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NUEVOS DATOS SOBRE LA FORMACIÓN LA ISABELA: ORIGEN E IMPLICACIONES PALEOGEOGRÁFICAS EN LA EVOLUCIÓN CUATERNARIA DE LA CORDILLERA SEPTENTRIONAL EN LA REPÚBLICA DOMINICANA

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La Formación Isabela fue descrita por Marcano y Tavares en 1982 en las proximidades de la población de La Isabela, en el NO de la provincia de Puerto Plata. Esta Formación, de edad Pleistocena, está constituida por un tramo basal, de unos 15 metros, de arenas y limos margosos marinos con intercalaciones de naturaleza fluvio-deltaica. Este tramo pasa rápidamente mediante una ligera discordancia erosiva, a otro tramo muy potente de calizas arrecifales que definen la parte alta de la serie. El objetivo de este trabajo es redefinir y ampliar los límites de esta formación en la Cordillera Septentrional y profundizar en su relación con la formación infrayacente (Formación Villa Trina) así como discutir las implicaciones paleogeográficas de la Formación La Isabela desde el Pleistoceno.

La Formación La Isabela se distribuye a lo largo de la costa norte de la República Dominicana, desde el oeste de Puerto Plata hasta las inmediaciones de Punta Rusia, y sus relaciones estratigráficas con la Formación Villa Trina son difíciles de precisar, aunque en algunos lugares se observa una discordancia angular (Playa de la Ensenada, Punta Rusia) con los materiales margosos de esta última formación. Hacia áreas más interiores, desaparece la Formación La Isabela, y encima de los materiales margosos de la Formación Villa Trina, que decrecen en potencia, se encuentran calizas masivas, arrecifales y paaarrecifales que constituyen el miembro La Piedra de la Fm Villa Trina. Estos materiales, aflorantes a cotas elevadas dentro de las posiciones interiores de la cordillera, representan una transición entre las margas de cuenca y las calizas arrecifales de la Formación La Isabela, situadas hoy día en las áreas más cercanas a la costa. Su datación precisa nos daría interesantes datos sobre la evolución paleogeográfica de los sistemas arrecifales desde el Plioceno superior hasta la actualidad, sirviendo además para cuantificar la rápida elevación que ha experimentado la isla desde el Pleistoceno a la actualidad, que ha dado como resultado un paisaje escalonado que se inicia en el nivel del mar actual y que supera los 250 m.

Abad, M. [1]; Pérez-Valera, F. [1]; Rodríguez-Vidal, J. [2]; Hernaiz Huerta, P.P. [1]; Pérez-Estaún, A. [3]; Ruiz, F. [2] y Cáceres, L.M. [2]

ANÁLISIS MORFOSEDIMENTARIO DE NIVELES ESCALONADOS MARINOS PLIO-CUATERNARIOS: UN CASO DE ESTUDIO EN LAS COSTAS NORTE Y SUROESTE DE LA REPÚBLICA DOMINICANA

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En este trabajo se analizan las morfologías escalonadas, de edad Plio-Cuaternaria, que se describen en dos zonas costeras de la Republica Dominicana. La primera se localiza cerca de Luperón, en el Norte de la isla; la segunda está situada entre las localidades de Pedernales y Cabo Rojo, en Suroeste de la misma. En ambos casos estos modelados han estado condicionados por dos procesos: la tectónica, mediante pulsos de elevación del continente y que parcialmente han controlado sus formas; y los procesos marinos ligados a las fluctuaciones eustáticas, que dan lugar a cortejos de morfologías erosivas.

En el Norte las morfologías resultantes constituyen un sistema escalonado de acantilados verticales, separados por plataformas de abrasión de diferente extensión y de escaso desarrollo. En general, cada uno de estos acantilados se corresponde con un escarpe de falla elaborado sobre las calizas arrecífales pleistocenas de la Fm. La Isabela. Se observan, al pie de estas morfologías, depósitos de brechas de corales.

En el Suroeste las morfologías son más complejas, de mayor escala y trazado menos rectilíneo, conformando “acantilados compuestos” adosados a plataformas de abrasión marina. Éstos se desarrollan sobre las calizas terciarias de Pedernales y calizas arrecifales cuaternarias, muestran evidencias de un fuerte retroceso erosivo y suelen estar cubiertos por depósitos asociados a procesos gravitacionales.

Los diferentes modelados costeros, descritos en las dos zonas de estudio, se deben a la diferente interacción entre dinámica sedimentaria, eustatismo y tectónica. En el Norte, confluyen la existencia de una barrera arrecifal, que atenúa la erosión del oleaje, y una tasa de elevación tectónica alta, que dan como resultado que los acantilados costeros queden colgados y preservados en las laderas como formas relictas. En el Suroeste, donde la tectónica no es tan importante, y los arrecífales no están bien desarrollados, los acantilados experimentaron un fuerte retroceso erosivo, sometidos durante mayor tiempo a las oscilaciones del nivel del mar.

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REVIEW OF EVIDENCE FOR UHP CONDITIONS IN THE CUABA TERRANE, RIO SAN JUAN COMPLEX, DOMINICAN REPUBLIC

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Ultra high pressure (UHP) conditions were established for the Cuaba terrane on the basis of phase relationships in garnet-bearing ultramafic (UM) rock. Dikes and orthocumulate textures indicate a magmatic origin. Mineral assemblages define a line of descent controlled by fractional crystallization: (I) olivine+clinopyroxene+orthopyroxene, (II) olivine+clinopyroxene+garnet, (III) olivine+clinopyroxene+garnet+spinel, (IV) clinopyroxene+garnet+spinel, (V) clinopyroxene+garnet+spinel+corundum. The last assemblage represents the only natural occurrence of garnet+spinel+corundum. Magmatic conditions were P > 3.4 GPa and T > 1540 °C (within the field of stability of coesite, hence UHP). The rocks document magmatic processes in the deepest part of the lithosphere or within the asthenosphere. We propose an origin in the mantle-wedge above a subduction zone, well away from the latter. The rock was delivered to the subduction zone by forced convection in the mantle wedge (corner-flow), coupled with erosion of the hanging wall. Models of such flow and P-T constraints suggest cooling at constant or increasing pressure. Garnet-clinopyroxene thermometry indicates ~900 °C at ~4 GPa when the UM rock was incorporated into, or otherwise mixed with, eclogite (deep-subducted oceanic crust).

Evidence for UHP conditions in the eclogite is not obvious. Two types of symplectic intergrowths, plagioclase+clinopyroxene (Sym-I) and plagioclase+epidote (Sym-II), are interpreted as the products of the decomposition of two types of omphacite, Omp-I and Omp-II. Sym-II (hence Omp-II) forms mantles on garnet and aggregates of non-symplectic epidote. Stoichiometric arguments show that non-symplectic epidote was derived from kyanite. Omp-II formed as the result of a retrograde reaction of the form, Omp-II + coesite = Omp-I + garnet + kyanite, according to which the maximum pressure for Omp-II is between ~2.8 GPa (~850 °C) and ~4.2 GPa (~950 °C), consistent with subsolidus conditions for UM rock. For eclogite, the highest-pressure mineral assemblage would have been Omp-I+kyanite+garnet+coesite.

Abrams Rivera, Deborah T.

CHARACTERIZATION OF THE UPPER QUEBRADA DE ORO MAYAGÜEZ AQUIFER SYSTEM USING SURFACE GEOPHYSICAL TECHNIQUES

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Detailed information on subsurface conditions is essential for the development and management of ground-water resources and the characterization of sites, like those being used for educational purposes. The objective of this research project is to compare two geophysical methods, Multi-Channel Analysis of Surface Waves (MASW), and Electrical Resistivity (ER) to identify near-surface features which control ground water flow. MASW is a seismic refraction method which is effective in estimating the saturated thickness of aquifers and the thickness of beds based on a material's elastic properties and density. ER measures the electrical properties of rocks which depend primarily upon the amount of water retained in the rock and the salinity of the water, which provides more information about the porosity of the material.

The study was performed on an alluvial valley adjacent to the Civil Engineering department at the University of Puerto Rico, Mayagüez campus in order to better understand the interactive systems

between alluvium deposits, bedrock, and ground water flow in the region. The site is presently used as an Environmental and Water Resources field laboratory with both pumping and observation wells installed. A geologic characterization of this aquifer has created a better understanding of the interactive systems taking place in this drainage basin and generated profile images of the environment from which water is being extracted.

Archie, Curtis

MUD VOLCANO ACTIVITY IN TRINIDAD - 1995 – 2007

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Mud volcanoes and their activity have been described in the literature from as far back as Wall and Sawkins (1861). Higgins and Saunders (1974) have produced the most comprehensive list and descriptions of 26 areas of modern activity and 3 ‘fossil’ events. Since 1995 there have been five extrusions of mud, the first 1995 at Devil’s Woodyard, 1997 at Piparo (the only eruption filmed), 2001 and 2002 offshore Chatham, and in 2007 to the north of Point Radix.

Devil’s Woodyard and Piparo have been monitored by the author since the eruptions , the locations of the vents, where a combination of mud - gas - muddy water is expelled, was plotted using a GPS 2003 and 2008 . The implications of the changes in number and distribution of these vents will be discussed.

Other recent areas of activity will be shown and relationship to the major tectonic features examined.

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POTENTIAL FIELD AND PETROPHYSICAL CHARACTERIZATION OF THE MAIN TECTONIC DOMAINS IN THE CENTRAL CORDILLERA, DOMINICAN REPUBLIC

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High resolution aeromagnetic and ground gravity data together with a petrophysical set of 586 density and magnetic susceptibility samples, which are representative of the main Dominican Republic lithologies, allow the characterization of regional tectonic domains on surface and the interpretation of its physical properties in depth. The main features of the potential fields are: 1) prominent NW-SE trending anomaly features, some coinciding with major strike slip fault zones, which are the limits of main tectonic domains; 2) excellent geophysical mapping examples of volcanosedimentary units, mainly from the Upper Cretaceous Caribbean island-arc; and 3) outstanding anomalies due to a widely spread magmatism, Lower Cretaceous to Lower Eocene in age. Focusing on magnetic susceptibility, this magmatism is bimodal, with magnetic and paramagnetic areas in any of the plutonic bodies and the volcanic belts in the Island. Induction dominates over remanence, which is only important in some acid volcanics and in the gabbroic plutonics. This fact makes easier the interpretation of magnetic surveys.

The Central Cordillera, structurally bounded to the N for the La Hispaniola Fault Zone and to the S for the Bonao-La Guácara Fault Zone, is made of well preserved oceanic-derived units that comprise from oceanic plateaus, like the Duarte Complex, to igneous sequences, island-arc-related, like the Tireo Group. Magnetic susceptibility and density variations over the lithologies sampled along two geological cross sections, have been used to build up two magnetic and gravity models that cross the main structures mapped at the Central Cordillera. The modelling reveals the petrophysical heterogeneities in depth and the subsurface geometry of contacts between tectonic units, as kilometer-scale faults and shear zones. One of the main results is the lateral changes in magnetic susceptibility across the Duarte Complex, probably as a result of the temperature changes during magmatic extrusion/intrusion processes through the island arc crust.

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LOWER BARREMIAN (LOWER CRETACEOUS) AMMONITES FROM THE VELOZ FORMATION OF CENTRAL CUBA: BIOSTRATIGRAPHIC AND PALEOBIOGEOGRAPHIC IMPLICATIONS

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Lower Barremian (Lower Cretaceous) ammonites from Central Cuba are studied for systematic and biochronostratigraphic purposes. The fossils under study come from previous and recent sampling from different Barremian stratigraphic exposures of the Veloz Formation, a litostratigraphic unit of the Placetas Belt within the Villa Clara Province. The Placetas Belt is a Cuban tectonostratigraphic unit that records the sedimentation originated in the Tethyan basins to the south of the North American Margin from the Late Jurassic through the Cretaceous. The ammonites studied herein were recovered from bedded calcarenites and biomicrites that represent a portion of that sedimentation during the Barremian times. A rich stratigraphically controlled assemblage of taxa belonging to the Family Pulchelliidae conforms the focus of the studied material, allowing for new discussions on the geographical distribution of this taxon within the Tethyan Realm. Preliminary results suggest that the ammonite association is predominated by representatives of the Subfamilies *Pulchelliinae* and *Psilotissotiinae* belonging to the genera and subgenera *Pulchellia* (*Pulchellia*), *Kotetishvilia*, *Nicklesia*, and *Psilotissotia*, among others. These coiled ammonites were sampled from the same stratigraphic levels together with a rich assemblage of small heteromorph ammonites belonging to the Subfamily *Leptoceratoidinae*, a group of small-sized uncoiled ammonites with ubiquitous Barremian age. The data herein discussed represent the first detailed systematic and biochronostratigraphic reports of these taxa in the Caribbean Islands, widening their paleobiogeographic significance and allowing for precise long distance correlations of standard Barremian ammonite zonations between Cuba and other areas of

the world. The faunal assemblage suggest that the portion of the Veloz Formation studied herein, was deposited somewhere during the middle-lower Barremian within the span of time comprised between the *Kotetishvilia nicklesi* and the *Kotetishvilia compressissima* ammonite biozones.

The faunal assemblage and an ongoing facies analysis suggest that the ammonites were recovered from facies indicative of well-oxygenated neritic platform environments.

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MAGNETIC PROPERTIES OF VOLCANICS AND OPHIOLITES FROM NORTHEASTERN CUBA: A PILOT STUDY

We sampled 19 sites (135 oriented cores), of Upper Jurassic to Eocene age, ophiolite and volcanic rocks at the northeastern Cuba region. AF demagnetization was better than thermal demagnetization process, excepting the gabbro that shows one to two magnetization components of mean unblocking temperature around 350°C. Characteristic remanent magnetization (ChRM) was defined in 102 samples, being magnetite, titanomagnetite and pyrrotite the magnetic carriers in a pseudo-single-domain magnetic state. Strong viscous magnetizations appear between 10-30 mT and 500-550°C and are destroyed between 35-80 mT or 575°C, suggesting magnetite as main carrier of remanence. 'Pot bellied' and 'wasp waisted' behavior curves of hysteresis experiments suggests ferromagnetic phases. Saturation magnetization and coercivity have, in general, medium to high values. ChRMs of 14 sites were well defined and stable, showing NE to NW directions, valuable for tectonic and geologic purposes. Mean paleodirections of whole region are $I = 32.65^{o}$, $D = 15.25^{o}$, $k = 3.9$ and $\alpha_{95} = 9.14$, and paleomagnetic pole Plat= 75.33^{o}, Plong= 173.3^{o}.

Baumgartner, Peter O.; Flores, Kennet; Bandini, Alexandre; Baumgartner-Mora, Claudia and Buchs, David

TERRANES OF NW-COSTA RICA AND THE HESS ESCARPMENT: A PRE-CAMPANIAN PALEO-PLATE BOUNDARY.

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The Hess Escarpment does not connect to a much younger EW-trending fault in the Santa Elena Peninsula as previously thought. It is the morphological expression of the boundary between the Mesquito Composite Oceanic Terrrane (MCOT) suspected in the Lower Nicaragua Rise and the Caribbean Large Igneous Province (CLIP) to the South. In NW-Costa Rica and S-Nicaragua the Southern edge of the MCOT is characterized by the serpentinite mélange including Late Triassic radiolarites of El Castillo and the Santa Elena Peridotite. The complex, relatively well known geology of NW-Costa Rica is interpreted as a puzzle of small Terranes that witness the paleotectonic MCOT-

CLIP boundary:

1. The Santa Rosa Accretionary Complex and Nancite "Arc Root" represent a mid-Cretaceous convergent margin of which the upper plate was the MCOT. MCOT-CLIP collision caused its pre-late Campanian overthrust by the Santa Elena Peridotite.

2. The Nicoya Complex s. str., a Cretaceous oceanic plateau devoid of arc-derived rocks, must have formed along the MCOT – CLIP paleo-boundary, since it contains highly deformed Jurassic radiolarites possibly reworked form the MCOT. Only its youngest igneous and sedimentary ages correspond to CLIP age. Older parts of this plateau (Matambu "Terrane") host Albian to early Campanian pelagic sequences (Loma Chumico-Sabana Grande).

3. The Manzanillo Terrane, characterized by a toleiitic basement including the Tortugual picritic suite of Turonian age, is covered by the Berrugate fore-arc basin that documents a Turonian-early Campanian mature arc system.

"True" Late Cretaceous CLIP crops out in S-Nicoya, W-Herradura and W-Panama.

MCOT-CLIP collision and uplift terminated the juxtaposition of the above terranes as documented by a common late Campanian to Eocene overlap sequence with paralic to pelagic sediments at its base.

Baumgartner-Mora, Claudia; Baumgartner, Peter O.; Buchs, David; Bandini, Alexandre and Flores, Kennet

PALEOCENE TO OLIGOCENE FORAMINIFERA FROM THE AZUERO PENINSULA (PANAMA): THE TIMING OF SEAMOUNT FORMATION AND ACCRETION TO THE MID-AMERICAN MARGIN.

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Planktonic and Larger Benthic Foraminifera recovered from pelagic and shallow water limestones in the Southern Azuero Peninsula allow to date the formation of accreted seamounts, as well as the time of their docking to the Mid-American convergent margin.

Paleocene-early Eocene ages are indicated by *Morozovella*-type planktonic foraminifera and small *Amphistegina* spp. determined in several interflow pelagic to offshore limestones from the SW-corner of the Azuero Peninsula. They document synchronous volcanic construction and carbonate sedimentation in one or several pacific seamounts.

Middle to late Eocene ages are indicated by rich assemblages of Larger Benthic Foraminifera both in tectonic mélanges that overly the seamount sequences, as well as at the base of the unconformably overlapping Tonosi forearc-sequence. Larger Foraminifera include *Pseudophragminides ssp.*, *Asterocyclina* in the older, paralic facies and abundant *Lepidocyclina* spp., and rare *Nummulites* sp, in the younger pure carbonate facies.

Latest Eocene and Oligocene ages are determined from shallow water limestones at the base of Tonosi

in the interior of Azuero documenting the progressive onlap of this fore-arc sequence onto the Late Cretaceous plateau and arc "basement". At least two distinct facies are characterized by: 1. abundant flat *Nummulites* spp. And 2. by dominant large Oligocene *Lepidocyclina* spp.

Bayona, Germán [1]; Montes, Camilo [2]; Cardona, Agustín [3]; Jaramillo, Carlos [3]; Ojeda, Germán [4]; Ruiz, J. [5] and Valencia, V. [5]

LATE PALEOCENE BASIN-FILLING, MAGMATISM AND TECTONIC SUBSIDENCE PATTERNS AT THE NW CORNER OF THE CARIBBEAN-SOUTHAMERICA PLATE MARGIN

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Syntectonic basins in collisional settings preserve the history of uplift and advance of the front of deformation. Geologic mapping, stratal architecture, sedimentological data, seismic stratigraphy, provenance, and paleocurrent analyses carried out in Maastrichtian-Paleocene strata constrain the timing of uplift of the Santa Marta massif (SMM) and Perija range (PR), as well as the pattern of filling of the Rancheria basin in northern Colombia. In the Rancheria basin, a basin bounded by the SMM on the northwest and PR on the southeast, Maastrichtian-Paleocene strata thicken southeastward up to 2.2 km. This succession includes, in stratigraphic order: foram-rich calcareous mudstone, oyster-pelecypod carbonate-siliciclastic strata, coal-bearing mudstones and feldspar-lithic bearing sandstones. Internal truncations are identified to the northwest of the basin. Although there are not major thrust faults at the NW margin of the basin and the SMM, provenance and paleocurrent analyses of Upper Paleocene units document the influx of terrigenous material derived from the SMM (e.g., metamorphic, microcline and garnet fragments). At the Late Paleocene, diachronous advance of paralic/deltaic environments continued eastward, even though the high tectonic subsidence rates in the Rancheria basin. Reactivation of intraplate weak structures controlled the thinner carbonate and mixed carbonate-siliciclastic deposition to the east of the PR. From the evaluation of rigid (Laramide-like basement uplifts, crustal tilting) and elastic (flexural foredeep, piggyback basins, and negative flexure) tectonic models, we consider that rigid deformation of the SMM controlled subsidence and sediment supply in the Rancheria basin. The collision of the SMM with the southern margin of the Caribbean oceanic plate and the installation of a subduction zone in the South American margin is indicate by Paleocene-Lower Eocene intermediate plutonic rocks at the SMM, U/Pb detrital zircon ages in the Rancheria basin and felsic pyroclastic rocks at the eastern flank of the PR.

Bengoubou-Valerius, Mendy

PRELIMINARY RESULTS FROM ACCELEROMETRIC DATA FOR FRENCH LESSER

ANTILLES

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The Lesser Antilles is an area of high volcanic and earthquake activity, characterized by a 1000 km convergence zone resulting from the Atlantic plate subduction under the Caribbean plate with a slow convergent motion (2 cm/year). This arc has a specific regional setting with important structural heterogeneities which can affect seismic characteristics: oblique subduction in the North, large accretion prism in the South, aseismic ridge sinking in subduction, shallow intraplate active faults close to the volcanic arc. More than 120 stations with short period, broadband or accelerometric sensors are installed in French Lesser Antilles. Our data base presents an homogeneous vision of Lesser Antilles arc seismicity and allows detecting low seismic activity zones, in the north near the Virgin Islands, and in the south between St-Lucia and Grenada. We are also studying the spatial and temporal variations of the b-value and present small-scale spatio-temporal mapping of the b-value along the Lesser Antilles arc. The spatial variations are tentatively attributed to depend on the fault heterogeneity and on the level of the stress and pore pressure in the crust.

Regional seismic hazard assessment are based on general attenuation model such as Youngs et al. (1997), Sadigh et al. (1997) or Ambraseys et al. (2005) which are not necessarily suitable for the local tectonic context. Local geology and topography in Martinique and Guadeloupe show large zones where strong amplification of surface ground motions are reported (Gagnepain-Beyneix et al., 1995; Castro et al., 2003; Lebrun et al., 2004). High quality, digital accelerometric data are recent in Lesser Antilles, and there is not yet any attenuation relationship adapted for Lesser Antilles. Preliminary results from our records show that standard attenuation laws overestimate peak accelerations at large distances by a factor of 2 to 3, showing the need to develop new formulae adapted to the Lesser Antilles context.

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GEOCHEMISTRY AND AGE OF A PARTIALLY MELTED SUBDUCTED SLAB. LA COREA MÉLANGE (EASTERN CUBA)

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The La Corea mélange (eastern Cuba) is composed of exotic blocks of diverse origin and composition (garnet-amphibolite, blueschist and greenschist are dominat) within a serpentinite-matrix. It is tectonically located below the ophiolitic massif of Mayarí-Cristal of the Mayarí-Baracoa Ophiolitic

Belt. The more abundant blocks are amphibolites and tonalites-trondhjemites which form dikes and veins in the amphibolites. The tonalites-trondhjemites are medium- to coarse-grained, including pegmatitic varieties, and are composed of quartz, plagioclase, epidote, ±pargasite, ±muscovite. Major and trace element geochemistry of the amphibolites indicate tholeiitic basaltic composition and NMORB affinity. The leucocratic rocks are trachyandesite, dacite and rhyolite in composition. Structural, petrologic and geochemical characteristics indicate that tonalitic-trondhjemitic rocks represent melts formed during partial melting of subducted amphibolites, and not magmatic arc intrusions nor subducted oceanic plagiogranite. These rocks do not show a calc-alkaline trend typical of intermediate-to-acid associations of volcanic arcs, but a trondhjemitic trend. Trace element abundances show REE depletion relative to the amphibolites, but variable LILE contents. The tonalitic-trondhjemitic rocks are similar to adakites of volcanic arcs though to represent slab melts: $SiO_2 > 56\%$, $Na_2O = 4.5\text{-}7.5\ \%$, very low $K_2O/Na_2O < 0.2$, high Mg# = 0.5-0.6, Ni < 20 ppm, Cr = 19-25 ppm, Sr = 100-800 ppm, Yb < 0.3 ppm and Y < 6, LREE enrichment, HREE depletion, Sr/Y >100 (up to 1250 in one sample), and La/Yb > 5. These data suggest infiltration of LILE-bearing fluids accompanied the formation of the tonalitic-trondhjemitic rocks after partial melting of the amphibolites. New zircon SHRIMP data indicate that partial melting occurred shortly before 110 Ma. These ages suggest onset of subduction of young Proto-Caribbean oceanic slab at ca. 120 Ma, in agreement with data from the mélange of Sierra del Convento (southeastern Cuba) and Río San Juan (northern Dominican Republic).

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THE CUBAN OPHIOLITES AND RESULTING NICKEL LATERITE DEPOSITS (A REVIEW)

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2. EMPRESA MECANICA ENRIQUE VARONA (SIME) – CUBA

The Cuban Ophiolites outcrops discontinuously along the northern half of the 1250 kilometers of the largest island in the Antilles. These ophiolites are considered as an allochtonous mélange thrusted northward and northeasterly during middle to upper Cretaceous time into foreland basins resulting in a complicated tectonic position and thickness that varies from West to East in the island.

Whereas in the West it dips to the North over Guaniguanico continental terrain, in Central Cuba it dips from South to Southwest over Bahamas platform terrain and in the Eastern Cuba, it sits nearly horizontal over volcano- sedimentary back arc rocks. Ophilotite thickness is 1-2 kms in the West, 5-6 kms in Central Cuba and only one kilometer thick in the East.

Nickel laterites profile development occurs in four distinctive regions over these ophiolites. In the West, the Cajalbana plateau show good nickel laterite development and is reported to contain attractive amounts of gold. In Central Cuba, the San Felipe platform is a proven deposit which contain mineralogical characteristics in the profile, which make it different to all the rest of the Cubans nickel laterites. In eastern Cuba, two distinctive regions, the Nicaro-Pinares region and the Moa-Punta Gorda region, hold the largest nickel reserves of Cuba and its most valuable exporting commodity. The nickel laterites resulting from the Cuban ophiolite is the single largest nickel reserve in the western hemisphere.

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THE EVOLUTION OF GARNET-BEARING PERIDOTITE IN HP COLLISIONAL TERRANES

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Garnet-bearing "orogenic" peridotite lenses are common in several metamorphic terranes characterized by high-temperature eclogite-facies assemblages. They usually occur within high-grade gneisses of continental affiliation (i.e. quartz-rich) and are believed to "intrude" the gneisses when microcontinents, relict arcs or the thinned edges of continents are pulled as slabs deeply (60 - 120 km) into the upper mantle by the previously subducted oceanic lithosphere. This mechanism places a mantle wedge above the crustal slab providing a plausible geometry for introducing pieces of the mantle wedge (the hanging wall) into the underlying crust (the footwall) although the exact mechanism is not well understood. The fragments, now "orogenic peridotites", share their subsequent history with the host slab. If the slab subducts deeper into the mantle the peridotites will form prograde garnet-bearing assemblages that will give the same age and P-T history as the eclogite facies assemblages in the host rocks. If the peridotites already contained garnet when introduced into the slab the assemblages will give a different P-T history and older ages that the eclogites in the host gneiss. Subsequent exhumation towards the surface occurs as the crustal host slab rises buoyantly through the denser mantle carrying the orogenic peridotite bodies as cargo. Peridotites associated with low-temperature eclogite facies assemblages (i.e. blueschist terranes) are usually serpentinites or spinel peridotites, but garnet peridotites have been described from the Sanbagawa Belt of Japan and from the Rio San Juan Complex of Hispaniola. The formation and exhumation of these terranes cannot be explained by the buoyant slab model described above suggesting there is more than one way of exhuming deep level peridotites from the mantle in convergent zones. An important clue may be the relative crystallization ages of the eclogites versus the garnet peridotites.

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LATE CRETACEOUS-MIOCENE TECTONIC DEVELOPMENT OF THE SW-MARGIN OF THE CARIBBEAN PLATE (COSTA RICA, PANAMA)

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The outer margin of the southern Central American Isthmus is composed of an uplifted arrangement of late Cretaceous - Miocene arc, arc basement and accretionary complexes. In southern Costa Rica and western Panama, we studied an area of the forearc extending ~450 km along strike. A new tectono-stratigraphy of the area was defined on the basis of: (1) mapping, at 1:5'000 to 1:50'000 scales, (2) microscope observations of >700 samples of sedimentary and igneous rocks, (3) remote and field structural analyses, (4) paleontological dating and (5) geochemical study of the igneous rocks.

The initiation of the subduction of the Farallon Plate under the western edge of the Caribbean Large

Igneous Province (CLIP) took place in the Campanian (~80-83 Ma). Proto-arc igneous rocks with atypical geochemical characteristics are found all over the studied area. After the initiation of the subduction, a volcanic front rapidly developed with compositions typical of intra-oceanic arcs. During the Tertiary, the arc front migrated progressively inland in response to subduction-erosion and slab flattening. Seamounts driven into the subduction zone were accreted and/or subducted and possibly played a role in the arc evolution.

In uplifted accretionary complexes, several pieces of accreted seamounts with consistent stratigraphy and geochemistry were recognized and mapped. Our observations indicate that seamounts are variously preserved during accretionary processes, mainly as a function of their initial morphology and setting on the subducting plate. Age changes within the accretionary complexes correlate with variations of the geochemistry of the igneous rocks and structural arrangements. On the basis of these observations, we provide new constraints on the development of accretionary prisms through time and on the evolution of the east Pacific plate(s) between the late Cretaceous and Eocene.

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PRESENT-DAY STRAIN AND STRESS DISTRIBUTION IN THE NORTHEASTERN CARIBBEAN

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The northeastern Caribbean region accommodates ~20 mm/yr of oblique convergence between the North American and Caribbean plates, distributed between the subduction interface and major strike-slip faults within the overriding plate. As a result, this heavily populated region has experienced eleven large (M>7.0) earthquakes over the past 250 years. This study is an effort to improve our understanding of the location and timing of these earthquakes, with an eye to understanding where current seismic hazards may be greatest.

In a first step, we use GPS and earthquake data to produce a present-day kinematic model that accounts for secular block rotation and elastic strain accumulation -- with partial coupling – on active faults. The model indicates full coupling along the Caribbean-North America subduction along the northern Hispaniola margin but only partial coupling further east along the Puerto Rico/Lesser Antilles subduction. In a second step, we use interseismic stress loading from the kinematic model, together with stress changes due to historical earthquakes, to derive the recent stress evolution in the NE Caribbean.

Slip rate deficit from the kinematic model, together with the dates of large historical earthquakes, indicate the potential for a large (Mw>7.5) earthquake on the Septentrional fault in the Dominican Republic, where the greatest net build-up of Coulomb stress changes occurred over the past 250 years. Similarly, the Enriquillo fault in Haiti is currently capable of a Mw7.2 earthquake if the entire elastic strain accumulated since the last major earthquake was released in a single event today. For oblique thrust faults, net stress build-up over the past 250 years is largest on the North American/Caribbean megathrust west of 70.5W. High Coulomb stress has also developed east of 65.5W, where no historic events have been inferred to relieve stress.

Calzadilla R., Maria

MAPAS DE AMENAZAS Y VULNERABILIDAD ANTE INUNDACIONES Y DESLIZAMIENTOS

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Ante la situación crítica que el país acaba de atravesar recientemente con el paso de las tormentas Noel y Olga, y tomando en consideración el volumen de información que se ha obtenido producto de los trabajos de mapeos realizados por el Proyecto Cartografía Geológica y Geotemática de la RD, hemos emprendido la tarea de elaborar los Mapas de Amenazas Geológicas por provincias.

Con la ayuda de estos mapas se pretende habilitar una herramienta de trabajo que será de suma utilidad para establecer las áreas vulnerables a determinados desastres con especial énfasis en las inundaciones y los deslizamientos, que han sido unos de los eventos de mayor incidencia en los últimos tiempos para la región.

De los productos generados por el proyecto contamos con los Mapas de Procesos Activos Geológicos, los cuales constituyen la fuente fundamental para la obtención de las áreas amenazadas. Como ejemplo práctico traemos el Mapa de Amenazas por Inundación y Deslizamientos de la provincia Bahoruco, donde se muestra la afectación que sufre la misma por dichos eventos, cabe señalar que con la ayuda de estos mapas establecimos las áreas vulnerables y definimos los umbrales de riesgo para esta región.

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LAS UNIDADES GEÓLOGO-AMBIENTALES UNA NUEVA HERRAMIENTA PARA LA FORMULACIÓN DE ESTRATEGIAS DE PLANIFICACIÓN FÍSICA Y DE GESTIÓN AMBIENTAL EN LAS PROVINCIAS HABANERAS, CUBA

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La planificación física y ambiental, de carácter preventivo, constituye una de las principales vías para la solución de los problemas ambientales y en este sentido el conocimiento del componente geológico del medio ambiente resulta imprescindible, por su función como soporte de las actividades humanas, por constituir una de las principales fuentes de recursos y por su papel en los procesos de la dinámica de la superficie terrestre, que tienen relación con el desencadenamiento de determinados peligros naturales.

Por esta razón, el desarrollo de esquemas metodológicos que permitan, el análisis, representación y evaluación de los factores geológicos en relación con los problemas ambientales relacionados con los mismos, debido a causas naturales o inducidos por las actividades del hombre, constituye sin lugar a dudas, un elemento a tener en cuenta en la gestión ambiental territorial.

En el trabajo se presenta un esquema regional a escala 1:100 000 de zonación de los rasgos geólogo ambientales de las provincias habaneras, con el objetivo de contribuir a perfeccionar la gestión ambiental de las misma, posibilitando la incorporación de los aspectos más relevantes del componente geológico al análisis de los problemas ambientales del territorio y en especial al análisis de los peligros vinculados a este componente. Atendiendo a las características del sustrato geológico, los rasgos geomorfológicos y el carácter de los procesos geólogo-geomorfológicos, se proponen tres niveles de unidades geólogo- ambientales homogéneas: ambiente geológico, zona geólogo ambiental y complejo geólogo ambiental, describiéndose en cada caso los problemas geólogo- ambientales presentes y las formas en que se debe orientar, la planificación física y la gestión de los problemas ambientales existentes, en los distintos municipios del territorio habanero.

En el trabajo se concluye que las unidades geólogo-ambientales dan una medida de la diversidad geólogo-ambiental de cada territorio, siendo por tanto necesario adecuar las estrategias ambientales territoriales a las características del componente geológico del medio físico, lo cual tiene una gran importancia desde el punto de vista práctico y económico.

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CARIBENORTE PROJECT: FUTURE COMBINED ONSHORE-OFFSHORE SURVEY IN THE NORTH-EASTERN CARIBBEAN PLATE

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Despite high number of studies carried out in the north-eastern Caribbean plate, there is not still a geodynamic model which can explain and integrate such diversity of involved tectonic settings. In 2003 we though this fact was a consequence of: most surveys were focused in the north of the island arc, absence of wide-angle refraction/reflection seismic profiling and absence of systematic surveying (gravity, geomagnetics and multibeam bathymetry).

These facts leaded us to realize the GEOPRICO-DO project, finished in 2006 which has produced interesting results, and has opened us the way for a new and more ambitious project: CARIBENORTE.

The survey planning includes: the systematic acquisition of multibeam bathymetry and potential fields (gravity and geomagnetics) covering an area of 50 000 km2, to the south of Dominican Republic and

Mona Passage; two deep-refraction seismic profiles north-south trending across the Hispaniola (with 550 km-length each one) and one more across Beata Ridge (based on signal reception on sea (OBSs) and on 150 land seismometers); and multichannel reflection profiles in the Beata Ridge zone. The acoustic signal will be yielded by the R/V Hespérides and by drill-hole explosions onshore.

The CARIBENORTE project is directed by the Universidad Complutense de Madrid. Collaborating institutions: Real Observatorio de la Armada Española and Instituto Español de Oceanografía. Invited institutions: Universidad Autónoma de Santo Domingo-Instituto Sismológico Universitario; Dirección General de Minería; Marina de Guerra de la República Dominicana; U. S. Geological Survey; and Puerto Rico Seismic Network.

