10. The LMT Outreach Program

The Large Millimeter Telescope is located on the extinct volcano Tlilteptl, also known as Sierra Negra, in the state of Puebla, Mexico. The site is inside the Parque Nacional Pico de Orizaba at 18°59′06″ North latitude, 97°18′53″ West longitude and an altitude of 4580 m above sea level. Tlilepetl is about 100 km west of Veracruz and the Gulf of Mexico, and 300 km from the Pacific Coast. Easy access is available via 100 km of motorway from the city of Puebla, followed by a 20 km access road to the summit. The journey from Puebla city takes about two hours.

Figure 10.1 Aerial view of Tlilteptl (Sierra Negra), the site of the LMT. In the background is the volcano Pico de Orizaba or Citlaltepetl. Both are within the National Park Pico de Orizaba.

10.1 The National Park

The site of the LMT is located only 7.3 km from the volcano Citlaltepetl, also known as Pico de Orizaba, the highest peak in Mexico. The area was declared a National Park in 1937 to preserve the climatic and biological equilibrium in the region. The goal was to protect the forests, the endemic vegetation, the aquifer mantles, and the ecosystems.

El Parque Nacional Pico de Orizaba is one of the most interesting in Mexico, covering an area of 19,750 ha within the states of Puebla and Veracruz. Citlaltepetl, Tlilteptl, and other mountains in the region contribute to a beautiful landscape. From the Citlatepetl summit there are views of three large basins: Papaloapan, Jamapa, and Oriental. Several major rivers arise there, flowing down towards nearby towns from the volcano.

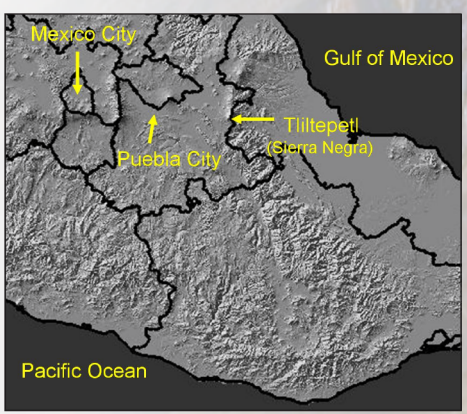

Figure 10.2 Tlilteptl, the site of the LMT, is about 100 km from Puebla City and about 100 km from the Gulf of Mexico. INEGE map[3].

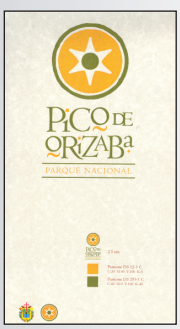

Figure 10.4 Logo of the National Park Pico de Orizaba.

High-elevation forests (altitude > 3200 m) are primarily important for protecting the ground against erosion and preserving the natural biodiversity of the plants, animals, fungi, and microbes that exist in these systems. In the National Park these forests are dominated by the pines *Pinus hartwegii* and/or *Pinus rudis*. These species are of considerable conservation interest because they are naturally rare, are restricted to high elevation in the central volcanic range of Mexico, and can grow at an altitude of up to 4000 m. Some of the largest trees on the upper slopes are over 300

years old, suggesting that the forest has never been cleared. It thus may fall into the important conservation category of "primary forest"—those areas which may have been partially logged, but were never clearcut by loggers or cleared for agriculture or pasture. However, partial logging certainly has occurred, and fires and infrequent seed production by the remaining mature trees may affect the ability of the forest to be self-maintaining.

Figure 10.3 Citlalltepetl or Pico de Orizaba, at 5700 m above sea level the highest peak in Mexico. The LMT site can be seen to the right in the background on the neighboring peak, Tliltepetl.

Sacred fir (*Abies religiosa*) forest is present between 3200 and 3600 m. Lower-elevation forests, at 2000 to 3000 m, are dominated by *Pinus pseudostrobus*, with *Abies religiosa* and *A. hickeli* in more protected, fertile areas, but other less common tree species are present as well[1].

The telescope's location within a national park requires the LMT project to fulfill the regulations of the Ecological Equilibrium General Law and the Environment Protection and other Laws. The project team carried out all the Environmental Impact Studies required for the approval of the construction of the road, the telescope itself, and the rest of the support infrastructure, including the power supply. A small portion of land was ceded by the National Park to INAOE for the construction of the telescope, on condition that the Institute undertake environmental restoration of the forest on the southeast slope of the mountain, the area through which the access road to the site has been built. Specifically, INAOE agreed to reforest 100 ha of land on Tliltepetl using native tree species. The reforestation efforts required interaction and cooperation with the people of the village of Texmalaquilla, who use the relatively flat lands at the base of the slope for agriculture, the lower slopes for grazing, and the somewhat higher slopes for cutting wood for fuel and for some timber. The LMT project completed the reforestation of this 100 ha in the required time by creating temporary jobs for people of the local communities.

