



From Forests to Deserts

A journey in the caves of Mexico



LA VENTA

From Forests to Deserts: A journey in the caves of Mexico

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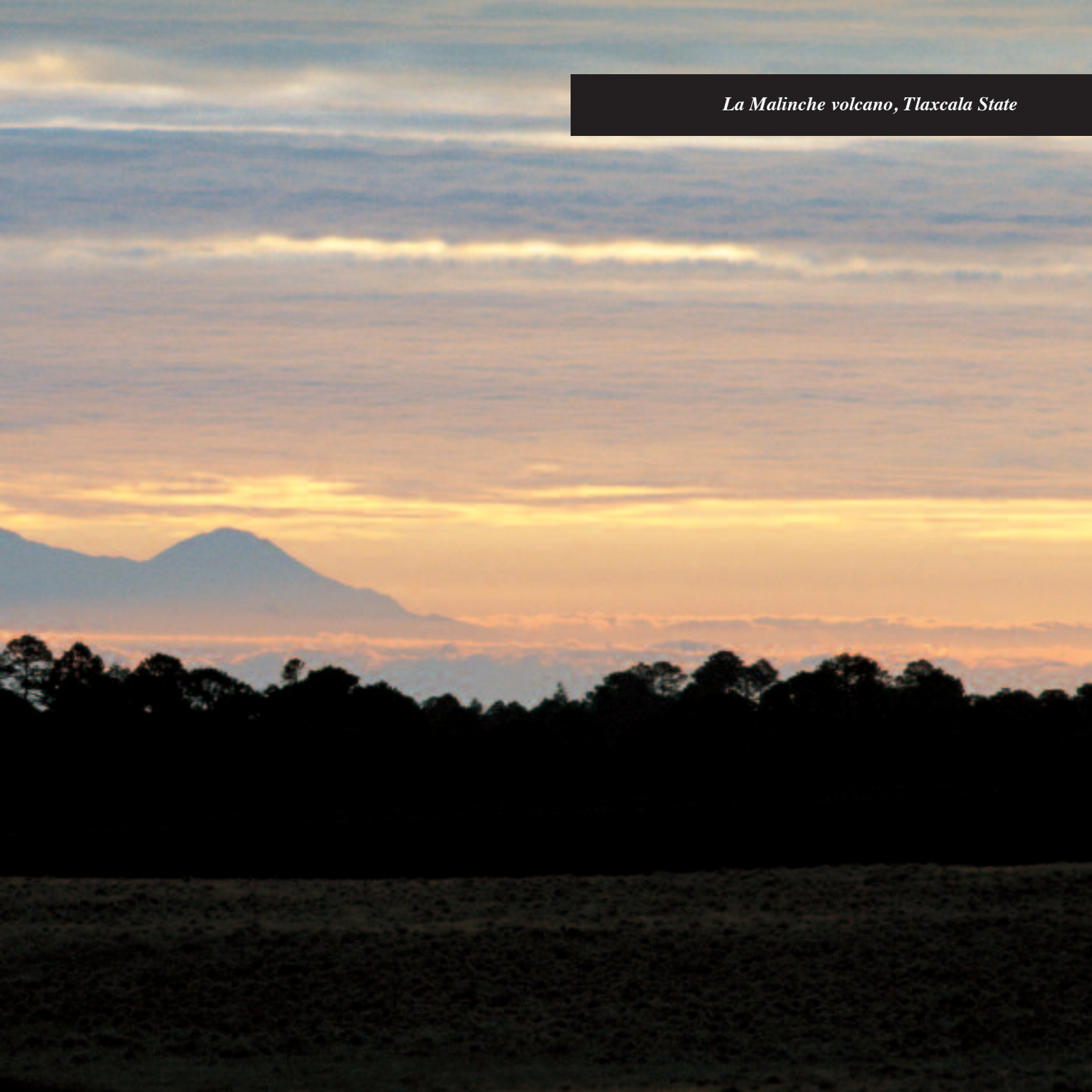
A journey in the caves of Mexico



LA VENTA
ESPLORAZIONI GEOGRAFICHE



La Malinche volcano, Tlaxcala State



Pisoliths, Sumidero I of Pecho Blanco, Chiapas



Foreword

I am again very honoured to be able to introduce a book written by my friends of the La Venta Group. This time it is about exploring karsts and caves in Mexico, a quest which they have been involved in since way back in 1981, on the various 'fronts' of the Rio La Venta, Cuatro Ciénegas and Rio Juquila karst areas.

Those who thinks they are holding a book for speleologists only will quickly have to change their mind. This work, splendidly illustrated, describes human, scientific, cultural and sporting adventures where there is no shortage of magic encounters, discoveries and conquests, narrow escapes, world firsts and prizes... If the La Venta group has made the exploration of the 'hidden side' of our planet their speciality, one shouldn't forget that they have always been dedicated to geographical research and sending into the field Italian and international experts of the highest level, coming from the most varied branches of speleology, archaeology, hydrogeology, anthropology, natural science, paleoclimatology and communications.

Page after page, this book transforms itself into an irresistible call to travel, for adventure, to explore these incredible places. As though by magic, we are suddenly wearing mountain boots, harness, helmet and ropes together with our La Venta friends, ready to leave for the discovery of worlds never seen before!

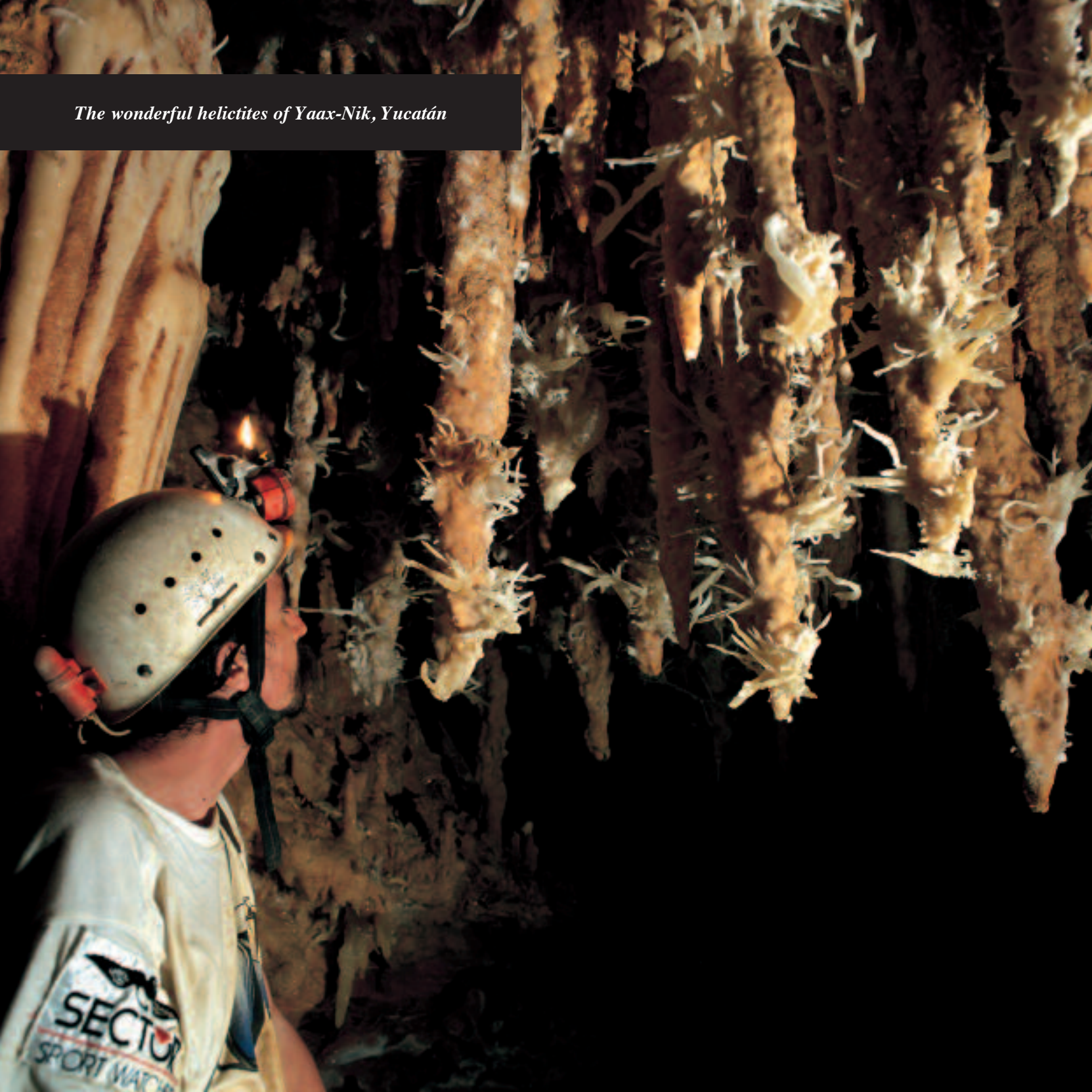
What you will discover in these pages has already attracted the well deserved attention of the international community and of UNESCO in particular. In 2006 Selva El Ocote in the state of Chiapas and the area of Cuatro Ciénegas, in the state of Coahuila, were added to the 'Biosphere Reserves' network of the UNESCO 'Man and the Biosphere' (MAB) program and are now candidates for being listed as UNESCO World Heritage Sites.

These are very important recognitions, which I like to think that our friends from La Venta have contributed a lot to, thanks to their unquestionable competence and their unparalleled enthusiasm.

Philippe Pypaert

*Responsible for the environmental programs
at UNESCO in Venice*

The wonderful helictites of Yaax-Nik, Yucatán



One of Mexico's most extraordinary natural resources is its caves and karst areas. For their wide geographical and geological variety, their exceptional beauty, the variety of life forms contained within, and for the uses which humans have put them to throughout history, Mexico's caves are one of the most important natural heritages in the world.

We shouldn't forget the great symbolic value which the Earth's interior held for the several Mesoamerican civilizations that lived in Mexico. Maize, according to the Aztecs and Mayas, had its mythical origins in the underworld and there are supernatural heroes who protect the maize beneath the soil. Only thanks to the benevolence of the most powerful gods does this cereal, which sustains human life in America, emerge from the ground together with other plants, through sacred mountains split open by the blows of divine swords.

As a universal symbol, the Earth's humid and fragile interior is the primary source of every life form. It is therefore, in the widest sense - which goes from historical and cultural richness to natural resources and biodiversity - a common universal heritage to which little attention has been paid up until now; a richness which adds to Mexico's many other riches. There are now thousands of known natural cavities in Mexico and many others wait to be found. The process of exploration and systematic study of this fascinating underground world only started fifty or so years ago. It was carried out by Mexican speleologists as well as others from other countries. In fact, the contribution made by friends coming from other latitudes, as we can see here, has been a fundamental and important boost for the progress of Mexican speleology.

The participation of the Associazione Culturale Esplorazioni Geografiche La Venta has been remarkable. The influence of its explorations has been felt both in the south and in the north of Mexico. The finds in Chiapas have been very important, especially in the Rio La Venta canyon from which the group took its name, but also in the Yucatán Peninsula's cenotes, in the Cuatro Ciénegas region (Coahuila) and more recently in the Juquila Canyon (Oaxaca) as well as in the marvellous Naica caves in Chihuahua. With this book La Venta presents us with some of the results of its explorations in these Mexican regions. The presence of Italian speleologists in Mexico dates back to the end of the sixties, with the excellent studies carried out by the biospeleologist Valerio Sbordoni of the University of Rome, who identified several new cave fauna species in different parts of the country. Following this, various Italian speleological groups began explorations in Chiapas, triggering an evolutionary process which gave birth to the association La Venta at the beginning of the nineties. Furthermore, the group not only explores in Mexico, probably their favourite place, but also in different regions of the world such as Venezuela, Patagonia, Antarctica, Central Asia, the Philippines, Myanmar (formerly Burma), and Mongolia, just to mention the most important. Given their strong relationship with Mexico, La Venta counts among its members some of the leading Mexican speleologists, who have made important contributions to the group's goals and especially towards extending their knowledge about Mexican caves.

It is a great pleasure to present this From Forests to Deserts: A journey in the caves of Mexico, which gives us an account of La Venta's most important successes in Mexico. It's an important contribution by this group, both in terms of content and presentation, and adds to previous publications such as Rio La Venta: Treasure of Chiapas, Under the desert: The mysterious waters of Cuatro Ciénegas, and Crystal Giants: In the caves of Naica.

Beyond the intrinsic value of this work, its content obligates us to think about and to work towards the active conservation of Mexico's deep bowels to an ever greater degree. Thanks to La Venta we can recognize this treasure of unimaginable landscapes, know about the various and unique forms of life and discover essential clues for understanding the geological origins of our land. In a word, this book does a great service to our country, as it allows us to appreciate these unique and little known places.

Alfonso Aguirre Muñóz
Ensenada, Baja California, Mexico



A crystal-clear pool in the desert of Cuatro Ciénegas (Coahuila); in the background the Sierra La Madera, a mighty limestone range



Altos de Chiapas



Table of contents

CAVES AND KARST PHENOMENA OF MEXICO

Carlos Sahagún Lazcano Page 15

LA VENTA'S EXPLORATIONS IN MEXICO

Tullio Bernabei Page 35

THE KARST AREA OF RIO LA VENTA

Tullio Bernabei, Antonio De Vivo, Marco Mecchia, Gianni Todini Page 57

THE KARST AREA OF CUATRO CIÉNEGAS

Antonio De Vivo, Leonardo Piccini, Giuseppe Savino Page 93

THE KARST AREA OF RIO JUQUILA

Tullio Bernabei, Leonardo Piccini, Francesco Sauro Page 125



Caves and karst phenomena of Mexico

Covering an area of almost two million square kilometres, Mexico is one of the world's richest countries as far as natural diversity is concerned. Its surface is characterised by a very varied geography, which manifests itself with sandy or rocky coasts, mountains, deserts, plains, forests, woods and other notable geographical and biological phenomena. In particular, Mexico draws attention to itself for the breadth and variety of its karst areas, which are among the most important and extended in the world.

Mexico contains five physiographic provinces, all of which have karst forms to a greater or lesser degree. In some cases, such as Chiapas or the Yucatán Peninsula, these karst forms affect practically 100% of their area.

General outline

Karst areas in Mexico cover about one quarter of the entire country and this works out to be nearly half a million square kilometres.

The provinces mainly involved are, apart from the previously mentioned Yucatán Peninsula and the mountains of Chiapas, the relevant parts of Sierra Madre Oriental, of the Sierra Madre del Sur, and the *sierra* and plains of the north. Other provinces also contain karst phenomena, albeit to a much lesser degree.

Referring to the political subdivisions, the federal states which are mainly affected by karst phenomena are Yucatán, Quintana Roo, Campeche, Chiapas, Oaxaca, Tabasco, San

Luis Potosí, Puebla, Guerrero, Tamaulipas, Veracruz, Morelos, Querétaro, Nuevo León, Jalisco, and Colima.

Among the factors which have permitted the development of extended karst areas, the most important are the presence of vast outcrops of Cretaceous limestone, the intensive tectonic phenomena which have fractured and raised the limestone, and a humid climate which has remained so for a long time.

A factor which has given richness and diversity to the karst phenomena is the fact that Mexico finds itself in a climatic

Diving in the galleries of Gran Cenote, Yucatán





transition zone, between arid conditions in the north and humid tropical and subtropical in the south, with temperate and cold climates at higher elevations.

All these geographical, geological and climatic factors have created some of the most spectacular karst in the world. The most impressive phenomena are the caves, but also other forms like karren fields, karst towers, dolines, and resurgences that show a remarkable degree of extension and variety.

Each physiographic province has its own character, which is the result of a particular evolution within the context of Mexico's geographical and geological history and caves are the structures where these differences are best observed. Their morphological variety is large and manifests itself in underground rivers with large flow rates, extended horizontal caverns, very deep abysses and completely flooded underground systems extending for dozens, if not hundreds, of kilometres. Kilometres of underground passages richly filled with an unusual variety of forms; large chambers and pits (even several million cubic metres), waterfalls, lakes, rock formations and crystals of extraordinary beauty.

To this aesthetic beauty is added a biological richness which manifests itself in a great variety of endemic cave-dwelling fauna which are not found anywhere else in the world. This biological diversity is a faithful reflection of the geographic variety, both above and below ground.

Equally rich and varied are the cultural uses that the caves have been put to by the inhabitants of these karst areas, both in modern and in ancient times. The archaeological discoveries have been spectacular, from ancient cultures who built their villages in caves to ritualistic and ceremonial uses of the cavities. Traces of the past within the caves are considerable and their use continues up to the present day, with groups of people who still inhabit them or use them for ceremonies and festivities.

Yucatán

The Yucatán peninsula is situated in the southwest of the country and is surrounded by the Gulf of Mexico and the Caribbean Sea. It is the most karstified region of Mexico due to the fact that its surface is made up entirely of limestones mainly from the Tertiary and Quaternary Eras.

Its surface is mainly level and the drainage is underground. In fact, the limestone behaves like a sponge full of water. On the surface are the *cenotes*, which are the entrances of mainly submerged caves. Those known to date number over 1000, and even though their exploration dates back to the ancient Maya their systematic surveying began less than 30 years ago.

The discoveries have been spectacular, as shown by the latest explorations in the Sac Actun and Ox Bel Ha systems, which have reached 158 km and 170 km respectively. These systems are completely submerged and are the longest known underwater caves in the world, as well as being among the longest overall in Mexico. Explorations are still going on and so it is expected that the number of discovered kilometres will increase.

Other important submerged caves are the Nohoch Nah Chic system with 67 km, the Dos Ojos system with 62 km, and the Naranjal system with 24 kilometres of development, just to mention the largest.

Since the Yucatán peninsula is a lowland area, the variations in sea level which succeeded one another during the Quaternary Era has played a significant role. In many submerged caves one can see a great quantity of spectacular speleothems, which formed when the phreatic level was much lower than today and the underground conduits were dry.

The types of *cenote* vary from area to area. In the northwest part of Yucatán State, the *cenotes* give access to vertical cavities. Flooded abysses over 100 m deep have been explored, such as the Sabak Ha 147 m deep, the Xkolac

Geological notes

Mexico is a country which is characterised by the large variety and complexity of its geological environments which is the result of the meeting of five coastal 'plates', each about 100 km thick and moving independently of each other.

The Baja California is a long, thin peninsula protruding from the north-western extremity of the country. It is made up of granitic rocks, formed at depth by the slow solidification of magma (plutonic rocks) and of metamorphic formations such as schist and gneiss, born from the transformation of pre-existing rocks through elevated temperatures and pressures. These rocks were formed at the time when reptiles dominated dry land, the Mesozoic Era (about 250-65 million years ago). The southern part of the peninsula contains volcanoes and a broad costal plain composed of more recent sediments.

The semi-desert region of the mountains and plains of the states of Sonora and Sinaloa extends to the other shore of the Gulf of California, an oceanic trench which is actively separating the two continental blocks.

To the northeast (States of Chihuahua and Coahuila) is another region with large desert plains and mountain ranges which are organised in structures and folds, largely composed of Cretaceous limestones (140-65 million years ago). This was the geological period most favourable for the deposition of calcareous sediments in the sea which, transformed into rock, would host most of Mexico's caves millions of years later. It is here that the area of Naica and the plain of Cuatro Ciénegas, surrounded by limestone mountains, are located.

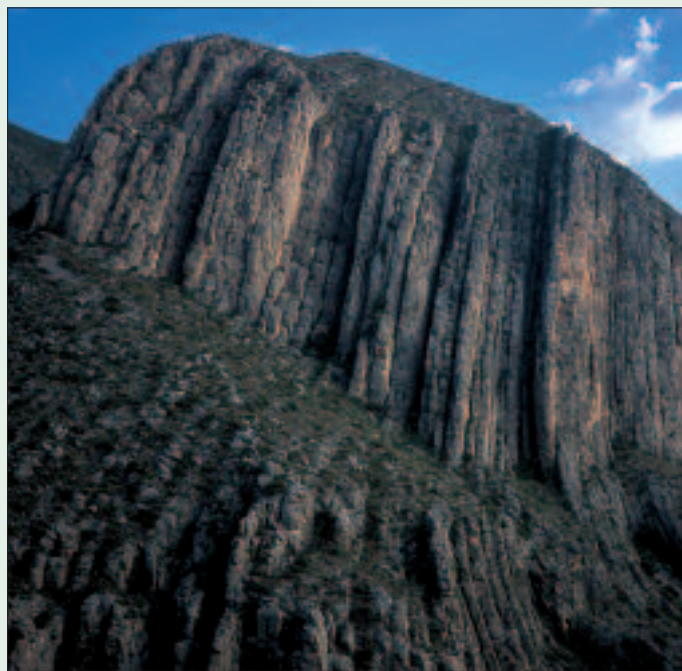
Separating the two regions is the Sierra Madre Occidental, mainly constituted of volcanic deposits and furrowed by many canyons.

Parallel to this and separated by a vast plateau is the Sierra Madre Oriental, an almost continuous series of folded ranges moulded from Mesozoic marine sedimentary rocks. In the valleys are detrital deposits from the Cenozoic, the 'era of mammals', which began after the catastrophic events that caused one of the biggest mass extinctions of Earth's history, the disappearance of the dinosaurs and about 60-70% of all existing animal and vegetable species, about 65 million years ago. From the great curve of Saltillo-Monterrey to the north, the range's overlapping front extends as far as central Mexico's volcanic belt.

This 'belt' is one of Mexico's most characteristic regions with several hundred eruptive centres emerging during the Quaternary, the latest terrestrial era, which by convention begins with the appearance of Mankind two million years ago. This volcanic region divides the country, stretching from the Pacific to the Gulf of Mexico along the 20th parallel, with alternating reliefs and plateaus from which isolated volcanic peaks emerge. Some of these volcanoes are still active including the Colima, the most dangerous Mexican volcano. Also Mexico City is located in a large basin which is surrounded by eruptive centres, with Popocatepetl dominating. Slightly further south stands Mexico's highest peak, the Pico de Orizaba (5747 m).

Descending towards the Tropics is the Sierra Madre del Sur, which rises from the Pacific Ocean next to an ocean trench over 6000 m deep. The Sierra is made up of sever-

Vertical limestone strata in the sierras of Cuatro Ciénegas, Coahuila



The great cone of Popocatépetl volcano (5452 m), Puebla State



al blocks of terrestrial crust surrounded by large faults. The Pacific coastal range consists of metamorphic and plutonic rocks mainly dating from the Palaeozoic, the era of 'ancient life', which began 540 million years ago with the expansion of animal life.