Cardona, Agustín [1]; Fernando, Duque José [2]; Ruiz, Joaquín [3]; Valencia, Victor [3]; Bayona, Germán [4]; Jaramillo, Carlos [5]; Ojeda, Germán [6]; and Orozco, Maria Teresa [7]

GEOCHRONOLOGY AND TECTONIC IMPLICATIONS OF GRANITOIDS ROCKS FROM THE NORTHWESTERN SIERRA NEVADA DE SANTA MARTA AND SURROUNDING BASINS, NORTHEASTERN COLOMBIA: LATE CRETACEOUS TO PALEOGENE CONVERGENCE, ACCRETION AND SUBDUCTION INTERACTIONS BETWEEN THE CARIBBEAN AND SOUTH AMERICAN PLATES

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The timing, structural relations and compositional features of granitoid rocks provide major insights on the tectonic setting and deformational stage of an orogen. Moreover their relations with host rocks allows to temporally constrain accretionary events. Field relations, U/Pb LAM-ICP-MS zircon geochronology, and reconaissance geochemistry from 18 granitoids units at the northwestern segment of Sierra Nevada de Santa Marta (SNSM) and adjacent Baja Guajira basin (BGB) were obtained in order to gain insights on the tectonic evolution of the South American continental margin and its interaction with the Caribbean plate. The oldest unit is an amphibolite facies arc related othogneiss with crystallyzation ages of 92.0 ± 1.7 Ma, that intrudes metamorphosed volcano-sedimentary rocks. An undeformed granodiorite with adakite like signatures from the BGB that also intrude Cretaceous? amphibolites yields a crystallization age of 70.3 ± 1.3 Ma. The must widespread magmatism in the northwestern SNSM includes a series of tonalite to granodiorite granitoids with minor two mica granites and dykes with continental arc signatures that cross-cut metamorphosed Cretaceous rocks link to the Caribbean intra-oceanic domains, as well as Late Paleozoic and Precambrian metamorphic rocks which are characteristic of northwestern South American. Their magmatic emplacement age extends between 65 Ma and 50 Ma, and include inherited zircons of the different host domains. This successive

tectonomagmatic events record major tectonic stages: (1) the growth of an intra-oceanic arc in proximity to the continental margin wich may have continue until ~76 Ma when it was apparently metamorphosed, as seen from detrital zircons in metavolcano-sedimentary rocks, (2) an ~70 Ma post-collisional event that follow crustal thickening due to accretion, and (3) the sealing of the accretionary events and the subduction of the Caribbean plate, that formed an active Paleogene continental margin with rapid magmatic growth probably triggered by subduction initiation and North America-South America convergence.

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LATE CRETACEOUS CARIBBEAN-SOUTH AMERICA INTERACTIONS: INSIGHTS FROM THE METAMORPHIC RECORD OF THE NW SIERRA NEVADA DE SANTA MARTA, COLOMBIA

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Segmented metamorphic complexes along the northern South American margin are major vestiges of the Cretaceous to Paleogene subduction and accretionary dynamics that controlled the tectonic evolution of the Circum-Caribbean. The NW segment of the Sierra Nevada de Santa Marta in northern Colombia is made of several metamorphic units disrupted by undeformed Paleogene granitoids, which temporally restricted their growth. The southeastern segment includes mylonitized granitoids with U/Pb crystallization ages of ca. 280 Ma, that are juxtaposed against an intercalation of metasediments and chlorite-actinolite schists with upper crust geochemical composition. Structural relations, deformation mechanism in the mylonites and the prograde metamorphism of the schists indicates that both units share a similar deformation history. The southcentral unit is made of orthogneisses and associated amphibolites and pelitic schist, with the sedimentary protoliths related to a major Pre-Cretaceous continental source (U/Pb detrital zircons). An orthogneiss yields U/Pb Turonian protolith ages, whereas the entire unit displays amphibolite facies metamorphism. Towards the coast is exposed a stack of volcanic-sedimentary rocks formed in an intra-oceanic to back arc setting after 83 Ma, also feed by an older continent. A discontinous metamorphic field gradient reaveals the existence of major thrusting juxtaposing pyroxene amphibolite rocks (preliminary P-T calculations suggest peak conditions of 620° C and 7 Kb) against transitional greenschist-amphibolite rocks.

These metamorphic complexes formed during the collision of the Caribbean arc with the South American margin. However they represent different colliding elements: (1) the South Ameican continent trap (margin?) within the deformational wedge, (2) a Turonian and older basement arc, and (3) the Upper Cretaceous active arc and back-arc basin. The local high temperature attained and the

persistence of medium pressure metamorphism within this accretionary seting is related to the effect of the relict arc-back arc geotherm. However, an additional potential heat source which may have influenced the thermal evolution of the accretionary wedge is the radiogenic heat provided by the felsic upper crust.

Castillo Burgos, Jorge Enrique

CUBA SUS RECURSOS MINERALES Y TERMALES (AGUAS MINERALES Y FANGOS MEDICINALES O PELOIDES)

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En el año Internacional del Planeta Tierra, muchas regiones están ávidas de Agua y Productos Naturales de Calidad, Cuba sin embargo es una verdadera potencia de recursos minerales termales, a saber, Aguas Minerales (Naturales y Medicinales) y Fangos Medicinales o Peloides, al disponer de más de 60 yacimientos de estos recursos, en diferentes grados de evaluación y certificación, de ellos más de 20 en explotación.

En nuestro País dichos recursos están tutelados por las legislaciones mineras y sanitarias y se rigen por las Normas Cubanas (según Codex-OMS). Las Aguas Medicinales y los Peloides forman parte del Sistema Nacional de Salud, aplicándose en Estaciones Termales y diferentes Unidades de Salud, en diversas patologías, así como en la industria farmacéutica y cosmética.

Los Peloides se originan en depósitos hídricos. Nuestros principales yacimientos están asociados a Salinas de Evaporación Solar.

El presente trabajo es el resultado de la sistematización, generalización y experiencia de más de 20 años, de investigación y desarrollo de estos recursos.

Se presenta ficha georeferenciada sobre los principales yacimientos de Aguas Minerales Naturales y Medicinales y Peloides de Cuba, con su calidad y potencialidad de Aprovechamiento para los fangos medicinales. Se explica la generalización de los resultados obtenidos en las investigaciones geológicas realizadas a estos yacimientos. La analogía o correlación de estos recursos desde el punto de vista químico- físico, y bacteriológico y de su uso real o potencial.

Se muestran las premisas de búsqueda de estos yacimientos dentro de un complejo salinero, en función de las densidades de las salmueras, válido para salinas tropicales.

Se exponen además nuestras experiencias en las Gestión de estos tan vulnerables recursos, en particular, en su Explotación y Protección. Con un caso Tipo.

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LITHOSPHERIC MAGNETIC FIELD MAPPING OF THE CARIBBEAN REGION

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Although several studies has been performed, and broad bibliography exist of north and south Puerto Rico and Dominican Republic area, there is a lack of magnetic information/studies at this geographical frame, mainly in the south: at the Caribbean plate. We have tried to fill this gap by using several sources of information: marine and terrestrial data.

Marine magnetic information comes from past cruises (1962-2002) downloaded from the National Geophysical Data Center (NGDC). Other are from GEOPRICO-DO geophysical campaign (March-April 2005), while terrestrial information comes from the Dominican Republic magnetic flight. The latter was performed in two phases: the first one in 1996 and the second in 1999.

All this information has been treated in order to make an homogeneous data set from it. A key step was the use of the Comprehensive Model 4 (CM4) in order to extract the core field component. It allows an estimation of the magnetospheric and ionospheric contribution, too. This model shows great improvement over its predecessors in terms of completeness of sources and noise reduction in the lithospheric field, as a result of improved data selection that includes not only POGO and Magsat satellite data, but also from Oersted and Champ satellites and Observatory network data.

The magnetic anomaly map obtained, shows not only the general character of the magnetic field pattern in the region, but depicts well-known geological and structural features too, as the Bahamas platform domain, Puerto Rico trench and Mona Block, providing a neither still shown nor discussed magnetic anomaly status southward, particularly a magnetic picture of the north Caribbean plate, where we could discerned isolated anomalies: north-south and east-west linear like anomalies.

In this work we present the map, and perform a description of its major magnetic features that could serve as background information for more detailed geological and geophysical studies.

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CONTINUOUS GEOTHEMATIC MAPPING IN THE EASTERN CORDILLERA OF THE DOMINICAN REPUBLIC

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The impact of the GIS (Geographic Information Systems) technology in the management and analysis of the geologic information is an obvious fact. The methods of data acquisition, procedures for storage and analysis of information and technics of map production has been significantly affected. However, even has not been reached to build the full development potential offered by this technology. There are several issues that have not been turned yet: the continuity of mapping beyond the sheet remains unit

capture and editing, and integrating information to be linked dispersed thematic databases or documentation in different formats are two key points unresolved.

Since 1997, several projects are being developed on Geothematic Mapping under the SYSMIN I and II of the European Union. As a result of these projects is getting at 1:50.000 Geological mapping and Geomorphological, Morphodynamic Phenomena, Mineral Resources and Geotechnicals 1:100.000 scale maps. In order to enhance the use of the geological and thematic information, a continuous geological digital map consisting of 10 sheets at 1:50.000 for the Eastern Range has been generated including the information collected during the development of the cartography. This digital map is supported on a complex data model which includes a complete geoscientific language.

At Units Cartographic given a significant number of properties, so that from a single file space objects can be obtained multiple views, and the consistency in the analysis space is guaranteed. The integration of the samples, with all the associated information that lead, allowing on the one hand, the selection of Cartographic units depending on analytical values of the samples, and on the other, the visualization of photographs and other documentation related with the Cartographic units.

Chicangana, Germán [1,2]; Kammer, Andreas [2] and Vargas-Jiménez, Carlos Alberto [2]

DEL MISMO EVENTO DE LA SUPERPLUMA CRETÁCICA: PLACA CARIBE Y LA MESETA DE ONTONG JAVA?, UNA ALTERNATIVA PARA EL ENTENDIMIENTO DE LA EVOLUCIÓN GEOTECTÓNICA DE LOS ANDES DEL NORTE DESDE EL CRETÁCEO HASTA HOY

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Con la revisión de información previa sobre geofísica, geoquímica y datos paleomagnéticos para sus cortezas como sobre el origen de la pluma que las creo, se sugiere aquí que tanto la Meseta de Ontong Java – MOJ, como la Placa Caribe, se originaron en un solo lugar y conformaron una provincia ígnea única durante el Cretáceo Inferior. Se asegura esto porque ambas presentan un grosor cortical anómalamente grueso, y surgen de un primer episodio de volcanismo excesivo con edad Aptiana de carácter toleiítico bajo en K, y además en ambas mesetas oceánicas se presenta un segundo episodio de pluma para el Turoniano. Estos eventos de plumas se origino de una gran superpluma que se presento durante el transcurso del Cretaceo Inferior en la cuenca del Océano Pacifico, y que esta ampliamente registrado en la literatura. Aquí se establece que el primer episodio se relaciona con la aparición de la cabeza de esta, y el segundo con su cola. Para el segundo episodio se destaca un volcanismo ultrabásico con alta temperatura, que para el Fanerozoico únicamente en el mundo se presenta solo en estas dos grandes provincias ígneas. De acuerdo a datos paleomagnéticos asociados a la corteza de la Placa Caribe, junto con la información geotectónica del margen noroccidental de Suramérica, se postula aquí que la Placa Caribe colisiono a finales del Cretaceo Superior con el margen noroccidental de Suramérica, dando lugar con ello al origen del contexto geotectónico de los Andes del Norte tal y como se conocen hoy en día.

Chicangana, Germán [1,2]; Kammer, Andreas [2] and Vargas-Jiménez, Carlos Alberto [2]

ACERCA DE LA HISTORIA DEL PROTO - CARIBE Y DE LA CONFIRMACION DEL MODELO ALOCTONO PARA EL ORIGEN DE LA PLACA CARIBE

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Para la región en donde hoy se emplaza la Placa Caribe, se observa que previo a la aparición de esta en el Cretáceo Superior, existía en dicho espacio otra corteza oceánica, la cual era el resultado de la expansión del rift Triásico – Jurásico que separó a Norte de Suramérica o, a Laurentia de Gondwana. Esta corteza era el Proto – Caribe. La presencia de esta corteza se ha verificado a partir de reconocimiento geológico y geoquímico de sus fragmentos en los márgenes de la Cuenca Caribe tanto al sur de la plataforma norteamericana en las Grandes Antillas, como en Centro América, y en el norte de Suramérica en Venezuela. Para inicios del Cretáceo Inferior tanto en el margen occidental suramericano, como en las Grandes Antillas y Centro América, se presentaron arcos volcánicos. Lo anterior hace estimar que la corteza Proto - Caribe era más liviana y presentaba mayor flotabilidad que la placa Farallon para esa época, la cual era más antigua y presentaba una boyancia negativa, por lo que por consiguiente subducía bajo la primera. Con la llegada de la Placa Caribe a finales del Cretaceo, este marco geotectónico cambia para dicho sector del planeta, y cesa la subducción bajo el Proto - Caribe, ya que este es fragmentado y destruido por la colisión de esta ultima con el sur de Norteamérica o Chortis, y el norte de Suramérica. El ajuste de la Placa Caribe produjo saltos en la subducción originando arcos volcánicos tanto en su margen occidental en Costa Rica y Panamá, como oriental en la Dorsal de Aves. En este trabajo se trata de reconstruir esta historia geodinámica a partir de la revisión de información geofísica y geológica previa.

Cobas Botey, Rosa María

CARACTERIZACIÓN GEOLÓGICA DE LAS LATERITAS DESARROLLADAS EN DIFERENTES REGIONES METALOGENICAS

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Por primera vez se acomete el estudio científico comparativo de las lateritas desarrolladas en las regiones metalogénicas exógenas de Cuba Oriental y Central con el objetivo de revelar las regularidades espacio-temporales de su origen y evolución, sus características geólogo-estructurales, geomorfológicas, composición sustancial, etc.

Con este conocimiento geológico será posible planificar y organizar de forma optimizada los estudios de exploración, facilitar la proyección de las investigaciones tecnológicas y de explotación minera.

Las diferencias en la evolución morfoestructural entre las regiones metalogénicas exógenas de Oriente Norte y Camagüey Central han condicionado el desarrollo espacio-temporal diferenciado de las cortezas de intemperismo niquelíferas que existen en ambos territorios.(Formell Cortina, 2002)

Mientras que en el bloque morfoestructural de Oriente septentrional los movimientos recientes de la corteza terrestre se han caracterizado por fuertes levantamientos que comenzaron en el Plioceno y continúan en nuestros días, en el bloque morfoestructural de Camagüey central esos movimientos han sido mucho mas débiles, dando lugar a una mayor estabilidad de la región y por tanto al desarrollo de un relieve mucho mas maduro y mucho mas antiguo que en Oriente septentrional. Esto ha traído por consecuencia que mientras que en la región metalogénica de Oriente Norte las cortezas en general se caractericen por perfiles abreviados de la formación menífera goethito ferro-cobalto-niquelífera y potencias moderadas (a excepción de las áreas con ocurrencia de dislocaciones disyuntivas, o relieves ondulados con presencia frecuente de contrapendientes), en Camagüey por el contrario las cortezas presentan perfiles completos, a veces complejos de la formación menífera nontronito-niquelífera con grandes potencias de sus perfiles.

Por otra parte, mientras que en Oriente la transferencia de las aguas es generalmente intensa o de intensidad media, en Camagüey la transferencia de aguas es generalmente lenta marcando esto otra importante diferencia entre ambas regiones metalogénicas en cuanto a la presencia de sílice libre en el perfil de las cortezas.

En los perfiles de las cortezas orientales prácticamente no hay presencia de sílice libre, mientras que en Camagüey, los perfiles se caracterizan por abundante sílice libre en forma de ópalos, calcedonias y marshalita presentes en prácticamente todos los horizontes de la corteza de intemperismo.

ABSTRACT

Comparative scientific study of nickel bearing laterites developed in exogen metallogenic regions of central and eastern Cuba has been for first time undertaken. Main objective is to reveal space-temporal regularities of their origin and evolution, their geological-structural characteristics, geomorphology, mineral composition etc.

Using the obtained geological knowledge will be possible to plan and organize future exploration works and project tecnological and mining researches

Differences in morphostructural evolution between northern Oriente and central Camaguey metallogenical regions have conditionated differentiated space-temporal development of nickel bearing weathering crusts existing in those regions.(Formell Cortina, 2002)

While in northern Oriente morphostructural block recent movements of earth crust have been characterized by strong uprisings starting in Pliocene and continuing up to date, in central Camaguey morphostructural block those movements have been much more weaks, giving rise to a more stability of the region and therefore to the existence of a much more older and mature relief of that of northern Oriente.

Consequently while in northern Oriente metallogenical regions in general profiles of nickel bearing weathering crusts are abbreviated of the goethite-iron-cobalt-nickeliferous meniferous formation(oxide ores) with moderated thicknesses(with the exception of areas of hilly landscape and presence of faults), in Camaguey on the contrary profiles are usually complete, sometimes complexes of the nontronite-nickeliferous meniferous formation(silicate ores) and with great thicknesses of the weathering crust.
Otherwise, while in Oriente water transference is usually intense or medium intense, in Camaguey, water transference is generally slow giving rise to another important difference related to the presence

of free silica in the profile of the weathering crust.

While in northern Oriente weathering crust profiles, free silica is generally absent, in Camaguey is common the presence of free silica as opals, chalcedonies and marshalite in practically all the horizons of the profile.

Colegial Gutiérrez, Juan Diego

MULTICRITERIA EVALUATION APPLIED FOR THE MINING AND ENVIRONMENTAL PLANNING OF NATURAL AGGREGATES IN JARAMA RIVER BASIN (MADRID, SPAIN)

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Development in more important urban centres demand building materials such a natural aggregates in great volumes and quantities, this materials have low value added; consequently, the aggregates mining is developing preferably in peripherals zones around urban centres with different scales of development and exploitation, competing with others land´s potentials. This condition is a typical quality in very important urban centres anywhere in the world.

The theme has been studied in diverse procedure such a simple allocation of minerals deposits or preparations of models about of insert the extractive activities by the light of the resource planning or land use planning. However, the question has certain insufficiency in explain models where the articulate the multi – criteria evaluation techniques with land use planning, and other side the structuring of the multi – criteria spatial decision support system focused to scarcity development.

This work has establishing several skills over mining and environmental planning of natural aggregates based on investigate the Jarama River Basin (Middle and low part) around Madrid, Spain:

Improvement of a model quantitative for the distributed allocation of extractive activities over natural aggregates deposits in the Jarama River Basin, taking into account impact and aptitude factors.

Foundations for structuring a prototype multi – criteria spatial decision support applied in a test region and evaluating its utility.

Obtain cartography for planning and decision making about of extractive activities of natural aggregates in GIS environmental applying multi – criteria decision aids techniques, constituting the essential element in the modelling of problems about of extractive activities in the territory.

Collins, Laurel S.

MIOCENE PALEOBIOGEOGRAPHY OF CARIBBEAN VS. EASTERN PACIFIC BENTHIC FORAMINIFERA DURING CLOSURE OF THE CENTRAL AMERICAN SEAWAY

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Benthic foraminiferal and molluscan faunas of the Paleogene to earliest Neogene from the Caribbean and Eastern Pacific have been reported to be quite similar because of a tropical seaway that connected the two oceans at that time. About four million years ago the Central American Seaway closed

completely, and today the two faunas are quite different in composition. This study compares Neogene benthic foraminifera of formations from either side of the Central American isthmus that are from the same time intervals and paleobathymetric zones, to measure changes in faunal composition up through the time of seaway constriction and complete closure. The prediction is that marine assemblages diverged as the Central American sill shallowed to close the seaway, and that deeper dwelling species were affected first.

The direct comparisons of coeval, isobathymetric faunas use Caribbean foraminifera from the Panama Canal and Bocas del Toro, Panama, and Eastern Pacific foraminifera from Ecuador and Darien, far eastern Panama. The Borbón – Manabí region of coastal Ecuador was the furthest south that tropical waters extended in the Eastern Pacific during the Miocene, just north of a stronger influence by the cold Peru Current.

The first results of this study indicate that most Eastern Pacific upper bathyal to inner neritic taxa are also in the Caribbean before the cutoff of the deep-water connection, which began large paleoceanographic changes. After the deep-water cutoff, about 1/3 of latest Miocene, middle neritic Pacific species are shared with the Caribbean. More taxa, formations and paleobathymetries will be added to this study of middle Miocene – late Pliocene biogeographic changes caused by the closure of the Central American Seaway.

Córdoba, D. [1]; Carbó-Gorosabel, A. [2]; Dávila, J. M. [3]; Pazos, A. [3]; ten Brink, U. [4]; Granja Bruña, J.L. [2]; Cotilla, M. [1]; Muñoz-Martín, A. [2] and Llanes, P. [2]

THE GEOPRICO-DO SEISMIC ONSHORE-OFFSHORE PROJECT: DEEP SEISMIC SURVEY IN THE NORTH-EASTERN CARIBBEAN PLATE

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In spring 2005 a deep seismic survey was carried out in the southern part of the Dominican Republic and in the north of the British Virgin Islands with the aim to investigate the deep crustal structure in the North-eastern Caribbean Plate Boundary Zone.

The airgun shots yielded from the Spanish Research Vessel Hespérides were recorded on land (in a set of 25 portable land seismometers deployed along 3 lines running across the Dominican Republic and in 8 seismometers at Tórtola and Anegada Islands) and offshore (in 9 OBS deployed in the north-eastern Puerto Rico Island and in a 2.4-km 96-channel streamer along 4 multichannel reflection profiles overlying the refraction profiles).

After seismic record processing, using ray tracing inversion methods, and preliminary interpretations, the experiment has revealed details on the p-wave velocities distribution. In the north of the Virgin Islands the subducting North-American slab dips about 10º and the Moho is located about 30 km below the Anegada Island. In the south of Dominican Republic, the crustal structure shows clear velocity variations as from the East to the West as in depth. Here, the Venezuelan Basin crust underthrusts beneath the Hispaniola Island at least 80 km northwards from the Muertos Trough with a dip of 22º and

the Moho is located about 40 km-depth. Westwards, at the intersection of the northeastwards trending Beata Ridge with the east-west trending island arc, seismic data reveal a more complex crust where underthrusting Venezuelan Basin crust slab is hardly identified.

Corredor, Freddy

DEEP-WATER SOUTHERN CARIBBEAN FOLD AND THRUST BELT MODELED AS A CRITICAL TAPER WEDGE, IMPLICATIONS FOR THE OFFSHORE OIL AND GAS EXPLORATION IN ACCRETIONARY PRISMS

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The Southern Caribbean accretionary prism offshore northern Colombia results from the collision of the Caribbean and South American plates, and has a regional detachment that dips down towards the continent, while imbricate thrust faulting builds a bathymetric slope that dips away from the shelf, defining an internally deforming wedge. The leading edge of this fold and thrust belt is formed by shear fault-related wedges, that growth by both limb rotation and kink-band migration, which is recorded by the patterns of growth sedimentation. These frontal wedges also record changes in the strength of the basal detachments within the accretionay prism. Critical-taper wedge mechanics theory is used to show that the Southern Caribbean thrust system deforms above a weak basal detachment induced by high pore-fluid pressures. The Southern Caribbean accretionary wedge exhibits similar rock properties but an anomalously low taper (sum of the bathymetric slope and dip of the basal detachment) compared with other orogenic fold belts. This low taper implies that the Southern Caribbean accretionary wedge has a weak basal detachment, which is interpreted to reflect elevated pore-fluid pressures within a prodelta marine shale sequence that contains the basal detachment horizon. The weak basal detachment zone has a significant influence on the structural styles in the fold belts of the Southern Caribbean and thus the exploratory efforts in the region. The overpressured and, thereby, weak shales deform as a ductile material within the cores of anticlines and in the hanging walls of frontal structures, leading to the development of shear fault-bend folds and wedges and detachment anticlines that form the main structural trap types in this region.

Coutou, Richard and Mitchell, Simon F.

STRATIGRAPHY AND THE HYDROCARBON POTENTIAL OF THE YELLOW LIMESTONE GROUP AT BROOMWELL, JAMAICA, AS A MODEL FOR THE WALTON BASIN

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The Yellow Limestone Group, is extensively exposed around the margins of Central Inlier. It underlies the rocks of the White Limestone Group and overlies Cretaceous-Paleocene volcanics. This Middle Eocene succession comprises the Stettin, Guys Hill and Chapelton Formations. Broomwell lies on the southern flank of the inlier, and the various lithologies in the group are picked out by geomorphological changes in the landscape. Individual isolated sections have been correlated using their geomorphological expression to develop a composite stratigraphy of the area. The Stettin Formation is represented by a few metres of impure limestones, frequently with sirenian remains, whereas the

Chapelton Formation consists of some 60 meters of impure limestone with abundant stick corals. The 350 meter thick Guys Hill Formation can be divided into (limestone-)mudstone-sandstone cycles that are reflected in the geomorphology. The formation contains levels of early-diagenetic concretions, abundant well-preserved mangrove-leaf impressions, and layers with a low-diversity, high-abundance fauna of small molluscs. It is, however, unlike the Stettin and Chapleton Formations, of particular interest as it contains both potential hydrocarbon source rocks and reservoir rocks, and a prominent horizon of organic-rich shales in the lower part of the formation has high total organic carbon contents (up to 7%) and is strongly sulphurous. These shales are interpreted to have formed in restricted bays surrounded by mangrove stands. The sandstones include thick units of sandstone with small-scale dune cross bedding and layers with heterolithic (mud-sand) laminations. The Guys Hill Succession is interpreted as a tidally influenced delta deposit with the sandstones representing tidally influenced distributary channels, and the mudstones, inter-distributary bay environments. Similar facies are present in Content Well #1 to the southwest and suggest the Guys Hill Formation is thickening moving towards the Walton Basin. If similar facies are present in the Walton Basin they will have significant hydrocarbon potential.

Cuevas, David N. [1]; Sherman, Clark E. [1]; Ramírez-Martínez, Wilson R. [2] and Hubbard, Dennis K. [3]

THE MID-HOLOCENE CAÑADA HONDA FOSSIL REEF OF THE ENRIQUILLO BASIN, SOUTHWESTERN DOMINICAN REPUBLIC: EVIDENCE FOR CORAL GROWTH AND REEF ACCRETION AT GREAT DEPTH AND HIGH SILTATION PRIOR TO ANTHROPOGENIC DISTURBANCE

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The Mid-Holocene Cañada Honda (CH) fossil reef, located in southwestern Dominican Republic, provides a unique opportunity to examine a well-preserved fossil coral reef that thrived in a high-sedimentation environment prior to any anthropogenic disturbance. Growth rates of fossil Montastraea faveolata and Siderastrea siderea were determined in order to make comparisons with growth rate data of these same species from modern coral reefs. Also, assessments of coral species abundance and distribution, morphology, age, as well as reef sediment composition were completed in order to determine the paleoenvironment of reef accretion.

The CH reef is characterized by the high abundance of sediment-tolerant coral species and their tendency to form almost monospecific stands. Individual colonies have a propensity to grow as encrusting, dome-shaped, platy-like forms and colonies of Montastraea faveolata commonly contain bands of sediment incorporated within their skeletons. Calibrated radiocarbon ages of fossil corals range from 9,256±137 to 6,737±94.5 BP. Correlation of radiocarbon ages with well-established Holocene sea-level curves indicates that most corals on this reef developed at depths greater than 15m. Growth rates in CH varied from 0.09-0.44 cm/yr and are relatively low compared with growth rates from modern reef sites, suggesting reduced light penetration caused by coral growth at great depths and conditions of high turbidity. Reef sediment is characterized by more than 85% carbonate material. A

significant portion of the carbonate is allochtonous and was derived from nearby Neogene limestones.

Our investigations indicate that the CH reef persisted for at least 3,000 years and corals were able to survive conditions at depths greater than 15m in combination with high siltation because of the high carbonate content of incoming terrigenous sediment that would have allowed better light penetration and that storms probably occurred sporadically providing intervening low-sedimentation periods during which reef corals could respond and grow back, "keeping-up" with sedimentation.

D'Aguilar, Georgette Felicia

THE LARGER FORAMINIFERAL GENUS *CUSHMANIA SILVESTRI* IN EOCENE ROCKS, JAMAICA

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This study investigates morphological variations among populations of the conical foraminifer *Cushmania Silvestri* from four Eocene localities of Jamaica, using samples from type localities of Haiti and St. Bartholomew as a reference. Variations are interpreted to determine the possible presence of distinct species and to observe any relations to biostratigraphic and environmental factors.

Cone parameters were measured and statistical methods applied. Biostratigraphic analysis involved plotting relative stratigraphic positions of samples against mean cone parameters. Palaeoecological analysis was conducted by noting the presence or absence of seventeen (17) foraminiferal genera in 372 samples, including well core samples.

Statistical analysis revealed two populations in the Haiti sample, *Cushmania puilboreauensis* (megalospheric), and a population broadly similar to *Cushmania codon*, Woodring, 1924. *C. codon* is proposed as a distinct species. The Saint Bartholomew population defined by *C. americana*, was proposed as distinct from the other populations studied. Variations were observed between the Beckford Kraal population and that of Chapelton and Rio Sambre. The variation for Beckford Kraal was mainly interpreted as resulting from the dominance of specimens assigned to the group *C. codon*. There is an apparent age difference for this locality when compared with the Jamaican localities that are dominated by megalospheric *C. puilboreauensis*. No controls of environmental factors were noted for variations of the Beckford Kraal population. However, the Saint Bartholomew population was proposed as occupying an environment distinct from those of all other localities except Rio Sambre.

Three forms are therefore proposed for the Cushmania populations – *C. americana*, *C. puilboreauensis* (megalospheric specimens) and *C. codon*. *C. codon* is proposed as occupying a shallow carbonate shelf slope environment, *C. puilboreauensis* both a carbonate shelf slope environment and an open-marine carbonate slope environment, while *C. americana* is proposed as representing an open-marine carbonate slope environment, all being shallow water.

Daly, G.E. [1]; Smith, A.L. [1]; Roobol, M.J. [2]; and Fryxell, J.E. [1]

GRANDE SOUFRIERE HILLS VOLCANO, DOMINICA, LESSER ANTILLES

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The Grande Soufrire Hills volcano is deeply dissected, but has a distinct circular crater that opens to the east within which is a lava dome. Unconsolidated pyroclastic deposits which mantle the southeast flanks of the volcano are almost entirely block and ash flows and surges suggesting that Pelean-style eruptions, dated between 10,000 to 12,000 years, have dominated its most recent activity. On the southeastern coast at Pointe Mulâtre and extending approximately 4 km north and 2 km west, is a megabreccia of large flow-banded andesite clasts set in a semi-lithified medium-grained ash matrix. At Pointe Mulâtre this megabreccia is overlain by unconsolidated block and ash flow deposits. To the north of the megabreccia, exposures in the sea cliffs reveal a consolidated sequence of well-bedded alternating coarse and fine deposits suggesting deltaic beds, which in turn appear to be overlain by a yellow-colored relatively coarse flow deposit with an irregular upper surface. The uppermost deposits in the sea cliffs are a sequence of block and ash flow deposits and interbedded fluviatile conglomerates equivalent to the younger flow deposits logged inland.

Volcanic rocks from the Grande Soufriere Hills are porphyritic andesites often containing hypabyssal inclusions. Dominant phenocrysts are plagioclase, augite and hypersthene. Geochemically these andesites show trends of decreasing values for Al_2O_3, FeO, MgO, CaO, TiO_2, Sr, V, and Sc and increasing values for Na_2O, K_2O, Ba, Rb, and Zr with increasing silica. Samples from the megabreccia can be chemically distinguished from the younger rocks of this center. Petrologic models suggest that the younger rocks from the Grand Soufriere Hills can be produced by fractional crystallization of basaltic magma such as those erupted from other centers (such as Morne Anglais to the west). Minor variations can be related to upper crustal fractionation of phenocryst phases.

de Chabalier, J.B. [1,3]; Feuillet, N. [2,3]; Fournier, N. [4]; Charade, O. [3]; Nercessian, A. [3]; Bazin, S. [2,3] and Beauducel F. [1,3]

ESTIMATION OF THE SEISMIC COUPLING IN THE LESSER ANTILLES SUBDUCTION ZONE

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The amount and geometry of coupling in the Lesser Antilles is not very well known, owing to the limited data along the plate boundary, and because interplate thrust events are infrequent. The last major earthquake attributed to a thrust event in this area is the M=7.5-8 northern Guadeloupe earthquake that occurred in 1843 and caused very large damages in Point-A-Pitre. We process 4 years of GPS measurements distributed on a 90 km profile perpendicular to the trench, in the Guadeloupe archipelago to quantify the strain accumulation in the subduction interface. A velocity gradient of about 2-3mm/yr of horizontal displacement is accumulated along the E-W profile. A levelling line have been installed in the Guadeloupe in 1950 and remeasured in 1988 by the French Institut Geographique National (IGN). It reveals that the eastern part of the island is uplifted of 8 cm relatively to the western part during the last for decades, consistent with interseismic loading in the thrust interface. We combine these two sets of data to evaluate the geometry and amount of coupling in the subduction interface. The data are consistent with a locked zone that reach 16 to 20 km depth. We extrapolate this result to evaluate the long term deformation in the Guadeloupe archipelago and compare it with the cumulative deformation recorded by the topography and the quaternary deformed marine terraces.

de León, R. Osiris

CONSTRUCCIONES VULNERABLES A SISMOS Y A INUNDACIONES

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La Rep. Dominicana es un país ubicado al borde norte de la placa tectónica del Caribe y en la misma trayectoria seguida por los huracanes de la región tropical del mar Caribe, lo que le expone a un alto riesgo sísmico que ya en el pasado ha generado seis grandes terremotos de magnitud superior a 7 grados en la escala de Richter, y a frecuentes vaguadas, tormentas tropicales y huracanes que generan una alta precipitación pluvial que afecta puentes, carreteras y otras importantes obras civiles.

Las construcciones coloniales del siglo XVI tomaban en consideración el riesgo sísmico y el riesgo de huracanes, motivo por el cual los ingenieros y arquitectos de la época colonial construían edificaciones bajas y de bases fuertes, a fin de poder contrarrestar las fuerzas horizontales generadas por las fuertes sacudidas sísmicas y por los fuertes vientos huracanados, sin embargo, las construcciones de hoy, en su gran mayoría, ignoran nuestra realidad sísmica y meteorológica, y en muchos casos hasta ignoran las condiciones geológicas y geotécnicas de los emplazamientos, lo que hace que en cada vaguada, tormenta tropical o huracán, nuestros puentes colapsen, nuestras carreteras se vean interrumpidas y los servicios básicos descontinuados, y que en caso de sismos, aún los de mediana magnitud como el del 22 de septiembre de 2003, de magnitud 6.5 grados Richter, colapsen importantes edificaciones escolares, viviendas y obras de servicio público, lo que representa una gran preocupación frente a un esperado próximo terremoto de magnitud superior a 7 grados Richter.

ABSTRACT

The Dominican Republic it is a country located to the North edge of the Caribbean tectonic plate and in the same trajectory followed by hurricanes of the tropical region of the Caribbean Sea, which exposes to a high seismic risk that already in the past have generated six great earthquakes of magnitude

superior to 7 degrees in the scale of Richter, and to frequent tropical storms and hurricanes that generate a high rain fall that affects bridges, highways and other important civil works.

