LA CHAINE CARÄIBE AU MERIDIEN DE CARACAS. GEOLOGIE, TECTOGENESE, PLACE DANS L`EVOLUTION GEODYNAMIQUE MESOZOIQUE-CENOZOIQUE DES CARÄIBES MERIDIONALES

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(Texto completo de 469 p. y dos mapas en DVD anexo, carpeta 17)

Los diferentes capítulos que componen esta memoria se pueden agrupar, aparte de la introducción (cap. I), en tres conjuntos: Los capítulos II hasta IV presentan un análisis estratigráfico, litológico y estructural de un corte de la cadena montañosa desde los llanos hasta la ladera sur de la Serranía del Interior de la Cordillera de la Costa; así se sigue del sureste hacia el noreste: el pie de monte, la zona piemontina (zona externa) y las tres Napas de Aragua (napas internas). Los capítulos V y VI completan el corte estudiado utilizando un análisis bibliográfico y algunas observaciones personales, presentando la Serranía del Litoral de la Cordillera de la Costa, incluyendo la franja Costanera-Margarita, zona más interna de la Cadena. El capítulo VII propone un esquema de evolución geodinámica mesozoica-cenozoica del sistema montañoso centra a lo largo de un corte transversal del margen norte de Venezuela; se propone un ensayo de integración de esta evolución en el dominio Caribe en su conjunto.

EL PIE DE MONTE

Correspondiente a una zona de transición entre el autóctono frontal no deformado y la zona piemontina, el pie de monte se compone:

- De dos espesas formaciones terrígenas con facies sublitoral hasta somera o parálico, de edades respectivas Oligoceno-Mioceno medio y Mioceno superior-Plioceno, separadas por una discordancia a lo largo del frente de la zona piemontina;
- De una serie mayormente calcárea de edad Neocomiense hasta Paleógeno, disociada tectónicamente dentro de las escamas frontales; el Eoceno medio superior o el Eoceno superior se encuentran localmente en discordancia angular por encima y gradan hacia arriba a las molasas del Oligoceno.

LA ZONA PIEMONTINA

Cortada en escamas tectónicas superpuestas, la zona piemontina sobrecorre por parte el pie de monte; ella se compone de tres unidades principales constituidas por un espeso flysch pelítico hasta arenoso-conglomerático de edad Paleoceno-Eoceno medio; este último suprayace concordantemente el Cretáceo Tardío, hemipelágico carbonático, silíceo y pelítico. Este último a su vez suprayace a calizas neríticas de edad Albiense, en la unidad meridional; en la unidad septentrional, el Senoniense superior o el Paleoceno superior-Eoceno inferior se encuentran discordantes sobre el borde sur de las Napas de Aragua.

LA SERRANÍA DEL INTERIOR: LAS NAPAS DE ARAGUA

Descansando alóctonas sobre el flanco sur de la zona de la Cordillera de la Costa, ellas forman un conjunto litológico y estructural característico del sistema montañoso central; estas napas sobrecorren también, hacia el sur, la zona piemontina. Se componen, desde abajo hacia arriba, de:

- La Napa de Caucagua-El Tinaco, compuesta de un zócalo pre-Mesozoico con anfibolita, cuarcita, esquisto y tronjemita-diorita intrusivas. Este zócalo infrayace a un manto epimetamórfico de calizas y lutitas intercaladas por flujos basálticos de edad Cretáceo Temprano - Senoniense inferior; esto infrayace, a su vez, calizas conglomeráticas discordantes de edad Senoniense superior;
- La Napa de Loma de Hierro, agrupando un basamento ofiolítico, una cobertura volcánica-sedimentaria de edad Cretáceo inferior, ella misma infrayaciendo a un espeso manto basáltico; el Senoniense superior, discordante sobre las series precedentes, se compone de conglomerados y calizas hemipelágicas, y esta a su vez retrabajado en lutitas con olistolitos, así como calizas macizas epineríticas de edad Paleoceno superior-Eoceno inferior;
- La Napa de Villa de Cura, compuesta de dos conjuntos: una espesa serie volcánica-sedimentaria andesítica metamórfica AP/BT, y una formación epimetamórfica con brechas y flujos basálticos fechada del Albiense.

