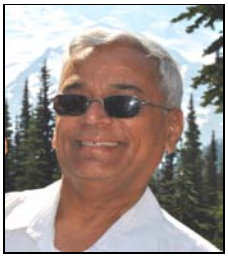
Open Access e-Journal
Earth Science India- www.earthscienceindia.info
Popular Issue, V (II), April, 2012, p. 1-10

LA BREA PITCH LAKE AND MUD VOLCANOES OF TRINIDAD, WEST INDIES

Arun Kumar



It is world's largest lake of tar located on the western coast of Trinidad about one mile south of Brighton. Pitch is another name used by Trinidadians for tar or asphalt. It covers an area of 126 acres and is over 273 feet deep at the center of the lake, which is shaped like an inverted cone……Several mud volcanoes are known in southern Trinidad and they are both active and fossilized i.e. not active for some time. They are of various forms and dimensions and are also known from offshore southern Trinidad.

Trinidad and Tobago (area 4,768 km^2) are two adjacent islands, surrounded by the Caribbean Sea to the north, the Columbus Channel to the south separating it from Venezuela, the Atlantic Ocean to the east and the Gulf of Paria to the west (Figure 1). These two islands form a country located off the coast of eastern Venezuela in southeastern corner of the Caribbean Sea (Figure 2). This country has large hydrocarbon deposits thus, is a major producer of oil and gas in the Caribbean region. These are stunningly beautiful islands having mountainous regions in the north (Figure 3), rolling hills and plains in central and southern regions (Figure 4). The islands are blessed with extensive swamps, beautiful beaches (Figure 5), and coral reefs. The La Brea Pitch Lake and several small and large mud volcanoes are significant part of the Trinidadian geology.

During the years 1973-1976 of my graduate studies at the Michigan State University, USA, I was repeatedly invited to visit Trinidad by my close friends, the Ramcharan family of Tacarigua, a sub-urban town of the capital city of Port-of-Spain. After successful completion of my research work and dreadful week long comprehensive examinations, I decided to take a break in October, 1975 and went on a ten days trip to Trinidad where I celebrated Diwali with Ramcharan family (Figures 6 and 7). This was indeed a memorable trip and my hosts did everything possible to make me feel happy and comfortable and took me as part of their own family. The roots of this family lay in rural Faizabad district of eastern Uttar Pradesh and they had migrated to Trinidad just two generations before. During nineteenth century, thousands of Indians mostly peasants from rural India were taken by the British to the Caribbean Islands to work in sugar cane farms and their Hindu heritage is evident by the presence of several Hindu temples all over Trinidad (Figure 8). Every day of my stay was packed with programs to visit places of tourist interest, Ramcharan relatives and their friends. I was always accompanied by Ramesh, his wife Dolly and his sister Ramkumarie (Manisha).

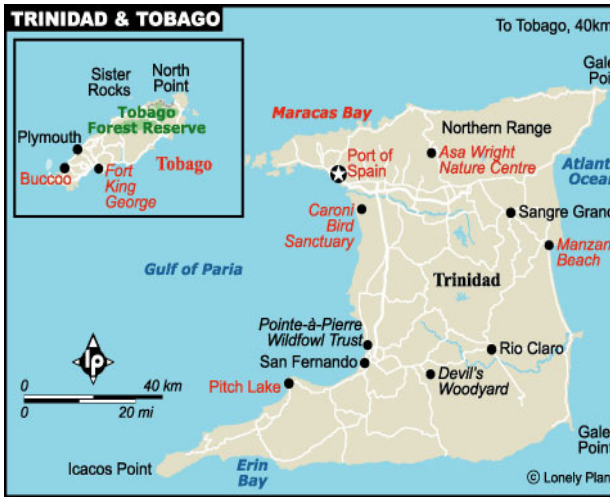


Figure 1.The island country of Trinidad and Tobago showing locations of major urban centers and the Pitch Lake. (Website 1)

Figure 2.Geographical location of Trinidad; southeastern island of the Caribbean Sea off the coast of eastern Venezuela.(Website 2).

