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MAGMATIC TECTONO-STRATIGRAPHY, AND GEODYNAMIC EVOLUTION OF THE GUANAJUATO CENTRAL SEGMENT OF THE UPPER JURASSIC-EARLY CRETACEOUS ALLOCHTHONOUS CORDILLERAN ISLAND ARC OF MEXICO.

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It is now generally accepted that the Mexican Cordillera is formed of Upper Jurassic-Early Cretaceous tholeiitic and calc-alkaline volcano-plutonic and volcano-sedimentary submarine arc sequences, formed in an intra-oceanic setting (Ortiz et al., 1991a and b; Lapierre et al., 1991).

Field relationships, petrological and geochemical studies show that these Upper Jurassic-Early Cretaceous allochthonous sequences belong to several segments of a single arc built on oceanic and/or continental crust (Ortiz et al., 1991b). The Guanajuato segment, present in central Mexico, belongs to the Guerrero tectonostratigraphic terrane, after Campa and Coney (1983) and Coney and Campa (1987). Located on the northwestern side of the Valles-San Luis Potosí carbonate platform, it represents the centralmost inlier of these exotic arc exposures. It consists of a Late Jurassic-Early Cretaceous (143-122 Ma; K/Ar age) ultramafic to silicic volcano-plutonic sequence, named the Guanajuato sequence. The latter is separated by high-angle faults from the contemporaneous Esperanza volcano-detritic Formation, interpreted as the cover of the Guanajuato arc sequence. The Esperanza Formation, is formed of volcaniclastic rocks, limestones and basic to acidic tuffs and minor calc-alkaline rhyolitic flows. The Guanajuato sequence is thrusted on the Arperos Upper Jurassic-Early Cretaceous siliceous flysch-like Formation. The latter rests conformably on alkaline oceanic pillow-basalts and doleritic dykes ($2.72 < (La/Yb)_N <$

3.87) and is considered to have been deposited in an oceanic basin (Arperos basin). It is overlain unconformably by the open shelf Albian-Aptian La Perlita reefal limestone (Chiodi et al., 1988). In the northestern side of the Guanajuato segment, the San Miguel de Allende Albian-Aptian volcano-sedimentary sequence is composed of calc-alkaline pillowed-basalts and basic andesites ($(La/Yb)_N = 4$) interstratified with black shales, radiolarian cherts, epiclastic rocks and redeposited pelagic carbonates. It is separated by thrust faults of a calcareous flysch-like sequence of probable Late Early Cretaceous age.

The Guanajuato volcanic levels are formed by pillowed and massive basaltic flows (±1000 m thick) overlain conformably by volcaniclastic sediments, calc-alkaline dacitic to rhyodacitic ($(La/Yb)_N = 3$) flows and tuffs and locally by basic tuffs. The basaltic flows are feeded by doleritic to basaltic dikes which intrude all the levels of the plutonic cumulate sequence, from the ultramafic rocks up to the gabbros and diorites. In the uppermost silicic plutonic rocks, ranging in composition from quartz-diorite to tonalite/trondhjemite, these dikes increase in number and form a dike complex. The lowermost ultramafic rocks of the sequence are intruded by Early Cretaceous acidic calc-alkaline plutons and magmatic breccias.

The Guanajuato igneous rocks of basic to intermediate composition are characterized by an enrichment in LILE and a depletion in HFSE, relative to MORB, with the exception of their Nb (≤ 4 ppm) content which is in the range of N-MORB. The basaltic and doleritic rocks show sometimes high-alumina characteristics and display flat (10-30x chondrites) to light rare earth elements depleted patterns with $0.88 < (La/Yb)_N < 1.56$. The diorites display with the gabbros the same flat REE patterns ($1.64 < (La/Yb)_N < 7.22$), but with higher concentrations, showing that they are more fractionated rocks. The ultramafic rocks have Ni/Co ratios ranging between 1.79-6.04 that suggest rather primitive features. Their eNd(T=122 m.a.) ($+7 < e\,Nd(T) < +9$) ratios fall within the small range of oceanic arc magmas and suggest that these rocks are cogenetic and derive from a depleted mantle source that was not contaminated by a crustal component.

The silicic rocks show also low-K tholeiitic island arc affinities; they are characterized by a depletion in Zr, Yb and Nb relative to Oceanic Ridge Granites. The most siliceous facies are characterized by "U" shape REE patterns, due to LREE and HREE enrichments ($3.22 < (La/Yb)_N < 5.12$) because of the presence of amphibole, allanite, apatite, sphene and zircon.

