RADIOLARIAN BIOSTRATIGRAPHIC EVIDENCE FOR A LATE JURASSIC AGE OF THE EL TAMBOR GROUP OPHIOLITES (GUATEMALA)

Marco Chiari*,✉, Paulian Dumitrica, Michele Marroni***,°, Luca Pandolfi***,°** and **Gianfranco Principi°°,***

* *Istituto di Geoscienze e Georisorse, CNR, Unit of Florence, Italy.*
** *Institut de Géologie et Paléontologie, Université de Lausanne, Switzerland.*
*** *Dipartimento di Scienze della Terra, Università di Pisa, Italy.*
° *Istituto di Geoscienze e Georisorse, CNR, Unit of Pisa, Italy.*
°° *Dipartimento di Scienze della Terra, Università di Firenze, Italy.*
✉ *Corresponding author, e-mail*: *mchiari@geo.unifi.it.*

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ABSTRACT

We present a radiolarian biostratigraphic study of the metacherts of the El Tambor Group ophiolites (South Motagua Unit), Guatemala. The ophiolite sequence comprises MOR pillow metabasalts, massive metabasalts, metacherts and micaschists. The age of the studied metacherts is referable to the Late Jurassic (Oxfordian - Kimmeridgian).

The radiolarian assemblage described in this paper is the first Jurassic finding in the ophiolitic MOR succession of the Motagua zone and represents a valuable tool to constrain the geodynamic evolution of the Caribbean area.

A review of the ages of Jurassic rocks associated with the ophiolites from the Caribbean area is also reported.

INTRODUCTION

In Guatemala, the boundary between the Maya Block of the North American Plate and the Chortis Block belonging to the Caribbean Plate occurs along a complex east-west trending, left-lateral strike slip fault zone. The main fault zone runs along the Motagua Suture Zone (MSZ), where slices of HP/LT ophiolites, known as El Tambor Group, occur.

Owing to the occurrence of pervasive deformation and the associated HP/LT metamorphism, the age of the ophiolite from the MSZ is still unknown. Generally, this ophiolite is interpreted as a remnant of Cretaceous oceanic lithosphere, but geodynamic reconstructions where these ophiolites are regarded as derived from a Jurassic oceanic basin have been also proposed (Beccaluva et al., 1995; Giunta et al., 2002).

The ophiolite sequence, cropping out in the southern side of the MSZ, is deformed under blueschist P/T conditions, but the primary lithological features are still preserved. In the metacherts, boudins of less deformed radiolarites have been sampled for biostratigraphy investigation.

The aim of this paper was to collect new paleontological data on the sedimentary cover of the El Tambor Group MOR ophiolites (southern side of the MSZ) in order to provide new valuable constraints for the geodynamic evolution of the Caribbean area.

GEOLOGICAL FRAMEWORK

The Caribbean Zone

The Caribbean zone (Fig. 1) consists of a geodynamically complex plate system in which the pivot role is played by the Caribbean Plate, around which move the North American, South American, Cocos and Nazca Plates.

The central portion of the Caribbean Plate (Colombia and Venezuela basins) consists of a Cretaceous oceanic plateau lithospheric block (Edgar et al., 1971; Case et al., 1990) overlain by flat-lying sediments (Bowland and Rosencrantz, 1988).

The margins of the Caribbean Plate are characterized by wide deformed belts that affect large portions of the Caribbean and adjoining plates. These belts result from both strike-slip and subduction tectonics active from the Cretaceous to the present.

The actual boundaries of the Caribbean Plate consist of two transcurrent systems and of two subduction margins (Pindell and Barrett, 1990; Giunta et al., 2002, with references therein) both with west-east trending movements. The two transcurrent systems run respectively in the northern (Guatemala - Greater Antilles) plate margin (e.g. Cayman, Motagua and Polochic Fault Systems) with a sinistral trend, and in the southern (Venezuelan) border (e.g. San Sebastian, La Victoria and El Pilar Faults, Audemard and Singer, 1996) with a destral trend. The convergent margins are represented by the Lesser Antilles Arc System, toward east, and the Central America Cordillera System, westward.

In this paper, as indicated in the introduction, we examined the ophiolites present in the Motagua Suture Zone (Guatemala) where a sinistral wrench structural system (Motagua Fault Zone), as west continuation of the Cayman Line, is still active.

The Motagua Suture Zone

The Motagua Suture Zone, Guatemala, where Ophiolitic Units of both MOR and IAT affinities occur, is squeezed between two continental lithospheric blocks, the Maya Block, belonging to the North American Plate, and the Chortis Block, belonging to the Caribbean Plate (Finch and Dengo, 1990; Burkhart, 1994).

