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Cuba: An Overview of Its Geology, Hydrocarbon Systems and Petroleum Industry

Cuba is a portion of the Great Arc of the Caribbean that obliquely collided with and was sutured onto the North American plate during the Late Cretaceous-early Tertiary. As such it contains both a long-travelled, allochthonous magmatic arc component as well as an autochthonous Florida-Bahamas Platform passive margin component, which have been tectonically intermingled in a complex fashion.

The pre-Mesozoic history of Cuba remains enigmatic, but the existence of Grenville-age (~1 Ga) metamorphic rocks in the Santa Clara belt indicates that at least this small piece of Cuba had a Precambrian continental origin and was probably derived from some part of North America (Laurentia) other than the basement underlying Florida (Pan-African, Gondwana-affinity). Conceivably, these Grenville-age rocks could have been torn off the Mexico/Chortis part of Laurentia as the Great Arc migrated into the gap between North and South America during the Cretaceous (Kevin Burke, personal communication).

The early Mesozoic to Recent geological history of Cuba, which is most relevant to the hydrocarbon systems, can be divided into three main tectonic phases: extensional/passive margin, collisional, and transcurrent/extensional. The extensional/passive margin phase affected only the autochthonous (Florida-Bahamas platform) portion of Cuba and began in the Triassic and/or Early to Middle Jurassic, associated with the rifting and breakup of Pangaea. Compression began to affect Cuba during the Late Cretaceous as a result of the northeastward migration of the Cuban magmatic arc. The Cuban fold and thrust belt and adjacent foreland basin formed during the Campanian-early Tertiary, when the Cuban arc obliquely collided with the southern margin of the North American continent. Terminal collision probably took place during latest Paleocene-early Eocene (Bralower and Iturralde-Vinent, 1997) and caused the obduction of volcanic arc-related rocks and ophiolites over the passive margin carbonates and evaporites of the Florida-Bahamas platform. Following the cessation of collision in the early Tertiary, a sinistral transcurrent fault system (Cayman Trough) developed to the south of Cuba and the Yucatan Basin; this transcurrent fault system has persisted to the present day and forms a portion of the boundary between the North American and Caribbean plates. Contemporaneous with the early development of the transcurrent plate boundary, crustal collapse led to extensional structures being superimposed on the hinterland of the Cuban orogen. In addition, some of the collisional-phase structures have been further modified by salt diapirism, especially in northwestern Cuba (Jamison and Podruski, 2000).

In 1508 the Spanish mariner Sebastián Ocampo found what he called a "liquid bitumen" in the area of Bahía de la Habana, which he used as a caulking material when he careened his ships. This is the earliest known use of petroleum by old-world colonists in the Americas (Pardo, 1992). Petroleum production in Cuba dates from 1881 when light oil production was established from Motembo Field in the central part of the island. Cuba currently produces an all-time record of approximately 50,000 bo/d of predominantly heavy crude and 55 MMcf/d of associated natural gas, mainly from a series of fields along a relatively small, 100km stretch of the northern coastline of Habana and Matanzas Provinces. This limited geographical area of oil and gas production has more to do with ease of logistics and

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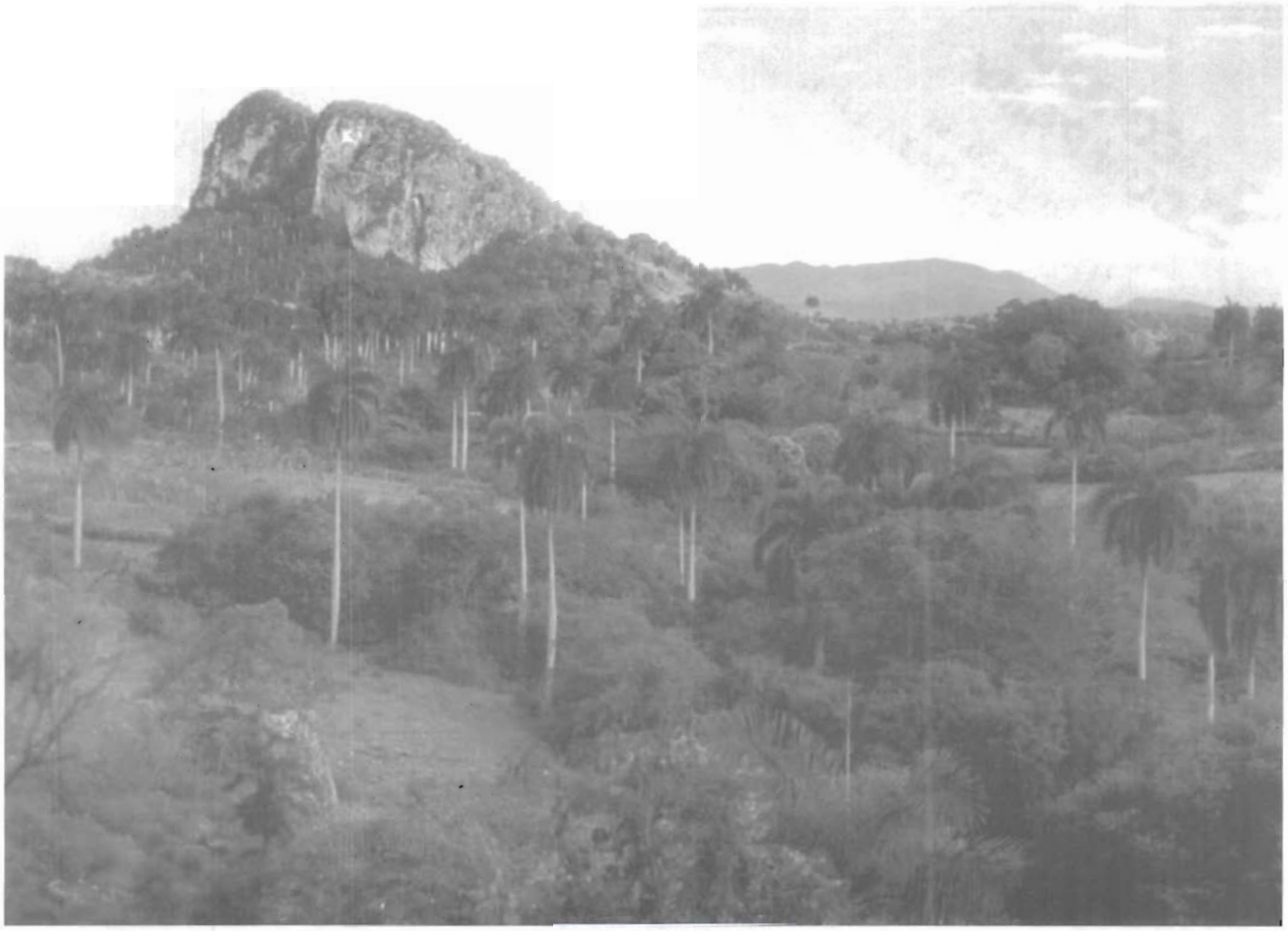

