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High pressure rocks of the Acatlán Complex, southern Mexico: Large-scale subducted Ordovician rifted passive margin extruded into the upper plate during the Devonian–Carboniferous

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ABSTRACT

High pressure (HP) rocks in the Paleozoic Acatlán Complex of southern Mexico occur in a median belt extruded into the complex, which is the root zone of a klippe to the west. These HP rocks are predominantly clastic metasedimentary rocks and include a bimodal suite of amphibolites and granitoids. U–Pb LA-ICPMS zircon dating indicates that one of the amphibolites was intruded at or before 461 ± 2 Ma, and a megacrystic granitoid yielded an intrusive age of $488\ +8/-7$ Ma, which is within the 490–450 Ma range of other dated HP megacrystic granitoids. The amphibolites have a tholeiitic (transitional to alkalic), within-plate chemistry derived from a heterogeneous mantle by various degrees of partial melting. The host metasedimentary rocks contain detrital zircons derived both from the Acatlán granitoids and the ca. 1.0–1.3 Ga Oaxacan Complex, and are inferred to represent rifted passive margin sediments. An age of $348\ +4/-1$ Ma from zircons in a migmatized amphibolite is interpreted as the time of migmatization and dates decompression melting following peak pressure at depths of 45–55 km. Retrogression from 530 °C to 370 °C occurred between 343 and 335 Ma. The predominance of reasonably coherent, rifted passive margin rocks over a surface area of 10×90 km suggests removal of a large slice of the upper plate during flat slab subduction. This slice was subducted to depths of ca. 45–55 km where it was underplated and transferred to the overriding plate. The absence of Oaxacan Complex rocks in the HP belt suggests the Oaxacan basement was subducted to greater depths. Underplating was followed by extrusion facilitated by extension in the upper plate that produced Mississippian rift basins east of the median HP belt. Westward overthrusting of the HP rocks produced a klippe that overrode Mississippian clastic wedge sediments.

1. Introduction

High pressure (HP) rocks are commonly inferred to represent remnants of subducted ocean basins with protoliths derived from both the subducting and overriding plates including ophiolites, oceanic arcs, bimodal volcanic and continental margin deposits (Liou et al., 2004). HP rocks derived from the upper plate are inferred to have been removed by subduction erosion, which can take place either continuously in piecemeal fashion producing in a tectonic mélange (von Huene et al., 2004) or episodically as large fault-bounded slices (Keppie et al., 2009a, 2012). Most such slices are below the resolution of seismic imaging, but a few large fragments have been recorded: (i) 2×20 km in cross-section along the Middle America Trench (Ranero and von Huene, 2000); (ii) 20×100 km in Cascadia (Calvert, 2003); (iii) two $\leq 4 \times 30$ and $0–10 \times 60$ km wedge-shaped slices beneath southern British Columbia (Monger and Price, 2002); and (iv) a slice of the order of 50×250 km is inferred to have been removed off southern Mexico in 6 my (Keppie et al., 2009a,b). If such removed pieces include continental crust, they may return to the surface by extrusion. Numerical modelling (Butler et al., 2011; Stöckhert and Gerya, 2005; Warren et al., 2008a, 2008b) indicates that extrusion of HP rocks is accompanied by considerable telescoping and internal deformation, which is consistent with the general field occurrence of thin tectonic slices. In this paper, we document that most of the HP rocks in the Acatlán Complex of southern Mexico are reasonably coherent, extruded, metamorphosed rifted passive margin rocks, 10×90 km in dimension, and were subducted from the fore-arc of the continental margin and extruded in <20 my, factors consistent with rapid subduction erosion of a large slice.

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Two HP belts occur within the Paleozoic rocks of the Acatlán Complex: the median Piaxtla-Organal–Asis–Mimilulco belt and the western Ixcamilpa–Olinalá belt (Fig. 1). Recent data on the median HP belt show this to include bimodal, rift-related tholeiites at Piaxtla and Asis (Keppie et al., 2011; Murphy et al., 2006), island-arc mafic rocks at Mimilulco (Meza-Figueroa et al., 2003), and periarc ultramafic–mafic rocks at Tehuitzingo (Galaz Escanilla et al., 2009; Proenza et al., 2004). However, no geochemical data are available at Organal and data are limited at Mimilulco. The protolith age may be recorded at Asis where zircon cores in eclogite yielded an Ordovician age (interpreted as a metamorphic age by Elías-Herrera et al., 2004, but a protolith age by Middleton et al., 2007). The age of HP metamorphism is Carboniferous at Piaxtla, Asis and Mimilulco (Keppie et al., 2010, 2011; Middleton et al., 2007). In the Ixcamilpa–Olinalá belt, the HP rocks have Ordovician protolith ages (Ortega-Obregón et al., 2009; Ramos-Arias and Keppie, 2011), but only in the Olinalá area are geochemical analyses available and these indicate the presence of rift tholeiites (Ortega-Obregón et al., 2009). In this paper, we present geochemical and U–Pb LA-ICPMS zircon data for rocks from the Ixcamilpa, Mimilulco and Organal areas that indicate an Ordovician tholeiitic affinity, derivation from a rifted passive margin along the leading edge of the upper plate, and overprinting by Carboniferous HP metamorphism.