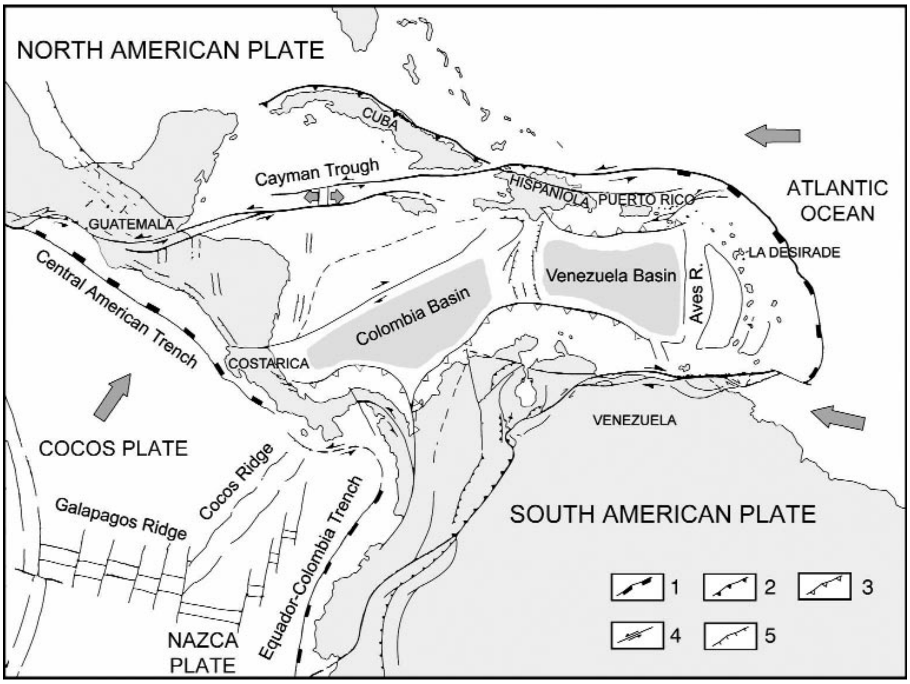

Fig. 1 - Geodynamic map of the Caribbean area: 1) subduction; 2) thrust; 3) accretionary prism; 4) strike-slip fault; 5) Beata Ridge Faults (modified after Giunta et al., 2002).

Presently, the boundary between the Maya and the Chortis Block is characterized for the presence of a left-lateral strike-slip fault known as Motagua Fault Zone (MFZ) (Giunta et al., 2002 with references therein).

The MSZ can be divided into three main sectors (see Fig. 2, Giunta et al., 2002, and references therein): a) a northern sector, including the Maya Block basement, its north-verging folded Cretaceous - Eocene covers and Quaternary volcanic units (cropping out in Mexico); b) a central sector corresponding to the Motagua Zone, where the strike-slip faults of MFZ run. These Ophiolitic Units overthrust northwards the Maya continental margin and southwards the Chortis continental margins, forming a mega flower structure (Giunta et al., 2002); c) a southern sector comprising the Chortis basement and its Paleozoic-Cretaceous covers, overlain unconformably by Tertiary and Quaternary volcanic units.

In the Motagua Zone the Maya and the Chortis Blocks are juxtaposed in correspondence of the MFZ. This latter consists of a relatively narrow E-W elongated area characterized by a complex net of still active E-W strike-slip faults. The MFZ is bounded to the north by the Polochic Fault and to the south by the Cabanas Fault, while the Motagua Fault runs parallel inside this zone (Fig. 2). Some pull-apart basins (e.g. Lago Izabal) developed within this strike-slip fault system. Both ophiolites and other continental units are grouped (Giunta et al., 2002, and references therein) either in the north verging North Motagua Unit (NMU) or in the south verging South Motagua Unit (SMU) starting from the Motagua Fault alignment. The ophiolites belonging to the first group mainly consist of IAT and MOR Ophiolitic Units, while those of the second group include essentially MOR Ophiolitic Units.

The NMU island arc ophiolites, known as Sierra Santa Cruz Unit, mainly consist of serpentinized mantle harzburgites, gabbros, and pillow andesitic basalts. This unit has been interpreted as an island-arc magmatic sequence associated with sub-arc mantle rocks (Beccaluva et al., 1995).

The NMU and SMU MOR ophiolitic successions consist of the so called El Tambor Group (Donnelly et al., 1990), comprising serpentinized mantle peridotites and gabbros, followed upwards by a thick pillow lava and massive basalt sequence, with MOR affinity (Beccaluva et al., 1995), radiolarian metacherts, metasiltites and meta-arenites (Phyllites Fm.). The top of the sequence is represented by the Upper Cretaceous Cerro de La Virgen Fm. In the El Tambor ophiolitic succession, characterized by HP/LT facies (sometimes retrograded to amphibolites facies), blocks of eclogites and jadeitites have been found (Mc Birney et al., 1967; Harlow et al., 2003).

Owing to pervasive deformation and associated HP/LT metamorphism, the age of the ophiolitic sequences from the MSZ is still badly defined. Generally, they are interpreted as remnants of the Cretaceous oceanic lithosphere, but geodynamic reconstructions where these ophiolites are regarded as derived from a Jurassic oceanic basin have also been proposed (Beccaluva et al., 1995; Giunta et al., 2002).

The previous datings of the radiolarites associated with basalts come only from the IAT ophiolitic belts and indicate a Berriasian-Albian age at the Sierra de Santa Cruz (Rosenfield, 1981), and a Hauterivian-Aptian age at Finca del Pilar near Los Amates (Donnelly et al., 1990). Fourcade et al. (1994) sampled the red cherts above the serpentinites and basalts at Puente Las Cabezas. The samples yielded not well preserved radiolarians. In the same area these authors sampled some chert pebbles in a Tertiary conglomerate where the radiolarian fauna indicated a Berriasian - Albian age.

DATINGS OF CARIBBEAN JURASSIC ROCKS ASSOCIATED TO THE OPHIOLITES

Jurassic ages of rocks associated to the ophiolites, in the Caribbean Plate margins and adjoining areas, have been found in Costarica, Cuba, Hispaniola, La Desirade, Puerto Rico and Venezuela (see also Bortolotti and Principi, 2005).

Costarica

In Costarica Jurassic radiolarites were found in the ophiolitic Nicoya Complex.