LA SERRANÍA DEL LITORAL

Representa una zona intermediaria entre las zonas internas (representadas por las Napas de Aragua y la zona de la franja costanera-margarita) y la zona externa (2. Piemontina). Ella está constituida por un zócalo pre-Mesozoico complejo y una cobertura sedimentaria metamorfizada; esta última se subdivide en un vala - Cretácico inferior calcáreo – dolomítico y terrígeno, y de un Albiense arenoso – lutítico. Al menos dos generaciones de plutones graníticos – dioríticos intrusionan el conjunto: unos, de edad Senoniense, no metamorfizados y no cizallados, y otros, de edad Jurásico superior o más antiguos, metamorfizados y cizallados.

La Franja Costanera – Margarita: Se trata de un conjunto polimetamórfico complejo, que se compone de una unidad ofiolítica y de una unidad con basamento [pre-Mesozoico?] e intrusiones. Esta segunda unidad se asemeja a

la Napa de Caucagua – El Tinaco. Las dos unidades de la Franja Costanera – Margarita poseen una cobertura común, sedimentaria y volcánica-sedimentaria metamorfizada, de edad cretáceo inferior – Senoniense superior. Esta, a su vez, infrayace a una formación de cherts y diabasas, de edad Senoniense superior. El conjunto infrayace discordantemente un flysch arenoso – lutitico calcáreo de edad Eoceno medio – Eoceno superior.

SÍNTESIS

La evolución geodinámica mesozoica – cenozoica del margen Norte de Venezuela, a lo largo del meridiano de Caracas, puede resumirse en:

- Una época de acreción oceánica Jurásico medio – superior (cf. Las ofiolitas de la zona de la Franja Costanera – Margarita y de la Napa de Loma de hierro); esta zona oceánica separa un arco insular (Napa de Villa de Cura) del cratón suramericano (Zona de la cordillera de la Costa y Zona Externa), y de su margen en distensión (Zona de la Franja Costanera – Margarita y napa de Caucagua – El Tinaco);
- Dos fases compresivas mayores grosso modo ortogonales al margen (Jurasico terminal y Senoniense) que ocasionaron una suturación del dominio oceánico, una obduccion, y un recorte del margen, la segunda fase siendo responsable del tectonismo y del metamorfismo de la zona de la Cordillera de la costa;
- El hundimiento, en posición intracratónica, de la cuenca del flysch piemontino y luego el tectonismo de aquello, durante el Paleoceno – Eoceno.

Las dos fases compresivas mayores están separadas por una larga Época (Aptiense – Albiense, hasta el Senoniense inferior) de distensión y de fallamiento transcurrente, asociados con un magmatismo básico generalizado; este último se divide: en una provincia de tipo detrás de arco ("back arc") que se desarrolla desde el margen suramericano hacia el Noroeste; y en un arco insular, que se desarrolla desde la futura isla de Tobago hacia el Noroeste.

MESOZOIC OCEANIC TERRANES OF SOUTHERN CENTRAL AMERICA-GEOLOGY, GEOCHEMISTRY AND GEODYNAMICS

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Sciences de la Terre de l'Université de Lausanne, Suiza. Tesis Dr. 2009.
(Texto completo de 329 p. en DVD anexo, carpeta 18)

