



# **Field Guide to Guatemalan Geology**

**Stanford Alpine Project  
2004-2005**

**Department of Geological and Environmental Sciences,  
Stanford University**

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# About this Guidebook and the Stanford Alpine Project

The Stanford Alpine Project (SAP) is one of many student organizations in the Associated Students of Stanford University (ASSU). SAP was founded after the 1989 Loma Prieta earthquake to promote academic and environmental involvement of Stanford students in the Earth's diverse geological settings. Every year or two, students organize and execute a field trip to some area of global geologic interest, culminating in the production of a field guidebook for submission to The Stanford University Libraries. This guidebook is associated with the SAP trip to Guatemala from June 27<sup>th</sup> – July 11<sup>th</sup>, 2005.

This guidebook is by no means a definitive "see-all" guide to the geology of Guatemala. Rather, it is a log of our trip through the country with a list of the places we visited and observations we made. Our route can be followed as strictly or as loosely as desired, or indeed not at all. Regardless, it is our sincere hope that our experiences and advice are helpful to other travelers and geologists who plan to visit Guatemala.

The guidebook with more pictures and maps is available online at:  
<http://pangea.stanford.edu/groups/SAP/>

Enjoy!

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## **Acknowledgments**

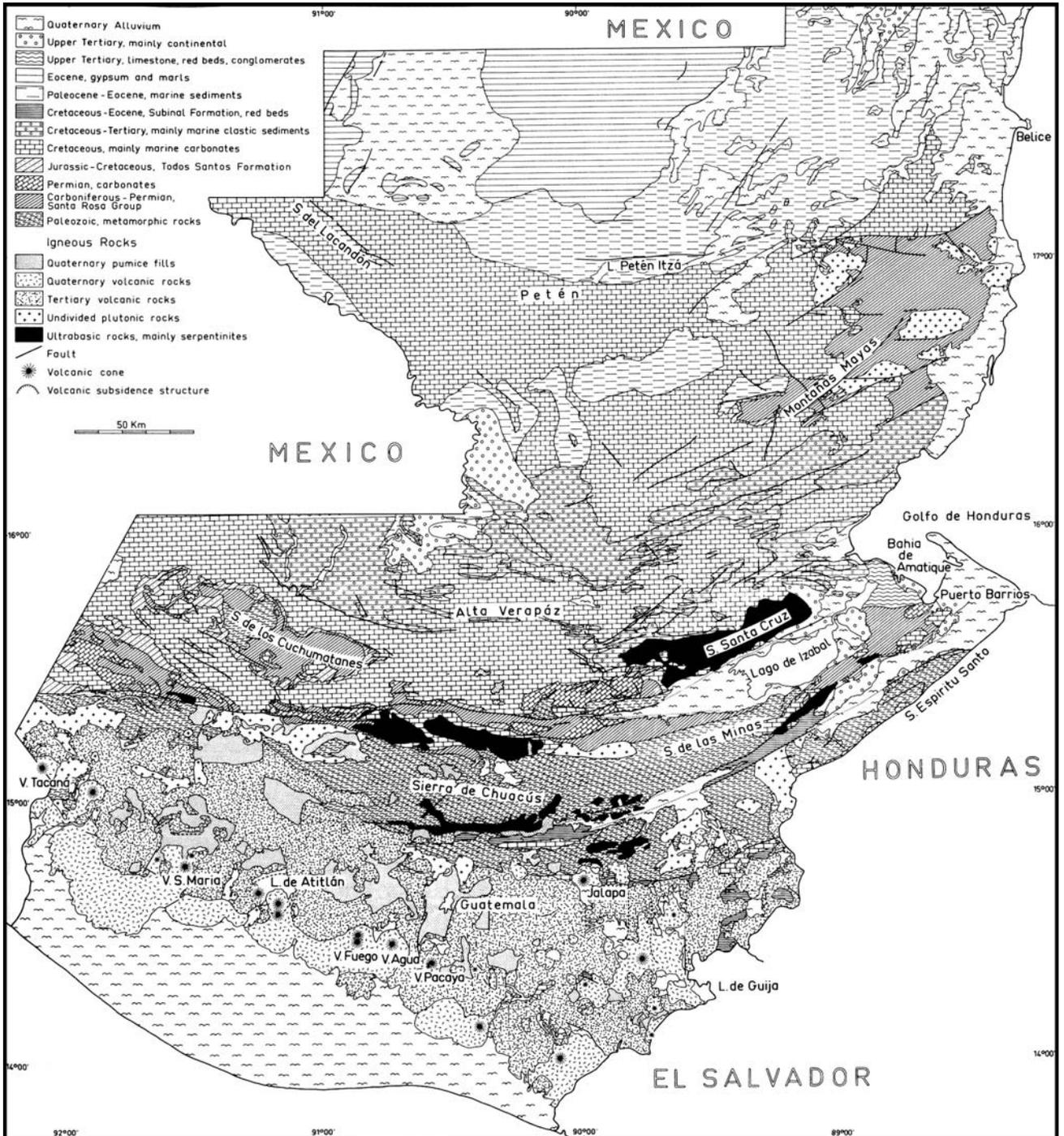
Special thanks to Stanford Earth Sciences Professor Gail Mahood, for lending us her time, expertise, and good company. This trip was made possible by funds raised by the Stanford Alpine Project (SAP), with contributions from the Dean's Office of the School of Earth Sciences, and numerous students, faculty, staff and other individuals from the Stanford Earth Sciences community. Most of all, the biggest thank-you goes out to Uwe Martens, a Stanford Earth Sciences PhD student and our local contact in Guatemala who was instrumental in making this trip the success that it was.

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## **Participants**

Peter Anthony, Sidney Carter, Julie Fosdick, Gwyneth Hughes, Theo Huzyk, Gail Mahood, Uwe Martens, Dale Meck, Benjamin Mirus, Kevan Moffett, Annie Scoffield, Utsav Sethi.

# Geologic Map of Guatemala



Source: Weyl, R., (1980), *Geology of Central America*, 2nd Ed., Berlin: Gebruder Borntraeger, 73.

# Introduction: Guatemalan Geology, Landscape and Culture

## Regional Tectonic Setting and Metamorphic History

*Julie C. Fosdick*

Guatemalan geology is characterized by the presence of active volcanoes, rugged terrain in the central cordillera, transform faulting, northern lowlands and extensive karst topography. Many of these features are the result of an active history of subduction, associated arc volcanism, plate collisions, ultra-high-pressure metamorphism, and deep-ocean basin or shallow-shelf deposition within the general plate tectonic evolution of the Caribbean region. The geologic terranes that compose Guatemala are best appreciated by evaluating the complex spatial and temporal evolution of plate boundaries between the Pacific, Caribbean, and Cocos plates. Though the geologic history of the Caribbean plate, and more specifically, Guatemala, remain poorly defined, the available studies illustrate a dynamic and complicated area of ongoing interest and debate.

Guatemala is centrally located within an area of active plate convergence and transform plate motion. The Middle American Trench is located along its southwest coast, formed by the Cocos plate subducting beneath the North American-Caribbean plates. The transverse plate boundary between the Caribbean and North American plates transects Guatemala's central region. Modern-day plate configurations can explain many of the geologic and geomorphic features of Guatemala, though regional variations in its geology are largely attributed to the older stages of the tectonic and volcanic evolution.

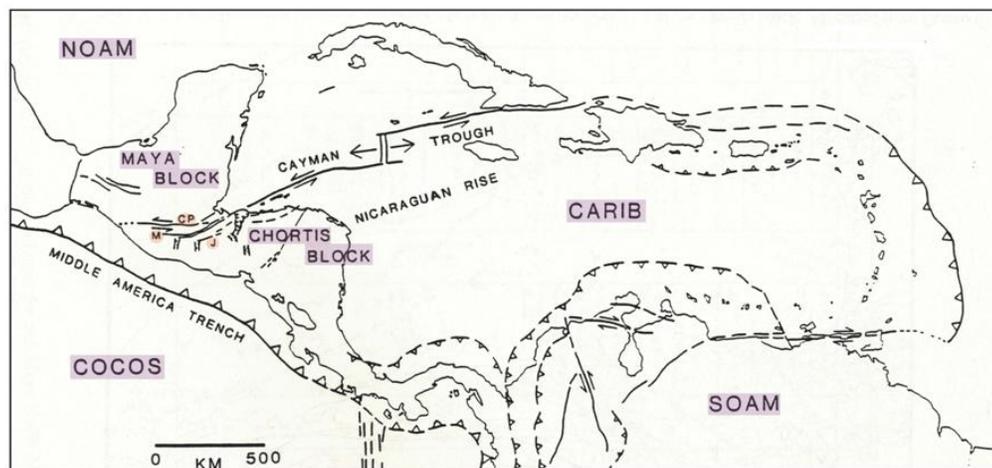


Plate tectonic setting of Central America showing the relative motions of the NOAM, Cocos, CARIB, and SOAM plates. Guatemala is subdivided into the Maya Block, of NOAM, and the Chortis Block, of CARIB association. These geologically distinct tectonic blocks are separated by the Motagua Suture Zone. CP = Chixoy-Polochic fault zone; M = Motagua fault zone; J = Jocotan fault zone

Many plate tectonic models for the Caribbean region have been hypothesized in the last 30 years (Dietz and Holden, 1970; White and Burke, 1980; Duncan and Hargraves, 1984; Pindell and Barrett, 1990), and yet a single, regionally integrated story has yet to gain popularity among Caribbean geoscientists. Additional geochronology, geologic mapping, and regional stratigraphic correlations are needed to resolve a regional tectonic evolution. The Pindell (1994) model provides a general summary of the major tectonic events that pertain to Guatemalan geology, including a) the Middle Jurassic break-up of the North American and South American plates, b) evolution of the proto-Caribbean seaway and oceanic crust, c) multiple island-arcs (proto- Greater Antilles and Costa-Rica/Panama island arcs), d) deep-water sedimentation along the northern Yucatan Peninsula, e) convergence between the Caribbean and proto-American plates, f) subduction zone and continental arc along western north and central America, g) Neogene transform plate boundary between Caribbean and North American plates.

Regardless of which model one subscribes to for regional tectonics, the major plate-tectonic components that are critical to any model are subduction-related magmatic arcs, orogenic collision zones, and remnant fragments of the oceanic lithosphere (Meschede and Frisch, 1998). Arc magmatism during the Late Jurassic period formed the volcanic arc that constitutes part of the Chortís block of southern Guatemala. Younger subduction magmatism within the Caribbean plate includes the Middle Cretaceous to Paleogene volcanic arcs such as Cuba, Puerto Rico, and the Virgin Islands. During the Late Cretaceous, continental collision occurred between a volcanic arc and the Mexico/Yucatán continental crust of the Maya block of northern Guatemala. This collision

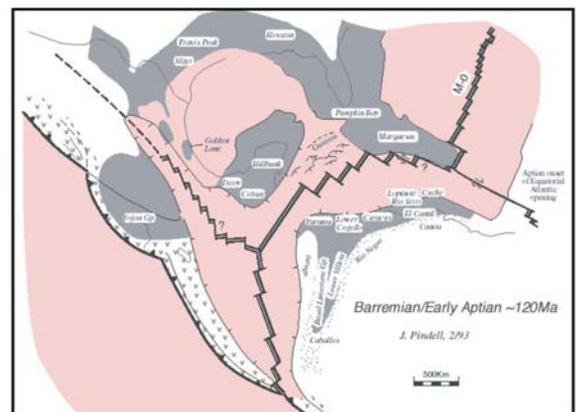
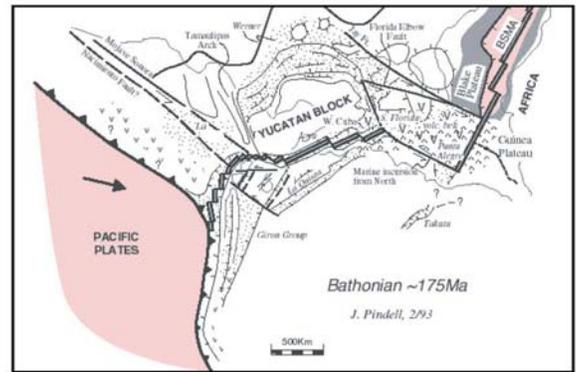


Plate reconstructions at 175 Ma and 120 Ma showing inception of an ocean spreading ridge in the proto-Caribbean region, island-arc magmatism, and ocean basin deposition (Pindell, 1994).

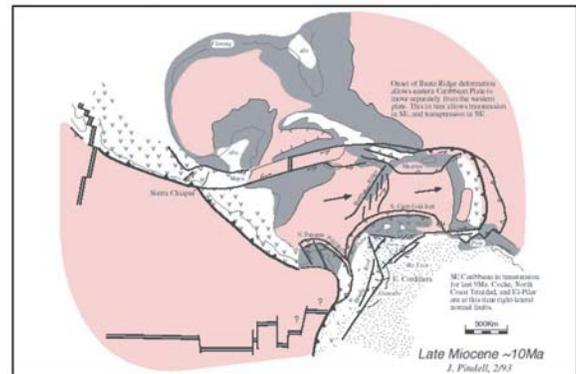
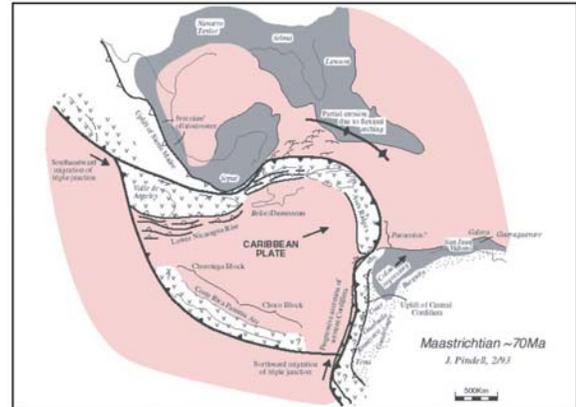
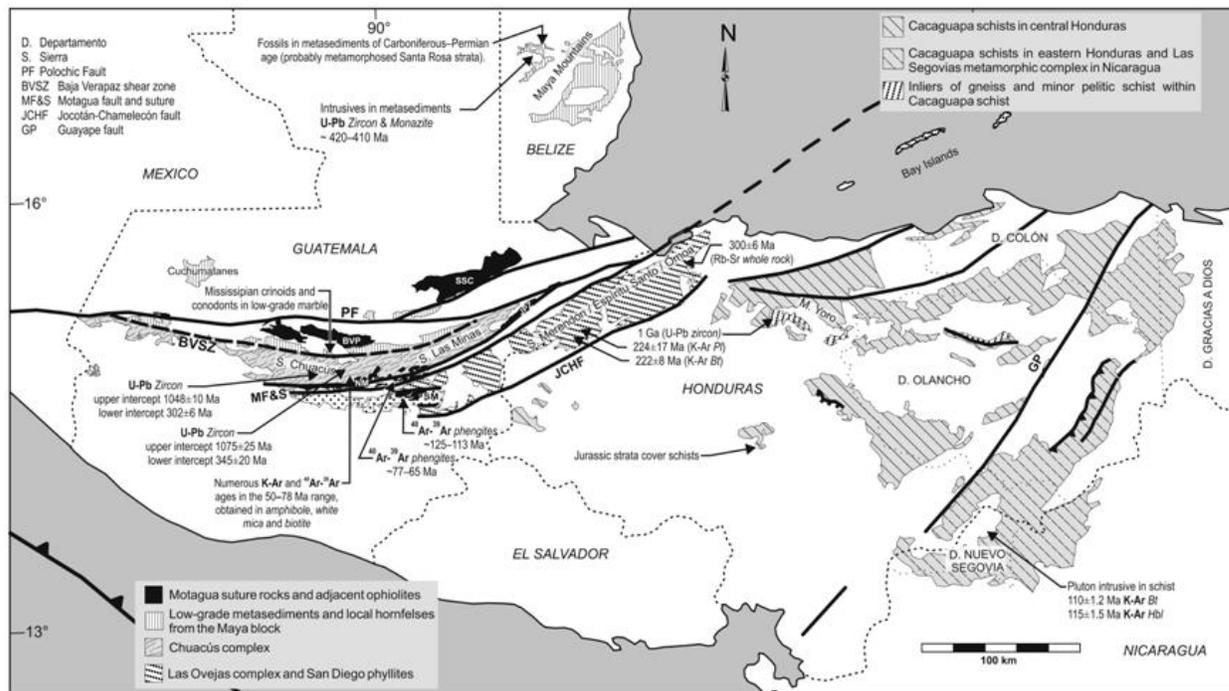


Plate reconstructions at 70 Ma and 10 Ma showing development of transform along northern margin of the Caribbean plate and evolution of subduction zones (Pindell, 1994).

resulted in the deformed ophiolites and high-pressure assemblages in the central belt of Guatemala (Martens et al., *in press*). In northern Guatemala, the formation of new oceanic crust by the process of Late Cretaceous/Early Cenozoic sea-floor spreading formed the low-lying sedimentary basin of the modern-day Yucatán Peninsula. The geology of this region consists of alternating siliclastic, carbonate, and evaporite deposits, indicating a dynamic sedimentary environment alternating from deep-water to shallow shelf setting through time.



Metamorphic map of Central America showing the various terranes along the Motagua Valley, Guatemala, including the Chuacús complex and low-grade metasediments that will be visited during the fieldtrip (courtesy of Martens et al. *in press*).