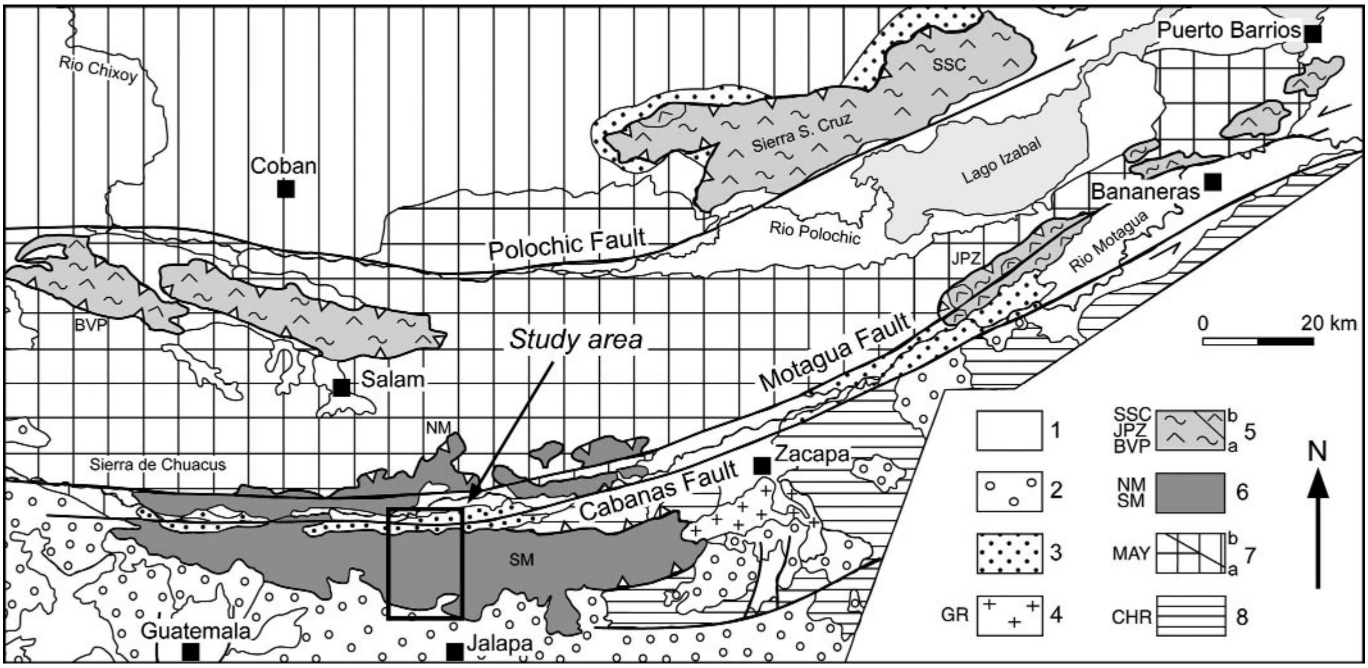

Fig. 2 - Tectonic map of the Motagua Suture Zone in Guatemala with location of the studied area: 1) recent deposits; 2) Tertiary-Quaternary volcanics; 3) Flysch and molassic deposits; 4) Arc tonalitic magmatism (GR- granitoids); 5) Volcano-plutonic supra subduction sequences [peridotites, gabbros, basalts, andesites, with IAT (5a) and IAC (5b) affinities] associated with carbonatic-terrigenous sediments; 6) MORB ophiolites (mantle peridotites, gabbros and basalts) with radiolarites to carbonatic-terrigenous sequences; 7) continental basement (7a) and sedimentary covers (7b) of the Maya Block; 8) continental basement of the Chortis Block. Units: MAY- Maya continental Block; BVP- Baja Verapaz Unit; SSC- Sierra Santa Cruz Unit; JPZ- Juan de Paz Unit; NM-North Motagua Unit; SM- South Motagua Unit; GR- Zacapa granitoids; CHR- Chortis continental Block (modified after Giunta et al., 2002).

In this complex the radiolarites associated with basalts are referable to the Tithonian - Valanginian (Pessagno in Galli Oliver, 1977 and Schmidt-Effing, 1979); to the Berriasian - Aptian (Baumgartner in Kuypers, 1979); to Bajocian/early Bathonian to middle Callovian/early Oxfordian after Baumgartner (1984b) and Baumgartner (1995). At last, Baumgartner (1987) indicated for the lowermost sediments above the basalts a Bajocian - Bathonian age (in the Huacas-Cartagena Zone) and a Kimmeridgian - Tithonian age (in the Bahia Brasilito Zone).

De Wever et al. (1985) dated six samples of radiolarites in the Nicoya Complex as: Pliensbachian?, Callovian, Oxfordian, Neocomian - Barremian, Valanginian - early Albanian, early Albian, Barremian-Cenomanian. The younger ages are in agreement with those indicated in previous papers (Cenomanian, Schmidt-Effing, 1980; Albian and Albian - Cenomanian, Azema et al., 1982)

In a recent paper Denyer and Baumgartner (2006) updated the ages of the radiolarites of the Nicoya Complex reported in previous works using the zonation of Baumgartner et al. (1995b). They define as Bajocian the oldest radiolarian assemblage.

For a more detailed description and a review on the Nicoya Complex see Denyer and Baumgartner (2006).

Cuba

In Cuba the mafic igneous rocks occur in the Northern Cuba Fold Belt, in the Allochthonous Terranes and in the Northern Ophiolitic Mélange (Kerr et al., 1999).