Their eNd (T=143 m.a.) ratios (+4.4 < eNd (T) < +5.2) are slightly lower than those of the more basic rocks and could be explained by an assimilation-fractional crystallization process. These silicic rocks, while they differentiated by crystal fractionation from the tholeiitic parent magma, assimilated material such as metamorphosed oceanic crust and sediments which formed the wall rocks of the magma chamber (Lapierre et al., 1991).

Thus, the Guanajuato sequence is considered to represent the base and the immature stage of the ensimatic segment of the Mexican Cordilleran exotic arc.

Both, the Guanajuato arc sequence, its volcaniclastic sedimentary Esperanza cover and the basinal Arperos Formation, which form presently different dismembered tectonostratigraphic units, were thrusted towards the NNE, on the Valles-San Luis Potosí carbonate platform (Monod et al., 1990), and amalgamed during the Late Early Cretaceous to the Albian-Aptian La Perlita limestone and to the contemporaneous San Miguel de Allende volcano-sedimentary sequence. The latter could represent a lateral variation of the contemporaneous La Perlita limestone. Both formations are considered to be the remnants of the top and the waning stage of the arc magmatic activity (Ortiz et al., 1991c).

The tectono-stratigraphic analysis and the geochemical characterization of these arc volcano-plutonic and volcano-sedimentary formations, belonging to the Guanajuato central segment of the allochthonous Mexican Cordilleran island arc (Ortiz et al., 1991b), or to the tectonostratigraphic Guerrero terrane (Campa and Coney, 1983; Coney and Campa, 1987), allows to clarify the geodynamical evolution of the Upper Jurassic-Early Cretaceous intra-oceanic island arc and its related Arperos oceanic basin, before and during their collision with the North American craton during Late Early Cretaceous time.

REFERENCES CITED

Campa, M. F. & Coney, P.J. (1983) Tectono-stratigraphic terranes and mineral resource distributions in Mexico. Canadian Journal of Earth Sciences, 20, 1040-1051.

Chiodi, M., Monod, O., Busnardo, R., Gaspard, D., Sánchez, A. & Yta, M. (1988) Une discordance anté-albienne datée par une faune d'ammonites et des brachiopodes de type téthysien au Mexique central. Geobios, 21, 125-135.

Coney, P. J. & Campa, P. J. (1987) Lithotectonic terrane map of Mexico. Unites States Geological Survey, Open file Report, 84-523, D1-D14.

Lapierre, H., Ortiz, Luis E., Abouchami, W., Monod, O., Coulon, C. & Zimmermann, J.L. (1991) A crustal section of an intra-oceanic island arc: the Late Jurassic-Early Cretaceous Guanajuato magmatic sequence (central Mexico). Earth Planet. Sci. Lett. (accepted).

Monod, O., Lapierre, H., Chiodi, M., Martínez, J., Calvet, P., Ortiz, E. & Zimmermann, J.L.(1990) Réconstitution d'un arc insulaire intra-océanique au Mexique central: la séquence pluto-volcanique de Guanajuato (Crétacé inférieur). Comptes Rendus de l'Académie des Sciences de Paris, 310, II, 45-51.

Ortiz, L.E., Lapierre, H. & Yta, M. (1991a) Late Jurassic-Early Cretaceous tholeiitic and calc-alkaline arc series in Mexico: Implications for the magmatic evolution of the Mexican Cordillera. In: Memoria de la Convención sobre la Evolución Geológica de México-Primer Congreso Mexicano de Mineralogía. Inst. de Geología de la U.N.A.M., 147-149.

Ortiz, E., Yta, M., Talavera, O., Lapierre, H., Monod, O. & Tardy, M. (1991b) Origine intra-océanique des formations volcano-plutoniques d'arc du Jurassique supérieur-Crétacé inférieur du Mexique centro-méridional: Comptes Rendus de l'Académie des Sciences de Paris, 312, II, 399-406.

Ortiz, L.E., Lapierre H., Monod, O., Vanneau-Arnaud, A., Caron, M., Yáñez, C. & Sánchez, A. (1991c) Mise en évidence d'un volcanisme calco-alcalin albo-aptien en bordure de la plate-forme carbonatée de Valles-San Luis Potosí (Mexique central): implications paléogéographiques. Comptes Rendus de l'Académie des Sciences de Paris (submitted).