The Northwestern edge of the modern Caribbean Plate, located in central Middle America (S-Guatemala to N-Costa Rica), is characterized by a puzzle of oceanic and continental terranes that belonged originally to the Pacific façade of North America. South of the Motagua Fault Zone, the actual northern strike slip boundary of the Caribbean Plate, three continental slivers (Copán, Chortis s. str. and Patuca) are sandwiched between two complex suture zones that contain HP/LT mafic and ultramafic oceanic rocks: The Motagua Mélanges to the North, extensively studied in the last ten years and the newly defined Mesquito Composite Oceanic Terrane (MCOT) to the South. No modern geological data were available for the oceanic terrane located in the southern part of the so called continental "Chortis Block". Classically, the southern limit of this block with the Caribbean Large Igneous Province (CLIP) was placed at a hypothetical fault line connecting the main E-W fault in the Santa Elena Peninsula (N-Costa Rica) with the Hess Escarpment. However, our study in eastern Nicaragua and northwestern Costa Rica evidences an extensive assemblage of oceanic upper mantle and crustal rocks outcropping between the Chortis/Patuca continental blocks and the CLIP. They comprise collided and accreted exotic terranes of Pacific origin recording a polyphased tectonic history. We distinguish: 1- The MCOT that comprises a Late Triassic to Early Cretaceous puzzle of oceanic crust and arc-derived rocks set in a serpentinite matrix, and 2- The Manzanillo and Nicoya Terranes that are made of Cretaceous plateau-like rocks associated with oceanic sediments older than the CLIP. This study has been focused on the rocks of the MCOT. The MCOT comprises the southern half of the former "Chortis Block" and is defined by 4 corner localities characterized by ultramafic and mafic oceanic rocks of Late Triassic, Jurassic and Early Cretaceous age: 1- The Siuna Serpentinite Mélange (NE-Nicaragua), 2- The El Castillo Mélange (Nicaragua/Costa Rica border), 3- DSDP Legs 67 and 84 (Guatemala fore-arc basin), and 4- The Santa Elena Peridiotite (NW-Costa Rica).

The Siuna Serpentinite Mélange (SSM) is a HP/LT subduction zone mélange set in a serpentinite matrix that contains oceanic crust and arc-related greenschist to blueschist/eclogite facies metamafic and metasedimentary blocks. Middle Jurassic (Bajocian-Bathonian) radiolarites are found in original sedimentary contact with arc-derived greenstones. Late Jurassic black detrital chert possibly formed in a marginal (fore-arc?) basin shortly before subduction. A phengite 40Ar/39Ar -cooling age dates the exhumation of the high pressure rocks as 139 Ma. The El Castillo Mélange (ECM) is composed of serpentinite matrix with OIB metabasalts and Late Triassic (Rhaetian) red

and green radiolarite blocks. Recent studies of the DSDP Legs 67/84 show that the Guatemala/Nicaragua fore-arc basin is composed of a pile of ultramafic, mafic (OIB-like) and arc related rocks with ages ranging from Late Triassic to Campanian. Finally, the Santa Elena peridiotites that mark the limit of the MCOT with the Manzanillo/Nicoya Terranes and correspond to an association of ultramafic rocks that comprise peridiotites, dunites and chromites of abyssal and fore-arc origin.

The SSM is the result of a collision between a Middle Jurassic island arc and the Patuca Terrane, a fragment of the Western N-American active continental margin. The Siuna Mélange (SSM) and the South Montagua Mélange share common characteristics with the Pacific NAmerican suture zone (E-Franciscan and Vizcaino mélanges), in particular, the Mesozoic ages of HP/LT metamorphic and the arc-derived blocks. For us, these mélanges imply an originally continuous, but slightly diachronous suture that affected the entire W-American active margin. It may imply the arrival and collision of an exotic intraoceanic arc (Guerrero-Phoenix) related to the origin of the Pacific Plate that initiated as a back arc basin of this arc. The present disposition of the fragments of this suture zone is the result of a northward shift of the active left-lateral strike slip motion between the N-American and the Caribbean Plates.