In the many ridges which extend eastward into the state of Oaxaca, the Cretaceous limestone deposits cover large parts of the original base. One of these ranges, the Mixteca-Zapoteca, has been explored by the Association La Venta. In a nearby sierra, the deepest caves on the American continent are to be found.

Further to the east the Gulf of Mexico is reached, surrounded by a flat strip made by Cenozoic marine sediments. The plain extends from the United States border to the Yucatán and is famous, amongst geologists, for the extremely rich petroleum deposits in its subsoil.

In Chiapas, the Sierra Madre consists of Palaeozoic granites and runs parallel to the Pacific coast. Further to the east are plateaus and folded ranges made of Cretaceous limestone, crossed by rivers such as Rio La Venta which contain lots of water due to the humid tropical climate and blocked by the largest dams in Mexico.

In the southeast extremity of the country is the Yucatán peninsula, a stable platform made up of Cenozoic limestones, where the karst plains with the famous *cenotes* are the dominant morphological features.

Marco Mecchia



Left: Sotano de la Lucha, Chiapas

Right: descent into the Hoya de la Luz, San Luis Potosí

cenote which is 121 m, and the Ucil cenote 118 metres.

A very peculiar influence, regarding the shape of the *cenotes*, comes from the famous Chubchulub meteorite, which collided with the peninsula at the end of the Cretaceous Era, forming an impact crater several hundred kilometres in diameter. This impact influenced the shapes of the *cenotes* and it should be remembered also that this meteorite is famous for being one of the probable causes for the extinction of the dinosaurs.

Another underground aspect for which the Yucatán stands out is the beauty of its speleothems. Especially Yaax Nik, a cave considered among the most beautiful in Mexico and America.

Sierras of Chiapas

Another region which is nearly 100% karstified is Chiapas. This province includes the *sierras* in the northwest and the northeast, as well as the plateau in the south of the state. Here the limestones date from the Cretaceous Era and have been greatly modified by tectonics. Also, this is one of the wettest regions in Mexico, with over 5000 mm of rain per year. The morphological variations are notable, because the karst has been formed in both temperate and tropical climates, in pine woods as in difficult to access tropical forests.

Among the horizontal caves, the Soconusco system with 22 km development, the Cueva del Río La Venta with 13 km, the famous Gruta de Rancho Nuevo with over 10 km, the Cueva Arroyo Grande with 10 km, and the Cueva del Chorro Grande with almost 10 km should be mentioned.

Among the deepest systems are the Gruta de Rancho Nuevo, which reaches 520 m depth, the Soconusco system -513 m, the Sima Dos Puentes -450 m, the Cueva del Río La Venta -430 m, the Sima La Pedrada -348 m, El Chorreadero -334 m, and the Cueva de la Perdida de



Gabriel Esquinca -326 metres.

The Sótano de la Lucha, one of the most voluminous shafts in Mexico, has a vertical pit 280 m deep and contains an underground river. The Sótano del Arroyo Grande has a 283 m free drop and the Sima de Don Juan contains a 278 m pit.

Sierra Madre del Sur

The Sierra Madre del Sur is one of the most varied physiographic provinces, with rock formations of various origins. In its eastern part, ranges of Cretaceous limestone rise up to over 3000 metres creating great altitude differences that have allowed the development of very deep canyons. For this reason the speleological potential is enormous as the lowest areas contain large karst springs fed by the high ridges.

The Sierra Madre del Sur contains some of the longest and deepest caves in Mexico and America, such as the Cheve system, 1484 m deep, the Huautla system -1475 m, the





Cenote Sabak Ha, Yucatán

The hydrothermal karst phenomenon

A hydrothermal cave is understood as being a natural cavity whose development has been caused, at least in part, by the circulation of hot water. This water, as opposed to that seeped in from the surface, rises from the depths of the earth, bringing not only the 'heat' which is present down there, but also gasses (essentially, but not limited to, CO_2 and H_2S) and the salts which it has dissolved in the course of its long underground journey. For this reason thermal caves have special characteristics, both from the peculiar types of corrosion and the abundance and diversity of the speleothems contained within.

In the last 25-30 million years, Mexico has been characterised by intensive volcanic activity, effusive and intrusive, resulting in a land particularly rich in ascending hot waters. It therefore also contains some of the most interesting thermal karst phenomena in the world.

Among these the Cueva de Villaluz (Tabasco) should be mentioned. This is a sulphurous cave which, because of its particular ecosystem, also contains large numbers of superior animals and has become a world-famous attraction, especially for the annual blind fish fishing ceremony.

If on one hand there are many natural cavities which have experienced a more or less extended thermal period, on the other hand, caves which have developed almost exclusively due to thermal waters are very rare.

These caves are characterised by a large basal chamber where the thermal waters were collected and from where a series of ascending branching conduits made up from small coalescing spherical chambers then depart. The secret behind their very particular development lies in the fact that the thermal water had no natural exit point and so they then developed exclusively due to the convective movements of the rising thermal water. The opening which now allows access to these cavities is

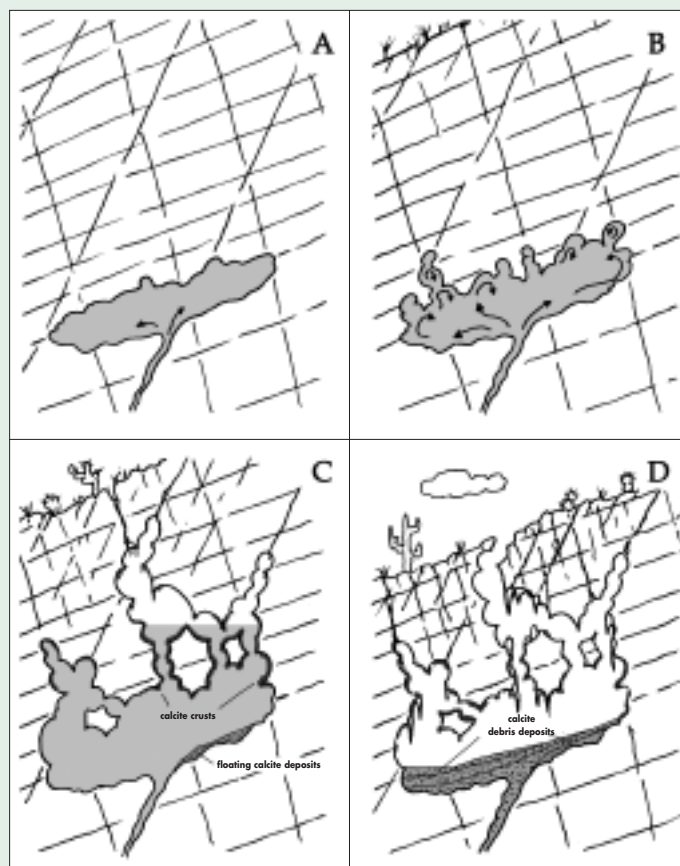
Evolution sketch of a typical hydrothermal cave in the Cuatro Ciénegas area.

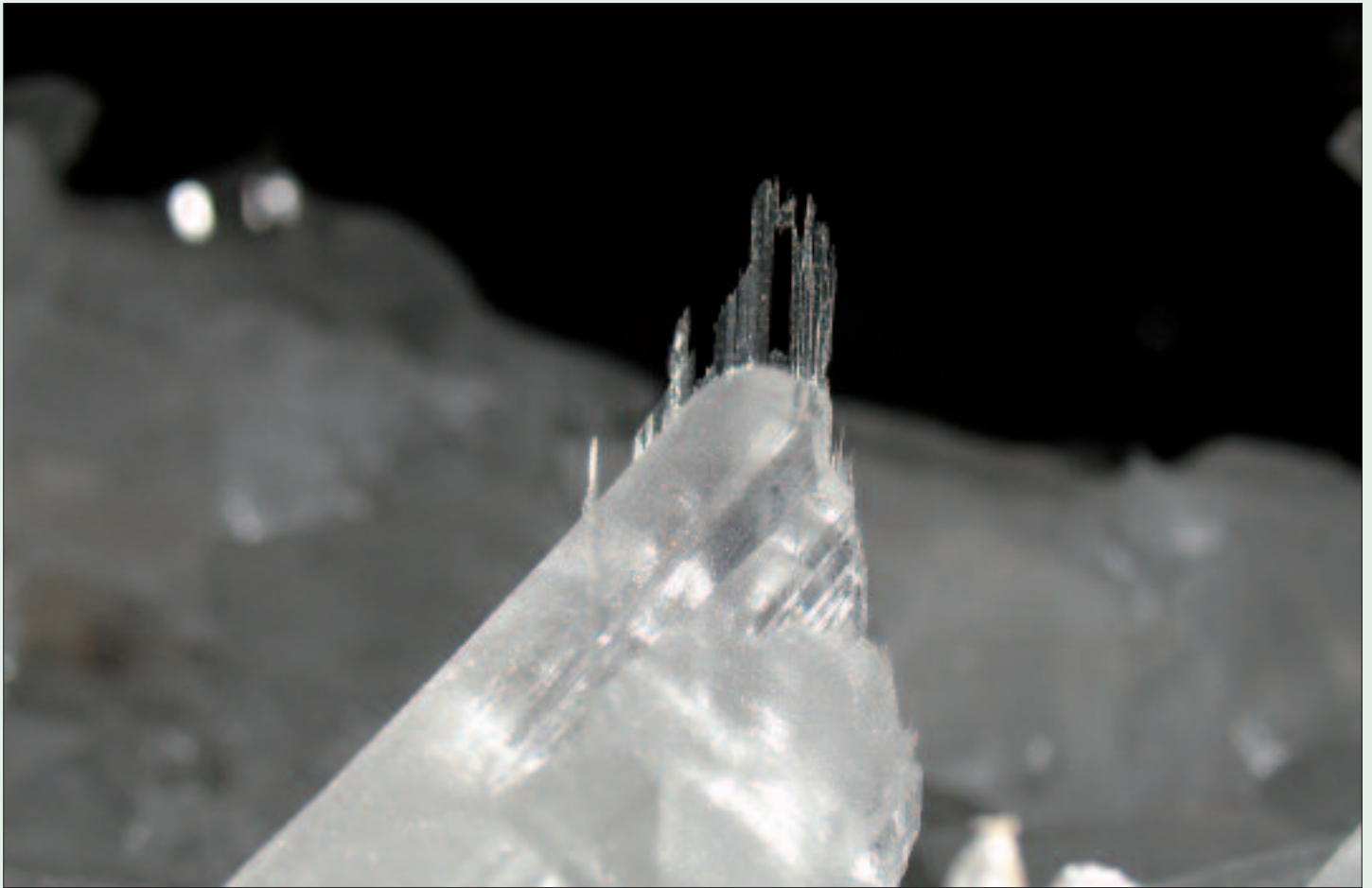
(A) The rising of thermal waters induces the development of large chambers in which the water accumulates.

(B) Convective motion develops the upward formation of a ramified series of coalescent sub-spherical voids.

(C) When the cave becomes partially drained due to the lowering of the local hydrologic base level, the loss of CO_2 to the atmosphere allows the development of wall crusts and sedimentation of calcite rafts on the cave floor from overlying free water surfaces.

(D) At the same time the seepage of meteoric water begins the normal calcite deposition in the unsaturated zone. Finally, erosion connects the cave to the land surface.





The “sails”, particular formations on the gypsum crystals of the Naica mine

completely accidental and is always successive to the development of the cave.

The Cueva di Rancho Guadalupe in the Cuatro Ciénegas desert is one of the very few examples of monogenic thermal caves in the world but its importance isn't limited to that as it is the secondary minerals it contains that make it unique. The studies carried out within the framework of the research conducted by the Association La Venta has shown that a truly remarkable number of different cave minerals (15) have developed inside, some of which are very rare in cave environments. But the most interesting thing is that it also contains some small crystals which have turned out to be a compound new to science (a hydrated magnesium carbonate) and whose study is still ongoing.

Finally, it should be remembered that Mexico also has the most unusual and unique thermal phenomena in the world, those which caused the growth of cavities within the Naica mine (Chihuahua) containing the largest gypsum crystals ever discovered on our planet. The cavities were only discovered a few years ago and their study has begun only very recently, thanks to La Venta.

Paolo Forti

*Active pits in the deep part of the Cheve Cave System,
Sierra Madre del Sur, Oaxaca*

Cueva Charco -1278 m, and the Akemati and Kijahe Xontjoa systems at -1226 and -1223 m respectively. Some of these caves also show considerable development, like the Huautla system with 56 kilometres, the Kijahe Xontjoa system with 31 km, and the Cheve system with 26 km. There is also the Cuetzalan system, almost 38 km long, the Tepepa system with 26 km, and Coyatl with 20 km. This is just mentioning the main systems that have been explored in the course of 40 years of speleological research.

Sierra Madre Oriental

The Sierra Madre Oriental, in the central-eastern part of Mexico, is one of the most interesting geographic provinces. Its mountains are composed mainly of Mesozoic marine sedimentary rocks, amongst which Cretaceous reef limestone predominates. The layers of these rocks are very deformed large folds, which form successively alternating crests and basins. The Sierra has peaks which exceed 3000 m a.s.l.

This province contains caves which are predominantly vertical in development and are very deep, such as the Purificación system - 953 m, the Sótano del Berro - 838 m, the Sótano de Trinidad - 834 m, the Resumidero del Borbollón - 826 m, the Sótano de Alfredo - 673 m, the Sótano de Tilaco - 649 m, and the Cueva del Diamante at - 621 metres.

Some caves also have a notable horizontal development, as is found in the state of Tamaulipas in the northern part of San Luis de Potosí, where the Purificación system has a horizontal development of 94 km, the Cueva Tecolote 40 km, the Sotano de las Calenturas 8 km, and the Sotano dell'Arroyo 7.6 km.

This region is also famous for the presence of large vertical chasms. Two of these were the deepest on the plan-



et for years; the Sotano el Barro with its 410 metre free drop and the Sotano de las Golondrinas which has a 376 m vertical tract. These two are still in the list of the deepest pits in the world. Other large vertical abysses in this province are the Sótano di Zacaton, with a 329 metre wet pit, the Sotano de la Culebra with 360 m, the Sotano de Ahuacatlan with 320 m, and the Sotano del Aire with 287 metres.

Left: the giant pit of Cueva de Las Golondrinas (Sierra Mazateca, Oaxaca), 376 m deep

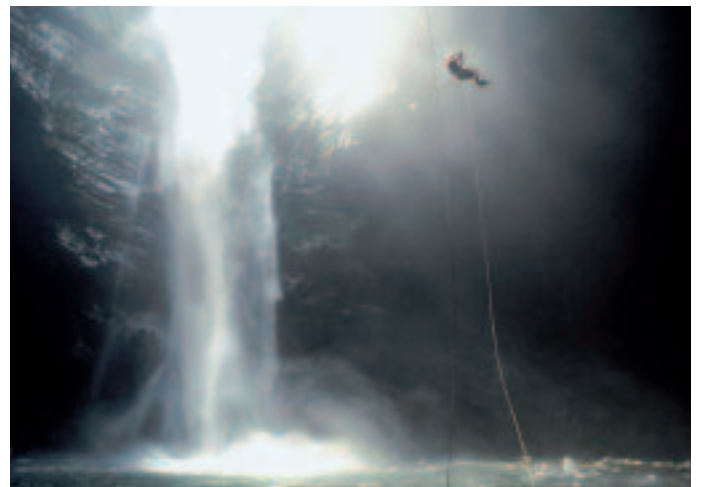
Right: Sumidero de Popoca, Veracruz



Sierras and plains of the North

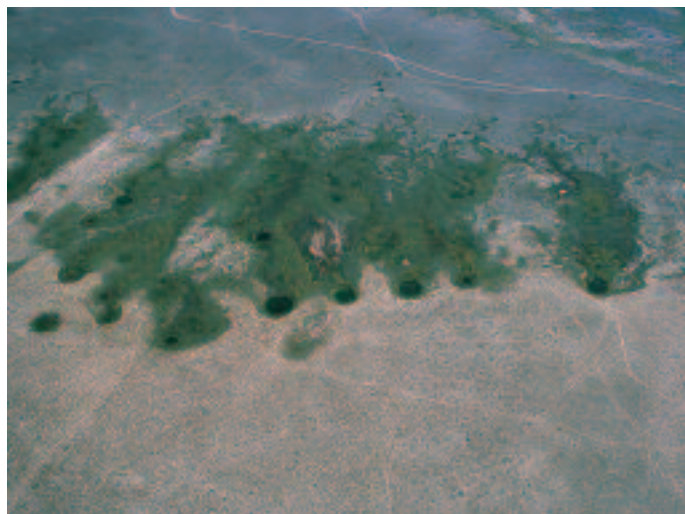
The physiographic province containing the sierras and plains of the North corresponds mainly with the northern states of Coahuila and Chihuahua. It has a dry and arid climate and also contains limestone reliefs with some cave development, although it is not nearly as extensive as in the previously mentioned provinces. These massifs, some with a considerable difference in altitude, experienced the development of karst phenomena at the beginning of the Quaternary Age when the climate was much more humid than today. Therefore, in many cases, the karst of this area is fossil or semi-fossil.

One of the regions that distinguishes itself through its system of springs is Cuatro Ciénegas, where one finds a large quantity of pools containing slightly thermal water. In Coahuila, the Cueva del Abra, almost 2 km long, is the longest known so far. This state also contains the cavity known as El Volcan, one of the deepest in the province at -



Left: a line of springs at the foot of Sierra San Marcos y Pinos, Cuatro Ciénegas, Coahuila

Bottom right: a stretch of white gypsum sand on the plain of Cuato Ciénegas, Coahuila



372 metres.

Chihuahua has the Cueva Tres Marías, with a development of 2600 metres, the longest known in this state. The deepest is the Sotano del Sauz at -220 metres. Without doubt, in this region the pride of place goes to the by now famous Cueva de los Cristales which even though it is small, not more than 100 metres in length, has a chamber full of selenite crystals whose sizes reach 11.4 metres with a diameter of almost 1 metre.

Minor areas and non-karst caves

The presence of karst in Mexico isn't limited to limestone outcrops. This phenomenon can also be found in some Jurassic gypsum outcrops in the Sierra Madre Oriental, albeit at a very small scale.

Caves have also developed in volcanic rock, mainly Tertiary and Quaternary basalts, where lava tube caves and other underground forms peculiar to these rocks can be

Right: equipping a rope descent to reach an entrance on the wall, Cuatro Ciénegas, Coahuila

found. The volcanic caves are found mainly in the Eje Neovolcanico physiographic province where outcrops of effusive igneous rocks, especially basalts and andesites, predominate. In some of these caves, several kilometres of galleries have been explored, especially in the surroundings of Mexico City and in the state of Morelos.

In some regions, such as the Baja California peninsula, caves caused by marine erosion have been explored, some of which extend for hundreds of metres.

With this short text we are only offering a brief panorama of Mexico's great karst and speleological richness. The studies and explorations are far from finished and every year kilometres of new underground conduits are discovered, as well as dozens of new caves. The final word, as far as dimensions are concerned, has yet to be written.

Carlos Sahagún Lazcano







A view of Sierra La Purísima which borders the east side of the Cuatro Ciénegas plain



Tropical karsts

In order to develop, karst phenomena essentially need three ingredients; easily soluble rock (usually of a calcareous type), water, and CO_2 .

These three ingredients co-exist in many places on Earth but it is especially in the inter-tropical zone where they result in particularly well developed karst phenomena. Let's see why.

In the wide area between the Tropic of Cancer and the Tropic of Capricorn are some of the most extended seas which are not directly connected to the oceans. They are basins characterised by limited depths and climatic conditions suitable for the formation of coral reefs. Think of the Caribbean Sea or the Indonesian Sea for example. This situation has existed for hundreds of millions of years and for this reason the limestone rocks, which originated from the coral reefs, are especially abundant. Currently, the largest outcrops of shelf limestone rocks are found in southeast Asia, between China, Indonesia, and the Indonesian Archipelago, as well as in Mexico and in the entire Caribbean area.

The inter-tropical zone contains both extremely arid areas, like the Sahara Desert, and very humid areas like Indonesia and the southern coasts of India. This difference is due to the distance from the sea and to atmospheric circulation. Abundant precipitations can be found in southeast Asia, with a strong seasonal regime influenced by the monsoons, and in the area of the Caribbean. The areas well endowed with limestone rocks are therefore also those with abundant precipitation.

Carbon dioxide (CO_2) is a gas present in the atmosphere and whose cycle, before humans altered it with massive inputs resulting from hydrocarbon combustion, is mainly tied to the biological activities of plants. The greater the biological activity, the more (as a rule) CO_2 is present in the environment, especially at ground level and in the first soil layer.

In humid tropical zones the vegetation grows luxuriantly. Even though the largest forests are located along the equator (the Amazon and the Congo Basin), large forests are also found in tropical zones, more or less in the previously mentioned areas.

In tropical zones, especially along the northern one where it bisects North America and Asia, all the conditions are met for the development of large karst systems, which is indeed what occurs.

Compared to temperate areas, where karstification is in



Cenote X-mait, Yucatán



The spectacular cone karst of Selva El Ocote, Chiapas

any case very well developed, tropical areas generally have more marked forms, especially regarding size.

The karst processes have even more effect mainly because of the low degree of seasonality. The lack of a cold season means that plants have a nearly continuous growth cycle, with a strong biomass production that, when it decomposes, releases CO₂ into the atmosphere. This, for example, allows the formation of well-developed forms of surface corrosion with dolines and karren fields often reaching unusual dimensions.

As far as underground cavities are concerned, the high degree of infiltration and the presence of closed basins, channels enormous amounts of water underground which give rise to true underground rivers that transport large quantities of sediment. In these conditions, alongside the chemical dissolution processes, mechanical erosion processes become very important, leading to the formation of large spaces. Such large underground spaces are by their very nature unstable, with ceiling collapses sometimes causing an opening on the surfaces, forming wide and deep abysses such as the *cenotes*, which are also characteristic of tropical karsts.

Leonardo Piccini



La Venta's explorations in Mexico

The reasons for a passion

La Venta is above all a group of friends with a common passion; the underground world, the caves. Some are highly experienced speleologists, others have peered over the edges of abysses more casually, fascinated by everything which revolves around explorations in far lands. Others again aren't speleologists but share the passion for exploration, documentation, discovery of unfamiliar territories and the possibility of finding new research topics. All this is because, while persistently studying caves in the most remote places, we have encountered many other topics which needed further investigation, in particular archaeology but also biology, physics, palaeontology, mineralogy, hydrology etc.