## **Tectonic Blocks**

Guatemala is subdivided into two major tectonic blocks, the Maya block and Chortís block, juxtaposed along the present-day Motagua Valley fault zone.

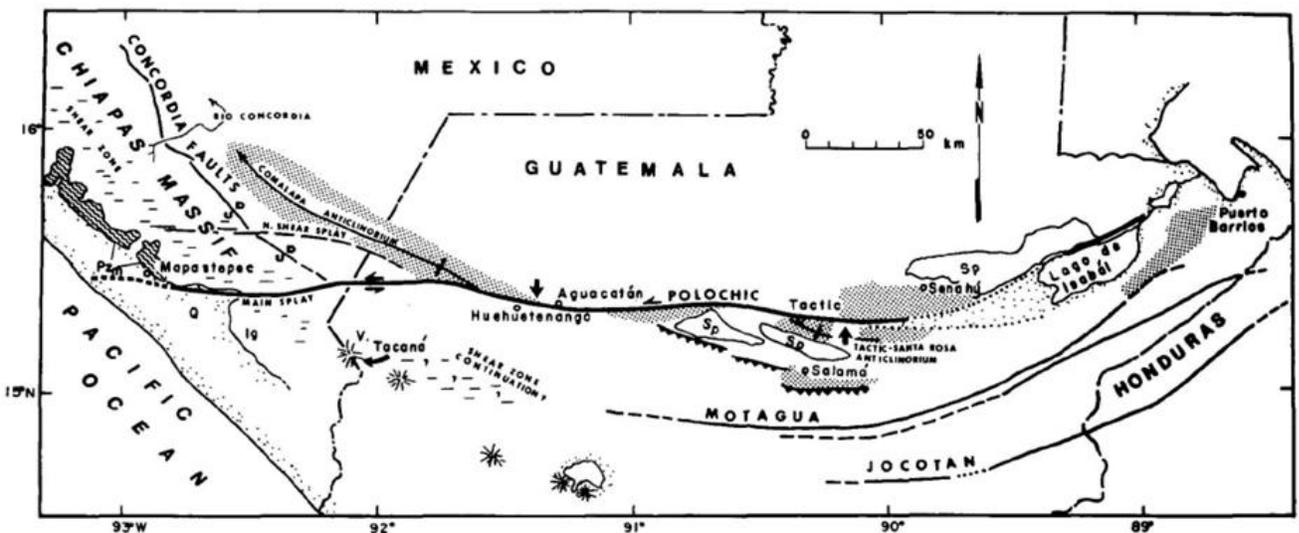
### **The Maya Block**

Northern Guatemala is a part of the Maya Block, the southernmost part of the NOAM plate. The oldest rocks within the Maya Block are igneous and metamorphic cratonic basement rocks, unconformably overlain by Upper Paleozoic metasedimentary rocks. Radiometric dating of these rocks has identified intense deformation and metamorphism during the Devonian period (Finch and Dengo, 1990). Mesozoic sedimentary rocks overly the Paleozoic section and consists of a thick sequence of alternating redbeds, marine limestone, and evaporates, indicating a long-lived and alternating terrestrial and marine deposition along the Yucatán Peninsula (Donnelly et al., 1990). The thick carbonate deposits are responsible for the karst topography in northern Guatemala. Regional deformation of the Paleozoic

and Mesozoic rocks occurred during a collisional orogeny, resulting in the uplift of the southern Maya block and the formation of the fold and thrust belt that today composes the central Guatemala cordillera. Tertiary rocks are largely marine clastic and volcanic, indicating a period of active volcanism, tectonic activity, and high erosion rates.

### The Chortís Block

Guatemala, south of the Motagua Valley, is part of the Chortís block and is considered the northernmost part of the Caribbean plate. The tectonic history of the Chortís block is quite controversial and has been generally recognized as having originated elsewhere and having been tectonically moved to its present position (Donnelly et al., 1990). Studies of the Mesozoic stratigraphy and basement rocks of the Chortís block suggest strong correlations with southwestern Mexico. This relationship is considered by many authors to indicate an eastern translation of the block to its present position south of the Maya block. This suturing event occurred by the end of the Mesozoic, contemporaneous with widespread and sporadic tectonic and magmatic activity. Brittle deformation and regional uplift characterizes the Late Cretaceous Chortís block, possibly related to regional uplift to the north in the Laramide Cordillera of Mexico. The Cenozoic history is dominated by plate interactions of the Caribbean plate with the North American and Cocos plate, the present-day subduction zone and transform margin, respectively (Donnelly et al., 1990). In the first case, oblique convergence with the Cocos plate has produced Quaternary development of an Andean-type volcanic front along the Pacific margin of Guatemala. In the second instance, left-lateral transform motion between the North American and Caribbean plates has resulted in strike-slip displacement along the Motagua-Polochic fault zone.



Map of western Guatemala and southern Chiapas showing the trace of the Motagua Fault zone and its relationship to the exposed Paleozoic sedimentary core (shaded) fold belt of northern Guatemala. Arrows indicate match-up points for reconstruction along the Polochic fault (From Burkart, 1978).

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## Arc Volcanism

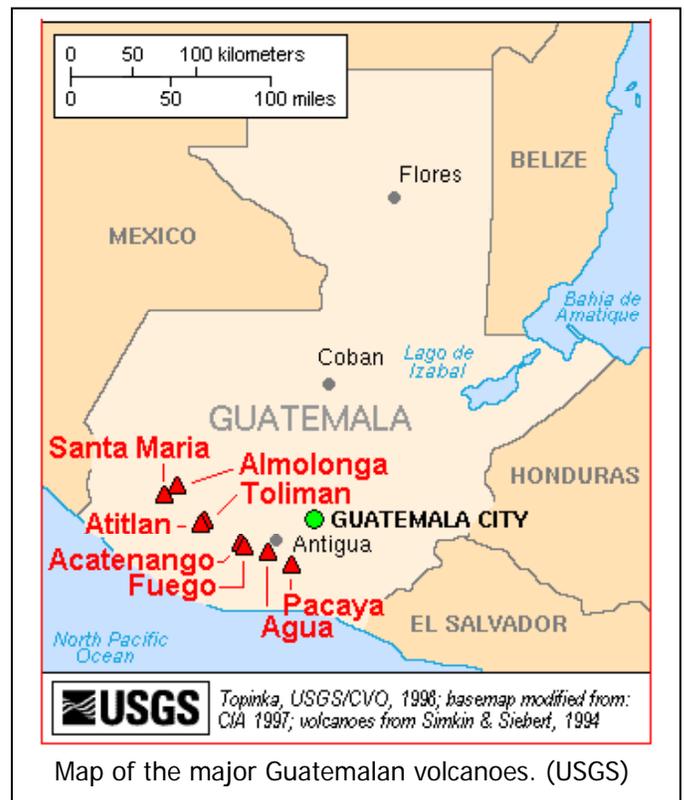
*Gwyneth Hughes*

The volcanoes of Guatemala are part of the Central American arc that extends 1100 km from the Mexico-Guatemala border to central Costa Rica. Subduction of the Cocos plate beneath the Caribbean plate has created the 15 km wide volcanic arc. Present and prehistoric volcanism in this region has significantly impacted both the regional landscape and the people of Guatemala.

Three types of volcanism dominate the regional geology of southwest Guatemala: the volcanic front defined by tall stratovolcanoes, silicic calderas that lie behind or north of the arc, and basaltic cones in southern Guatemala associated with extensional faulting (Carr and Stoiber, 1990). The large stratovolcanoes, such as Pacaya, Fuego, Acatenango and Santa Maria, are still very active and as of May 24, 2005, all of these but Acatenango were erupting to some degree. Various types of volcanic activity can occur at each volcano including ash falls, lava flows and pyroclastic flows. While the stratovolcanoes are the most obvious feature of volcanism, it is important to note that the pyroclastic deposits of large, silicic, caldera-forming eruptions make up much of the landscape. Lake Atitlán lies inside a 15 by 25 km Atitlán caldera, the third in a series of calderas occurring in the same area since 14 Ma. The output and plutons associated with these successive calderas are visible in Lake Atitlán's vicinity. The Los Chocoyos eruption of Atitlán III in 84 ka emitted 270 km<sup>3</sup> of magma, creating the thick, pink, Los Chocoyos formation, an ignimbrite that crops out throughout the volcanic highlands (Newhall, 1986).

Arc volcanism in Guatemala extends back to the Jurassic. Before the formation of the current Central American arc, the Chortís arc was active from the Jurassic to the Eocene as evidenced by plutons associated with a subduction setting. During the Eocene, the current subduction setting developed and the Central American arc overprinted the pre-existing Chortís arc in Guatemala (Pindell and Barrett, 1990).

As long as people have inhabited the area, the volcanic arc has both posed a natural hazard and provided resources to the population. The Maya, for example, mined obsidian from the volcanic highlands for tool-making (Rice et al., 1985). Additionally, the ash that



the Maya used to temper their ceramics was likely blown into the lowlands rather than mined and transported, indicating that the arc was quite active during the Classic Period (600-900 C.E.) (Ford and Rose, 1995). Volcanism has posed a major hazard in modern times -- the arc has produced over 16km<sup>3</sup> of volcanic output since 1680. Perhaps the most famous eruption was the 1902 Volcán Santa María plinian-type eruption that killed 1,500 people. While the active volcanoes pose a threat, they also provide a major source of income in the form of tourism and potentially, in the future, geothermal energy production.

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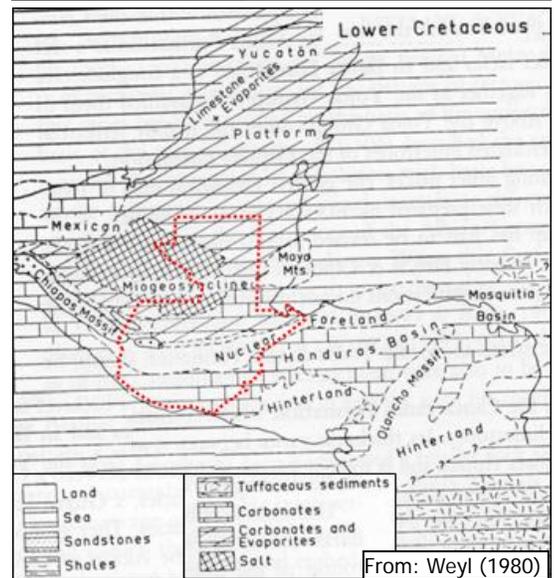
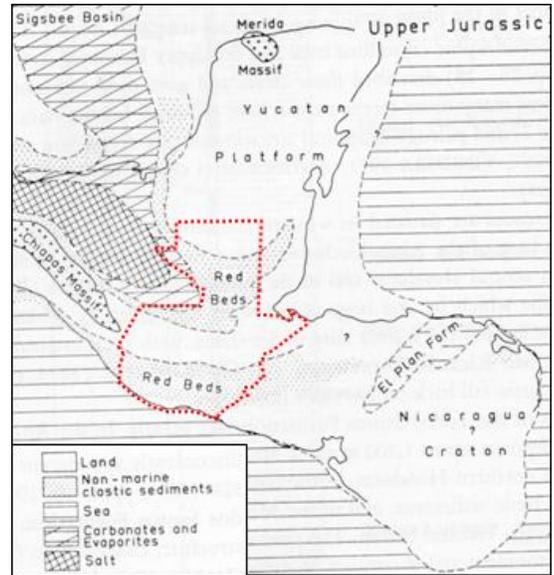
# Sedimentary Geology

*Kevan Moffett*

There are three regions with different sedimentary stratigraphy in Guatemala. The following section focuses on the bulk of the nation's sedimentary rocks, all north of the North American-Caribbean plate boundary on the Maya Block. A smaller region with different geologic history is located southeast of the plate boundary (on the Chortis Block); the reader should pursue references on Honduran stratigraphy for more information about this area. The third region is the Pacific Coastal Plain, which is composed almost entirely of poorly dissected sediments of volcanic origin up to 30 km wide and an estimated 4000 km deep. The remainder of the country is either part of the central metamorphic belt or the volcanic arc, both already discussed above.

The sedimentary history of Guatemala is closely connected to the tectonic time-line of this highly active region. The oldest unit known to crop out at the surface is in the Santa Rosa Group, found in the Sierra de los Cuchumatanes – the northwestern Guatemala highlands – as well as in some locations just to the north of the Polochic fault and in the Maya Mountains of Belize. Characterized by basal shale with overlying greywacke and then sandstone, this group is thought to have its origin in submarine fans deposited in the Pennsylvanian or Permian periods; this is supported by the presence of Permian carbonates in some of the same locations. There are magnificent sites in the Cuchumatanes exposing 7500 meters of sedimentary section – the thickest continuous outcrop in all of Central America, and one is also one of the oldest (middle Paleozoic). The overall stratigraphy of the Maya block of northern Guatemala dips northwards with an estimated gain of over 3000 m depth from central to northern Guatemala. This trend continues into southern Mexico, where it is much more difficult to find outcrops of very old sedimentary rocks.

During the Jurassic period the North American and South American plates separated, and the volcanic arc comprising much of southern Guatemala (the Chortis block) formed. During this tectonically active period, thick "red beds"

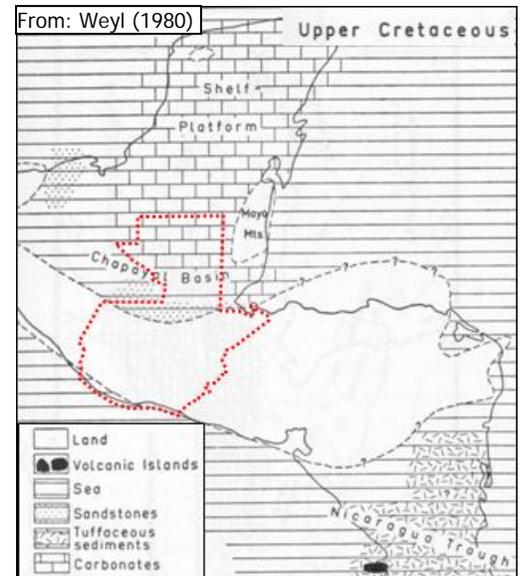


were deposited as alluvial fans in grabens and basins in the region. Collectively called the Todos Santos Formation, these sedimentary rocks are characterized by red continental conglomerates, sandstones, and shales. In the northern lowlands of Petén and the central Alta Verapaz regions of Guatemala, the upper portion of the Todos Santos Formation includes interbedded carbonates and evaporites, merging in places with overlying Cretaceous carbonates.

Marine transgression commenced in the early Cretaceous period, during which time massive shelf carbonates were formed along a passive margin in the proto-Yucatan region. This widespread sequence exists through Guatemala and southern Mexico and is known as the Ixcoy or Cobán Formation of shelf limestones. These massive carbonates are responsible for the karst terrain of much of northern and central Guatemala. These thick deposits are characterized by about a kilometer of dark gray, fossil-free dolomite and limestone containing lithoclastic breccias, overlain by a central section of fine-grained clastics and topped by another kilometer of fine-grained gray/brown layers including microfossils. The late Cretaceous (90 Ma) saw the collision of the Maya and Chortís blocks most notably causing massive metamorphism in central Guatemala and deposition of the Jalapa Mélange along the suture zone (and what is now the modern transform plate boundary). This was followed by deposition of the resulting foredeep (75 Ma) of the Verapaz Group, which has three different regional expressions: the Chemal red shale, calcarenites, and conglomerate limestones in central Guatemala; the Sepur red sandstones, shales, and fossil-rich limestones of the shallow marine deposits slightly to the north; and the Lacandón carbonate Yucatán shelf deposits of Petén in northern Guatemala.

Tectonic quiescence and continental erosion in the Paleocene allowed for further foredeep subsidence and deposition of the Petén Group over the Verapaz Group in the lower Eocene. The Petén Group includes the Cambio, Reforma and Toledo Formations' clays and shales and the overlying Toledo and Santa Amelia Formations' carbonates and evaporites (in the northern Yucatán region). Subsequent uplift led to deposition of further "red beds". Two further limestone formations follow, the Carillo Puerto Formation on the Yucatán and a shallow reef system associated with Lago Izabal and Río Dulce near the Gulf of Honduras. This period also documents deposition of the Subinal Formation in southeastern Guatemala.

Finally, Pliocene-Quaternary clastic deposition accounts for greater than 2000 meters of sediments in some of the grabens in central Guatemala (such as that in which Guatemala City resides) and Quaternary alluvium partly fills the great basin of northwestern Petén as well as dominating the coastlines.