Figure 3. Northern mountains of Trinidad covered under thick tropical forest.(Photo: Arun Kumar, October 1975).

Figure 4.The highway connecting Port-of-Spain in the north to San Fernando in the south showing rolling hilly region of central and southern regions of Trinidad.(Photo: Arun Kumar,October 1975).

Figure 5.One of the several beaches of Trinidad (Photo: Arun Kumar,October 1975)

Figure 6. The author (second from left) and three members of the Ramcharan family sitting on top of mountainous northern coast of Trinidad facing the Caribbean Sea. (Photo: Ramesh Ramcharan, October 1975)

Figure 7. A road cut showing outcrops of mainly Tertiary sediments in the central region of Trinidad. Ramesh Ramcharan and his wife Dolly in the foreground. (Photo: Arun Kumar, October 1975)

Figure 8.A Hindu temple in Port-of-Spain, Trinidad.(Photo: Arun Kumar, October 1975)

This trip had given me a unique opportunity to visit Pitch Lake and mud volcanoes; geologically wonderful places of interest. I had collected samples of pitch to carry out palynological study with the objective of finding the stratigraphic source of the pitch. Later, I had published two research papers based on my palynological study of the pitch samples (Kumar, 1979, 1981). In this article I present some very interesting geological information about the La Brea Pitch Lake and mud volcanoes of Trinidad.

La Brea Pitch Lake

The La Brea Pitch Lake is a circular depression containing dark, brownish-black to black viscous to solid natural pitch (Figure 9). It is world's largest lake of tar located on the western coast about one mile south of Brighton. Pitch is another name used by Trinidadians for tar or asphalt. It covers an area of 126 acres and is over 273 feet deep at the center of the lake, which is shaped like an inverted cone (Suter, 1960).The "lake" has been mined and asphalt exported since 1859. The lake appears to be inexhaustible because a hole dug one day is completely filled the next day. Although most of the surface is firm there are soft areas too.The mass of tar constantly and slowly moves up from the subsurface to surface and also from center towards edges due to the continued influx of solid material along with gas, water, sand and clay at the center (Kumar, 1981).

The native Amerindians of Trinidad called this lake by its Spanish name *'Tierra de Brea'* and they introduced Sir Walter Raleigh to this lake in 1595. Raleigh recognized the economic potential of the tar and on his second voyage to the Caribbean he carried tar back to England, where it was used to pave Westminster Bridge for the opening of Parliament. Tar from this lake has been used to provide high grade road surfaces not only in Trinidad and Tobago and the other islands of the Caribbean, but it has also paved streets in over 50 countries including the United States of America, England, India, Singapore, Egypt, and even Japan (website 1and 2).

Geology of southern Trinidad is structurally quite complex and has a series of east-west trending folds and faults (Figure 10). Los Bajos Fault is a major structural feature of the southern Trinidad that intersects major oil fields and has influenced the migration and accumulation of oil in the region (Wilson, 1940).

There are different ideas about the source of the pitch. Suter (1960) considered that the formation of this lake took place during Pleistocene Epoch and the asphalt is derived from a Cretaceous reservoir which penetrated Oligocene beds from which it has picked foraminifers, heavy minerals and some additional oil. According to Jacobson and Neff (1974), Merrimac, Rousillac, Vessigny and Brighton are oil fields around the Pitch Lake area and all of them produce oil from Forest and Cruse Series of Miocene Epoch. Thus, most likely pitch too is sourced from these sediments of Miocene age. I collected freshly dug samples of pitch for my own palynological study (Figure 11). By inventing a novel maceration technique, I was able to isolate a fairly good assemblage of palynomorphs from the pitch samples that included angiospermous and gymnospermous pollen, pteridophytic spores, fungal spores, cuticles, tracheids, and some algal structures resembling dinoflagellate cysts (Figure 12). This was first study of its kind and I was able

to demonstrate that the pitch has been sourced from Miocene reservoirs which are producing horizons of oil in the Brighton area (Kumar, 1981).