ESTRATIGRAFÍA DEL ÁREA RÍO FRÍO-CERRO LAS MINAS, ESTADO TÁCHIRA, VENEZUELA

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U.C.V. Facultad de Ingeniería. Escuela de Geología, Minas y Geofísica. 2012.
Tutores: Wolfgang Scherer y Omar Contreras.
(Texto completo de 136 p. DVD anexo, carpeta 19)

En el presente trabajo se realiza el estudio geológico de las rocas de origen sedimentario que afloran en el área entre el Caserío Río Frío y Cerro Las Minas, en los alrededores de San Cristóbal, estado Táchira. Con el objetivo de estudiar las relaciones estratigráficas, sedimentológicas y en menor grado estructurales, entre las unidades Cretácicas que afloran en el área, para lo cual se estudiaron cortes de carretera entre el Caserío Río Frío y Cerro Las Minas. La metodología de trabajo comprendió cuatro etapas, iniciando con la recopilación bibliográfica, seguida de trabajos de campo en la cual se describieron diecisiete secciones de campo y se realizó la toma de muestras, durante la tercera etapa de laboratorio, se realizaron los análisis petrográficos, bioestratigráficos y en menor cantidad geoquímicos, finalmente durante la cuarta etapa de interpretación de resultados se integró la información de campo y laboratorio y se generaron los mapas, columnas litoestratigráficas y el corte geológico. La geología local está representada por las formaciones Rio Negro, Apon (Miembro Tibu) y Aguardiente correspondientes al Cretácico temprano. Siendo esta secuencia el principal objetivo de estudio, sin embargo más al noroeste y suroeste del área de Cerro Las Minas afloran las formaciones Capacho, La Luna y Colon-Mito Juan las cuales fueron descritas puntualmente. Las rocas sedimentarias, agrupadas en las secuencias de las formaciones: Río Negro, Apón y Aguardiente son a grandes rasgos: areniscas de colores claros, rojizos y amarillo claro, calizas de colores oscuros, azulosos, ocasionalmente con olor a petróleo y lutitas gris claro.

La edad de la secuencia de rocas estudiadas comprende desde el periodo Barremiense hasta el Albiense, asignando a la Formación Río Negro una edad Barremiense – Aptiense en base a la presencia del polen *Cycadopites sp., Corollina sp*. y restos de plantas de Otozamites correlacionable con las formaciones Barranquín y Cantil, del Grupo Sucre de Venezuela Oriental. Así como una edad Aptiense temprano – Albiense temprano para la Formación Apón, en base al bivalvo *panopea sp.* y nanofósiles, perteneciente a la familia de los Nannoconus: *Boletus Quadriangulus, Apertus, Wasalli* y *cf. Vocontiense* Los ambientes sedimentarios interpretados para la Formación Río Negro, cuyos depósitos están caracterizados por areniscas conglomeráticas de color claro, carbones, restos de plantas y pirita, indican facies deltaicas con dominio fluvial en general, interpretándose depósitos de la llanura deltaica hacia la base, con depósitos del frente deltaico (barras de desembocadura) y posibles facies del prodelta hacia la parte media y superior de la unidad indicando una profundización. Para la Formación Apon ambientes marinos de aguas llanas, representados por calizas oolíticas, coquinoides y arenosas. Y finalmente posibles facies de ambientes marino someros para la Formación Aguardiente. La tectónica del área está controlada por esfuerzos, transpresivos, atribuidos mayormente a las fallas de Bramón, Capacho y Santo Domingo, ubicadas al suroeste, noroeste y sureste del área de estudio, respectivamente. Estos esfuerzos generan corrimientos profundos, de ángulo bajo y zonas de duplex, asociados a una tectónica de piel delgada. Un aporte significativo a la geología de Venezuela, lo constituye la actualización del mapa geológico de la compañía Creole (H-2-B, 1:50.000), en base a datos litológicos y edades, en

el área Cerro Las Minas. En la secuencia de rocas estudiada, se detectan fuertes evidencias de presencia de crudo, especialmente en calizas del Miembro Tibú, de la Formación Apón y en el Miembro Guayacán, de la Formación Capacho, este hecho, sumado a la interpretación geológica y estructural, crean alentadoras expectativas para la explotación petrolera en el área de estudio.