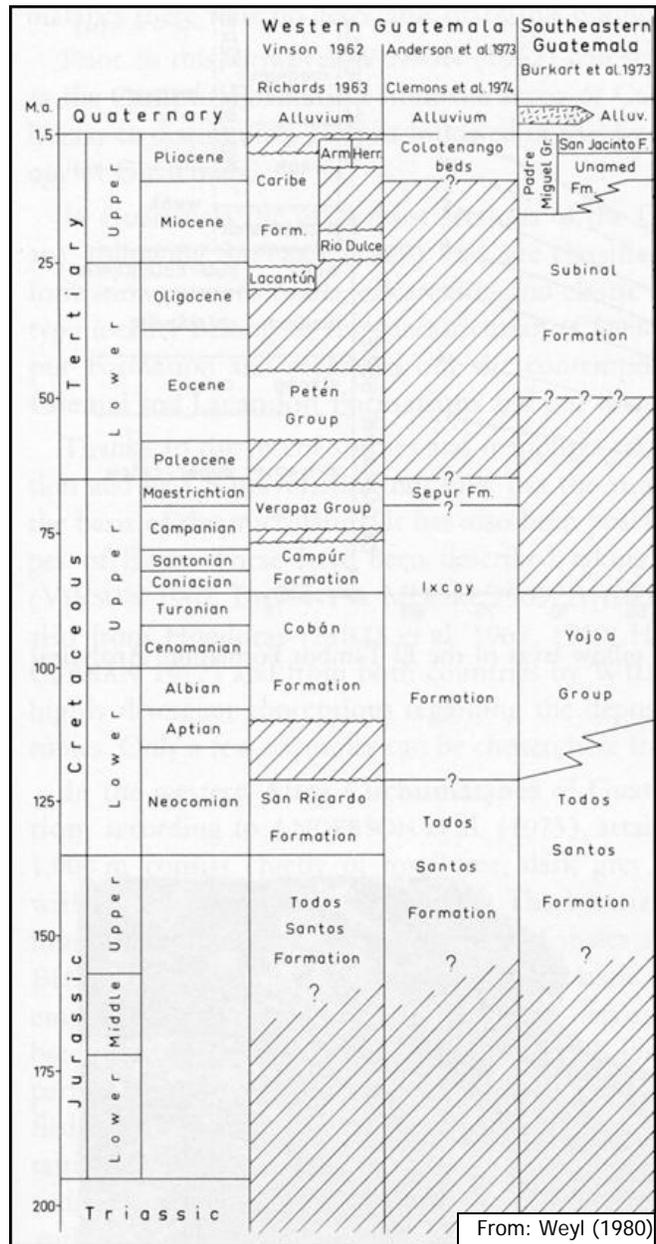
Refer to the geologic map at the beginning of the Introduction for an overview of the sedimentary units and their locations.

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## Caves and Karst Topography

*Benjamin Mirus and Peter Anthony*

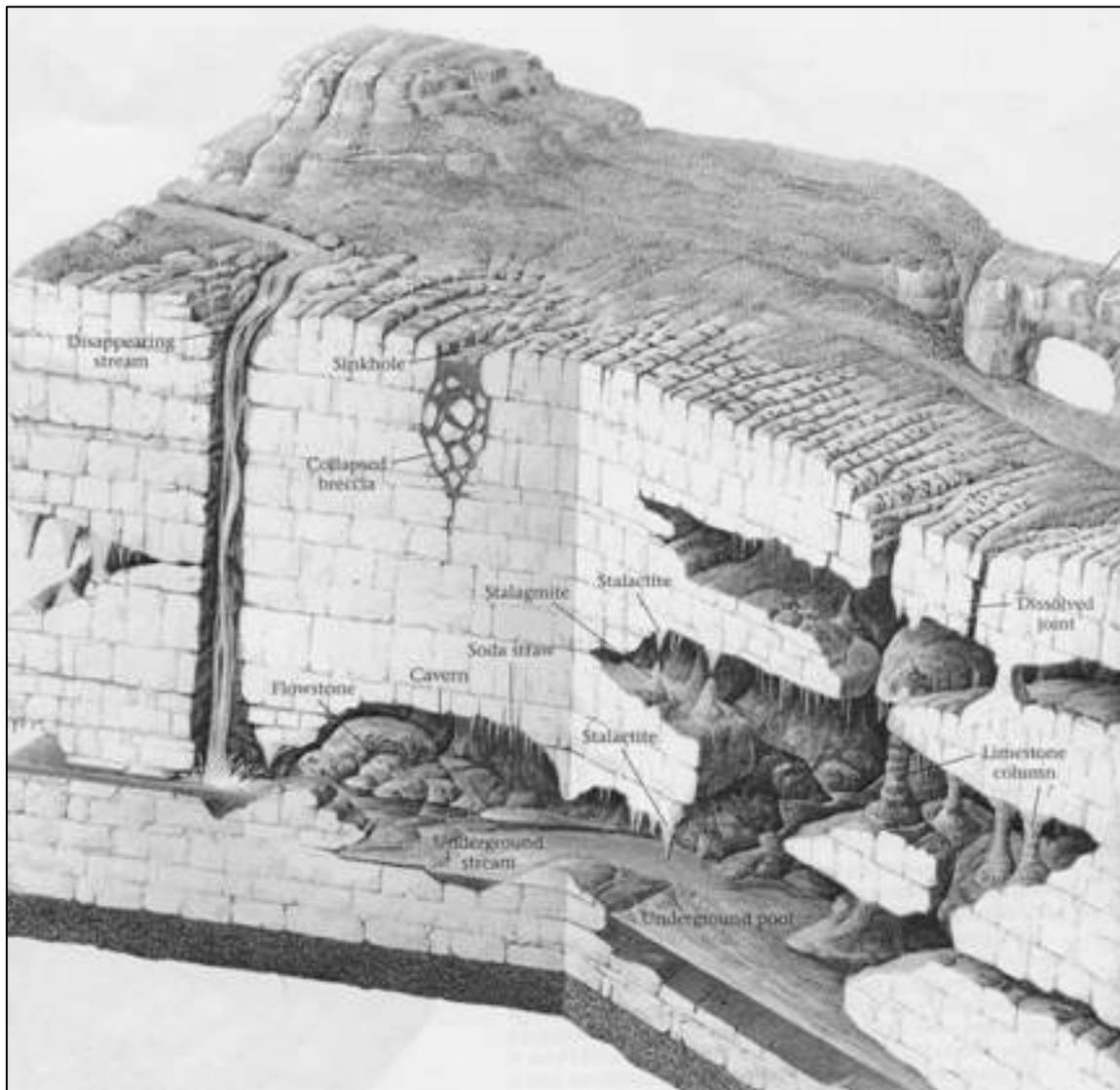
Dissolved carbon dioxide in groundwater creates a weak carbonic acid that is capable of dissolving carbonate minerals. When carbonate rocks are fractured and uplifted, drainage of groundwater slowly removes the dissolved calcium and carbonate ions from the system. Through time, large cavities are hollowed out as groundwater drains along fractures and joints. This is the basic process by which caves are formed.

Once a cavern network has been uplifted above the local water table it is possible to enter it without scuba gear (provided it has a large enough connection to the surface). Here, in the unsaturated zone, water dripping in these caves is likely to be rainwater that has infiltrated from the surface. This water also dissolves carbonates along its way. As it infiltrates into the cave it evaporates, leaving behind the calcium carbonate it once dissolved. The beautiful morphologic features that result are called *speleothems*, which include stalagmites, stalactites, "bacon," "pop-corn," and "pearls." Many speleothems are beautifully sparkled with extremely fine *sparry calcite*, but one should be careful not to touch them, as the natural acids secreted by the skin will ruin their fine crystalline appearance and prevent any future growth.

As underground caverns enlarge, the overlying roof is undermined and eventually collapses. Small-scale roof collapses are evidenced by an angular pile of boulders below an indent in the roof. However, much larger collapses also occur, which are called *sink-holes*, or *cenotes* in Spanish, if they connect with the ground surface. Sink-holes were important to the Maya; even during the dry season most would contain a pool of freshwater at the bottom.

In addition to cenotes and caverns with beautiful speleothems, Guatemala has numerous submerged caves. Many of these are the sources for the gushing rivers that seem to emerge out of nowhere and flow into nothing. These morphologic features of carbonate rocks are found predominantly in the karst mountains of the Sierra de Chuacús in Baja Verapaz. Karst terrains are characterized by an abundance of sink-holes separated by hills, creating a high-relief landscape relative to regional slope gradients. Karst topography is the surface expression of chemical weathering of carbonate minerals in the subsurface, a fascinating intersection of geomorphology, hydrogeology and geochemistry.

Typical features of caves and karst landscapes (From Marshak, 2004).



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# **Archeology and Mayan civilization**

*Sid Carter*

## **Overview of Ancient Maya Civilization**

Maya culture emerged around 2000 B.C.E., reached an apogee of complexity from 600 C.E. to 800 C.E., and experienced a complex decline about 900 C.E.. Based on this general pattern of cultural progression, archaeologists have divided Maya chronology into the Preclassic (2000 B.C.E. – 300 C.E.), Classic (300 – 900 C.E.), and Postclassic (900 – 1542 C.E.) periods. At its greatest extent, Maya civilization was spread across all of modern Guatemala and El Salvador and parts of southern Mexico and northern Honduras. In addition, the Classic period Maya had economic and, perhaps, ideological ties to central Mexican cultures, particularly to the urban center of Teotihuacan. By the Classic period, major sites in the lowland Maya region flourished as city-states that vied for economic and political prominence through shifting alliances and military power. This trip focuses on two of these sites: 1) Tikal, a large site in the central Petén area that was an important center from about 800 B.C.E. to 1000 C.E.; and 2) Quirigua, a relatively small site in the lower Motagua River Valley that prospered from 450 – 850 C.E..

The cultural achievements of Maya civilization include: 1) an elaborate cosmology, which established relationships between humans, supernatural beings, and maize agriculture as well as the mediation of these relationships through rituals, such as the Mesoamerican ballgame, bloodletting, and human sacrifice; 2) a base-20 mathematical system; 3) a complex calendrical system, which recognized the solar year and incorporated two cyclical calendars and a linear calendar; and 4) a hieroglyphic writing system, which documented mythology and the history of rulers. During this trip's visits to Tikal and Quirigua, the visibility of these features of Maya culture was limited to their reflections in ceremonial architecture and sculpture. However, this trip's focus on the geological variability of Guatemala invites consideration of two geological materials exceptionally important in Maya culture: jade and obsidian. As discussed below, geological perspectives on the sources of jade and obsidian have made crucial contributions to the archaeological understanding of Maya economy and society.

## **Jade in the Maya Region**

Jade was prized by the Maya as an intrinsically valuable material and a vibrant medium for representational art, as evidenced in burials and ceremonial contexts throughout the Preclassic and Classic Maya world. The symbolic associations of the green hues of jade with life and agriculture were important throughout Mesoamerica.<sup>1</sup> Maya artisans fashioned jade into burial masks, statuettes, ceremonial containers, ear spools, and necklaces. Although the density and hardness of jade undoubtedly made processing the material difficult, the associated durability of jade added to the value of the finished goods and facilitated the extended life of many jade artifacts as heirlooms. The only tool-material

available to the Ancient Maya hard enough to work Jade was Jade itself. In addition, the Maya appear to have revered blue-green jade artifacts of the Olmec (1500 – 300 B.C.E.), as suggested by Olmec artifacts engraved with Maya glyphs. While possession of jade artifacts appears to have been restricted to the Maya political/religious elite, jade functioned in ritual and economic activities that were visible throughout Maya society.

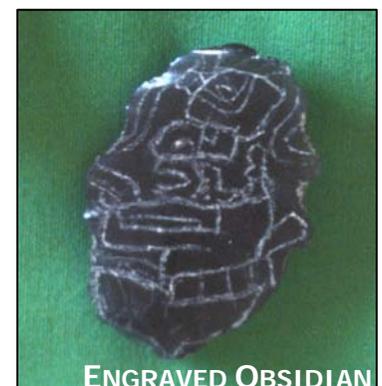


In contrast to the broad geographical distribution of jade artifacts throughout Mesoamerica, the sources of jade appear to be restricted only to the high pressure/low temperature metamorphic rocks in the Motagua River Valley of Guatemala. Jadeite (rock composed principally of jadeite) occurs in association with serpentinites along the Motagua fault zone, which defines the boundary between the Maya block of the North American plate and the Chortis block of the Caribbean plate.<sup>2</sup> Since jadeites are products of chemical alteration due to fluid interaction (i.e., metasomatism) in mineralogically-heterogeneous protoliths, they exhibit considerable chemical variability within a single geological source area.<sup>3</sup> As a result, attempts to constrain Mesoamerican sources of jade through multielemental chemical analysis have led to confusion regarding chemical variation and the number of jade sources represented by such variation.<sup>4</sup> In contrast, ongoing mineralogical analysis of jade samples and artifacts suggests that most of the visually and chemically distinct types of jade found in Mesoamerica still originated in the Motagua River Valley.

### **Obsidian in the Maya Region**

Unlike jade, obsidian appears to have been accessible to all segments of Maya society. Although the extent of elite control on the distribution of obsidian in the Maya remains a topic of debate, obsidian implements and debitage (waste material from production) have been found in domestic contexts associated with the full range of Maya socioeconomic status.<sup>5</sup> Obsidian was used primarily for chipped stone cutting tools (such as prismatic blades and triangular points). Yet, the recovery of obsidian artifacts from ceremonial caches and burials suggests that some obsidian tools had ceremonial significance beyond their utilitarian functions; for example, the Maya seem to have favored obsidian blades for bloodletting rituals.<sup>6</sup>

Three volcanic areas of highland Guatemala were the primary sources of obsidian in the Maya world. While lowland Maya sites rarely obtained obsidian from only one source during any period, the San Martin Jilotepeque source area was dominant during the Preclassic period, the El Chayal source area was dominant during the Classic period, and the Ixtepeque source area was dominant during the Postclassic period.<sup>7</sup> In addition to these



sources, at least seven central Mexican sources of obsidian are represented in low abundance at lowland Maya sites ranging in age from the Late Preclassic to the Early Postclassic.<sup>8</sup> As with the highland Guatemalan sources, the identification of most of these central Mexican sources has been based on analysis of their trace elemental compositions. However, obsidian from one central Mexican source (Pachuca) has been recognized at sites throughout the Maya area due to its distinctive golden-green color. Although there is no evidence for green obsidian being valued as a prestige commodity by Maya elite at Tikal,<sup>9</sup> the contextual associations of green obsidian tools in the Copán Valley suggest that these goods were valued as elite commodities at Copán, perhaps due to the symbolic significance of their color and/or their association with the central Mexico.<sup>10</sup>

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  - <sup>2</sup> Harlow, George E., et al., (2003), "High-Pressure, Metasomatic Rocks Along the Motagua Fault Zone, Guatemala," *Ofoliti* 28.
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  - <sup>5</sup> Rice, Prudence M., (1984), "Obsidian Procurement in the Central Peten Lakes Region, Guatemala," *Journal of Field Archaeology*, 11:192.
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## Modern Guatemala History and Culture

Guatemala the largest country in Central America, located directly south of Mexico on the Central American isthmus. It is about the same size as Iceland and slightly smaller than the state of Ohio. Agriculture dominates its economy, especially coffee, sugar, and bananas; primary industries are sugar and textiles/clothing. To a tourist, the three most prominent aspects of Guatemalan culture today are probably the modern Maya, the colonial Spanish influence, and the recent civil war.

The ancient Maya civilization covered the entire Yucatán area for about 3000 years. As the popular story goes, the ancient Maya suddenly disappeared around 1000 C.E. without explanation – this appears most pronounced in the archeology of the central lowlands (of which Tikal was a part); however, some ancient Maya cities in other locations did persist and new, more modern cities grew up. Most likely the ancient city-states dissolved for a combination of reasons and the population dispersed back to a more individual



agrarian lifestyle for a while. More significantly, the Maya people never died out – about half of the population of Guatemala today is still native Mayan and speaks native language(s), usually in addition to Spanish. This is a fascinating cultural heritage that is quite different from the cultural experience of many Americans and other westerners, the nations of whom have largely lost their native cultures. There are 23 native languages officially recognized by Guatemala; language is one of the few ways to quantitatively gauge the diversity of active cultures. The country is largely Christian, but it is typical for religious practice to smoothly mix in a variety of local rites and traditions; in fact, much of modern Guatemala culture relies heavily on its Mayan ancestry. The beautiful and colorful traditional clothing still worn by many women and sometimes by men in towns throughout Guatemala is one symbol through which the people express their heritage. Different regions and tribal heritages use different patterns in making the hand-woven cloths for these garments. It is said that to stop being a native Maya all one need do is shed the traditional clothing, suggesting the symbolic power of this attire.

The Spanish influence in Guatemala began with Pedro de Alvarado's conquest, acting as a proxy for Hernán Cortés, between 1523-1527; he established Ciudad Vieja as the capital and himself as governor. Antigua, Guatemala, was the second capital of the Spanish colony and today still preserves some of the best colonial-period architecture despite the ravages of natural disasters over the years. Guatemalan independence was won in 1821.

The other major cultural influence one is likely to experience while traveling the country at this time is the legacy of the Guatemalan Civil War of 1960-1996. The war was a harrowing experience for the country, claiming an estimated 200,000 lives with at least a quarter-million more displaced and still recovering (relative to a 2005 population of about 14 million).