2. Geological setting

The Acatlán Complex is bounded on three sides by tectonic boundaries (Fig. 1a): (i) on its eastern side, the Permian, Caltepec dextral ductile shear zone (Elías-Herrera and Ortega-Gutiérrez, 2002) juxtaposes the Acatlán Complex against the ca. 1.0–1.3 Ga Oaxacan Complex; (ii) to the south, the sinistral transtensional, Cenozoic, Chacalapa–La Venta Fault places it against the Mesozoic–Cenozoic Xolapa Complex (Tolson, 2005); and (iii) on its western margin, the Late Cretaceous Papalutla thrust places the Acatlán Complex over the Cretaceous Morelos-Guerrero platformal strata (Cerca et al.,

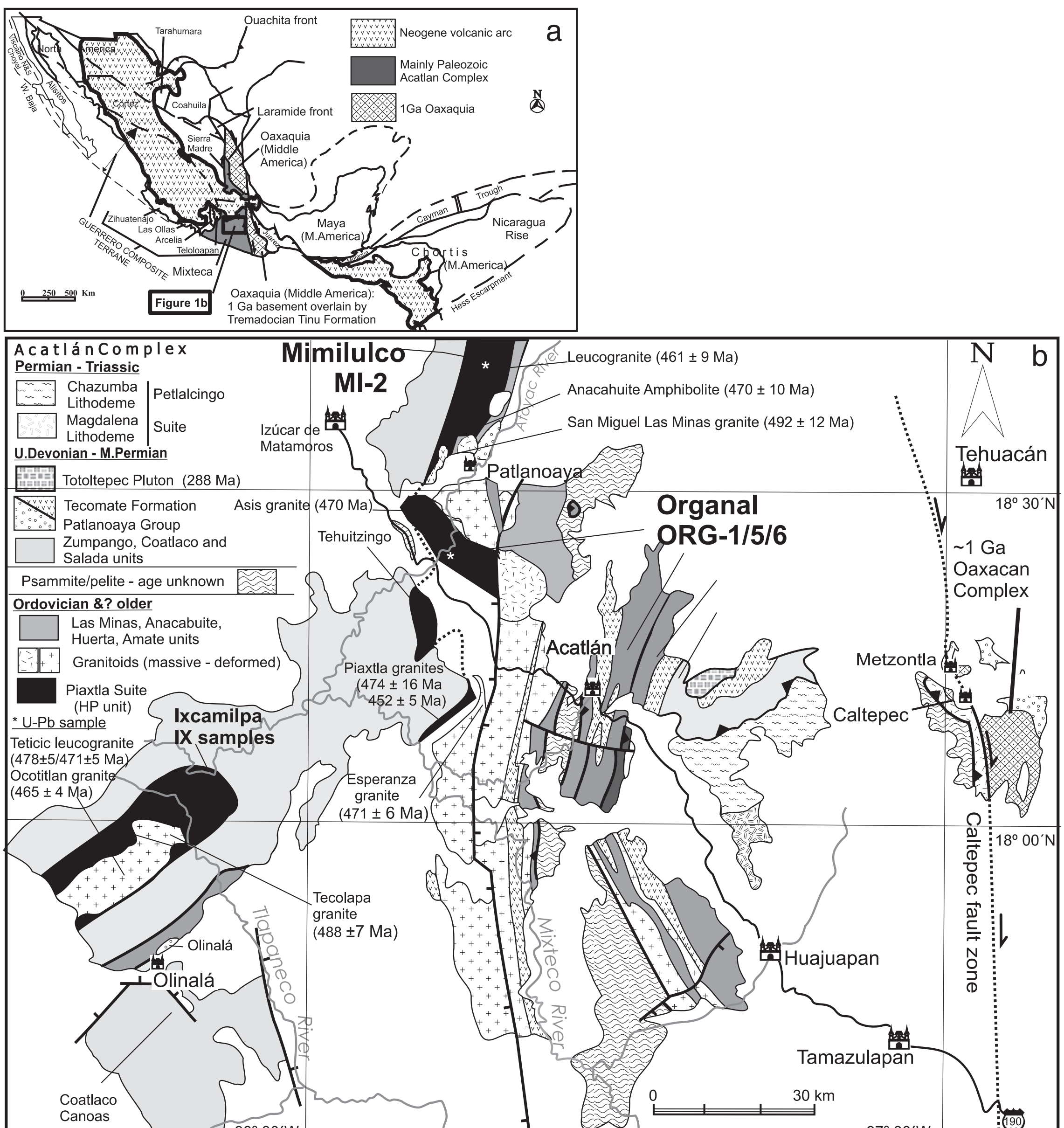

Fig. 1. Maps of Mexico showing: (a) terranes (modified after Keppie, 2004), and (b) a geological map of the Acatlán Complex (modified after Ortega-Gutiérrez et al., 1999, and Keppie et al., 2008).