The colonial constructions of XVI century took in consideration the seismic risk and the hurricane risk, reason by which the engineers and architects of the colonial time constructed low buildings with strong bases, in order to be able to resist the horizontal forces generated by the seismic shakes and strong hurricane winds, nevertheless, the constructions of today, in their great majority, ignores our seismic and meteorological reality, and in many cases until the geological and geotechnical conditions of the locations are ignored, which does that in each tropical storm or hurricane, our bridges collapse, our highways are interrupted and the basic services be discontinued, and that, in case of earthquakes, still those of medium magnitude like the one of the 22 of September of 2003, of magnitude 6,5 degrees Richter, break down important children school, houses and public services building, which represents a great preoccupation in front of hoped a next earthquake of magnitude superior to 7 degrees Richter.

Draper, G. [1].; Abbott, R.A. [2]; Escuder Viruete, J. [3]; Joyce, J. [4]; Krebs, M. [5]; Maresch, W.V. [5]; Pérez-Estaún, A. [6]; Pindell, J.P. [7] and Schertl, P. [4]

TECTONIC OVERVIEW OF THE LATE CRETACEOUS-PALEOGENE SUBDUCTION ZONE ROCKS OF HISPANIOLA

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Rocks of the Hispaniola subduction zone are found in three separate areas.

The Samaná terrane consists of marbles and lawsonite-bearing mica-schists whose protolith was continental margin sediments. Structurally overlying these is the Punta Balandra (PBZ) zone which contains garnet-blueschist and eclogite blocks/boudins in a calc- and mica-schist matrix. In the PBZ, mica K-Ar ages range 37-40Ma, but glaucophane yields Sm-Nd ages of 78-90 Ma.

The Rio San Juan Complex (RSJC), west of Samana, consists of coherent blueschists inter-leaved with serpentinite and serpentite-matrix mélanges, the latter two of which we interpret to be remnants of Hispaniola's subduction channel. Mélange blocks consist of blueshists, eclogites and jadeitites with ages of 62 Ma to 103 Ma (Ar/Ar, Rb/Sr, Lu/Hf). One block has a protolith age of 139Ma (U/Pb).

The southern terrane of the RSJC consists of mafic gneiss matrix with garnet peridotite pods both of which have experienced UHP conditions of over 30kb. An essentially isothermal P-T exhumation curve suggests rapid uplift, but is unconstrained by geochronology.

In Puerto Plata, conglomerates in the Paleocene Imbert Formation contain clasts of serpentinite and schists indicating exposure of part of Hispaniola's subduction zone by about 60Ma.

We suggest that the SW-dipping Greater Antilles(GA) subduction zone began in Albian times and that the PBZ represents the early subduction channel. The Samana terrane underplated during the Campanian GA-Yucatan collision. The RSJC subduction channel was formed as the GA later moved NE across the Proto-Caribbean. The UHP terrane was partially exhumed during this time processes not completely understood. Rollback the Proto-Caribbean oceanic lithosphere in latest Cretaceous or early Paleogene produced extension in the GA fore-arc, uplifting the PBZ/Samana terranes and other parts of the sub-forearc. By the Eocene, Hispaniola began its highly oblique collision with the Bahama. Further exhumation resulted from erosion associated with compressional uplift and/or by low-angle normal faults generated by the highly oblique collision.

Duarte-Forero, Jairo Alexander [1] y Duque-Caro, Hermann [2]

CORRELACION BIOESTRATIGRAFICA DEL MIOCENO TARDIO AL PLEISTOCENO DE LOS POZOS ODP 999 Y ODP1000 CON EL MARGEN CONTINENTAL COLOMBIANO (POZO BARRANQUILLA-1)

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Se estudiaron los foraminíferos planctónicos para el intervalo Mioceno Tardío (Messiniano) al Pleistoceno, de 28 muestras del pozo ODP 165 1000AB y 24 muestras del pozo ODP 165 999A ubicados en la Cuenca de Colombia delimitándose ocho (8) zonas bioestratigráficas, que de más joven a más antigua son: Zona de *Globorotalia excelsa - Globorotalia tosaensis*, Zona de *Globorotalia tosaensis - Globorotalia excelsa*, Zona de *Globorotalia miocenica - Globorotalia tosaensis*, Zona de *Neogloboquadrina altispira - Globorotalia miocenica*, Zona de *Globorotalia margaritae - Neogloboquadrina altispira*, Zona de *Globorotalia evoluta - Globorotalia margaritae*, Zona de *Globorotalia primitiva - Globorotalia evoluta* y Zona de *Globorotalia humerosa - Globorotalia primitiva*. Estas zonas se han correlacionado con la bioestratigrafía correspondiente del Pozo Barranquilla-1, margen continental colombiano.

Duerto, Leo [1]; Pico, Antonio [2]; Bastos, Paula [1]; Acosta, Natasha [1] and Mendoza, Rocio [1]

TECTONIC HISTORY OF THE ESPINO GRABEN, EASTERN VENEZUELAN BASIN: A NEW PERSPECTIVE

1. PDVSA

2. BEICIP

This paper presents a new model for the structural development of the Espino Graben, located in the Central Venezuela.

Two periods of tectonism are proposed during Palaeozoic times in Central Venezuela. Based in regional seismic correlation and well data it is proposed that above the Guyana Shield was produced a foreland basin from Late Proterozoic/Cambrian to possibly Devonian. This basin, opened to the northeast, was bordered in the northwest by a folded thrust-belt with southeast vergence and NE-SW trend. This first episode of tectonism is dated in Barinas wells: APURE 1, APURE 2, APURE 3, AGL1X, SZW3 and

TIC-1X.

Following this event, a new compressive episode took place at Carboniferous – Permian. During this period a new basin, opened to the northwest, was bordered in the northeast by a folded thrust-belt with southwest vergence and NW-SE trend. The second period of deformation is dated in the Espino area wells: GXB2, GXB8 and MCH-2-3X.

After the Palaeozoic, a semi graben evolved in the northern part of the present day Espino graben during the Lower Jurassic times. This graben had an approximately N50W trend and was bordered by the Guama-Ruiz Saman faults in the north. A new semi-graben evolved in the south part of the area during the Middle Jurassic times with approximately N30E trend. This graben was bordered by the Altamira-Anibal faults in the south. At Late Jurassic is documented by truncations of seismic reflectors a moderated tectonic inversion of the Espino graben and the developing of an arch with NE-SW trend in the northern part of Guarico Area. This arch was prolonged during Early Cretaceous and produced and older sedimentation towards the Serrania del Interior (Barremian) than towards Guarico (Aptian).

The present study has important new implications for the tectonic evolution of the area as well for the exploration of hidrocarbons.

Escuder Viruete, J. [1] y Pérez-Estaún, A. [2]

THE RIO VERDE COMPLEX, CENTRAL HISPANIOLA: A FRAGMENT OF LOWER CRETACEOUS BACK-ARC BASIN OF THE PRIMITIVE CARIBBEAN ISLAND-ARC

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The nature, age and subduction polarity of the oldest and chemically most primitive island-arc in the Caribbean Basin is a key element for the Caribbean plate tectonic model reconstruction during the Lower Cretaceous. Located in the Cordillera Central of Hispaniola, the Río Verde Complex (RVC) is composed of gabbros, dolerites, basalts and minor oceanic sediments, as well as variable foliated metamorphic equivalents, which represent a dismembered fragment of this Caribbean subduction system.

Combined detailed regional chemostratigraphy, geochemistry, Sr-Nd isotopic estudies and Ar-Ar geochronology, show that the mafic rocks of the RVC are compositionally intermediate between mid-oceanic ridge basalts and island-arc tholeiites. Relative to N-MORB, these rocks have Nb-Ta negative anomalies and higher abundances of LILE such as Rb, Ba, K, Pb and Sr. Mafic protoliths have very restricted (ε_{Nd})$_i$ values between +9.69 and +10.37 (where *i*=118 Ma), in the range of N-MORB, which are compatible with a homogeneous source dominated by depleted mantle without incorporation of pelagic sediments. In contrast, ($^{87}Sr/^{86}Sr$)$_i$ ratios are highly variable (0.70295 to 0.70357), which is indicative of seawater hydrothermal alteration. By their transitional N-MORB to IAT geochemistry and weak subduction-related signature (Nb/Th=5-11.5), we interpreted these rocks as tholeiitic back-arc basin basalts.

^{40}Ar-^{39}Ar plateau ages of hornblende in Fe-Ti metagabbros (118.6±1.3 Ma) and amphibolites with a S-L fabric (110.3±1.4 and 110.7±1.6 Ma) are Aptian and Lower Albian, respectively. These cooling ages are interpreted as the crystallization age and the ductile shearing in a oceanic setting of the mafic

protoliths, which was also accompaigned by the syn-kinematic intrusion of dolerite dykes with BABB signature.

The regional presence of boninitic and island-arc tholeitic rocks in the contemporaneous Los Ranchos Formation, suggest that initial sea-floor spreading to form the RVC protoliths occurred in the back-arc setting of a SW-facing primitive island-arc (in present coordinates), built on the NE edge of the Caribbean plate.

Escuder Viruete, J. [1]; Joubert, M. [2]; Pérez-Estaún, A. [3]; Friedman, R. [4]; Ullrich, T. [4]; Weis, D. [4]; Urien, P. [2] y Lopera, E. [1]

LOS BLOQUES TECTÓNICOS DEL DOMINIO CENTRAL DE LA ESPAÑOLA: APORTACIONES BASADAS EN DATOS ESTRUCTURALES, GEOQUÍMICOS Y GEOCRONOLÓGICOS DEL ÁREA DE MANABAO-JARABACOA

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La macroestructura del área de Manabao-Jarabacoa se caracteriza por varias zonas de falla de dirección NNO-SSE a ONO-ESE, que limitan dos bloques tectónicos con una diferente estratigrafía Turoniense-Campaniense y composición geoquímica de las rocas volcánicas constituyentes.

El bloque de Jicomé está limitado al N por las zonas de cizalla de La Meseta o de Bonao-La Guácara, y está compuesto por varias unidades volcánicas englobadas en el Grupo Tireo. La Formación Constanza constituye una serie toleítica de arco-isla Albiense-Turoniense; la Formación Restauración posee una asociación de adakitas, andesitas magnesianas y basaltos ricos en Nb, así como un volcanismo dacítico/riolítico calco-alcalino, acumulada desde el límite Turoniense-Coniacense (~89 Ma) hasta el Campaniense Inferior. La Formación Peña Blanca está compuesta por toleitas ligeramente enriquecidas en LREE y la Formación Pelona-Pico Duarte por basaltos transicionales y alcalinos fuertemente enriquecidos en LREE. Estos basaltos han proporcionado una edad 40Ar-39Ar de 68.4±0.7 Ma (Campaniense Superior-Maastrichtiense).

El bloque de Jarabacoa está limitado al N por la zona de falla de La Española. Comprende el conjunto volcano-plutónico de Loma La Monja, que representa un fragmento de corteza oceánica proto-Caribeña Jurásico Superior, el Chert de El Aguacate, las picritas y basaltos magnesianos de edad posiblemente Aptiense (>96 Ma), y las dacitas y riolitas (89.1±0.9 Ma) de la Formación Restauración, así como sus equivalentes deformados y metamorfizados. Los gabbros de Los Velazquitos (89.3±1.6 Ma) fueron emplazados como lacolitos en el sector NE del bloque y poseen una signatura MORB con un débil componente subductivo.

En resumen, el dominio Central de La Española está compuesto de varios bloques tectónicos que representan diferentes dominios corticales del arco-isla Caribeño. Las edades 40Ar/39Ar obtenidas en anfibolitas de la zona de cizalla de La Meseta indican que su yuxtaposición tuvo lugar durante el intervalo 88-74 Ma.

Espaillat, Julio

REVISION MINERALOGICA DEL YACIMIENTO DE SULFUROS MASIVOS CERRO DE MAIMÓN

Corporacion Minera Dominicana, Santo Domingo, DN, Rep. Dominicana

El yacimiento poli-metálico de Cerro de Maimón, está ubicado a unos 3 km del municipio de Maimón, provincia de Monseñor Nouel, al norte de la Cordillera Central Dominicana.

Cerro de Maimón se encuentra emplazado en una secuencia de rocas volcánicas y volcaniclásticas bi-modales, tholeitícas primitivas, intercaladas con sedimentos calcáreos, carbonosos y silicios de edad Cretácica Inferior, descritas por C. Bowin como la Formación Maimón.

Estructuralmente el yacimiento se encuentra dentro de una zona de intensa deformación, dominada por una fuerte esquistosidad y plegamientos reflejados en la mineralización y desarrollados principalmente durante el emplazamiento del cinturón de Peridotitos de Loma Caribe en el Cretácico Medio. El principal conjunto de lentes de sulfuros masivos económicamente explotables, forma un corredor mineralizado de unos 1,000 metros de longitud x 140 metros de ancho y un espesor variable entre 10 y 40 metros. La principal alteración hidrotermal se observa en el piso de la mineralización, donde es conspicua una fuerte silicificación, acompañada de moderada a intensa sericitización y una menor cloritización. Las rocas del techo estan prácticamente inalteradas. Las rocas encajantes presentan alteración metamórfica al grado de esquistos verdes, siendo notoria la gran abundancia de esquistos cloróticos y en menor medida de esquistos sericiticos.

En la parte superior del yacimiento Cerro de Maimón, la mineralización hipogénica se encuentra total o parcialmente remplazada por minerales de alteración meteórica o supergénica hasta una profundidad de unos 130 metros desde la superficie actual. Cerro Maimón presenta tres zonas bien diferenciadas desde el punto de vista mineralógico y metalúrgico: Zona de Óxidos; Zona de Supergénica y la Zona Hipogénica.

Metalúrgicamente para la liberación económica de los metales, Cerro Maimón representa una combinación de procesos complejos y retadores. En la zona de óxidos es factible la separación del oro y la plata (dore) mediante un proceso de lixiviación con cianuro. En la zona supergénica, las fases cupríferas son de grano grueso, permitiendo una separación por flotación, mientras en la zona primaria la granulometría de los sulfuros es tan fina que exige la disolución mineralógica selectiva para su potencial separación.

Further refinement of the paleoenvironments of the Urumaco Formation will help to clarify the paleogeography and paleotectonic evolution of the Falcón Basin.

García-Senz, J. [1] and Pérez-Estaún, A. [2]

MIOCENE TO RECENT TECTONIC ELEVATION IN EASTERN DOMINICAN REPUBLIC

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Modern topography of eastern Dominican Republic is evolving from a deformational episode of oblique contraction starting 20 My ago, responsable for the exhumation of a former planation surface created near the sea level. Remnants of this surface are buried under the mio-pliocene strata at the flanks of the Cordillera (e.g. the karstic plain where is located the capital Santo Domingo) or raised to altitudes of more than 500 m (e.g. the Haitises Park). Correlative peneplains with thick alteration soil profiles are encountered south of the Miches village.

This former planation surface provides a good reference to calculate the volumetric shape of the uplifted area. To do this, we integrate the structural contours of the miocene unconformity, together with the contouring of the correlative peneplains and, in heavily dissected areas as the eastern part of the cordillera, we use the contour lines connecting the high points of the modern land surface. The result is a computer simulation of the undisected surface (previous to the main fluvial excavation), showing that the cordillera is composed of three left-stepping, N110 topographic highs, interpreted as pop-up crests, separated by two depressions on the relay areas. From the model also emerge some pristine structural features that were not evident in previous digital elevation models, as the rhomboidal pop-up geometry of the area east of the Yabón fault.

The quantification of the deformation cumulated in eastern Hispaniola since the Miocene can be compared with the results of GPS velocities and help to prevent seismic hazards.

Gaumet, Fabrice [1]; Sánchez, Jorge R. [2]; Letouzey, Jean [1] and Linares, Evelio [2]

SEDIMENTOLOGY, SEISMO – STRATIGRAPHY AND PALEOGEOGRAPHY OF THE NORTHWESTERN CUBA DEEP OFFSHORE ZONE

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This integrated study, combining seismic stratigraphy and sequence stratigraphy, provides a paleogeographic mapping of Mesozoic-Cenozoic seismic sequences at the scale of the southeastern Gulf of Mexico. It gave an available tectono-stratigraphic framework allowing the investigation of petroleum systems in an offshore setting, north of Cuba. The studied area encompasses the NW Cuban Exclusive Economic Zone (EEZ), in which a new CGG seismic survey was acquired in 2001 to support its opening for oil exploration. The tectono-stratigraphic evolution started with a syn-rift system JI (Lower - Middle Jurassic) in relation with the rifting stage between Laurentia and Gondwana. Ocean spreading in the Gulf of Mexico then controlled the second syn-rift system JII (Oxfordian to Berriasian), which was a NNW-SSE trending rift zone restricted to the northern Central Basin. Contemporaneously, a post-rift system J2 came along with a first phase of platform building along the proto-Caribbean margin (Oxfordian to Tithonian). Cretaceous post-rift systems C1 (Berriasian-Barremian) and C2 (Aptian-Cenomanian) developed in the western Straits of Florida during the second phase of platform building. The Bahamian mega-platform ceased to exist from the Aptian when intra-

shelf seaways were initiated. However, few local build-ups could have persisted in the western Straits of Florida during the Upper Cretaceous (post-rift system C3). Since Late Cenomanian time, a major unconformity equivalent to the MCU developed throughout the Central Basin by the cumulative plays of starvation, condensation and contourite current scouring. The Mesozoic history ended with the collisional phase of the Great Antille Arc against the North American plate margin, marked by the Cuban Belt thrusting and the deposition of syn-tectonic flysch sequences within the foreland. Deep-marine post-orogenic Tertiary sequences finally onlapped the Central Basin, while contourite carbonates dominated elsewhere, notably around the present day Florida platforms and in the western Straits of Florida.

Gil Gil, Nelson de Jesús

FORMACIÓN DE RECURSOS HUMANOS PARA EL SECTOR GEOLÓGICO MINERO DE LA REPÚBLICA DOMINICANA

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Distinguidos voceros y representantes del sector geológico minero dominicano han planteado la necesidad de volver a formar recursos humanos que den respuesta a los requerimientos de las instituciones privadas y gubernamentales que trabajan en esta área.

Un argumento para sustentar el planteamiento anterior se refiere a la edad de quienes actualmente están dedicados a las actividades propias del sector. En efecto, un análisis de las cohortes de egresados formados en el país, y de las conclusiones de una reciente investigación sobre este tema, demuestran que un elevado porcentaje supera los 36 años. Como no existen generaciones de relevo, ya que hace varios años se suspendieron los programas formativos desarrollados por las dos Instituciones de Educación Superior que lo ofrecían (en Santiago y Cotuí), se hace muy difícil conseguir técnicos y especialistas nativos para trabajar en los proyectos mineros y geológicos que actualmente se desarrollan o planifican en el territorio nacional. Hay, por consiguiente, una demanda insatisfecha de profesionales en estas áreas.

Por otro lado, de acuerdo con la investigación mencionada en un principio, los programas que se desarrollen deberán incorporar los adelantos que en el campo geológico minero se han hecho en el área de la informática, la geofísica y la geoquímica, y temas tan cruciales como la relación entre la geología y la minería con el medio ambiente y el desarrollo. Deberán tener en cuenta, además, la aplicación de los conocimientos geológico mineros al análisis, diseño y construcción de obras civiles, y al análisis y evaluación de los eventos sísmicos con el fin de disminuir su impacto en la vida de los habitantes, bienes e infraestructura del país.

Un interrogante crucial se refiere a la financiación de los recursos necesarios para iniciar y mantener el programa con la calidad y excelencia que de él se esperan.

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PALEOMAGNETIC RESULTS FROM CRETACEOUS ARC TERRANES IN CENTRAL HISPANIOLA: IMPLICATIONS FOR THE PALEOGEOGRAPHY OF THE CARIBBEAN PLATE

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Paleolatitude constraints on Cretaceous arc components are critical for testing kinematic models of the origin and evolution of the Caribbean plate. Rotational controls on lithospheric structures that comprise, or are adjacent to, the North American- Caribbean plate boundary zone reveal the complex tectonic mechanisms that have accommodated North American and Caribbean plate interactions. The general consensus among previous paleomagnetic work supports northward transport and anti-clockwise rotation for Greater Antilles arc terranes, yet the extent of displacement remains poorly constrained. We report new paleomagnetic results from the Lower Cretaceous Los Ranchos Formation and Upper Cretaceous Tireo Group arc volcanic and volcaniclastic rocks of the eastern and central cordillera of Hispaniola. A stable ChRM component carried by magnetite (unblocking temperatures 550-580° C) or hematite (650-675° C) was isolated in 6 sites. For the Tireo, 4 sites give a mean direction of D=320.7°, I=19.1°, k=98.3, alpha95=9.3° and yield a positive fold test. The site mean inclination implies a paleolatitude of 9.8° +5.3° / -4.9°. Comparison of the observed Tireo paleomagnetic pole against the 80 Ma North American reference pole indicates anti-clockwise vertical-axis rotation of 22.9° ± 9.1°, and northward transport of 10.9° ± 8.8°, with respect to the North American plate. The 2 remaining sites from the older Los Ranchos Formation significantly differ from the Tireo Group results, although insufficient sites for the Los Ranchos preclude the calculation of a mean direction. However, shallow inclinations and westerly declinations of the Formation significantly differ from the Tireo Group results, although insufficient sites for the Los Ranchos preclude the calculation of a mean direction. However, shallow inclinations and westerly declinations of the existing Los Ranchos data suggest near equatorial placement and additional anti-clockwise vertical-axis rotation.

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MORPHOSTRUCTURE OF THE MUERTOS CONVERGENT MARGIN

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The Muertos convergent margin is a 650 km east-west tectonic feature along the southern insular slopes of Dominican Republic and Puerto Rico. This margin is located in the back arc area of an ongoing inactive Cretaceous island arc and is a consequence of the oblique subduction of the North American plate beneath the Caribbean plate along the Puerto Rico Trench. From gravity, reflection seismic and seismological data was suggested that the Caribbean plate was actively being underthrusted or subducted under Puerto Rico and Hispaniola islands.

Recently acquired multibeam bathymetry data and reprocessed seismic reflection data also support an

active process of convergence along the Muertos margin. The Muertos Accretionary Prism can be divided across the slope in three east-west morphotectonic provinces on basis to structural and sedimentological criteria. Different provinces from lower to upper slope correspond with different evolution stages in the accretion process. Muertos Accretionary Prism shows an asymmetric development with a width decreasing eastwards possibly consequence of the oblique convergence along the margin and to the presence of tectonic corridors in the eastern area. The sub-parallel normal faulting in the outer wall of the Muertos Trough, which only appears in the western area, could be a consequence of this major development of the accretionary prism in this part, which has created much more overload of accretionary material over the underthrusting plate yielding the 300 m step over the trough axis.

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GRAVITY MAPS IN THE NORTH-EASTERN CARIBBEAN PLATE BOUNDARY ZONE

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Along eastern Greater Antilles is taking place a high oblique interaction between the Caribbean and North American plates. Such interaction results in a broad band of deformation with active tectonics. During last decades, to resolve this complex setting different tectonic processes along the margin have been proposed (e.g., microplates, opposing subducted slabs, strain partitioning, oblique subduction, a tear fault in the North American plate). Mainly these models are well constrained in the shallower crust. Seismological data provide information about the disposition in depth of the lithospheric slabs, but seismicity does not always show a clear distribution pattern (e.g., Muertos margin and Hispaniola region). Therefore result evident the necessity of using other data sources like deep seismic sounding and potential fields (gravity and geomagnetism) to constrain in depth this boundary plate.

Here we present the analysis of different anomaly gravity maps. Maps have been realized from the integration of gravity data acquired during the Spanish PRICO (1997) and GEOPRICO-DO (2005) cruises (calibrated with on land absolute-gravity stations), on land data and satellite gravity data. Data was examined for quality, edited, and processed using Oasis montaj and GMT software.

The analysis of densities distribution, integrated with geomagnetic, seismologic and deep seismic sounding data is the way to approach the study of deep crust in the north-eastern Caribbean boundary plate and to elaborate lithospheric models constrained in depth.

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MIDDLE OLIGOCENE - RECENT EXTENSION ON THE NORTHERN PUERTO RICO MARGIN

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The integration of multiple, high-quality marine geophysical data sets including multibeam bathymetry, sidescan sonar imagery, and single- and multi-channel seismic reflection profiles document two phases of east-west Middle Oligocene to Recent opening of the Mona rift on the northern Puerto Rico margin. Extension of the southern and central rift occurs along a west-dipping, listric normal fault on the east side of the rift, and east-dipping antithetic normal faults on the west side of the rift. Stratigraphic thickness changes across the rift indicate that extension initiated in the Middle Oligocene, approximately 30 Ma. This is much older than the previous estimate of 1.2 Ma that was predicted based on extrapolating the present-day rate of opening using GPS measurements. A total minimum extension of 6.05 km is calculated. The extension is proposed to have occurred in at least two phases. Phase I with 1.66 km of opening, occurred from the Middle Oligocene to Late Miocene at a very slow rate (0.087 mm/year). A possible cause of initial rifting may have been oblique subduction along the Puerto Rico trench. Phase II occurred from the Late Miocene to the Recent and resulted in at least 4.39 km of extension. The oblique collision of the Bahamas platform with the northern margin of Puerto Rico and resulting counter-clockwise rotation of Puerto Rico is proposed to have initiated the later, more rapid (0.4 mm/year) stage of extension. The dramatically different trend and axial gradient, and the minimal fill in the northern portion of the Mona rift suggest that it may have experienced different structural controls. The possibility that the northern rift formed as an extensional zone at the trailing edge of a forearc sliver is explored.

Guzmán Ospitia, Georgina

STRATIGRAPHY AND SEDIMENTARY ENVIRONMENT AND IMPLICATIONS IN THE PLATO BASIN AND THE SAN JACINTO BELT NORTHWESTERN COLOMBIA

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In western Colombia, the interconnection between the South America, Nazca, Cocos and Caribbean plates induced the geological complexity of the South America north corner. Their mutual evolution has conditioned to a great extent the regional paleogeography. The main unconformities of the Neogene of north-western South America and their tectonic and sedimentary implications correlated with some hiatuses previously recorded in the sedimentary series identified in the nearby ocean. The Caribbean margins of Southern Colombia grew through accretions which have affected the San Jacinto and Sinú belts. North-western Colombia coastal area resulted from two accretions exemplified by the western Sinú Belt and by the San Jacinto Belt in which two sedimentary cycles have here been recognised. The tectonic deformation of the San Jacinto Belt dated from the Cretaceous to the Early Oligocene whereas the Sinú Belt developed from the Oligocene to the Early Pliocene. These two main belts of the North Colombian coast became finally tectonically structured during the Miocene. The first accretion phase matched the San Jacinto Belt but the tectono-dynamic event did not preserve Oligocene and Miocene sediments. During the second accretion which affected the San Jacinto Belt, the Miocene sedimentary series together with the reworking of blocks composed of older sedimentary deposits became also

affected as witnessed by several diapiric phenomena in the present day substratum and by the occurrence of multiple mud volcanoes, both processes defining the geomorphology of the belt.

The cartography of the San Jacinto Belt resulted in a highly diversified mosaic of lithostratigraphic units genetically related to the development of small-sized isolated sedimentary basins bordered by basement thresholds. It is well recognized two distinct basins with different continental basement, located east of the Romeral Suture, The first concerned the San Jorge Basin in the eastern part of the studied area and the second basin at north corresponded to the Plato Basin.

Guzmán-Speziale, Marco

BEYOND THE MOTAGUA AND POLOCHIC FAULTS: ACTIVE TRANSFORM FAULTS IN THE NORTH AMERICA - CARIBBEAN PLATE BOUNDARY ZONE

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Traditionally, the Motagua and Polochic faults have been regarded as the North America-Caribbean plate boundary in Guatemala. The Jocotán fault is sometimes also considered as part of the plate boundary.

Using teleseismic as well as regional seismic data, we found another active fault, next to the Motagua-Polochic system. This fault is shown in at least two geologic maps, without a name. We call it the Ixcán fault system. It is a structure concave to the north with a length of about 100 km, just north of the Polochic fault. Seismic activity along this fault is well documented, with magnitudes up to 5.5. Reported focal mechanisms indicate left-lateral strike-slip faulting.

Historic records show two great crustal earthquakes that took place in the area: The 1816 (M=7.5) event along the Polochic fault, and the 1902 (M□7.7) to the northwest, along the Concordia fault, a 200-km feature along the Grijalva river, in Chiapas, Mexico. Given the distribution of intensity IX sites, it is posible that the Guatemala earthquake of 1816 (M=7.5) propagated along the Ixcán fault and the Concordia fault. The 1902 event ocurred only along the Concordia fault.

We propose a connection between the Polochic-Ixcan and Concordia faults, as part of the North America-Caribbean plate boundary. The Chicomuselo anticlinorium would act as a fault-step between the two fault systems.

Helle, S. [1]; Varela, B. [2]; Jerez, O. [1], Kelm, U. [1] y Pincheira, M. [1]

METODOLOGÍA PREDICTIVA DE LA LIXIVIACIÓN DE SULFUROS DE COBRE HOSPEDADOS EN ANDESITAS ALTERADAS

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El objetivo del trabajo es mostrar una metodología predictiva del comportamiento de la roca con soluciones de ácido sulfúrico, durante los procesos de lixiviación en pilas. Se hace una relación entre la

mineralogía total y ensayos de lixiviación en columnas de laboratorio de andesitas alteradas, en las cuales se hospedan sulfuros de baja ley (0.2-0.35% CuT; 0.07-0.18% CuS) principalmente calcosina y covelina. El comportamiento de la ganga reactiva de las unidades estudiadas se presenta como un caso de estudio para ayudar a la planificación del proceso productivo de extracción de cobre. Las muestras estudiadas se diferencian por variaciones en la mineralogía de alteración y proporción de ella:

A- alteración cuarzo-sericítica dominante: micas >> caolín

B- alteración argílica dominante y cuarzo-sericítica secundaria: caolín > micas > esmectitas

C- alteración cuarzo-sericítica dominante y argílica secundaria: esmectitas >> micas > cloritas > caolín

D- alteración argílica dominante: caolín >> micas >> esmectitas

El estudio considera una caracterización química y mineralógica con énfasis en la mineralogía de ganga y sus relaciones texturales. Se mide la conductividad hidráulica, el consumo de ácido y se aplican métodos de re-extracción post lixiviación para complementar ensayos de lixiviación, conducentes a predecir el comportamiento del mineral durante el proceso industrial.

Se concluye que el protocolo empleado es adecuado para este tipo de estudio y se demuestra que las especies minerales de ganga no solo determinan su comportamiento frente al proceso por sus inherentes características físico-químicas y cantidad sino también por la relación textural que presentan en el arreglo total de la roca.

Hernaiz Huerta, P.P. [1]; Díaz de Neira, A. [2]; García Senz, J. [2]; Lopera, E. [2]; Escuder Viruete, J. [2] y Pérez-Estaún, A. [3]

CONTRASTING STRUCTURAL STYLES IN SW DOMINICAN REPUBLIC AS AN EVIDENCE OF STRAIN PARTITIONING IN AN ISLAND ARC (HISPANIOLA)-CONTINENT (NORTH AMERICA) OBLIQUE COLLISIONAL SETTING

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In obliquely converging collisional chains the ubiquity and coeval development of purely compressive structures (thrusts and reverse faults) and sub-parallel conspicuous strike-slip faults, has been proposed as one of the evidences for strain partitioning.

In SW Dominican Republic, the variety and contrast among the different structural styles that characterize the main domains, confirm these terms. On one hand, the Peralta belt, with a typical fold and thrust general structure, shows a relatively homogeneous, pure shear controlled deformation. Its frontal thrust is one of the inland main structures that, at least in the studied transect, shows a wide horizontal translation (10-15 km of thrusting over the Azua basin). The part of the island arc basement corresponding to the Tireo Fm, has also a fold and thrust general structure but folds are interpreted as fault-bend folds in comparison to fault-propagation faults of the Peralta belt. In this case, pure shear must be also the dominant component but there may be structures partly formed under the simple shear component that rules the deformation in the Median Belt.

On the other hand, on one and the other side of the Peralta belt, both the Median belt, and the group of relieves formed by the sierras de Neiba, Martín García and Bahoruco, display general structures characterized by the participation of conspicuous strike-slip faults, but with quite different styles. In the Median belt, (sinestral) shear strain is well localized along discrete structures, specially the Hispaniola fault zone. However, in sierras de Neiba, Martín García and Bahoruco (and their neighbouring Enriquillo and Azua basins), the simple shear (sinistral) controlled deformation is very well distributed throughout the whole transpressive general structure of this region, as shown by the widespread and pervasive intense fracturing developed coevally to folds and high angle thrusts.

RESUMEN

En cadenas colisionales con convergencia oblicua, la coexistencia y formación simultánea de estructuras netamente compresivas (cabalgamientos y fallas inversas) y desgarres, se argumenta como una de las evidencias de que la deformación está partida o fraccionada

En la zona de estudio, la variedad y contraste entre los estilos estructurales que caracterizan a uno y otro dominio confirman estos términos. Por una parte, el cinturón de Peralta, con una estructura típica de pliegues y cabalgamientos, muestra una deformación relativamente homogénea por cizalla pura. Su cabalgamiento frontal es una de las pocas estructuras del interior de la isla que, al menos en la transversal estudiada, muestra una importante translación horizontal (10-15 km). La parte del basamento de arco de islas correspondiente a la Fm. Tireo tiene una estructura similar de pliegues y cabalgamientos, aunque con pliegues de acomodación en contraposición a los pliegues de propagación que caracterizan al cinturón de Peralta. En este caso, probablemente también domina la componente de cizalla pura, pero quizá alguna estructura acuse todavía la influencia de la componente de cizalla simple que domina el cinturón Intermedio.

Por el contrario, a uno y otro lado del cinturón de Peralta, tanto el cinturón Intermedio como el conjunto formado por la sierras de Neiba, Martín Garcia y Bahoruco, presentan una estructura con fuerte participación de desgarres, si bien sus estilos son diferentes. En el cinturón Intermedio la deformación por cizalla simple (sinestral) está muy localizada a lo largo de estructuras singulares, fundamentalmente la zona de falla de La Española. Sin embargo en las sierras de Neiba, Martín García y Bahoruco (y sus cuencas limítrofes de Enriquillo y Azua), la deformación por cizalla simple (también sinestral) está muy distribuida por todo el conjunto de la estructura transpresiva que caracteriza este sector, como manifiesta la presencia de una intensa fracturación muy repartida y desarrollada de forma conjunta a pliegues y cabalgamientos de alto ángulo.

Hubbard, Dennis K. [1]; Ramírez-Martínez, Wilson R. [2]; Davis, Allicia [3]; Cuevas, David N. [4]; Erickson, Timmons [1] and Estep, Andrew [1]

SEDIMENTATION, SEA LEVEL AND FACIES GEOMETRY: ENRIQUILLO VALLEY REEFS, WESTERN DOMINICAN REPUBLIC

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Spectacular outcrops in the Enriquillo Valley expose Holocene reefs that flourished between 11,000 and 4,000 CalBP. All the zones found on modern Caribbean reefs are represented within the facies exposed at a single reef near Cañada Honda on the north side of the valley. The occurrence of a well-defined storm-debris bed provides insight into reef geomorphology and paleo-water depths associated with reef facies and individual corals. While coral-growth rates and reef accretion rates are slower than those on open-Caribbean reefs, species abundance (>50%) and richness (n>25) remain high. This is probably related to the high but sporadic sediment input (mostly in May and October) in an otherwise desert climate. Coral-growth rates were nearly balanced by sedimentation, and both coral morphology (dominantly conical or columnar) and bioerosion (dominantly *Lithophaga*, versus sponges and worms on open-Caribbean reefs) are reflective of higher inputs of terrestrial clastics and nutrients.