Here is a timeline of selected events in Guatemalan history:

2000 B.C.E. – 300 C.E.	Preclassic Maya period
300 – 900 C.E.	Classic Maya period
900 – 1250 C.E.	Postclassic Maya period
1523-1527	Conquest by Pedro de Alvarado, made a Spanish colony
1543	Capital moved to La Antigua
1776	Capital moved to Guatemala City
1821	Independence from Spain
1901	United Fruit Company (UFC) begins operation in Guatemala, to dominate land and other industrial holdings and even politics for the next 50 years
1944-1954	"Ten years of Spring," relative freedom following dictatorship overthrow; President Jacobo Arbenz leads land reform/redistribution.
1954	U.S. CIA coup overthrows "communist threat" government with Operation PBSUCCESS, possibly at the urging of the UFC. US presence and CIA support of the government continued for years afterwards.
1960	Civil War begins with a small military revolt and then continued with guerilla action and military counterinsurgencies.
1976	On top of the war toll, an extensive earthquake kills 23,000. [This same event resulted in an average of a meter displacement in one day over the 230 km of rupture of the Motagua Fault Zone.]
1982	Ríos Montt took the presidency and directed the military in the 17 bloodiest months of "scorched earth" offensives against civilians, especially Maya natives.
1983	Óscar Humberto Mejía Victores took office and returned democracy though countryside armed harassments continued, especially against natives.
1992	Guatemalan Maya's rights advocate Rigoberta Menchu awarded Nobel Peace Prize.
1994-1996	Human rights, displaced persons, and native cultures' rights were legally addressed under a reformed constitution.
1996	Peace accords under President Álvaro Arzú officially end the civil war.
1990-2005	The democratic process continues, but with a series of leaders facing a variety of economic, social, and political problems and occasional unrest.
2002	An agreement is drafted to try to settle the long-term border dispute between Guatemala and Belize.

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## **Traveling in Guatemala**

### **Language and Culture**

The official language of Guatemala is Spanish and, except in very remote villages, most people will speak it. Few Guatemalans speak much English with the exception of tourist havens like Tikal, Antigua, and Panajachel. It is exceedingly helpful to have at least one fluent Spanish speaker in your group and it is essential to have someone along who can at least get by with the basics of ordering food and securing accommodation.

### **Food and Drink**

Guatemala is not known for its food, which tends to be rather bland and monotonous. Breakfast: eggs (*huevos*), black beans (*frijoles*), cheese (*queso*), fried plantains (*plátanos*), and crema. Lunch / dinner: chicken (*pollo*), meat (*carne*), or eggs, with rice (*arroz*) or French fries (*papas fritas*). You can always rely on fresh, hot, tasty tortillas to come with each and every meal. The bakeries (*panaderías*) are great places to get cheap, tasty, somewhat dry, snacks for the road.

The basic meals are usually pretty good, though rarely prepared with much flair; order other than the above standards and be prepared for a surprise (whether it be a pleasant surprise or not). Western foods (pizza, burgers, sandwiches) are often available, but are prepared with variable degrees of success and are usually a bit of a gamble. In general, the major tourist centers will have better quality food with more options and cleaner kitchens, so these are the places to be “adventurous” - or just the opposite if you want to try really good “regular” food. Ask for *salsa picante* if you want to spice up your meal a little bit.

All un-peelable fruits and vegetables (e.g., lettuce) are highly inadvisable, but anything you peel yourself should be fine (e.g. banana). Do not drink the tap water or anything made with tap water (e.g., *aguas frescas* and, sadly, ice); always stick to bottled drinks like sodas (*gaseosas*), Gatorade, purified water (*agua pura*) and beer (*cerveza*).

Tips (*propensia*) are always welcome and should be around 10% of your bill when you eat out. Some establishments in touristy locations will charge a service fee equivalent to a tip so keep your eyes open.

### **Roads and Driving**

Most foreigners traveling around Guatemala use the extensive bus system to get around. However, for visiting many of the geologic sites recorded in this guidebook buses are an impractical option. Although renting vehicles is more expensive and has some risks associated (see below), it allows you an exceptional degree of freedom and mobility. Still, because it is less common, few tourist guidebooks provide an adequate description of the potential issues with driving around Guatemala.

The driving in Guatemala is varied and can be dangerous. The route described in this guide includes the full range from smooth, paved, two-lane highways to narrow, curving dirt roads, virtually impassable to vehicles without 4WD and high-clearance. Small rock falls may block one lane of traffic, particularly on the steeper and more remote roads. Take extra care on winding mountain roads as there are rarely any guard-rails, and the outside shoulders (if they exist) are often undercut by erosion.

Marked speed limits appear to mean little, but drive at a safe speed. Watch out for *tumulos* (speed bumps), which are usually effectively large, and are found when any major road passes through a small rural hamlet. If you are lucky there will be a warning sign 100 m before the first bump, but more often there is not.

The bus and truck drivers are fairly daring, as are many other drivers. Most vehicles are in various states of disrepair and often heavily overloaded (e.g., pickups with over a dozen people standing up in the bed of the truck). We even saw someone's hood flip up to obstruct their whole windshield while driving on the main highway to Guatemala City. Flat tires are common, but can be fixed easily for a few Quezales at any business displaying the word *pinchazo*.



If there are lines down the middle of the road (dotted or solid, single or double) do not expect anyone to respect them: passing on curvy roads into oncoming traffic is disturbingly common. On the main road between Chimaltenango and Los Encuentros we drove on a wide stretch with no lines where traffic generally stayed to the shoulders and used the middle of the road as an unofficial passing lane. Nevertheless, most drivers are remarkably patient and considerate, especially outside of the major cities. Hand signals are commonly used to encourage passing maneuvers, but you should not necessarily trust that it is safe to pass if a truck driver ahead of you on a windy mountain road waves to tell you to pass. Honking lightly is usually a way of saying: "hello" or "thank you" or "please go ahead"; rarely will someone honk at you aggressively.

Be prepared for anything to happen on the road. Live animals (chickens, turkeys, pigs, horses, cows, dogs), pedestrians, cyclists and playing children all share the roads and are thus common obstacles. No matter how small and remote the road you are on, expect a bus or large truck to come barreling at you around any corner. It is worth mentioning that in Guatemala there is no such thing as full coverage insurance. So when renting a car, you will have to make a rather large deposit on the vehicles from which they will deduct charges for any damage to the vehicle. Also, very few vehicles are automatic, so be prepared to drive a manual transmission.

Do not drive anywhere at night unless you absolutely have to: highway robbery is still quite common in Guatemala. Police check-points are common along main roads to Guatemala City and virtually anywhere at night. Be sure to have a valid driver's license, a copy of your vehicle rental agreement and also your passport to show the police should you get stopped. They should not require more than this and you should never give up possession of any of these.

# Geologic Tour Plan

- Day 1. Arrive in Guatemala City, Drive to Antigua, Visit Jade Lapidary
- Day 2. Hike Volcán Pacaya
- Day 3. Drive Antigua to Panajachel, visit Reserva Atitlán
- Day 4. Boat tour of Lago de Atitlán
- Day 5. Panajachel to Pachalúm *via* Chichicastenango and Joyabaj
- Day 6. Pachalúm to Salamá and Mixco Viejo
- Day 7. A'Chi Museum and the Maya Block
- Day 8. Jade locality and Chuacús orthogneiss
- Day 9. Salamá to Poptún *via* Quirigua
- Day 10. Parque Nacional Tikal
- Day 11. Tikal to Sayaxché *via* Grutas Aktún Kan
- Day 12. Sayaxché to Lanquín
- Day 13. Semuc Champey and the Grutas de Lanquín, then to Cobán
- Day 14. Cobán to Guatemala City

# Tour Route Map



[http://www.lib.utexas.edu/maps/americas/guatemala\\_rel00.jpg](http://www.lib.utexas.edu/maps/americas/guatemala_rel00.jpg)

## **Day 1 – Antigua and a Jade Lapidary**

After arriving in Guatemala City and securing rental vehicles, head straight to the town of Antigua Guatemala. Antigua is one of the oldest cities in all of the Americas; it was a regional Maya capital before the Spanish made it the colonial capital in 1543. Repeated earthquakes, notably the major quake on July 29, 1773, destroyed much of the city, necessitating the move of the capital to present day Guatemala City in 1776. Antigua is surrounded by active volcanoes: Acatenango and Fuego are to the west, Pacaya is to the east, and Agua towers above the city directly to the south. Despite its troubled past with seismic activity and being surrounded by the constant threat of volcanic eruption, the city has a slow, peaceful feeling about it. Some of the 17<sup>th</sup> and 18<sup>th</sup> century colonial-style buildings remain, as do some ruins, and the entire city has a ban on large billboards and storefront signs. Walking down the cobblestone streets and in its quaint central square it seems that little has changed in this town since the capital was moved, except for the people and the occasional outside influence.



Although nowhere near the jade localities along the Motagua Valley, the large number of tourists flocking to the city has turned Antigua into Guatemala's biggest market for jade artifacts. Even if you think you know everything about jade, it is worth visiting one of the lapidaries for a tour and historical explanation of jade's role in Mayan mythology. The largest and most famous lapidary, Jades, S.A. was established in 1974 by archeologist, Mary Lou Ridinger and was featured as the September 1987 *National Geographic* magazine cover story.<sup>1</sup> Jades, S.A. is located near the center of town at 4a Calle Orienta No. 34; Telephone: (502) 7832-3841 / Fax: (502) 7832-2755; [jades@mailzone.com](mailto:jades@mailzone.com) / [www.jademaya.com](http://www.jademaya.com). This establishment's tour includes an open view of the jade workshop, museum-like display cases of some Mayan artifacts and mythology, and a certified-jade store of their worked pieces. We also heard that there is a coffee factory in town that gives tours, but did not visit it.



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<sup>1</sup> Ward, Fred, (1987), "Jade: Stone of Heaven," *National Geographic*, 172(3).

## Day 2 – Hike Volcán Pacaya

Volcán Pacaya is the southern-most of the large stratovolcanoes that line the volcanic front caused by the subduction of the Cocos plate under the Caribbean Plate and the western shore of Guatemala. Pacaya has been active for about 23,000 years. McKenny cone (the currently active one) is 2,562 m tall. Some recent history of the volcano includes dormancy from 1860-1961 and then collapsed in 1962. Lava from 1962 was measured at 850-970°C, remained fluid for 5-8 days and spread 8-9 km away. Current Pacaya activity is strombolian and plinian: fairly constantly emits gas (mostly water vapor) and also sometimes lava from crater and flanks or pyroclastic ejections. With 55-60% silicate, the volcanic products are generally andesitic and rhyodacitic though the volcano composition is largely hornblende and hypersthene with a tufa/pumice base. Even more recently, there was a 4.5 km high eruption in 1989 and significant lava flow in 1990-1991. The best source for geologic information on Pacaya is the *Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología de Guatemala*.<sup>2</sup>



Finding the entrance to Pacaya might have been rather difficult had we not hired a guide in Antigua to go the whole way with us – hiring a local guide is highly recommended. One set of directions to get there is as follows, but is not necessarily the route we took, so one should proceed with caution:

Start out taking Departmental Route #1 (a secondary road) south toward Palin. After 4.2 kilometers we will pass San Juan El Obispo village. To the southwest we will be able to see the cone of Volcano Agua. After 3.8 more kilometers there will be a junction heading toward Volcano Agua...we stay straight. After 1.0 more kilometers, we will pass through the village Santa Maria de Jesus. 11.2 kilometers further down the road we will intersect CA-9 on the outskirts of Palin, which we will turn left (north) on toward Guatemala City. We will stay on this highway for 2.3 kilometers, at which point take a right on Departmental Route #3, which leads toward San Vicente Pacaya. After 4.5 kilometers, a road will split off to the left to San Vicente Pacaya village. We stay straight past this fork, and then after .2 kilometers turn left toward Lake Calderas. We take this road for 2.3 kilometers to a fork at El Cedro village, where we take a sharp right. We take this road for 2.7 kilometers to San Francisco de Sales.

The entrance fee to climb Payaca is Q. 25.00 / person. Local children will happily take money to watch your vehicles while you are



<sup>2</sup> Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología de Guatemala (INSIVUMEH): Ministerio de comunicaciones infraestructura y Vivienda. Guatemala C.A. <http://www.insivumeh.gob.gt/geofisica/pacaya0.htm>

away, but the potential for trouble in this tiny hamlet is likely small.

The trail starts just beyond the visitor center at a cement-paved walkway. There are (at least) two routes up/down the mountain: one easier “front” route that takes the left-fork a bit up the hill from the cement walkway; a second “back” route that is steeper with a less well-defined trail that comes down the right-fork to the same starting location. The guide indicated that there are variations on the route that we took – we went up the “front” and down the “back,” but the return trip down the mountain included “skiing” down the side of a completely unconsolidated cinder cone and pushing through overgrown vegetation back to the main trail, rather than going down a different way and walking back along a portion of the road.

There are trail-signs in Spanish periodically along the “front” route explaining the basics of volcanoes. At the top of the “front” route there is a sign warning of potential poisonous gases in the air and a cement pillar at the overlook. Be sure to pick a clear day as fog will greatly impede the view. You will then want to ask your guide to take you down onto the lava plain, as we did, to see some geology close-up before returning one way or another to the visitor center.

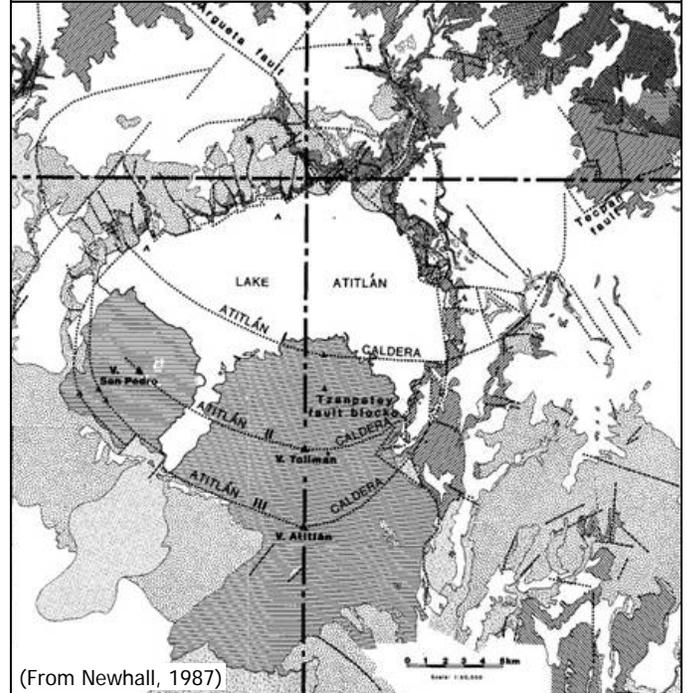
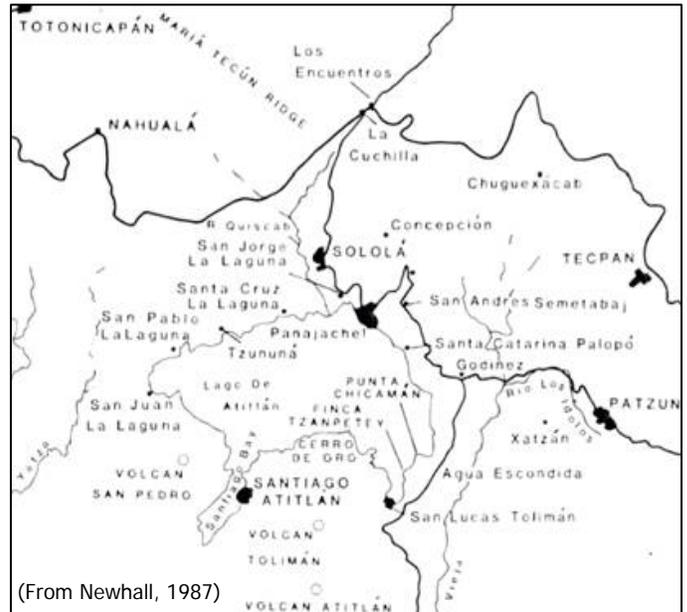


## Day 3 – Antigua to Panajachel

To get to Panajachel from Antigua, head north ~20 km from Antigua to CA-1. (Reset the odometer at town Aldea Luis Las Carretas just outside Antigua.) Travel west on CA-1 for ~66 km to Los Encuentros junction. Turn south on National Highway 1 towards Sololá; continue on down to Panajachel.

Driving north, the roads pass through more of the volcanic terrain evidencing subduction and arc magmatism. Lago de Atitlán, fills part of the outline of Atitlán III : a large silicic caldera that is the third in a cycle of caldera formations beginning in this region around 14 Ma. While the reason for the existence and southwestern migration of the Atitlán caldera complex are not well understood, Newhall (1987) suggests that it is possibly related to 1) a Zuni "segment boundary hotspot" or tear in the subducting plate, 2) the intersection of a NNE trending segment boundary with the volcanic front, and/or 3) the southeastern motion of the Caribbean plate with respect to the mesosphere.<sup>3</sup>

Approaching Lago de Atitlán, one drives through the erupted material (predominantly thick ash fall) of the Atitlán III caldera and its predecessors Atitlán II and I, as well as Tertiary laharcic and andesitic flows and massive Quaternary pyroclastic deposits. If the sky is clear, Volcán Acatenango and Volcán Fuego are visible from the road. Reddish-brown tuffs seen here, to the north of Lake Atitlán, are collectively called the María Tecún tuffs of Atitlán I.<sup>4</sup> [For this part of the tour, the rule-of-thumb is that "red" means María Tecún–Atitlán I.]



<sup>3</sup> Newhall, C.G., (1987), "Geology of the Lake Atitlán Region, Western Guatemala," *Journal of Volcanology and Geothermal Research*, 33(1-3).