In the *Northern Cuban Fold Belt (Placetas Belt)* the radiolarian cherts associated to pillow basalts have a Tithonian - Maastrichtian age (Iturralde and Mari Morales, 1988). After Iturralde-Vinent (1988) these mafic rocks were formed during the rifting phase.

In the *Allochthonous Terranes*, the El Sàbalo Formation consists of a sequence of pillow basalts formed in a continental rift setting (Iturralde-Vinent, 1988; 1996b) and of hyaloclastites with limestone intercalations of late Oxfordian - early Kimmeridgian age (Kerr et al., 1999).

The *Northern Ophiolite Mélange* is an unit of oceanic affinity (Iturralde-Vinent, 1994; Kerr et al., 1999) and comprises mafic igneous and sedimentary rocks. Iturralde-Vinent (1989; 1994; 1996a) interpreted this unit as formed in a marginal sea-backarc environment, while Andó et al. (1996) in a suprasubduction forearc setting.

In Central Cuba the Sagua la Chica Formation (*Northern Ophiolite Mélange)* is constituted by basalts intercalated with sediments and tuffaceous rocks. The age of this formation is referable to the Tithonian (Llanes et al., 1998).

In Eastern Cuba the volcanic-sedimentary sections (*Northern Ophiolite Melange)* of oceanic tholeiite have been dated as Tithonian - Campanian (Iturralde-Vinent, 1996a).

Hispaniola

In Hispaniola, radiolarian cherts associated to ophiolites were found in the Puerto Plata basement complex and in the Duarte Complex.

The *Puerto Plata basement Complex* comprises pillow lavas and other volcanic rocks with greenish cherts containing radiolarians of Late Jurassic age (probably Tithonian) (Montgomery et al. 1994a). According to these authors this complex could belong to the proto-Caribbean oceanic crust.

Montgomery et al. (1994b), dated the red cherts of the *Duarte Complex* near El Aguacate (that are associated to metamorphosed mafic volcanics rocks) as early Oxfordian to Tithonian. In another locality, at Janico, the red cherts could have the same age (or slightly younger) of those sampled at El Aguacate (Montgomery et al., 1994b).

The Duarte Complex was initially considered a fragment of metamorphic oceanic crust (Bowin 1975; Palmer 1979); Lewis et al. (1983), Draper and Lewis (1989) and Lewis and Jiménez (1991) proposed a seamount origin. Montgomery et al. (1994b) considered this Complex as representing several seamounts developed in the oceanic crust of the Farallon Plate.

La Desirade

In the La Désirade basement Complex, pillow metabasalts are interbedded with pelagic limestones and red ribbon cherts of Tihonian age (Montgomery et al., 1992; 1994b). MOR plagiogranites dated to 145±5 Ma (Mattinson et al., 1980), that is Tithonian-Berriasian according to the Geological time scale by Gradstein et al. (2004), are also present. According to Mattinson et al. (1973; 1980), the Complex is probably an oceanic remnant. On the contrary, Donnelly et al. (1990) interpreted these rocks as a primitive IAT association, while Montgomery et al. (1994b) considered them of spreading ridge or seamount origin developed in the oceanic crust of the Farallon Plate, like the Duarte Complex (Hispaniola).

Puerto Rico

In the ophiolitic mélange of the Bermeja Complex, Mattson and Pessagno (1979) dated the radiolarian cherts as early Tithonian, Hauterivian to late Aptian and late Aptian.

Also Montgomery et al. (1994a) studied the cherts associated to basalts and/or serpentinites (Bermeja Complex) in the northern and northwestern margins of the Sierra Bermeja. The radiolarian faunas indicated ages ranging from late Pliensbachian (older fauna) to early late Tithonian (younger fauna). These Jurassic ophiolites developed in the oceanic area of the Farallon Plate (Montgomery et al., 1994b).

Venezuela

The Siquisique ophiolites (Loma de Hierro, Venezuelan Coastal Range), located in west-Central Venezuela, were dated by Stephan (1982), Bartok et al. (1985) and Stephan et al. (1990) as Bajocian (possibly early Bathonian), using fragments of Ammonites found in the sediments associated with the MOR pillow basalts.

Summarizing the above data, the older ages found in the radiolarian cherts associated to the Caribbean ophiolites could be as old as Pliensbachian (Early Jurassic), but the Middle - Late Jurassic ages are the more common ones.

SAMPLED SEQUENCE

The sampled sections (Figs. 3 and 4) crop out near the Puente del Rio Grande transect (southern side of the MSZ).

In this composite transect an ophiolite sequence belonging to the South Motagua Unit (including El Tambor Group, Donnelly et al., 1990) has been recognized (Giunta et al., 2002). The sequence consists of (Fig. 3):

– MOR pillow metabasalts, intercalated with interpillow radiolarian metacherts, passing to massive metabasalts (Fig. 5a, 5b). The metabasalts show preserved stratigraphic relationships with
– red and gray metacherts (Fig. 5a, 5c) gradually passing upwards to the
– Phyllites Fm., represented by micaschists (metashales, metasiltstones and meta-arenites). The stratigraphic relationships between the metacherts and the Phyllites Fm. are not well preserved (see Fig. 5d).

