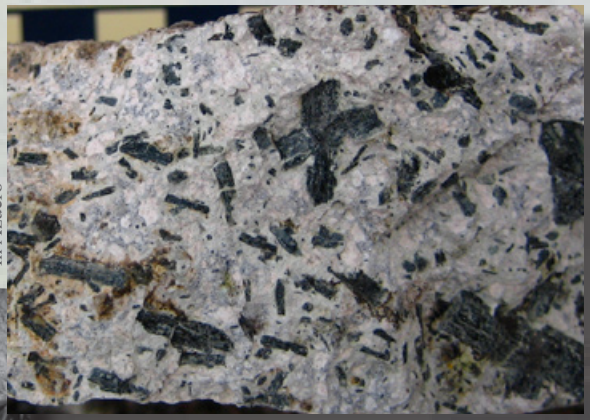
The Panamá Geology Project

Cenozoic Evolution of the Panamá Isthmus

Smithsonian Tropical Research Institute

Chucunaque basin, Darién



Granitic rock in Azuero

Fossil forest, Cucaracha Fm.

The Smithsonian Tropical Research Institute (STRI) in Panamá has assembled a team of scientists under the umbrella of the Center of Tropical Paleontology and Archaeology (CTPA) to study the geology of Panamá. This project has already collected a large amount of information from remote areas of Panamá where no mapping or sampling had been done in the past, as well as from areas where information already exists and needs to be re-evaluated. This project aims at building a more refined understanding of the geology of the isthmus from a brand new set of data.

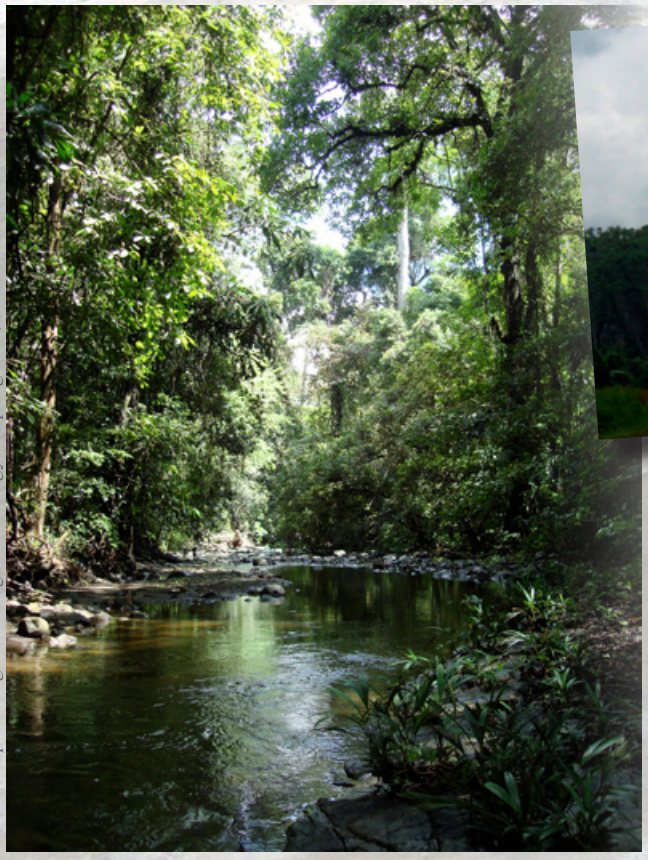
Goals

The goal of this project is to build a tectonic and chronostratigraphic framework of events leading to the consolidation of the Panama isthmus. This project should:

1) Define the extent and timing of magmatic events and geochemically characterize them

2) Constrain basin geometries, thicknesses, continuity and connection between sedimentary basins

3) Integrate these constraints on timing and styles of magmatic events and structural deformation with exhumation histories to produce a process-based model for the formation of the isthmus



Search for paleomagnetic and geochronology sampling sites, Darién

Anticipated results

The Project will significantly impact our understanding of mineral and hydrocarbon resources in the region. New data being collected and analyzed will help characterize and understand metalogenetic events, and map the distribution, maturation and migration of potential hydrocarbon resources.