The continuous outcrop exposure allows careful examination of both reef facies and their migration under the influence of rising sea level. Before 7,000 CalBP, facies deepened upward under the influence of rapidly rising sea level (~5.5 m/ky). Water depth over the reef surface increased, from 0-5m 10,000 -11,000 CalBP, to ~15m in less than 3,000 years. After 7,500 CalBP, the reef quickly caught up with sea level and eventually built seaward over deeper-water facies as accommodation space progressively diminished. These patterns are consistent with recent proposals that facies geometry in Holocene reefs is less dependant on depth-related patterns of carbonate production and more related to a combination of production, bioerosion and transport that, collectively, cede control to the rate of sea-level rise with regard to patterns of reef aggradation, progradation, backstepping or drowning. These realizations solve the "reef drowning paradox" that has, over the past three decades, dominated discussions of reef accretion.

Huérfano, Victor [1]; Pulliam, Jay [2]; ten Brink, Uri S. [3]; Lopez-Venegas, Alberto [3] and von Hillebrandt-Andrade, Christa [1]

EARTHQUAKES AND TECTONICS IN THE SOMBRERO SEISMIC ZONE CONSTRAINED BY PASSIVE OCEAN BOTTOM SEISMOGRAPHS

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Ocean bottom seismographs (OBSs) were deployed in the Northeast Caribbean in 2005 and 2007 to record earthquakes in the Sombrero Seismic Zone (SSZ). Our goals were to better constrain earthquake locations, to identify crustal features, including a possible rupture in the subducting North American Plate, that could cause tsunamigenic events and to clarify the tectonics that lead to larger earthquakes and tsunamis. Data were analyzed jointly with records from permanent stations of the Puerto Rico Seismic Network (PRSN), whose stations are located on islands to the south of the SSZ and are therefore biased and incomplete without offshore complements. Our goal was to identify, locate, and estimate focal mechanisms for small-magnitude seismic events in this corner of the Caribbean.

In the 2005 data set we identified and analyzed thirty-five events on at least four OBSs and one or more

PRSN stations and an additional fifteen events that were observed on four or more OBSs only. Upon relocation, the jointly recorded events revealed tighter clustering and clear biases with respect to original PRSN locations. Changes in epicenters were greatest in the northeastern limit of activity, while there was a consistent progression toward deeper focal depths for events closer to the island of Puerto Rico. The average change in focal depth for the cluster of five events closest to Puerto Rico was 35 km. Events located solely with OBSs were consistent with the relocated events.

Most of the relocated events are consistent with the depth and dip of the subducted North American plate in this region and may therefore be associated with active subduction, rather than the shallow tectonics suggested by original locations. Events recorded during the longer 2007 OBS deployment are being analyzed to explore this association and its implications for tearing of the North American Plate lithosphere during subduction.

Huérfano, Victor and von Hillebrandt-Andrade, Christa.

AN EARTHQUAKE EARLY WARNING FOR PUERTO RICO AND THE CARIBBEAN

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Rapidly available information regarding the geographic distribution of ground shaking in relation to the population and infrastructure at risk can assist emergency response communities in a more efficient and optimized allocation of resources following a large earthquake. An earthquake early warning (or alerting) system provides notification that an earthquake is occurring and that potentially damaging ground motion is approaching. Ideally, a network of field stations equipped with strong motion instruments will detect the initiation of an earthquake and if the earthquake meets or exceeds a given ground motion or magnitude value, an alarm is declared by the data processing system. As a result, a public warning is then issued to the government officers and eventually to populations at risk. Warning times depend on the distance between the earthquake source and the populated area and may vary from no warning at all to more than a minute if the source is quite distant.

We have developed and are implementing a tool to broadcast automatic or reviewed earthquake information as well as tsunami messages for Puerto Rico, the Virgin Islands which could be expanded to the Caribbean. This tool will help the PRSN (Puerto Rico Seismic Network) personnel on duty with the generation of valuable information like ShakeMaps, focal mechanism, update web pages and catalogues, etc. The system can feed and relay messages and alarms from different sources like a local EarthWorm/EearlyBird installation or messages from global warning centers (PTWC, ATWC) or the USGS NEIC (National Earthquake Information Center). The user can navigate on a specific list of preconfigured messages and can select the method to broadcast the message using direct email trough service lists, cell pages, or a server/client tool to push messages to a remote display client.

Hunter, Vernon F.

TERTIARY CARBONATE BUILDUPS OF THE SOUTHERN CARIBBEAN MARGIN: TECTONOSTRATIGRAPHIC SETTINGS AND HYDROCARBON ASSOCIATIONS

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Of the many carbonate models present within the Tertiary of the southern Caribbean margin, only two specific models have so far been found to be associated with economic hydrocarbon accumulations. Both are located in northwest Colombia; the giant Ballena-Chuchupa gas field off the west coast of the Guajira Peninsula, and the smaller fields associated with the Cicuco/ El Dificil limestones of the Lower Magdalena Basin. Both carbonate models comprise dominantly algal/foraminiferal bodies of Early Miocene age which originally formed on continental basement blocks and were subsequently incorporated into the convergence zone between the Caribbean and South American plates. During the collision processes these blocks became subject to rapid subsidence and tilting; the Lower Magdalena carbonates represent an early stage of collision while the original Ballena stratigraphic profile has been completely reversed by a late stage Pliocene tilting.

The majority of other similar carbonate bodies cap accreted terrain and have remained positive features to the present day. These are particularly widespread throughout the southern Caribbean margin at the Middle-Late Eocene and Middle -Late Miocene levels. A few Middle-Late Eocene allodapic models are also recognized in the region but, by reason of their mode of deposition, display low porosity and lack permeability. Several marginal marine sequences contain a high percentage of carbonates but any associated hydrocarbons are primarily hosted by interbedded clastic horizons.

Ionica, F.

TELEMETRED MULTICHANNEL SYSTEM FOR GEOPHYSICAL CABLE

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A new telemetred multichannel system for geophysical cable is presented. The investigation of the boreholes is very important to be done using as many measuring channels as possible in order to have fast and effective results.

Multiwire cables, which are now used in multichannel systems, are very problematic due the connectors, durability and wear. Water tightness must be very high degree because of high pressure, which exist in boreholes over 1000 meters. Also noises and disturbances generated by external electromagnetic fields are big problems especially in VSP or HSP measuring where all the signals, including the weakest reflections must be recorded at sufficient resolution.

Taking in account the above requirements it was designed one modular system which is constructed to function on one coaxial cable where all the channels are located in parallel in frequency domain. This kind of system is called telemetry system and it is used mostly in airplanes and space equipment.

These telemetry systems consist of transducer units (everyone with three geophones), preamplifiers, circuits to transfer signals to the coaxial cable, electronic controls and power supply components.

These units are connected on a strong main coaxial cable as many as needed. Physically they are in series with cable but electrically are in parallel as on a bus line.

Iturralde-Vinent, Manuel A. [1]; Díaz-Otero, Consuelo [2]; García-Casco, Antonio [3] and van Hinsbergen, Douwe J.J. [4]

PALEOGENE FORELAND BASIN DEPOSITS OF NORTH-CENTRAL CUBA: A RECORD OF ARC-CONTINENT COLLISION BETWEEN THE CARIBBEAN AND NORTH AMERICAN PLATES

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Paleogene deposits of North-Central Cuba have been identified as a deformed foreland basin, whose stratigraphy recorded very well the collision of the Bahamas-ProtoCaribbean realm (North American Plate) with the Caribbean Plate, a process that occurred since latest Cretaceous to the early late Eocene time. The debris incorporated in the foreland basin has several sources, including 1) allochthonous Cretaceous arcs, ophiolites and serpentinite melanges; 2) pre-Paleogene sedimentary rocks derived from the southwestern edge of the substrate of the foreland basin, and 3) Cretaceous Bahamian carbonate platform rocks. The evaluation of the age, size and volume of these debris demonstrate the formation of a forebulge within the Bahamas platform in response to the collision of the Caribbean-North American Plates, and the northeastward migration of the axis of the foreland basin since the Paleocene. By the early late Eocene, structural shortening ended in Central Cuba , with uplift and deep erosion, followed by a quick transgression before the end of the Eocene. The resulting upper Eocene sediments unconformable cover the deformed foreland deposits and underlying rocks.

Jansma, Pamela E. and Mattioli, Glen S.

CONSTRAINTS ON TECTONIC MODELS OF THE NORTHEASTERN CARIBBEAN FROM OVER A DECADE OF GPS GEODETIC MEASUREMENTS IN THE NORTHEASTERN CARIBBEAN

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We have collected GPS geodetic data in the eastern Greater Antilles and northern Lesser Antilles since 1994 to address a number of tectonic problems. These include 1) constraining North America-Caribbean relative motion, 2) developing a stable Caribbean reference frame and testing overall plate rigidity, 3) isolating discrete tectonic blocks within the northeastern Caribbean plate boundary zone with emphasis on Puerto Rico and the Virgin Islands, 4) assessing strain partitioning due to oblique convergence in the northern Lesser Antilles, and 5) examining potential elastic strain accumulation from locking along the subduction interface. Although much progress was made on the first three during the initial ten years of data collection, results for the last two remained elusive as a consequence of the slow relative plate motion between the Caribbean and North America. New data acquired from sites in Puerto Rico, the Virgin Islands, Saba, St. Eustatius, St. Maarten, Anguilla, Antigua, Barbuda, St. Kitts, Nevis, Monsterrat, Redonda, and Dominica now permit discrimination among various competing models for the tectonics of the northeastern Caribbean, such as the presence or absence of a rigid Lesser Antilles forearc, independent block rotation in the northern Lesser Antilles, magnitude of arc parallel extension, and extent of locking along the plate interface in the eastern Caribbean.

Jolly, W.T. [1]; Lewis, J.F.[2] and Proenza, J.A. [3]

MINERALOGY AND MINERAL CHEMISTRY OF THE RIO GUANAJIBO PERIDOTITES, SOUTH-WEST PUERT RICO WITH COMPARISONS

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In southwest Puerto Rico, three northeast-ultramafic belts crop out: Monte del Estado peridotite belt (MEPB), Rio Guanajibo peridotite belt (RGPB), and the Bermeja Complex. Their protolith age is probably Late Jurassic or Lower Cretaceous. Dunites, harzburgites and lherzolites are all present even over a small area. Whether or not they are all part of the one peridotite mass that has been dismembered is not understood. These serpentinized peridotites have features similar to abyssal peridotites. The Rio Guanajibo body was the subject of extensive investigations by Hess and others [*Burk, C.A., (ed.), 1964. National Academy of Sciences, National Research Council, Pub. 1188*]. A gravity survey associated with a 305-m-deep core drilling project indicates that the RGPB is at least 2.8-km thick [see Bromery and Griscom, 1964: *The AMSOC core hole near Mayagüez, Puerto Rico: Nat. Res. Count., Washington, D.C., Publication No. 1188, 61–74]*. In this contribution we present new data about the mineralogy and mineral chemistry of Rio Guanajibo serpentinized peridotites, which has revealed the presence of two distinct groups of peridotite samples.

Group I peridotites (G1) are partially serpentinized and contain relic olivine, orthopyroxene and clinopyroxene. The G1 peridotites show porphyroclastic textures with orthopyroxene phenocrysts usually show kink-bands and undulatory extinction. They are predominantly spinel lherzolite and Cpx-rich harzburgite, and contain brownish aluminous spinel with Cr# = 0.14-0.16 and Mg# = 0.75-0.77. The Mg# of olivine is ~ 90, with NiO content between 0.39 and 0.43 wt%. Opx compositions are in the ranges En_{86-92}, with Al_2O_3 and Cr_2O_3 contents of 3.2-6.3 wt% and 0.32-0.85 wt% respectively. The Cpx Mg# ranges from 0.90 to 93. The Al_2O_3 content range from 2.61 to 6.18 wt%., Cr_2O_3 content from 0.3 to 1.0 wt%. The mineral chemistry is similar to those of peridotites from MEPB and to those of the most fertile abyssal peridotites, and do not seem to have been affected by a subduction component. In contrast, Group 2 peridotites (G2) are extensively serpentinized, but textural differences between mesh-texture lizardite and bastite indicate that most of the serpentinized peridotites were predominantly harzburgite. Their accessory Cr-spinel is Cr-rich, with Cr# = 0.72-0.74 and Mg# = 0.32-0.42. These compositions resemble supra-subuction zone mantle peridotites (e.g. fore arc peridotites).

Our main conclusion is that the Rio Guanajibo peridotites are heterogeneous. Group 1 peridotites (G1) are refractory abyssal-type peridotites, which probably were not involved in the generation of Puerto Rico island arc magmas. The other group (G2) correspond to highly refractory peridotites comparable to those of supra-subduction zones, and might represent the pathway of arc-related melts in the mantle.

Jolly, W.T. [1]; Schellekens, J.H. [2]; and Lidiak, E.G. [3]

EARLY TERTIARY VOLCANISM IN PUERTO RICO AND THE VIRGIN ISLANDS:

EFFECTS OF OFF-SCRAPPING OF PELAGIC SEDIMENTS DUE TO INCREASING OBLIQUITY OF SOUTH-DIPPING SUBDUCTION

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Early Tertiary strata in the Greater Antilles Island Arc occur as part of two distinctive, partly contemporaneous arcs. The most extensive, extending from Cuba to the Virgin Islands and beyond, consists of a west-trending belt, concentrated along the northern flank of the Antilles arc platform, containing strata ranging in age from mid-Albian to mid-Eocene. Comparatively limited incompatible element concentrations are consistent with south-dipping subduction of the Atlantic basin involving an N-NORM-type wedge composition. The second arc, which contains a Santonian to Campanian forearc assemblage including high-Mg andesites, consists of a northwest-trending belt, concentrated in southwest Puerto Rico, containing arc strata ranging in age from Turonian to mid-Eocene. Lateral arrangement of rock types and elevated incompatible element concentrations in the second belt are consistent with north-dipping subduction of the Pacific basin involving an E-MORB-type wedge composition. Incompatible element-enrichment of the wedge source of northeast-trending belt is interpreted to have resulted from processes related to emplacement of the Turonian Caribbean mantle plume immediately preceding arc volcanism. In the east trending belt, there is a marked decrease in incompatible element abundances, and in La/Sm, from the Paleocene Guaracanal Formation to the mid-Eocene Jobos Formation in Puerto Rico. The compositional evolution is consistent with a decrease in the magnitude of the subducted pelagic sediment component. The decrease in sediment proportions corresponds with a progressive increase in obliquity of subduction in the west-trending arc system, and is interpreted to result from off-scrapping of subducted sediment from the downgoing slab before it reached the melting zone, as happens in the Cenozoic western Aleutians island arc. Volcanism in the Greater Antilles became extinct following extrusion of lavas from the Jobos Formation.

Joyce, James and Cerpa, Roberto

BEDROCK STRUCTURAL CONTROL OVER SLOPE STABILITY, EVOLUTION AND DRAINAGE SYSTEMS IN TORTOLA, BVI

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The geology of Tortola is characterized by steeply inclined volcanic strata that are cut by steeply to moderately inclined joint sets. In general slopes are steep with very poor soil cover over only partially weathered rock. Slope drainages or ghuts tend to be linear with steep gradients and filled with colluvial deposits indicating debris flow activity. The ghuts tend to parallel joint set intersections suggesting their origin as debris flows formed in joint wedges. Several slope areas showed disperse colluvial deposits from debris avalanches. All of these slopes were parallel to moderately, outward inclined joint sets and showed evidence of periodic reactivation. The occurrence of colluvium and the distribution pattern of joint sets and their intersections were used to develop a slope vulnerability map for the island.

Joyce, James; Rohena, Reynard and Mihalik, Mario

BEDROCK FAULT STRUCTURES IN THE GREAT NORTHERN PUERTO RICO FAULT ZONE AND SAN LORENZO BATHOLITH

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The Great Northern Puerto Rico Fault Zone in eastern Puerto Rico is comprised of the Cerro Mula and Peña Pobre Faults. The fault zone is marked by a belt of hydrothermally altered volcanic rocks and considered to be a major crustal boundary that underwent large scale left lateral dispacement during the Late Cretaceous. The pronounced geomorphic expression (principally parallel river valleys) of the fault zone and other faults in eastern Puerto Rico raises the question of recent or active displacements along these faults. Recent GPS studies by Jansma and Mattioli (2005) suggest up to a few mm/yr of NE to ENE extension may occur between the northeast and northwest ends of the island. This differential movement is likely accommodated by reactivation of favorably oriented older bedrock faults. Bedrock structures include minor faults with fault striations, foliations and conjugate joint systems. The major faults are poorly exposed and largely inferred to underlie Quaternary alluvial sediments. Recent excavations and quarries along the fault zone have been used to obtain fault kinematic data. The fault data is largely consistent with near east-west trending left lateral faulting and NE transpression. Structural data near the southeast end of the Cerro Mula Fault where it trends NW however suggests right lateral movement. An exposure of the inferred Cerro Mula Fault in hydrothermally altered rock further west shows S-SSE directed thrusting along E-ENE trending faults which is also inconsistent with E-W left lateral movement. Right lateral displacement is also suggested for associated NW faults that cut the San Lorenzo south of the major fault zone. Trenches across the fault traces showed no evidence of recent movements.

Kammer, Andreas [1]; Chicangana, Germán [1;2]; and Vargas-Jiménez, Carlos Alberto [1]

EARLY SUBDUCTION-DOMINATED AND LATE COLLISIONAL DEFORMATION PHASES IN THE ACCRETION OF OCEANIC TERRANES OF WESTERN COLOMBIA

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The Romeral or Cauca-Almaguer fault defines an accretionary limit between Northandean oceanic terranes to its W and a complexly structured continental margin to its E. Contrarily to what might be expected for the juxtaposing of anomalously thick oceanic and continental crust, this suture unveils the characteristics of a subduction zone, along which accreted oceanic crust was forced into a steeply E-dipping attitude. The hangingwall of this suture is affected by two subduction complexes, among which a western one comprises crustal slivers embedded within ultramafic rocks, while an eastern one is made up of a major crustal flake which conserves a steeply E-dipping Cretaceous cover. These two complexes document various stages of a tectonic erosion of the continental margin, which include the entrainment of crustal slivers to intermediate subduction depths and their return flow and exhumation to present exposure levels. An initial docking of the western oceanic terranes is evidenced since the Campanian by the deposition of clastic sediments sourced from the continental margin. A regional

Upper Cretaceous to Paleogene unconformity marks a transition from subduction-dominated to collisional tectonics, in the course of which the continental margin was pushed into an E-dipping monocline and underwent a significant exhumation. This large-scale tilting was partly mitigated by gravitationally driven extensional tectonics, as attested by normal faults that dissect the continental margin and helped to reduce the tilt angle of the monocline. On the oceanic plate the blocking of the subduction-dominated convergence is evidenced by an imbrication of upper crustal units and a tightening of the bend at the Romeral suture which, in analogy to the extensional tectonics of the hangingwall block, became affected by crustal-scale normal faults at a later stage.

Key Words: Abandoned subduction zone, strain partitioning, Antioquia batholith.

Khan, Shakira A. [1]; Coutou, Richard [1]; Robinson, Edward [1]; Rowe, Deborah-Ann [2] and Johnson, Monique [1]

GIANT WAVE AND SURGE DEPOSITS IN THE COASTAL ZONE: THEIR EMPLACEMENT AND EVOLUTION AND THE IMPLICATIONS FOR COASTAL MANAGEMENT

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Holocene boulder deposits occur at several coastal sites around the island of Jamaica. They occur primarily on raised Pleistocene limestone terraces, at elevations up to about 10 metres and typically where the island shelf is narrow. Three main kinds of deposit are found. At the rear of the platform occur ridges of unsorted carbonate sand and coral debris with small boulders. Nearer the shoreline perched beaches of imbricated modern coral rubble may be found. Large isolated boulders of Pleistocene limestone are frequently strewn over the platform surface.

We conclude that the ridges result from the progressive emplacement and movement, throughout the past five millennia, of storm and/ or tsunami generated debris over the platform into zones where the energy level of the impacting waves or surge is reduced. Here clasts accumulate, evolving into ridges that increasingly provide a barrier to further incursion of debris inland. The large isolated boulders are torn off from the platform bedrock and are either in-transit towards the ridge deposits, or following initial emplacement on the platform, are too big to be moved subsequently by hurricane-generated waves. In the latter case initial emplacement may be from tsunamis. The perched beach deposits are essentially ephemeral, formed during the passage of storms, and modified or destroyed by later wave events.

We have observed movement of boulders of up to 100 tonnes on platforms elevated up to 9 metres above current sea level and emplacement onshore of boulders up to some 15 tonnes during recent hurricanes.

For coastal management practice, the position of the debris ridge is critical, effectively delimiting that seaward part of the platform, vulnerable to storm impacts, from the protected area behind the ridge. Destruction of the ridge during development projects may increase vulnerability to storm impacts of those areas originally protected by the ridge.

Lewis, John [1]; Mattietti, Giuseppina Kysar [2]; Perfit, Michael [3] and Kamenov, George [3]

GEOCHEMISTRY AND PETROLOGY OF THREE GRANITOID ROCK CORES FROM THE NICARAGUAN RISE, CARIBBEAN SEA: IMPLICATIONS FOR ITS COMPOSITION, STRUCTURE AND TECTONIC EVOLUTION

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The Nicaraguan Rise is a major submarine structure of poorly known origin. Its lithologies have been studied from dredges and land outcrops in the Greater Antilles and Central America and its structure from geophysical data. In this paper we present analyses of granitoid rocks that were recovered during the seventies from cores drilled on the Nicaraguan Rise for oil prospecting. These first geochemical analyses available for three sites situated in the northern section of the Nicaraguan Rise show a strong arc signature similar to that of granitoids from Above Rocks (Jamaica) and Terre Neuve (Haiti). Some affinity is noted also with the more depleted Sierra Maestra suite of southern Cuba. All of these lithologies are from the Late Cretaceous – Paleocene time. Key element abundances of K, La, Ce, Nd, Hf, Zr and Sm – indicate that these rocks present a closer affinity with mature oceanic arc rocks rather than mature continental arcs. The Pb-Sr-Nd isotopic composition of the Nicaraguan granitoid rocks suggests they were derived from a common, depleted mantle reservoir. In addition, the Pb isotope data indicate that the Nicaraguan Rise granitoids have not been contaminated by Paleozoic or Pre-Cambrian crustal rocks in the Chortis block. On other other hand granitods dredged from the north wall of the Cayman Trough have Pb isotope signatures indicating contamination from crustal rocks from the Chortis block. We postulate that the Northern Nicaragua Rise was most likely a Caribbean oceanic arc system that may have interacted only at its margin with the continental blocks bounding the region to the west. These data on the composition of the granitoids are very relevant in assessing the tectonic terrane map of the Chortis block and southwestern Nicaraguan Rise (Rogers and Mann, 2007) which is based on their compilation of geological and geophysical data. This map and a tectonic terrane map of the Chortis block and Nicaraguan Rise by Flores (2007) based on his work in Siuna area of Nicaragua will be discussed.

Locutura, J.; Lopera, E. and Bel-Lan, A.

STREAM SEDIMENTS GEOCHEMICAL MAPPING AS A WAY FOR THE KNOWLEDGE OF LAND SURFACE AND ITS MINERAL RESOURCES POTENTIALITY. A CASE STUDY IN THE DAJABÓN-MAO-RESTAURACIÓN-ARROYO LIMÓN AREA (DOMINICAN REPUBLIC)

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The studied, within the Cordillera Central, covers 5332 km^2 and 1.908 samples were collected with a sample density of 1 sample / 2,8 km^2.

The outcropping geological units are formed by a cretaceous sequence, unconformably covered by

Cenozoic sediments. The mineralizations hosted are typical of this geotectonic setting: epithermal (Au, Ag), volcano-sedimentary massive sulphide (Cu-Zn).

Stream sediments are mostly coarse grained, sand and gravels. The soils development is quite heterogeneous, leading to laterite soils in some specific places. A test survey has been carried out in different geological settings in soils and stream sediments. Both media show the scarcity of fine grained materials, similar geochemical contents of the majority of elements and similar relationships between them.

The regional geochemical patterns, even with the interference of local metallogenic, morphoclimatic or antropic factors, are mainly controlled by geological or lithological factors. At the same time, regional scale geochemical variability is noticed in function of contrasted lithologies, as well a very low background of some elements like Pb, Ba or Be. This fact is in agreement with the oceanic affinity with scarce continental contribution, of most of the geological units.

The multivariant statistical treatment of the multielemental data has consisted in a principal components analysis and in a clustering or classification process. The elemental geochemical anomalies can so be defined against these backgrounds and a whole analysis accomplished in order to delineate several prospective areas. The most interesting of them are located in the sedimentary back arc basin (possible epithermal mineralizations), following NW-SE or NE-SW shear structures (or in their intersections), probably related with buried granodioritic stocks (epithermal Au-Ag).

López, Alberto M. [1]; ten Brink, Uri S. [1] and Geist, Eric L. [2]

SUBMARINE LANDSLIDE AS THE SOURCE FOR THE OCTOBER 11, 1918 MONA PASSAGE TSUNAMI: NEW GEOLOGICAL EVIDENCE, OBSERVATIONS AND TSUNAMI MODELING RESULTS

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The October 11, 1918 ML 7.5 earthquake in the Mona Passage between Hispaniola and Puerto Rico generated a local tsunami that claimed approximately 100 lives along the western coast of Puerto Rico. The source of the tsunami was poorly understood until newly-acquired high-resolution bathymetry and seismic reflection lines in the Mona Passage evidenced a fresh submarine landslide 12 km northwest of Rincón in northwestern Puerto Rico. Submarine telegraph cables were reported cut by a landslide in this area following the earthquake, suggesting further that the landslide was the result of the October 11, 1918 earthquake. On the other hand, fresh scarps were not observed at the previously suggested source of the 1918 tsunami, a normal fault along the east side of Mona Rift, suggesting that it was not active recently. The fault escarpment along Desecheo Ridge and our landslide appear, on the other hand, to be rather fresh. Using the extended, weakly non-linear hydrodynamic equations implemented in the program COULWAVE, we modeled the tsunami as generated by a landslide with a finite duration and with the observed dimensions and location. Marigrams (time series of sea level) were calculated at locations near to reported locations of run-up. The marigrams show a leading depression wave followed by a maximum positive amplitude in agreement with the reported polarity, relative amplitudes, and arrival times. Our results suggest this newly-identified landslide, which was likely triggered by the 1918 earthquake, was the probable cause of the October 11, 1918 tsunami and not the

earthquake itself. Results from this study should be useful to help discern possible tsunami sources of other case studies in which their sources are still poorly constrained.

López Rivera, Juan Guillermo; Domínguez, Bernardo René; Sánchez Arango, Jorge y Valladares Amaro, Silvia.

PLAYS EXPLORATORIOS Y RETOS PARA LA EXPLORACION PETROLERA EN EL AREA CUBA – LA ESPAÑOLA

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La parte más occidental de las Antillas Mayores, donde están situadas Cuba y La Española, pertenecen al dominio petrolero del Tetys, con un probado potencial exploratorio y productivo. Aquí se conjugan cuencas con diferentes características, formadas por la interacción de las placas Norteamericana y Caribe, lo que da lugar a variados escenarios geólogo – petroleros y tipos de plays, ante los cuales están planteados retos específicos en el desarrollo de la exploración de petróleo y gas.

Los principales retos para la exploración de yacimientos de petróleos y gas en Cuba y La Española, aunque con diferencias por el desigual grado de estudio y conocimientos geólogo – petroleros, son semejantes, destacándose entre los mismos los siguientes de (norte a sur):

El descubrimiento de yacimientos gigantes en los mares profundos septentrionales asociados a reservorios carbonatados relacionados con pliegues y altos estructurales, tanto en el borde de las plataformas de Yucatán y Florida - Bahamas, como en la cuenca de antepaís, así como plays estratigráficos relacionados con las brechas del talud de las plataformas mencionadas.

El descubrimiento de yacimientos gigantes y grandes, tanto en los mares profundos, plataforma insular y tierra septentrionales de Cuba y La Española, asociadas a reservorios carbonatados en duplex, semejantes a los yacimientos de la Franja Norte de Crudos Pesados de Cuba.

El descubrimiento de yacimientos de petróleo pequeños y posiblemente medianos, asociados al tope de secuencias volcánicas y ofiolíticas, así como algunos niveles de reservorios clásticos y carbonatados en las cuencas relacionadas con la Placa Caribe.

El descubrimiento de yacimientos de gas biogénico, principalmente pequeño, pero posiblemente abundantes y someros, asociados a reservorios de diferentes tipos en la parte superior del relleno sedimentario de las cuencas relacionadas con la Placa Caribe.

Pensamos que es cuestión de tiempo y de hacer un mínimo de inversiones necesarias, para la obtención, a mayor escala, de resultados positivos en el empeño de descubrir los yacimientos, que indudablemente están presentes aquí.

Mann, Paul [1] and Calais, Eric [2]

IMPACT OF GPS STUDIES ON THE UNDERSTANDING OF CARIBBEAN NEOTECTONICS (1989-2008)

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Before the advent of GPS-based geodesy, active tectonic processes around the Caribbean plate were dimmly perceived from maps of earthquake epicenters, focal mechanisms of larger, teleseismically, and fault and fold-related deformation of late Neogene sedimentary rocks. These methods provided the basic structure of the Caribbean plate although in some cases subtle late Quaternary faults bounding the plate evaded detection until their catastrophic rupture during great earthquakes. GPS results collected since 1989 have provided insights into tectonic processes that previous geologic studies either were incapable of recognizing or only hinted at. This talk uses a total of about 100 GPS vectors collected by a variety of workers to illustrate three key tectonic processes affecting the active Caribbean plate margins. The GPS vectors are displayed in various of frames of reference to highlight the three processes:

- Indentation and convergent strain partitioning and forearc slivers in the northern Caribbean and the Pacific margin of Central America

- Indentation and tectonic escape in northwestern South America

- Divergent strain partitioning and arc disruption in northern Central America

Understanding these processes leads to more effective strategies for evaluating seismic hazards and producing realistic models for the physical processes controlling the deformation.

Mann, Paul [1] and Pierce, Stephen [2]

REGIONALLY-ISOLATED HYDROCARBON OCCURRENCES IN SOUTH-CENTRAL DOMINICAN REPUBLIC: PAST EXPLORATION AND FUTURE PROSPECTS

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Natural oil seeps and small-production oilfields in south-central Hispaniola are regionally isolated from much larger and older hydrocarbon provinces in the circum-Gulf of Mexico and northern South America. In this talk, we evaluate the tectonic, stratigraphic, and structural setting of these hydrocarbon occurrences in this era of rapidly escalating energy costs. GPS studies have shown that the area of maximum oblique plate convergence between the Caribbean and North America plates is centered on the topographically elevated and seismogenic island of Hispaniola. The zone of oblique convergence includes the Bahamas Platform, Cretaceous and Paleogene arc rocks in Hispaniola, and the Cretaceous Caribbean oceanic plateau. The onset of oblique collision occurred in late Miocene time.

Since 1904, hydrocarbon exploration in west-central Hispaniola has been concentrated in the elongate, northwest- to west-northwest-trending, thrust- and strike-slip-fault-bounded Cibao, San Juan-Azua, and Enriquillo basins. Previous drilling has largely focussed on drilling surface anticlines formed by Late

Miocene and younger oblique plate convergence. Analyses of Cretaceous to Neogene rocks in the Dominican Republic shows that most rocks contain poor to marginal total organic carbon values and low source rock potential. In the San Juan, Azua, and Enriquillo basins, the middle Miocene Sombrerito Formation exhibits TOC values within the lower end of petroleum generative capacity. Five Neogene stratigraphic units are summarized in this talk because of their close association with known hydrocarbon production areas and seeps.

The future promise of Dominican exploration lies offshore in the Ocoa and offshore San Pedro basins both of which have been been mapped using widely spaced seismic lines but no offshore wells have been drilled in either area (three wells were drilled in the onshore San Pedro basin in the 1970s). Potential reservoirs in these basins include quartz-rich sand eroded from the plutonic terrane of the Cordillera Central and carbonates formed on highs and in coastal areas. Source rocks remain problematic as seen in our study of the onshore basins.

Mann, Paul [1]; Calais, Eric [2]; Demets, Chuck [3]; and Prentice, Carol S.[4]

ENRIQUILLO-PLANTAIN GARDEN STRIKE-SLIP FAULT ZONE: A MAJOR SEISMIC HAZARD AFFECTING DOMINICAN REPUBLIC, HAITI AND JAMAICA

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The Enriquillo-Plantain Garden fault zone (EPGFZ) extends from south-central Hispaniola to Jamaica and defines the southern edge of the Gonave microplate. The EPGFZ forms a continuous and prominent geomorphic lineament from the Enriquillo Valley of the Dominican Republic , through the southern peninsula of Haiti , across the Jamaica Passage between Jamaica and Haiti and along the Plantain Garden fault zone bounding the southern edge of the Blue Mountains of eastern Jamaica . The linearity of the fault and its association with en echelon folds, pull-apart basins, and restraining bends indicates that motion is left-lateral and late Quaternary in age. Historical earthquakes indicate that the last major ruptures of the fault occurred in an east to west time-space progression that began in 1751 in south-central Hispaniola and perhaps culminated in the Kingston , Jamaica , event in 1907. Recorded seismicity over the past 40 years is sparse as expected from a fully locked fault plane. GPS-constrained block models with elastic strain accumulation give ~8 mm/year of slip rate on the fault. Since the last major event in south-central Dominican Republic was in 1751, that yields ~2 meters of accumulated strain deficit, or a Mw=7.2 earthquake if all is released in a single event today. The two largest cities within 30 km of the fault zone are Port-au-Prince , Haiti , and Kingston , Jamaica , with a combined population of 3.65 million inhabitants. There have been no paleoseismic studies of the EPGFZ to determine the exact chronology of its historic and prehistoric ruptures but these studies should be considered high priority given the seismic hazards posed by the fault.

Maresch, W.V. [1]; Schertl, H.-P. [1]; Krebs, M. [1]; Baese, M. [1] and Draper, G. [2]

JADEITITE FROM THE RIO SAN JUAN COMPLEX, NORTHERN DOMINICAN REPUBLIC

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Recently, Harlow et al. (Can. Mineral., 44, p. 305, 2006) described jade (jadeitite) artefacts from Antigua, West Indies, and speculated on their provenance. Jadeitite and other HP-LT rocks are well-known (e.g., Harlow et al., Geology, 32, p. 17,2004) from serpentinite mélanges both north and south of the Motagua fault zone in Guatemala. Here we report new occurrences of jadeitite from the Rio San Juan Complex (RSJC) in the northern Dominican Republic, where diapir-like serpentinite mélanges cut Upper Cretaceous to Lower Tertiary HP-LT mafic schists. The RSJC represents a fossil intra-oceanic subduction zone active between ~120 and ~55 Ma (Krebs et al., Lithos, doi:10.1016/j.lithos.2007.09.003). The jadeitites form irregular individual masses as well as layers within lawsonite blueschist blocks. They are fine-grained, whitish-green, and contain jadeite as the main constituent. Phengite, omphacite, epidote, Na-amphibole, plagioclase and quartz occur in minor amounts. Lawsonite, pumpellyite, and stilpnomelane have been observed. Titanite and rutile are accessories. Generally, jadeite forms euhedral to subhedral prismatic crystals; however, anhedral massive intergrowth textures may be found. The homogeneous cores of the crystals reach 98% jadeite end-member composition (variations in one sample investigated are Jd85-97.8Ag0-6.8Di0.6-7.2Hd0.4-2.5) and are surrounded by very thin retrograde omphacitic rims with pronounced aegirine- and diopside-components (Jd34.1-69Ag7.6-20.6Di3.7-39.5Hd0.7-6.2). The very high amounts of SiO_2 and Na2O in these rocks correlate with low amounts of K2O. A calcalkaline trend is indicated. In comparison to other blocks in the mélanges, the jadeite-rich rocks appear to have experienced a high degree of metasomatism during their formation. The RSJC jadeitites are analogous in both mineralogy and fabric to jadeitites described from occurrences south of the Motagua Fault Zone in Guatemela as well as to the artefacts from Antigua. The RSJC jadeitites should therefore also be considered as potential source material for jade in the Mesoamerican/Caribbean region.