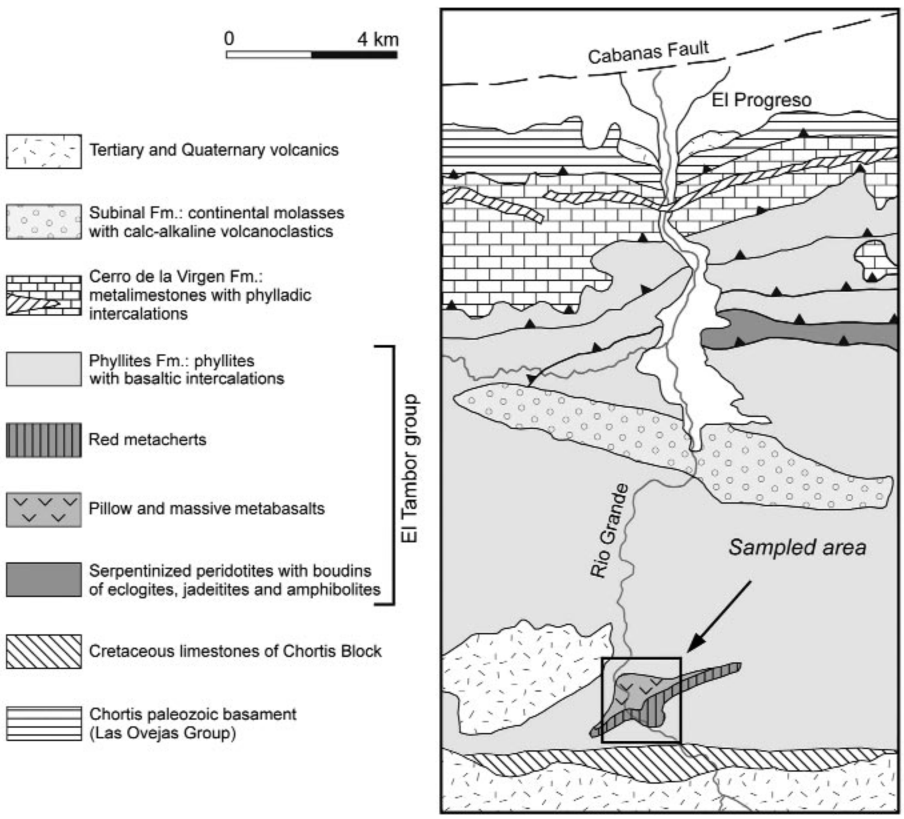

Fig. 3 - Geological Map of the Rio Guastatoya and Rio Grande area (modified after Giunta et al., 2002).

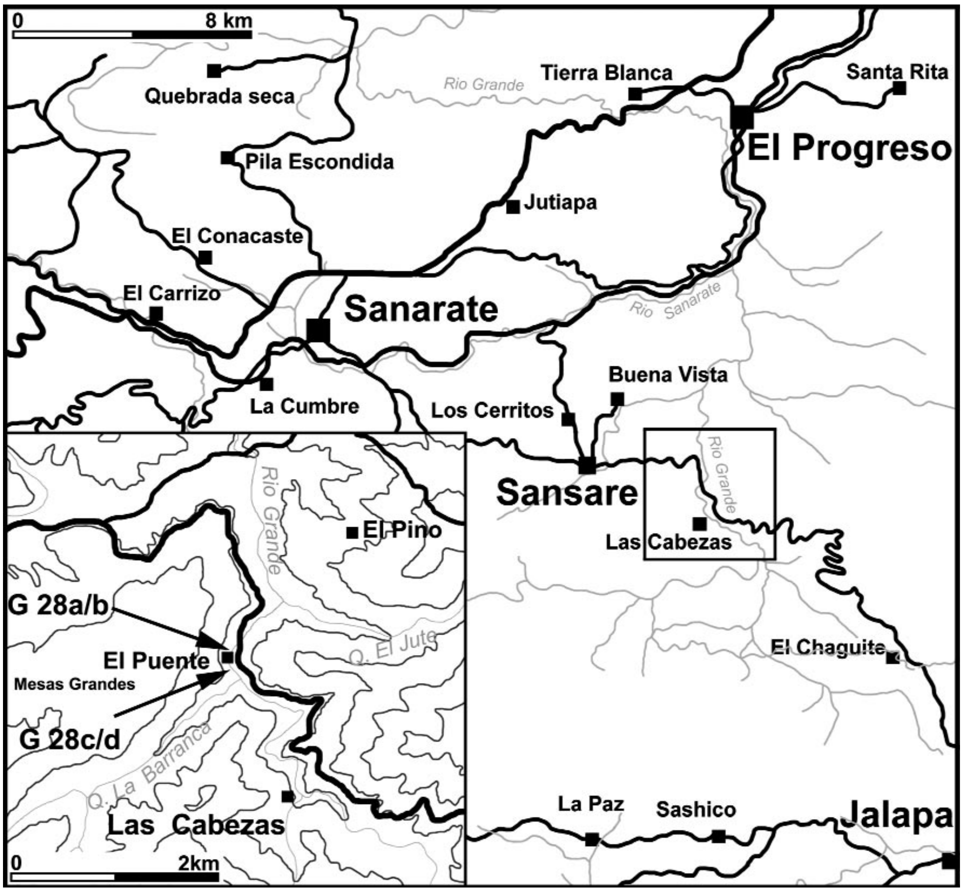

Fig. 4 - Location of the studied samples along the Rio Grande River.

This sequence was deformed under blueschist P/T conditions, but the primary lithological features are still preserved. In the metacherts, boudins of less deformed rocks have been sampled for radiolarian biostratigraphic study (Fig. 5c).

RADIOLARIAN BIOSTRATIGRAPHY

The radiolarian metacherts have been first treated with hydrochloric acid to remove the carbonates and afterwards with diluted hydrofluoric acid at different concentrations, using the method proposed by Dumitrica (1970), Pessagno and Newport (1972), Baumgartner et al. (1981), De Wever (1982) and Chiari et al. (2004).