3D rendering of mapping and sampling sites in the Culebra Cut, Canal zone

Major impacts are expected regarding:

1) Timing of metallogenetic events (more than 150 geochemical/ geochronology samples already in hand)

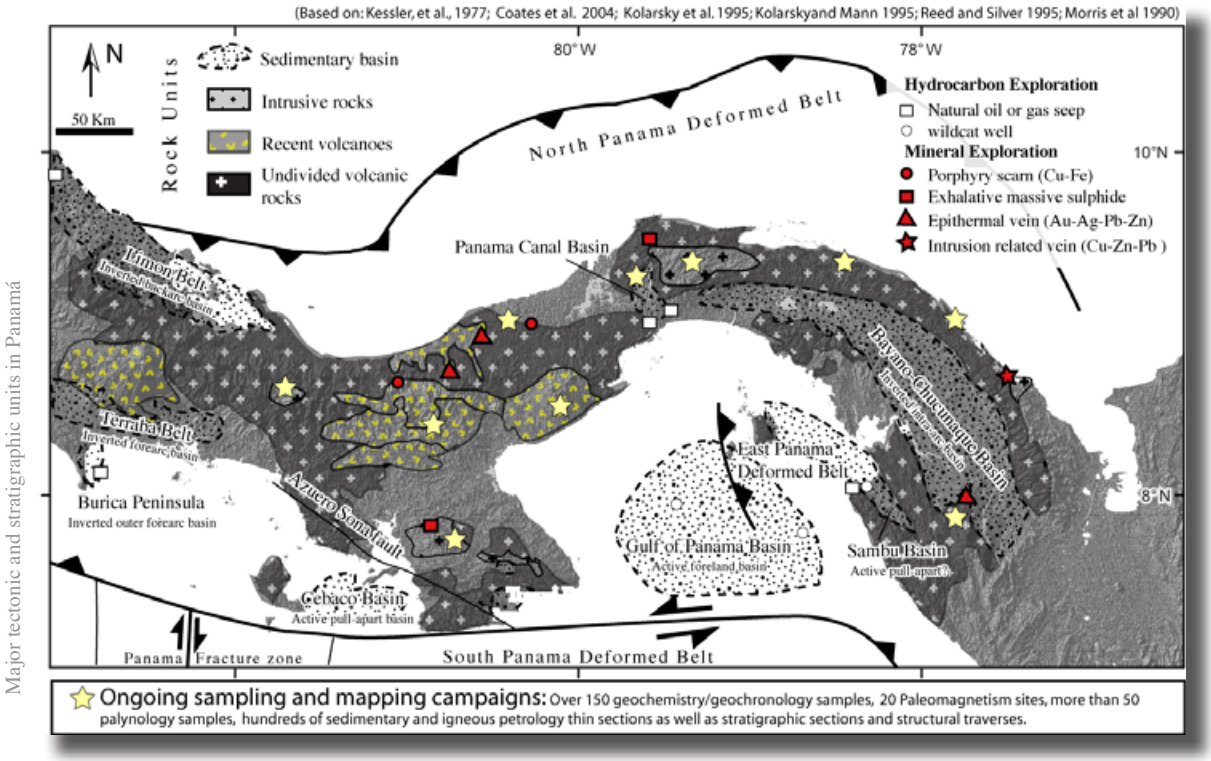
2) Basin formation and probable distribution of reservoir/source rocks (ongoing geologic mapping and provenance analyses)

3) Paleogeographic evolution of the isthmus within a Caribbean tectonic framework (more than 20 paleomagnetic sites already drilled)

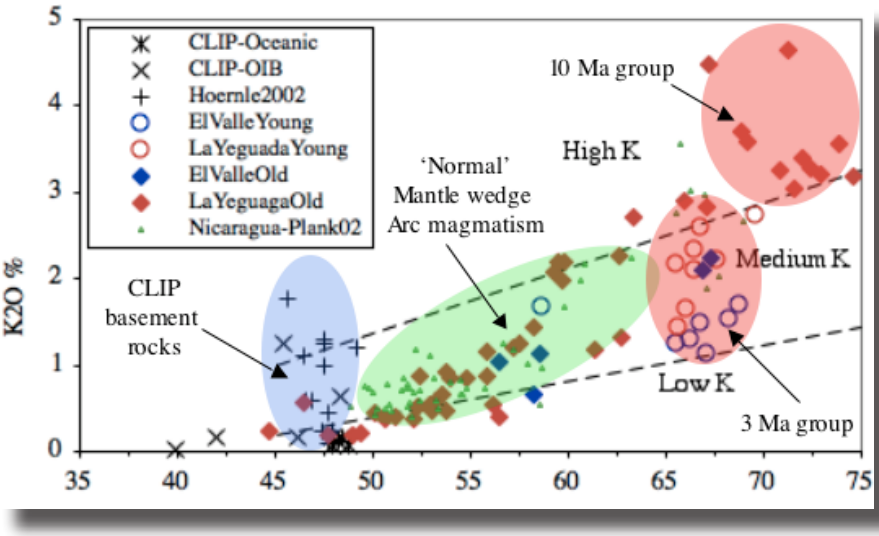
A Brief Outline of Panama's Geology

Due to its prolonged geologic record (ca. 90 Ma), intra-oceanic character, and triple plate interactions, the evolution of the Panama isthmus is influenced by numerous overlapping tectonic interactions since the late Cretaceous, ending with its collision with the corners of the South and North America plates.