Marroni, Michele [1]; Pandolfi, Luca [1] and Giunta, Giuseppe [2]

THE DUARTE COMPLEX IN JARABACOA AREA (HISPANIOLA): TECTONO-METAMORPHIC RECONSTRUCTION AND IMPLICATION ON THE NORTHERN CARIBBEAN PLATE MARGIN EVOLUTION

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In the northern Caribbean Plate boundary (Guatemala-Greater Antilles) remnants of subduction as well as arc-related complexes are still preserved, generally as poly-deformed and poly-metamorphic terranes.

In Hispaniola the Caribbean oceanic plateau crust outcrops, un-deformed in the Massif de La Hotte-Borohuco of Haiti, while the Duarte complex is the greatest part of the deformed plateau involved in the Caribbean margin.

In the Jarabacoa area, quite different from the Bonao one, the Duarte complex outcrops in a wide fold north-eastward overturned on the Loma Caribe unit. This fold, which upper limb is represented by the Tireo unit, includes different thrust sheets composed by basaltic lavas, radiolarites and volcanoclastics, subdivided in two metamorphic bodies, amphibolitic the lowest and green shist the uppermost, both intruded by tonalitic plutons.

Both the amphibolitic and green-schist bodies are interested by a S1 foliation with a N-S strong L1 mineral lineation, refolded by F2 isoclinal folds producing an S2 foliation generally parallel to S1, which in turn is crenulated.

The whole metamorphic complex is deformed by D3 and D4; D3 is a crenulation cleavage (S3) connected to F3 cylindrical folds, asymmetric with NE vergence. Along the S3 cleavage cataclastic shear zones develop until thrust faults formation, which also constitute the main decollements between Duarte, Tireo, Loma Caribe, and thrust-sheets inside the Duarte itself. The last D4 deformations are F4 open folds with sub-vertical axis and no-penetrative geometries.

The metamorphic and structural characteristics of the Duarte complex, together with the age reconstruction, seem to confirm the involvement of the original oceanic plateau in a middle-Late Cretaceous oblique convergent zone (eo-Caribbean phase), as the consequence of a triple-junction shifting eastward, building progressively the northern margin of the Caribbean Plate and allowing the further bending of the Aves-Lesser Antilles arc.

Martens, U. [1], Solari, L. [2], Mattinson, C.G. [1], Wooden, J. [3], and Liou, J.G. [1]

POLYMETAMORPHISM AT THE SOUTHERN BOUNDARY OF THE NORTH AMERICAN PLATE: THE EL CHOL UNIT OF THE CHUACÚS COMPLEX, CENTRAL GUATEMALA

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The El Chol unit in the Sierra de Chuacús contains banded gneisses, migmatites, and multiple generations of pegmatites with at least 3 phases of deformation. Amphibolitic domains contain eclogitic relicts. Banded gneisses grade into migmatite and trondhjemite bodies. Three samples from El Chol were dated by SHRIMP-RG: a refolded leucosomal band, a mylonitized metapegmatite, and a trondhjemitic gneiss.

Zircon CL patterns are similar in all samples, with inherited cores and three generations of rims. Core ages are 1.05-1.25 Ga. The first generation of rims is CL-light, homogeneous, and truncates core textures. Most ages are discordant, but a ~950-1050 Ma age group suggests a first metamorphic event late in the Grenville orogeny. The second generation of rims is CL-dark, with oscillatory zoning typical of igneous zircon. Ages from metapegmatite cluster at 385-403 Ma, and ages from trondhjemite cluster at 385-391 Ma, constraining the age of migmatization. The third generation of metamorphic rims is CL-gray, homogeneous, and yields a mean age of ~225Ma, coeval with calc-alkaline intrusions southwest of El Chol. No Cretaceous rims were present in the zircons, although a Cretaceous

metamorphic event is well-documented elsewhere in the Chuacús.

The El Chol unit represents a deeper polymetamorphic portion of the southernmost North American crust. Ages of cores and innermost rims indicate affinity with a Grenvillian province. Mesoproterozoic crust was extensively reworked and partially melted during the Devonian (~390Ma). Two deformation phases that refolded Devonian leucosomes are interpreted as the result of the Triassic (~225Ma) metamorphic event recorded in the last generation of metamorphic zircon rims of El Chol, and the Late Cretaceous (~75Ma) event recorded in previously dated samples of the Chuacús complex.

Martínez-Colón, Michael [1*]; Hallock, Pamela [1]; and Green-Ruiz, Carlos [2]

SHALLOW WATER BENTHIC FORAMINIFERS AS BIO-INDICATORS OF POLLUTION BY POTENTIALLY TOXIC ELEMENTS: A REVIEW

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Pollution by potentially toxic elements (PTEs) in estuaries is a major concern for scientists, resource managers and regulatory agencies. Bio-availability, uptake rates, speciation, clay mineralogy, pH, and complexation are some of the factors that control behavior of PTEs in marine systems, especially in estuaries. Breakthrough work has examined incorporation and assimilation of metals into marine macro-invertebrates. However similar work applied to marine protists is still on its earliest stages. Foraminifers, which are shelled protists characterized by granuloreticulopodia, are found in all marine ecosystems. Research in coastal environments has established foraminiferal assemblage distributions and frequencies of morphological abnormalities as useful bio-indicators for anthropogenic pollution. The purpose of this review is to examine environmental factors affecting PTEs in coastal waters with the goal of proposing ways to enhance the use of benthic foraminifers as bio-indicators of such pollution.

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GK-12 OCEANS: AN UNBELIEVABLE EXPERIENCE!!

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The GK-12 OCEANS partnership between USF's College of Marine Science and East Lake High School in Pinellas County-Florida is bringing the ocean science into the classroom. GK-12 OCEANS provide hands-on inquiry activities to enhance the learning about the local marine environment by establishing comparisons with fresh water ponds. In addition, GK-12 provides a unique link between Marine Science graduate students and educators by creating a learning tool based on environmental research. Science-based inquiry, scientific equipment, data collection and problem solving skills provide the students with the unique opportunity to monitor and research habitats within the vicinity of

their school ponds, located near Tarpon Springs-FL. The science concepts learned from monitoring fresh water settings will then be compared via fieldtrips to marine settings. Data collected from the fieldtrips were taken to establish comparisons and analogies between the different environments. All lessons are aligned with states standards (i.e. life processes, ecosystem diversity, and energy). The GK-12 OCEANS is funded by NSF, Progress Energy and the USGS-St. Petersburg, FL.

Martínez-Colón, Michael and Hallock, Pamela

FORAMINIFERAL RESPONSES TO NATURALLY AND ANTHROPOGENICALLY INDUCED STRESSES IN TORRECILLA LAGOON, PUERTO RICO

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Torrecilla Lagoon is a moderately-polluted estuary on the northern coast of Puerto Rico. Foraminiferal assemblages (Ammonia spp. and Quinqueloculina rhodiensis) from 30 cm cores contain a relatively high occurrence of deformed tests (up to 18%), especially among the miliolids, while rotaliids show fewer deformities. Preliminary results for potentially toxic element analysis from bulk sediment samples show concentrations below toxicity levels except for copper. Copper concentrations (50-138 ppm) fall between the Effect Range Low and Effect Range Median values, representing possible to occasional detrimental effects to the aquatic environment. Organic matter content (loss-on-ignition) ranging from 10-23%, coupled with framboidal pyrite, indicates low oxygen conditions. Ammonia spp. show no significant variation in size with sample depth. However, A. tepida is not found in the intervals with highest organic concentrations. The distribution of foraminifers and abundance of Ammonia spp. appears to be related to hypoxiic events coupled with pH and salinity variability. Ammonia-Elphidium index values, a previously established indicator of hypoxia, are 69-100, reflecting the lack of Elphidium species. Diversity indices indicate temporal variability in abundance and distribution of foraminifers. Foraminiferal assemblages coupled with diversity indices and organic matter content indicate that TL has undergone several episodes of hypoxia. Such conditions could explain the relatively high percentage of test deformities, although elevated copper concentrations may be a compounding factor.

Martorell Serra, Nelsy

PASIVOS AMBIENTALES EN LA ACTIVIDAD MINERA NO METALICA EN CUBA

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A lo largo de la historia de la minería en Cuba, la actividad extractiva de yacimientos no metálicos ha sido y es intensa, fundamentalmente la referida a los materiales para la construcción. Los yacimientos que ya no se encuentran en activo por diversas razones técnicas, económicas o sociales, los denominados Pasivos Ambientales, constituyen huellas dejadas en el entorno que reclaman la toma de medidas para su rehabilitación.

Para el Estado Cubano, el objetivo primordial es lograr un desarrollo sostenible, esto es, la compatibilización de los intereses de la economía con los del medio ambiente. Es por ello que ha emprendido acciones concretas desde el punto de vista legal para garantizar, primeramente, que las concesiones mineras actuales contemplen de manera prioritaria la proyección de la rehabilitación de las áreas minadas, así como establecer un programa de recuperación de los Pasivos Ambientales, en función de los intereses territoriales o nacionales.

En el presente trabajo se aborda esta problemática, partiendo del marco regulatorio jurídico e institucional establecido en el país y como parte del trabajo de la inspección estatal geólogo-minera en el territorio de las provincias Ciudad de La Habana, La Habana y Matanzas. Se han identificado y caracterizado las áreas degradadas que no están concesionadas en ese territorio y se recomiendan medidas para su rehabilitación a corto, mediano y largo plazo.

Mazabraud, Yves and Voitus Emile

PROFESSIONAL PREPARATION OF SECONDARY SCHOOL TEACHERS IN THE FRENCH WEST INDIES: THE DILEMMA BETWEEN NATIONAL PROGRAMS AND CARIBBEAN GEOLOGY

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The three territories of the French West Indies (islands of Guadeloupe and Martinique and the French Guyana in South America) are facing a fast increase of population. This implies a strong need in primary and secondary school teachers. Traditionally, secondary school teachers were receiving their initial formation in mainland France. Although they receive quality education, there are not fully prepared to teach within the specific environment of the Caribbean (especially in scientific fields such as geology or biology). To solve this problem and to allow the candidates to be prepared near their home (mainland France is over 6000km away), we opened in 2005 a dedicated teaching unit in Guadeloupe. After presenting the discrepancy between the national programs of education and the local particularities, I will focus on the pedagogical responsibility of the teachers. Indeed, they have to face a highly competitive selection, on the national scene, and then have to be able to contextualize their teaching to the environment of their pupils. Then, I will plead for the institute to institute organization of cross-student exchange and common field trips within the Caribbean.

McCann, William R.

ACTIVE FAULTING IN EASTERN HISPANIOLA AS THE HISPANIOLA-PUERTO RICO MICROPLATE BOUNDARY: IMPLICATIONS FOR REGIONAL EARTHQUAKE HAZARD

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An extensive tract of limestone of mostly Pleistocene-Recent age covers the Eastern part of the Dominican Republic. Numerous distinctive marine terraces outcrop along the southern and eastern coast, the lowest of which has been dated at about 125Ka. In the eastern area, the highest terrace is very variable in elevation, but correlates with a terrace along the southern coast. Manipulation of gridded

SRTM and marine data reveals the location of the upper marine terrace as well as numerous scarps with 10's of meters of relief tending WNW across the region. The relief grid 2nd derivative is used to objectively locate the upper terrace, which is compared to the elevation grid to develop an along escarpment profiles of terrace elevation. If undisturbed, this feature should be contour parallel. Systematic elevation changes along profile suggest titling and numerous abrupt vertical (~30-50m) and at least one horizontal offset (375 m) of this feature. Terrace displacing scarps can be traced many kilometers from offshore, across the coast parallel marine terraces, and continuing inland as linear features that I interpret as active normal faults cutting the limestone platform. Five systems of normal faults have been identified in this manner, the longest of which may be capable of generating earthquakes of about magnitude 7 - 7 ¼. If the age of the upper terrace is roughly about 250Ka, then the observed horizontal displacements of about 375 meters suggest fault motion rates on the order of mm's/yr for each of the 5 faults. This total rate of deformation of several mm/yr is similar to the rate of deformation between the Hispaniola and Puerto Rico microplates calculated from GPS studies, suggesting that much of the inter-microplate motion is not contained to the offshore regions of the Mona Passage, but rather passes onshore in the eastern part of the Dominican Republic.

McCann, William R.

HISTORIC EARTHQUAKES OF THE CARIBBEAN BASIN

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The Caribbean region has a written earthquake record that covers up to 500 years. This information, when combined with paleoseismological studies gives us some insight to the nature of the regional earthquake and tsunami threat. Even though historic earthquake catalogs vary in their quality and completeness for the earlier period, certain regional trends in earthquake activity can be discerned. In the 500-year history many areas have experienced at least one significant earthquake, however, few if any have seen a repeat event on the same fault segment. This probably stems from the slow regional strain rates. Large earthquakes cluster in either space and time or both, with quiescent periods for the Caribbean region lasting for many decades being punctuated by a few decades with numerous destructive earthquakes sometimes occurring over several hundreds or thousands of kilometers. An example of regional sequence occurred with great earthquakes in 1842, 1843, 1856, 1887 in the Greater and Lesser Antilles, and along the Caribbean coasts of Honduras and Panama. Examples of more local sequences are those in the period 1751-1770 affecting southern Hispaniola and 1943-1953 along the northern coast of Puerto Rico and Hispaniola. Maximum earthquake size in the 500-history is about magnitude 8-8 ¼, but while the complexity of fault systems might limit earthquakes larger than that range in certain areas, others, including several which have been quiescent for many centuries, should be considered capable of producing events in the 8 ½ to 9 range. The subduction zone of the southern Lesser Antilles and the northern flank of South America are notable in this regard. Tsunami (slow) earthquakes might also be threat along the eastern and southern subduction zones. Tectonic environments vary along the Caribbean Basin, with subduction zones and strike-slip faults accounting for the bulk of the seismic sources.

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CARIBBEAN AND ATLANTIC PALEO-CLIMATE RELATIONS FROM A PUERTO RICAN SPELEOTHEM

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A 1225-year paleotemperature record has been obtained from an active stalagmite (PDR-1) that grew in a cul-de-sac chamber 350 meters from the mouth of Cueva Perdida of north central Puerto Rico (18.3°N) at 340 m a.s.l. Following collection in 2006, it was cut along the vertical axis, and three U/Th (Multicollector ICPMS) dates within the top 1.7 cm were obtained from the polished slab. A hand-held dental drill milled 200 paired C-O samples at intervals of 0.05mm along the growth axis, with each interval analyzed for $d^{18}O$. Resolution was annual from 2005-1833AD, and every 4th year thereafter to ~780AD.

Puerto Rico is well-located to record migratory shifts of the Intertropical Convergence Zone. These $d^{18}O$ values closely match the existing SST (Sea Surface Temperature) instrumental record for the North Atlantic and are in close agreement with the tree-ring-based AMO (Atlantic Multidecadal Oscillation) through the middle of the 19th century.

Comparison with data at the coastal Arecibo (Puerto Rico) meteorological station showed broad association of the $d^{18}O$ with a clear trend of rising temperatures (1.4°C / 74 yr) since records began in 1931. Modern isotopic data from Puerto Rico and Barbados (eastern Caribbean) also demonstrate a correlation between monthly-weighted $d^{18}O$ of rainfall, and precipitation. The abrupt change in $d^{13}C$ from -8 to -2‰ may be associated with the dramatic reforestation of Puerto Rico since the 1930's.

An initial climate reconstruction shows wide century-scale variation over the past 1200 years, with rainfall and temperature increasing over the half-millenium from 800 AD to maxima at 1300 AD. Thereafter, they decreased to 1900 (but with a peak at 1700) apparently recording both the Medieval Warm Period and Little Ice Age. At present, both are approximately midway between the maxima and minima of the last 1200 years.

Mitchell, Simon F. [1]; Hastie, Alan [2]; Ramsook, Ryan [1]; Brown, Ian [1] and Kerr, Andrew C. [2]

CRETACEOUS EVOLUTION OF JAMAICAN TERRAINS AND THEIR RELATION TO THE EVOLUTION OF THE CARIBBEAN PLATE

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A mid Cenozoic block and trough structure is well established in Jamaica and controlled facies patterns during the deposition of the Yellow Limestone and White Limestone groups. The Cretaceous history, however, is difficult to determine due to a combination of late Miocene-Recent tectonics, limited outcrop, and the poor understanding of stratigraphic and magmatic evolution. Through the integration of new stratigraphic data and igneous geochemistry, we recognize three Cretaceous terrains: the western and central Jamaica (WCJ) block, the SW Blue Mountains (SWBM) block, and the NE Blue

Mountains (NEBM) block. The WCJ block contains a Valanginian to Paleocene succession of arc and fore-arc basin rocks. The arc rocks show a progressive change in geochemistry from island arc tholeiitic basalts and rhyolites to calc-alkaline andesites to dacites. The SWBM block contains a 'basement' of amphibolites and blue schists (with a possible Aptian, but probably older, protolith) and an ultramafic complex, overlain by Campanian to Maastrichtian calca-alkaline volcanics, volcaniclastics and minor limestones. The NEBM block has a basement consisting of Turonian-Coniacian plateau basalts, overlain by a shallowing upwards succession passing from deep-water (?Coniacian-Santonian) turbidite systems to Campanian back arc volcanics and intercalated limestones. The assembly of Jamaica from three separate terrains, and associated formation of short-lived rift basins, occurred in the Late Maastrichtian to Paleocene due to the collision of the leading edge of the Caribbean Plate with the Yucatàn Block. An Late Campanian angular unconformity in the arc rocks of the WCJ block marks the onset of the collision. Using larger formainifers and rudist bivalves (which can be linked to chronostratigraphy) from the shallow-water limestones, the intercalated arc rocks of Jamaica can be correlated with successions elsewhere in the Caribbean as well as with the international timescale. This allows the reconstruction of the magmatic and stratigraphic evolution of the Great Arc.

Mitchell, Simon F.; James, Sherene; Ramsook, Ryan; Coutou, Richard and Fisher, Jason

ST. ANN'S GREAT RIVER INLIER, JAMAICA: A STANDARD SECTION FOR THE SANTONIAN TO CAMPANIAN STAGES (CRETACEOUS) OF THE ANTILLEAN REGION?

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Norman Sohl (1979, Annales du Museum D'Histoire Naturelle de Nice, IV, p. XXXXI.2) stated that the "stratigraphic continuity and occurrence of both mollusks and foraminifera make this [St. Ann] one of the most important sequences in the Antilles for establishing a detailed biostratigraphy of the Caribbean Province", yet little work has subsequently been undertaken.

We constructed accurate GPS base maps, mapped and logged the stratigraphic succession. Many small-scale faults and one larger fault are present, but previously suggested 'major faults' are of minor importance, and our largest fault within the Cretaceous has not previously been recorded. We logged 1,200 m of section, with a gap in Early Campanian corresponding to the major fault. The section consists of alternating units consisting of mudstones, interbedded mudstones and conglomerates, and conglomerates, worthy of lithostratigraphic status. Conglomerates include diamictites and clast-supported conglomerates with abundant mudstone rip-up clasts; we interpret these as slope deposits.

Macrofossils are abundant in many matrix-supported conglomerates (admixtures of shelf and shallow water-faunas) and mudstone units. A thin unit of interbedded mudstones and rubbly platform limestones, containing abundant rudist bivalves, is present in the upper part of the succession. The fauna includes abundant ammonites (e.g., *Peroniceras*, *Texanites*, *Bevahites*), inoceramid bivalves (e.g., *Mytiloides*, *Platyceramus*, *Cataceramus*), 'pelagic' crinoids (*Uintacrinus*), gastropods, rudist bivalves and benthic and deep-water planktic foraminifers (e.g., *Dicarinella*, *Sigalia*). Calcareous nannofossils have previously been described from the succession, and can be related to our logs. These allow a comparison of the faunal succession in the Caribbean tropics, and a correlation with the international chronostratigraphy. These occurrences demonstrate significant differences between 'established' and actual ages of various rudist bivalves (e.g., *Barrettia*). It is clear that the section in St.

Ann's Great River Inlier is extremely important, not only for correlation within the Caribbean, but also as an index section for global correlation.

Montes, Camilo [1]; Morón, Sara [2]; Bayona, Germán [1]; Cardona, Agustín [2] and Jaramillo, Carlos [2]

THE SALVAGE PANAMA CANAL GEOLOGY PROJECT: WORKING PLAN AND MAJOR QUESTIONS

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In 2007 the Panamá Canal Authority received the green light to start excavations along the Canal area to open new access channels to new and existing locks and to widen and deepen existing navigational channels. These works will afford an outstanding opportunity to collect fresh samples along the working areas and study the geology of the isthmus from a set of brand new outcrops. Additional to the surface outcrops, hundreds of geotechnical cored-boreholes, both existing and from future drilling, will be re-examined and re-interpreted. A number of geological transects are being planned in coordination with the Panamá Canal Authority to gather as much data as possible during the expansion works. The main objective of the geological transects is to characterize the structural style across the isthmus, unravel stratigraphic relationships, refine the ages of the volcanic bodies with geochronology to establish timing of volcanism, carry out paleomagnetic studies to establish the paleolatitudinal positions and characterize tectonics blocks, collect paleontological material to constrain the migration of vegetation across the isthmus and carry out low temperature thermochronological research to reconstruct the timing of unroofing. Major questions to be answered include the affinity of the volcanic assemblages (Bas Obispo, Panama, Caimito, Caraba, Las Cascadas, Pedro Miguel Formations), in particular whether they record the growth of the Central American arc over the Caribbean Large Igneous Province (CLIP) since the Late Cretaceous (90 Ma), and the interactions with the Pacific plates and the South American margin. Deformation styles along the projected transects should help understand the genesis of the isthmus, whether it is an orocline due to collision and exhumation of part of the CLIP, or it is a island arc that is being progressively accreted to the South American margin. Pre-accretionary deformational events may be also uncovered from the structural and temporal constraints gathered during the project.

Mora Páez, Héctor

GEORED: RED NACIONAL PERMANENTE GPS CON PROPÓSITOS GEODINÁMICOS DE COLOMBIA

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El Instituto Colombiano de Geología y Minería-INGEOMINAS presenta a la comunidad internacional el proyecto RED NACIONAL PERMANENTE GPS CON PROPÓSITOS GEODINÁMICOS, más conocida como GEORED, el cual se encuentra en etapa de implementación, como consecuencia de los

interesantes resultados obtenidos después de veinte años de trabajo. Esta propuesta surge bajo consideraciones de pertinencia técnica, científica, social, económica y política, como la manera apropiada de incrementar el grado de conocimiento de la geodinámica en la esquina noroccidental de Suramérica para reducir las amenazas asociadas como sismos y erupciones volcánicas y así ayudar en la adecuada toma de decisiones. GEORED es una herramienta esencial para determinar la deformación de la corteza terrestre y es fundamental en el análisis de deformación interplaca e intraplaca y del ciclo sísmico actual. Es a su vez otro escalón en el despliegue a mediano plazo de una red de instrumentación y observación geofísica multipropósito que mejorará las capacidades de la red geofísica actual. En la actualidad, el INGEOMINAS está operando otras tres redes: la Red Sismológica Nacional-RSN, la Red Nacional de Acelerógrafos-RNA y la Red de Observatorios Vulcanológicos. La primera fase de la red corresponde a la instalación de una red núcleo compuesta por lo menos de 30 estaciones de operación continua. Complementariamente, estaciones de campo de operación anual proporcionarán información específica de zonas de estudio particular.

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PETROGRAPHY AND GEOCHEMISTRY OF MIOCENE VOLCANIC ROCKS, EASTERN DOMINICA

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Geologically the island of Dominica can be divided, based on stratigraphy and age dates, into four major stratigraphical units: Miocene (7.0-5.3 Ma), Pliocene (4.0-2.0 Ma), “Older” Pleistocene (2.0-1.8 Ma) and “Younger” Pleistocene-Recent (<1.8 Ma). The Miocene volcanic rocks, which are only exposed on the eastern side of the island, appear to be dominantly lavas flows and subaerial volcaniclastic deposits. Paucity of on-land exposures together with significant weathering and erosion of the Miocene rocks make it very difficult to define individual volcanic centers, so that the suite will be described as a whole. Petrographically the Miocene volcanic rocks are dominated by phenocrysts of plagioclase with lesser amounts of orthopyroxene, clinopyroxene, olivine and magnetite. Geochemically they range from basalts and basaltic andesites (most abundant) to andesites (minor) and, on the basis of K2O content, appear to show two distinct fractionation trends with values of K2O of 0.8 and 1.41% at 60% SiO2. As a whole the suite shows decreasing trends of Al2O3, Fe2O3, MgO, CaO, V, and Sr and increasing trends of Na2O, K2O, Ba, Rb and Zr with increasing silica. The relatively low values of MgO, Cr, and Ni in the basalts suggest that even the most basic rocks have undergone significant fractionation.

Morón, Sara and Jaramillo, Carlos

MIOCENE CULEBRA - CUCARACHA FORMATION BOUNDARY IN PANAMA. CLIMATIC OR TECTONIC CHANGE?

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The Culebra and Cucaracha Formations are exposed in the Panama Canal Basin. The Early Miocene

Culebra Formation consists of mostly carbonaceous shale, black mudstones, and a minor proportion of lithic sandstone and sparse cobble conglomerates. Foraminifera, ostracods and bivalves are reported at the base of this unit and mammals, fossil leaves, seeds, and abundant pollen to the top. This biota change shows the beginning of a progradational deltaic system. The Early to Middle Miocene Cucaracha Formation is composed by reddish to grayish mudstone and claystone with some conglomerates and an ash layer in the middle of the unit. Fresh-water mollusks, turtles, crocodiles have been found. Its depositional environment is interpreted as a deltaic plain with fluvial channels, mangroves, and flood plains and represents the maximum progradation of the system. The contact between Culebra and Cucaracha formations is abrupt, easily recognizable by a color change, it is of regional extent, and could be used to unravel stratigraphic relations in the Panama Canal Basin. It is interpreted as a sequence boundary, product of an abrupt change (progradation) of the entire depositional system. Besides the use for regional correlation of this contact, it could also record an important event in the region. It could represent a rapid aridification of the basin, changing from a humid climate in the Culebra to much drier conditions in the Cucaracha as has been proposed by G. Retallack recently. This change could be related to the onset of the Middle Miocene Climatic Optimum, a global event that represents the warmest phase peak of the Neogene. An alternative explanation for the contact could be a significant decrease in subsidence rates that could generate an increase of the time of exposure of the sediments, producing extensive paleosols deposition.

Muñoz Tapia, Santiago J. [1] y Rodríguez Reyes, Jesús [2]

ATLAS DEL POTENCIAL GEOLOGICO-MINERO DE LA REPÚBLICA DOMINICANA

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El Servicio Geológico Nacional de la República Dominicana, está desarrollando el Proyecto denominado “ATLAS DEL POTENCIAL GEOLOGICO-MINERO DE LA REPÚBLICA DOMINICANA”, que tiene como principal objetivo promocionar, orientar y poner en conocimiento de la administración del Estado, de la sociedad dominicana y de los inversionistas promotores, en los recursos geológicos-mineros, los indicios minerales y las rocas ornamentales, localizados en todo el territorio dominicano. Estos puntos y zonas con potencial económico, se referenciarán en los mapas regionales, provinciales y municipales, con el interés en potenciar económicamente cada renglón.

Inicialmente se ha elaborado un proyecto piloto para dos provincias, (Monte Cristi y Monte Plata), con un estimado de tres meses. Posteriormente se revisará el trabajo realizado y se continuará el trabajo con otras fases, hasta completar todo el territorio de la República Dominicana.

Muñoz Tapia, Santiago J.

LA IMPORTANCIA DEL SERVICIO GEOLÓGICO NACIONAL Y LOS AVANCES DE LOS ESTUDIOS GEOTEMÁTICOS EN LA REPUBLICA DOMINICANA

Servicio Geológico Nacional (Dirección General de Minería)

El Servicio Geológico Nacional de la Republica Dominicana se creó mediante el decreto Numero 207-

98, del 3 de junio de 1998, dentro del Reglamento de Aplicación a la Ley Minera 146, como una subdirección de la Dirección General de Minería, con personalidad Jurídica y Patrimonio Propio. El Objetivo del Servicio Geológico Nacional es de servir, generar y transferir información básica geológica, minero-económica, conocimientos científicos y técnicos para el desarrollo: minero, infraestructuras de desarrollo como puentes, carreteras, edificaciones, la prevención de riesgos geológicos, desastres naturales, las aguas subterráneas, ordenamiento territorial y la protección del medio ambiente.

Los Servicios Geológicos Nacionales son los depositarios del conocimiento científico de la geología del territorio de sus respectivos países, de su actualización y de su adecuación para contribuir a satisfacer las necesidades de los ciudadanos y mejorar su calidad de vida. El SGN posee el inventario de estudios Geotemáticos en la Republica Dominicana que se han generado en los últimos 10 años, además los estudios que actualmente se realizan hasta el año 2010. Estos estudios han arrojado resultados que enmarca al país en una excelente posición en cuanto a la calidad y cantidad de las informaciones geocientíficas.

En el año 1996, la Unión Europea acometió el desarrollo del Programa Sysmin I para países ACP (Asia, Caribe y Pacifico) cuyo objetivo es dotar de una base infraestructural a dichos países, que posibilite el desarrollo del sector Geológico-minero. Uno de los proyectos seleccionados fue el denominado “Cartografía Geotemàtica en la Republica Dominicana”, luego se continuo en el año 2002 con la segunda fase y los proyectos del Bloque Noroeste (K) y el (L) suroeste y (L) este. En el año 2007 se inicio el Programa Sysmin II para la realización de la cartografía geotemática que complete todo el territorio de la Republica Dominicana.

Muñoz-Martín, A. [1]; Granja Bruña, J.L. [1]; Carbó-Gorosabel, A. [1]; Córdoba-Barba, D. [2]; Martín-Dávila, J. [3]; Llanes Estrada, P. [1] and Catalán, M. [3]

CRUSTAL MODELS ACROSS THE MUERTOS MARGIN: INSIGHT FROM NEW GEOPHYSICAL DATA AT THE SOUTHERN SLOPE OF DOMINICAN REPUBLIC

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The Muertos convergent margin is an east-west tectonic feature located in a back-arc region along the eastern Greater Antilles southern slope. This margin is a result from the convergence between the North American plate and the Caribbean plate. Muertos Trough is considered as the southern boundary of Hispaniola microplate and Puerto Rico-Virgin Island block. From different data sources has been suggested a subduction process taking place along this margin, but nevertheless new geophysical data could suggest different interpretations.

In this work we discuss different geophysical models for the Muertos margin. Cross section models are north-south trending at 69.25ºW and go from Venezuelan Basin through Muertos margin to southern coast of Dominican Republic. For constraining models we have mainly used data collected along the

central region of Muertos margin during the GEOPRICO cruise (2005) aboard the Spanish R/V Hespérides. Data include multibeam bathymetry, potential fields (gravity and geomagnetic) as well as deep seismic sounding recorded by land seismometers. Moreover, we have constrained the models using regional seismicity, previous multichannel reflection profiles as well as data from DSDP holes 146/149 in the Venezuelan Basin. We have tested different models for this tectonic boundary from subduction of the Venezuelan Basin crust beneath island arc to limited underthrusting of the Venezuelan Basin crust beneath the southern insular slope.

Nelson, C.E.

CRETACEOUS VOLCANIC DOMES AND GOLD MINERALIZATION, PUEBLO VIEJO DISTRICT, DOMINICAN REPUBLIC

Gold, silver and zinc mineralization throughout the Pueblo Viejo district is spatially and temporally related to Early Cretaceous volcanic domes that vary from basaltic andesite to dacite in composition. In the Moore deposit, gold mineralization surrounds a dacite porphyry volcanic dome dated at 111 Ma (U-Pb date on zircon). In the Monte Negro deposit, an andesite dike coeval with volcanic domes of the same composition has been dated at 109 Ma (U-Pb date on zircon). These dates confirm a Cretaceous age for volcanic dome emplacement; the presence of hydrothermally altered clasts within volcanic facies of the dacite porphyry and the andesite indicate that gold mineralization was coeval with volcanic dome emplacement.

An intrusive origin for the dacite porphyry dome in the Moore deposit is indicated by crosscutting contacts between the dacite porphyry and surrounding sedimentary rocks, by a baked contact metamorphic aureole adjacent to the dome margin, and by tilting of flat-lying epiclastic carbonaceous sedimentary rocks adjacent to the contact. Inclined drill holes confirm the presence of a dacite porphyry feeder dike beneath the dome.

Quartz eyes, eroded from the Moore dacite porphyry dome, occur in the adjacent carbonaceous epiclastic sedimentary section. Lenses of dacite porphyry slump breccia are interbedded with carbonaceous epiclastic sedimentary rocks near the dome margin. These observations confirm an exogenous origin for the dacite porphyry dome at the Moore deposit. Similar andesitic crumble breccias mantle volcanic domes of identical composition in the Monte Negro deposit.

A genetic link between Cretaceous dome emplacement and gold mineralization is indicated by the spatial association of domes and mineralization and by abundant evidence for coeval dome emplacement and gold mineralization. Hydrothermally altered fragments occur in the dacite porphyry volcanic dome and the surrounding carbonaceous sedimentary section; hydrothermally altered fragments also occur in crumble breccias that mantle volcanic domes of andesitic composition in the Monte Negro deposit. U-Pb dates confirm a Cretaceous age for emplacement of volcanic domes and related dikes at Pueblo Viejo; observations in the pits indicate that gold mineralization was coeval with dome emplacement.

Nelson, C.E.

INTRODUCTION TO GENETIC MODELS FOR THE PUEBLO VIEJO GOLD-SILVER-ZINC DISTRICT, DOMINICAN REPUBLIC

A total of 5.3 million ounces of gold and 24.4 million ounces of silver has been recovered from five open pits in the Pueblo Viejo district since mining commenced in 1975. After mining through the oxide reserve, the deposit operated on a reduced schedule during the 1990's and closed in 1999. The rights to develop the remaining sulfide resource were won by Placer Dome in an international bidding process and, in 2005, Barrick Gold announced a measured and indicated gold resource of 150 Mt at an average grade of 3.2 g/t gold, sufficient to generate 600,000 ounces per year for 17 years at a cash operating cost of $200 per ounce.

Genetic models for the origin of the deposit differ sharply over both the age of mineralization (Early Cretaceous versus Late Cretaceous to Paleocene) and the geologic setting (volcanic dome field versus maar-diatreme). Kesler et al. (1981) proposed that Pueblo Viejo formed in a hot spring environment on the flanks of a Cretaceous volcano. Sillitoe and Bonham (1984) argued recognized that a portion of the sedimentary section was actually of pyroclastic origin and suggested a maar-diatreme setting. Russell and Kesler (1991) adopted the maar-diatreme volcanic setting and went on to desribe gold mineralization in a large (2 km) maar crater filled by carbonaceous sedimentary rocks. Nelson (2000) rejected the maar-diatreme setting and presented the results of geologic mapping as evidence for gold mineralization in a Cretaceous volcanic dome field.

Despite the differences, these models agree that gold mineralization was coeval with deposition of the Los Ranchos Formation, a primitive island arc of Early Cretaceous age. Recently, however, Sillitoe et al. (2007) attributed gold mineralization to an underlying calc-alkaline intrusion proposed to be approximately 40 Ma younger than the Los Ranchos Formation.