<sup>4</sup> *Ibid.*

### Stop 3.1. Pyroclastic flow deposit.

Stop 6 km after Aldea Luis Las Carretas below a steep, sharp right-hand turn in the road. This stop is at a fantastic ignimbrite exposure – the first of *many* on this trip. These rhyolitic ignimbrites frequently have pine trees growing on them since their high Si content and low Ca and Mg lead to relatively acidic soils of which pines are tolerant but other plant species may not be. The pyroclastic flow deposit, here characterized as unwelded, massive and poorly sorted, contains slightly rounded lithic clasts and abundant pumice. Pumice is formed by



quenching and degassing of rhyolite or dacite magma during eruption. The unwelded nature of this deposit indicates emplacement temperatures below 600°C. The lack of charcoal within the ignimbrite also tells us that it incinerated any vegetation, and thus emplaced at temperatures above 450°C. This deposit was deemed to be of rhyolitic/dacitic composition, also including slightly rounded andesitic lithics. In a pyroclastic flow, one can expect to find slightly rounded grains due to fragmentation during flow. Being somewhat lithic-rich, this ignimbrite is likely located near a vent or a caldera collapse locality (such as we know Atitlán to be). Another interesting feature observed at the site were *elutriation vents* in which a local gas concentration would have escaped upwards through moderately fluidized material, removing ash and other fines and leaving a “chimney” of fairly well-sorted lithics. Additional gas (air) can be entrained by the flow, particularly when flowing over rough topography. Over time, and with warmth and moisture, this ash deposit will turn to clay; development of a soil profile at the top of the exposure was evident.

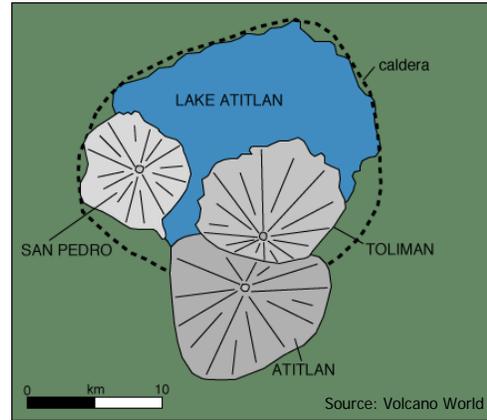
### Stop 3.1. La Mirador.

Continue on through Sololá as per the above directions. Partway down into the caldera you reach La Mirador. From La Mirador there is the famous, fabulous view of Lago de Atitlán.



This is the best place to view the overall Atitlán III caldera walls. From this vantage-point, one can also appreciate the geomorphic processes that have been acting on the caldera such as incision of stream channels into the caldera rim.

Mass-wasting may also be evidenced by scars of landslides and debris flows. Visible across the lake (looking north-to-south) is Volcán Toliman (on the left – east) and Volcán San Pedro (on the right – west). From the right angle or on a particularly clear day, Volcán Atitlán may be visible as a second peak almost exactly behind Volcán Toliman.<sup>5</sup>



**Stop 3.2.** Reserva Natural Atitlán.

An optional stop in Panajachel (“Pana”) is the Reserva Natural Atitlán. Hike there by starting up the highway (up the hill out of town towards Sololá), take a left down the road/driveway that goes past the Hotel Atitlán; the Reserva is beyond on the right. Entrance fee is Q. 20.00 / person. The reserva includes a spider monkey preserve, a section of suspended bridges past a waterfall, a butterfly enclosure (which had no butterflies when we were there), views of the lake, and a trail passing exposures of María Tecún rosy tuff.



<sup>5</sup> “Atitlan, Guatemala,” [http://volcano.und.nodak.edu/vwdocs/volc\\_images/south\\_america/guat/atitlan.html](http://volcano.und.nodak.edu/vwdocs/volc_images/south_america/guat/atitlan.html)

## Day 4 – Boat tour of Lago de Atitlán

There are two ways to traverse the beautiful Lago de Atitlán, either by privately owned speedboats or with the ferryboat. With a large enough group (e.g., eleven people) it is nice to hire your own speedboat, which will ultimately be cheaper and faster than a ferry and it allows you the freedom to set your own pace and choose your own stops around the lake. A word of caution, the winds tend to pick up in the afternoon making the ride home choppy and often wet; minimize everyone's discomfort by making sure your boat does not get overloaded with people (i.e., no more than 15 people) and do not let anyone sit on the bow if the waves are big.

8:30 – Depart Panajachel

**Stop 4.1.** 09:00 – Village of Santa Catarina Polopo.

From Panajachel the village of Santa Catarina Polopo is a five minutes boat ride southeast along the shore of Lago de Atitlán. The village is still relatively untouched by the massive development, which is spreading around the lake in response to increased tourism.

**Stop 4.2.** 10:00 – Aguas Calientes.

A few kilometers further along the eastern shore of the lake it is possible to locate the edge of the Atitlán III caldera as evidenced by hot springs that discharge directly into the lake through the rocks just below the shoreline. Enjoy the mixture of hot, sulphurous spring water and the cold waters of the lake by taking a little dip. The hot springs are also accessible by kayak or canoe from Panajachel -- look for the small pipe pumping hot spring water from the lake up to a private mansion above.



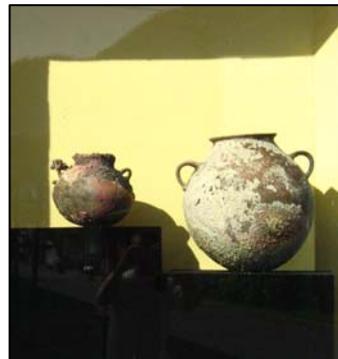
**Stop 4.3.** 11:00 – Santiago Atitlán.

On the ride across the lake from Aguas Calientes to Santiago Atitlán, you will get a chance to see the dacite dome Cerro de Oro that is on the flank of Volcán Atitlán up close. Santiago Atitlán is a small town touted to tourists as one of the best places to see native culture (dress, markets, etc.), but we did not see much here that was different from other towns other than the sufeit of goods for sale to tourists. The town does lie between the two lake-side volcanoes, however, and provides a different perspective on the lake from its waterfront.



**Stop 4.4.** 14:30 – Panajachel

Return home before the lake gets too choppy (and likely rainy) in the mid-afternoon. There is a museum in Pana at the bottom of the main street (near the lake) called Museo Lacustre de Atitlán that exhibits many Mayan artifacts recovered from the lake. It is small, but worth visiting if one is interested in archeology. The entrance fee is minimal.



## **Day 5 – Panajachel to Pachalúm via Joyabaj**

Today marks the last day of travel through Guatemala's volcanic arc and the beginning of the journey through the central metamorphic belt along the active complexes of the Motagua and Polochic faults. From Panajachel, head North via Sololá and Los Encuentros towards the town of Santa Cruz del Quiché. Along the way, take a stop in the town of Chichicastenango, which hosts the most famous market in all of Guatemala on both Thursdays and Sundays.

From Quiché, head east following the headwaters of the Río Motagua into the beginnings of the grand Motagua Valley, which cuts a curvilinear arc through the center of Guatemala and is related to the boundary between the North American and Caribbean plates. To the north and roughly parallel to the Motagua Valley is a network of valleys associated with the Polochic fault which is now thought to be the actual plate boundary (Martens, personal comm.). Unfortunately, the faults and valleys as well as the main rivers flowing along them all share the same names – an annoying source of confusion when describing the relationships between the landscape and the geology.

The metamorphic rocks in this leg of the trip are individually spectacular and part of a much larger sequence complex of highly controversial metamorphic rocks within the Chortis block. The overarching geologic history of this area is still very open to debate, so our focus is on finding and describing the rocks and making local interpretations based on our observations of the available geology, rather than hypothesizing about potential geologic models for the development of the Caribbean region.

### **Stop 5.1.** 8:00 – Waterfall on the way out of Pana.

Only slightly outside Pana on the way back up the hill towards Sololá there is a waterfall; it is possible to pull off to the right just after the bridge under which the creek flows to stop and visit the waterfall. Here is a great example of a subaqueous ash-flow deposit overlain by volcanoclastic sandstone normally graded to ash-rich mudstone. Subaqueous deposition of the ash-flow is suggested by the dominance of pumice and noticeable lack of lithic fragments (density stratification in aqueous environments). Most of the caldera wall exposed at this stop consists of the reworked ignimbrites older than those erupted during the youngest Atitlán eruption.



### **Stop 5.2.** 10:00 – Market and churches at Chichicastenango.

The town of Chichicastenango ("Chichi") is about 17 km north of the junction at Los Encuentros on the way towards Santa Cruz del Quiché. On market day you will be overwhelmed with the bustle of the vendors and shoppers alike, on other days it

might be a little “under-whelming.” Either way, it is worth stopping to stretch your legs, get a bite to eat and explore the two churches that sit on the main plaza. Tourists are warned in commercial guide-books only to enter the main church on the plaza from the side entrance – the front entrance, while it may be standing wide open, is largely ceremonial and it is considered somewhat rude to waltz in this way.

**Stop 5.3.** 14:00 – Garnet-kyanite gneisses, Caquil River. From Chichi, continue north to Santa Cruz del Quiché then take the road east towards Chinique and Joyabaj. The road is actually paved all the way to Joyabaj but is quite bumpy and curvy; watch out for potholes, oncoming traffic and unmarked *tumulos* (speed bumps). The main road then continues to be equally rough, but now is unpaved. Continue east towards Pachalúm, about 10 km past Joyabaj, the road crosses the Caquil River, a tributary of the Río Motagua. There is plenty of room to park the vehicles here.

Along the channel cut by the river the bedrock has been exposed. Look for a huge gneiss boulder with garnets up to 5 cm in diameter and kyanites of equally impressive size off to the left. Notice how the sandy banks and bed of the stream sparkle with mica flakes. This region of Guatemala may be fondly nicknamed “Mica Land,” and you will notice most of the country rock in this region sparkling throughout the next few days. Spend some time scouring through the sands and you are likely to find yourself some nice, large specimens of kyanite and low-grade garnet. Small (1 cm diam.) garnets can be found on the banks here almost by the handful.



**Stop 5.4.** 16:00 – Metamorphic Mélange. In the northwest end of Pachalúm is the road leading towards Las Moritas. After crossing the bridge and leaving town, the road becomes unpaved and narrow. Reset the odometer to zero at the bridge. At 1.8 km is a fork in the road with a sign, “Las Moritas 3” indicating left; stay right at this junction and follow the road another 4.5 km uphill. Shortly after the 79 km marker the road cuts through a small meadow with a large outcrop of dark boulders on the left and a small creek on the right, pull over here



and proceed on foot. There are two places to take note of at this stop.

The Cuevas de Saltan–Tuncaj region consists of a complex area of around 5 km<sup>2</sup> of large eclogite and amphibolite knockers as well as diverse metamorphic cobbles and pebbles of eclogite and ultramafic rocks. Judging by its spatial distribution and geomorphology these rocks are interpreted to be part of a subduction zone mélange or perhaps a slumped mélange, judging by its spatial distribution (Martens, personal comm.). The age of metamorphism is consistent with the timing of a ~120 Ma subduction zone further north in the Motagua Valley, suggesting a single convergent boundary as opposed to distinctly separate early Cretaceous *and* late Cretaceous subduction zones proposed by earlier studies (Martens, personal comm.).

First, head down to the stream on the right and look at the rocks exposed in the channel. Some of the rock types that we identified here include beautiful amphibolite with large, euhedral phenocrysts; eclogite; albitized pyroxenite; and very interesting calcium-metasomatized serpentinites with intricate zoisite crystal splays. Also of interest are the large bluish boulders, which are actually talc with some siderite weathering. These rocks are found only in the Tuncaj region and were called *Sascaguin* by the Mayan peoples who came from as far away as Rabinal to collect these rocks for use in making pottery.

Second, cross the road and climb the fence into the cow pasture and have a look at the boulders ahead and to the left by the outcrop that include Na-pyroxene, omphacite, garnite, quartz, and rutile.



**Stop 5.5.** 17:30 – Retrace route back to Pachalúm for dinner and sleep.

*Nota Bene 1:* Food, and anything at all, really, is very hard to find in small towns after about 5 pm anywhere in Guatemala. Even in larger cities, things close early.

*Nota Bene 2:* Saturday is Market Day in Pachalúm.

### **Restaurants and Lodging:**

Hotel y Restaurant Kimberly, Pachalúm, offers the best, and most reliable food in town (and cheap!), but the kitchen closes at 18:30. The fried chicken and traditional dishes are good, but avoid the sandwiches. Rooms are also cheap and clean, but the place is noisy at night – but in such a small town there are not really any other options.

## **Day 6 – Pachalúm to Salamá**

The day begins with a visit to the Mixco Viejo archeological site, which sits atop an ignimbrite terrace. The afternoon will take us through a number of interesting metamorphic terrains as we journey from Pachalúm eastwards along the Motagua valley and then cut north over the Sierra de Chuacús into Rabinal and then further west to Salamá.

7:00 – **Breakfast:** Hotel y Restaurant Kimberly offers cheap, basic Típico.

8:30 – Depart Pachalúm

**Stop 6.1.** 9:00 – Mixco Viejo Archeological Site.

The site is 13 km south of Pachalúm. From the church in Pachalúm head south down the steep and winding paved road towards Guatemala City.

Take note as you cross the Motagua River about 7 km out of town: the metamorphic bedrock exposed along the banks of the river is the most likely source for the building blocks of Mixco Viejo. After crossing the Motagua, the road climbs over a ridge and drops down into a tributary valley; at this point start looking for the turn off to Mixco Viejo, which is between the 60 and 59 km markers (kilometers decrease, counting down the distance to Guatemala City).

Mixco Viejo was a moderate-sized city, now restored ruins, of the Post-Classic Era Maya civilization. The site was founded in the 12<sup>th</sup> century on a defensive location by peoples from around present-day Oaxaca, Mexico and so exhibits strong central Mexican influence. The hill-top location is significant, indicative that the Maya world was more unsettled during this period as neighboring city-states went to war against each other. Despite being located atop an ignimbrite terrace, the sparkling mica-rich stones used for the buildings were all hauled up from the river-valley. Though the ruins at the site now sparkle yellow-white in the sun (from the muscovite), they would originally have been sealed with brilliant white plaster and covered by wood and thatch structures.



The peak population of Mixco Viejo in the early 16<sup>th</sup> century may have been around 10,000 people. In 1525, after a siege of more than three months, the city was conquered by Pedro de Alvarado, a Spanish Conquistador. The Conquistadors then burnt down the city, depopulating it. The ruins have the remains of over 120 major structures, including temples, palaces, and courts for playing the famed Mesoamerican ballgame which was a central part of Mayan religious ritual and mythology: through the roots of the story are nebulous, the ballgame is thought to be connected to the two twin brother-hero-gods that dominate much of the mythology and also to have something to do with the supposed sacrifice of the loser...

There is a small museum and visitor center at the ruins as well as a scale-model of the ruins. Be sure to bring your own water and toilet paper, as the facilities there are sufficient but limited.

Recall the distance as you drive back down to the Motagua River and imagine what a feat it must have been, individually hauling those slabs of metamorphic rock all the way up the hill.



**Stop 6.2.** 12:00 – Lunch in the town of Granados.

From Mixco Viejo, head back to Pachalúm and then turn right at the church to take the main road east towards Saltan. The road is not only unpaved, but very rough and narrow in parts, so drive with caution. Stay on the main road towards Granados/Rabinal. After about 25 km you will enter the town of Granados; the main road through the town is paved. About half-way into town there is a basketball court on the northwest side of the road, across from which there is a nice *comedor* associated with the Hotel Don Lorenzo and Antojitos Doña Alicia. The staff is friendly, the food cheap (set-lunch menu with beverage for 20Q), clean and tasty. From this point reset the odometer to zero.

**Stop 6.3.** 13:00 – Granados pegmatite at “Mica Headquarters”.

From the *comedor* in Granados head west, continuing on the same road you took into town. At 5.5 km turn left onto a small dirt road and follow this a few hundred meters down. The road emerges onto a pegmatite quarry that looks more like a sparkling field of mica – which it is. Here you can collect textbook examples of “mica books.”

This pegmatite contains large plagioclase and quartz crystals coexisting with (three or?) four varieties of mica, each with its own bit of



geologic information about the rock's history. The outcrop is locally surrounded by serpentinite. See if you can spot the conspicuous contact- and metamorphic-alteration reactions between, and within, the rocks -- evidence that the pegmatite was actually intruded into the serpentinite.

The rare green mica (fuchsite) in the pegmatite is a chromium-rich variety, uncommon in felsic magmas from which typical mica-bearing pegmatites form. Its presence suggests interaction with an ultramafic rock, such as the serpentinite, resulting in pegmatite-derived fluids that remove chromium from the serpentinite to form fuchsite. Other micas present in the pegmatite are white mica (muscovite) and yellow mica (unknown). Phlogopite is a fourth type of mica found in the core of the serpentinite (amber-brown), common in Mg-rich peridotite that may have been the protolith prior to serpentinization.



**Stop 6.4.** 14:30 – Vista across the Motagua Valley. After mica headquarters, turn back east (right) onto the main road and head back to the town of Granados. Reset the odometer to zero at the same comedor (Stop 6.2) and then continue along the road out of town. After about 2 km have a brief stop to take a look at the spectacular view across the Motagua Valley. The linear ridgelines are the geomorphic expression of this active strike-slip fault complex, which last moved in 1986.