Figure 10.5 Reforestation campaign in the National Park, coordinated by the LMT project.

In Mexico there are several Protected Areas subject to special Management Programs for Conservation (MPC) that define the range of allowed activities; for example, forestry exploitation, ecotourism, environmental education, and research activities. The MPC establish the specific regulations and geographic subdivisions where these activities are permitted, to guarantee the environmental conservation of the area. El Parque Nacional Pico de Orizaba is not yet under any special protection program.

Consequently, the LMT project has been working very closely with the environmental authorities and has been the driving force in a joint effort pursuing the development of a Management Program for Conservation. This program must include reforestation, the restoration and conservation of native species, and the establishment of criteria for the operation and management within the Park. For example, one of the goals is to establish sustainable forest management on communal land (*ejidos*). To guarantee the success of such an ambitious program, it is fundamental to involve the local communities, governmental agencies, and non-governmental organizations in the states of Puebla and Veracruz. As the coordinator of this effort, the LMT project has shown that is not only interested in astronomical research, but also is actively willing to contribute to the conservation and restoration of the environment.

Figure 10.6 Aerial view of the access road to the summit.

The LMT project's leading role in the elaboration of the MPC guarantees that the current low level of radio frequency interference (RFI) will be preserved in the long term. In particular, we are endeavoring to protect the LMT operating frequencies from 70 to 350 GHz through the International Telecommunication Union based in Geneva and the Comisión Federal de Telecomunicaciones in Mexico, following the guidelines of the International Astronomical Union[2].

Figure 10.7 Excellent observing conditions: image taken from the LMT site, showing clouds forming below the summit, leaving the sky clear for observations.

An important consequence of the successful completion of the LMT is the promotion of exchanges of U.S. and Mexican professionals and students, as well as the engendering of closer links between educational institutions in the two countries. As an example, scientists from the Departments of Natural Resources Conservation and Anthropology at UMass Amherst are collaborating with colleagues from Mexican institutions, primarily the Especialidad Forestal of the Colegios de Postgraduados and the Instituto de Ecología, to assist the LMT project in meeting its environmental goals by working within the framework of an Integrated Conservation and Development Project. By ensuring that sound ecological and anthropological research is conducted and documented, it will be possible to generalize their findings and thus to allow the LMT to serve as a model for incorporating into future advanced technology projects the social, economic, and environmental concerns of the local area[1].

Whereas many conservation programs are initiated because of concern for a particular problem—perhaps an endangered animal species or unique natural area—in our case, interest in the rehabilitation of a major national park was a direct outcome of plans to build and operate the LMT. Apart from its scientific and collaborative value, the active participation of the LMT in the development of the MPC signals an awareness that large-scale scientific projects, everywhere in the world, must be conscious of the environmental and social consequences of macroprojects. As an added benefit, such an awareness would not only broaden avenues connecting different social science and environmental disciplines, but also open needed contacts between those who work in the hard sciences and their colleagues in the social sciences and humanities.

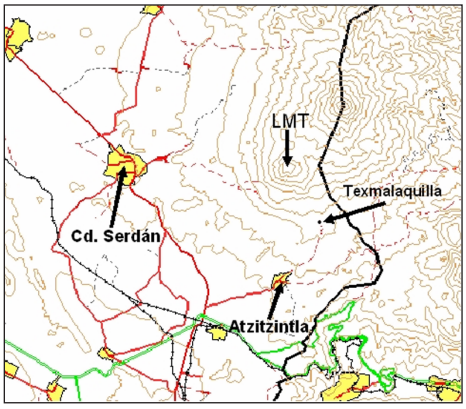

Figure 10.8 INEGI map of the region near the LMT site. North is upwards. Texmalaquilla is at 5.3 km from the summit, Atzitzintla at 9 km and Ciudad Serdán at about 14 km.

El Parque Nacional Pico de Orizaba is, at present, a largely undeveloped resource for environmental conservation and recreation. This national park, so close to the nation's capital and other major urban centers, represents an exceptional site of great potential value to the Mexican public. The LMT commitment to actively participate in the elaboration and execution of a Management Program for Conservation offers an important opportunity to interact with, and serve the needs of, a broad spectrum of people.

10.2 The LMT and the Local Communities

The closest village to the telescope site is Texmalaquilla, a small community of about 1300 inhabitants, at 3100 m above sea level and 5.3 km from the summit. The main activities are rainfall farming of potatoes, peas, lima beans, cattle, and sheep. There are three schools: a kindergarten, a rural elementary school, and a distant junior high school. Services are very basic.

The people of the community depend upon using the surrounding forests for their subsistence, so a primary focus of a management plan is to improve their forest management methods and to explore the potential of using ecotourism to diversify the village economy. There is a good opportunity to create plantations to produce several cash crops. Christmas trees may be the most likely commercial tree crop that can bring a profit in a relatively short period, say 7 to 10 years.