Figure 1. *Upper Cretaceous Maastrichtian carbonates over ophiolite complex, Holguín Province, eastern Cuba. Photo courtesy of Jim Podruski.*

proximity to the main market (Havana) than to prospectivity. The largest of the currently-producing fields is Varadero Field (Tavares, 1999), with an estimated 2 billion barrels of oil in-place. Most of the present-day production comes from fractured Upper Jurassic and Lower Cretaceous carbonate reservoirs (originally part of the Florida-Bahamas platform) in structural traps of the north Cuban deformed belt. Relatively minor production has also been established from fractured serpentinites and other basement rocks. The major hydrocarbon source rocks are probably Upper Jurassic and/or Lower Cretaceous in age. With the application of modern drilling and completion techniques since Cuba opened its E&P sector to foreign participation in the 1990s, recently-drilled wells commonly have sustained production rates above 1,000 bo/d, with some wells reaching 3,000 bo/d. Despite these successes, current production still only meets around 30% of Cuba's domestic demand. There are, however, indications that production and reserves could be significantly greater in the future. Cuba may well attain energy self-sufficiency within the current decade, and could even become a significant exporter of crude oil and natural gas.

While U.S. oil companies are barred from doing business in Cuba by the U.S. Government, a number of Canadian independents have been aggressively filling the niche; in addition, significant players from Europe and other parts of Latin America have recently entered the Cuban E&P scene. Acreage is currently available for exploration both onshore and offshore by direct negotiation with the national oil company Cubapetróleo (CUPET), as well as via several farm-in opportunities.

Most recently, the entire 110,000 sq km Cuban sector of the Gulf of Mexico was subdivided into blocks and made available for licensing, and is deemed to have significant hydrocarbon exploration potential in a variety of trends (Hernández-Pérez and Blickwede, 2000). In this mostly deepwater area, the offshore extension of the productive Cuban fold and thrust belt and its associated foreland basin remains undrilled and constitutes a possible major petroleum province of the future. Additional potential is foreseen in traps and reservoir facies associated with Florida and Campeche Escarpments and around the flanks of basement high "knolls." Oil recovered from DSDP Site 535, in the central portion of the Cuban sector of the Gulf, confirms the existence of thermally-mature, viable oil source rocks in this frontier exploration area.

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Figure 2. *Jurassic-Lower Cretaceous carbonates, Guaniguanico Range, Pinar del Río Province, western Cuba. Photo courtesy of Jim Podruski.*

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Biographical Sketch

JON FREDERIC BLICKWEDE is currently regional manager, Mexico, Central America and Caribbean for the IHS Energy Group. He earned a BS degree in geology from Tufts University in 1977 and an MS in earth sciences from the University of New Orleans in 1981. From 1981 through 1996, he worked as a petroleum geologist for Amoco Production Co. in New Orleans and Houston, and as exploration coordinator for Amoco Venezuela in Caracas. Since leaving Amoco, he has served as manager of geoscience at The Andrews Group International, providing E&P-related technical consulting for Petróleos Mexicanos (Pemex), as well as recent positions at Petroconsultants/IHS Energy in Geneva, Switzerland and Houston, Texas. He is a member of the AAPG, Houston Geological Society, Asociación Mexicana de Geólogos Petroleros, Sociedad Geológica Mexicana, and the Geological Society of Trinidad & Tobago. Among other professional honors, Blickwede was the 1988 recipient of the AAPG Matson Award for his paper on the Perdido Foldbelt of the deepwater western Gulf of Mexico. □