**Stop 6.5.** 15:00 – Gneisses of the Chuacús formation. Approximately 6 km east of Granados the main road crosses a tributary to the Motagua River. Stop on the west (upstream) side of this bridge and take a short hike up both sides of the creek to have a look at some spectacular gneiss outcrops.

The bedrock outcrops at this stop expose the Chuacús banded gneisses, intruded by syntectonic and post-tectonic Mesozoic pegmatite dikes. The gneisses have been strongly metamorphosed to eclogite facies, overprinted by younger amphibolite facies. Despite the complexity of the rocks' genesis, it is easy to appreciate the artistic character of the gneiss, with its conspicuous mineral banding and water-smoothed surfaces. There is a particularly excellent outcrop of



folded gneiss (with a syntectonic pegmatite dike and eclogite- and amphibolite-grade minerals including garnet and amphibole) partially in the water a short way up-stream on the left bank. There is also a textbook chevron fold axis exposed along the trail on the left bank.

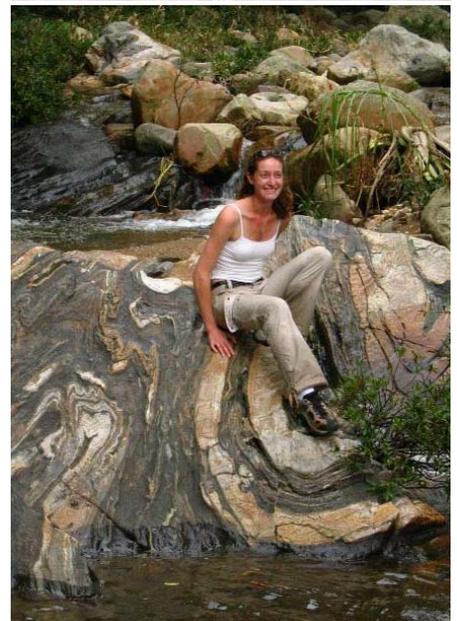
The timing and events involved in the evolution of the Chuacús metamorphic complex has substantial implications for large-scale plate dynamics in the region, but the details remain heavily debated. Their highly deformed and metamorphosed nature of these rocks led many geologists to classify the Chuacús complex as Guatemala's pre-Cambrian stable craton, citing analogies to similar terrain in the Canadian Shield. Revised field studies, geochronology, and dating of peak metamorphism now suggest a much younger metamorphic event, tying the Chuacús to the Mesozoic collisional history of the Chortís block (Martens, personal comm.).

**Stop 6.6.** 16:00 – El Chol migmatites.

Another 5.5 km east is the town of El Chol where the road crosses yet another tributary to the Motagua. Again, stop at the bridge to have a look at some spectacular metamorphic rocks. On the northwest (upstream) side of the bridge the rocks exposed in the creek bed display evidence of partial melting. Rocks on the southeast side of the bridge are eclogites, indicating the remnant eclogite facies metamorphism within the transition between melting and partial melting zones.

This last field stop within the Chortís Block represents some of the most metamorphosed and deformed rocks in the Chuacús complex: the El Chol migmatites. Here metamorphic temperatures increased to the point where felsic minerals, such as quartz, feldspar, and biotite, melted and recrystallized as granitic pockets and bands, concentrating more mafic minerals into bands as well. During this stage, the rock contained both melt and solid crystals, allowing the rock to “flow” and deform under stress. The result is a semi-chaotic mixture of folded light (felsic) and dark-colored (mafic) bands. The migmatites contain multiple generations of outcrop-scale and mesoscopic folds, clearly visible by contrasting dark and light bands within the migmatite.

This outcrop again illustrates how the Chuacús complex might have been interpreted as a stable craton. Just 40 m downstream, however, we can see another



outcrop of amphibolite facies gneiss with relict eclogite. Whether or not the events responsible for forming the migmatite pre-date Mesozoic metamorphism and collision, it is a reasonable argument that the Chuacús complex was at least partially involved in the peak Mesozoic metamorphism.

**Stop 6.7.** 17:00 – View of the Sierra de las Minas from the Sierra de Chuacús. As the road climbs into the Sierra de Chuacús it veers northwards and at 21.2 km out of Granados it is possible to look both east and west from the crest of the Sierra de Chuacús. From here it is only another 15 km down to the town of Rabinal.

**Stop 6.8.** 19:00 – Salamá.

From Rabinal, head east along Route 5 to Salamá, which is home-base for the next three nights, while exploring the surrounding area.

*Note: today could just as well end in Rabinal, which is indeed a closer base-camp for the local geology outlined for Day 7.*

### **Restaurants and Lodging:**

Hotel Real Legendario is clean and reasonably priced, with large fans in each room and free drinking water in the courtyard. The service is friendly and good.

Hotel Rosa de Saron (5a Calle 6-39), just off the main square has excellent views from the second and third floor rooms. Sometimes there is someone around who speaks English, but the A'chi owner is not particularly friendly or helpful. The comedor downstairs offers cheap, tasty set meals, but avoid uncooked foods as well as any beverage that doesn't come straight out of a bottle.

Campero is a reasonably priced Guatemalan fast food chain that has spread to the US and other parts of the world. They offer a standard fare of fried chicken, French fries and sometimes pizza (at least at the one in Salamá); it stays open late and opens early – which may be a welcome change if you have been having trouble finding breakfast or dinner to fit a geologist's sunrise-to-sunset schedule. Their breakfast is actually pretty decent and their fried chicken is quite good. The other really nice thing about Campero is that it is very clean and the ice is safe. Campero in Salamá is located on a corner of the main plaza in the center of town.

## **Day 7 – A'Chi Museum and the Maya Block**

In the 1980's, Guatemala was devastated by civil war, which took its greatest toll on the indigenous Maya peoples. The small museum in Rabinal is less a museum and more of a memorial to the victims of the violence in the region, lest they be forgotten. Along the way to the museum on road between Salamá and Rabinal there are many opportunities to view the stunning landscape and intensely metamorphosed rocks. There are numerous outcrops along the steep switchback roads, just be sure to stop in a safe place where you can be seen by traffic traveling in both directions. The last stop today helps unravel the puzzle as to how and why the metamorphism may have occurred.

*Nota Bene:* Sunday is market day in Rabinal.

### **Stop 7.1 – Maya block metasedimentary rocks and Granite.**

From the top of the pass between Rabinal and Salamá is the turn off to San Gabriel, a steep, winding, paved road with great views of the valley below. Stop at an appropriate location and have a look at the landscape around you. In the distance to the north are the Sierra de las Minas, a series of aligned ridges that follow the trace of the Polochic fault – which is the fault now thought by some to be the true location of the North American-Caribbean plate boundary.



The climate in this region fluctuates from extremely arid for most of the year, to very wet during the rainy season. Much of the topography in this region is shaped by the Atitlán ash flows that have blanketed the landscape and filled the now-nearly flat-bottomed valleys below. It is amazing to think that ash flows would have had to climb up passes as much as a kilometer high to form ignimbrite deposits here. The A'Chi Maya called these valleys *Uram*, and they were very important due to the fertile volcanic soils. Upon careful inspection, some of the hillsides can be seen to be ignimbrite terraces.

Descending further northward into the San Gabriel valley from Salamá provides some nice exposures along the steep switchbacks. These low-grade metasedimentary rocks make up much of the southern Maya block. Now on the North American plate, we have traversed out of the metamorphic Chuacús complex and into a terrain dominated by large granite plutons overlain unconformably with metasedimentary rocks. Carbonate beds within the Chochal Formation supposedly contain Permian crinoid and conodont fossils, though our efforts to find them were unsuccessful. We did, however, hike across the lower contact of the Chochal Formation made up of nearly unrecognizable, intensely sheared granite.

## **Stop 7.2 – Museo Regional in Rabinal.**

The Museo Regional in Rabinal (properly, Rab'inal) provides both historical and modern cultural perspectives on the A'Chi Maya. The A'Chi are one of the many tribes comprising the Maya people; it is thought there are at least 20 distinct dialects and sub-Maya cultures, of which the A'Chi are one. The Maya-A'Chi have always been centered in the area that is now the Alta and Baja Verapaz territories.

The museum is relatively close to the ESSO gas station (sort of behind it) near the center of town. The exact location is rather difficult to find and is not well indicated by signs, so if you have trouble finding it, just ask the locals.

Distant past, recent past, present, and future are all represented in the museum. Like other native cultures world-wide, the Maya-A'Chi are searching for harmony in the modern world both at the personal level and at the cultural level. One room at the museum focuses on the present culture regarding the status of women, describing a local project seeking to encourage self-confidence in young women that they might take an active role in forming their own futures as well as that of their culture. Another room displays the arts and crafts native to the region and describes efforts to maintain cultural knowledge of such heritage as basket-weaving and ritual dances.

A dominant piece in the history of the Maya-A'Chi, however, unfortunately centers around violence inflicted on them, and the third room in the museum is a memorial to local victims of the recent civil war. The extended history of the region perhaps lends some light to the more recent violence. Of all the Maya peoples, the ancient Maya-A'Chi are thought by some historians to have been the most aggressive; whatever the truth of this statement, Spanish colonization faced the most difficulty conquering the Maya-A'Chi region. The initial colonial period in this region was very bloody, seemingly without either side being able to get the upper hand. After a while, the history-story goes, Catholic missionaries approached the military and suggested a break from the violence, allowing the missionaries a chance to try to pacify the region. In the end, the missionaries succeeded and dubbed the region "Verapaz" for "True Peace" when it was finally colonized.

The colonial history is perhaps relevant because during the civil war (1962-1996) Rabinal was a key logistic center connecting transportation routes between different parts of Guatemala. Some historians suspect that part of the violence perpetrated against the Maya-A'Chi in the region during the civil war was intended more as a pro-active (and bloody) deterrent to ensure that the military forces maintained control of the region. The massacres were certainly carried out under the auspices of controlling guerillas.

The museum exhibit comprised a memorial to the men, women and children from Rabinal killed during the civil war, especially during the massacre of 1981-1983. The walls and display boards in the room are lined with old photos of some of the victims. In fact, the display notes that two copies of each photo was made – one to give to the family in remembrance, and one for display in the museum memorial. The introduction to the memorial says, in translation (K. Moffett):

This historical display includes photographs of victims of the violence that Rabinal, our town, suffered during the so-called internal armed conflict (1962-1996).

The Historical Clarification Commission (CEH) concluded:

*“During the period between 1981 and 1983, in Rabinal, military or paramilitary groups assassinated at least 4411 people (20% of the population).”*

The CAH continues:

*“99.8% of the victims registered by the CEH were maya-achi. The elevated percentage of victims from the maya-achi population, much greater than the distribution in the overall population (82% maya-achi and 18% others), demonstrates that the violence in this region was not random, as it is said to be, it did not affect the whole population equally nor did it affect each group according to its proportion of the total population, but it was discriminatingly and dominantly directed against the maya-achi population.”*

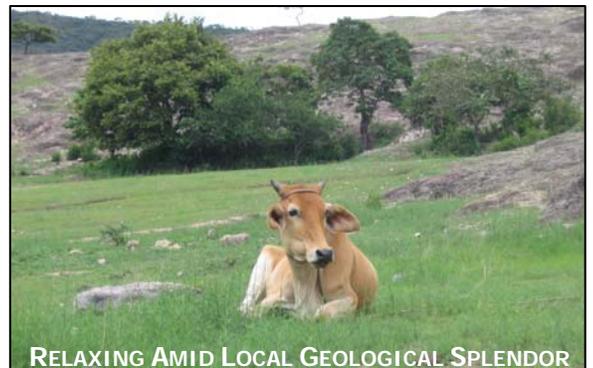
The “scorched-earth” policy during the governments of Lucas García and Ríos Montt tried to finish off the maya-achi town of Rabinal, transforming the territory into a great hidden cemetery.

### **Stop 7.3 – Sheared granites**

From the Esso gas station near the Museo Regional reset your odometer, take the road north out of town. You should pass the sports fields on your right (used to be the military’s air strip). At 1.2 km take a soft right onto a dirt road and follow it 3 km down before taking another right turn on another dirt road. Continue another 2 km until you reach the San Miguel elementary school at the end of the road. Park here and continue on foot. It is a short hike across quartz and plagioclase rich granite; the best exposures are along the creek bed, so just follow the sound of water ahead and to the right over behind the buildings. As you make your way toward the stream you can find fine-grained mafic enclaves within the granite as well as dike-intrusions.



Now the barely identifiable granite we first stumbled upon at Stop 7.1 becomes much more recognizable as a tectonized and sheared granite. The rocks here have been intensely sheared and subjected to greenschist-facies metamorphism, but not as much as those observed earlier. It is believed that this section of the Maya block has been deformed and metamorphosed as a result of the Chortís block being thrust over the Maya block during continental collision. This relationship suggests that the granite is in fault-contact with the overlying Permian, fossil-bearing rocks from Stop 7.1. Proximal to this contact, the sheared granites transition into a narrow zone of ultra-mylonite fabric, provoking a curious discussion of how large amounts of deformation can be spatially distributed over a surprisingly narrow zone (Martens, personal comm.).



RELAXING AMID LOCAL GEOLOGICAL SPLendor

### **Stop 7.4 – Back to Salamá.**

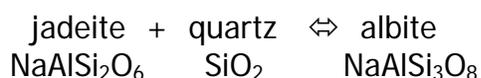
## Day 8 – Jade locality and the Chuacús orthogneiss

Along the road this day one can observe huge serpentinite exposures in the road-cuts, excellent sedimentary structures in tuffs that were re-worked by the Motagua River, and the occasional mélangé block thrown in for good measure.

Beginning at the Shell gas station by the river in Salamá, exit the city heading towards Guatemala City. Stay on the main road, to the right, at the fork, take CA-14 towards El Rancho. Take CA-9 towards Puerto Barrios to the left; go straight at the town intersection. 88.8 km from the start, take the gravel road on the right at the sign with a left-curving arrow on it. Park a little ways up and then go off into the bushes over the bank to the left of the road; watch out for the local variety of stinging nettle.

### **Stop 8.1 – Jade locality**

At this jade locality, we walked through the trees and underbrush to an area of sparse jade blocks scattered beneath the bushes. Due to hydrothermal alteration, the jadeite has been albitized to a whitish green color, resulting in sub-gem quality jade that is largely good for a nice set of bookends and for making petrologists happy. The reaction involved here is:



### **Stop 8.2 – Lunch at El Rancho**

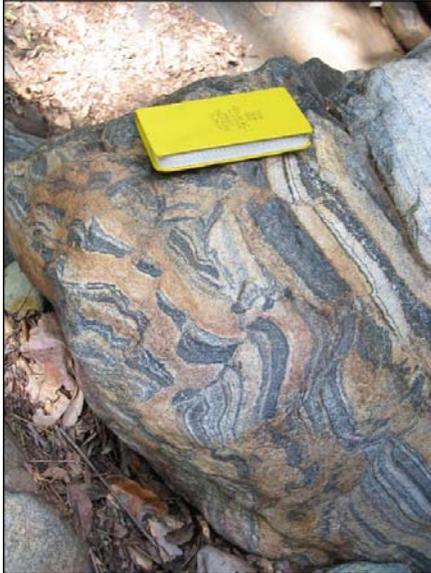
El Rancho has a large, rest/bus stop and cafeteria.

Head left out of the El Rancho parking lot and then take CA-14 straight towards Cobán. At 18.3 km since the parking lot make a right turn onto a gravel road going down towards the river somewhere around the 104 km marker, plus or minus. A short way down (~0.3 km) on the right there is a path down to the river.

### **Stop 8.3 – Chuacús orthogneiss**

This dry stream bed outcrop of the Chuacús orthogneiss, though genetically associated with the Chortís block, has been tectonically emplaced over the Maya block. Unlike the gneisses previously seen near Pachalúm that are derived from sedimentary rocks, the protolith to this metamorphic rock was igneous. These gneisses have large, complex folds and conspicuous metamorphic minerals indicative of intense ductile deformation. Above the stream channel on the right





side are abundant eclogite blocks with a serious case of euhedral garnet "chicken pox," the colloquial term used for these rocks by regional geologists.



Continue to the end of the gravel road, about 1 km further on the odometer, until the dusty gray gravel turns to a brighter red earth road at a crest in the road.

**Stop 8.4 – Quartz crystals**

Here, you can stop and look around the edges of the road and in the dirt for easily accessible quartz crystals. Nicely formed clear (translucent) unbroken samples that we found upon brief inspection in the road dirt ranged from about 3 cm long and 0.5 cm wide to 1 cm long and 1 mm wide.

Return to the main road, turn right, and pull off on the available area to the right at about 9.8 km since the quartz stop.

**Stop 8.5 – Black marble and travertine**

Walk back to the last road-cut exposure: along either side of the road there is black marble, some of which has been dissolved and redeposited to form a travertine crust on the surface and along fracture traces in the face of the exposure.



## Day 9 – Salamá to Poptún via Quiriguá

The first leg of this journey returns to the Motagua valley and follows the river's course down towards the Gulf of Mexico. Along the way we stop at the Maya ruins at Quiriguá, which boast some of the most well-preserved Mayan stelae (pillars) and zoomorphs (animal-form boulders), carved from sandstones of the Todos Santos Formation. Shortly before reaching the coast, we head north through Río Dulce. If you have extra time, it is rumored to be well worth taking a cruise from Río Dulce down to the port town of Livingston on the Gulf of Honduras of the Caribbean Sea.

