 Ma (youngest detrital zircon) and ca. 464 Ma (the age of cross-cutting granitoids, Ortega-Obregón et al., 2009). These granitoids intrude and are intruded by mafic bodies (informally called here "Tlaxco Amphibolite") suggesting that they are pene-contemporaneous (Ortega-Obregón et al., 2009). The "Tlaxco Amphibolite" is typically coarse grained, finely banded and consists of albite porphyroblasts containing oriented inclusions of epidote and amphibole in a matrix consisting of oriented epidote and chlorite and minor opaque minerals. Locally, the amphibolite contains bands rich in garnet, plagioclase and amphibole and is intruded by granitic dikes that consist of large megacrysts of K-feldspar, in a matrix of quartz, plagioclase and muscovite with accessory zircon and locally garnet.

These amphibolite facies rocks are in fault contact with the Devono-Carboniferous Progreso Unit in the southern fault block (Fig. 2), which consists of pelitic and psammitic rocks intruded by mafic dikes that underwent greenschist facies metamorphism and polyphase deformation during the Carboniferous and Permian