IN-SITU U-PB SECONDARY ION MASS SPECTROMETRY (IN-SIMS) GEOCHRONOLOGY FROM THE LEEWARD ANTILLES ISLANDS OF ARUBA, CURAÇAO, BONAIRE, AND GRAN ROQUE: IMPLICATIONS FOR THE TEMPORAL EVOLUTION OF THE CARIBBEAN LARGE IGNEOUS PROVINCE (CLIP) AND EARLY ARC MAGMATISM

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University of Georgia. Tesis M.S., 2009.
Thesis director: James E. WRIGHT.
(Texto completo de 92 p. DVD anexo, carpeta 20)

In-situ U-Pb secondary ion mass spectrometry (IN-SIMS) was performed on both microbaddeleyite and micro-zircon from mafic samples of the Leeward Antilles islands of Aruba, Curaçao, Bonaire, and Gran Roque in order to gain a better understanding of the temporal evolution of both the Caribbean large igneous province (CLIP) and early arc magmatism. IN-SIMS analysis of CLIP samples from Aruba, Curaçao, and Gran Roque indicate a ~30 Ma span of CLIP magmatism from the Aptian to Coniacian (ca. 115-87 Ma). The extensive duration of CLIP magmatism argues against the formation of the CLIP within a few million years (e.g. SINTON *et al*. 1998, KERR *et al*. 2003). IN-SIMS geochronological results from Bonaire in addition to U-Pb SHRIMP data from WRIGHT & WYLD (2010) indicate that early arc activity occurred on Bonaire from the Albian to Cenomanian (ca. 112-95 Ma).

THERMOCHRONOLOGY, GEOCHRONOLOGY AND GEOCHEMISTRY OF THE WESTERN AND CENTRAL CORDILLERAS AND SIERRA NEVADA DE SANTA MARTA, COLOMBIA: THE TECTONIC EVOLUTION OF NW SOUTH AMERICA.

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Faculté des sciences de l'Université de Genève. Tesis Dr., 2010.
(Texto completo de 166 p. DVD anexo, carpeta 21)

This thesis presents geochronological, thermochronological and geochemical data from rocks exposed in the Western and Central cordilleras and the Cauca-Patía Valley of Colombia, extending from the southern border with Ecuador to the north where basement rocks are buried beneath the southern Caribbean plains. Low temperature thermochronological methods have also been applied to the Sierra Nevada de Santa Marta (northern Colombian coast). This abstract provides a summary of the project aims, results, interpretations and general conclusions.

Northern Andean Segment (north of 5°S; including Ecuador and Colombia) is unique within the Andean orogenic chain because it was built by numerous terrane collision and accretion events since the Early Cretaceous. The accreting terranes retain an oceanic geochemical and lithological character, and are juxtaposed against the paleo-continental margin across the diffuse, Romeral Fault System, which entrains anastomosed blocks of allochthonous and para-autochthonous rocks. The temporal framework for the evolution of the Colombian Andes has been constrained by scarce U-Pb zircon [e.g. CARDONA *et al.*, 2006; VINASCO *et al.*, 2006; ORDOÑEZ-CARMONA and PIMENTEL, 2006], K/Ar, Rb/Sr [see compilation in ASPDEN *et al.*, 1987; RESTREPO *et al.*, 2009] and apatite (U-Th)/He data [RESTREPO-MORENO *et al.*, 2009], which were interpreted to determine the timing of metamorphism and intrusive magmatism within the Central Cordillera. This thesis presents new isotopic data including 16 zircon U-Pb ages, 35 multiphase 40Ar/39Ar ages, apatite and zircon fission track data from 76 rocks and 21 apatite and zircon (U-Th)/He ages. In addition, 43 whole-rock geochemical analyses have been performed to characterize the tectonic origin of significant geological units.

Chapter 1 gives an introduction on the theoretical background and the aims of this thesis.