Our point of view has slowly changed, the purely speleological exploration has become geographical, understood as the multidisciplinary study of places which are little, if at all, known, described and documented. The caves have almost become a pretext, however desirable, for understanding an area and often protecting it, or at least helping to do so.

However, an initial distinction is necessary to understand in which way the results of the La Venta group must be seen. With a few exceptions we do not do pure science, we produce scientific documentation. An activity which is the first step, the indispensable trail which opens the way for research proper, the systematic kind, which is the domain

of universities and institutes which are not based, like our association is, on volunteer work.

Mexico for us has been and still is a privileged nation, loved, rich in yet to be completed possibilities and dreams. Our explorations in this great country have had caves, forests, canyons, cenotes and even volcanoes as their backdrop. A large body of research which began in the 1980's and is still going on today. Why?

There are many reasons but among these is certainly a

A team of cave divers just before plunging into the sump



Fossil hall of Rancho Nuevo, Chiapas



great attraction to this marvellous territory, its people, and its extraordinary nature. But there are also personal reasons, which have pushed some of us to leave Italy ever more often in order to spend part of our lives under the Mexican skies.

The initial seeds of the La Venta group are at least as old as the speleological activity of its founding members, that is, a quarter of a century or more. Each began going into caves as a youngster, took the customary cave course and then carried out an ever more intensive activity.

The beginning

In 1981, while still young men, some of us came to Mexico following the speleological and zoological research expeditions organized by the Circolo Speleologico Romano and the University of Rome, and

sponsored by the Accademia dei Lincei. The explorations took place in Chiapas, especially in the area to the southwest of Lake Malpaso (Selva del Mercadito) and on the Altos, including the famous Gruta de Rancho Nuevo near San Cristobal de las Casas.

During the excursions on Lake Malpaso, the final part of the Rio la Venta Canyon could be seen. At the time it was something mysterious, almost impossible to completely explore due to its length. Eighty kilometres! The canyon was eighty kilometres long and there were no reports of it ever being descended. A place that was certainly unexplored and full of caves, but also too big a challenge for the capabilities we had at that time.

Almost 10 years later, in January 1990, six of us arrived in Mexico. With us were three inflatable dinghies bought from Russian speleologists, some aerial photographs, some home made hammocks and an incredibly scanty food supply. To us, as we had to carry it on our backs, it seemed enough. We tackled the canyon and, after 12 days, lots of excitement and many lost kilos, we finished the complete descent. During that intense experience, some of us realized that the exploration of those places was only beginning and deserved a fair part of our lives.

We gathered together and decided to give ourselves a structure which would allow us to continuously carry out expeditions like the one just completed, while also finding support and financing. A group which wasn't only tied to a city but was widened to include a country, Italy and in the future others as well, something which could become a self-financing international team. So in 1990, the Associazione Culturale Esplorazioni Geografiche La Venta was born, with legal seat in Padova and five founding members: Tullio Bernabei, Antonio De Vivo, Marco Topani, Italo Giulivo and Gaetano Boldrini. Immediately afterwards, Giovanni Badino and Ugo Vacca joined as

well. We were now seven Italian speleologists from five different cities.

The name, however, wasn't only tied to the fantastic Rio which gave us the decisive stimulus. Also in Mexico, we visited the Olmecan archaeological site of La Venta, famous for its colossal granite heads bearing Negroid features. The mystery of the origins of those gigantic *cabezas* fascinated us and in some way closed the circle. Exploration is basically a journey made balanced between myth, dreams and reality; a route through time and across nature, accompanied by a slow change of perspective. Also, even though we did not yet know it, the Olmecs were the fathers of that little known Zoque culture, which was to be the source of a great deal of satisfaction in Chiapas in the coming years.

The Rio La Venta Project

After a few expeditions to Venezuela and the Soviet Union in 1993, we returned to Mexico with a great boost: our Rio la Venta Project had won the *Rolex Awards for Enterprise* prize, given every three years to the best exploration project, and chosen among thousands worldwide. It was the first Italian win and we arrived in Chiapas to start that research which still continues today, 15 years later.

While preparing the Rio la Venta research project, we took the opportunity of exploring the majestic Canyon del Sumidero. To reach El Arbol de Navidad, a cave-resurgence on a cliff face, we carried out a 750 metre rope descent: the longest descent ever undertaken to reach a cave entrance. Two expeditions were necessary, the first having been interrupted by an accident which luckily did not have serious consequences. Finally, the cave that is the summit of the large cliff waterfall was reached. However the exploration stopped after about thirty metres at a siphon lake. The gallery was flooded and it was impossible to go on.

The waterfall of Arbol de Navidad in the Sumidero canyon, Chiapas, originating from a spring hanging 250 m above the river level





*Starting the dizzy descent from the hanging spring of
Arbol de Navidad*

Still in 1993, we moved to the Yucatán peninsula with some cave diver colleagues, both Mexican and Italian, starting an intensive exploration campaign in the famous *cenotes*, crystalline lakes and wells in the middle of the forest which give access to labyrinthine submerged cave systems. We also made a documentary entitled *The submerged wonders of Yucatán*. Today the *cenotes* are visited and explored by divers from all over the world, but in 1993 we were among the pioneers of the first professional explorations.

The following year was almost completely dedicated to the Rio la Venta project, for which we organised two expeditions, in spring and in autumn. Even our most optimistic hopes were surpassed by reality. We found unknown buildings in the forest, cavities full of ancient artefacts, underground rivers and hundreds of caves, all waiting to be explored. The long canyon and the limestone massifs which surrounded it turned out to be a speleologist's paradise and an archaeologist's dream, even if we still weren't officially involved in archaeology.

At the end of the year we won another important prize, this time in Mexico, the Yucatán documentary won the *Lente de Plata*.

In 1991 we also started recording the expeditions with carefully made film and video. This capacity to document the research and discoveries, along with that of honouring our commitments, will always be one of the winning points of the La Venta group.

The Rio la Venta Project proceeded enthusiastically and between 1994 and 1998 carried out an average of two expeditions per year. In 1995 there were some important speleological discoveries, in the first place was the Cueva del Rio la Venta, which was to become the '*grotta regina*' of the project. With the collaboration of several Italian universities and research institutes, we also began multi-disciplinary studies ranging from geomorphology to

hydrology and even paleoclimatology. Also another film prize was won through Mexico. It was the *Genziana d'Argento* at the 1995 Trento Festival, for the documentary shot the previous year in Chiapas entitled *A canyon between two oceans*.

In this period, the Association contributed both morally and materially to the establishment of the first Chiapas speleological group, the Vaxakmen, and also to the second, the Jaguar Group. Also, courses on speleology, techniques, topography and karst hydrology were given at the Chiapas Science and Arts University (UNICACH).

The April 1996 expedition was another memorable one. We achieved the connection between the two known parts of the Cueva del Rio la Venta, which became a thrilling 13 km journey between the jungle and the bottom of the canyon. We also found many ancient artefacts and decided to fully incorporate archaeology into the heart of the group.

In 1997 we undertook a great organisational effort for almost three consecutive months. Between canyons and the Selva El Ocote, we needed to manage about fifty researchers and two troupes, who had to film a documentary co-produced by the main United States, French and Italian broadcasters. Technically, we found ourselves engaged in lowering down and then recovering archaeologists and materials from rock faces of all kinds, some of which were very high. The fact that almost all of us were experienced cave and mountain rescue team members was decisive.

In the end everything finished well. The archaeological discoveries, along with the speleological and hydrological ones, guaranteed years of research and the possibility of writing a book on the whole project. Also the documentary was very successful and won in various international festivals, including Trento for a second time.

The spring 1997 super expedition was important as it was

Light-dumb waters

The submerged wonders of Yucatán is the title of the documentary made in 1993, the main reason for our journey to the Mexican peninsula. It may be a slightly trite title, but it is unlikely that other words could better describe those underground labyrinths travelled by endless rivers. I re-read the journal from those days, full of *cenote* names filled with magic and history; Sac Actun (“White Cave”), Bolom Chohol, Templo Dum, Chak-Zinik-Che, Noc Ac and Dzibilchaltun (“Place where there is Writing on Flat Rocks”).

It was September 1993. Seven of us arrived in Cancun (Tullio, Matteo, Marco, Alessandro, Gigi, Bea and I) with over seven hundred kilos of diving and film equipment. I don’t know how we managed to get it through without paying any weight surcharge. Really different times...

In two weeks we had to document that underwater world between Yucatán and Quintana Roo, supported by Mexican cave divers who had worked for years in close collaboration with U.S. explorers, principally Jim Coke. Over fifteen years had passed, but already fantastic tales were being told about the boundless underground network which probably connected many of the known cenotes. The explorations of the last few years have shown that the plateau’s subsoil actually does contain hundreds, maybe thousands, of submerged galleries, a puzzle which cave divers from half the planet are putting together, a piece at a time.

Ours wasn’t an explorative expedition; we only wanted to document that extraordinary natural phenomenon. There wasn’t even the time, the means, or the manpower to really explore. But as often happens when caving, the cenotes contained some wonderful surprises for us, whether archaeological, paleontological, or ‘merely’ speleological.

Our first base of operations was at Akumal, on the coast, and we couldn’t have had a better baptism. It was the clear waters of Sac Actun, the Gran Cenote, which allowed us to experience the first wonderful journey. It was a vast decorated gallery, through which one swims suspended between stalagmites and stalactites, witnesses to the cavity’s remote above-water past. The most fascinating aspect is being able to move, suspended through a thousand speleothems; a dream come true, before returning towards the light, a piece of sky where fish fly instead of birds. Sac Actun, apart from welcoming us, also gave us a firm and useful lesson which I will never forget. The surroundings do nothing to prepare you. The waters are warm, clear and welcoming. You lose yourself looking around, completely absorbed, and aren’t able to realise in time what’s happening. There were four of us in the water, to film the passing of a bottleneck between two large chambers. The idea was simple, all pass through and then two go back, filmed by the cameraman and lit by the fourth, me. Then the reverse angle was to be shot, the same scene shot from the other side. I well remember the moment when I passed perhaps a little too close to Gatto the cameraman. A flipper blow in the face, my swerve, my flipper striking the vault, dense milk which suddenly descended replacing the clear water. Never had I been more thankful for the guide line. I managed to grab it (I hadn’t been holding on to it as everything was so clear and calm...) only because I was very close to the bottleneck and the line couldn’t have been anywhere else. I exited, followed by the others, thanking Sac-Actun for the courtesy and the lesson. Whilst Gran Cenote is fascinating because of its size and

Helictite speleothems in Yaax-Nik, Yucatán



the extraordinary dance of its speleothems, Templo Dum with a pit entrance in the middle of the forest, has other hidden qualities. It surprised us with the morphology of its gallery, a breathtakingly beautiful inclined slide.

In the following days we dived in Car Wash, a pool of water used by the locals for washing their cars, from which we reached galleries marked by a danger sign. We then moved on to Merida in Quintana Roo. The first *cenote* we visited was Bolom Chohol, a narrow access pit which we had to rig with ropes. Beneath the pit, a lake lit up by the magical filtered light, a submerged gallery from whose sides' ancient Mayan artefacts peeked out, pieces of polychrome vases which still clearly lie beneath sediments thousands of years old. At Dzilam de Bravo we tried to enter the sea resurgences, the plateau waters' boiling points of arrival. The Cerbero cenote, a large entrance opened up only a few months previously by the sudden sinking of the ground, gave us clouds of evening mosquitoes and the rib of an ancient manatee buried in the silt of a gigantic unexplored gallery. There were other days of fantastic dives, of unusual passages through the mixing points of salt and fresh water, of journeys on the old train which goes to Chak-Zinik-Che and the last *desfibradoras*, where henequen fibres were manufactured from agave plants.

Then it was Dzibilchaltun's turn, famous both for its Mayan archaeological site containing the 'Temple of the Seven Dolls' and its cenote, used as a natural swimming pool throughout the year. Large and deep galleries lay hidden beneath the water's surface, which were first explored by a National Geographic expedition in the 1960's. Even Dzibilchaltun had a surprise for us. Gigi Casati continued well beyond the limits of previous exploration, stopping in black galleries for lack of adequate equipment and time.

The nicest gift, however, came from a dry cave, the by now legendary Yasnik, or Yaax-Nik. There we found one kilometre of chambers and galleries, containing extraordinary aragonite and calcite speleothems. A kind of gigantic geode accidentally discovered while digging an artesian well. Local speleologists belonging to the Aktunob group accompanied us, asking us not to reveal the caves location, with the aim of preserving it. Unfortunately, we are among the few to have seen it whole. Through the years the cave has been completely plundered by crystal collectors. Yasnik is our fondest memory, precisely because it no longer exists.

The waters of silent light themselves can become fragile and defenceless carriers of pollution, but manage to defend what's concealed within their stone shells very well. Few can follow the passages, as too much technique is required of potential explorers. Yasnik had preserved itself quite well over geological time only to finally succumb to a drill, but especially to unlimited stupidity. It would have been nice, many years later, to be able to say "Yasnik is still there"...

Metal rig used by the cave divers to descend into a small cenote in the Yucatán Peninsula







*The remains of a Zoque temple called El Tigre
in the El Ocote forest, Chiapas*

the moment that the Association opened itself to new members. From this moment the number of members would continue to rise, albeit slowly, since La Venta doesn't aim to become a mass association. Better only a few people, but qualified and well motivated.

Explorations in the forest

In 1999, the Rio La Venta Archaeological Project systematically began which would result in a large expedition every year and is still ongoing, with our member Davide Domenici as coordinator-in-charge. The archaeological research has revealed a completely new aspect of the El Ocote-Rio la Venta area, depicting a sacred territory teeming with life, where the Zoque culture plays a leading role. A culture which is in no way inferior to the twin Maya and Olmec cultures and which has, in some ways, survived to the present day.

Also in 1999, the book *Rio La Venta - Treasure of Chiapas* was presented in Tuxtla Gutierrez and Mexico City. This volume, in which Italians and Mexicans who participated in the project collaborated, was presented in four versions (Spanish, English, French and Italian) and enjoyed great success. Almost 10 years later, it is still used by local institutions such as the Reserva de la Biósfera El Ocote to present the protected area to international partners for financing.

One year earlier, in 1998, research began which at the time of writing this book was still ongoing: the discovery and exploration of the Ombligo del Mundo.

Since 1994, the study of aerial photos showed, in the heart of the Selva El Ocote, the presence of a large and deep pit, a black hole in the forest's green. It seemed inaccessible because of its distance from known areas, the ground's morphology full of rocky cracks and without drinkable surface water, as well as for orientation problems.

Aerial view of the Sima del Chute Redondo, Selva El Ocote, Chiapas: sotanos like this are common in the karst area of Rio La Venta

Difficult progression on the sharp limestone blades which characterise the tropical karsts of Chiapas



Reaching this abyss became a dream, the incarnation of all the caves on Earth and this is why we called it ‘*Ombligo del Mundo*’ (The World’s Navel).

A few attempts on foot did not succeed. Others by helicopter were partially successful, but unacceptable risks were involved. I’ll never forget the sight of Ugo Vacca, our surgeon, suspended by a rope 80 metres below the helicopter, totally defenceless, with the jungle passing quickly under him as a green blur. Nor the more dramatic time when Tono De Vivo and Gaetano Boldrini, also suspended along with about a hundred kilos of backpacks, disappear into the vegetation because the pilot mistook his height while at the same time the turbine lost power. I have no photographs of that moment, because I was hold-

ing the knife that should have cut the rope in case of emergency, and that was truly an emergency. A few seconds of the rope (or the human cargo hanging on it) getting caught in the trees would have brought down the helicopter, including myself on its runner with the Hamlet-like dilemma of whether to cut, saving the helicopter and its crew, or not to cut, keeping the two suspended comrades alive but risking a complete disaster. I now know that I never could have used that knife. Sometimes fortune smiles on those who truly believe.

We then decided to gamble everything on a new attempt on foot in the spring of 1998, this time taking a different route from north to south, with the help of local guides and porters, at least in the first part.

Fifteen days of forced marching in humid heat and with little water, along a 7 km distance as the crow flies, but many, many more when fighting the Ocote’s sharp rocks, surveying and checking metre by metre with compass and clinometer. The abyss was reached at the last moment, in the last effort of the last day by the advance group of men, almost as though it were a Himalayan ‘8000’. We descended 150 metres, but the presence of a large collapse complicated things, making finding the continuation very difficult. Because of the small amount of time available, the expedition was forced to retreat without having solved the Ombligo’s mystery.

A further attempt was made in April 2007, this time from the southwest, but the abyss repulsed the attack yet again. The explorers gave up only 700 metres away, but this was offset by the fact that they plotted an easier route than the others which would allow us, in the near future, to reach the big pit with the composure and safety necessary for a complete exploration. In fact a year later, in the spring of 2008, the Ombligo was reached again and explored, unfortunately without finding any new continuation.







Network of channels originating from the springs on the edge of the Cuatro Ciénegas plain, Coahuila

From forests to deserts

Again, 1998 was an important year for our Mexican activities because after Chiapas we undertook two important reconnaissance tours. One in the northern desert, in Coahuila, to determine whether or not a group of karst springs in the Cuatro Ciénegas valley had anything to do with the presence of caves, the other in the state of Oaxaca, to fly over an unexplored canyon, the Juquila.

In both cases the results were positive. Caves were present, but nobody had explored them. It was therefore worthwhile organising a speleological and hydro-geological research project.

At Cuatro Ciénegas we undertook a preliminary expedition in 1999 and three large expeditions between 2000 and 2002.

The challenge was very big, as was the mystery of the origin of the water that feeds the desert's crystalline wells. Thanks to the exploration of over 50 caves, both above and below water, as well as various descents into ancient and dangerous mine shafts up to 600 metres deep in order to sample the most remote waters, we were able to give a hydrological analysis of the underground waters' origin and cycle.

We also undertook a topographical survey, positioning each of the over 200 pools via satellite, furnishing the protected area's officials with precious data for future conservation strategy. The involvement of some enthusiastic young locals quickly led to the founding of the state's first speleological group, the Espeleocoahuila.

At the project's end we came out with another large book, *Under the Desert: The Mystery of the Cuatro Ciénegas Waters*. This one was also in several languages and likewise a great success. Finally, we made a documentary for the National Geographic Channel which was aired around the world, increasing the fame of this marvellous place.

Canyons and sierras

The other new area, the Juquila Canyon (Oaxaca State), was the object of a first expedition in April 2002. The goal was the exploration of the central part of the canyon, which turned out to be another wonderful place full of underground structures but also having ancient traces of human presence. Just like the exploration of the Rio la Venta 12 years earlier the food ran out too soon. The last days of the canyon's descent, also marked by a couple of not too serious accidents, involved some effort.

The next year, 2003, we return in November with the goal of searching for caves on the mountains surrounding the canyon, especially in the Tepelmeme area. Several abysses were found, one of which reached 250 m depth, but the great underground system which we were convinced must exist in the heart of those imposing limestone mountains still wasn't found.

We didn't give up however and returned in 2004, looking for caves on the Cerro Verde's higher reaches, and then again in 2006. On this last occasion, when the research seemed about to produce a significant result, we came up against the Tepelmeme community's opposition, resulting in their not renewing our permit to search for and explore caves in their territory. We had to fall back to a neighbouring area, S. Maria Ixcatlàn, where we discovered thirty or so new caves, some of which were very interesting from an archaeological and morphological point of view. At the end we succeeded in presenting our results to the local community on the spot, gaining their respect and trust.

In January 2007 we signed a new agreement with the Tepelmeme authorities, who recognised our capabilities and granted us the permission to research for another three years, until the end of 2009. Backed by this authorisation, in November 2007 we finally set off for the first

*One of the final drops
in the Juquila canyon, Oaxaca*



big speleological expedition in the canyon and on the surrounding reliefs. The areas of Mauizapán and Cerro Verde were systematically explored, while another team carried out the complete descent of the canyon in eight days, exploring the part above Puente Colossal for the first time. The area was very rich in caves but not so generous in great extension. On the other hand, many unknown archaeological sites were brought to light and the canyon itself turned out to be more complex and demanding than expected. The area of the springs was what, in the last days, finally gave good results and is probably the area where future explorations will concentrate on.

Going back for a moment to 2003, when we found a completely new area, we engaged for the first time with some Mexican explorers belonging to the VIBO Foundation and UNAM. What we found were very deep canyons, dozens of kilometres long, which cut through the Sierra Madre in Durango State and are called *quebradas*.

Here an ancient and still unknown people lived in small villages built in caves and caverns suspended at dizzying heights. The remains of dwellings, objects and human bones are to be found. While one team began exploring some sites and collecting the first archaeological data, two other teams carried out the first five day complete descent of two deep gorges, Piaxtla and Piedra Parada, descending waterfalls of up to 170 metres high. They are among the most challenging gorges in the world for their technical difficulty, the harshness of the surroundings, and their isolation.

In 2006, a second expedition sponsored by the La Venta group and carried out by Italian speleologists, explored the canyon known as Arroyo de la Apomar de Santa Rita, also part of the Piaxtla system, taking six days. In this case also the surroundings were extraordinary and very challenging.

*Rope descent along
the Piedra Parada canyon, Durango*



The cave of crystals

Going back even further, to 2002, we need to mention an important moment in the La Venta group's explorations in Mexico. This was the first foray into Naica's Cueva de los Cristales, in the state of Chihuahua, probably the most extraordinary cave on Earth.

The cavity was found by chance inside a silver mine at a depth of 300 metres and partially explored by our member Carlos Lazcano. It contained a series of gypsum crystals of exceptional size, up to 12 m long, but complete exploration was hindered by an internal temperature of almost 50° C which, together with the very high relative humidity, only allows humans to remain inside for no more than a few minutes. The cave continued, but special technological measures were needed in order to explore it completely. We therefore returned in October 2002, this time wearing suits which allowed us to move between the crystals for about 30 minutes.

But this time still wasn't enough to explore in safety and carry out some truly scientific research in order to give answers to the most important questions. When did these giant crystals form and why particularly in this place? Is there life in this extreme, alien environment? How big is the cave? What do people risk in exploring it? Finally, what is the future of this underground wonder?

We only started to find the answers in 2006, when an agreement with the Gruppo Peñoles, owners of the mine, and the Mexican company Speleoresearch & Films allowed us to begin experimenting with refrigerated suits and very sophisticated respirators which led to stays of over an hour. Thanks to 6 expeditions carried out over 18 months, the physical monitoring of the cave, systematic scientific research, medical tests, detailed topographical surveys and deeper explorations we are off to a good start. This chapter is still open and is currently going through its

most important phase.