The examined residues contain very poorly preserved, undeterminable radiolarians. Only further examinations of small pieces of metacherts etched with hydrofluoric acid permitted to recognize, at the scanning electron microscope (SEM), some very poorly preserved specimens in sample G28c (Plate 1). The assemblage of this sample comprises *Archaeospongoprunum* sp. or *Pantanellium* sp. or *Triactoma* sp., *Dactyliodiscus* sp. 1 or *Emiluvia ultima* Baumgartner and Dumitrica, *Mirifusus* sp., *Podobursa* sp., *Praeconocaryomma* sp. or *Acaeniotyle* sp., *Triactoma* sp. Except for *Dactyliodiscus* sp. 1 (Plate 1b) the age suggested by the radiolarians of this extremely poorly preserved assemblage is very vague.

The shape of the radiolarian specimen indicated as *Archaeospongoprunum* sp. or *Pantanellium* sp. or *Triactoma* sp. in Plate 1a (generic determination of the specimen is difficult because of the very poor preservation), would suggest a Jurassic to Early Cretaceous age. The shape of *Mirifusus* sp. (Plate 1c) could be identified as *Mirifusus guadalupensis* Pessagno (latest Bajocian - early Tithonian) or *Mirifusus diane* s.l. (Karrer) (late Bathonian - late Hauterivian): two species of rather similar shape but differing in the number of rows of pores in each segment. *Podobursa* sp. (Plate 1d) suggests a Bajocian - early Aptian interval. The shape of the specimen in Plate 1e, suggests either *Praeconocaryomma* sp. (Early Jurassic to Late Cretaceous age interval) or *Acaeniotyle* sp. (a Late Jurassic to Late Cretaceous genus). At last, *Triactoma* sp. (Plate 1f) suggests a Pliensbachian to Coniacian age.

The specimen determined as *Dactyliodiscus* sp. 1 (Plate 1b) is the only one that allows a more precise age determination. *Dactyliodiscus* sp. 1 was illustrated by Hori (2001) (*Dactyliodiscus* sp. in Hori, 2001, Plate 5, Fig. 20) from the Middle/Late Jurassic of Japan (*Transhuum maxwelli* Zone) and considered to be Kimmeridgian in age (Matsuoka and Yang, 2000). Moreover, *Dactyliodiscus* sp. 1 is also common in many Oxfordian assemblages from the Eastern Carpathians and Apuseni Mountains (Romania), under study by one of us (P. Dumitrica).

Due to the low preservation, identification of the specimen of Plate 1b is ambiguous. It could also be assigned to *Emiluvia ultima* Baumgartner and Dumitrica. This species that has 4 spines, and commonly 19 nodes on each face, of which one central, 6 around the central one, and 12 on a peripheral ring, ranges in the UAZones 10-11 (Baumgartner et al., 1995a), indicating a late Oxfordian - early Kimmeridgian to late Kimmeridgian - early Tithonian age. Cumulating the data of the two possible determinations it would result an Oxfordian-Kimmeridgian age for the sample G28c. This does not contradict the age suggested by the other taxa determined in this sample.