**Stop 9.0.** Time permitting – Museum of Paleontology at Estanzueala.

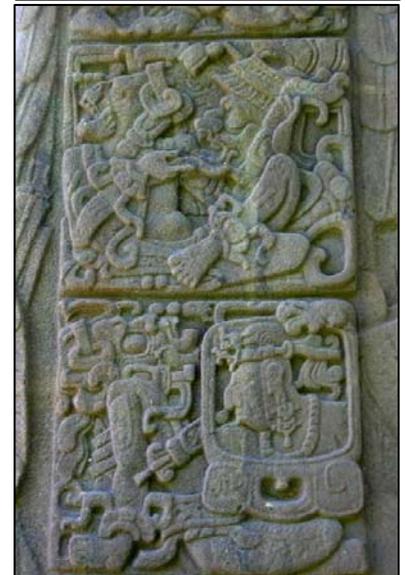
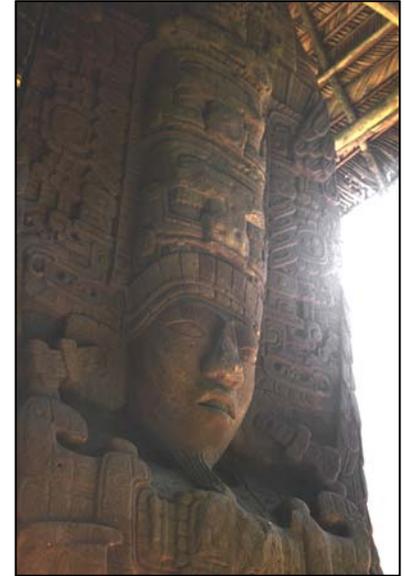
If you find yourself with extra time, take a short detour South at Río Hondo to the city of Estanzuela, which has a spectacular paleontology museum. [Note: The 2005 SAP trip did not include this stop.]

**Stop 9.1.** 12:00 – Ruins of Quiriguá.

The turn off for the ruins is just east of the town of Quiriguá and is well marked. To get there, follow the dirt road through the Del Monte banana fields (formerly of the famous and highly controversial United Fruit Company) until you get to the Inguat sign for the ruins at the gate. There is an entrance fee of Q. 25.00 per person.

Although Quiriguá is not an expansive urban site like Tikal, it was a significant Classic period ceremonial and economic center with important ties to Copan. Quirigua is best known for its remarkably carvings, in particular the nine stelae and four zoomorphic sculptures of the site core, most of which are in their original spatial contexts. As noted by art historian Matthew Looper:

“The monuments are of intrinsic significance to archaeology and art history for their massive scale, elaborate carving, and excellent state of preservation. In view of their colossal size, their high sculptural quality, and the eloquent poetics of their hieroglyphic texts, the sculptures of Quirigua stand out as some of the greatest achievements of Classic Maya civilization.”<sup>6</sup>

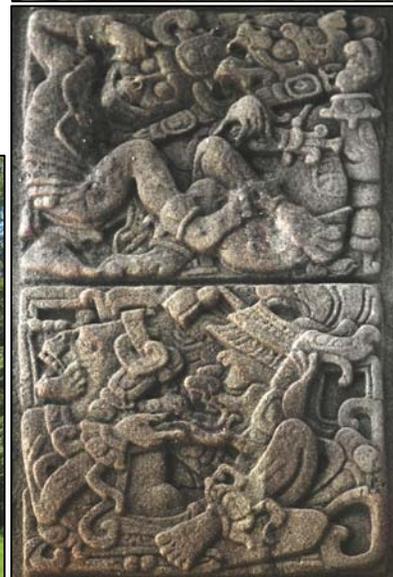


<sup>6</sup> Looper, Matthew G., (2003), *Lightning WarRior: Maya Art and Kingship at Quirigua*, Austin: University of Texas Press, 6.

**Stop 9.2.** 17:00 – Finca Ixobal, lodging.

After the ruins of Quirigua, continue east along CA-9 towards Puerto Barrios. At La Ruidosa Junction, take the road north towards Flores and Río Dulce for another 140 km to reach the town of Poptún. As you travel northwards you enter terrain underlain by carbonate bedrock; notice how the landscape changes to one dominated by karstic features: cenotes (round ponds), relatively isolated hills of steep slope, etc.

Finca Ixobal is located just south of Poptún (exit left before entering town), and boasts a variety of day-trips, such as river rafting, caving, horseback riding, and various jungle treks, if you choose to stay for a while. The Finca itself is very large with a variety of accommodations from camping to private rooms. It is host to young travelers from all over the world and the all speak excellent English (some are even from the USA). There is a community atmosphere, meals are served buffet-style, and snacks and drinks are always available from the kitchen via entering your consumption in a book according to the honor system. There is also a swimming pond and “bar.” It is in an isolated area, so the Finca is your only option for food and entertainment and the food and drink bills can add up fast if you are not careful with their pay-all-your-bills-at-the-end system -- but it is a relaxing atmosphere a bit like an adult summer camp, if there is such a thing.



**SNAKE-HEAD ZOOMORPH -- AND GEOLOGY!**

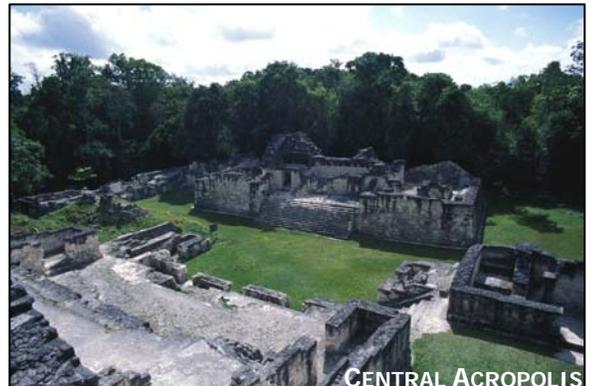
## Day 10 – Parque Nacional Tikal

Tikal is probably the most famous of the Mayan ruins. The classic pictures of temples hiding in the jungle are usually of Tikal (also in a frame of Star Wars 4 – the hidden rebel base).



Other than an unconfirmed trip through the ruins by a missionary in 1696, the first recorded visit to the Tikal ruins was in 1848 under the supervision of the Guatemalan government. Mapping of Tikal began in the 1881 by the archeologist Alfred P. Maudslay and was followed later by Harvard's Peabody Museum (1895-1911) and the Carnegie Institution of Washington (1914-1928). However, excavation was delayed until 1956 when the University of Pennsylvania began its intense 14-year project. Since 1979 Guatemala has been pursuing further excavation and restoration at the site.<sup>7</sup>

The origin of Tikal is somewhat uncertain. The city emerged as a preclassic city-center between 800-500 B.C.E. The first stone building was not erected until around 200 B.C.E.. Around 50 B.C.E. rulers began to be buried at the North Acropolis, an area in the center of the city that housed the tombs of many early rulers. There is evidence that between 50 B.C.E. and 200 C.E., Tikal became more of bureaucratic state, with a ruling elite and class stratification. The transfer of power was usually patrilineal, and each king subsequently traced his lineage to the founder of the major Tikal royal dynasty, Yax Moch Xoc, born in 219 C.E.



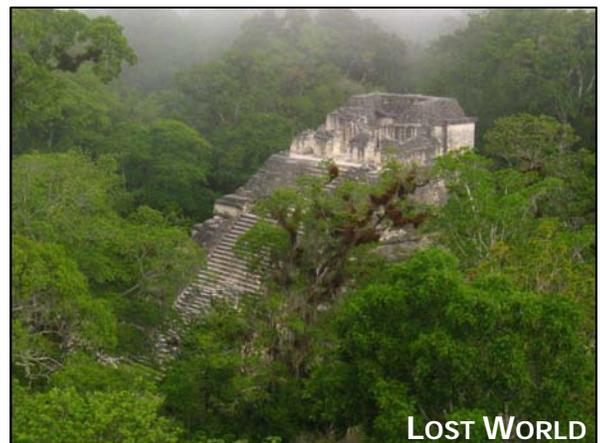
From about 200-500 C.E. Tikal grew rapidly in population and land area. Through capture of military leaders in neighboring cities, Tikal also gained political power. The rulers constructed temples, palaces, *katun* (a pair of pyramids that celebrated a religious holiday), and graves near the North and Central acropoleis. Tikal reached its zenith around 500 C.E., at which point it was estimated to have contained over 100,000 inhabitants. The city dominated the central lowlands economically (through control of trade, e.g. of such materials as jade



<sup>7</sup> Jorge Pérez de Lara, "A Brief History of the Rediscovery of Tikal and Archaeological Work at the Site." <http://www.mesoweb.com/tikal/features/history/history.html>

- outlined above) as well as politically. However, between 534-692, a period referred to as the "Middle Classic Hiatus," construction of monuments in the city came to a halt. One major cause of this is hypothesized to have been the capture of Tikal's king by neighboring city Caracol, which was beginning to rival Tikal in size.

The Middle Classic Hiatus ended in 692, when Ah Cacau's assumed the role as 26<sup>th</sup> ruler of the Tikal dynasty. He began a program of "cultural revitalization" in an attempt to resuscitate Tikal, which at this point was noticeably in decline. He did so through renewed construction, a return to the traditional religious ceremonies of earlier times, and invigorated military conquests. He closed off the North Acropolis, which had, until this point, been the primary burial place of the royal family. The shrine of Ah Cacau is one of the seven large temples (helpfully now named Temples I-VII since they have been excavated), that were built after the hiatus. Ah Cacau's son continued the program of prolific construction, but by the end of his reign Tikal was irreversibly in decline and the empire apparently suddenly collapsed – or dispersed into smaller groups of regional Maya - between 800-900 C.E..



The best times to visit the park are before 9am and after 3pm. If you purchase your entrance tickets after 3pm, then they are valid for the next day allowing you to spend two half days for the price of one full day (Q. 50.00) without having to endure the mid-day heat in the park. Be sure to bring enough water and food to keep you going in the jungle heat. Especially water – and a sun hat and sun glasses. We found the evening portion from 3pm-6pm (park closure) to be the best because it was quite foggy the following morning at 6am (park opening). You can arrange for dawn tours if you stay in the park, but if it is foggy paying for the morning tour is probably not worth it unless you are very interested in morning bird and howler monkey calls. There is also a small museum in the park which has some nice pieces if one is especially interested in archeology.



**Suggested Reading:**

Harrison, Peter D., (2000), *The Lords of Tikal: Rulers of an Ancient Maya City*, New York: Thames and Hudson.

McKillop, Heather, (2004), *The Ancient Maya: New Perspectives*, Santa Barbara: ABC-CLIO.

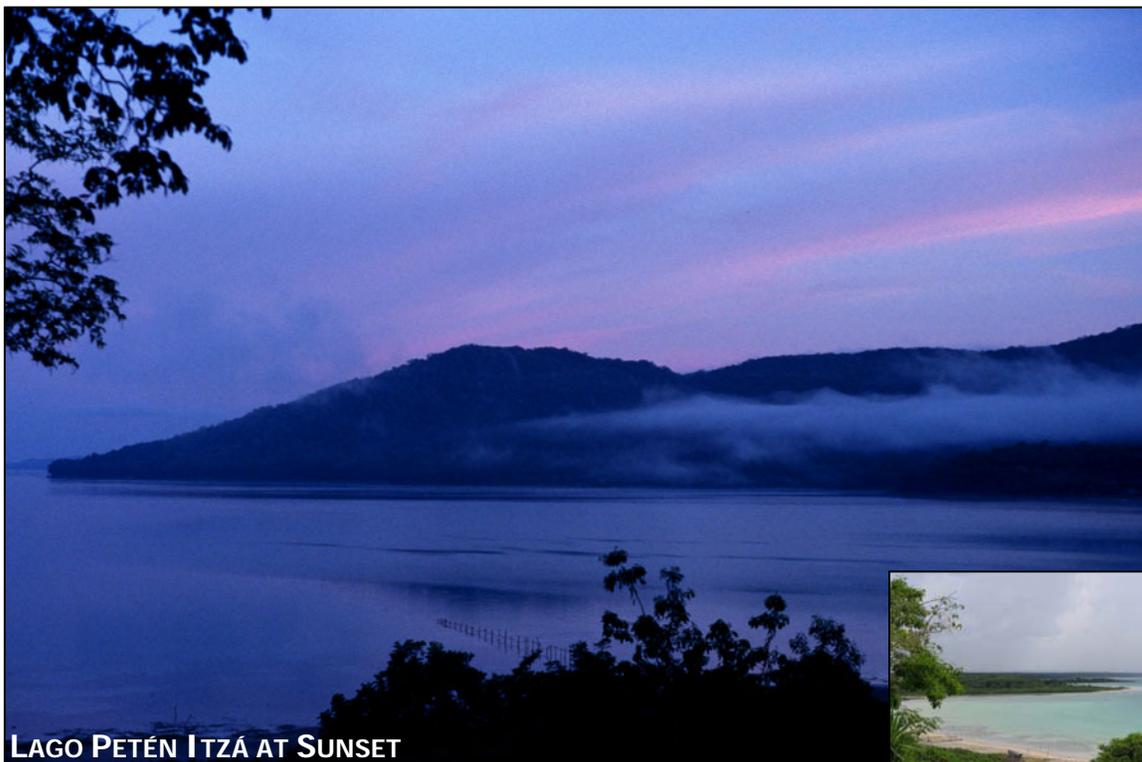
Sharer, Robert J., (1994), *The Ancient Maya*, 5th Ed., Stanford University Press.

"The Maya Race and Mythology," *Metareligion.com*, [http://www.meta-religion.com/World\\_Religions/Ancient\\_religions/Central\\_america/maya\\_race\\_and\\_mythology.htm](http://www.meta-religion.com/World_Religions/Ancient_religions/Central_america/maya_race_and_mythology.htm)



**Lodging:**

SAP spent the night in El Remate on the eastern shore of Lago Petén Itzá, but in hindsight this was a mistake as the lodging options were poor. Although it is more expensive, it is probably well worth the extra money to spend the night inside Parque Nacional Tikal. A range of options from camping to pricey hotels are available, all of which allow you to stay after the park closes at 18:00 and re-visit the ruins in the early morning for sunrise before the park gates re-open at 6:00.



## **Day 11 – Tikal to Sayaxché via Aktún Kan**

Having reached the northern apogee of the trip at Tikal, this day begins the journey south toward the central mountainous region of Guatemala, transitioning from the archaeological grandeur of El Petén to the stunning karst topographies of Alta Verapaz (discussed in more detail in Day 12 entry). First, we'll re-visit the Mayan ruins at Tikal in the early morning for one last taste of ancient human history. Then, after stopping in the city of Flores for lunch, we will check out the Grutas Aktún Kan, also known as the Serpent Caves, (returning to our geologic history tour) before continuing south to Sayaxché. The roads are paved and in good condition for most of today's journey.

### **5:30 – Depart El Remate**

**Stop 11.1.** 6:00 – Ruins of Tikal. Depart ruins at around 10:30.

Be sure to bring along some snacks and *plenty* of water, it gets VERY HOT by 10 am, though was foggy and dripping wet up until then.

**Stop 11.2.** 12:00 – Lunch in Flores.

From the ruins, head back south the 33 km to El Remate, then continue south and then west another 35 km to the town of Santa Elena. The roads are paved, straight and the whole journey takes just over an hour. In Santa Elena turn right on 6a Avenue to take the causeway over to the island town of Flores.

The three contiguous towns of Flores, Santa Elena, and San Benito compose the urban center of El Petén located on the south shores of Lago Petén Itzá. Flores is particularly beautiful as it sits on an island in the lake; it is linked to Santa Elena by a 500m causeway. You may want to spend a brief time touring Flores by foot. Most restaurants and other tourist attractions in each town are concentrated near the causeway. A 24-hour supermarket, Internet café, and bank are all located within a block of each other in Santa Elena, at the intersection of 4a Calle (the main east-west highway) and 6a Avenue (the street leading to the causeway).

Flores' history includes a unique relationship between the indigenous Maya and the Spanish conquistadores. The island was settled by the 15th century by exiles from the Yucatan civilization of Chichén Itzá. Hernán Cortés encountered the city in 1525 and, despite his penchant for bloodshed, merely offered his lame horse as a gift. The Itzás, as the people of Flores were known, made a statue of the horse and eventually worshiped it as a manifestation of the local rain god. When the Spanish arrived again in 1697, they plundered the city and destroyed all nearby pyramids and temples; thus, there are no sites like Tikal near Flores.

**Stop 11.3.** 1:30 – Cuevas Aktún Kan and Jobitzinaj.

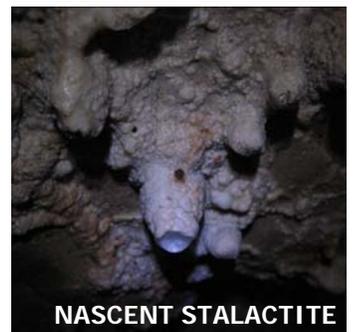
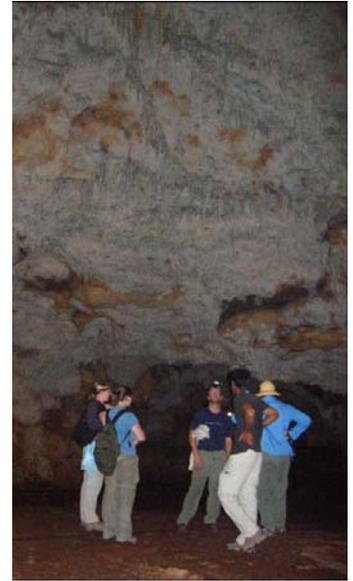
The caves are reached by driving south along 6a Avenue to the end of the road, then jog left (east) for 300 m and turn right (south) at the power plant. Continue

another kilometer or so along this road to the parking lot. The caves are fairly easy to find as the route is well marked with big “Cuevas” signs.