In the meantime, the Association has grown from its 5 founding members in 1990 to the present membership of 40, five of whom are in Mexico. La Venta has become something bigger and different, to the point of co-operating with UNESCO for the investigation and preservation of planet Earth's underground areas.

But the base remains a group of friends, with many shared interests, and especially a shared outlook on life, the relationship with the environment and relationships between people.

The story of the Mexican explorations began over 20 years ago, but still seems young and full of prospects.

The Cueva de los Cristales in the mine of Naica, Chihuahua



Table of the expeditions

Expedition	Period	Place
First complete descent of Rio La Venta canyon	January 1990	Chiapas
Rio La Venta Project (first pre-expedition)	June 1993	Chiapas
Yucatán '93	September 1993	Yucatán
Árbol de Navidad, Sumidero	October 1993	Chiapas
Rio La Venta Project (second pre-expedition)	October 1993	Chiapas
Rio La Venta Project	March - April 1994	Chiapas
Rio La Venta Project	November 1994	Chiapas
Rio La Venta Project	April - May 1995	Chiapas
Rio La Venta Project	November 1995	Chiapas
Rio La Venta Project	April 1996	Chiapas
Rio La Venta Project	January - March 1997	Chiapas
Rio La Venta Project	November 1997	Chiapas and Oaxaca
Cuatro Ciénegas Project (pre-expedition)	November 1998	Coahuila
Cuatro Ciénegas Project (pre-expedition)	May 1999	Coahuila
Rio La Venta Archaeological Project	April 2000	Chiapas
Cuatro Ciénegas Project (pre-expedition)	November - December 2000	Coahuila
Rio La Venta Archaeological Project	February - April 2001	Chiapas
Cuatro Ciénegas Project	October - November 2001	Coahuila
Rio La Venta Archaeological Project	January - April 2002	Chiapas
Juquila Project	April - May 2002	Oaxaca
First expedition to Naica	May 2002	Chihuahua
Cuatro Ciénegas Project	September - October 2002	Coahuila
Second expedition to Naica	October 2002	Chihuahua
Rio La Venta Archaeological Project	January - April 2003	Chiapas
Quebradas de Durango	November 2003	Durango
Juquila Project	November 2003	Oaxaca
Rio La Venta Archaeological Project	January - April 2004	Chiapas
Juquila Project	January - February 2006	Oaxaca
Naica Project	January 2006	Chihuahua
Naica Project	April 2006	Chihuahua
Naica Project	June 2006	Chihuahua
Naica Project	November 2006	Chihuahua
Naica Project	February 2007	Chihuahua
Naica Project	April 2007	Chihuahua
Naica Project	May 2007	Chihuahua
Rio La Venta Project (Selva El Ocote)	May 2007	Chiapas
Naica Project	July 2007	Chihuahua
Naica Project	September 2007	Chihuahua
Juquila Project	November 2007	Oaxaca
Naica Project	January 2008	Chihuahua
Rio La Venta Project (Selva El Ocote)	April 2008	Chiapas
Naica Project	January 2009	Chihuahua

Mexico's snakes

Mexico is the country with the largest number of reptile species in the world. There are an estimated 717 different species, compared to 686 in Australia, 600 in Indonesia, and 467 in Brazil. Of these, 322 are snakes.

Harmless snakes, mainly consisting of colubrids (250 species), make up 81% of the total. The rest are poisonous species; viperids (44), coral snakes (15) and sea snakes (1). Not all of their poisons are a threat to man. In Mexico there are two snake families having lethal bites, the elapids and the viperids, the latter being more specialised in their production and use of poison. The two most fearsome representatives of the viperids are the Nauyaca (*Bothrops asper*), the main threat in the humid tropical forests of the southern states such as Yucatán and Chiapas, and the rattlesnake, typical of the northern desert states like Coahuila and Chihuahua, locally called *cascabel*.

A nauyaca in the forests of Chiapas



Nauyacas can be over two metres long and among its natural enemies, apart from man, is its kin the colubrid *Clelia clelia*.

Nauyacas feed on small mammals, lizards, and birds, killing its prey by biting and injecting its very powerful venom through the large hollow fangs present in its mouth. It's a very aggressive reptile, active also by night, hiding itself among rocks or vegetation, keeping perfectly still as it lies in wait. It has a courageous and irascible temperament and won't retreat when threatened, even if the threat is a much bigger animal. This is what makes it dangerous even for man. Its poison, very powerful and devastating because of the innumerable toxins it contains, is one of the main causes of death among the farmers who live inside Mexican woodlands. In the case of the *cascabel*, the poison (one of the most complex biochemical substances known to man) contains very many active substances which quickly compromise blood coagulation and the nervous system, with lethal effect even for humans. This snake prefers dry and stony desert areas where it is well camouflaged thanks to its colouring, in tone with the surrounding environment. The danger of a possible encounter lies in the fact that, because of the high temperature differences between day and night characteristic of deserts, and the snake being cold blooded, it is often not fully active. Fortunately the *cascabel*, when threatened, has the habit of frantically shaking its tail, which is made up of several horny rings (the theory that each ring corresponds to a years lifespan isn't reliable). This behaviour, more defensive than offensive, alerts the unwary and spares them a painful surprise. The loud noise, similar to the call of a cicada, can even be heard from dozens of metres away. In the northern states, the inhab-



A cascabel in defence attitude

itants attribute the *cascabel* with special therapeutic, mystical and, unfortunately for the snake, culinary qualities. In the areas where the La Venta expeditions took place, the risk of meeting these reptiles is very high. In the event of a bite, however, the poison doesn't always act in the same way. The seriousness of the poisoning depends on the quantity of poison injected, the number of bites, the size of the reptile, the location of the bite and the victim's general state of health.

The symptoms of the poisoning can be roughly described as; intense pain, edema (swelling) and erythema (inflammation) localised in the bite area, somnolence, nausea, vomiting, haemorrhage, and destruction and necrosis of muscular and cartilaginous tissues due to the myotoxins in the poison. As the poisoning progresses, there will be progressive loss of vital organ function, renal failure, pulmonary edema, respiratory paralysis and, in extreme cases, death.

Francesco Lo Mastro

The wide collapse chamber of Cueva Hundida in the area of Cuatro Ciénegas, Coahuila







The karst area of Rio La Venta

The karst area crossed by the Rio La Venta, with plateaus which extend on both sides of the long canyon, is a place with exceptional characteristics as far as the underground features, the beauty of the settings, the archaeological remains, and the entire natural environment are concerned. It's not just by chance that, apart from giving the association its name, it is also the area where we have put in the most effort in terms of the number of missions, researchers involved, and the accomplished documentation.

The expeditions

In the 1970s, the Rio La Venta area aroused the curiosity of speleologists, becoming a coveted and prestigious goal for Italian, French and Canadian expeditions. The contribution of Mexican guides and the Chiapaneco Speleological Movement were fundamental, the latter expanding to eventually become an important presence. In the first decade, the explorations led to the discovery of caves such as Cueva del Aguacero, the Pecho Blanco system, the Los Bordos cave, and the Sima Chute Redondo. In 1990 an Italian group, which included some Roman pioneers of the expeditions in Selva del Mercadito, carried out the first descent of the Rio La Venta since Mayan times, finding many caves along the canyon and bringing pre-Columbian archaeological finds to light. This is the spark which led to the birth of the La Venta Association,

*Aerial view of the great canyon of Rio La Venta,
the site that has named our association*



whose name and logo are taken from this fantastic Mexican canyon.

In 1993 the La Venta project took off. It was to continue for more than 10 years and lead to the discovery and documentation of over 250 caves with a total of more than 60 kilometres of surveyed galleries.

After two 'light' expeditions in 1993, March and April 1994 saw the first big expedition taking place, using three different teams. The first descended the Rio La Venta, exploring and surveying Castillo and some other caves such as Cueva de la Vuelta and the first section of what would become Cueva del Rio La Venta. The second team worked in the higher parts of the canyon, climbing up to several cliff face caves, among which some were of notable archaeological interest like Tapesco del Diablo. The third penetrated Selva El Ocote, searching for a couple of large sotanos seen on aerial photographs and finally reaching and descending Sotano de Carlos (Fundillo del Ocote). Unfortunately, the large circular hole called Ombligo del Mundo, in the inner part of the forest, appeared to be unreachable. In Agualito, the ruins of an ancient building inside the intricate Mexican forest were surveyed.

The second expedition, in October and November of the same year, focused on the karst area to the left of the Rio La Venta, where many caves around the Lázaro Cárdenas and Unidad Modelo colonies were explored and new access routes to the canyon were found. At this time, our association organised some meetings on the science and techniques of speleological research, involving the young members of the Club Topos of Ocozocoautla.

In April and May 1995, the exploration of the Cueva del Rio La Venta extended more than 7 kilometres into the mountain. Interesting archaeological finds were discovered in the Las Cuevas cave, between Rio La Venta and

the Rio Negro. In this cave, two young expedition members contracted histoplasmosis by inhaling the spores of a particular type of fungus which thrives in the massive bat guano deposits. The archaeological work continued in the Huellas del Tiempo and Cueva de la Sorpresa caves as well as at Castillo, in collaboration with the Instituto Nacional de Antropología e Historia.

The fourth expedition took place in November and December, operating in two areas. While the speleologists discovered many caves containing archaeological finds, two ENEA (Italian Agency for New Technologies, Energy and the Environment) geologists carried out a study on the morphological evolution of the canyon and on the origins of the Traforo del Rio La Venta, a tunnel over 500 metres long traversed by the river. Climbing up long and dangerous cliffs, as well as unstable gullies, the gigantic entrance to the Camino Infinito, on the right side of the Rio La Venta, was reached. Around López Mateos, our efforts finally led to the discovery and exploration of the upper entrance of Cueva del Rio La Venta, allowing the underground crossing from plateau to river for the first time. The known extension of the cave reached 13 kilometres.

Between April and May 1996, a small group returned to continue the explorations in the areas to the left of the canyon. The many caves discovered made it ever clearer that all the underground phenomena are actually part of a single, vast system. Particularly in the area of López Mateos, a number of large and richly decorated caves were explored; Cueva del Cafetal, Sotano del Quetzal, Sumidero I, Cueva del Rio Osman and the Cueva del Ejidal. In the Lázaro Cárdenas area, the exploration of two new underground systems began in the Neblina and the Clarín. Meanwhile in Tuxtla Gutiérrez, the state capital, the Association organised a speleological course on behalf



The first descent of Rio La Venta

The dream had been there since 1981, born on Christmas night during a bivouac under a rock shelter near La Junta, the confluence between Rio La Venta and Rio Negro. Some adventure companions, who I didn't yet know and who I would meet many years later on the naked ranges of the Pamiro Allaj in Central Asia and the dense karst forests of Palawan in the Philippines, thought about it.

Six of us descended it, in January 1990. Twelve very intense days that marked the birth of our association as well as a good piece of our successive lives.

Re-reading the journal of those days, I realise just how much the knowledge and perception of an area changes over time. The marks laid down by geography become direct experiences which then transform themselves into geographical symbols. Dante's *color bruno* (brown colour) which little by little invades the white of the paper; in those days we knew nothing about that long and deep fracture and the river which runs through it, of the caves suspended on its walls, of the ancient Zoque culture sites, or of the underground waters which we would study for years to come. The question marks in that journal are now plots of caves kilometres long, archaeological maps, underground hydrology diagrams, and tracks in the forest which reveal the movement of people from the past. A book in four languages and two documentaries. In these years others have descended that river hidden between sheer walls, we ourselves have descended it, in parts or in its entirety dozens of times. But that time we were the first ones, the precursors, to start placing the marks and symbols in order to ignite the white paper and create the mental map of that territory.

The Rio La Venta canyon extends for about 80 kilometres and is the southern border of the El Ocote karst plateau, in the state of Chiapas. Fairly wide in its upstream part, it's then invisible for about a third of its course, being so narrow and deep. The great allure of that descent was exactly there, in that invisible stretch, in that apparent impossibility of finding lateral escape routes. We were six, with two inflatable dinghies: Tullio Bernabei, Gaetano Boldrini, Marco Topani, Matteo Diana, Marco Leopardi and I. We had to travel light, as lightly as possible, and reduced everything to the absolute minimum, even the food. The journal of those days is pervaded by that excessive zeal, by exertions not balanced by an adequate diet.

The first days were not especially difficult if not for our continually empty stomachs. We only ate once a day, a frugal dinner consisting of dried soups and a little dried meat; our attempts at fishing had little success. We learned little by little how to steer the dinghies in calm water and how to control them, ourselves in the water with them, on the easier rapids. We learned how to transport them along the sides of the river when the rapids became white and angry. Little by little, we immersed ourselves in this magical place, followed by flights of herons and parrots. The hunger pangs slowly became feebler.

The fifth day we reached a wide loop in the river and in the middle of it, on the right-hand side about fifty metres above the river, we found a small temple with flights of steps and walls which were still partially plastered. With great surprise we found inscriptions dating back to 1942. We obviously weren't the first to pass through there. It was the Media Luna temple, of Zoque origin, studied by the archaeologist Thomas Lee in the 1960's. That temple,

Crossing La Junta, jammed with tree trunks, on a fragile inflatable boat in the final part of the Rio La Venta canyon



in that place, began to make us understand that the Rio La Venta canyon must have had an important meaning. We couldn't yet imagine the dozens of sepulchral caves, the forest sites, and the many archaeological expeditions aimed at interpreting the signs from the past. The next day, a stream coming from the left led us to ascend a short valley. In a karst area like that a stream is an important sign and indeed we were met by a wide dark portal. The water exited slightly beneath, between the rocks. We entered for a few dozen metres, enough to make certain that we'd be going back there. We descended between large speleothems until we heard the sound of the underground river, the roar of a large waterfall. Without much imagination but suitably, we named it Cueva del Rio La Venta. Now we know all of it (perhaps), a large underground system extending 13 kilometres and 400 metres deep. It passes through the entire karst plateau to the left of the river and is one of the most beautiful underground through-trips in the World. We then entered the narrowest tract of the river, the one which remains hidden from view. That, perhaps, is the most magical part of Rio La Venta. The thin strip of the sky barely made it through the green threshold 600 metres higher up. The irresolute light lit up the vertical walls from which the vegetation had been ripped away for dozens of metres upwards by the extraordinary flood caused by hurricane Hugo the previous year. We passed under the great waterfall. The walls here aren't vertical or even parallel, the gorge remains but there is no visible access to the strip of sky. The water from a spring falls from somewhere far above, bouncing off the walls, nebulising itself throughout the entire channel. Green walls, green river water. Beautiful... beautiful.

Then the tunnel, where we remain speechless, where words are not very useful. Saying that one arrives in this place is a great understatement. It's the tunnel that absorbs you, that accompanies you, that welcomes you into its domain. We knew that we were getting close; we had sensed something during the fly over. The walls close and the sky strip gets thinner. Then we passed from light into darkness, accompanied by parrot cries amplified by strong echoes. Half a kilometre of large gallery in a half-light and then we could see the arch of the portal downstream, nearly 150 metres high. Feeling very tiny, we passed from darkness back into light.

There were other days with rapids and rain, with caves barely touched, with signs from the past, with forest immersed in the fog and with ever emptier stomachs.

We passed the Junta, opening a way through the tree trunks brought by the fury of the hurricane, then paddled for an entire day, on the now calm waters of a river transforming itself into a lake. By now we were on Lake Malpaso. It was an astonished fisherman's family who gave us the first welcome. Then it was the turn of Agua Blanca's beans and rice.

A long lake on Rio La Venta





of the Universidad de Ciencias y Artes de Chiapas, which led to the establishment of the Vaxakmen group.

The sixth expedition evolved through January and February 1997. In slightly less than three months, between speleologists, archaeologists and film crews, almost sixty people worked in the area. The speleologists descended the canyon again and highlighted the existence of structures and walkways which climb towards Selva El Ocote. Also the impressive Grande Cascata was climbed while the exploration of Cueva de la Vuelta continued. Around the López Mateos settlement, many new caves were explored, particularly Cueva del Naranjo. A second attempt to reach the Ombligo by land failed because of the complete lack of access to drinking water. Nearing the end of the expedition however, two explorers managed to lower themselves from a helicopter and finally peer into the imposing sotano.

In November 1997, the focus of the project moved to an area on the border with the state of Oaxaca, where the legendary lost city of Chimalapa was apparently located. However, the unfavourable climatic conditions, health problems, and the resolute opposition of the local population stopped the effort halfway through. The return journey ended up being very difficult due to flooding. The off-road vehicle used to reach the area had to be abandoned at the Rio Frio and the crossing of the Rio Portamoneda had to be accomplished with a ropeway.

On the eighth expedition in March 1998, a new attempt was organised to reach the Ombligo by land. The *sótano* sunk in the green rainforest was reached after a 20 day 'approach' and explored to a depth of 150 metres. In the meantime, another team had begun the exploration of the Cueva de Enrique on the Ocozocoautla plain and a third group worked in the Salina Cruz area on the shores of Lake Malpaso, opening up unexpected opportunities

thanks to the discovery of two large caves, the Cueva del Tepescuintle and the Cueva de los Caracoles.

Another attempt to reach the Ombligo was made in April 2007, starting from an 'easier' area SW of the pit. The expedition just missed its target, coming within 700 metres of its edge, but the lack of available time forced yet another postponement of the pit's real exploration. However, there was a good result insofar as we got to know the terrain better, with its difficulties and its water supply points, and identified an approach route which was easier than the previous ones. The next expedition, in April 2008, was the decisive one. The Ombligo was reached and meticulously explored and surveyed. Unfortunately no new continuations were found.

The physical environment

Chiapas, in Mexico's southwestern extremity, contains

Aerial view of the area of Chimalapa



One of the first pits in the Cueva del Rio La Venta



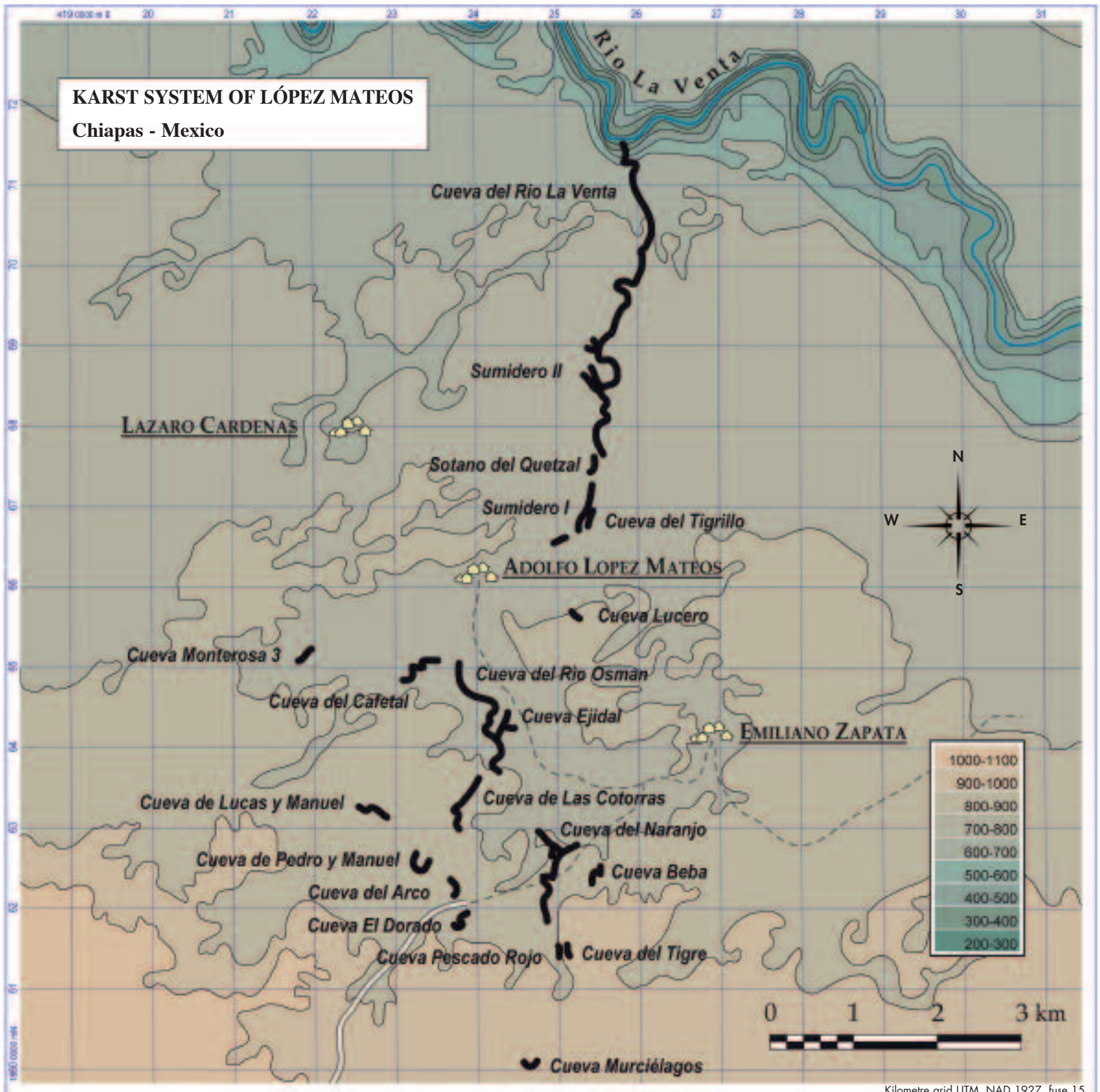
very varied regions; the Pacific coastal plain, the granite mountains of the Sierra Madre, the Valle Centrale, and the limestone sierra of the interior. These varied environments are subjected to profoundly different climates which are influenced both by the trade winds, blowing from the northwest and loaded with moisture sweeping over the Sierras del Norte and the eastern and central *meseta* to finally arrive dry in the Valle Centrale, and by the monsoons coming from the Pacific which release their rain along the coast colliding with the Sierra Madre. The climate is therefore complex and very different, including conditions ranging from warm-humid to temperate sub-humid.