Reconciliation of these models, if it occurs, will rely on geologic mapping and on direct dating of gold mineralization at the mine. This workshop provides a forum for discussion of the various genetic models and the various intrusive, extrusive, pyroclastic, epiclastic, and sedimentary rock units that have so long been a subject of controversy at Pueblo Viejo.

Nelson, C.E.

METALLOGENIC MAP OF THE CARIBBEAN BASIN

The Caribbean Basin is host to over 2000 known mineral occurrences and boasts a current mineral endowment of 100 million ounces (Moz) Au, 1048 Moz Ag, 35.7 million tonnes (Mt) Cu+Pb+Zn, plus substantial lateritic Ni and Al. A metallogenic map has been prepared that shows the distribution of these deposits on a geologic base providing a point of departure for discussions of metallogenic provinces, evolution of the lithosphere, and metallogenesis at convergent plate margins.

Sisson, V.B.; Avé Lallemant, H.G.; Hemming, S.; Valencia, V.; Brueckner, H.; Roden-Tice, M.; Blythe, A. and Harlow, G.E.

NEW U/PB AND FISSION TRACK GEOCHRONOLOGIC CONSTRAINTS ON THE SUBDUCTION HISTORY OF CENTRAL GUATEMALA

Two belts of high-pressure/low temperature (HP/LT) metamorphic rocks occur in the central Motagua fault zone, the boundary zone between the Caribbean and North American plates in Guatemala. To the south (Chortís block) the HP metamorphic event was reached at ~130 Ma, whereas in the north (Maya block), there were several HP events with the latest occurring between 88-65 Ma (U/Pb and $^{40}Ar/^{39}Ar$). The oldest rock in the central Maya block is an augen gneiss (447 Ma, U/Pb) that is in contact with the Jones Fm. phyllite, which contains detrital zircons from 318 to 2170 Ma with a peak at 580 Ma. The oldest rocks in the Chortís block are the San Diego phyllite with detrital zircon ages that tie the Chortís block to Mexico or southern California and support a Permian depositional age. Ar/Ar ages from the Chortís basement as well as HP rocks suggest different PTt paths. In contrast, the final Tt path for both the basement and HP rocks in the Maya block are similar. Fission track ages suggest that the Maya block was cooled through ~200 to 100 oC between 55 to 31 Ma; this in contrast with Chortís block which was exhumed later between 35 and 15 Ma.

During the first thermal event the Chortís block collided with central Mexico and an ocean-vergent fold and thrust belt developed. In the second event, the Chortís block collided with the Maya block and a continent-vergent fold and thrust belt developed. Two more cooling events occurred in Oligocene and Neogene time related to plate interactions. The structural, stratigraphic, and geochronological data suggest that exhumation of the HP / LT rocks occurred in four phases: (1) gravitational instability, (2) plate-boundary parallel stretching resulting from oblique convergence along a curved arc; (3) forearc extension; and (4) crustal thrusting and erosion.

Nivia Guevara, Álvaro

THE WESTERN CRETACEOUS OCEANIC LITHOSPHERIC PROVINCE OF COLOMBIA, A POSTULATED REMNANT OF THE CARIBBEAN PLATEAU

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Since the demonstration in late 1980's that in Colombia the Cretaceous volcanic rocks that make up the bulk of the oceanic materials outcropping to the west of the Cauca-Almaguer Fault (former Romeral Fault) display a geochemical signature akin to oceanic plateaus, several lines of evidence have increased favoring such hypothesis. These materials, referred as Western Cretaceous Oceanic Lithospheric Province, consist on mafic igneous rocks -volcanic and plutonic- associated to marine sedimentary rocks. Although the majority of the volcanics are tholeiites with a narrow range of composition, two local facts are noteworthy in relation to them: first, presence of Mg-rich rocks such as picrites and even komatiites; and second, the bi-modal tholeiite-rhyolite composition of some pyroclastic segments. The latter characteristic is also observed in the plutonic rocks that include both gabbros and tonalites. This province outcrops as shrunken intercalated slices of rocks, the deformation of which strongly depends on their competence, being the sedimentary intervals the most affected, specially the finer grained rocks that were transformed into mylonites. Original sedimentary sequences are deformed to the point that stratigraphic units are impossible to define and in consequence all the

sedimentary rocks have been grouped and referred as the Dagua Complex. The deformation of the complex is interpreted as the result of an Early Eocene collision of South America and the proposed Caribbean Oceanic Plateau during its westward drifting. During the collision, and due to the buoyancy of the plateau, some of its fragments were welded as an accretionary complex to the active continental margin and clogged the subduction zone that was forced to jump westward of the accreted fragments. Since then, this province has behaved as the leading edge of the active continental margin suffering all the consequences of this tectonic situation such as continental margin magmatism and forearc basin development.

Odum, Jack K. [1]; Williams, Robert A. [1]; Stephenson, William J. [1]; Worley, David M. [1]; von Hillebrandt-Andrade, Christa [2]; Asencio, Eugenio [3]; Irizarry, Harold [2] and Cameron, Antonio [2]

COMPARISON OF NEAR-SURFACE VS30 AND NEHRP CLASSIFICATIONS FROM PASSIVE SOURCE SURFACE WAVE AND ACTIVE SOURCE BODY WAVE DATA IN PUERTO RICO

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In 2004 and 2005 the Puerto Rico Seismic Network (PRSN), Puerto Rico Strong Motion Program (PRSMP) and the Geology Department at the University of Puerto Rico-Mayagüez (UPRM) collaborated with the U.S. Geological Survey to study shallow shear-wave (Vs) velocities in and around major urban areas of Puerto Rico. Data were acquired using active source (hammer and timber) body wave (seismic refraction-reflection) and passive source (cultural noise) surface wave (refraction microtremor-ReMi) techniques along the same seismic profile. Twenty seven sites were selected on the premise that they are generally representative of the primary geologic units found in the major urban areas. Units surveyed include Cretaceous intrusive and volcaniclastic bedrock (Vs=660-2,400 m/s), Tertiary sedimentary (Vs=440-1,200 m/s) and volcanic units (Vs=770-2,210 m/s), and Quaternary unconsolidated to consolidated reef, eolian, fluvial, beach, and lagoon deposits (Vs=120-1,025 m/s). Adding complexity to interpretations, sub-tropical weathering has altered bedrock to thick sections of saprolite soil (Vs=140 m/s) at some sites.

We calculated average Vs to 30-m depth (Vs30) and assigned NEHRP (National Earthquake Hazards Reduction Program) site classifications. Distribution of NEHRP classes is as follows: three class "E" (Vs30<180 m/s), nine class "D" (Vs30 between 180-360 m/s), ten class "C" (Vs30 between 360-760 m/s), and four class "B" (Vs30> 760 m/s). Analysis of ReMi dispersion curves (phase velocity versus frequency) show that a “feel” for site stratigraphy can be gained from the characteristic pattern and form of the curve. There does not appear to be a consistent bias between the techniques in that one method did not give consistently higher values.

Both methods are noninvasive and ideal for urban area studies. The wide range of geologic settings combined with localized deep bedrock weathering, provide an opportunity to evaluate the strengths and weaknesses of these complementary techniques under a variety of site conditions.

Ojeda, Germán [1]; Vargas-Jiménez, Carlos Alberto [2]; Cerón, John [3]; Rey, Carlos [2]; and Cardona, Agustín [4]

UPLIFT AND SUPPORT OF THE SANTA MARTA MASSIF: ONGOING REMOVAL OF MANTLE LITHOSPHERE?

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Mountains in local isostatic equilibrium are entirely supported by low-density crustal roots floating in the mantle. The corresponding geophysical signature of locally supported mountains is typically a gravity 'low' that results from the lateral crust-mantle density contrast across the root. In the southwestern Caribbean, however, the 5.8 km high Sierra Nevada de Santa Marta (SNSM) is known to coincide with a significant (>150 mGal) gravity 'high', thus indicating conditions of local isostatic disequilibrium. We attempted to model the state of isostasy of the SNSM and adjacent basins as supported by flexure of an elastic plate. Our models, however, failed to replicate the observed gravity anomaly and basement geometry, ruling out conditions of regional isostatic compensation and confirming that the adjacent basins were not produced by flexure due to SNSM topography load. By performing a 3-D inversion of the gravity field we demonstrate that the SNSM rests on a Moho that is elevated up to 11 km relative to the surrounding Plato, Rancheria and Tayrona basins. Sharp gradients in both observed gravity anomalies and modeled Moho topography across the Santa Marta and Oca strike-slip faults, which delimit the SNSM to the SW and N, are evidence that these faults are vertical discontinuities that dislocated the entire crust and possibly the mantle lithosphere. The significant Moho relief suggested by our gravity model, in addition to the apparent absence of a crustal root under the SNSM, disagrees with mountain building models based on lateral shortening or crustal thickening. The lack of a crustal root is best explained by a model involving localized removal of mantle lithosphere, or delamination. This 'mantle deblobbing' model offers a sensible explanation for the SNSM's (1) gravity anomaly and apparent lack of crustal root; (2) localized uplift; and (3) high P-wave velocity detected by available tomography models.

Paleobathymetries for the Urumaco Formation range from inner to outer neritic (<200m). Preliminary paleoenvironmental interpretations are as follows: (1) The great abundance of *Ammonia parkinsoniana gp.* is indicative of inner neritic depths, and the common frequency of *Elphidium discoidale* further suggests a neritic-lagoonal zone. (2) The extremely low diversity in samples of the Urumaco Formation suggests stressed environments. Values of Fisher's alpha <5 agree with marginal marine environments such as a brackish marsh or hypersaline lagoon. The high frequency of *A. parkinsoniana gp.* also supports this interpretation, as this species can tolerate a wide range of salinities and is commonly dominant in both low-salinity mainland lagoons and hypersaline lagoons. (3) These assemblages, including well-preserved ones, are nearly barren of miliolids and rich in *Textularia panamensis*, suggesting a siliciclastic depositional environment with low amounts of carbonate relative to the Caribbean today.

Pase, Danya R. [1]; Schweig, Eugene [2]; Tuttle, Martitia [3] and Joyce, James [4]

TECTONIC ACTIVITY OF THE GREAT NORTHERN PUERTO RICO FAULT ZONE: REMOTE SENSING AND FIELD VALIDATION

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Earthquake hazard in Puerto Rico is high, as evidenced by historically damaging earthquakes, tsunamis, and high rates of instrumental seismicity both onshore and offshore. Although not yet demonstrated as active, the Great Northern Puerto Rico fault zone (GNPRFZ) is of particular concern because it is a major, through-going structure mapped from the eastern coastal plain, along the Gurabo River valley, into the Central Cordillera, and passing just south of the densely populated San Juan metropolitan area. Empirical magnitude-rupture length relations suggest that the GNPRFZ is capable of producing an earthquake of moment magnitude 7.3, given a maximum rupture length of 80 km. We analyze aerial photography and LiDAR (Light Detection and Ranging) data to identify active faulting in the coastal plain near Punta Santiago, the Mambiche hills, and the headwater valley of the Gurabo River of northeastern Puerto Rico. Aerial photography is analyzed for geomorphic features such as lineaments, offset ridges and streams, and transpression ridges that are suggestive of surface deformation. LiDAR data are used to create a 1 m DEM within an ArcGIS framework. Areas of interest are identified, sampled, and processed with hillshade, aspect, slope, sink, and other various geomorphometric techniques. Aerial photography and LiDAR are compared in ArcGIS to identify cultural features and changes in vegetation index. Field targets are selected on the basis of aerial photography interpretation and analysis of LiDAR data indicating several lineaments in the vicinity of the mapped trace of the Cerro Mula fault in the valley south of Peña Pobre. Ultimately, we excavated two trenches along the presumed trace of the Cerro Mula fault. One trench revealed equivocal evidence of faulting in deeply weathered Tertiary volcanic rocks, truncated upward by slope colluvium. The second trench was in spoil, possibly from railroad construction. A nearby stream exposure, however, displayed clear evidence of shearing in weathered Tertiary volcanic rocks with the overall appearance of strike-slip flower structures. All faults are truncated upward by alluvial rock fragments. No datable material was found at any of the exposures. Results from this study do not change hazard assessment for San Juan, Puerto Rico, but suggest other targets for further investigations.

Patarroyo Camargo, German David

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PALEOECOLOGÍA DE UNA LAGUNA ARRECIFAL EN UNA ISLA OCEÁNICA PARA EL MIOCENO MEDIO BASADA EN LA MACROFAUNA UN CASO DE ESTUDIO: SAN ANDRÉS ISLA, CARIBE COLOMBIANO

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Sometida a las fluctuaciones del nivel del mar a lo largo de su formación, la isla de San Andrés ubicada en la parte occidental del Caribe Colombiano, constituye una estructura arrecifal de tipo atolón

gradualmente depositada sobre un basamento volcánico de posible edad Paleógeno.

El presente trabajo ilustra los resultados obtenidos del estudio sistemático de la macrofauna fósil recolectada en 17 afloramientos en la parte montañosa sur y central de la isla y pertenecientes a la Formación San Andrés de edad Mioceno Medio.

Los afloramientos estudiados aquí, basados en la malacofauna encontrada y las interpretaciones de Geister (1975) con corales, ilustran el siguiente paleoambiente:

Un paleoambiente de laguna arrecifal donde asociados a parches sectorizados de corales ramificados tipo *Porites* y/o *Acropora*, hay bivalvos infaunales tipo *Cardita*, *Anodontia*, *Lucina* y *Chione* y la ocasional aparición de los gasterópodos *Strombus*, *Fasciolaria* y "*Natica*". Estos organismos son encontrados como moldes internos, debido a la disolución total o parcial de sus conchas originalmente aragoníticas.

Bivalvos de concha gruesa en una menor proporción, y de composición calcítica se encuentran representados por los géneros *Ostrea*, *Crassostrea*, *Hyotissa* y *Spondylus*. Adicionalmente es notorio ilustrar la presencia del bivalvo *Pycnodonte*, acumulado en grandes proporciones sobre los afloramientos de la parte central de la isla.

La fauna reportada muestra condiciones de baja energía, con profundidades entre 5 y 20 m, donde la parte mas central de la isla muestra las profundidades mas grandes y que gradualmente se someriza hacia el sur del área colinada como lo ilustran la presencia de corales masivos como *Montatrea* y *Siderastrea*, y organismos epifaunales en grandes cantidades como *Pecten* y *Chlamys*. Adicionalmente, la presencia de *Strombus* de considerable tamaño en el sector suroccidental y la granulometría mas fina de los sedimentos podrían estar evidenciando la presencia de pastos marinos sectorizados.

Payero, J. [1,3]; Kostoglodov, V. [2]; Shapiro, N. [4]; Mikumo, T. [2]; Iglesias, A. [2]; Pérez, X. [2] and Clayton, R.[5]

NON-VOLCANIC TREMOR OBSERVED IN THE GUERRERO SUBDUCTION ZONE, MEXICO

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Non-volcanic tremor (NVT) activity is clearly identified as episodes of higher spectral amplitude in the range of 1-8 Hz in daily spectrograms from the continuous records at broad band seismic stations in the Guerrero state, Mexico. The analyzed data cover a period of 2001-2007 when in 2001-2002 a large slow slip event (SSE) had occurred in the Guerrero-Oaxaca region, and then followed by a steady-state interseismic epoch of 2003-2005 and a new large SSE occurred in 2006. The tremor signals in Mexico are very similar to those obtained in Cascadia subduction zone. The average tremor burst duration is of 10-60 min, and it apparently has S-wave propagation velocity. More than 100 strong NVT bursts were recorded by the most of the Meso-American Subduction Experiment (MASE 2005-2007) seismic

stations with the majority of epicenters clustered in the narrow band of ~40 x 150 km2 to the south of Iguala city and in parallel to the coastline. NVT hypocenters are poorly constrained but mostly scattered in the continental crust between 5 and 45 km depth. Tremor activity is relatively higher during the 2001-2002 and 2006 SSE compared with that for the "quiet" period of 2003-2005. Very low NVT occurrence for the period of about 2 months right after the SSE is apparent in 2002 and 2006. Similar to the Japan and Cascadia subduction zones, the main tremor activity in Mexico develops in the area close to the mantle wedge. In Mexico it is located at approximately 200 km inland from the trench. Gravity and magnetic anomalies modeling favors a hypothesis that the NVT is apparently related to the dehydration and serpentinization processes. Nevertheless a conductivity pattern obtained from the magnetotelluric profile in Guerrero does not correlate directly with the NVT distribution.

Payero, J.[1,2]; Pujols , R. [1,3]; Martínez, F. [1]; y Arias, J. [1]

62 AÑOS DE INSTRUMENTACIÓN SISMICA Y 500 AÑOS DE SISMOS EN REPUBLICA DOMINICANA: PREPARATIVOS DEL SISTEMA DE ALERTA TEMPRANA EN EL ISU-UASD

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3. Red Sísmica de Puerto Rico, Posgrado en Ingeniería, UPRM, Puerto Rico.

La instrumentación sismológica dominicana se inicia a raíz del terremoto del 4 de agosto de 1946 (M8.1). El sismólogo, Rvdo Joseph Lynch, colocó un sismómetro de manera temporal para estudiar las réplicas de dicho terremoto. Se instaló la Estación Central SDD, con instrumentación triaxial (SP) y (LP) moderna, el 26 de febrero de 1948. Decenas de terremotos (telesismos) y miles de sismos locales fueron registrados hasta final de los 70´s. En 1979 se procedió a la instalación de la red del Valle del Cibao, permitió la primera zonificación y elaboración de Normas de Edificaciones. La colaboración de la UE permitió la instalación de la red sísmica del noreste, en 1998 (Sysmin I). Se logró el catálogo digital, mejor zonificación sísmica (10 zonas). En el 2002 se amplió la red nacional del ISU, se instaló una estación BB en la sede y seis (SP) en el interior.

Actualmente la Red Sísmica del ISU cuenta con 5 estaciones BB, tres de ellas instaladas mediante la colaboración del USGS y la RSPR y otra con la colaboración de la Universidad de Texas en Austin (J. Pullian), más 6 estaciones análogas. Se reciben tres de Puerto Rico y otras 3 de Cuba, Jamaica e Islas Turcas y Caicos, utilizando el sistema "Earthworm" para el procesamiento e intercambio de datos e informaciones por Internet, incluyendo el servicio en tiempo real. Desde el 2005 el ISU está participando de los preparativos de la "Red de Alerta Temprana contra Tsunamis en el Caribe, Golfo de México y Atlántico Medio", con la cooperación de los Estados Unidos de Norteamérica (McNamara, 2005) y los países de Centroamérica y el Caribe. El proyecto GEOPRICO-DO (2005) con la UCM y el ROA de España, han complementado estos preparativos. El ISU interviene activamente en la Comisión Nacional de Emergencias en materia de protección sísmica y cuenta con el catálogo sísmico dominicano 1500-2007 actualizado diariamente.

Peña Lantigua, Luis R.

LINEAMIENTOS GENERALES, ESTRATEGIAS Y ACCIONES PRÁCTICAS PARA LA REDUCCIÓN DEL RIESGO SÍSMICO, EN UNA ZONA DE ALTA SISMICIDAD (REPÚBLICA DOMINICANA)

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La República Dominicana se ubica en la parte oriental de la Isla Hispaniola ocupando las dos terceras partes de la misma. Los estudios geotectónicos, geofísicos, geodésicos y paleosísmicos indican que la Isla se encuentra dentro del contacto norte de la Placa del Caribe con Norteamérica y por consiguiente en una zona de altas Amenazas o Peligros Sísmicos.

Se conoce que el alto riesgo sísmico es el resultado de combinar las amenazas o peligros sísmicos con una alta vulnerabilidad social - estructural y que los escenarios de desastres son el producto del riesgo manifiesto mal manejado. Se presentan en esta exposición, estrategias y acciones para la reducción del riesgo sísmico en una zona de altas amenazas o peligros sísmicos como la República Dominicana.

Dentro de las estrategias se analizan:

La participación de todos los sectores públicos y privados para la obtención de resultados positivos.

Un cambio de actitud cultural en cuanto a las amenazas o peligros sísmicos en la Isla, ya que sus manifestaciones en eventos pueden abarcar una o más generaciones, conllevando al olvido de la realidad.

Desarrollo e Integración de acciones prácticas dentro del Sistema Educativo, Ordenamiento Territorial, la Seguridad de la Infraestructuras o Vulnerabilidad Estructural y Gestión Moderna de Riesgos, que permiten la reducción del riesgo sísmico en las comunidades y las áreas construidas.

Pérez-Estaún, A. [1], Hernaiz Huerta, P.P. [2]; Lopera, E. [3]; Joubert, M. [4]; Escuder Viruete, J. [3]; Díaz de Neira, A. [3]; Monthel, J. [4]; García-Senz, J. [5]; Ubrien, P. [4]; Contreras, F. [2]; Bernárdez, E. [2]; Stein, G. [4]; Deschamps, I. [4]; García-Lobón, J.L. [3]; and Ayala, C. [3]

GEOLOGY OF THE DOMINICAN REPUBLIC: FROM ISLAND ARCS TO ARC-CONTINENT COLLISION

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The Geology of Hispaniola Island results from the oblique-convergence to final collision of the North American Plate, underthrusted beneath the Cretaceous Caribbean island-arc since the Eocene times. Located in the northern edge of the Caribbean Plate, Hispaniola consists of a tectonic collage of fault bounded igneous, metamorphic and sedimentary rocks of Late Jurassic to Cretaceous age, accreted in

an intra-oceanic island-arc setting. These rocks are regionally overlain by a cover of Eocene/Oligocene to present time siliciclastic and carbonate sediments, that post-date island-arc activity and record the period of dominant left-lateral strike-slip motion between the North America and Caribbean plates. During collision, deformation took place under a transpressive tectonic regime. Magmatic island arc rocks, forearc and backarc basins, together with exhumed HP rock complexes and other collisional units are recognized in the Hispaniola Island. The high-P complexes with eclogites, blueschists facies metamorphic rocks and ophiolitic mélanges that outcrop in the Cordillera Septentrional of Hispaniola, and in the Samaná Peninsula form part of the accretionary wedge related to the collision between the North American Plate and the Caribbean Plate.

Pérez-Valera, F. [1]; Abad, M. [1]; Rodríguez-Tovar, F.J. [2] y Monthel, J. [1]

ICNOFACIES Y SEDIMENTACIÓN TURBIDÍTICA EN LA FM. LUPERON (CORDILLERA SEPTENTRIONAL, PUERTO PLATA, REPÚBLICA DOMINICANA)

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En este trabajo se describe por primera vez una asociación de trazas fósiles que aparece en materiales sedimentarios atribuidos a la Formación Luperón, una formación de Edad Eoceno superior-Mioceno inferior definida en el área de Luperón- Puerto Plata, en el ámbito de la Cordillera Septentrional (norte de la República Dominicana)

Se ha estudiado un afloramiento situado en las inmediaciones de la ciudad de Puerto Plata, donde se encuentran algunos niveles correspondientes a una potente sucesión de margas con intercalaciones de areniscas laminadas en niveles centimétricos, que según las características litológicas y a partir de la cartografía realizada, corresponden a niveles de la parte media de la Formación Luperón, en este sector con una facies particular y con fauna de edad Oligoceno.

En el techo de los niveles de arenisca aparece una asociación de trazas fósiles dominada por las icnoespecies *Helminthoides* y *Paleodyction*, que muestran, además diferentes tamaños, bien visibles en *Paleodyction*, cuya variabilidad oscila entre celdillas hexagonales de 5 mm a 20 mm y con retículas que pueden llegar a formar cuadros de 5x5 cm. Las trazas de *Helminthoides* también muestran una cierta continuidad, llegando a ocupar superficies de varios centímetros cuadrados.

Esta asociación de icnofósiles es característica de la icnofacies de *Nereites*, que se interpreta como una asociación de trazas fósiles propia de ambientes marinos profundos, generalmente ligados a sistemas turbidíticos desarrollados en las partes distales del talud o en cuencas profundas.

Los datos de los icnofósiles, por tanto, en conjunción con los datos litológicos y sedimentológicos, permiten interpretar que los sedimentos de la Formación Luperón en el área de Puerto Plata se depositaron en ambientes turbidíticos generados en cuencas profundas durante el Oligoceno.

Pérez-Valera, Fernando [1]; Hernaiz-Huerta, Pedro Pablo [1]; Abad, Manuel [1] y Pérez-Estaún, Andrés [2]

DATOS PRELIMINARES SOBRE LA ESTRATIGRAFÍA DE LA CORDILLERA

SEPTENTRIONAL EN EL SECTOR DE IMBERT-EL MAMEY (PUERTO PLATA, REPÚBLICA DOMINICANA)

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A partir de la realización de la cartografía geotemática a escala 1:50000 de este sector de la Cordillera Septentrional, se ha puesto de manifiesto la existencia de tres unidades turbidíticas de edad Eoceno sup.-Mioceno inf., depositadas en contextos similares en otras partes de la cuenca y de manera discordante sobre sedimentos volcánicos y vulcanosedimentarios del Cretácico superior-Eoceno medio (Fm Palma Picada, Fm Los Caños, Fm Los Hidalgos y Fm Imbert). En la parte sur, entre la zona de falla Septentrional (ZFS) y la zona de falla de Camú (ZFC) se ha reconocido la Fm Altamira, una secuencia siliciclástica compuesta por una alternancia de areniscas turbidíticas y margas, con potentes niveles de conglomerados y calcarenitas en la parte superior. Al Norte de la ZFC se reconoce la Fm Luperón, con distintas facies y procedencia de clastos de un área fuente distinta. Entre ambas formaciones, y situada en la ZFC se encuentra una serie de nueva definición: la serie de Agua Clara, que tiene características intermedias entre la Fm Altamira y la Fm Luperón.

Por encima de estas unidades aparece en discordancia una secuencia perteneciente a otra unidad de nueva definición: los conglomerados de La Jaiba, reconocida principalmente en la ZFC y compuesta por potentes series de conglomerados y arenas, de edad Mioceno medio, con clastos procedentes principalmente del Complejo de Puerto Plata. En los sectores más occidentales pasa hacia arriba a otra serie turbidítica: la serie de Gran Mangle (Mioceno med-sup). Al sur de la ZFC, y hacia el oeste de El Mamey, también se reconoce la serie de Gran Mangle, en este caso depositada de manera discordante sobre la Fm Altamira y la Fm Los Hidalgos, sin la presencia de los conglomerados de La Jaiba. La serie de Gran Mangle continúa al oeste hacia la zona de Buen Hombre, donde se sitúa directamente por encima de los materiales volcánicos y vulcanosedimentarios de la serie del Carcheal (Cretácico-Paleoceno).

Pindell, James

EARLY CRETACEOUS CARIBBEAN TECTONICS: MODELS FOR GENESIS OF THE GREAT CARIBBEAN ARC

Tectonic Analysis, Ltd.; Dept. Earth Science, Rice University

Since the 1980's, consensus has favoured a Pacific origin for the Caribbean Plate's oceanic interior, and debate centers mainly on how and when, rather than if, Caribbean crust entered the inter-American gap. Along Jurassic western Pangean margin, E-ward dipping Cordilleran subduction spanning North-to-South America is indicated by continuous Jurassic arc plutons/volcanics in reconstructions. But polarity of the Great Caribbean Arc (Antilles) was W-dipping from Aptian onward, as indicated by the spatial association of HP (trench) complexes in Guatemala, Cuba, Hispaniola, Margarita, and Venezuela, whose metamorphic histories were initiated in the Aptian, and coeval Albian-Eocene magmatic arc complexes. Thus, in simple cross section, Aptian (possibly late Neocomian) polarity reversal is inferred. But in three dimensions, the EFFECT of polarity reversal can be achieved more in other ways. Here I examine feasible Neocomian plate boundary geometries to deduce options for what Early Cretaceous Antillean geology might be telling us. In particular, the role of sinistral strike slip and

potential associated complexities along the lengthening Neocomian plate boundary connecting SW Mexico and Ecuador is examined, with predictions of possible geological associations made. These associations are then compared to known Antillean geology as well as to processes known from other plate boundary systems like the Aleutians. Favourable comparisons might indicate new explanations for aspects of Antillean geology, as well as which Neocomian plate boundary geometries might be most likely. I conclude that the Aptian onset of W-dipping subduction at a transform boundary connecting the Americas is at least as likely as a true polarity reversal. Thus, arguments which might dampen enthusiasm for true polarity reversal do not necessarily affect the concept of the Pacific origin of Caribbean crust. The results of this analysis probably provide leads for future research which can better elucidate alternative Early Cretaceous tectonic models for the early inter-American gap.

Pindell, James

EXPLORATION SETTING OF BARBADOS RIDGE: ONE PRISM OR TWO?

Tectonic Analysis, Ltd.

Barbados Ridge has long been interpreted as a single, E-facing prism of accreted SoAm-derived sediments formed by W-dipping Atlantic subduction. However, a prism-prism collision model, in which the Caribbean AND SoAm margins were already convergent boundaries above the doubly-subducting Proto-Caribbean lithosphere as W-E diachronous collision progressed, appears to better satisfy: Atlantic plate kinematics; seismic tomography; Venezuelan and Trinidadian basin and sand distribution histories; and structural data on Barbados. In this model, the north-facing ENE-trending SoAm hanging wall passes from the Atlantic westward beneath Barbados where it is subducted beneath Caribbean Plate. In East Venezuela-Trinidad, 150km of N-S convergence occurred at this SoAm subduction zone before Caribbean collision, shortening and metamorphosing SoAm's Mesozoic Araya-Paria-Northern Range slope strata. At the higher structural level of Barbados, the SoAm trench accretion is represented by portions of Scotland and prism cover beds. Upon collision, far-travelled Caribbean prism was thrust over pre-existing SoAm prism, represented by obducted Manicuare, Copey, ?Toco, Sans Souci, ?Galera, Oceanics, and some Scotlands of Ven-Trin-Barb. Caribbean-SoAm collision in Barbados is Mid-Miocene, and Tobago Basin backwedging is a triangle zone where SoAm prism was wedged beneath Caribbean prism Oceanics, but above Caribbean forearc basement; the latter, in turn, overthrust the SoAm hanging wall (like today). During collision, the SoAm prism was accreted to the Caribbean Plate; this composite prism has moved 300km E wrt SoAm, driving E-vergent accretionary folds east of Barbados Ridge. The two-prism model predicts previously overlooked tectonic domains. The N-vergent SoAm prism is the largest stratal domain present, represented by much of the tuff-lacking Scotlands and the Tobago forearc backwedge, which may comprise Oligocene-Early Miocene SoAm-derived clastics accreted N of the structurally higher Eocene Scotlands. In contrast, Caribbean prism may comprise only rocks above the backwedge (eg., tuff-bearing Oceanics), which may explain why Caribbean prism is nearly absent in cross-sections of the Venezuelan collision zone: (easily eroded). This model ties much of Barbados Ridge and backwedge to SoAm, rather than allochthonous Caribbean, with beneficial associations for source rocks, quartzose clastics, and oil/gas generation.

Prentice, Carol S. [1]; Mann, Paul [2]; Weber, John [3]; Crosby, Christoper [4] and Peña, Luis R. [5]

PALEOSEISMOLOGY IN THE CARIBBEAN: A REVIEW

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Throughout much of the Caribbean region, the major seismogenic structures are offshore, and inaccessible to traditional paleoseismic techniques. However, where onshore faults occur, excavations reveal faulted Holocene sediments that record paleoseismic events. In addition, Quaternary landforms reveal evidence for active tectonics. Over the the last decade, we have conducted paleosesimic research in the Domincan Republic, Puerto Rico, Trinidad, and most recently in Jamaica.

Our studies of the Septentrional Fault zone (SFZ) in the Dominican Republic show that the most recent rupture on the SFZ east of Santiago, in the central part of the Cibao Valley, occurred about 800 years ago, and was associated with a minimum of about 4 m of left-lateral strike-slip displacement. The penultimate event occurred after AD30, suggesting a recurrence interval of 800 to 1200 years. Studies of offset Holocene stream terraces suggest a SFZ slip rate of 6-12 mm/yr, indicating that this structure accommodates about half of the geodetically determined total plate-boundary motion of approximately 19 mm/yr.

The major structures of the North American-Caribbean plate boundary are offshore north of Puerto Rico. However, our mapping and paleoseismic studies demonstrate that repeated Holocene surface rupture has occurred on a previously unrecognized fault scarp in the Lajas Valley of southwestern Puerto Rico. Several excavations across this scarp exposed faulted alluvium and evidence for two, and possibly three earthquakes. Radiocarbon ages suggest that at least two earthquakes occurred on this fault in the last 5000 years.

Trinidad is located along the plate boundary between the South American and Caribbean plates. Geodetic studies suggest that a significant fraction of the total plate-boundary motion is being accommodated across the Central Range Fault in central Trinidad. Our excavations across the Central Range Fault indicate that the most recent surface rupture occurred within the last 2700 years, and prior to 550 years ago.

Proenza, J.A. [1]; Zaccarini, F. [2]; Rudashevsky, N.S. [3]; Cabri, L.J. [4]; Garuti, G. [5]; Rudashevsky, V.N. [3]; Lewis, J.F. [6]; Longo, F. [7]; Galí, S. [1] ; Tauler, E. [1]; Labrador, M. [1]; and Bloise, G. [7]

MINERALOGY AND CHEMISTRY OF NI-LATERITES FROM FALCONDO, CENTRAL DOMINICAN REPUBLIC: PRELIMINARY RESULTS ON PLATINUM GROUP MINERALS (PGM)

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As part of a detailed study of the mineralogy and chemistry of the laterites formed over the El Caribe peridotite massif, Central Dominican Republic, a combination of Electric Pulse Disaggregation (EPD) [Cabri et al., 2008*: Canadian Mineral Processors Conference*, paper #14] and the separation of heavy minerals by hydroseparation (HS) technology [Rudashevsky et al., 2002: *Transactions of the Institution of Mining and Metallurgy* (Section B: Applied Earth Science) 111, B87–B94)] was applied to study one sample from a Ni-lateritic profile at Loma Peguera area, to determine the occurrence of the platinum group minerals (PGM). EPD liberates accessory minerals from many rock types in a pristine condition without damaging them. The hydroseparation technology is very efficient in separating trace amounts of PGM from the fine fractions of powdered samples [Cabri et al., 2005: *Minerals Engineerin*g, 18, 887–897]. The analyzed sample (3.3 kg), was taken from the saprolitic zone (horizon D, This horizon consists of predominantly hard fragments of serpentinite from 5-25 cm in diameter set in a matrix of soft serpentine minerals. The fragments are a pale yellow ochre or dark grey color and often show concentric alteration zones.

The <40 μm fraction HS concentrates of saprolitic sample show several PGM. The PGM assemblage comprises Ru, Os, and Ir-rich phases, including laurite [$(Ru,Os,Ir)S_2$] and unknown Ru-Fe and Ir-Os-Fe alloys/oxides. In general, PGM are characterized by an irregular shape, rugged surface and high porosity. To the best of our knowledge, this is first record of in situ PGM in a Ni-laterite profile derived from ophiolite-related peridotites. The heavy concentrate also included chromite, magnetite, goethite and awaruite grains, as well as metals: Fe, (Fe,Cr), Ni, Cu, Sn and Pb. The silicate minerals consist predominantly of serpentine, and minor olivine and quartz.

The PGE alloys/oxides present in the saprolitic zone at Loma Peguera may represent the product of alteration of pre-existing PGM, or may result from precipitation under lateritic conditions. Their occurrence suggests the existence of mechanisms of remobilization and crystallization of PGE in lateritic environments. This study was funded by the Ministerio de Educacion y Ciencia, Spain.