Chapter 2 focuses on the tectonic origin of major igneous and metamorphic units. The Central Cordillera of Colombia is built from autochthonous rocks that define the pre-Cretaceous continental margin (the Tahami Terrane), juxtaposed against a series of para-autochthonous and allochthonous terranes that accreted during the Cretaceous and

which are exposed in the Western Cordillera and the Cauca-Patía Valley, along the regional-scale Romeral Fault System that extends into Ecuador. We present the first regional-scale dataset of zircon U-Pb LA-ICP-MS ages for multiple intrusive and metamorphic rocks of the autochthonous Tahami Terrane, Early Cretaceous igneous para-autochthonous rocks (Quebradagrande Complex) and accreted Late Cretaceous oceanic crust of the allochthonous Calima Terrane. The U-Pb zircon data are complemented by multiphase 40Ar/39Ar crystallization ages. The geochronological data have been combined with whole rock major oxide, trace element and REE data (XRF and LA-ICP-MS) from the same units to constrain the tectonic origin of the rock units and terranes exposed in the Central and Western cordilleras of Colombia. Our data show that metamorphic rocks forming the basement of the Tahami Terrane, which are exposed in the Central Cordillera consist of a complex assemblage of lower Paleozoic gneisses that were intruded by Permian granites, which were unconformably overlain by Triassic sedimentary rocks that subsequently underwent anatexis (Cajamarca Complex). Discrete Precambrian age populations indicate the Paleozoic-Triassic sedimentary rocks were probably derived from the Guyana Shield and are native to South America. A distinct peak of U-Pb detrital zircon ages at 220-240 Ma yielded by the Triassic metasedimentary rocks defines their maximum depositional age. The S-type granites yield ages as young as 240 Ma, suggesting the high-temperature metamorphic event that partially melted the sedimentary rocks was related to the disassembly of Pangea, and the initiation of the western Tethys- Pacific Wilson cycle. Continental arc magmatism spanned the entire Jurassic and is preserved along the whole length of the Central Cordillera. The youngest pulse of Mesozoic continental arc magmatism occurred at 145 Ma.

An oceanic marginal basin and intra-oceanic arc, represented by the Quebradagrande Complex formed during the Early Cretaceous, and its inception may have been caused by back-stepping of the Jurassic slab due to the introduction of buoyant sea-mounts. The coexistence of both MORB-like gabbros and basalts in close association with pillowed arc basalts, locally covered by marine sediments with both an oceanic and continental provenance suggests an oceanic arc origin for the Quebradagrande Complex, with a backarc located proximal to the continent. The Quebradagrande Complex accreted against the Tahami Terrane during the late Aptian, which was accompanied by the obduction of medium-high P–T metamorphic rocks of the Arquía Complex onto the Cretaceous forearc. The oceanic basement of the Western Cordillera and the Cauca-Patía Valley (the Calima Terrane) formed above an oceanic hotspot, which generated a plateau that was intruded by an intra-oceanic arc, forming the Late Cretaceous Caribbean-Colombian Oceanic Province. Geochronological analyses of the plateau rocks yield an age range of 100-92 Ma. The remnant ocean basin located between South America and the Caribbean-Colombian Oceanic Province was consumed via a double-vergent subduction system, giving rise to a continental and oceanic arc. The Caribbean-Colombian Oceanic Province collided and accreted to South America during ~75-70 Ma along the Cauca-Almaguer Fault, resulting in the cessation of both arcs and the Paleocene onset of subduction beneath the accreted oceanic crust.