Limestone mountains spread over a large part of the State. The La Venta Association's research concerned the Meseta Central in a mountainous *selva* area which is subject to heavy rain and thick fog. The outcropping lime-

stone rocks form a continuous belt about 30 km wide which, from Oaxaca State, crosses the Chiapas from northwest to southeast for 250 kilometres forming mountains in the north and continuing in the Valle Centrale region as far as Guatemala. They are limestone and dolomitic rocks deposited in the Cretaceous, several hundred metres thick. The Rio La Venta canyon cuts through the limestone belt completely, deeply furrowing its surface over a length of 80 km. The limestone rests on marl, sand, and clay soils which are not very permeable or karstifiable and which emerge in narrow strips at the edge of the limestone belt. Following their deposition on the ocean floor, the limestone layers were deformed by tectonic stresses, taking on elongated fold geometry along the NW-SE axis, parallel to the route of the Rio which flows within the range.

The Rio La Venta originates in the far away Sierra Madre del Chiapas, crosses the arid savannahs of the Central Depression and finally meets the limestone mountains. Upon entering the karst area, the average flow rate of the river is already 400 m³/s. Upon exiting the limestone range, the river flows into the Rio Grijalva. However, since 1965, the building of a hydroelectric and flood control dam has created an artificial lake, the Malpaso, at the confluence point, which extends for almost 300 km² and is one of the largest in Mexico. The Grijalva hydroelectric system, to which the Presa Malpaso belongs, supplies electricity to half of Mexico. The lake borders the eastern slopes of the limestone chain, but one of its branches enters into the centre of the karst area. The Rio Mezcalapa is born from the artificial barrier and continues North on its way towards the Gulf of Mexico.

The area targeted by the speleological and archaeological research extends around the Rio La Venta canyon, limited by the geographical coordinates of 16°30' - 17°10' north latitude and 93°15' - 94°00' west longitude. The canyon is





*The great entrance of Cueva de las Cotorras,
Rancho El Mercadito*

a narrow gorge entrenched into the limestone rock between vertical cliffs around 400 metres high. Above the walls extends an area with an undulating topography and peaks reaching 1500 metres. The parts to the right of Rio La Venta is called Selva El Ocote, while the part to the left, not having an official name, is identified by the settlements which are present there; Lázaro Cárdenas, López Mateos, Unidad Modelo, Emiliano Zapata and Venustiano Carranza. To the north of Rio Negro, a left hand affluent of the Rio La Venta, the area takes the name of Selva del Mercadito.

The climate of the *selva* is characterised by a mean annual temperature of 24-25 °C and a mean precipitation of 2300 mm/year at Lake Malpaso. On the other hand, in the areas around the selva the precipitation is much less abundant, falling to 800 mm/year in the Ocozocoautla and Cintalapa plains, which are situated at the edge of the range.

The environment is distinguished by the presence of one of the last unscathed rain forests in Mexico, Selva El Ocote which, with the nearby Los Chimalapas in Oaxaca and Uxpanapa in Veracruz, once made up one of the largest extensions of humid tropical forest on Earth. Unfortunately, in the course of the last 50 years, over half of the Mexican rain forests have been destroyed.

This green ocean enfolds the landscape typical of tropical karsts, where emerging forms like pinnacles and conic hills stand out. In between the cones are depressions, with irregular 'star' or 'sinuous corridor' shapes. In the international geological literature, these tropical dolines are called cockpits, a term coined in Jamaica for their similarity with the arenas once used for cock fights.

The vegetation cover, which even today is fairly intact, hides the detailed karst forms, such as the sharp limestone blades, which can be up to 10 m high and make moving around slow, difficult, and dangerous. Nothing however

*The Rio La Venta gorge, almost 30 km long,
is one of the major canyons of Mexico*



Ombligo: *ex cælo, pedibus calcantibus*

It was at the end of the 1997 expedition. We had already tried twice, in 1994 and earlier that same year, but it was all useless. To be honest not really useless I suppose, the selva (the tropical forest) had taught us lots of things, had given strict and enlightening lessons. It had eroded our male egos as seasoned navigators and destroyed our delusional hopes of resisting thirst and fatigue, but it also nurtured the dream's seed and made us even more determined to eventually succeed. The forest had stopped us with the lack of water, the razor sharp limestone blades, the humid and oppressive heat, and the brutal weights.

So we decided to try from above, to reach the cave from the sky, entrusting the dream to technology and daring. Undoubtedly an outmoded term, but daring the attempt certainly was.

The Ombligo is a large and deep sotano at the bottom of a blind valley, a probable entrance gate to the underground world of El Ocote, embedded between limestone cones and cloaked with mighty trees. The idea was to lower oneself by rope, suspended from a helicopter. Said like this it sounds pretty simple but the reality of such a feat is rather complex. A pretty powerful helicopter is needed, one that is able to hover long enough for the descent. An expert and very determined pilot is also needed, able to bring the machine right into the valley. Finally, someone determined enough to descend the rope attached to the cabin, immerse themselves into the embrace of the vegetation and let themselves be abandoned in the green sea by their companions who withdraw along with the sound of the rotors.

We had everything. The PGR (Procuraduría General de la República - Mexico's Attorney General) had granted us support with a hefty number of flight hours. Our pilot Guillermo Navarro Torres (who only a few months later would unfortunately die in a crash during a normal control operation) had shown great technical skills as well as enthusiasm for our mad project. Among us, volunteers weren't lacking and the chosen ones were selected by common agreement. Teamwork was necessary, someone on the rope and someone else to manage the flight along with the pilot, solve problems, and handle emergencies.

The plan was for two of us to go down, with a descent of between 80 and 100 metres, to what from above looked like a clearing with low vegetation. The two would have opened a sort of landing pad for the helicopter, with machete and, if necessary, chain saws. This would have allowed our companions to come down as well and everyone could explore the great abyss. Not secondary by any means, the pad would have permitted our return as well, since the rope technique was intended to be a one way ticket.

A few days after the fly over, two of us descended. I went first followed by Gaetano. Many years have now passed, but everything is still so clear, vivid and precise. It was a long descent. Butterflies in my stomach, the descender hot in my hands, my thoughts directed towards Tullio with the knife in his hand, ready to cut the rope in an emergency (one must always consider the least of all evils). The landing, suspended metres from the ground on a tangle of trees and vines, the radio communication with my companions

Starting the rope descent during an attempt to reach the Ombligo from the sky



*The arrival to Linda Vista,
after a long trip hanging from the helicopter*



in the cabin works. I've arrived and they can unfasten the rope, its whistling through the air and whipping the leaves and branches. Then the helicopter disappears from sight, the forest returns to peace, and I wait for the second trip and my comrade in adventure.

They were magical days. We reached the Ombligo and on its edge sang the Italian national anthem, just to spite a secessionist expedition member who had tried to reach it by land a few weeks earlier. We descended the first drop and the long detrital cone to the start of a deep pit. We passed wonderful nights immersed in the absolute charm of the forest and its inhabitants.

But the idea of landing the helicopter turned out to be absurd. Not even a squad of lumberjacks could have opened a space big enough for that purpose. The valley was too deep, too narrow, had too little available space and, fortunately, too many green Cyclopes were blocking the way.

So the problem now was how to get out. Guillermo and our companions made several attempts to reach us, to descend with and without someone hanging beneath the helicopter, but it was really difficult and we were already beginning to consider an unlikely escape on foot. While at night we rested under the green vault, accompanied by the crackling of the fire, Tullio, Ugo, Italo, Paolo, Pasquale and Paco were fine-tuning an extraordinary means of evacuation. The next morning it was a water tank attached to two long ropes which reached the clearing. The ropes were lowered with extraordinary speed and precision and then secured to the cabin. We attached ourselves and the bags to that long anchor. The helicopter began to rise, to take us out of the valley, but then it moved sideways a little too early, we saw the treetops come nearer rather than go farther away.

We ended up in them, and in that moment I thought again

of Tullio and of his knife ready to cut. However, we did get out in one piece, the green Cyclopes, perhaps through gratitude, perhaps through simple indifference, perhaps glad to rid themselves of the intruders, didn't want to keep us down there with them. They saw us disappear into the sky, where we flew for six kilometres. We didn't yet know that we'd be back.

Pedibus calcantibus

We had reached the dream, we had entered it. The meeting was extraordinary but fleeting, a quick, borrowed exploration. The next year we decided to go back, without any space-time restraints this time, looking for an alternative access route from the first attempts.

So we started from Salina Cruz, to the north, where we had been deposited the previous year. We knew that it would be tough, but would never have imagined how tough. We carried out several flyovers in order to study the route and to find some weak spots in the El Ocote conic karsts' ramparts. From above, everything looked simple, calm and linear, but the

reality down there was like a fractal, and underestimating it could lead to serious mistakes.

There was the supply problem, since not everything could be carried on our shoulders.

It was thus that the adventure began with materials (food, water, and technical equipment) being parachuted from the helicopter. The parachute was a simple sheet, attached by its corners to a large bag. We saw it disappear, a blue handkerchief in the intense green, trying to fix its likely landing spot in our minds.

We set up an advance camp, Campo Frijoles, easily reachable by foot and with the animals. From there to the Ombligo there were only six kilometres as the crow flies, a distance that could be covered in little over an hour on an easy trail.

Then we entered that other world, the tropical karst forest, perhaps the most difficult terrain that exists on this earth. Here

Advancing in the karst forest of El Ocote often requires hard climbs on razor-sharp rock blades



Man is out of place, his body struggles to move and his mind to understand. Here everything is extreme; the oppressive heat, the lack of water, the difficulty of getting one's bearings. One rambles on, balanced between blades and limestone peaks, immersed in the green explosion, trying to avoid the prickly palms (*chichón*) and watching out for the Nauyaca Real, one of the forest's most dangerous snakes. Even light is an unwanted guest, faded by the vegetation's thick canopy. Everything is a little dark and muffled.

We moved a few hundred metres a day, opening the path and returning to base camp at night. Then the travel time started becoming too long to continue being forest commuters and so we set up an advance camp.

Some youths from Salina Cruz were with us, the same ones who had almost decided to get rid of us the previous year when they saw us hanging from an anti-narcotics corps helicopter.

One of them, in particular, had an unusual level of endurance and an extraordinary capacity to adapt to the environment. They called him El Diablo, perhaps with good reason, because he had certainly made a pact with someone. Other friends from Salina began daily water deliveries and we, at a point invisible from above, kept on opening a gap towards the Ombligo.

Days went by. A few brief and intense rains added to our meagre supplies and partly helped pacify the fires which blazed, as we discovered later, very close to our route. It had been a terribly hot and dry season and the fire was consuming acres of forest. The karst forest is assailable only with difficulty and is equally difficult to defend. The fire runs along the roots, hides in the rocky ravines and waits patiently while rivulets of rainwater pass it by. It then restarts and moves on to other areas, attacking from the base.

We were three, but at a certain point Tullio had to go back. Paco and I were left, along with Diablo and a couple of his

companions. We reached the Ombligo after three weeks. Three weeks for six kilometres. It would have taken a little more than an hour on an easy path. My heart leapt when I re-entered the clearing that I had flown away from just a few months earlier. We found the parachuted materials, albeit somewhat damaged. Unfortunately the impact had caused the loss of the water supplies.

Paco and I explored the pit left back in 1997, after a long and heated argument with the guides to convince them not to follow us down the ropes without equipment. We descended for about a hundred metres, more as a search for precious fluids than in the spirit of exploration. The pit however ended in a collapse and not even a drop of water could be seen. We exited, discovering the presence of a second pit at the base of the detrital cone, but we didn't have enough time and, especially, enough water to give it a try. The following day a long journey back to the advance camp was waiting for us and we couldn't afford to waste even a drop of water. The Ombligo seemed to be teasing us. We had found another access route, but the door was in fact still shut by the lack of water. Another exceptional lesson imparted by the *selva*...

The next morning Paolo with two other Salina companions reached us. He also didn't have water. They had searched for some in another cavity not far from the camp but without success. Paco had even slipped and opened a wide gash in his hand on a rock blade.

We began the return, our throats already parched from the start. We walked without words, concentrating on our unsure and unstable steps, without seeing the wonders around us. We were all at the limits of our thirst and strength.

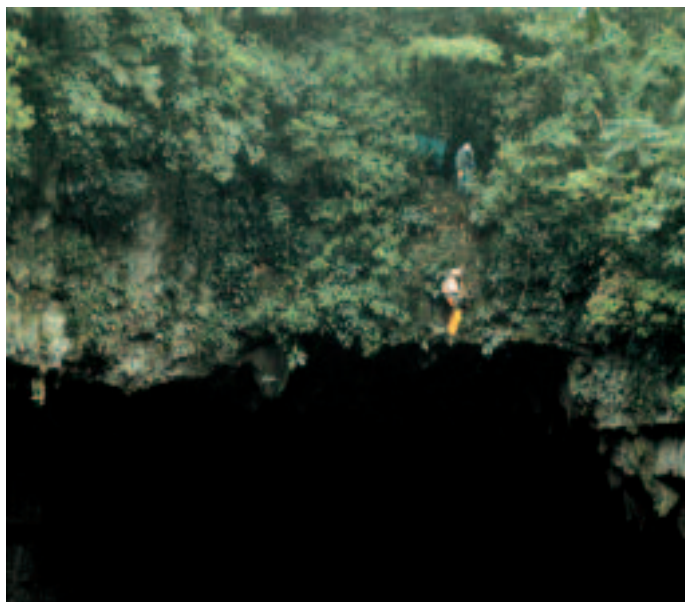
Our Salina friends, however, were looking around, searching for something. They searched for a long time and then finally found it. It was the liquid poetry hidden inside the *bejucos de agua*, long lianas full of water, a wonderful forest treasure, which by ourselves we would never have found. The *selva* continued to beat us on one side and save us on the other...

The *bejucos* allowed us to move on a bit more. We reached a very small pool (a few litres) of putrid water, but that was our salvation. It was about to get dark, one certainly couldn't be picky. For me especially, from that moment on the return was a nightmare. Moving through that kind of forest in the dark is difficult enough for people with good eyesight, but for a nearsighted person like me it required an extreme degree of concentration.

Rock and vegetation represent the main obstacles while advancing in the forest



Descending the Sótano di Carlos, Selva El Ocote



can hide the big sotanos - deep, round karst pits with diameters of dozens or hundreds of metres which are unmistakably revealed by aerial photographs. Flying over the forest in a helicopter, one even sees streams which disappear into nothingness, and the nothingness, the void, is often a sinkhole. Observing carefully, one can have the good fortune of noticing the ruins of buildings abandoned centuries ago and swallowed up by the green.

On the other hand, to the left of the canyon and in the areas around the perimeter of the reserve, deforestation has already stripped the terrain of a significant part of its primary forest. The construction of roads, despite making moving around much easier, has contributed greatly to the

alteration of the original characteristics of the place.

Karst phenomena

Rio La Venta flows between deeply carved walls with a meandering course. The current route was established when the Rio crossed a plain and the river's current flowed lazily, forming itself into wide loops. Then, about 90,000 years ago, the block to the northeast of the great fault, which has since been the western border of the limestone range, began to rise. Since then the block has been raised an average of 5 millimetres a year, resulting in a total rise of 400 metres today.

The raising of the limestone block corresponded to the progressive down-cutting of the canyon. Currently, at various heights on the vertical walls which trap the river, the remains of ancient 'river terraces' can be found, being level surfaces which formed during the evolution of the canyon due to the lateral wanderings of the water course during the pauses in its vertical deepening. The summit of the mountain range, strongly modelled by erosion and especially by karst processes, is what remains of the original level plain where the ancient Rio La Venta peacefully flowed. It is in this time period and context that the underground karst network originated and evolved. The rain waters which fell on the forest passed, and still pass through, the karst conduits which over time grew and changed. The conduits lead the underground streams to several emergences at the base of the canyon walls, adding themselves to and increasing the Rio La Venta's flow.

In the Rio La Venta karst area, over 250 caves are known with a total of over 60 km of surveyed underground passages. The sector in which the speleological explorations were able to completely reveal the structure of the underground karst network is that of López Mateos, a small settlement reachable in about two hours with an off road vehicle from Municipio de Cintalapa, road conditions per-

mitting. The López Mateos underground system is currently made up of 20 caves, segments of that underground network which allows the waters falling on the slopes starting at the southwest edge of the limestone, to head north and eventually pour into the Rio La Venta canyon. In the westernmost part of the mountainous area, the draining of the water takes place partly on the surface and partly through underground conduits. The topography is characterised by closed basins, within which the waters gather themselves into surface streams which are then swallowed by karst conduits probably laid out on layers with a slight slope to the north. These passages pass a little way beneath the 'cone' karst landscape and emerge from resurgences inside other closed basins, again flowing along the surface until swallowed by a new sinkhole. In the western area about fifteen caves have been explored, some are hundreds of metres long while others are over a kilometre in length, like Cueva del Naranjo (2.5 km), Cueva de las Cotorras, and the Cueva Ejidal.

In the central part of the mountain, at about 700 m altitude and on the edges of one of these closed basins, is the village of López Mateos. The level bottom of the large basin is carved out by the Rio Osman, whose flow is very variable and averages between 1 and 2 m³/s. Following it upstream, several bifurcations are reached, each leading to a cave-spring: Cueva del Cafetal (1,000 m long), Cueva del Rio Osman (680 m), and Cueva Monterosa III (240 m). In the Cueva del Rio Osman, the discovery of a connecting passage allowed the resurgence and sinkhole (Cueva Ejidal) to be joined, making the cave traversable from end to end. In the others, a connecting passage is not possible due to the presence of collapses or siphons. In some, a higher and richly decorated fossil level is found, while the active part containing the underground stream is about ten metres below. Downstream, Rio Osman reaches the edge of the

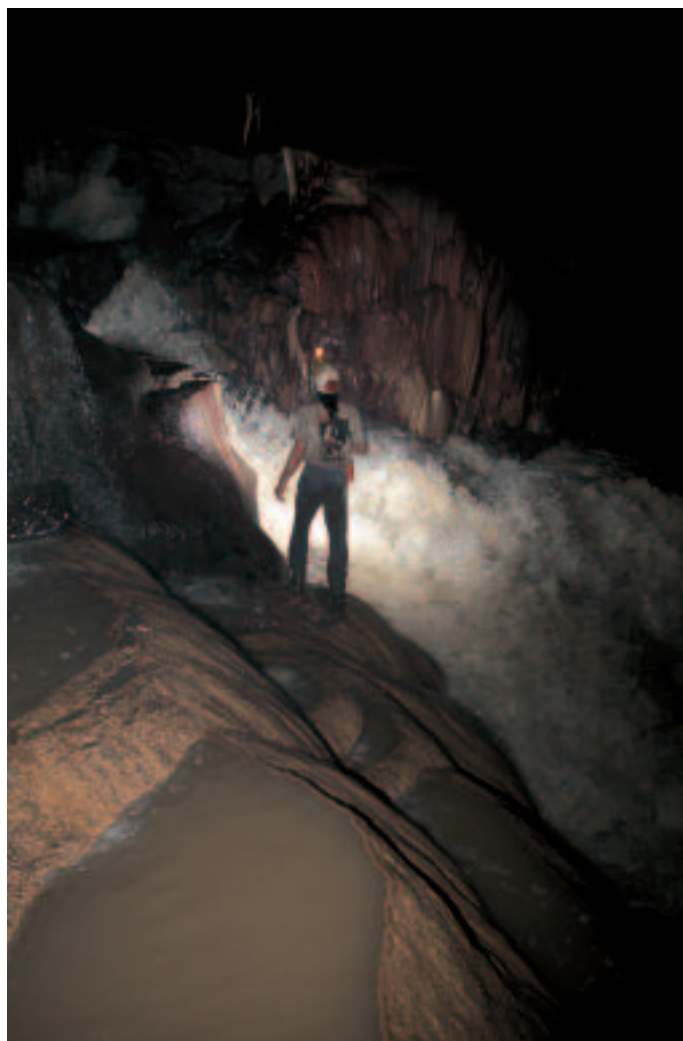
The great springs of Los Bordos, along the Rio La Venta, collect waters from the highland of Veinte Casas



López Mateos plain and disappears, swallowed up by the Traforo di Osman at 680 m elevation. From here on it stays underground until the resurgence in the Rio La Venta canyon.

In the eastern sector, the river that disappears into the Traforo di Osman is found again downstream, still underground, in Sumidero I and then flows under the Sotano del Quetzal to finally enter, several hundred metres further along, the Cueva del Rio La Venta. This last cave can be completely traversed in a spectacular descent into the canyon. In 1995, the passing of some unstable collapsed blocks in Sumidero II, through which a light air current passed, brought the speleologists to the shores of the Lago degli Ignavi (Lake of the Slothful), the previous year's exploration limit that had been reached by climbing up the stream from the canyon side. The journey in the dark is nearly 13 kilometres long and is accompanied by a strong draught and the stream water. In some places the stream flows peacefully, at times rests in lakes, and sometimes explodes down roaring waterfalls. The names given to the various places by the explorers evoke magical images, sometimes surprising and sometimes ominous: Salone della Cascata (Chamber of the Waterfall), Kinich Ahau Chamber, Chaac Rapids, Gallerie Via Col Vento (Gone With The Wind Galleries), Bella Addormentata (Sleeping Beauty), Forra dei Sogni (Gorge of Dreams), Salone Porte del Caos (Doors of Chaos Chamber), Galleria Segnali di Fumo (Smoke Signals Gallery), Salone della Città Perduta (Chamber of the Lost City)... From its appearance in Cueva del Rio La Venta, the water flows through passages which are more inclined compared to the nearly horizontal ones seen in the upstream caves. Continuing towards the canyon, the inclination increases while, above the speleologist's heads, the outside surface gets farther away. Finally, at 275 m altitude, a large gallery leads to a majes-

Sumidero II of Cueva del Rio La Venta



tic portal, through which one can see daylight once again. In the final tract, the water follows narrow fissures and emerges as a spring on the shores of Rio La Venta.

To the north of Rio Negro, a left hand tributary of Rio La Venta, is an underground system which has hydro-geological features similar to those of the Cueva del Rio La Venta. This is the Pecho Blanco system, explored for over 6 kilometres by speleologists from Rome and made up of different caves with connecting tracts which are only partly physically passable by humans. This group of conduits allows the Selva del Mercadito waters to flow from the western edge of the range towards Lake Malpaso.