The history of these interactions begins with mafic volcanism related to the growth of the Caribbean Large Igneous Province (CLIP) approximately 90-75 Ma ago. This basement was intruded and overlapped by submarine mafic early arc plutonic and volcanic rocks 65-50 Ma ago that are now exposed throughout northern Panama in the San Blas massif and to a lesser extent in the Azuero Peninsula. Sedimentation on this complex basement started with Upper Cretaceous deep marine sediments in the Chucunaque-Tuira, the Bayano and the Sambu basins in the Darien Province. Subduction of the Farallon and Cocos plates flared up a volcanic arc during the Oligocene and until about 10 Ma, while sedimentation became progressively shallower throughout the isthmus. Radical changes



Major tectonic and stratigraphic units in Panamá



Geochemical discriminatory diagram

Compiled from: Kesler et al., 1977; Mann and Kolarsky, 1995; Defant et al., 1991; Hoernle et al., 2002; Plantk, et al., 2002.

in plate geometry and kinematics since the Late Miocene resulted in the shutting down of volcanic arcs, eruption of unusual volcanic magmatic rocks, opening of new sedimentary basins and distortion of existing ones, as well as changes in weather patterns, culminating in the final closure of the isthmus about 3 Ma ago.

Most of the events summarized above have only been cursory examined, and therefore significant **metallogenetic provinces remain to be recognized**, and most offshore and onshore basins with thick sedimentary piles, **remain virtually uncharted**. A finer temporal and spatial resolution is needed to properly forecast the opportunities and distribution of mineral and hydrocarbon resources.

Century-old gold mining infrastructure, Darién

Project Team

The Project team is composed of an international group of post-doctoral researchers and research assistants working independently towards a common goal. The team includes sedimentologists, structural geologists, geochronologists, paleontologists and stratigraphers expert in a wide range of geological tools. The team has the logistical support of STRI in Panamá with access to all of the Smithsonian Institution laboratories and libraries in Washington DC, as well as ongoing collaborations with industry, such as the Panamá Canal Authority, local government, and other research centers.

Camilo Montes

Ph.D., 2001, Structural Geology, Panamá Geology Project leader. Camilo's main interests are digital geologic mapping and 3D modelling -digital and analog- combined with kinematic analysis. Camilo has studied the Caribbean-Andes connection using these tools, and has implemented systematic mapping tools at large-scale mining operations. Camilo's industrial experience includes leading the geology group of one of the largest open-pit coal mines in the world (in charge of operations and exploration), as well as international experience in South Africa and at the French Institute of Petroleum.

Gold Hill, Culebra Cut.

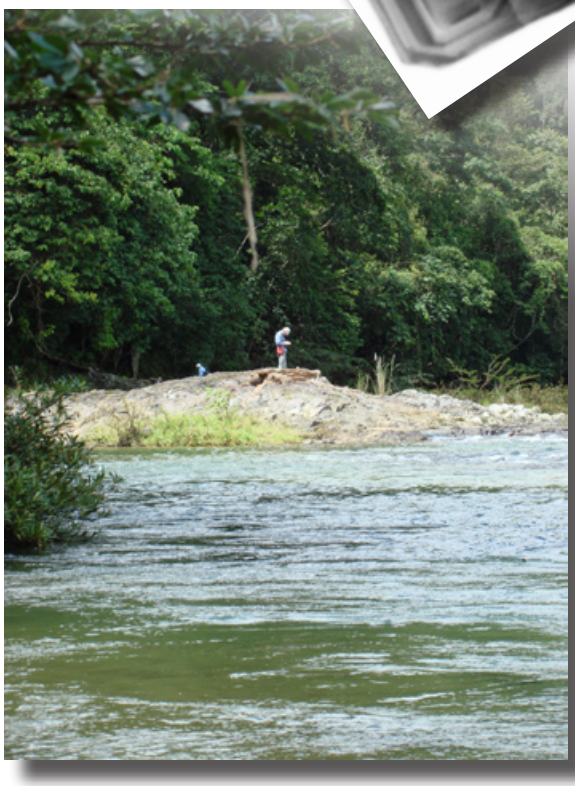
Cerrejón Coal Mine, N Colombia

Agustín Cardona

Ph.D., 2006, Geochemistry and Geotectonics. Agustín integrates the compositional record (whole and mineral chemistry, isotopes and geochronology) of igneous, sedimentary and metamorphic rocks with field and petrologic constraints to trace tectonic processes and assessed paleogeographic issues. Recently he has been involved in a collaborative project to analyze the major Meso-Cenozoic accretionary, magmatic and basin filling events in northern Colombia in relation to Caribbean-South American plate interactions.