In 2002 INAOE sponsored a four-week summer course on the solar system and the use of telescopes at the elementary school, given by Dr. Clarice Lolithc of the NASA Jet Propulsion Laboratory, an expert on special

education. The program was very successful and was repeated the following year in close collaboration within the school's director and teachers. The course was given to a group of 60 children; similar activities are planned for the near future. A literacy campaign is planned for the summer 2006 as part of the yearly campaigns organized by the University of Puebla.

Figure 10.9 Children from the Texmalaquilla elementary school attending Dr. Clarice Lolitch's course on the solar system.

Atzitzintla is slightly larger than Texmalaquilla, with a population of about 3000. It is at an altitude of 2680 m and is about 9 km from the summit. The LMT project has established an office in Atzitzintla and has contracted with members of the local community to buy building materials, rent machines, and transport materials and water. Since some of the LMT employees and contractors live there, the community has seen extra income from house rentals and from new jobs. Restaurants and a few stores have been opened since the project started. In addition, the LMT has supported the community by loaning a land-leveling machine, which has been used to clean or flatten access paths. The project has also helped to establish a link between the federal, the state, and the local authorities.

Figure 10.10 (a) Visitors to the LMT exhibition at the Ciudad Serdán City Fair in August 2004. Boys examining a model of the LMT.

Ciudad Serdán has the most services of any town close to the LMT site, including three small hotels at the center, five or six restaurants, a post office, three banks, two hospitals, churches, and a market place. It is located about 14 km from the summit at an altitude of 2540 m, is the Regional Center with the regional Court House, and has a population of about 34,000 inhabitants. It has a number of kindergartens, elementary schools, and junior high and high schools. Ciudad Serdán is frequently visited by Citlaltepetl mountain climbers.

The municipal authorities of Ciudad Serdán are very interested in the LMT project and have been working very closely with it. The LMT office has organized several public talks for local government people and

students, with the specific purpose of explaining the goals and importance of the LMT. During the last City Fair at the end of August 2004, an LMT exhibition was very successful and attracted the attention of a few thousand visitors. The response was overwhelming. This exhibition has been a model for additional outreach efforts by the project.

Figure 10.10 (b) Ciudad Serdán Fair. Visitors watching a slide show on the construction of the telescope.

The exhibition in Ciudad Serdán included many photographic images of the construction site, a huge LMT scale model, posters, and videos and scientific films. There was also a section dedicated to children, who made their own models of a radio telescope and the NASA space shuttle Atlantis with scissors, paper and glue; and a table where the children and their parents could see interesting physics experiments and big magnetic puzzles of planets. Generally speaking, the visitors to the exhibition told INAOE researchers that they had heard something about the construction of the LMT. This project, some of them wrote in a notebook, is a source of pride for Ciudad Serdán and the surrounding region, which will result in educational as well as cultural benefits for their communities. The LMT project plans to participate regularly in the annual city fair.

10.3 The LMT and the General Public

The LMT project has been very active in its outreach to the general public through the project webpage, articles and interviews in newspapers and magazines, and brochures and public talks both in Mexico and the U.S. Several members of the collaboration have been interviewed by different media, including local and national television channels and international news agencies. In the long term, a project News Office is planned.

Figure 10.10 (c) Ciudad Serdán Fair. Girls making their own NASA shuttle.

The project is planning to have a Visitor Center in one of the towns near the summit, similar to the information centers that are so successful at large telescope facilities such as Arecibo and Green Bank. The main goal is to educate people about astronomy and the LMT, including the project's importance in Mexico, the U.S., and worldwide, the challenges involved in its design and construction, and the expected scientific results. We anticipate that there will be exhibitions and special activities. Once the telescope is in operation,

Figure 10.10 (d) Ciudad Serdán Fair. Putting together a puzzle of the planets.

there will be explanations of the astronomical discoveries that will take place. School trips to the Visitor Center will be organized, both to create programs for teachers and to develop educational programs that will benefit the wider community.

In these activities the LMT will benefit from the long experience that INAOE and UMass Amherst have gained over the years in outreach activities at their observatories and campuses. The LMT Observatory is also very interested in establishing collaborations with other universities, to help ensure the success of such activities.

10.4 References

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2. McNally, D., ed. (1994), "Report and Recommendations of IAU Commission 50 (Identification and Protection of Existing and Potential Observatory Sites)," in *The Vanishing Universe: Adverse Environmental Impacts on Astronomy*, Cambridge University Press.

3. INEGI: Instituto Nacional de Estadística, Geografía e Informática. (www.inegi.gob.mx).

Figure 10.11 Children from an elementary school learning about the Sun at INAOE.

Figure 10.12 An elementary school class visiting the Sunwheel at UMass Amherst to learn about the apparent motion of the Sun during the year and the progress of the seasons.