In the sector to the right of the Rio La Venta, Selva El Ocote, territorial explorations have not progressed so much, mainly because of the difficulties involved in penetrating the virgin forest where progression is extremely slow. Ways through the thick tangle of vegetation have to be opened with machete, ridges have to be crossed, and deep folds descended, all the while trying to keep a straight line given by the compass, which is indispensable for not losing oneself in the labyrinth of corridors and cockpits. The exploration of the heart of the forest was motivated by clues such as the grandiose *sotanos* which are visible on satellite images, but everything which remains hidden in the thick vegetation is still unknown. The most remote sotano, a hole with a diameter of over 50 m called Ombligo del Mundo, was reached with great effort and descended in 1998 and then again in 2008. It was bottomed at 177 m depth without finding any continuation.

Another large opening, Fundillo del Ocote, had been reached a few years previously and explored to its base 85 m down, where the forest extends just as luxuriantly as on the surface. All around the heart of the forest, the search has led to the discovery of numerous caves, such as

sotanos, pits, and horizontal galleries, which together extend for several kilometres. At the base of the canyon's wall, always to the right of the river, French speleologists have explored over 5 km of the large Los Bordos resurgence, which drains the waters from a sector of the southern karst area.

Conclusions

Despite the massive amount of work carried out, which over the years has involved more than 200 people including speleologists, archaeologists, researchers, guides, and companions, there is still much to do in the Rio La Venta karst area. Both to the left and right of the river, several caves still need to be thoroughly explored and many others have yet to see an explorer's light for the first time. The canyon itself contains many cave entrances, at different heights, which have never been reached by the speleologists.

The way traced by the research carried out by the La Venta Association is very clear: to continue to explore, describe, document, and divulge, so that mankind can get to know this extraordinary territory, appreciate its value and protect it. This is a constantly evolving process which cannot be interrupted, both in regard to the local resident population as well as the political and technical authorities who determine the territory's use and conservation strategies.

We can only hope that other speleologists and researchers follow in our footsteps and carry the knowledge forward. We would like it if it were done with the same spirit of sharing and co-participation with the areas' inhabitants, which we have always tried to stick to, so that slowly the young locals will also become speleologists and learn to protect their land, both above and below the surface.

In the first halls of Cueva del Rio La Venta





*Tullio Bernabei, Antonio De Vivo,
Marco Mecchia, Gianni Todini*

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Selva El Ocote, the millenary sacred landscape of the Chiapas Zoque

Apart from being the Mexican region where the La Venta Association has worked the longest, Selva El Ocote is also the place where the Association has carried out the most in depth archaeological investigations. After the discoveries made during the first explorations, the Rio La Venta Archaeological Project was launched in 1997, the first Italian archaeological project in Mexico carried out in collaboration with the University of Bologna (Italy) and the Universidad de Ciencias y Artes de Chiapas (Mexico), partly financed by the Italian Foreign Ministry.

The investigations, carried out in constant collaboration with the Selva El Ocote Biosphere Reserve, at first focused on the exploration of the selva in order to assess the extent, chronology and the cultural affiliation of the many archaeological remains in the region. These explorations led to the identification of over one hundred archaeological sites, whose analysis has permitted us to make some hypotheses regarding ancient settlement dynamics. Through the excavation of some cave and open sites, it was possible to test and verify these hypotheses and formulate a first interpretative outline of the region's archaeology.

The data gathered up to now indicates that the Selva El Ocote area was frequented from the Late Pre-classical period (300 B.C. – 300 A.D.) by Zoque groups, who came from the nearby Jiquipilas and Ocozocoautla valleys in order to access the area's many caves and carry out ritualistic activities within them. Even though the area wasn't very attractive to agricultural groups as it was not very suitable for farming, its many caves were instead seen as access areas to the aquatic under-

world, within a cosmic context dominated by water and fertility divinities.

Until about 600 A.D., Selva El Ocote remained essentially uninhabited, while massive offerings, consisting mainly of hundreds of ceramic dishes, were deposited in its caves.

Around 600 A.D., corresponding to the beginning of Late Classic period (600-1000 A.D.) which was a time of great cultural change and demographic peaking in all Mesoamerica, a first phase of the selva's colonization began, attested to by dozens of surface settlements, many of which are of a monumental nature. The study of these settlements, which have surprisingly complex and spectacular architectural characteristics, has allowed the investigation of the processes of human adaptation to a particularly extreme tropical karst environment; processes which imposed successive modifications to the monumental settlements' structures and locations.

The selva's colonization, which continued until about 1000 A.D., did not result in an end to the underground rituals. During the Late Classic period, significant ritual activities were carried out in the area's caves, now favouring those located in difficult to reach places on the Rio La Venta's walls, as though wanting to maintain a spatial dis-

Textiles discovered during the archaeological excavations in the Cueva del Lazo



inction between the inhabited areas and those intended for ritual use.

After being briefly abandoned in about 1000-1200 A.D., the selva was again colonized around the 13th century by Zoque groups from the Jiquipilas area, who re-occupied some of the old settlements, probably to escape the invasion of the Jiquipilas region by the war-like Chiapanecs. Apparently, this second colonization ended with the Spanish conquest.

The Rio La Venta Archaeological Project's investigations have therefore reached several notable results. Besides allowing an outline of the sequence summarized here so far, the extensive excavations at the El Higo site has made it possible for a thorough study of the extraordinary architectural characteristics typical of the region, as well as allowing detailed investigations of aspects of ancient Zoque life. The excavations in several caves made studies of ancient ritual activities possible and also led to the recovery of some exceptional material, such as the many perishable materials dug up in the Cueva del Lazo where, associated with the remains of a multiple child sacrifice, the most important textile collection in Mesoamerican archaeology has been found. They are currently being studied and restored.

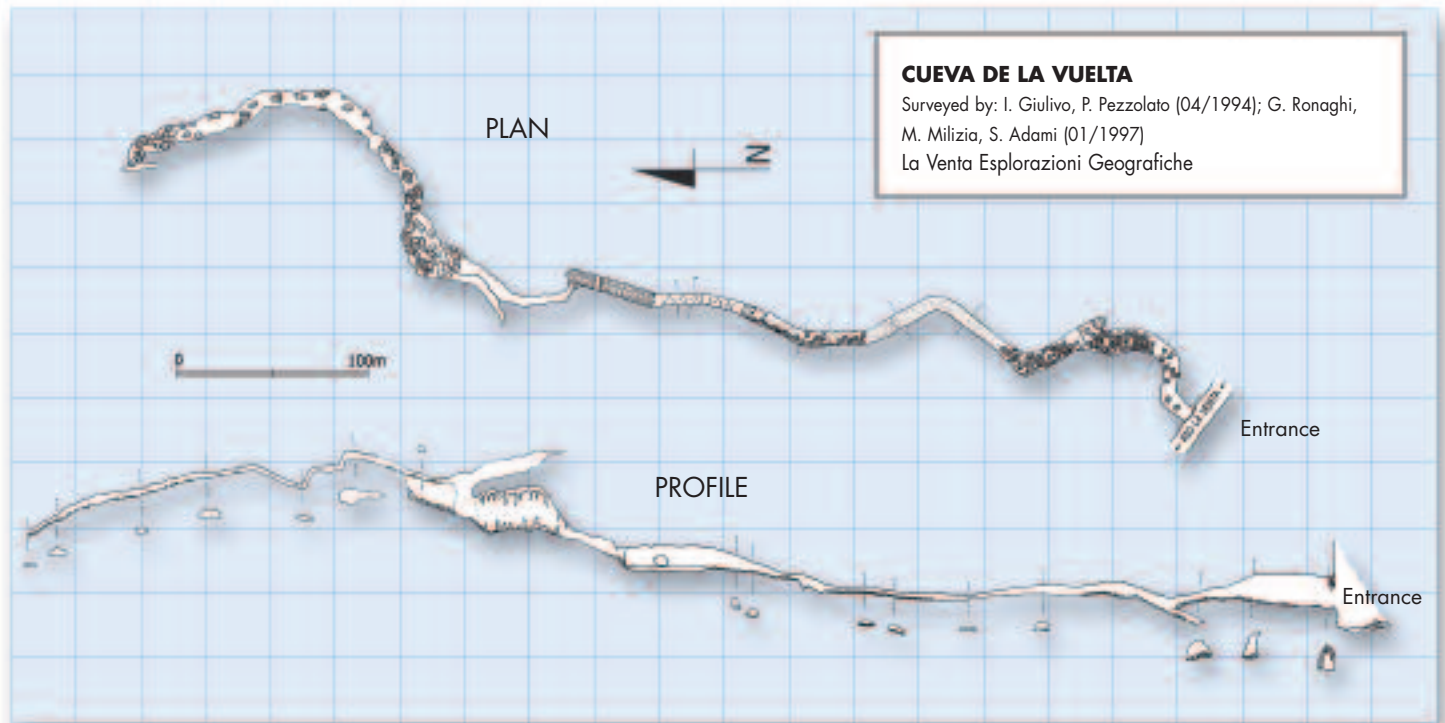
However, perhaps the most interesting aspect is the comparison between the obtained archaeological data and the many pieces of historical and ethnographic data which testify to how the Selva El Ocote was considered by the Zoque as a sort of 'sacred landscape' at least up to the middle of the 20th century when it was known by the Zoque name Norte Ipstek, *The Twenty Houses of the Rain*. Our archaeological investigations have shown that an unexpected story covering at least two millennia lies behind this name.

Davide Domenici



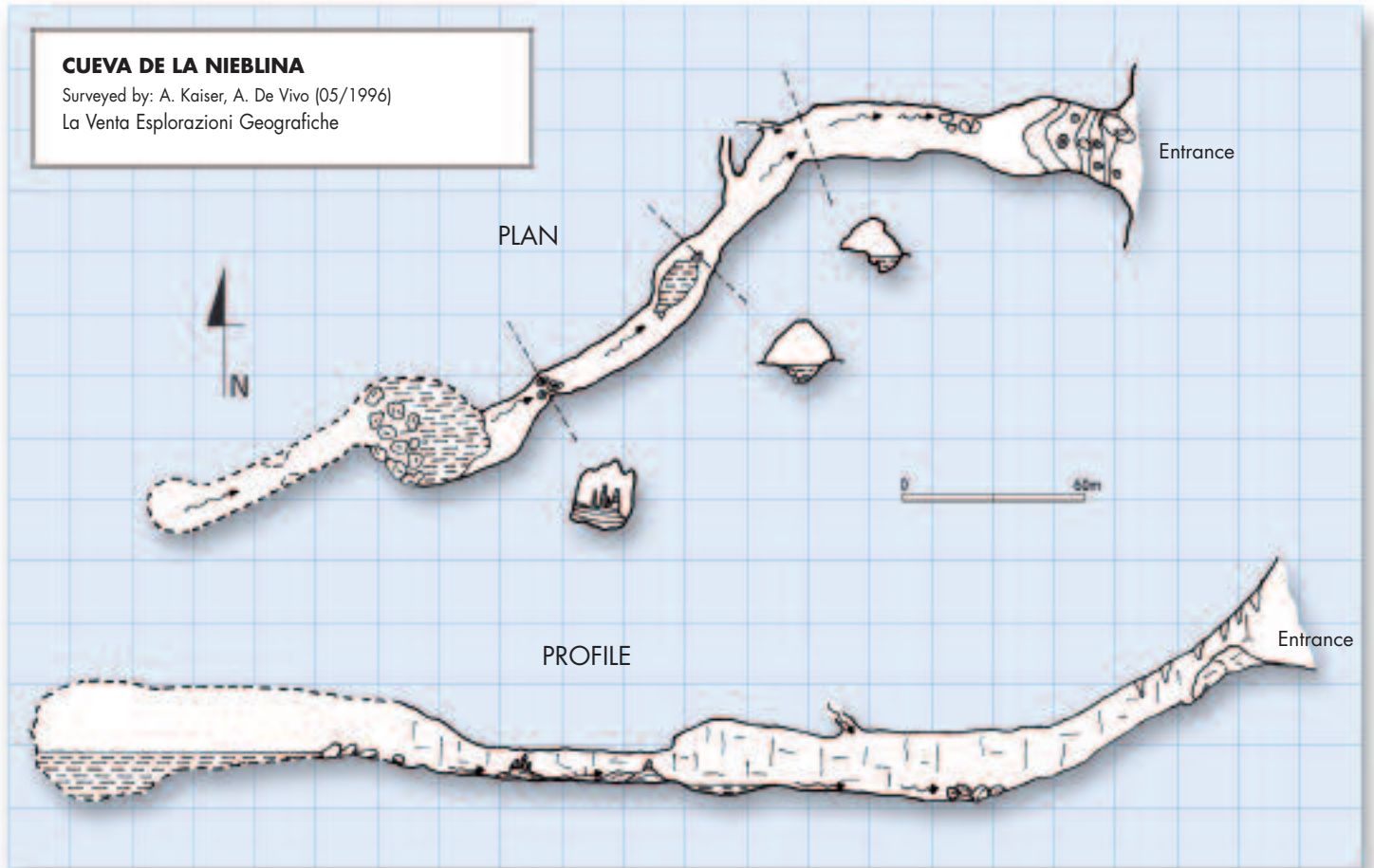
The monumental site of El Higo

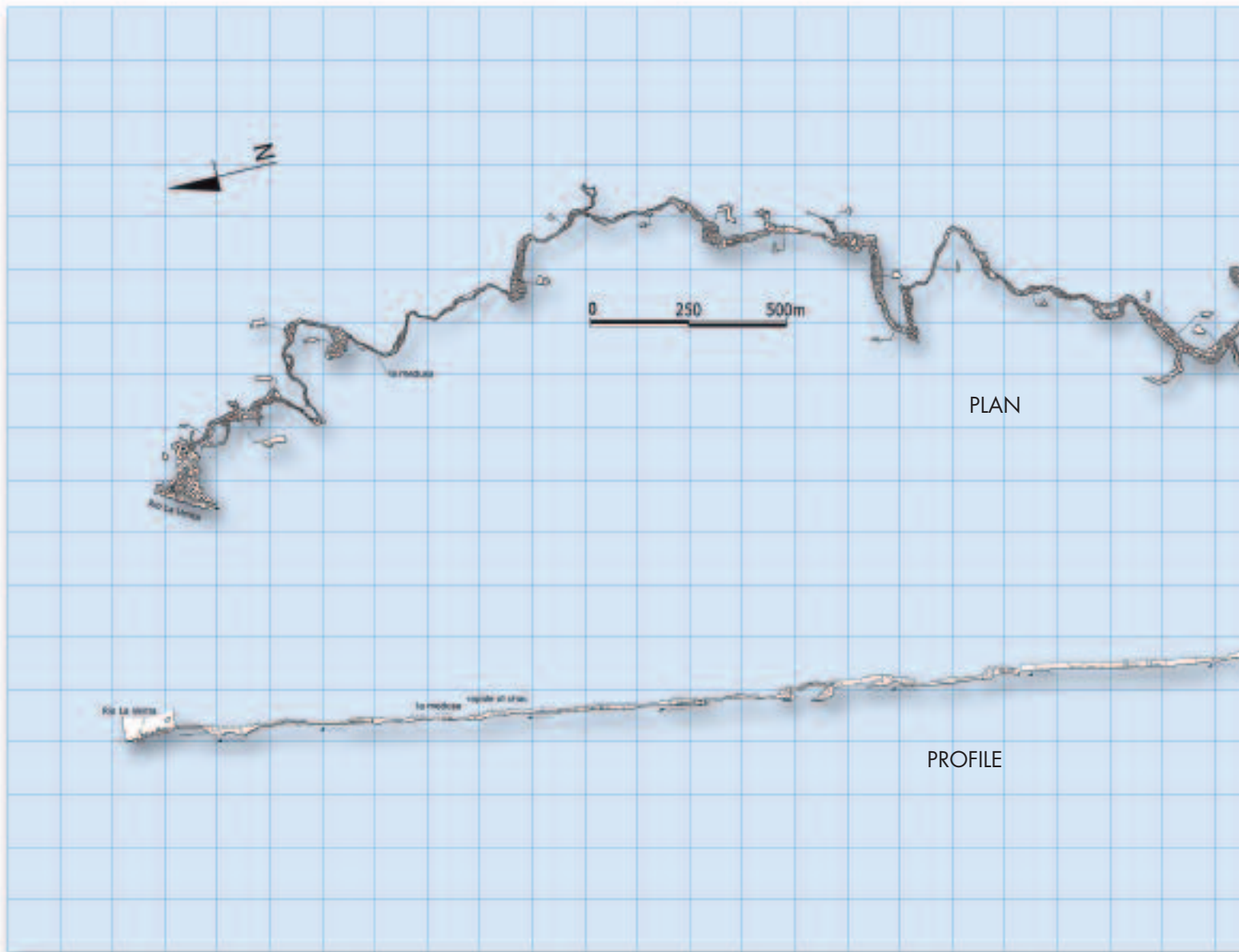
Appendix

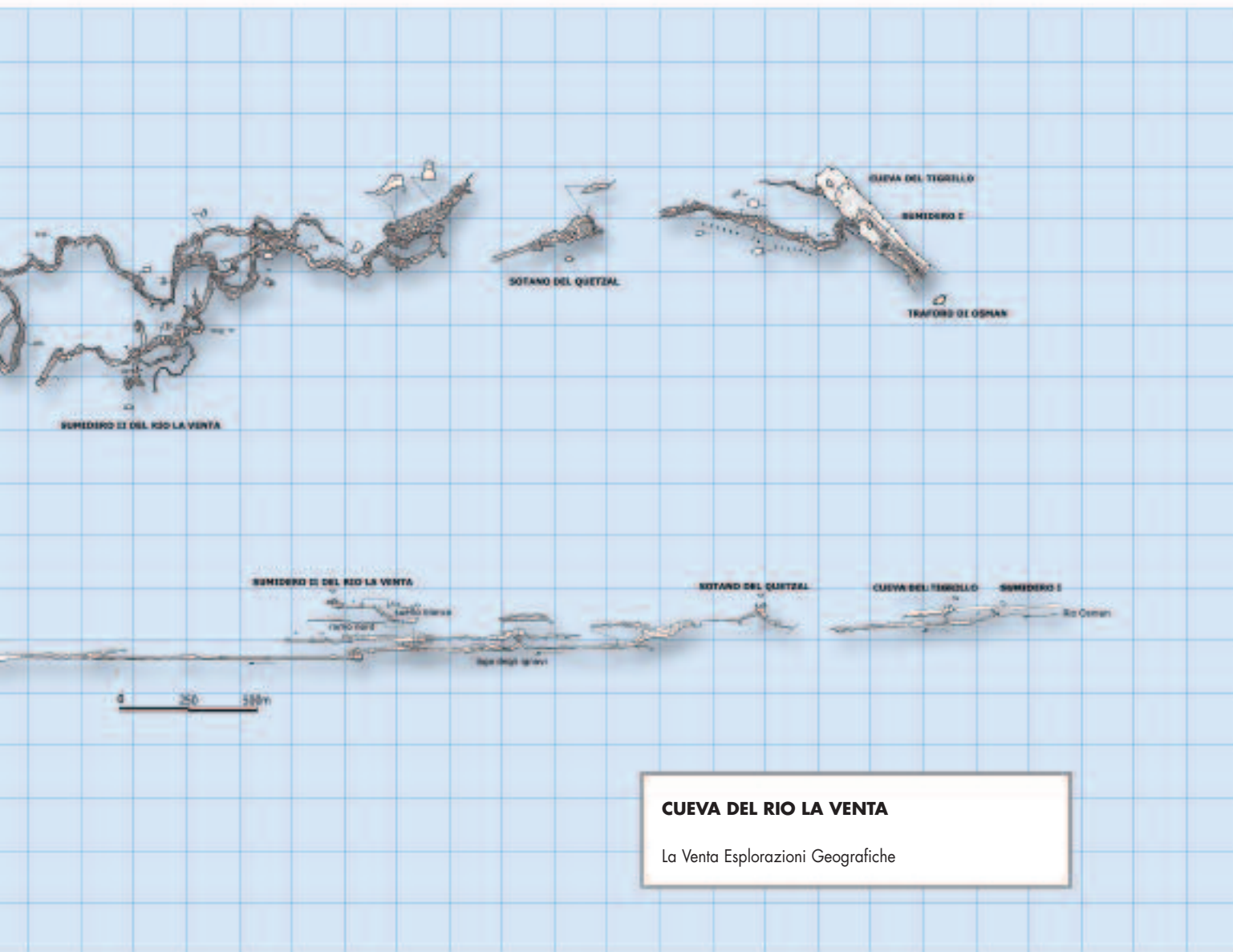


CUEVA DE LA NIEBLINA

Surveyed by: A. Kaiser, A. De Vivo (05/1996)
La Venta Esplorazioni Geografiche

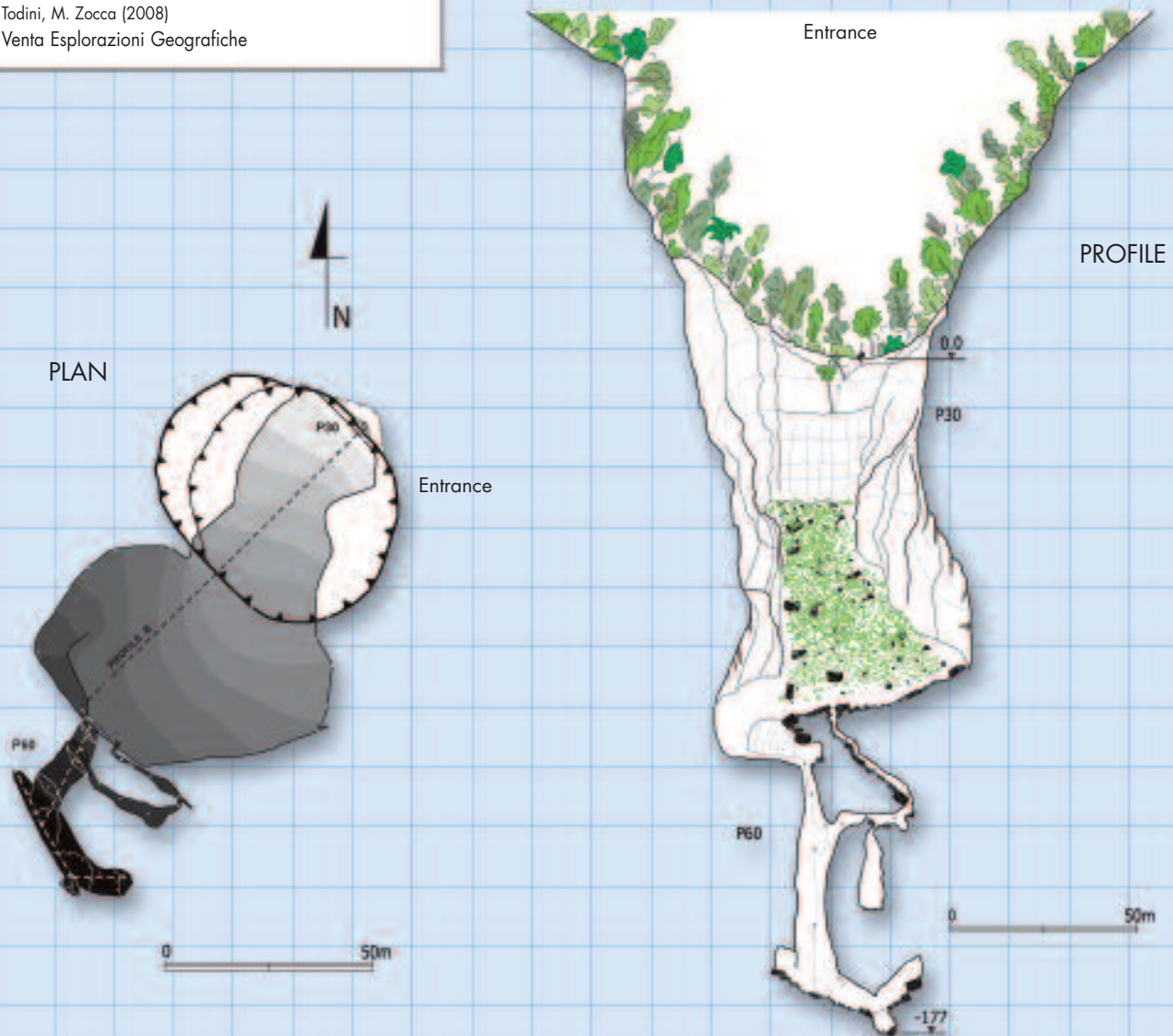






OMBLIGO DEL MUNDO

Surveyed by: T. Bernabei, A. Davila, M. Mecchia, M. Nafate,
L. Ruiz Perez, C. Sanchez, F. Sauro, G. Strapazzon,
G. Todini, M. Zocca (2008)
La Venta Esplorazioni Geografiche





*Plays of light at the base of the first shaft
in Ombligo del Mundo*

*One of the wide natural pools characteristic
of the Cuatro Ciénegas plain*







The karst area of Cuatro Ciénegas

In northern Mexico, not far from the United States border, is a region characterised by mountains up to three thousand metres high with very deep canyons and mysterious wells filled with crystalline water which open in the middle of the desert. It's the area of Cuatro Ciénegas, a small mining town known especially as the birthplace of Vetustiano Carranza, one of the fathers of the Mexican revolution.