Pujols, Rafael [1,2]; Ierkic, Mario [1]; Huérfano, Victor [3] and McNamara, Daniel [4]

BACKGROUND SEISMIC NOISE OF PUERTO RICO BASED ON DATA FROM THE PUERTO RICO SEISMIC NETWORK

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We characterize the background seismic noise in Puerto Rico using data from twelve broadband seismic stations for a period of three years from 2005 to 2007. We make the calibration files and convert the data for each seismic station to the Standard for Exchange of Earthquake Data (SEED) format, and then we use the software PQLX to make noise analysis, which use power spectral density (PSD) and probability density function (PDF) with algorithms describe in McNamara and Buland (2003). The different noises that we characterize are: 1) Cultural noise, 2) Wind, water and geological noise, 3) Microseisms and 4) System artifact in the PDF noise field like data gaps and sensor glitches, which is very useful for seismic network quality control. Besides we make diurnal, seasonal and geographical variations of the seismic noise. We include a special session with the studies of the seismic noise affect by tropical storm in the long period band. In general we observe that PRSN have a good performance in their broadband seismic station and need to dense their seismic station in the north part of the Puerto Rico Island.

Pulliam, Jay [2]; Huérfano, Victor [1]; von Hillebrandt-Andrade, Christa [1]; Odonel Gomez, Luis [3] and Payero, Juan [4]

THREE-DIMENSIONAL CRUSTAL STRUCTURE OF THE NORTH AMERICAN-CARIBBEAN PLATE BOUNDARY IN THE DOMINICAN REPUBLIC

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The Northern Caribbean Plate Boundary Zone is a complex region that has been modified extensively by the relative eastward movement of the Caribbean Plate and the plate's impact with the buoyant Bahama carbonate platform. The results include extensive subduction of oceanic crust belonging to the North American Plate, a broad zone of deformation to accommodate strain, the development of several new transform and normal faults to relieve stress after collisions, the formation and rotation of microplates, and the rearrangement and aggregation of crustal fragments into new islands.

On 22 September 2003, a large (mW=6.5) earthquake struck the Dominican Republic, causing widespread damage that included partially collapsed buildings and bridges in the cities of Santiago and Puerto Plata and landslides in the mountainous outlying areas. Aftershocks reaching mW =5.1 followed for weeks afterward. This earthquake sequence is the strongest to affect the Dominican Republic since a series of powerful thrust events, including five earthquakes ranging in magnitude from 7.1 to 8.1, occurred between 1943 and 1953. Prior to 1943, significant earthquakes occurred in 1564 (in which the city of Santiago was destroyed), 1783, 1842, 1887, and 1897.

Following the 2003 Puerto Plata main shock we deployed 10 broadband seismographs borrowed from the IRIS PASSCAL Instrument Center around the aftershock zone for a period of two months and analyzed the data jointly with data from two permanent seismic networks in the Dominican Republic. Analyses included estimating a new 1D model of earth structure, re-locating more than 300

aftershocks, producing a 3D tomographic model of the fault zone from phase arrivals, and computing focal mechanisms. We will report the results of these analyses and their implications for regional structure, tectonics and seismic hazard.

Ramírez-Martínez, Wilson R. [1]; Diaz-Diaz, Viviana [1]; Ruiz, Tanisha [1]; and Hubbard, Dennis K. [2]

CORAL GROWTH RATES, SEDIMENTATION RATES, SEDIMENT COMPOSITION AND CORAL COVER IN THE CAÑADA HONDA HOLOCENE REEF, DOMINICAN REPUBLIC

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The high degree of preservation of the fossil corals and the reef structure makes Cañada Honda an excellent example of a Holocene shallow water coral reef. This outcrop presents an exceptional opportunity to study a fossil marine ecosystem without human induced variables. Annual growth rates were measured and averaged (fifty years per sample minimum) for 19 coral samples of the species *Montastraea faveolata* and *Siderastrea siderea*. The growth rates of most samples, regardless of species, stratigraphical and/or lateral location, varied between 0.13-0.45cm/yr. These growth rates are similar to growth rates of the same species in modern reefs. In some cases corals with the lower growth rates were located stratigraphically higher in the section. This may be an important clue to unravel the reef history. Foliations present in a *Montastraea faveolata* colony were used to estimate sedimentation rates. The foliations were interpreted as a period of re-growth after episodes of continuous sedimentation. Ten foliations were measured. The growth rate in the foliations varied from 0.11cm/yr to 0.26cm/yr. The average sedimentation rate was calculated to be 0.17cm/yr. for an average reef accretion of 1.7m/1000yrs. This value is consistent with the 1m per1000yrs of reef accretion cited in the literature. The composition of the sediments within the reef was also measured (n=13). The sediments contain more than 90% carbonate material, with 0.80% to 9.40% insoluble material. A time surface present along the reef (marked by a layer of broken coral and sediments) allowed to measure the living coral cover on the reef paleosurface. Six fifteen meters transects were measured for a total linear surface of ninety meters. Living coral colonies per transect varied between 14-20. The number of species per transect varied between 10-14. The coral cover (coral alive at the time of burial by the event) varied between 37-55 percent.

Ramírez-Martínez, Wilson R. [1]; Johnson, Claudia [2]; Martínez, Michael [3]; Torres, María del C. [1]; Ortíz, Verónica [1] and Vélez, Jorge [1]

STRONTIUM ISOTOPES STRATIGRAPHY FROM *KUPHUS INCRASATUS*, CENOZOIC LIMESTONES, PUERTO RICO

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2. Kansas University

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Low magnesium calcite shells of *Kuphus incrassatus* were collected from basal units of the Lares Limestone and Ponce Formation, northern and southern Puerto Rico, respectively. Petrographic

examination in plane polarized light, cathodoluminescence, trace element and stable isotope geochemistry identified diagenetically altered shell areas. Eleven calcium carbonate samples were collected from bivalve shell regions with lowest probability of alteration. $^{87}Sr/^{86}Sr$ isotopic compositions were converted to numerical ages to obtain the age of shell formation and an estimate of the age of the limestone where the *Kuphus* shells were in original growth position. Northern coast $^{87}Sr/^{86}Sr$ isotopic values from *Kuphus* collected above the San Sebastián - Lares Limestone contact range from 0.708087 to 0.708105 and span the interval from 26.58 to 27.17 Ma. Based on foraminiferal assemblages and a sequence boundary, the age of this contact was previously estimated as Late Oligocene. The strontium isotope data are consistent with the previous age assignment and increase the chronologic resolution. Southern coast 87Sr/86Sr isotopic values from shells collected above the contact between the Ponce Formation and the Angola Limestone equivalent range from 0.708889 to 0.708880 and suggest deposition from 9.92 to 11.56 Ma. $^{87}Sr/^{86}Sr$ values are again consistent with previous work and refine the chronologic resolution of the contact from the Middle Miocene based on foraminiferal assemblages to the earliest Late Miocene. This preliminary study suggests that strontium isotope values extracted from *Kuphus incrassatus* shells can be used successfully to better constrain the chronostratigraphy of Cenozoic limestones in Puerto Rico.

Ramírez-Martínez, Wilson R.; Chardón, Samanta; Morales, Rafael J.; Adorno, Yamira; Ortíz, Marisol; Camacho, Ivellisse and Rosario, Vanesssa

DOLOMITES OF MONA ISLAND, PUERTO RICO

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Its isolation and 100% carbonate rock composition make Mona Island ideal to study dolomitization. Mona Island is located in the Mona Passage, 72 km west of Puerto Rico, and was formed by tectonic uplift during the Mio-Pliocene. Five (twenty meters) stratigraphic sections along the north coast of the island were measured and sampled. Seven depositional facies were identified; Red Algal Wackestone, Skeletal Packstone, Foram-Red Algal Packstone, Grainstone, Red Algal Packstone and Skeletal Wackestone. Facies with high concentrations of red algae show higher percentages of dolomite. Facies with abundant foraminifera have higher porosities and lower dolomite percent. Dissolution of foraminifera has produced abundant moldic porosity. Lateral and stratigraphic variations are present in the degree of dolomitization. Dolomite occurs in a wide range of crystals forms, fabrics and mosaics and ranges from fabric destructive to retentive. Microcrystalline dolomite is widely distributed. Euhedral, limpid dolomite commonly fills the intergranular porosity. Lower in the stratigraphic sections (10 to 20 meters below ground) the units show extensive dolomitization. Higher in the sections (upper 10 meters) dolomitization mostly affect the matrix. Dolomites are calcian with CaCO3 mean mole percentage of 53. Average δelta18O and δ13C values relative to PDB are +3.7 0/00 (+ 0.9 0/00) and +2.0 0/00 (+ 0.8 0/00) respectively. Mean dolomitic Sr concentration is 243 ppm. Fe and Mn mean concentrations are 4,183 ppm and 100 ppm respectively. Sr isotopic ratios are bimodal in distribution. Surface samples ratios are higher (0.709018 + 0.000008) than subsurface ratios (0.708965 + 0.000008). If effected by marine waters these Sr isotopic ratios suggest two different times of dolomitization, middle and late Miocene. However, these variations can be explained also by Sr contamination from non-marine waters. The petrographical and geochemical data obtained is compatible with dolomitization in a mixture of marine and aquifer waters.

Ramsook, Ryan and Mitchell, Simon F.

ICHNOLOGY AND SEDIMENTOLOGY OF A DEEP WATER PALEOCENE SYN-RIFT DEPOSIT, BLUE MOUNTAIN INLIER, EASTERN JAMAICA

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The siliciclastic turbiditie-mudstone sequence of the Moore Town Formation (Maatrichtian? to Paleocene), Blue Mountain Inlier, eastern Jamaica, hosts a diverse association of trace-fossils. The depositional setting is interpreted to be a part of a syn-rift basin into which turbidity currents dumped a variety of sediments (rift-filling). The formation comprises four sedimentary facies, three of which are characterized by diverse ichnofossils (from base to top): Facies I (alternating thinly bedded lignitic shales, siltstones and mudstones), Palaeodictyon-Amitoidea-Chondrites-Planolites-Cosmorhaphe; Facies II (alternating thinly bedded bioturbated siltstones, shales and fine grained sandstones with PCL), *Helminthopsis – Cosmorhaphe – Spirorhaphe – Helminthorhaphe – Planolites – Thalassinoides - Taphrhelminthopsis*; Facies III (poorly sorted, clast and matrix supported conglomerates); Facies IV (massive, thick calcareous, organic rich medium grained sandstones and coarse grained concretionary sandstones), *Scolicia – Palaeophycus - halassinoides*. The trace-fossil associations are dominated by the *Nerites* Ichnofacies in the lower part of the formation (Facies I) and the *Cruziana* Ichnofacies in the upper part (Facies II and IV), showing behavioral diversity from suspension to deposit feeders. The three distinctive litho- and ichnofacies associations recognized and the stratigraphic disposition reflects a general shallowing upwards palaeoecological relationship; abyssal marine-mid/distal continental shelf-nearshore shelf, based on modern analogues of ocean slope and shelf zones. Further, Ichnological studies of the Moore Town Formation indicate that the benthic palaeocommunity was dominated by annelids or similar worm-like animals living predominantly within the sediments.

Rangel, Buitrago N. y Posada, B.

EROSIÓN COSTERA EN EL CARIBE COLOMBIANO. EJEMPLOS: DEPARTAMENTOS DE CÓRDOBA, MAGDALENA Y LA GUAJIRA

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En la zona costera de los departamentos de Córdoba, Magdalena y La Guajira (Caribe colombiano) se observan serias evidencias de la acción a gran escala de la erosión litoral. Este fenómeno se ha convertido en un serio inconveniente para los diferentes elementos que conforman el paisaje, tales como pobladores, estructuras civiles, parques nacionales y una amplia variedad de ecosistemas ubicados a lo largo de sus líneas de costa. Ante esta problemática, el Instituto de Investigaciones Marinas y Costeras (INVEMAR) ahondó en el conocimiento de los procesos de erosión y su influencia dentro de cada ecosistema para el establecimiento de una base de conocimiento en el componente geológico marino. Mediante análisis comparativos de fotografías aéreas y levantamientos en campo se determinaron los cambios (erosión-acumulación) ocurridos en la línea de costa de estos departamentos.

En todos los casos se determinaron tasas de erosión que en ocasiones superan los -1,5 m/año; este fenómeno erosivo trae consigo pérdidas significativas de terreno y genera impactos negativos a la economía. Los datos obtenidos permitieron definir que los procesos erosivos son favorecidos por las altas condiciones hidrodinámicas, desequilibrio en aportes sedimentarios, destrucción de ecosistemas, tectónica y el ascenso en el nivel del mar. Muchas veces estos procesos son multiplicados por la intervención antrópica que se manifiesta con la construcción indebida de estructuras y explotación inadecuada de materiales como arena y manglar.

Rheubottom, A. [1,2]; Smith, A.L. [2] and Roobol, M.J. [3]

PETROLOGY OF MORNE DIABLES, A LATE PLEISTOCENE TO RECENT STRATOVOLCANO, DOMINICA

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The island of Dominica located bear the center of the Lesser Antilles island arc comprises at least eight potentially active volcanoes. One of these is Morne aux Diables, an isolated composite cone situated at the extreme northern end of the island. Age dating suggests the main cone building activity occurred between 1.5 and 1.0 million years ago. Exposed on the volcano's northern and western flanks however are a number of unconsolidated valley-fill block and ash flow deposits, two of which gave dates of >46,000 and 43,710 years B.P., suggesting more recent activity. Other evidence of potential activity from this center includes the presence of warm (27˚C), acidic (pH 1.6) sulfate-rich springs on the summit of the volcano, hot springs on the coast, and the occurrences in 2002 and 2003 of shallow earthquake swarms partially located beneath the volcano. Morne aux Diables is dominantly composed of deposits of block and ash flows and associated domes from Pelean-style activity, however semi-vesicular andesite block and ash flows and surges (Asama-style activity) and pumiceous lapilli falls (Plinian-style activity) are locally abundant. The Pelean domes are located both in the summit region and along the southern flanks of the volcano. Petrologically, the volcano is composed of a monotonous series of porphyritic andesites and dacites containing phenocrysts of plagioclase+augite±hypersthene with very sparse crystals of hornblende and quartz. Petrological models suggest the Morne aux Diables andesites and dacites can be produced by fractional crystallization of basaltic magma (similar to those erupted from centers such as Morne Anglais and Morne Plat Pays in the south). Minor variations within this suite of andesites and dacites can be related to upper crustal fractionation of phenocryst phases.

Rodríguez Crombet, Ramona; Lavaout Copa, Waldo; Ferro Espinosa, Pedro y Perez Alfaro, Rafael

CARACTERÍSTICAS PETROLOGO GEOQUÍMICAS YACIMIENTO CAMARIOCA NORTE, MACIZO MOA BARACOA

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El presente trabajo tiene como objetivo la determinación de las características petrologo- geoquímicas

de las rocas ofiolíticas del Macizo Moa Baracoa, Yacimiento Camarioca Norte, como vía de posible pronóstico de las cortezas ferroniquelíferas cobaltiferas.

La región de estudio está constituida por ofiolitas que forman parte del cinturón septentrional de Cuba, y a la faja Mayarí Baracoa, propias del substrato del mar marginal, formadas en zonas de suprasubducción, Iturralde V.1996.

Las ofiolitas objeto de estudio pertenecen al macizo Moa Baracoa, este se localiza en el extremo oriental de la faja Mayarí Baracoa con un área aproximada de 1500 Km2, presentando un gran desarrollo de los complejos ultramaficos, cumulativos y volcanosedimentarios, se observan harzburgitas, dunitas, lherzolitas, wherlitas y sus serpentinitas, gabros normales y olivinicos, troctolitas, peridotitas impregnadas, intrusivos leucocraticos, piroxenitas, anortositas, diques de gabro pegmatitas, bordeando a este macizo se observan rocas pertenecientes al arco volcánico del Paleógeno y Cretácico además de la cobertura del Neógeno Cuaternario reciente.Ver Fig1.

Este se elaboró con 134 muestras, 49 muestras del basamento de pozos de perforación petrográficos y mineralógicos a los cuales se le realizaron análisis químicos mediante ICP, y 85 pozos petrográficos de estudios anteriores. Se pudieron detectar harzburgitas y sus serpentinitas, dunitas y sus serpentinitas, peridotitas crisotilicas, antigoriticas, peridotitas plagioclásicas, gabros y plagioclasitas.

Para el análisis petrológico y geoquímico se utilizó el sistema NEWPET (1992) y para la Petrografía la Clasificación del IUGS (1996), Subcomisión de la Sistemática de la Rocas Igneas.

Después del estudio petrológico y geoquímico pudimos llegar a la conclusión de que en el área se observan los niveles Ofioliticos de complejo transicional o MTZ y en menor cantidad el de las tectónitas (peridotitas metamórficas). Es necesario comentar la dificultad que presenta el yacimiento al predominar el nivel transicional por la complicación que presentan las Harzburgitas y sus serpentinitas con las peridotitas impregnadas, los sills y diques de gabros, intrusivos leucocráticos, que afectan la productividad de las cortezas ferroniqueliferas.

Rodríguez, Mateos, Eduardo [1] y García, Fidel [2]

PLAN HIDROLÓGICO NACIONAL DE LA REP. DOMINICANA. INFLUENCIA DE LOS RECURSOS DE LAS AGUAS SUBTERRÁNEAS EN EL BALANCE HÍDRICO DE LAS DIFERENTES CUENCAS HIDROGRÁFICAS DEL PAÍS DOMINICANO

1. GRUSAMAR. Grupo Elsamex (España)

2. Wegroup (R. Dominicana)

El objetivo general del Plan Hidrológico es revelar la situación de los recursos hídricos de la República Dominicana, identificando áreas que merecen de intervención prioritaria y determinar las actuaciones necesarias que aporten a la racionalización y aprovechamiento sustentable del agua para solucionar o prevenir problemas que afectan o amenacen el crecimiento social y económico de la nación. El objeto básico del Estudio ha consistido en identificar y estimar las demandas actuales y futuras para todos los sectores sociales y productivos de manera regionalizada, así como cuantificar los recursos hídricos disponibles por cuencas hidrográficas, con el fin de determinar los balances hídricos correspondientes en diferentes años horizontes e identificar zonas de déficit actual y pronosticar posibles consecuencias en el Sector Agua con implicaciones sociales y económicas. A partir de este diagnóstico, se han

definido para distintos escenarios de crecimiento económico, social y ambiental, las acciones, proyectos pertinentes para enfrentar con racionalidad estos problemas y cuantificar las inversiones necesarias e identificar las posibles fuentes de financiación a fin de satisfacer las demandas citadas con las garantías adecuadas para cada sector. Con los resultados de este estudio se espera contar con un marco orientador para la toma de decisiones sobre las acciones prioritarias para solucionar los problemas del agua en la República Dominicana. En las conclusiones obtenidas, se han destacado los recursos hidráulicos de origen subterráneo (reservas hidrogeológicas) como uno de los elementos básicos para satisfacer las demandas hidráulicas existentes en el país Dominicano. Su buena calidad y su disponibilidad hacen de su uso, actual y futuro, un pilar estratégico a contemplar en el reparto de los recursos hidráulicos disponibles entre la demanda existente. En la presente ponencia, se reflejan tanto la distribución de dichos recursos como su utilización actual, por cada cuenca hidrográfica, así como su posible empleo futuro dentro del marco de las Directrices Generales del P. Hidrológico Nacional, cuya primera fase se ha desarrollado en el año 2007.

Rodríguez-Delgado, Alejandra M. and Ramírez-Martínez, Wilson R.

SHORELINE CHANGES ALONG SARDINERA BEACH, MONA ISLAND, P.R.

Department of Geology, University of Puerto Rico, Mayagüez Campus

Beach rock exposures present along the shoreline in Sardinera Beach, Mona Island, Puerto Rico, have increased considerably during the last decade. A new management plan is being developed for Mona Island and Department of Natural Resources (DNR) of Puerto Rico wants to better understand the beach sand dynamics on this and other Mona Island Beaches. This work presents the initial data collected on a study that will last two years and that will help to better understand the shoreline changes as well as seasonal variations in sand movement and composition in Sardinera Beach. The work will also establish the logistics and methodology basis for further studies that will expand to other Mona Island Beaches. Benchmarks, GPS coordinates and landmarks were used to establish ten permanent beach profiles along Sardinera Beach. Beach profiles were (and will be) measured monthly. During the period measured the section of the beach with most significant morphologic changes detected by the profiles was the berm. The significant changes coincide with storm occurrences combined with normal weather patterns. Images from 1977 to 2007 were analyzed to determine changes along the coastline. Aerial and satellite images show recession of the coastline from 1977 to 2007 and influences of a mad made structure present along the beach (concrete dock) on the sand movement. Beach sand texture, composition and mineralogy were characterized in several sites along the beach. Abundant micriticized and recrystallized grains as well as lithic fragments characterize the sand. Non-altered skeletal components are scarce with the exception of the foram *Homotrema rubrum* that is very common. The beach rock present along the shore was also studied. Cementation, porosity, grain recrystalization and micritization of skeletal and non-skeletal components in the beach rock vary and suggest different relative times of beach rock formation.

Roig-Silva, Carla and Joyce, James

IDENTIFICATION, CHARACTERIZATION, AND QUANTIFICATION OF NATURAL

OCCURRING ASBESTOS IN SERPENTINITES OF SOUTHWEST PUERTO RICO

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Natural occurring asbestos (NOA) occur in ultramafic bodies and had been found in serpentinites to the extent of being regulated by some US states (e.g., California), and being in process of development in states (e.g., Georgia). Regulation of NOA in Puerto Rico serpentinites does not exist at the present time. In order to establish the need for regulation, a general survey determining the occurrence of asbestos in Puerto Rico, needs to be done and is the purpose of this study. Preliminary data is presented and suggests the occurrence of chrysotile asbestos as the only or principal asbestos mineral found on the serpentinites. The occurrence is on the range of 2 to 5 vol. % by point counting method. Samples analyzed include outcrops in Sabana Grande and Cabo Rojo. Future analyses include more sampling evaluation, quantitative XRD, and SEM imaging of the fibers.

Roig-Silva, Coral and Asencio, Eugenio

GEOPHYSICS FOR QUATERNARY- FAULT MAPPING IN CABO ROJO, PUERTO RICO

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Two major seismotectonic structures have been mapped as active faults within and or near the Municipality of Cabo Rojo, Puerto Rico: (A) the South Lajas Fault, and (B) the Muertos Through. The Department of Geology at the University of Puerto Rico suggests another active seismotectonic structure, the *North Boquerón Bay Fault Zone* (NBBFZ). This study provides new evidence that support this hypothesis. We argue that a depth converted high resolution shallow reflection seismic profile overlying a (2-D) Multi-channel Analysis of Surface Waves (MASW) shear - velocity depth - model images the fault zone. This work also provides geophysical data that delineates the fault zone.

Rosenfeld, Joshua H.

ONSHORE EXTENSION OF THE NORTH CAYMAN FRACTURE ZONE INTO BELIZE AND SOUTHWARD MIGRATION OF THE CARIBBEAN-NORTH AMERICAN PLATE BOUNDARY

Yax Balam, Inc., Granbury, TX

The northern boundary of the Cayman Trough consists of two segments: a seismically active transform fault east of the spreading center (Oriente Fracture Zone) and an aseismic lineament west of the spreading axis, herein referred to as the North Cayman Fracture Zone. Recent petroleum exploration in Belize has revealed that the North Cayman Fracture Zone was an active strike slip fault during the initial (Late Eocene to Oligocene) left-lateral motion between North America and the Caribbean, with toital offset estimated to be tens of kilometers. This displacement resulted in the uplift of the Maya Mountains.

Abundant west trending lineaments across the Maya Mountains and southern Belize into Guatemala document southward migration of the active North American-Caribbean Plate Boundary to its present location in the Motagua Valley. A major fault along the northern Maya Mountains (name?) continues through northern Guatemala into Mexico where it appears to coincide with the northern boundary of

the Sierra de Chiapas and the southern edge of the Macuspana Basin. A zone of pull-apart basins and flower structures just north of the Maya Mountains is ideal for trapping hydrocarbons migrating eastward from the central Yucatan Platform.

Ruidiaz Santiago, Cyd Marie and Santos, Hernan

GEOLOGY AND STRATIGRAPHY OF THE PICO RODADERO AREA, YAUCO, PUERTO RICO

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The area of Pico Rodadero in Yauco, Puerto Rico, was mapped as part of the "Yauco and Punta Verraco Quadrangle" by Krushensky and Monroe (1979) as being compose of three different lithologies: Maricao Basalt, augite trachybasalt, and porphyritic hornblende dacite, with ages ranging from Campanian to Eocene. In this area, a prominent recrystalized limestone unit of more than 30 meters of thickness was described by Krushensky and Monroe (1979) within the Maricao Basalt but was not mapped. This research was focus in separating the limestone from the Maricao Formation as a different unit and to make a more precise description of its surrounding geology, in order to establish stratigraphic correlation with that of southwestern Puerto Rico proposed by Santos (1999) and have a better stratigraphic control. In this study, the limestone is dated as Maastrichtian in age based on fossil content, including the rudistid bivalve *Titanosarcolites giganteus*. Overall, the area presents a stratigraphic sequence of interbedded siltstones and sandstones of the Yauco Formation, followed by a sequence of volcanic flows, capped by the limestone. These units have been correlated to the west with the Yauco and El Rayo formations. This study clarifies the geology of Pico Rodadero area.

Rymer, M.J.; Catchings, R.D.; Goldman, M.R.; Prentice, C.S.; Zachariasen, J. and Steedman, C.E.

HIGH-RESOLUTION SEISMIC IMAGING OF FAULTS IN WESTERN PUERTO RICO

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In March 2004, we acquired high-resolution seismic reflection and refraction data across known and hypothesized faults in western Puerto Rico. Three studies were conducted to determine the locations and geometries of these faults. The seismic profiles ranged in length from 365 to 1200 m. The Heno and Escuela profiles, both in the Añasco basin, were intended to cross the Cerro Goden fault; the Cartegena profile, west of Laguna Cartegena, crosses the South Lajas fault. We used tomographic P-wave velocity imaging to characterize the subsurface along each profile. The resulting velocity models were used to migrate the simultaneously acquired seismic reflection data. Seismic reflection images along the Heno profile show prominently offset and terminated reflectors in a zone approximately 100 m wide. This 100-m-wide zone has relatively lower seismic velocities than the surrounding rock and is interpreted to represent the main section of the Cerro Goden fault zone. Inferred faults in the Heno profile extend from depths of at least 1400 m to about 5 or 10 m below the surface. Seismic images for the Escuela profile show minor warps in velocity contours and seismic reflectors. Paleoseismic trenching across the warps showed that they likely are due to infilled stream channels and not tectonic

faulting. Seismic images for the Cartegena profile show lateral variations in the velocity structure, with higher velocities to the south. North of the higher velocities is a 200-m-wide zone of offset seismic reflectors at depths of about 500 m; near the surface, the prominent zone of offset reflectors is about 100 m wide. The zone of offset reflectors likely represents the South Lajas fault, which extends to within at least 10 m of the ground surface.

Sánchez-Solís, Manuel Rolandi [1]; Rodríguez, Héctor [2]; Pineda Velasco, Antonio [1] y González Vázquez, Pedro [1]

CARACTERIZACIÓN Y FUNCIONAMIENTO HIDROGEOLÓGICO DE LAS UNIDADES CARBONATADAS DE LA SIERRA DE BAHORUCO Y DE LA PENÍNSULA SUR DE BARAHONA (SUROESTE DE LA REPÚBLICA DOMINICANA)

1. TIHGSA

2. INDRHI

Las unidades carbonatadas de la Sierra de Bahoruco y de la Península Sur de Barahona (suroeste de la República Dominicana) constituyen un clásico ejemplo de karst costero tropical, en el que el que se ha desarrollado un importante aparato kárstico, que ha condicionado la práctica desaparición de las formas de drenaje superficial, así como importantes procesos de carstificación, tanto del tipo abiertos, como cerrados, sobre todo en sus vertientes suroriental y meridional, entre los que cabría destacar los números campos y alineamientos de dolinas al oeste de la Llanura de Oviedo, así como la propia laguna del mismo nombre, que es muy posible que constituya una gran depresión cártsica, actualmente invadida por aguas marinas.

Con una superficie de materiales permeables aflorantes (fundamentalmente calizas del Eoceno y del Mioceno) próxima a los 3,280 km^2 de y un volumen de recarga anual renovable (para año medio) de 250 Hm^3, cuyo 50% termina descargando lateralmente al mar, estas unidades presentan un escaso aprovechamiento actual de sus recursos hídricos (solamente el 16% de sus recursos anuales renovables), aunque si un cierto grado de explotación minera, como son los casos de las explotaciones de pectolitas (conocida comercialmente como “Larimar”) y de bauxita.

Schafhauser, A.; Randall, K.; Sharland, P.R.; Simmons, M.D. and Sutcliffe, O.E.

GLOBAL SEQUENCES AND IMPLICATIONS FOR HYDROCARBON EXPLORATION IN THE CARRIBBEAN

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It is well established that sequence stratigraphy is a powerful tool for predicting reservoirs, source rocks and seals. An internally consistent global model of sequence development, built “from the rocks up” and biostratigraphically constrained allows for detailed correlation and mapping, even in tectonically active areas such as the Carribbean, since the pace and amplitude of eustatic events overprints tectonics and sediment supply. For example, Kean et al. (2007) interpret an Upper Oligocene- Early Miocene fan complex on seismic data from offshore Suriname. We know from our sequence stratigraphic model that a eustatic lowering of sea-level and development of a sequence

boundary occurred at the Chattian-Aquitanian boundary, coincident with marked growth of Antarctic ice sheets. The fans developed in response to this lowering of sea level. Additionally, source rocks are often deposited during periods of high sea level. The black shales of the early Berriasian Veloz Formation in Cuba have been biostratigraphically correlated with a globally recognized maximum flooding event (K20) in our model.

In our sequence stratigraphic model, another sequence boundary occurs in the latest Eocene, recognized in, for example, the base of the Arida Formation in Libya, the East Java Sea, and the Santos and Campos Basins of Brazil. Fan complexes associated with this sequence boundary form reservoirs in the Furrial and Quiriquire oilfields of Venezuela (Sams, 1995), and should be considered as potential reservoirs in other areas of the Caribbean. This surface is coincident with the marked growth of Antarctic ice sheets, likely caused by a combination of factors such as the opening of the Drake and Tasman Passages, uplift of the Himalayas, and changes in seasonality caused by astronomical forcing.

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Sams, 1995, Interpreted Sequence Stratigraphy of the Los Jabillos, Areo, and (Subsurface) Naricual Formations, Northern Monagas area, Eastern Venezuela Basin. Bol. Soc Venezolana de Geol., 20, 30 – 40.

Schertl, H.-P. [1], Krebs, M. [1], Maresch, W.V. [1] and Draper, G. [2]

THE INTRA-OCEANIC RIO SAN JUAN COMPLEX (NORTHERN DOMINICAN REPUBLIC) AND ITS ECLOGITES: PETOGRAPHY, PT-PATHS, CONSEQUENCES

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The Rio San Juan Complex of the Northern Dominican Republic represents subduction-related mafic schists, which during the Late Cretaceous were cut by diapir-like serpentinite mélanges. The latter may represent the deep-seated roots of “serpentinite mud” volcanoes and seamounts as observed on the sea floor within the trench of several present-day subduction zones.

The blocks (“knockers”) of metamorphic rocks entrained in the Rio San Juan mélange exhibit distinctive arrays of interrelated PT-paths. The lithologies observed comprise blueschists, eclogites, marbles, gneisses, glaucophane-lawsonite rocks, jadeitites, and cymrite-bearing rocks – our main focus here is on the different occurrences of eclogite.

Na-amphibole-bearing eclogites underwent early prograde metamorphic stages at about 380-450°C/8-12 kbar and 500-550°C/16-18 kbar along a intermediate P/T-gradient (ca. 40 bar/°C); peak metamorphic conditions are 600-650°C/18-22 kbar. A retrograde stage is indicated at 480-550°C/8-12 kbar. In addition, some of these eclogites recorded an early HT/MP-metamorphic event at ca. 600-650°C/7-8 kbar.

Another group of eclogites exhibiting this prograde P/T-gradient is characterized by an anticlockwise

PT-path with an early greenschist- to amphibolite-facies overprint (450-580°C/ 8-12 kbar) and maximum conditions at about 750°C und 24 kbar. The exhumation is characterized by initial isobaric cooling to 550-580°C followed by almost isothermal decompression to ca. 500°C/12 kbar.

Na-amphibole-free eclogites record early stages of 560-630°C/8-11 kbar along shallower gradients (ca. 30 bar/°C). The maximum PT-conditions derived are about 850°C/28 kbar, which is extremely close to the quartz-coesite transition curve.

In essence, different samples of eclogite (but also of other high-pressure metamorphic lithologies) of the Rio San Juan Complex show various PT-paths with different peak metamorphic conditions. Such an array can only be explained by circulation of blocks in an evolving funnel-shaped subduction channel.

Although no unequivocal proof for UHP-metamorphism has been found thus far, the heterogeneity of peak-metamorphic conditions suggest that more intensive study may lead to the discovery of blocks which may have reached the coesite stability field.

Serrano, Lina [1]; Ferrari, Luca [1] and López Martínez, Margarita [2]

NEW AGES AND GEOCHEMICAL DATA FOR GORGONA ISLAND, COLOMBIA: INDICATION OF A ~25 MA LONG BUILDING OF THE CARIBBEAN PLATEAU?

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The Gorgona Island, located 50 km west of the Pacific coast of Colombia, is a key element for reconstructions of the interaction between the Caribbean and the northwestern part of the South American Plate. Gorgona is formed by an igneous complex which includes komatiites, peridotites, gabbros, picritic basalts and breccias, affected by reverse and oblique faulting with a general E to NE vergence. Previous datings on basalts yielded ages of 86 Ma (K-Ar), 88.9±1.2 Ma (Ar-Ar) and 89.2±5.2 Ma (Re-Os) and petrologic studies showed a large spread in radiogenic isotopes and incompatible trace element ratios. Previous authors interpreted Gorgona as the product of a single mantle plume with different reservoirs and whose present expression would be either the Galapagos or the Salas y Gomez hotspot.

Using Ar-Ar laser step heating we obtained reliable plateau and/or isochron ages which fall within those reported for rocks sampled in situ in the Caribbean large igneous province (CLIP) (~90-65 Ma). Only one basaltic sample from the western coast yielded an age comparable with those reported in the literature. Two basalts intercalated with komatiites and a gabbro yielded younger ages (~75 – 62 Ma), similar to those reported for rocks exposed along the western coast of Colombia. Our high quality trace element data for Gorgona show substantial differences with respect to the Sala y Gómez hot spot and seems more similar to those from the Caribbean Plateau. Considering the new ages, the Gorgona suite displays a secular variation from more enriched to more depleted terms. We propose that Gorgona represents the last piece of the CLIP to be accreted to the Colombian margin in early Tertiary times and that the suite was produced by several pulses of magmatism with progressively higher grades of mantle melting in a ~25 Ma interval. This cast doubts on the generation of the CLIP from a mantle plume.

Sherman, C.; Ruíz, H.; Nemeth, M.; Bejarano, I.; Carlo, M.; Appeldoorn, R.; Ballantine, D. and Pagán, F.

PRELIMINARY SURVEYS OF DEEP-REEF HABITATS ON THE UPPER INSULAR SLOPE OF SOUTHWEST PUERTO RICO

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Although coral reefs have been a focus of intense study for several decades, few studies have examined reefs beyond depths of ~50 m. This has largely been due to limitations of traditional open-circuit scuba techniques and the fact that most submersible or ROV studies have focused on much deeper settings. A multidisciplinary study is currently underway at the University of Puerto Rico-Mayagüez to examine the biology, geology and ecology of deep-reef habitats between 50 and 100 m water depth along the upper insular slope of southwest Puerto Rico. The geological component of this research is focused on characterizing the geomorphology and sedimentology of the deep reefs and their relationship with deep-reef ecosystems. ROV surveys help to characterize research sites. However, a key component of this work is the utilization of technical closedcircuit-rebreather diving techniques that allow for in situ surveying and sampling of the deep-reef habitats.