These are the first caves we will encounter on the trip. Caves are unusual for El Petén because their formation requires uplifting of the limestone bedrock above the water table. Most of El Petén is low-lying having experienced minimal tectonic uplift.

The “Grutas Aktún Kan” is also known as *La Cueva de la Serpiente*, or cave of the serpent. Although no serpents should be encountered, we'll see rock formations that look vaguely like humans and animals. The two caves are linked; Aktún Kan has been developed and lighted for visitors, while Jobitzinaj has not. Jobitzinaj is more extensive and can be accessed from the same hill bearing the entrance to Aktún Kan, but on the opposite side.

The developed portions of Aktún Kan can be explored in under one hour. The entrance fee is Q. 20.00 / person. Although the speleothems are relatively uninspiring and the caverns are not excessively large, Aktún Kan is a nice, safe introduction to exploring caves. If you are feeling adventurous, you can spend as much time as you like getting lost in the unlit portions of the cave and emerge on the other side. Be very careful to keep track of where the exit is and bring *at least* two flashlights per person as well as extra batteries, just in case.



NASCENT STALACTITE

#### **Stop 11.4.** Sayaxché – final destination for the night

From the Grutas Aktún Kan head back into the town of Santa Elena all the way down to the main highway along the lake-shore where you should turn left (west). This is Highway 5 and will take you out of town to the southwest. Upon leaving town the road becomes unpaved for approximately 20 km but the remaining 40 km south to Sayaxché are straight, flat and nicely paved. The total 60 km take a little longer than an hour.

The town of Sayaxché is located on the south bank of the Río de la Pasión at a bend in the river. To get to the town you will have to cross the river via an out board



SAYAXCHÉ SUNSET

motor-powered ferryboat (~Q. 20.00). The ferries run frequently during the daytime (i.e., whenever there is enough freight to make the journey worthwhile) and the lineup can backup quite a bit depending upon traffic.

**Restaurants  
and Lodging:**

Hotel Guayacán is clean, bright and has air conditioning in the upstairs rooms (fans in downstairs rooms). It also boasts a spectacular top floor patio for viewing the sunset over the Río de la Pasión with the most comfortable rocking chairs in the world. Q 175.00 for a double with AC. Q 150.00 for a double without AC.

The Comedor at Hotel Guayacán has a pricey set menu dinner for Q. 50.00 per person. Restaurant Costa Río a few blocks up into town offers some cheaper options (e.g. three tacos for Q. 10.00, soups for Q. 16.00, and Papas Fritas) but as in all small towns, most places close by dark and you may have to talk your way in any time after 5pm.



**SAYAXCHÉ SUNRISE**



**SAYAXCHÉ MORN'**



**SAYAXCHÉ DAY**

## **Day 12 – Sayaxché to Lanquín**

Today's route will take you through the scenic karst terrain as you travel from the northern lowlands into the central mountainous region of Guatemala. The entire route is underlain by a sedimentary sequence of Cretaceous age carbonate rocks of the Verapaz group and the Ixcoy/Cobán formation(s). However, the rocks themselves are less interesting than the geomorphic features of the landscapes that result from the typical physical and chemical weathering patterns of carbonates. On this leg of the journey you will see first-hand how the uplift and fracturing of carbonate rocks associated with the active tectonic margin between the Chortís Block and the Maya Block, has blessed Guatemala with some spectacular karst landscapes and amazing cave networks.

Keep your eyes open for obvious sink holes and rivers that seem to emerge from underground. With the dense vegetation and weathering of the rocks it is difficult to spot bedding planes, but when visible they tend to be horizontal or sub-horizontal. Rarely do their dipping angles approach the steepness of the local relief, indicating that the steep karstic topography was caused by sinkholes collapsing, rather than folding and faulting.



### **Stop 12.1. Raxruja.**

The first stretch from Sayaxché to Raxruja is 97 km on a relatively straight, paved road and should take about 1.5 hrs. After 90 km you will reach the junction at San Antonio Las Cuevas, a T-intersection with one spur heading westwards towards Chisec and the Parque Nacional de Laguna Lachuá (see below). Take the other turn, left (east) towards Raxruja, Sebol and Fray Bartolomé de Las Casas. Raxruja is only 7 km further along this road.

The most exciting part of this drive comes shortly before the junction at San Antonio de Las Cuevas where the road begins winding as it gains elevation, then eventually cuts through a natural gate formed by two large karst mountains.

There is not much in the way of services in Raxruja, but it is supposedly the only place in the region that offers basic services: food, lodging and gas. There is a Texaco gas station on the left hand side as you leave town; if you are at all unsure about having enough gas for the next hundred kilometers, tank-up here. Same goes for food and water.

### **Stop 12.1b: Parque Nacional Laguna Lachuá (if you have extra time).**

Laguna Lachuá, or "sulphur lake," is a water-filled sinkhole. Its karst pedigree is evident from the high limestone content of the water and the presence of tufa deposits and calcified tree skeletons at the edges. The lake is almost perfectly round, has a striking turquoise color, and is 222 m deep. Interestingly, the

elevation of the lake surface above sea level is only 173 m, and so the bottom of the lake is below current sea level. The reason for the lake's exceptional depth remains unclear. In many places the shore of the lake looks like a sandy beach, but is actually white calcite mire, into which trespassers can sink. ***Be careful!***

The lake is surrounded by a dense rainforest in which jaguar, parrots, and toucans are often sighted. The mahogany trees in the forest are popular targets of loggers; for this reason, the area has been made a national park and access has been restricted. Only 84 visitors are allowed into the park each day and only 21 are allowed to stay overnight.

Laguna Lachuá requires a considerable detour along a remote and poorly maintained road. From Raxruja head west past San Antonio Las Cuevas in the direction of Chisec. The highway is reportedly well maintained. In approximately 20 km, take the right fork in the road toward Playa Grande. This road was in terrible disrepair during the civil war as much violence was concentrated in this area, but it is in much better shape today. It remains largely unpaved and takes about 2 hours from San Antonio. From the park entrance, which is approximately 10k m short of Playa Grande, a 4 km walk is required to reach the lake. Contact (as of 2001): 704-1509. [Note: The 2005 SAP trip did not include this stop.]

### **Stop 12.2: Sebol.**

Crossing a bridge over a creek takes you southeastwards out of town. At this point the road becomes unpaved and exceedingly rough: 4WD and high clearance are strongly recommended. Though it is only 15 km away, it will take almost a half hour to make it to Sebol, but get ready because this is just the beginning.

From Sebol it is supposedly possible to visit the famed Grutas de Candelaria. The Candelaria caves are perhaps the longest network of caves in Latin America stretching over 20 km between Chisec and Sebol. The Tzul Tacca chamber is the size of a cathedral nave, approximately 200m long, 30m wide and 60m high. The caves are sacred to the local Mayan tribes. For example, the Q'eqchi' Maya believe they are the entrance to Xibalba, the underworld, and still come to pray here. The Lacandon Maya believe that every night the god of the underworld carries the sun through the caves in a basket, in order to return it to the eastern sky the next morning. Mayan archaeological sites are common throughout Candelaria.

Although it is reported that tours of the caves are operated out of Sebol, SAP was unable to find the entrance to these caves or a guide to take us there. Some locals had never heard of the caves and still others told us that it is possible to tour the caves starting at the other end via Chisec, but this is a 50 km drive taking well over two hours. Different maps show the caves in different locations, alluding to the many entrances and passageways. The general misinformation also points to the fact that not very many people actually know where these caves are, or, if they do, are choosing to keep their location a secret. If you have your heart set on visiting the Grutas de Candelaria, get as much information as you can ahead of time and consider going through a guided tour operation based out of Cobán.

**Stop 12.3:** Pajal junction.

South of Sebol, the road climbs its way up the mountains through the heart of karst country on the most beautiful and remote section of the trip. The road is very rough, curvy and slow, but well worth it. The 50 km between Sebol and the Pajal junction will take upwards of 3 hours to traverse. There are ample places along this stretch to make stops to enjoy the scenery and take pictures, however, keep in mind that buses and large trucks use this road regularly, so do not block it with your vehicles.



The towns along the way are small and offer few services, giving any traveler new appreciation for how much of rural Guatemala has remained untouched by tourism and development.

From the Pajal, you can get an amazing view down the Lanquín Valley. At the junction the paved road heading straight runs eastwards to Cobán, while the gravel road to the left heads east down into the deeply incised valley in the headwaters of the Río Cahabón.

**Stop 12.4:** 18:15 (Dusk) – Grutas de Lanquín I: the bats

The descent into the Lanquín valley is even steeper than the stretch between Sebol and Pajal, but it is only 11 km and takes about a half hour. Just before entering the town of Lanquín is a turnoff to the left whereby you will reach the Grutas de Lanquín, a network of caves that is the birthplace of the Lanquín River (*Nacimiento del Río Lanquín*). Indeed the river gushes out from an underground cavern at an astounding rate, which in and of itself is a sight worth seeing. The other attraction is the thousands upon thousands of bats that flood out of the cave's entrance at dusk each night to feed (on insects!).

It is a good idea to go secure a hotel before observing the bats, as it will get quite dark, quite quickly. Entrance to the caves is Q. 25.00, which, if you arrange it with the guards, allows you to go see the bats exiting in the evening and then return the next day to explore the cave itself. Depending upon the time, you may be able to do this today as well. Exploring the caves takes about an hour (see Stop 13.2, tomorrow's entry), but no one is allowed to enter after 17:00.

**Stop 12.5:** Lanquín, final destination for the night.**Restaurants and Lodging:**

Hotel el Sapote is a small backpacker-style hostel located a little over half-way between Lanquín and Semuc Champey. It is basic, with no hot water (as if you'd want it in this climate!) and with shared bathrooms, but the price is right at Q. 15.00 / person for a bed in the dormitory style loft (you may want mosquito netting) or Q. 30.00 for a private room. The set meals are good and very filling for Q. 25.00.

## Day 13 – Semuc Champey and Grutas de Lanquín

Today we will visit both Semuc Champey and the Grutas de Lanquín, which are separated by a short drive along a bumpy, dirt road. Both are spectacular geomorphic features unique to carbonate rocks. The driving is minimal in distance, but the road between Lanquín and Semuc Champey is very rough and slow, 4WD vehicles with high clearance are strongly recommended. The Grutas Lanquín are the first left turn as you enter the town of Lanquín, while Semuc Champey is 11 km past town on the road towards Cahabón. The two attractions are separated by about a half hour's drive and both are easy to find as they are well marked with signs.



### **Stop 13.1:** 9:00 – Semuc Champey.

Semuc Champey is said to be one of the most beautiful places in all of Guatemala (and possibly the world), and for good reason. Here, in the heart of karst country, the Río Cahabón has incised a deep canyon through the limestone bedrock. Above the level of the river are springs, the cool waters of which are saturated with carbonates. At the emergence of these springs, the mineral *travertine* is deposited, which slowly builds the spring out away from the rock and over the river. At this location, nature has built a substantial dam (“travertine bridge”) across the Río Cahabón. The river flows in a raging torrent deep under the extensive bridge before re-emerging on the downstream side. The bridge itself spans more than 300 m of the river's length and is pocketed with crystal-clear freshwater pools ideally warm enough and deep enough for diving and swimming.

Semuc Champey opens at 6:00, so if you want the place to yourself, get there early and spend as much of the day as possible enjoying the various pools and scenery. It starts getting crowded around 11:00 when the sun heats up and the cool spring water is



that much more inviting. Bring some food and enough water to keep you going: swimming works up an appetite! Entrance fee is Q. 20.00.

Although this will be a relatively mellow time, a stringent warning is in order: ***be very careful around the upstream edge of the bridge, one wrong step could be fatal.*** If you fall into the river, you will be dragged under; a park guard may be on duty to help prevent such fatalities.



**Stop 13.2:** 14:00 – Grutas de Lanquín II: the caves.

If you were not scared off by the thousands of bats from the previous night, it is time to have a look inside the caves. They run several kilometers into the earth and, after the first paved and lit section are relatively untouched, though getting to the greater and darker depths of the caves is rather difficult. Still, the speleothems in the lit portion of the cave are spectacular in size and shape; plus if you hunt around you may find some spectacular sparry calcite.



Just below the entrance to the cave is the birthplace of the Lanquín River where it emerges from underground. If you listen carefully as you enter the cave you can hear the rush of flowing water beneath you. In Spanish the place is known as *Nacimiento del Río Lanquín*. The other attraction of the Grutas de Lanquín are the thousands of bats that exit at dusk each day for their evening meal (see previous day).

**Stop 13.3:** 18:00 – Cobán.

After retracing the first 11 km of treacherous, winding dirt road up out of the Lanquín valley, the 50 km stretch of road to Cobán is well paved, though still quite curvy. The whole trip takes slightly less than two hours.

**Restaurants and Lodging:**

Hotel y Cafeteria La Paz (6a Avenida 02-19, Zone 1, Tel. 7952-1358) is just off the main street (1a Calle) and offers cheap, decent rooms, though the cafeteria was never open. Down the street, at 6a Ave and 1a Calle, is a decent *comedor* for with the usual (eggs, beans, cheese, meat, etc.). Cobán also has a Campero Restaurant: from the church, head up 1a Calle towards Lanquín and take your first right on 2a Av, go down to the corner of 3a Calle.

## **Day 14 – Roadside Geology: Cobán to the Capital**

Today is the last day of the trip, driving from Cobán back to Guatemala City with various roadside geology stops along the way. [206 km, ~4.5 hours+stops.] Stay in Guatemala City this night and depart the next morning.

### **Stop 14.1 - The Polochic fault**

The Polochic fault segment is one of the major strike-slip faults that accommodate transform motion between the Caribbean and North American Plates. The fault is thought to have been more active in the past than it is today, and clearly has a substantial normal component as evidenced by the parallel ridges and valleys along the fault zone. In the vicinity of the town of Tactic (32 km from Cobán along the highway), the Polochic fault juxtaposes Permian carbonates with the Cretaceous Cobán Formation, which also consists of a carbonate sequence, much to the confusion of many geologists and confounding an early thrust fault interpretation. There is a good view of the fault trace from the small plaza by the church on the hill.



The Chixoy River drains from north to south although it has been rerouted east-west along the Polochic fault zone as a result of progressive fault displacement. Using such drainages as geomorphic markers, up to 25 km of displacement has been measured. Unfortunately, there are no accurate estimates of the age of these river channels that could be used to calculate a short-term average rate of offset. Rerouted river basins, terraces, and trends of pre-existing fold axes have been used to constrain the timing and amount of offset along the Polochic fault, though a detailed study of the fault activity and seismic hazard is greatly needed. The steep scarps and valleys are populated by small towns and villages, though there has been no estimate of whether the area is



stable or a disaster waiting to happen.

### **Stop 14.2 – All My Faults Are Normal**

Farther west, the east-west trending Polochic fault zone is intersected by a relatively young, prominent normal fault, oriented obliquely to the strike-slip zone. The normal fault is a classic example of an extensional half-graben system, in which the basin drops down relative to the steep-walled, sub-linear horst-block. From our road stop, we can see (to the east) textbook examples of vegetated “wine-glass” canyons and faceted range fronts, typical of normal fault blocks.



### **Stop 14.3 – Roadside Ultramafic rocks**

The roadcuts along this part of the highway, north of La Cumbre, consist of extremely weathered, iron and magnesium rich ultramafic rocks. These rocks are mostly mantle peridotite with olivine, orthopyroxene (opx), and clinopyroxene (cpx). The mineral percentage of opx and cpx each exceed 5%, indicating a relative enrichment of magnesium in the peridotite, characteristic of the “fertile mantle.” One possible explanation for this rock’s petrogenesis is the undepleted mantle beneath a fast-spreading center in the old ocean basin between the Maya and Chortís blocks. A fast-spreading center might limit the time needed for opx and cpx in the mantle to partially melt and be extracted into mid-ocean ridge basalt (Martens, personal comm.).

### **Stop 14.3 – Roadside Obsidian**

Further along the highway, close to Guatemala City-limits, there is a roadcut through an obsidian deposit. This dark, black “weapons-grade” obsidian would have been preferred by the Maya for making tools over lighter colored, more brittle obsidian varieties. (However, there is evidence that various colors of obsidian were also used decoratively.)



2004-2005 Stanford Alpine Project Members



Sid                      Dale                      Peter                      Gail                      Theo Gwyn Utsav  
Ben                      Julie                      Annie                      Kevan

Editors: Ben Mirus, Kevan Moffett, Julie Fosdick, Gwyneth Hughes, Sid Carter

Layout: Kevan Moffett

Photo Credits: Kevan Moffett, Sid Carter, Julie Fosdick

Other Contributions: Dale Meck, Peter Anthony, Theo Huzyk, Ustav Sethi, Annie Scoffield

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