Sampling, upper Mamoní river

Magmatic Zircon



Geologic mappping along river exposures,

David Farris

Ph.D., 2006, David's research focuses on the tectonic and geochemical evolution of magmatic arcs using high-resolution field mapping coupled with strain data, potential field geophysics, U/Pb and Ar/Ar geochronology, geochemical modeling, and geospatial analysis. His past work involved understanding how a spreading-ridge subduction event in southern Alaska influenced magmatic behavior in the arc, and current research is focused on unraveling the confluence of tectonic and magmatic events that led to the formation of the Panamanian Isthmus.

Nikki Strong

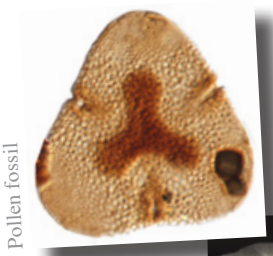
Ph.D., 2006, Sedimentology-Stratigraphy. Nikki has worked as a theoretical and analogue sedimentary basin modeler, seismic stratigrapher, and as a field geologist in East Africa and Panamá. Nikki has also served as an instructor of industrial short courses at St. Anthony Falls Laboratory at the University of Minnesota (Shallow and Deep Water Sedimentary Processes) and with the Petroleum Technology Transfer Council (Sequence Stratigraphy for Explorationists).

Coastal outcrops near Colón

Germán Bayona

Ph.D., 2003, Stratigraphy - Paleomagnetism. Germán's research in the Northern Andes focuses on the interaction between mountain-building processes and the formation and filling of adjacent sedimentary basins, integrating different data sets such as provenance, stratigraphic correlations, geodynamic models of mountain belts and paleomagnetism. In Panama, he is using paleomagnetic techniques to document the translation of different tectonic blocks, and the kinematics of rotations of those blocks during the closure of the Panama isthmus.

Drilling for paleomagnetic analyses



Pollen fossil

Carlos Jaramillo

Ph.D., 1999, Paleontology-Biostratigraphy, STRI Staff Scientist. Carlos investigates the causes, patterns, and processes of tropical biodiversity at diverse scales of time and space. He intends to address questions from a paleontological perspective (mainly using fossil pollen, spores and dinoflagellates). Carlos is also interested in Cretaceous-Cenozoic biostratigraphy of low latitudes, developing methods for high-resolution biostratigraphy and the paleobiogeography of Tethys.

Fossil leaf

Research Assistants

A local and international group of research assistants with excellent academic backgrounds, and relevant experience in particular geological areas is maintained to support the post-doctoral researchers. They are typically aiming at continuing their graduate studies in subjects related to the Project. Current RAs include **Sara Morón** in stratigraphy, **Cesar Silva** in paleomagnetism and **Aldo Rincón** in paleontology.

Darién

Selected Publications

Bayona, G., Cortés, M., **Jaramillo**, C., Ojeda, G., Aristizabal, J., and Reyes-Harker, A., 2008, An integrated analysis of an orogen-sedimentary basin pair: Latest Cretaceous-Cenozoic evolution of the linked Eastern Cordillera orogen and the Llanos foreland basin of Colombia. Geological Society of America Bulletin, in press.

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Jaramillo, C., Muñoz, F., Cogollo, M. and Parra, F. 2005. Quantitative Biostratigraphy for the Paleocene of the Llanos Foothills, Colombia: Improving Palynological Resolution for Oil Exploration. In: Recent Developments in Applied Biostratigraphy, Powell, A.J. and Riding, J. (eds), The Micropaleontological Society Special Publication, pp. 145-159.

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Jaramillo, C. and Dilcher, D.L. 2000. Microfloral diversity patterns of the late Paleocene-Eocene interval in Colombia, northern South America. Geology 28: 815-818.

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Montes, C., Restrepo-Pace, P. A., Hatcher R. D. Jr., 2003; Three-dimensional structure and kinematics of the Piedras-Girardot foldbelt: Surface expression of transpressional deformation in the northern Andes; in Bartolini,C., Buffler, R., Blickwede, eds: The circum-Gulf of Mexico and the Caribbean: Hydrocarbon habitats, basin formation and plate tectonics: AAPG Memoir 79, p. 849-873.

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Sponsoring the Project

The results of the Project will be available to sponsors typically one year before publication and will include the entire datasets collected during the Project in the form of an annual report, plus the opportunity to interact with team members for special consultations and guided field trips. **To have access to the full benefits, a donation of U$50K for the September 2008 - September 2009 period is suggested**.

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Fossil seed

Outcrop along the Canal

Gatún Lake

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