To speleologists, when thinking about all that water which springs in a quasi-desert area, it is a natural reaction to ask where it came from. The limestone nature of the surrounding sierras does, in fact, postulate the existence of vast karst systems which collect the scarce precipitation from the mountains, channelling it towards a few emergence areas.

The prospects were therefore tantalizing and the results, at least on a speleological level, were not that unsuccessful, even if research showed that the springs are fed by deep thermal circulation processes. The caves explored, which were many but widely distributed, appear to be the relics of an ancient karst phase whose underground systems are by now largely fragmented and clogged up.

The expeditions

The idea for this project was inspired by the content of an issue of National Geographic Magazine, full of fan-

tastic images of those pools, the desolate mountains, and the desert all around. The article focused on the extraordinary biological peculiarities of the springs, true oases in the desert, but the thing that made us the most curious was all that water, concentrated in a confined space. Where did it come from?

Cuatro Ciénegas seemed to be the right place to start a new research project in Mexico as the Rio La Venta Project was approaching its end. Another reason was that speleological research in this area was practically non-existent.

Our interest was also stimulated by the evident geological similarities to a certain area in the southern United States where some of the most extraordinary karst complexes in the world can be found, such as the Lechuguilla Cave or Jewel Cave, vast caves created by hydrothermal processes and full of wonderful concretions.

In fact, a couple of years previously, in May 1997, a reconnaissance had been held, during which information was gathered which would prove decisive for the final decision. Certainly the stories told by Don Beto, an irreplaceable and punctual local guide, about caves and mines were one of the factors that encouraged us to start the project.

Another reconnaissance, in May 1999, made us realise just how big, badly connected and sun-blasted the area



*The abandoned mine village of La Reforma;
in the background is the Sierra San Marcos y Pinos*

was. In one word... difficult.

The first real expedition was in 2000 and revolved around the fundamental component of the whole project, water. We therefore decided to begin the exploration of the wells using cave diving techniques. Only one of these wells, known as Campana, had already been explored a few decades before by American divers. Of the others nothing, or almost nothing, was known.

*Don Beto, an old miner of Cuatro Ciénegas
and indispensable guide during our research project*



Let's begin with the largest and deepest wells; Becerra, Churince, Anteojo, Azul, Azules, Hundido, Venado, La Vega, Garabatal, Orozco and still more, all related by their position, as though they were crowning the northernmost extensions of the Sierra San Marco y Pinos.

The exploration of these wells ended up being more complicated than expected. The presence of narrow passageways, mud, and loose deposits sometimes caused zero visibility, seriously testing our divers and generally making operations very difficult.

The underwater explorations did not yield any particular surprises but did reveal the presence of water currents at depth, proving the existence of a network of passages under the Cuatro Ciénegas plain.

Unfortunately these passages are impassable.

At the same time and in small groups, we began searching the surrounding sierras, beginning with San Marcos, sometimes following local guide reports and sometimes independently, going up the many *barranco* which furrow these sharp ridges.

The investigations progressively moved on to all the main sierras; Sierra San Marcos y Pinos, Menchaca, Purísima, Madera, San Vicente, and La Fragua, leading to the discovery of many caves although mostly rather small. The moment finally came for some good speleological results, particularly in the Canyon El Pedregoso in the Sierra Purísima, by the creation of advanced camps which we reached and set up through the use of mules, off road vehicles, and in some cases helicopters. The larger caves were found on the mountain slopes, inside the canyons. They develop horizontally, some over a kilometre long, but appear to be relics of ancient systems now dismantled by erosion and filled with sediments and speleothems. That is also indicated by the complete lack of air circulation. We found hardly any-





The long ridge of Sierra San Marcos Y Pinos encloses the west side of the Cuatro Ciénegas plain

thing in the high parts of the sierra, where karstification seems limited to a few superficial forms. The hopes of finding large systems disappeared little by little.

In autumn 2001, we returned in force determined to carry on the same project, taking nothing for granted, and to complete the photographic documentation for an ambitious book on the area's karst phenomena.

During this second expedition, after some external searches which led to the detection of a few new caves, and after having revisited some of the caves already surveyed by the previous expedition, we finally decided to take a risky gamble, to search inside mines. There are quite a few examples around the world of large caves found inside mines so why not at Cuatro Ciénegas?

We try La Reforma mine, the largest of the area, where we organize a camp, re-populating with cavers what was once an old mining village. Our hope in travelling the many galleries and descending the shafts, often unstable and rather ghostly, was to find caves intersected by the mining operations.

The mines turned out to be vast, a real labyrinth at several levels and at least 700 metres deep. We began the descent of one of the service shafts which connects all the levels and we found many natural cavities but all were of limited extension. Some large chambers were covered with glittering calcite crystals.

The last expedition, in 2002, was mainly aimed at making a documentary and descending that which for us had become the "Big Pit" in the Reforma mine. In this way we managed to reach the deepest levels of the mine which are partially flooded. No caves were found, but the investigations carried out and the rock and water samples collected allowed us to get a better picture of the area's hydro-geological structure.

The mine caves

One of the first motives which prompted humans to explore caves was the search for minerals which were otherwise not to be found on the surface. Among these are the pigments which cave men used for their paintings. Even today, in some parts of the world, caves are intensively used as mines, essentially to extract the large guano deposits they sometimes contain for use as a fertilizer.

More recently, mining activities, with their excavation of underground galleries, has allowed us access to a very particular type of cavity, the *mine caves*. That is, caves without a natural outlet to the surface. The importance of these caves is enormous, especially from a scientific point of view, as they are environments which have been completely isolated and kept uncontaminated for hundreds of thousands, if not millions, of years. Also, the accompanying presence of mineral deposits (often mixed sulphides) makes them ideal places for the occurrence of complex chemical reactions which can sometimes lead, thanks also to the particular microclimate existing within these cavities, to the development of peculiar speleothems and rare mineralisation, often limited to a single cave on the planet.

Mexico's territory is rich with both *cave mines* and *mine caves*, some of which are certainly of planetary relevance. Totally characteristic *cave mines* are present in the Cuatro Ciénegas desert (Coahuila State) from which, up until a few decades or so ago, guano was extracted. Even today some of these caves, such as the Cueva Rosillo for example, are home to huge bat colonies. The mining work has sometimes significantly modified the cave's original morphology, creating true mine galleries inside the mighty deposits of this material.

Still in the Cuatro Ciénegas desert, there are interesting *mine caves* encountered within Miniera Reforma. The most important of these is a bell shaped chamber about 40 metres high which has been intersected by a mine shaft. Its interior contains beautiful crystallisation made of calcite and secondary minerals, due to the oxidation of the adjoining mineral deposits.

One of the first mine caves known in the world was discovered at the beginning of the twentieth century inside the Naica Mine (Chihuahua). It is the Cueva de las Espadas, which immediately became famous all over the world for the large gypsum crystals which completely covered its walls. These crystals were mostly removed and sold to the most important mineralogical museums all over the world, where they can still be admired. Recently, inside this same mine, 3 other caves have been discovered which contain the largest gypsum crystals in the world (up to 12 metres in length).

Cave of Lol Tun (Yucatán): stylized image of Bat God realized making use of guano as a chromatic element



A mine gallery excavated in the guano deposit of Cueva Rosillo



The giant wall entrance of Cueva de Los Murciélagos, in Sierra San Vicente, reached after a long climb

The physical environment

We are in northern Mexico, a part of the Great Chihuahuan Desert in the middle of Coahuila state, in a basin which extends for about 850 square kilometres. All around the basin is bordered by rugged mountains which touch 3000 m altitude; Purísima, San Vicente, Menchaca, la Fragua and San Marcos y Pinos. It is within this basin that Cuatro Ciénegas, the small town which lends its name to the entire valley, is located.

It is a desert area which is characterised by the presence of hundreds of small lakes, contained within a protected natural area instituted by the Mexican government in 1994 to protect the flora and fauna which live in the extended complex of springs, rivers, pools and lagoons. The climate is semi-desert, with an annual precipitation reaching 250 mm on the plain and slightly surpassing 500 mm in the mountains.

The mountain ridges are made up of long asymmetric anticline folds, oriented from NNW to WNW and cut by deep canyons which expose the rocks present in the core of the folds.

In this area rocks are mainly well stratified Cretaceous limestone in a thick series inter-layered with marly-siltstone beds and discontinuous gypsum horizons which lie on prevalently continental metamorphic sediments. Above, the succession continues with Paleogenic marls, siltstone, shales and sandstones.

The entire area has been subjected to intensive volcanism during the tectonic phases from the Oligocene to the Pliocene. The late stages of this volcanic activity are connected to the hydrothermal phenomena which gave origin to the mineralization, mostly various metallic sulphides, which permeate the basal levels of the carbonate succession.

The modelling action of the meteoric waters, in climatic conditions unlike the current ones, caused the shaping

of the reliefs and the filling of the inner mountain basins with detrital and alluvial deposits. In a progressively dryer climate, which imposed itself during the late Quaternary, Endorheic (closed) basins formed which dried up to form the current flat areas.

The karst phenomena

Karst is well-developed but only in some areas, being especially typical on the ridges.

In these areas, epigeal (surface) forms are present with frequent karren on bared limestone beds. Dolines are very scarce and only very few are found at fairly high altitudes or at the bases of reliefs, the latter probably as a result from collapse of existing cavities.

The underground karst phenomenon is not very well developed either, apart from certain cases which often show hydrothermal origins. Rock shelters and overhangs are instead very frequent, especially along the walls of the many canyons.

All in all about sixty cavities were explored and mapped, of which only a small percentage extend over one hundred metres. They are mostly ancient caves, formed by the evolution of karst drains, the latter being proof of deep hydrological activities in ancient times.

The presence of karst forms having hydrothermal origin is very interesting and is proven by characteristic morphological elements. Relevant examples can be noticed in the El Rosillo 1, El Junco, Tanque Nuevo, and Rancho Guadalupe caves. Their origin is attributable to the rise of hot waters, which being very aggressive, dissolves the rock creating vast cavities with peculiar shapes.

In Sierra San Vicente, the largest explored cave is the Cueva del los Murciélagos. It is a cave used for guano extraction, tons of guano. It opens at about fifty metres high on a wall and has developed mainly by exploiting



a vertical fracture which makes it of remarkable interest as an example of speleogenesis. The initial gallery leads to an enormous chamber, twenty metres wide, one hundred metres long, and about twenty metres high. This large chamber is almost completely filled with guano and, in the central part, by some large blocks.

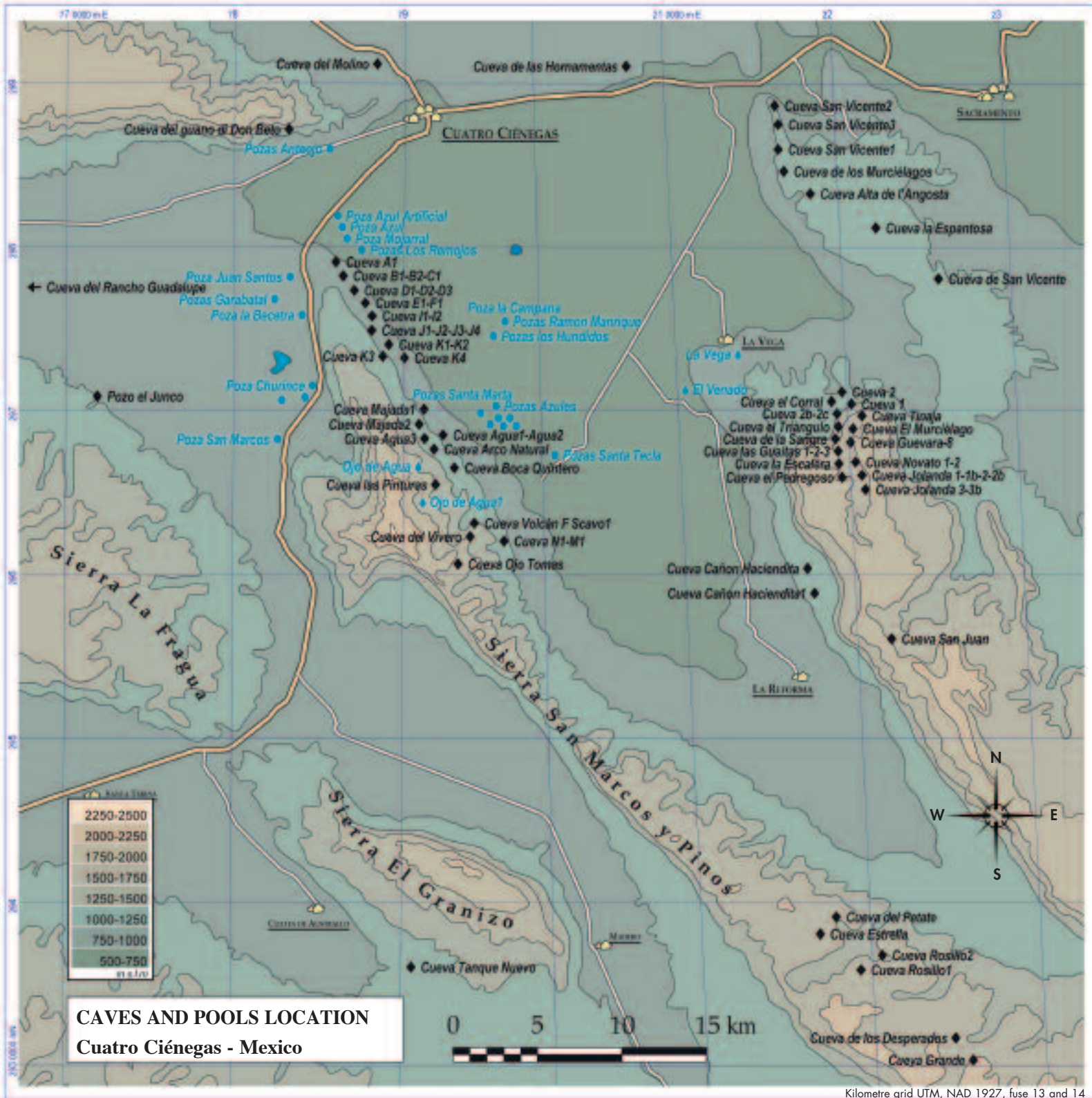
The really interesting things however, are the signs of human presence which can still be found preserved within the cave. Wooden ladders and platforms, hoists and tackle mounted on steel cables driven into the rock, and indications, small indications, of the many souls who lived in there in order to bring out the guano in the kind of conditions which we can only imagine today.

The area where the biggest number of caves was found is Sierra La Purísima. The largest caves are found at the base of the walls in Canyon El Pedregoso. This canyon, over ten kilometres long, has been the object of careful investigation, especially along the walls which, in the final tract, are high and overhanging. The caves mostly open where the lithology changes and among these, Cueva El Pedregoso 380 m, Cuevas Las Guaitas 220 m, and Cueva El Triangulo 55 m should be mentioned. These caves consist of interlayer conduits formed by pressurised water and of segments characterised by vadose downcutting. They also appear to have been truncated by the canyon's deepening. The largest cave is Cueva La Tinaja, which extends for about 670 metres to the NW and whose morphology reveals its phreatic origin when ancient waters under pressure travelled through the fissures. This cavity, like almost all of the preceding ones, has also been a guano extraction site.

In the long and extensive Sierra San Marcos y Pinos, one should mention two caves which open in a right hand tributary of the Canyon El Rosillo, one of which extends for nearly a kilometre. Both were intensive mining sites for the extraction of phosphate (rock composed

mainly of apatite group minerals, calcite and organic minerals) originated by the chemical alteration of limestone rock by organic acids, themselves products of guano decomposition. The main cave, which we called Cueva El Rosillo 1, consists of a single gallery about nine hundred metres long with a few small lateral branches. The dimensions are considerable and throughout most of the main gallery the height reaches up to twenty metres, remaining so almost until the end of the cave. In the final tract the quantity of guano increases as the cave gets smaller. The guano, among other things, has strongly contributed to the cave's shape due to its aggressive nature. In fact there are many dome shaped forms in the cave ceiling, the result of this type of aggression and which is still currently occurring.

In the flat Sierra La Fragua only two caves were explored. The first opens in the bed of Canyon El Junco and is made up of a pit about twenty metres deep with an entrance between rock and debris, descending an elongated fracture closed by debris at the bottom. Even though the cavity is now in an advanced state of deterioration some wall and ceiling forms on the fracture hint at hydrothermal origin. The area's most interesting cavity is found in the northernmost sector of the sierra near Rancho Guadalupe. The entrance, a small circular pit 2 m deep, is on a rocky slope just a few metres above the limit of the plain. It leads to a descending gallery about 1.5 m in diameter with the dome shaped vault typical of cavities created by hydrothermal fluids. After a few dozen metres, the cave divides itself into several maze-like tunnels, formed by the interconnection of spherical chambers. The walls are often covered by calcite and gypsum crusts. One of the descending tunnels goes into a space made up of a wide gallery which leads to a vast chamber. Here the dissolving action of the thermal waters is clearly seen and has left hemispherical cavities



A wide gallery in Cueva de los Murciélagos



The art of improvisation

Natural cavities are an example of how nature manages to develop something over time which borders on perfection. Underground, even empty space materialises, becoming an architectural component, an invisible structure controlled by perfect equilibriums, where the vast chambers and the deep pits coexist in silent symbiosis.

However, when the intrusive and violent works of man make their way through them, like with mines, this equilibrium is shattered and what was eternal becomes ephemeral.

There is no environment more dangerous than mines. Working in them and descending the deep shafts after decades of inactivity means facing a significant risk.

In the Cuatro Ciénegas mines the risk of collapse is extremely high, due to the poor condition of the wooden shoring and the possible sudden detachment of material from the shaft walls. This is because of the degradation of the rock laid bare by mining activities and also because of the dilation of the rock itself due to the staggering external temperature variations of up to 30° C.

While planning the exploration of La Fortuna shaft in Reforma Mine (-700 m), the calculation was quickly made: a stone falling down the shaft and bouncing off the walls would have a very high chance of striking anyone descending it.

This risk led us to plan a personal protection system. Protecting the body was the *condicio sine qua non* to carrying out the exploration. Since nothing readymade was commercially available, we invented a kind of protective shell made by cutting up some ABS nautical buoys.

The protection shield used during the descent in the deep pits of Reforma Mine



The structure consisted of two parts; an encircling one for protecting the shoulders made by cutting the buoy in half lengthwise and the other for the head, made by modelling part of the buoy into a sort of helmet. Both parts were assembled with a system which would dissipate the energy produced by an object striking it. The helmet was attached to the shoulder protection with five flexible pieces of steel, which kept it at a distance as well. The entire structure was padded on the inside with sponge of varying thickness and density, according to the parts being protected. Special buckles and straps, finally, guaranteed the protection's perfect adherence to the body, keeping it stable.

We ironically called the system Lord Fenner (Darth Vader) for its resemblance to one of the Star Wars films' protagonists. In practice, it turned out to be pretty safe and reliable despite its great bulk, which was however inevitable in order to provide a sufficient degree of coverage for the body. The difficulty of movement during the descending and ascending manoeuvres was certainly a point against it, as the entire structure weighed down the person hanging on the rope and kept them from managing their progression in the best way. We can however consider ourselves satisfied with the results, as we were able to explore while being protected, at least psychologically. Along with Lord Fenner, the name of the shaft itself *La Fortuna* (the Luck), brought us good luck as nothing happened and we all returned to the surface in one piece.

Francesco Lo Mastro

Cuatro Ciénegas' ancient hunter-gatherers

The explorations carried out by the La Venta Association on the mountain ranges surrounding the Cuatro Ciénegas valley have led to the identification of many archaeological sites. They are mainly distinguished by important examples of cave art and, to a lesser degree, human remains, stone tools production artefacts, and perishable materials left inside the caves and under rock shelters.

The presence of archaeological material in Cuatro Ciénegas is no surprise. It was here, between 1937 and 1947, that U.S. archaeologist Walter Taylor dug in a number of cave sites, bringing to light one of the longest archaeological sequences in northern Mexico, extending from 8000 B.C. to 1600 A.D.