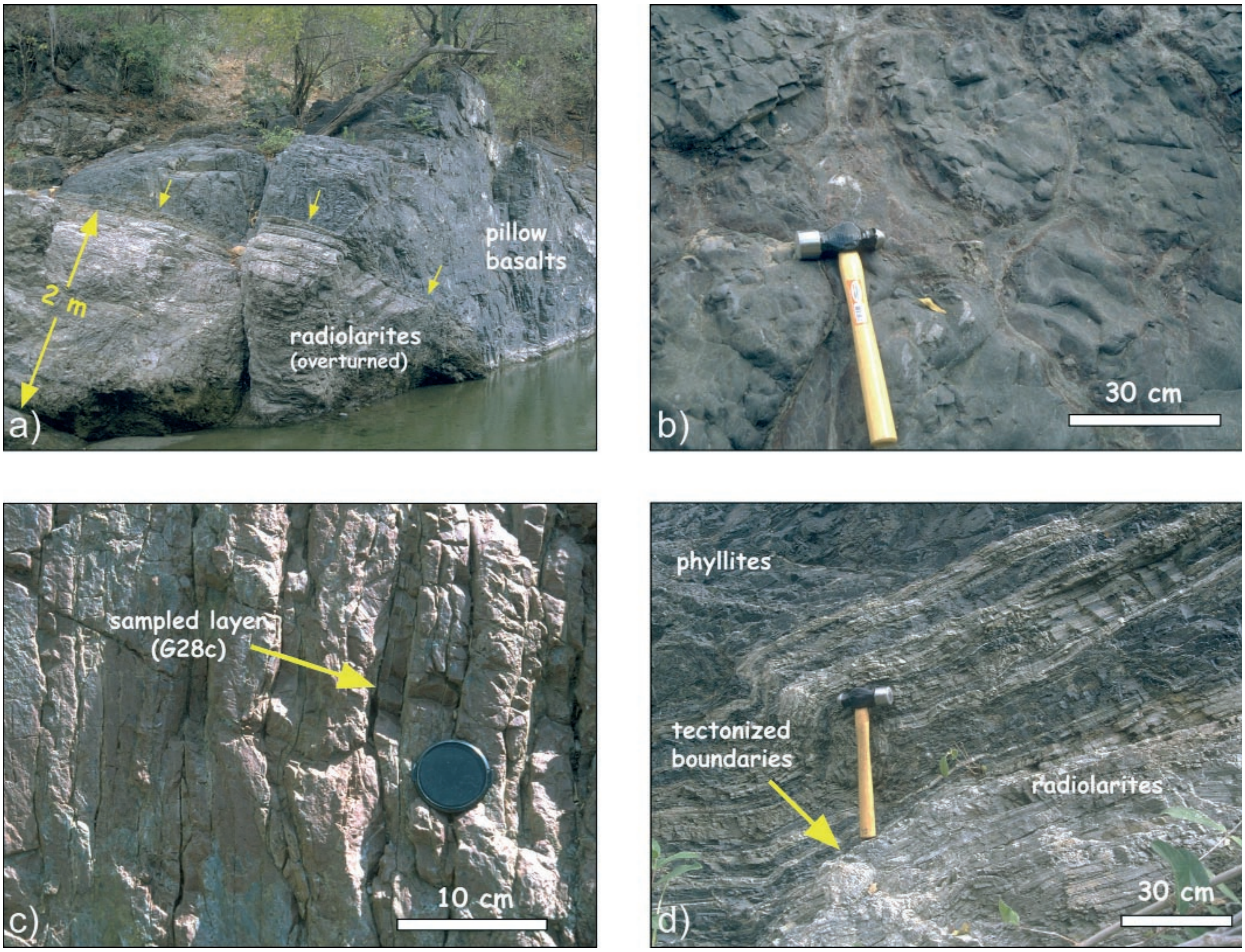

Fig. 5 - Photos of the sampled outcrop (El Tambor Group, South Motagua Unit) along the Rio Grande River: a) Field relationship between pillow lavas and metacherts, the sequence is overturned, b) Pillow lavas underlying the studied metacherts, c) Sampled layer (sample G28c) in the metacherts, d) Field relationship between metacherts and overlying phyllites.

DISCUSSION

In the last years, the plate-tectonic evolution of the Caribbean area has been matter of debate, mainly concerning the origin of the fragments of oceanic crust, today preserved in the collisional belts around the Caribbean Plate. At this regards, the age of the ophiolites can provide valuable constraints for the existing models. For instance, different paleogeographic reconstructions have been proposed concerning the presence of oceanic crust in the Late Jurassic between the Maya/Yucatan and Chortis continental Blocks. In the model proposed by Meschede and Frisch (1998a) for the Late Jurassic, these continental blocks are connected with an area characterized by continental crust. In this model, the occurrence of oceanic crust among the microplates is postulated starting from the Early Cretaceous onward. By contrast, the occurrence of Upper Jurassic oceanic crust between the Maya/Yucatan and Chortis continental blocks is suggested by other models as that by Giunta et al. (2002) who admit the presence of a Jurassic proto-Caribbean Tethys.

In the circum-Caribbean region radiolarites associated with ophiolitic rocks, both Jurassic (as seen before) and Cretaceous in age are documented (Aiello and Chiari, 1995 and Kerr et al., 1999 for Cuba; Beck et al., 1984 for Venezuela; Montgomery et al., 1994b, for Hispaniola; Mattson and Pessagno, 1979, Montgomery et al., 1994b for Puerto Rico; Rosenfield, 1981 and Donnelly et al., 1990, for Guatemala; Denyer and Baumgartner, 2006, for Costarica).

The magmatic affinities of the Jurassic ophiolites, are mainly MOR-like whereas the Cretaceous ones are both MOR and SSZ.

However, both the age of opening of the proto-Caribbean Ocean, and the presence of a Caribbean Tethys are still a vexing question (see Bortolotti and Principi, 2005, for a wider discussion).

In fact, Montgomery et al. (1994b), considering the radiolarian paleolatitudinal model proposed by Pessagno and Blome (1986) and Pessagno et al. (1987; 1993), suggest that the radiolarites and all the Caribbean lithosphere originated in the Pacific Ocean, according to a geodynamic model proposed by Pindel and Barrett (1990).

Other authors, on the contrary (e.g. Case et al., 1990; Stephan et al., 1990; Meschede and Frisch, 1998b; Giunta et al., 2002 cum bibl.), consider the peri-Caribbean MOR ophiolites, as remnants of a paleo-Caribbean Tethys, bypassing the radiolarian paleolatitudinal model.

A intermediate solution could be to consider the Jurassic and Cretaceous ophiolites of the eastern side of the Caribbean area (Puerto Rico and Lesser Antilles) as derived from the Central Atlantic lithosphere (subducting under the

Caribbean Plate), and those of the western side (Costarica) the remnants of the Pacific Ocean.

Therefore the late Pliensbachian radiolarian age (found in Puerto Rico, Montgomery et al., 1994a) seems too old for the peri-Caribbean basin. This age results excessively old also if these ophiolites are considered as belonging to the Central Atlantic Ocean, because the older age of it is middle Bathonian (Baumgartner 1983; 1984a, Baumgartner and Matsuoka, 1995), as found in samples from DSDP Leg 76, Site 534A (located in the Blake Bahama Basin between the Magnetic Anomaly M25 and the Black Spur Anomaly).

If a late Pliensbachian age is confirmed, the hypothesis of Montgomery et al. (1994b) of a Pacific origin for these ophiolites could have a strong support (see also Bortolotti and Principi, 2005).

In any case it is very difficult to hypothesize an extra-Caribbean origin for the Motagua ophiolites. In fact they are now squeezed between the Chortis and Maya continental Blocks, in a suture zone linked to a probably destral Jurassic transform fault which becames sinistral since the Middle Cretaceous (Giunta et al., 2002). A paleogeographic restoration of the Maya and Chortis Blocks, should place the latter to the southwest of the Motagua ocean seaway, in an intra-paleocaribbean location.