Chapter 3 focuses on low- and medium-temperature thermochronometers. New multiphase 40Ar/39Ar data, fission track (zircon and apatite) and (U–Th)/He (zircon and apatite) ages record a complex cooling history in the Central and Western cordilleras of Colombia that is a function of Early Cretaceous to late Miocene tectonic events. Alkali-feldspar 40Ar/39Ar cooling ages obtained from crystalline rocks located to the south of the laterally extensive Ibagué Fault yielded ages of ~138–130 Ma and are contemporaneous with the cessation of Jurassic arc-magmatism and a major unconformity within the retro-forearc region of the Northern Andes. We interpret these ages as cooling driven by exhumation in response to a dynamically supported upper plate and isostatic rebound during and subsequent to fragmentation of the Jurassic slab. Oceanward, back-stepping of the slab during the earliest Cretaceous gave rise to the Lower Cretaceous Quebradagrande oceanic arc sequence. Medium-temperature thermochronometers (biotite and alkalifeldspar 40Ar/39Ar with closure temperatures >230°C) in rocks of the Central Cordillera (paleocontinental margin) located north of the Ibagué Fault reveal the presence of a younger cooling event at 107–117 Ma, which was contemporaneous with hornblende 40Ar/39Ar cooling ages (cooling below 550-500°C) obtained from medium–high P–T metamorphic rocks of the Arquía Complex, which are probably a relict of the Late Jurassic - Early Cretaceous subduction channel. This previously unidentified cooling event has been attributed to exhumation driven by the collision and accretion of the Quebradagrande arc against the continental margin, and the obduction of the subduction channel onto the forearc. Numerical modelling of low-temperature thermochronometric data (zircon and apatite fission track and (U–Th)/He), acquired from rocks sampled throughout the Central and Western Cordillera reveals three periods of rapid cooling since the Late Cretaceous. The earliest phase is recorded by Jurassic and Cretaceous granitoids (Ibagué and Antioquia Batholith) that were emplaced in the Central Cordillera in Colombia and cooling rapidly from ~550˚C to ~60˚C during 75–65 Ma. We attribute cooling to exhumation of the continental margin at an average rate of ~1.6 km/Ma during ~75-70 Ma, which was forced by the collision and accretion of the Caribbean-Colombian Oceanic Province in the Campanian. Contemporaneous clastic sedimentation sourced from

rocks of the Central Cordillera fed the retro-foreland basin and the peripheral basin corroborating observed exhumation. The Central Cordillera exhumed at moderate rates of ~0.3 km/Ma during the Eocene (~45–30 Ma), which are also observed over widely dispersed regions along the Andean chain, and were probably caused by an increase in continent-ocean plate convergence rates. Elevated exhumation rates in the middle - late Miocene have been identified from the apatite (U-Th)/He data. The greatest amount of middle - late Miocene exhumation occurred in southern Colombia, and spatially corresponds with elevated exhumation rates in northern Ecuador. The spatial pattern suggests that exhumation was a consequence of erosion during and subsequent to rock uplift, in response to collision and subduction of the buoyant Carnegie Ridge.

Chapter 4 describes how low-temperature thermochronology can help constraining variations on vertical tectonics at a continental crust-oceanic plateau boundary zone, and how this knowledge can be used for tectonic reconstructions. We have used apatite fission track data (with U contents obtained by the LA-ICP-MS method) collected along several traverses and a single vertical profile to quantify the thermal histories of surface rocks of the Sierra Nevada de Santa Marta (SNSM). The topographically prominent Sierra Nevada de Santa Marta is hosted by a faulted block of continental crust located along the northern boundary of the South American Plate, hosts the highest peak in the world (~5.75km) whose local base is at sea level, and juxtaposes oceanic plateau rocks of the Caribbean Plate. Quantification of the amount and timing of exhumation will constrain interpretations of the history of the plate boundary, and the driving forces of rock uplift along the active margin. The Sierra Nevada Province of the southernmost Sierra Nevada de Santa Marta exhumed at elevated rates (≥0.2 km/Ma) during 65-58 Ma in response to the collision of the Caribbean Plateau with north-western South America. A second pulse of exhumation (≥0.32 km/Ma) during 50-40 Ma was driven by underthrusting of the Caribbean Plate beneath northern South America. Subsequent exhumation at 40-25 Ma (≥0.15 km/Ma) is recorded proximal to the Santa Marta–Bucaramanga Fault. More northerly regions of the Sierra Nevada Province exhumed rapidly during 26-29 Ma (~0.7 km/Ma). Further northwards, the Santa Marta Province exhumed at elevated rates during 30-25 Ma and 25-16 Ma. The highest exhumation rates within the Sierra Nevada de Santa Marta progressed towards the northwest via the propagation of NW-verging thrusts. Exhumation is not recorded after ~16 Ma, which is unexpected given the high elevation and high erosive power of the climate, implying that rock and surface uplift that gave rise to the current topography was very recent (i.e. ≤1 Ma?), and there has been insufficient time to expose the fossil apatite partial annealing zone.

Chapter 5 presents a summary of the results, interpretations and conclusions.