Off La Parguera in southwest Puerto Rico, the shelf extends ~8 km offshore before dropping abruptly to oceanic depths. The average depth of the shelf break is ~20 m. Preliminary surveys indicate a few general trends that are presented here. Steeper regions of the slope are characterized by a higher density of live benthic cover consisting primarily of macroalgae, coralline algae, sponges and corals. In these regions unconsolidated sand is restricted to narrow grooves. Regions where the slope angle is more gradual are characterized by a lower density of live benthic cover. The substrate in here consists of a sparsely colonized, well-consolidated hardground that in many cases is covered by a broad, thin sheet of unconsolidated sand. A prominent submarine terrace occurs at depth of ~80-90 m and likely represents an erosional terrace or relict reef formed early during the deglacial rise in sea level and drowned during meltwater pulse IA.

Smith, A.L. [1], Tinnin, B. [2], Killingsworth, N. [3] , Schneider, S. [1], Deuerling K. [4], Roobol, M.J. [5] and Fryxell, J.E. [1]

STRATIGRAPHIC AND GRANULOMETRIC STUDIES OF IGNIMBRITE SEQUENCES ON DOMINICA, LESSER ANTILLES

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The island of Dominica, located in the central part of the Lesser Antilles island arc, has witnessed, probably in the last 100,000 years, three large volume Plinian eruptions associated with the center of

Morne Diablotins, and the Morne Trios Pitons and Wotten Waven calderas. These eruptions produced a series of pyroclastic flow fans some of which contain both welded and unwelded facies. Detailed stratigraphical and granulometric studies of the Morne Diablotins and Morne Trois Pitons pyroclastic fans will be presented, together with preliminary data on the fans associated with eruptions from the Wotten Waven caldera. These studies show that the ignimbrites of the Grande Savane fan overlie a sequence of block and ash flows and are overlain by pumiceous surges, some of which contain accretionary lapilli. The ignimbrites contain unlithified, lithified and welded horizons, with welding extending to within 20 cm of the base, and do not appear to be underlain by an associated fall deposit. In contrast, the Layou ignimbrite sequence is underlain by fall deposits, some of which contain accretionary lapilli, and welding does not occur until at least 10m above the base. Of the ignimbrite sequences associated with the Wotten Waven caldera, two (Roseau and Grand Bay) contain thick welded zones, whereas the Grand Fond ignimbrite is unwelded. Modeling of these data will provide information on the dynamics of these Plinian eruptions including the effect of water/magma interaction.

Smith, A.L. [1]; Estrella, L. [1]; Roobol, M.J. [2] and Fryxell, J.E. [1]

SOUFRIÈRE VOLCANO, ST. VINCENT, LESSER ANTILLES: STUDIES OF THREE ERUPTIVE SEQUENCES

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Studies on three pyroclastic sequences from Soufrière Volcano are described: 1) Deposits from Late Pleistocene eruptions. These deposits, which range in thickness from 50m in the north east to 2 m in the south, form a complex stratigraphy produced by a variety of eruptive styles; 2) Deposits from the 1902 eruption. The stratigraphy of these deposits, from series of excavated pits near the Wallibou river on the west coast, indicate an initial sequence of surges and flows overlying a well developed paleosol, followed by many thin fall beds. Both fall and flow deposits are composed of vesicular juvenile clasts, lithic fragments, juvenile crystals , accretionary lapilli and accreted grains. Although the abundance of accretionary lapilli, and accreted grains in most deposits indicates a significant hydrologic component throughout the eruption, the variations in their amounts between the different beds suggest that the water-magma contact fluctuated significantly during the eruption; 3) Deposits from the 1979 eruption. These are dominantly fall deposits with abundant accretionary lapilli, plus minor pyroclastic flows and surges. The fall deposits, which can be subdivided into a lower blue-grey (explosive events of April 13 and 14) and an upper yellowish brown unit (explosive events April 17-26), generally show a bimodal grain-size distribution with the secondary coarse mode usually produced by the abundant accretionary lapilli. The earlier eruptions (April 13-22) all had a general E-W distribution, in contrast the maximum distribution for the April 26 eruption was NW-SE. The presence of abundant uncharred wood and cauliflower-surfaced bombs in the pyroclastic flows, and the abundance of accretionary lapilli together with the fine-grained nature of the fall deposits all suggest that the eruptions were phreatomagmatic.

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GEOLOGICAL EVOLUTION OF DOMINICA, LESSER ANTILLES

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The geology of the Dominica can be divided into 4 units: Miocene; Pliocene; 'Older Pleistocene'; 'Younger Pleistocene'-Recent. The Miocene rocks are only exposed along the east coast. Separated from the Miocene by a major unconformity are a number of eroded stratovolcanoes of Pliocene age often composed of pillow lavas and submarine volcanic breccias, overlain by subaerial lava flows interbedded with pyroclastic deposits. The 'Older Pleistocene' centers of Morne aux Diables and Morne Diablotins are confined to the N of the island and are characterized by the presence of Pelean domes and associated aprons of block and ash flow deposits. Around 1 Ma activity switched from the N to the S, where six major volcanoes, (Morne Trois Pitons, Wotten Waven/Micotrin, Watt Mountain, Grand Soufriere Hills, Morne Anglais, and Morne Plat Pays) developed. Activity also continued in a reduced manner at the two northern centers. Within the last 100,000 years, 3 major periods of Plinian activity produced extensive subaerial and submarine pumiceous deposits. These eruptions, each of which is estimated to have produced tens of km3 of pyroclastic material are associated with Morne Diablotins, and the calderas of Morne Trois Pitons and Wotten Waven/Micotrin. Morne Plat Pays in the SW corner of the island has also been subjected to at least 3 sector collapses during the past 300,000 years.

Volcanic rocks on Dominica range from basalts to dacites and are usually porphyritic (phenocrysts of plagioclase, augite and hypersthene). The Pliocene and older deposits tend to show the complete range of compositions in contrast, the younger sequences are often much more restricted in composition so that geochemically it is difficult to distinguish between the different centers. Spatial and temporal variations of both individual centers as well as inter-volcano variations will be present and discussed in terms of the overall petrological evolution of Dominica.

Smith, Carly J. and Collins, Laurel S.

PALEOENVIRONMENTAL ANALYSIS OF THE MIOCENE URUMACO FORMATION, FALCÓN STATE, VENEZUELA, USING BENTHIC FORAMINIFERA

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The Urumaco Formation of Falcón, northwestern Venezuela, consists of shallow marine to continental deposits of late Miocene age, and is known for its spectacular vertebrate fossils that include giant crocodiles, turtles, and rodents. The formation is generally divided into a lower, middle, and an upper part. The lower and middle parts are comprised of both marine and nonmarine shales with thin, intercalated coal seams, siltstones, sandstones and limestones. The upper part also consists of mostly shales but with more sandstones and coal seams than the two older parts, suggesting a more terrestrial influence. This study uses benthic foraminiferal assemblages from the three parts of the Urumaco Formation to determine past marine depositional environments. Paleoenvironmental and paleobathymetric reconstruction are based on the modern habitats of the common species and the faunal diversities.

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THE TIMING OF HP METAMORPHISM IN SUBDUCTION COMPLEXES - EXAMPLE FROM THE ESCAMBRAY MASSIF, CUBA

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An increasingly complete, integrated set of geological,geochemical and geochronological data is now becoming available for the Great Antillean Arc (GAA). As in Puerto Rico and Hispaniola, in Central Cuba the subduction related magmatism of the GAA lasted at least from 132 Ma until ~75 Ma. This timing of subduction related magmatism gives a frame for expected age data on HP metamorphism. In Cuba, the subduction-accretion complex of the GAA crops out in dome-like massifs in the hinterland of the thrust front. The p-T-t-d data set from the Escambray Massif in Central Cuba constrains at least four nappes, of which two clearly indicate high-pressure (HP/LT) metamorphism. Boudins of eclogite and blueschist-facies rocks corroborate maximum conditions of 16-25 kbar and 580-630°C. Conventional U/Pb and new Lu-Hf data on metamorphic minerals gave an uniform time of about 70 Ma for the peak metamorphism of the HP nappes. SHRIMP zircon ages of 220 -106 Ma likely date eclogite protoliths.

Stemann, Thomas A.

RE-EVALUATING THE BIOGEOGRAPHY OF CENOZOIC CARIBBEAN REEF CORALS

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Traditionally, the Cenozoic biogeographic history of Caribbean reef corals was thought to include a late Paleogene cosmopolitan phase in which many genera and some species were found across much of the global tropics. This wide-ranging fauna apparently became progressively more restricted in the Neogene, especially with the closure of the Panamanian Isthmus. In the Plio-Pleistocene, roughly 20% of Caribbean reef coral genera go locally extinct but persist as important parts of the Indo-Pacific fauna. The modern Caribbean fauna was thought to consist of solely endemic species, though all family level taxa and 1/3 of the genera were considered to be cosmopolitan.

Recent work on coral genetics and skeletal micromorphology, however, has brought to light a radically different picture of the systematics and biogeography of modern Caribbean reef-building corals. Some traditionally defined coral families and genera have been shown to be polyphyletic. Notably, Caribbean species in the families *Faviidae* and *Mussidae* are more closely related to each other than either is to con-familial or con-generic species in the modern Indo-Pacific. The data indicate that in these important coral taxa much of the Caribbean coral fauna has been distinct from that of the Indo-Pacific since perhaps the Eocene. This suggests the possibility that some extinct Cenozoic Caribbean taxa may actually have been erroneously shoe-horned into modern Indo-Pacific genera.

The present study summarizes the biogeographic significance of ongoing systematic work on Caribbean fossil corals using skeletal micro-architectural characters. In some cases, such as in the family *Agarciidae*, placement of extinct Caribbean taxa into modern Pacific genera seems sound.

Other cases, such as Paleogene records of the Pacific genus *Seriatopora* or the *Pectiniidae*, appear unsupported by available data. More work on well-preserved fossil material will be critical to understanding the relationships between Cenozoic Caribbean reef corals and those of other tropical provinces.

Tauler, E. [1]; Lewis, J.F. [2]; Proenza, J.A. [1]; Labrador, M. [1]; Galí, S. [1]; Longo, F. [3]; Bloise, G. [3]

"GARNIERITES" FROM DOMINICAN REPUBLIC AND EASTERN CUBA NI-LATERITE DEPOSITS: A NEW LOOK AT A LONG-STANDING MINERALOGICAL PROBLEM

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"Garnierites", green silicates commonly described in Ni laterites, do not have a well-defined structure and composition and are not a mineral species recognized by the Commission on New Minerals and Mineral Names (CNMMN). Here, we report new data on the mineralogical composition and mineral chemistry of garnierite veins in Ni laterites from central Dominican Republic and eastern Cuba. These garnierite samples come from Falcondo Mine, Dominican Republic and Yamanigüey (Moa Bay deposit, Cuba). Laterite mineralogy was investigated using X-ray diffraction, optical microscopy, X-Ray diffraction (XRD), scanning electron microscopy, transmission electron microscopy, and electron probe microanalysis.

In eastern Cuba deposits, the Ni mainly is associated with Fe oxyhydroxides in the limonite zone and these deposits are classified as the oxide-type. However, in some cases, Ni-rich secondary lizardites, dominate the laterite profiles forming typical hydrous silicate-type deposits. Here, the saprolite zone contains microscopic veins (<1mm), that follow fractures and grain boundaries. The XRD data showed peaks at 7 Å and 10 Å, characteristics of the structures of lizardite and talc, respectively. The "garnierite"-like minerals have composition ranging from Ni-lizardite (up 5 wt% Ni) to Ni-bearing talc (up to 25 wt% Ni). Systematically, Ni-lizardite contains varying amounts of Fe, whereas the talc-like phase is iron-poor (< 0.5 wt% Fe).

In the Dominican Republic, Ni-laterite deposits are classified as the hydrous silicate-type, and the main Ni-bearing minerals are hydrous Mg-Ni silicates occurring in the saprolite zone. Ni-rich garnierite occurs as veins, fracture-fillings and coatings. Dominican garnierites also show both 7 Å and ~10 Å basal spacing in XRD patterns. EMP and XRD show that garnierite veins include Ni-talc (up to 32 wt% Ni), lizardite, "chrysoprase" (a green cryptocrystalline variety of quartz with ~ 2 wt% Ni), quartz and sepiolite (falcondoite).

The composition of Ni-talc in the garnierite veins from Dominican Republic is similar to that of eastern Cuba. Characterized talc-like minerals belong to the willemseite [(Ni,Mg)3SiO4O10(OH)8] - talc [(Mg)3SiO4O10(OH)8] series. Very often Ni rich talc-like minerals (d001 ~10Å) in Ni-laterites have been referred as Mg-Ni kerolite and pimelite [Ni3Si4O10(OH)2.4H2O]. However, kerolite is not a mineral species recognized by the CNMMN, and pimelite belong to the smectite group giving a ~15Å basal spacing. Thus, the common occurrence of pimelite in Ni laterites is doubtful, and further work is

needed to establish the true nature of pimelite vs. willemseite.

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OIL EXPLORATION IN CUBA: MAIN RESULTS

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Hydrocarbon exploration in Cuba started in middle XIX Century. In 1881 the first struck in Motembo, Northern Central part of the island. Cuban archipelago is an Early Tertiary folded and thrusted belt derived from the interaction between the Caribbean Volcanic Arc and the sedimentary basins of the southern margin of North American Continent. After the orogeny, Tertiary basins deposited above the orogen. Three tectonic regimes are recognized: extensive - since lower Jurassic up to middle Cretaceous; since middle Cretaceous to middle Eocene – compressive; since Middle Eocene - a mild compressive stage.

The object of hydrocarbon exploration in Cuba and surrounding areas are two Oil and Gas Provinces. Northern Province includes Lower and Middle Jurassic synrift sediments, Jurassic and Cretaceous syndrift sediments, as well as Upper Cretaceous and younger, syn -orogenic and post - orogenic sequences. Total thickness, sometimes increased by tectonic stacking, can reach up to 12 km. Southern Province includes sediments deposited in the Caribbean Plate. There are basins related to volcanic arc as well as synorogenic and postorogenic basins. Some depocenters reaches up to 6 km of sediments.

Northern Province has the most part of discovered oil fields. Those fields are located in hinterland areas characterized by alpine deformation style composed by thrusted and folded sequences of Jurassic – Tertiary age. As result of the huge tectonic shortening, exploratory wells in the northern province frequently penetrate several tectonic - stratigraphic units. Southern province is the less studied and explored, only a few small oil fields has been discovered so far. Depocenters of southern basin can be grouped in three large basins – Western, Central and Eastern. According to the petroleum system studies the Northern Province has by far more perspectives than the Southern Province.

Despite the fact that all Northern Province has a similar geological constitution all along the northern half of the island, studies and exploratory practice reveal that the best results have been achieved in the area located to the north of Havana and Matanzas provinces (western part of Cuba). Neighbouring deepwater Gulf of Mexico basin is considered to have also a very high potential. A second priority is preliminarily assigned to northern central and eastern part of the island and a third priority to the westernmost sector. Main exploratory efforts are concentrated so far in those areas where best exploratory efforts have been achieved: Havana – Matanzas oil belt. Those efforts include exploratory drilling, 2D and 3D seismic. The evaluation of the hydrocarbon potential estimated the resources of this area in 3000 million barrels of oil.

Urbani, Franco

THE NAPPES OF THE ´CORDILLERA DE LA COSTA´, VENEZUELA

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The completion of 230 geological maps at scale 1:25.000 of northern Venezuela, served to realize the need of a description and nomenclature update of the igneous and metamorphic rocks using the rules of lithodemic units. Following such work and using the geographical division of the Cordillera into ´Serranía del Litoral´ and ´Serranía del Interior´ (separated by the subvertical-dextral La Victoria fault), excluding the southern sediments the whole mountain system can be divided into six nappes, as follows:

`Serranía del Litoral` Nappes: 1) *Coastal Nappe* with Nirgua and Antímano units (high P/T metamorphism, eclogites) and Tacagua (green-schist facies, chlorite). Mesozoic. 2) *Ávila Nappe* with San Julian, Peña de Mora and Guaremal (there are granulite facies elements but all retrograded to green-schist facies). Proterozoic-Paleozoic. 3) *Caracas Nappe* with Las Mercedes and Las Brisas metasediments (green-schist facies, chlorite). Jurassic-Cretaceous. Since the pioneer work of Menéndez (1966) this whole section was considered part of a single ´Cordillera de la Costa Belt´.

`Serranía del Interior` Nappes: 4) *Caucagua-El Tinaco Nappe* with La Aguadita (granulite facies metamorphism) and Tinaquillo (fragment of subcontinental mantle), also with scattered WPB. Proterozoic to Cretaceous. 5) *Loma de Hierro Nappe* with ophiolitic units, including Paracotos Phillite. 6) *Villa de Cura Nappes*, with a northern part, the *Villa de Cura Nappe* (sensu stricto) with El Caño, El Chino, El Carmen and Santa Isabel (high P/T metamorphism), and a southern part, the *San Sebastián Nappe* with Las Hermanas and Chacao (prehnite-pumpellite facies). Cretaceous.

The subdivision of the previous single ´Cordillera de la Costa Belt` into three environmentally and geochronologically distinct nappes, and also the subdivision of the previous ´Villa de Cura Belt´ into two different nappes places new constraints and helps to better understand the evolution of the Venezuelan Coast Range.

Valls Alvarez, Ricardo A.

GEOLOGICAL EVOLUTION OF THE NW CORNER OF THE CARIBBEAN PLATE

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The NW corner of the Caribbean Plate is complicated by the presence of a continental type block, the Chortis Block, within a mostly oceanic plate and a combination of a slip-strike boundary to the north running from the Belize-Guatemala border with a subduction zone to the west where the Cocos Plate is subducted beneath the Caribbean Plate, and an extinguished subduction zones to the north and south, were the Caribbean Plate was temporarily subducted beneath the Maya and Chortis Block.

The migration of the Chortis block in an S-SW and then N direction was one of the mechanisms responsible for the changes observed among the ophiolitic complexes in Guatemala. We are introducing the idea of the pre-existence of a trench associated with the Motagua-Jalomáx slip-strike fault system near the north border of Honduras, currently filled up and destroyed by the northward migration of the Chortis Block. Also we introduce the idea of an orogenic event - The Chuacús Orogeny - probably the same age as the Laramide Orogeny in North America. We postulate that the Chuacús Orogeny pushed younger ophiolites complexes in Guatemala to the surface and is responsible for the metamorphic basin of Central Guatemala - The Chuacús Series. The obduction of the oldest

ophiolites on the western end of the belts may have being caused by the passing by of the Jamaica block on its way to its present position south of Cuba.

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GEOLOGY AND MINERAL RESOURCES POTENTIAL OF NORTHERN HAITI

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The Northern border of Haiti corresponds to a volcanic arc of Meso-Cenozoic Age that can be traced from Central Cuba, through the Dominican Republic and forms part of the mountains of the Massif du Nord group. This group is composed mainly by volcanic tuffs and lavas from the volcanic belt, ranging in composition from felsic, through intermediate, to mafic and ultramafic rocks. The belt is composed of numerous lenticular bodies of lavas and pyroclastic material of felsic composition, varying from dacite to rhyolite, embedded in a thick series of predominant mafic volcanoclastic rocks, mainly andesite with lesser amounts of basalts, with numerous intercalations of diverse sedimentary rocks, like radiolaries cherts, carbonate rocks, and tuffs.

Copper and gold are the two main ore types in the area. Copper is usually found associated with the porphyritic facies, the apophyges of micro tonalites, and the silicified zones, filling fissures and fractures, as well as disseminated.

Within the quartz vein systems, the copper is contained in the chalcopyrite, while the gold appears both as native gold and as a very fine disseminated gold in the sulphide zone. It can also form spectacular concentrations on the oxidised cap.

The native gold is usually found associated with the chlorite, as well as in grains of pyrite and chalcopyrite. A second generation of gold is usually found associated to the quartz and the chlorite. Gold rich quartz veins are usually enriched in Cu, Pb, Zn, Ba, Mn, Mo, Cr, and Ti, and depleted of Ag, Hg, As, Bi, Th, U, Sr, Rb, Ir, Se, and F.

Verdeja, Eduardo

CÓMO CREAR CONCIENCIA EFECTIVA DE RIESGO SÍSMICO

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El Riesgo Sísmico es el producto de la Peligrosidad Sísmica y la Vulnerabilidad que frente a ella tiene una nación. Gran cantidad de los desastres ocurridos por sismos se producen por daño, colapso o destrucción de estructuras civiles, ya sean éstas de infraestructura vial, industrial, comercial, de seguridad, de comunicación, urbana o residencial, generando pérdidas de propiedades, de funcionalidad, de operatividad, pérdidas económicas y pérdidas de vida.

La vulnerabilidad de las estructuras responde muchas veces a que se ha subestimado el potencial sísmico o se han obviado conceptos básicos de diseño sismorresistente lo cual, a su vez, ocurre porque los responsables de su concepción, diseño, construcción y supervisión, ya sean estos instituciones,

individuos, o el Estado, carecen de la conciencia necesaria de Riesgo Sísmico.

Para minimizar el Riesgo Sísmico es necesario transferir de manera eficiente los conceptos básicos de peligrosidad sísmica y reducción de vulnerabilidad a todos los niveles del sistema que conforman la infraestructura física y económica de una nación. Para ello es necesario conocer y adoptar el "idioma" de aquellos actores clave a quienes se les debe transferir estos conceptos. La reincidente presencia de estructuras vulnerables refleja que la comunicación hasta ahora utilizada no ha logrado dicha transferencia y por ende no se ha creado aún la necesaria conciencia de Riesgo Sísmico.

Este trabajo presenta una propuesta de estructura de comunicación simple, pero eficiente, de conceptos básicos y fundamentales para que puedan ser entendidos y asimilados tanto por el público en general como por los distintos profesionales que intervienen en el diseño y construcción de estructuras civiles. Estos conceptos van desde la dinámica de la Tierra, origen de los terremotos, ondas sísmicas, interacción suelo-estructura, ordenamiento territorial, planificación y desarrollo urbano, diseño arquitectónico, diseño estructural, construcción y supervisión, ya que conocer el peligro es la base para evitarlo.

Viscarret, Patxi [1]; Wright, James [2] and Urbani, Franco [3]

U-PB SHRIMP ZIRCON GEOCHRONOLOGY OF EL BAÚL MASSIF, COJEDES STATE, VENEZUELA

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Five new U/Pb ages from zircon extracts were obtained from granitic and volcanic rocks of El Baúl region. The samples come from three units of plutonic rocks and two of volcanic rocks. Of the zircon extracts finally 25 grains were selected manually, which were analyzed at the SHRIMP-RG facility at Stanford University. The results are as follows :

Guacamayas Super-Suite

Teresén Rhyolitic Suite

Corcovado Rhyolite:	286.4 ± 2.8 Ma	(Early Permian)

El Peñón Latitic Suite

Segoviera Rhyolite:	283.3 ± 2.5 Ma	(Early Permian)

El Baúl Granitic Suite

Piñero Granite	289.0 ± 2.9 Ma	(Early Permian)
Mata Oscura Granite	294.1 ± 3.1 Ma	(Early Permian)
Mogote Granite	493.8 ± 5.2 Ma	(Late Cambrian)

The results are quite different from the ages previously known: For the Mogote Granite ages of 287±10

Ma Rb/Sr isochron and 270±10 Ma K/Ar were mentioned, whereas the Guacamayas volcanics were considered Mesozoic (192±3.8 and 195±3,9 Ma K/Ar whole rock). Our results require new interpretations of the magmatic events of northern Venezuela, since. They add two plutonic events (Cambrian and Permian), non-correlative to those known of the Guayana Shield, as well as one Permian volcanic event, not previously recorded.

These ages as well as the known Paleozoic metasedimentary rocks, allow interpreting that El Baúl massif has a geological history more compatible to the Mérida Andes than the Guayana Shield as previously thought.

Weber, John [1]; Ritter, John [2] and Prentice, Carol S. [3]

NEOTECTONICS RESEARCH IN TRINIDAD AND TOBAGO: REVIEW AND SYNTHESIS

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Trinidad and Tobago sits in the actively deforming Caribbean-South American plate boundary. By applying GPS (Global Positioning System), paleoseismology, Quaternary geology, and geomorphology techniques we are beginning to understand the horizontal neotectonics, Holocene slip history, and seismic risk associated with some of the active structures. The new geodetic and geologic results should be used to improve the accuracy of the current earthquake-only-based national seismic risk map. In addition, we are studying Trinidad and Tobago's vertical neotectonics which reflect: a) westward sinking and tilting into the Gulf of Paria pull-apart basin, and b) sinking of Tobago's oceanic forearc by dextral-normal inversion of the Tobago terrane boundary. These vertical motions relate to flooding risk in western Trinidad and Tobago's seismic risk.

According to the GPS data, paleoseismology trenching, and geomorphic mapping, the Central Range fault is the principal active transform fault in the Trinidad/Tobago segment of the Caribbean-South American plate boundary. With a GPS-estimated slip rate of 12+/-3 mm/yr, it takes up ~60% of the 20 mm/yr of ~eastward current plate motion. This fault may be locked and could pose a significant seismic risk for Trinidad. Currently it generates no small (creep-related) earthquakes. It does not obviously offset cultural features built across it (e.g., Plaisance Park, Navet Dam). Where observed in paleoseismic trenches (Bonne Aventure, Tabaquite) a strand from a possible paleoearthquake cuts > 2710 year old sediment, and is blanketed by an unbroken < 550 yr. old packet of sediment (ages from 14C analyses). The Central Range Fault extends eastward into offshore oil fields where has been observed cutting the youngest sediments and seafloor in seismic profiles.

The active Gulf of Paria pull-apart basin links the Central Range transform with the active Venezuelan El Pilar transform. Geomorphic analyses of the landscape features of northern Trinidad (coastlines, alluvial fans, rivers, and surface elevations) clearly reflect long-term west-down titling and sinking into the Gulf of Paria pull-apart, with some associated flexural uplift in eastern Trinidad. We are using OSL (optically stimulated luminescence) to determine the uplift rates of exposed marine terraces in the northeastern Northern Range and geomorphic DEM landscape analysis to quantify characteristics of the sunken topography in northwestern Trinidad.

We presume that the Los Bajos fault is active because of its sharp geomorphic expression which we have mapped using a DEM. We also trenched young sediments (yet undated by 14C) across the Los Bajos fault trace and observed recent faults. Because of extensive pitch dike intrusions, however, we could not rule out that the faults were simply pitch intrusion-related. The current GPS data permit a few mm/yr of strike slip across the Los Bajos fault. The Los Bajos fault probably extends southeastward offshore into the southern offshore (Columbus Channel). The lack of earthquakes on this structure suggests that it may also be locked, but clearly, we need more data to better evaluate its risk.

The sub-sea South Tobago/North Coast fault system ruptured violently during the 1997 M 6.6 earthquake. We captured this earthquake with GPS at two stations in Tobago, and used the GPS displacements to estimate the fault geometry and slip. This low-angle (28°), WSW-striking, dextral-normal fault reactivated and reversed motion on (i.e., inverted) the sub-Tobago-terrane thrust via gravitationally driven, northward sliding of the obducted dense Tobago terrane oceanic forearc. This event also included a significant fraction of slip related to dextral plate motion.

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ACTIVE TECTONICS AND SEISMIC HAZARD IN JAMAICA

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The tectonics of the north-central Caribbean, between the Cayman Islands and eastern Hispaniola including Jamaica, is dominated by a broad zone of left-lateral strike-slip faulting. This is significantly different from the subduction associated with the plate margins of the eastern Caribbean. During the 1960's and 1970's the Jamaica region was described as a diffuse plate boundary spanning about 200 kilometers of the Caribbean Sea from the southern Cuba to possibly southern Jamaica. In the 1980's the area was presented as a microplate with Jamaica being a restraining bend, which accounted for the growth of the Blue Mountains in eastern Jamaica. The microplate thesis was endorsed during this decade based on Global Positioning System (GPS) measurements taken on Cuba, Hispaniola and Jamaica. However, the basic issue of which faults in Jamaica are active or not remains unanswered.

The past eighteen to twenty years have been the most consistent period of operation by the Jamaica Seismograph Network. Seismic monitoring has grown to include twelve seismographs, eight accelerographs and about thirty GPS measuring points. In this paper these data are used to analyze and discuss active tectonics on the island and seismic hazard implications for the country.

Wilder, Roche

APROVECHAMIENTO INTEGRAL DE LOS RESIDUOS DE LA INDUSTRIA CUBANA DEL NÍQUEL. HACIA UNA MINERÍA MÁS LIMPIA Y UN FUTURO SOSTENIBLE

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En el proceso minero y metalúrgico relacionado con la Industria Cubana del Níquel, se generan anualmente volúmenes millonario de mineral de bajos contenidos de níquel entre 0.5 y 0.6 % (Escombros) y colas con altos contenidos de Hierro (45-47 %) y otros metales.

La acumulación histórica de estos residuos constituye verdaderos yacimientos, patrimonio que garantizará la sostenibilidad de las generaciones futuras, pero que a su vez representan verdaderos riesgos ambientales para las comunidades y el entorno en general de la parte más oriental del país.

Los volúmenes acumulados en depósitos de los denominados escombros y colas superan los 145 millones de toneladas respectivamente.

Con vista a lograr su futuro aprovechamiento, se desarrollan programas de investigaciones tecnológicas, en las que participan diversas organizaciones del país, encaminadas a encontrar soluciones viables a su procesamiento en gran escala.

Lograr en un futuro no lejano la explotación y procesamiento de estos residuales garantizará:

Un aprovechamiento mas optimo y racional de los recursos minerales no renovables en un momento donde ya el hombre prevé su agotamiento y dirige sus miradas al fondo de los océanos y al espacio exterior.

Un mejoramiento apreciable en las condiciones medioambientales del entorno de la parte Nororiental de Cuba, y la disminución de los grandes riesgos asociados al mantenimiento en operaciones de grandes presas de colas.

La continuidad de las operaciones mineras una vez agotados los yacimientos actuales, sustento de numerosas comunidades que durante más de 6 décadas han vivido relacionadas a esta actividad y que abarca en la actualidad aproximadamente más de 130,000 habitantes.

Williams, Nekesha [1]; Pyrtle, Ashanti [1] and Dixon, Barnali [2]

SEDIMENT FINGERPRINTING: A POTENTIAL TOOL FOR WATERSHED AND COASTAL MANAGEMENT

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Anthropogenic activities such as urbanization, agriculture and mining have contributed to accelerated soil erosion world-wide. Increased sediment inputs to coastal environments have the potential to not only alter natural ecosystem functions, but also facilitate the transportation and deposition of pollutants such as pesticides, nutrients and heavy metals in these systems. Sediment Fingerprinting is a technique used to identify sediment source areas in watersheds. In the proposed study, sediment fingerprinting in combination with environmental models (SWAT and RUSLE) and radionuclides (Cs-137 and Pb-210) will be used to identify sediment provenance within tropical estuaries on the island of Puerto Rico. Fingerprints will be obtained through grain-size analyses, X-ray Diffraction and gamma spectrometry. Authors expect that each fingerprint will be uniquely expressed in each of the study estuary, which may

be reflective of the land use types, geology and soils within the individual coastal watersheds. Additionally, results from this study will provide insights leading to better management practices specifically in coastal watersheds.

Williams, Patrick [1]; Tuttle, Martitia [2]; Joyce, James [3] and Soto, Alex [4]

PALEOSEISMIC EVALUATION OF THE GREAT NORTHERN PUERTO RICO FAULT ZONE

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A broad pattern of northwest and west-northwest trending faults and lineaments across northeastern Puerto Rico is referred to as the Great Northern Puerto Rico Fault Zone (GNPRFZ). A detailed evaluation of the GNPRFZ was conducted to discover any potentially active faults near a planned reservoir in the Valenciano Valley, Puerto Rico, and to support the evaluation of ground motions and seismic design parameters for the planned Rio Valenciano dam. The geometry of the GNPRFZ is distributed and complex, and detection of possible active features required a broad reconnaissance investigation. Studies utilized: a) published sources of geological mapping and contextual information, particularly published USGS quadrangle mapping; b) analysis of very high quality sets of LIDAR topographic data; and c) analysis of high resolution historical aerial photography, dated 1936-1937 which benefits from very low vegetation cover and absence of cultural development.

Potential active fault landform features identified with the aid of remotely sensed data were inspected in the field. Sites for additional subsurface (trenching) investigation were selected for the coincidence of bedrock faults and prominent topographic lineaments.

During the sum of the landform analysis, field study, and trenching phases, no evidence of Holocene surface faulting was detected across any part of the GNPRFZ study area. Several prominent linear range-fronts bound fault-line valleys that extend west-northwest between Caguas and Naguabo/Humacao. Detailed inspection of all of the valley margin areas failed to identify any pattern of offset of valley-margin and inter-valley features such as ridge spurs, ridge segments or stream valleys. This indicates the absence of strike-slip movement of the GNPRFZ in late Quaternary time. These findings are consistent with the absence of any significant displacement of Oligocene - Early Pliocene carbonate rocks that are mapped across northern Puerto Rico.

Zaccarini, F. [1]; Proenza, J.A. [2]; Rudashevsky, N.S. [3]; Cabri, L.J. [4]; Garuti, G. [5]; Rudashevsky, V.N. [3]; Melgarejo, J.C. [2]; Lewis, J.F. [6]; and Longo, F. [7]

A POSIBLE ASSEMBLAGE OF NEW PLATINUM GROUP MINERALS IN THE LOMA PEGUERA CHROMITITE, CENTRAL DOMINICAN REPUBLIC.

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In a recent paper (Proenza et al. 2007: *The Canadian Mineralogist*, 45, 631-648) it has been shown that the Loma Peguera chromitites have an unusual composition and display a peculiar Platinum group element (PGE) distribution and mineralogy. The total PGE concentrations, up to 2.04 ppm, show an enrichment in Os + Ir + Ru relative to Rh + Pd + Pt. Among the latter group, a positive Pt anomaly is present. According to these geochemical data, the first results on the Loma Peguera Platinum group minerals (PGM), obtained using the traditional method of an situ investigation, revealed that the PGM assemblage is characterized by the presence of small sized (always <10μm) specific phases of Ru, Os, Ir and Pt and by a large mineralogical variation, including possible new PGM. In ~~the~~ recent years, the hydroseparation (HS) technique has been developed to concentrate heavy minerals from geological samples, [Rudashevsky et al., 2002: *Transactions of the Institution of Mining and Metallurgy* (Section B: Applied Earth Science) 111, B87–B94)]. Here, we report the first PGM data obtained from the Loma Peguera chromitites using this innovative technique after comminution of the sample by Electric Pulse Disaggregation (EPD). This combined EPD + HS technique has recovered significantly more, as well as novel, PGM grains than the in situ mineralogical examination ~~and~~ with a size between 20 and 120 μm (see also Oberthür et al., 2007: *Goldschmidt Conference Abstracts,* p. A28). The new PGM assemblage comprises: $Ir(Ni,Fe)_3$, $Pt(Ni,Fe)_3$, $PtFe_3$, $Ir(Fe,Ni)_3$, (Ir,Pt)(Fe,Ni), (Ru,Pt)(Fe,Ni), $(Fe,Ni,Ru,Os,Co)_2S$, and RhNiAs. Even though the concentrates provide a more representative assessment of PGM, in situ textural information is lost. As a consequence, a combination of both types of investigation, in situ and EPD + HS concentration, is strongly recommended to obtain a complete characterization of the PGE mineralogy.

Authors Alphabetical Index (presenting authors underlined)