Figure 9. Aerial photograph of the Pitch Lake (Website 5)

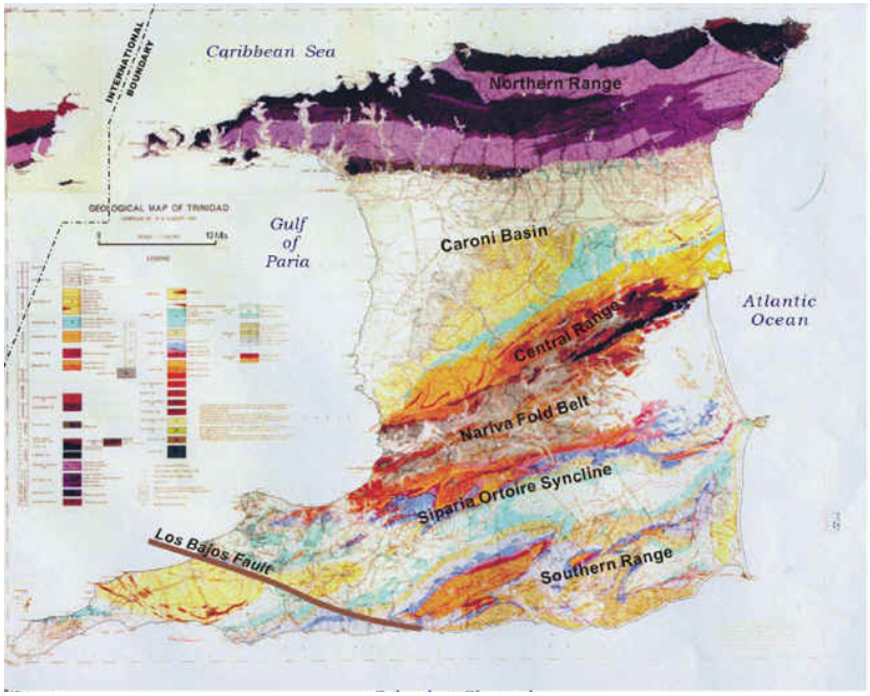


Figure 10. Surface geological map of Trinidad showing Los Bajos Fault (Website 3)

Figure 11. Author is examining freshly dug 'pitch' and collected samples for palynological study. (Photo: Ramkumarie Ramcharan, October 1975)

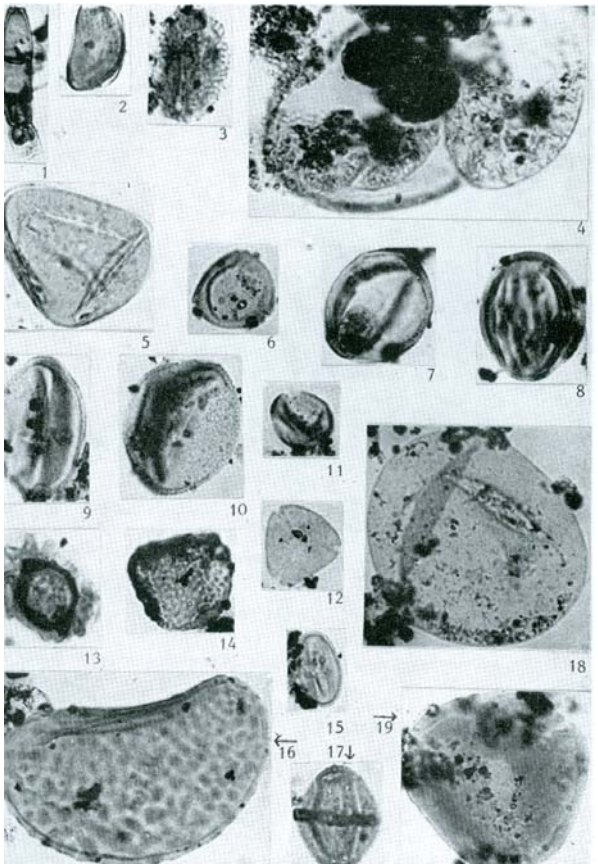


Figure 12.Palynomorphs recovered from the Pitch Lake, Trinidad (Kumar, 1981).