CONCLUSION

This paper documents, for the first time, the Late Jurassic age (Oxfordian - Kimmeridgian) of the South Motagua Ophiolitic Unit in the Motagua Suture Zone of Guatemala, which developed in an oceanic basin located between the Chortis and Maya-Yucatan continental Blocks; according to Beccaluva et al. (1995) and Giunta et al. (2002), in an intra-Caribbean realm. This ocean basin continued eastwards, as proved by the occurrence of the Jurassic-Cretaceous MOR basalt ophiolites in Cuba, Hispaniola, Puerto Rico, La Desirade (Lesser Antilles), and southwards in Venezuela.

The Motagua and all the Caribbean ophiolites could document the western termination of the Jurassic Tethyan break up of Pangea (see Auboin et al., 1977; Giunta, 1993; Bortolotti and Principi, 2005).

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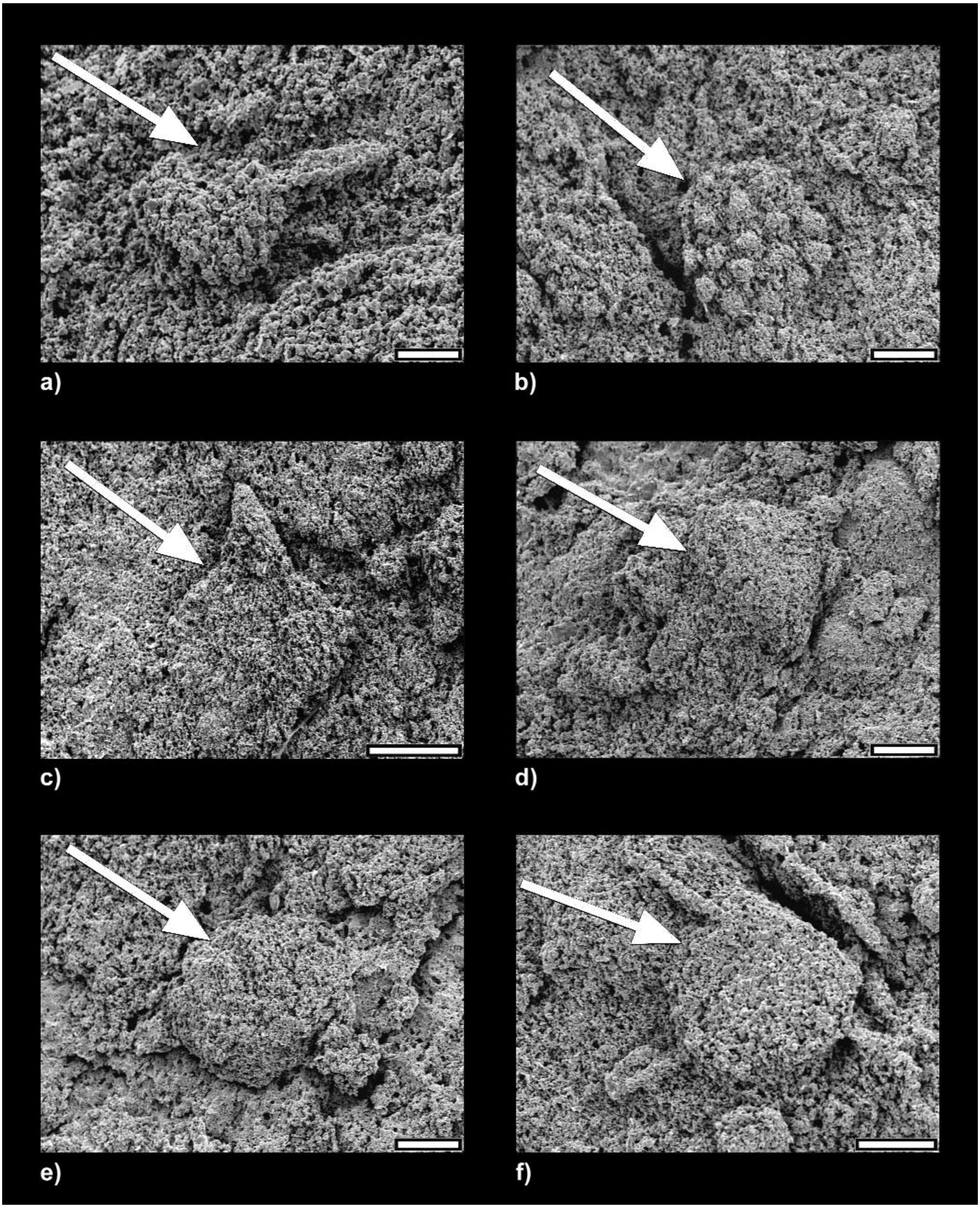

Plate 1 - a) *Archaeospongoprunum* sp. or *Pantanellium* sp. or *Triactoma* sp., sample G28c, (scale bar = 50µm). b) *Dactyliodiscus* sp. 1 or *Emiluvia ultima* Baumgartner and Dumitrica, sample G28c, (scale bar = 100µm). c) *Mirifusus* sp., sample G28c, (scale bar = 200µm). d) *Podobursa* sp., sample G28c, (scale bar = 100µm). e) *Praeconocaryomma* sp. or *Acaeniotyle* sp., sample G28c, (scale bar = 100µm). f) *Triactoma* sp., sample G28c, (scale bar = 100µm).