Mud Volcanoes

Several mud volcanoes are known in southern Trinidad and they are both active and fossilized *i.e.* not active for some time. They are of various forms and dimensions (Figures 13 – 17) and are also known from offshore southern Trinidad. The website of the Geological Society of Trinidad and Tobago (Website 4) is a good source of information on this subject.

Mud volcanoes are eruption of mud or liquefied clay mostly associated with methane gas that forms solid mud or clay deposit around its vent which may have a conical shape like volcanoes. The source of mud in such volcanoes is traced to a sub-surface layer of soft claystone or shale. Mud eruption takes place along fractures or fault planes and they provide information about lithology of subsurface sediments. The force responsible for a mud volcano eruption is usually the weight of the overburden rock borne by the fluid content of under-compacted claystones or shales. These are associated with quietly or explosively escaping methane gas, an essential feature of the phenomenon. The mud of the volcanoes is a mixture of clay and salty boiling water forming slurry by the mixing of escaping methane gas. Methane gas usually is derived either directly from organic matter in muds or shales or from secondary accumulations in sand bodies within the source-rock shale or from larger reservoirs just above or just below such shales.

Commonly the activity of a mud volcano is simply a mild surface upwelling of muddy and usually saline water accompanied by gas bubbles. However, many instances are known of highly explosive eruptions where large masses of rock have been violently blown out hundreds of feet into the air and scattered widely over the countryside. These intermittent violent eruptions strongly suggest that motive force is not merely weight of gradually increasing overburden but is due to periodic buildup and release of internal pressure from the generation of methane gas within the shale body or diaper (Websites 1 and 4).

Figure 13.A field of mud volcanoes in southern Trinidad. (Website 4)

Figure 14. Mud eruption in southern Trinidad. (Website 4).

Figure 15. Mud eruption in southern Trinidad showing concentric rings of oozing mud (Website 4).

Figure 16. A fossilized mud volcano in southern Trinidad (Website 4)

Figure 17. An active mud volcano in southern Trinidad (Website 4)

Suggested Readings:

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Website 2: http://en.wikipedia.org/wiki/Pitch_Lake
Website 3: http://www.gstt.org/map/kugler_1959_geological_map.htm
Website 4: http://www.gstt.org
Website 4: http://www.gstt.org/geology/pitch%20lake.htm

About the Author

Dr. Arun Kumar is Adjunct Research Professor, Department of Earth Science, Carleton University, Ottawa, Canada. He received his first Ph.D. (Stratigraphic Palynology) from Michigan State University, USA and another Ph.D. (Environmental Micropalaeontology) from Carleton University, Canada. He held post-doctoral positions at Sheffield University, England and Nagasaki University, Japan. Prof. Kumar has wide experience of teaching geology at Kumaun University, India; University of West Indies, Jamaica; Carleton University and Concordia University, Canada and King Fahd University of Petroleum and Minerals, Saudi Arabia. He also worked as a geologist and palynologist with Oil and Natural Gas Corporation, India and Core Laboratories International (USA) in Singapore and Indonesia. He has published extensively on Mesozoic and Cenozoic pollen, spores and dinoflagellate cysts, environmental applications of thecamoebians, benthic foraminifera as paleoclimate and paleoceanographic proxies, and on current environmental issues. His new research interest is in natural hazards. He has recently co-edited a special issue of the journal Natural Hazards on paleotsunami.