Taylor subdivided the whole sequence into the Ciénegas (8000 - 4000 B.C.), Coahuila (7500 B.C. - 1 A.D.) and Jora (1 - 1600 A.D.) complexes. They give evidence of the presence, over millennia, of hunter-gatherer groups adapted to the arid environments of northern Mexico and who evidently found an unusual abundance of resources in Cuatro Ciénegas' *bolsón* due to the presence of the water pools.

Taylor's study also brought to light a series of changes which occurred over a long period of time. If the Ciénegas Complex hunters could count on prey such as grizzly bears, elks and bison, a progressive warming of the climate meant that the hunter-gatherers of the Coahuila and Jora complexes had to slowly adapt themselves to hunting smaller animals, as well as gathering wild plants. To do so, they had to travel nomadic circuits which were much wider than those used by their predecessors, whose nomadic movements were, according to Taylor, 'tied' to relatively stable base camps located in the caves at the base of the mountain ranges.

The Coahuila and Jora hunter-gatherers must have been the direct predecessors of the errant nomadic groups which the Europeans met and exterminated when these areas were colonised. Their descriptions of the natives weren't very flattering.

The Coahuiltec nomads are described as miserable individuals who wandered about naked, their shoulders covered by small deer or rabbit skins, faces decorated with paint and scars and wearing their hair long and unkempt. They lived in small bands of about fifteen individuals, dedicated mainly to hunting, gathering and plundering. They often clashed with other bands, especially to capture women.

The Cuatro Ciénegas archaeological remains however, also attest to much more complex activities of a religious type. The many sites with cave paintings, among which the large shelter discovered by the La Venta Association in the Quintero canyon stands out for the number and quality of its paintings, must have been frequented in the course of shamanic ceremonies aimed at 'communicating' with spirits and supernatural beings. Historical sources do indeed mention large gatherings during which long and exhausting dances took place and peyote (*Lophophora williamsi*) was ingested in order to reach a state of ecstasy. On these occasions, during which the cave paintings were probably also executed, alliances and marriage agreements were settled. The great Cuatro Ciénegas rock art heritage, still not well known and currently being stud-

Wall paintings in the Quintero canyon





Wall paintings inside a small cave in Sierra San Marcos y Pinos

ied by a group of Mexican archaeologists led by Leticia González Arratia, is an important document of these activities, undertaken by groups who are now extinct.

The fate of the Coahuilan nomads was harsh. Beginning at the end of the 16th century the area was colonized by the Spanish and their native Tlaxcaltec and Otomí allies from central Mexico and this brought the local nomads to the verge of extinction. In the course of the 18th century, it was the turn of the Apache and Comanche incursions, often directed against the now weakened Coahuiltecs. The final blow came with the U.S. and Mexican military campaigns in the second half of the 19th century, when the nomads were definitively exterminated with horrific methods such as the poisoning of the few water holes in the area.

So the sedentary people defeated the Coahuilan nomads, erased forever from those extraordinary places which since remote epochs had permitted their existence, in a state of fragile equilibrium, and which still now bears the traces of their millenary history.

Davide Domenici



of up to four metres on the walls and ceiling, in some cases still covered with precipitated calcite crusts. Vadose formations formed by infiltrated water are also present but by now are only sporadically active.

In the plain areas where the many spring pools are found, only one cave is present. Called Poza La Campana, it's the only one that has underground passages which can be explored. The entrance opens as a sinkhole right in the middle of the desert plain, and after a leap into the void of about six metres one finds the water blue and transparent, unimaginable in that place.

In the middle, about three metres beneath the water's surface, a detrital cone functions almost as a watershed. From here, two branches take off, one towards the northwest, the other towards the west. The first branches out, zigzagging for about seventy metres, reaching a depth of about nineteen metres. It is interrupted by narrows which, although passable, make progression quite complicated. The rock tends to crumble even with the slight disturbance caused by the air bubbles emitted from the diver's regulator and creates that sludge which reduces visibility to practically nothing. The other branch is less developed and goes down to about seventeen metres and closes at a bottleneck.

Concluding remarks

Most of the caves discovered are interlayer cavities of limited extension and of uncertain origin. In many cases one has the impression that they are local phenomena due to particular lithological conditions or to circulation between the layers.

The largest caves exhibit forms indicating a dissolving action by rising thermal waters which are characterised by slow flows. Among these caves, Cueva Rancho

Guadalupe shows the forms most indicative of hydrothermal origin.

In the area of Sierra San Vicente, and especially in that of El Pedregoso, there are relics of caves having phreatic origins tied to the circulation of meteoric waters. In all cases it is an ancient karst, preceding the phases of intensive surface erosion which led to the incision of the dense canyon network.

Summing up, many caves have been explored along the almost impenetrable canyon walls, in places needing great organizational and logistical effort to reach them. Their sub-horizontal morphology did not allow entry into the mountains or to descend to great depths. To do so there was only one way, through mines, old mines, like the many present in the area around Cuatro Ciénegas where mining activities date back to the 16th century. Mineral de Reforma is today a ghost town but it once had over 3000 inhabitants before the miners left the Miniera Reforma whose shafts reached down approximately 700 metres.

In that fantastic place inside the realm of memories, we organized our camp, thus re-populating the old village for a few brief days. The hope, for those who descended the ghostly and often unstable shafts, was to find caves that had perhaps been intersected by the mining activity.

The attempt was rewarded. Descending the shafts, which in some places were really falling apart, we met some karst conduits where the movement of water, which is rather plentiful at certain depths, had created extraordinarily beautiful deposits. Pisolites, cave pearls of pure aragonite, were found at 300 metres depth in a passage where the mine is slowly transforming itself into a cave.

All this leads us to believe that the chances of access-

A giddy rope descent to reach one of the several entrances peeping from the canyon walls

ing vast underground complexes are limited, because the caves are probably interrupted by infills of both chemical and physical origin. The only possibility of exploring vast caves is tied to the discovery of cavities having hydrothermal origins. To support these hopes are the not too distant examples found in fairly similar geological conditions, the vast complexes of the same origin found in the United States, including the famous Lechuguilla Cave.

*Antonio De Vivo, Leonardo Piccini,
Giuseppe Savino*



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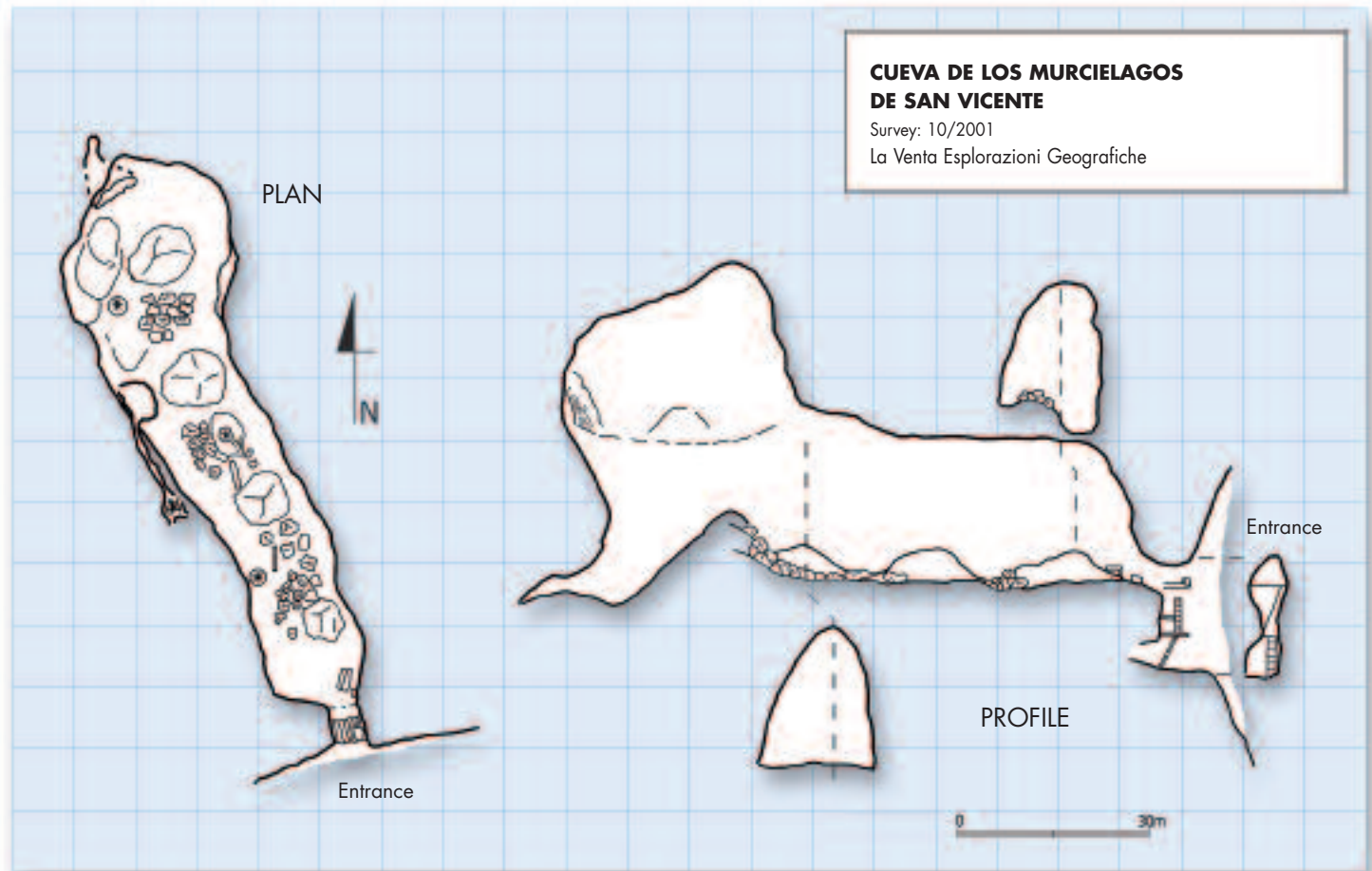
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Surveying Cueva Rosillo



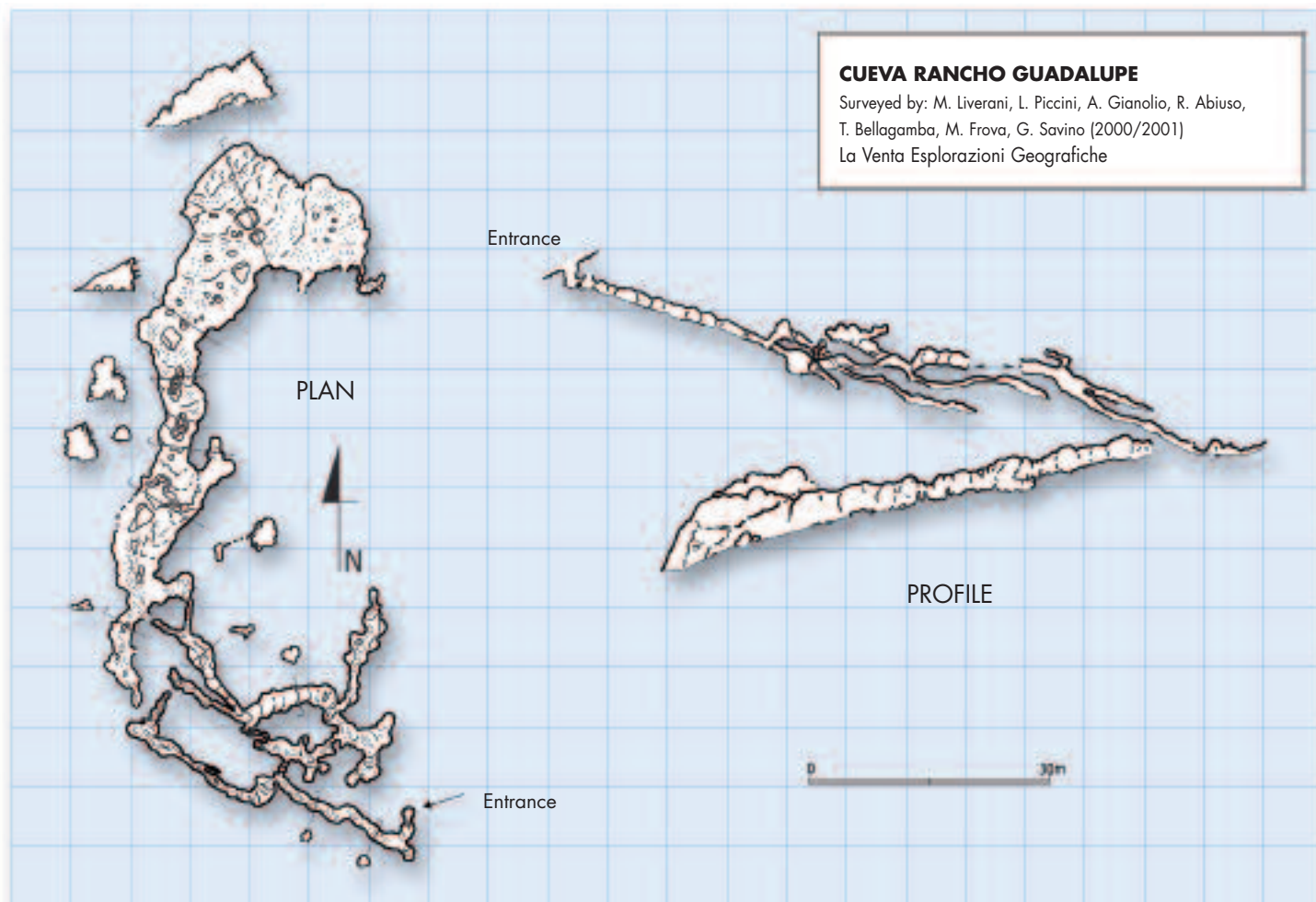


Appendix



CUEVA RANCHO GUADALUPE

Surveyed by: M. Liverani, L. Piccini, A. Gianolio, R. Abiuso,
T. Bellagamba, M. Frova, G. Savino (2000/2001)
La Venta Esplorazioni Geografiche



CUEVA TINAJA

Surveyed by: V. Grassi, A. Beltrame, A. Santini, M. Nafate,
G. Savino (11/2000)
La Venta Esplorazioni Geografiche

PLAN



PLAN AND PROFILE



CROSS SECTION

Entrance

Entrance

PROFILE

CUEVA ROSILLO 1

Surveyed by: M. Liverani, G. Savino, P. Suriano,
V. Grassi (11/2000)
La Venta Esplorazioni Geografiche

Entrance

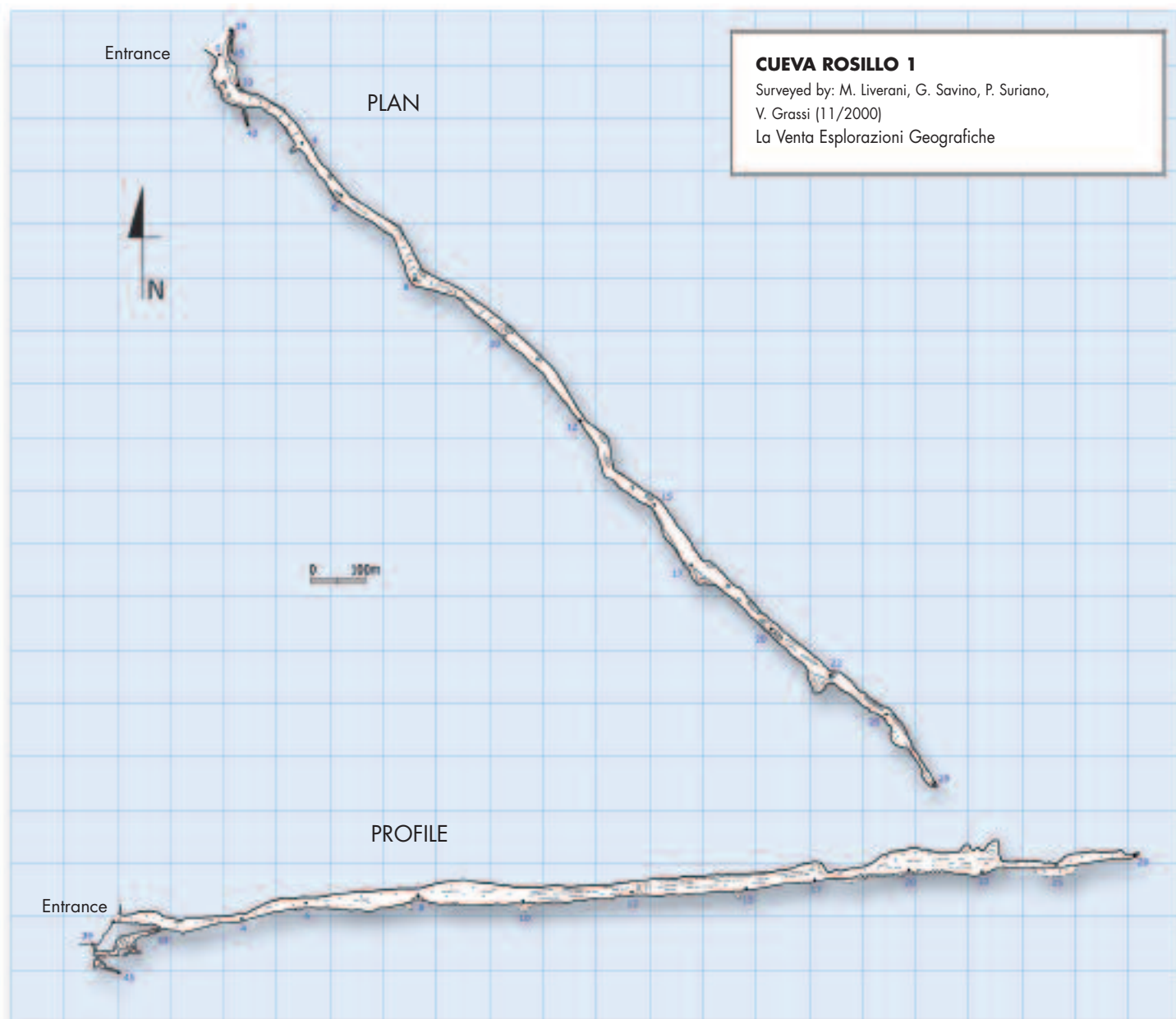
PLAN



0 100m

PROFILE

Entrance

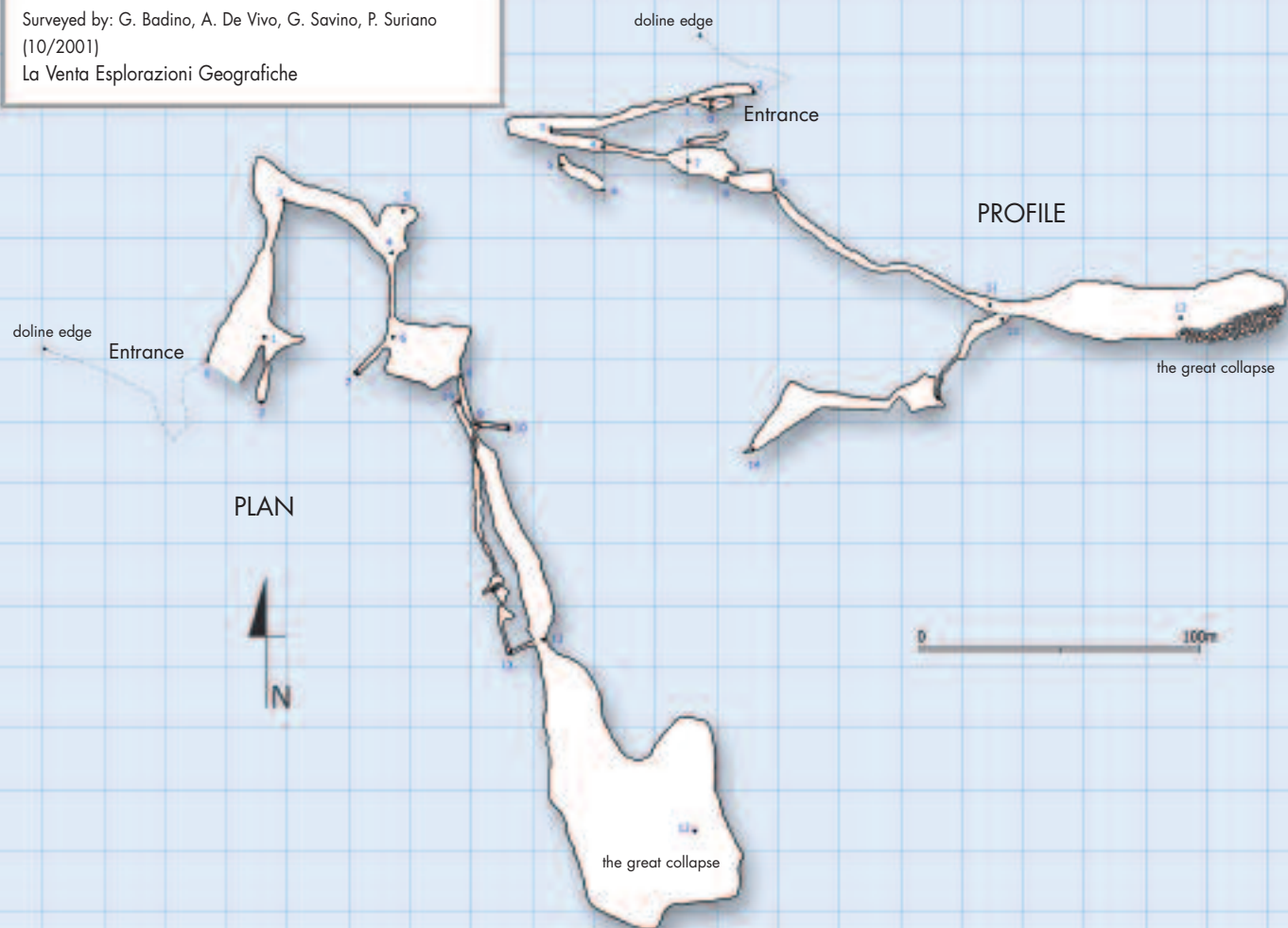


CUEVA HUNDIDA

Surveyed by: G. Badino, A. De Vivo, G. Savino, P. Suriano

(10/2001)

La Venta Esplorazioni Geografiche



CUEVA DEL GUANO DI DON BETO

Surveyed by: M. Liverani, T. Bellagamba (11/2001)

La Venta Esplorazioni Geografiche

0 50m

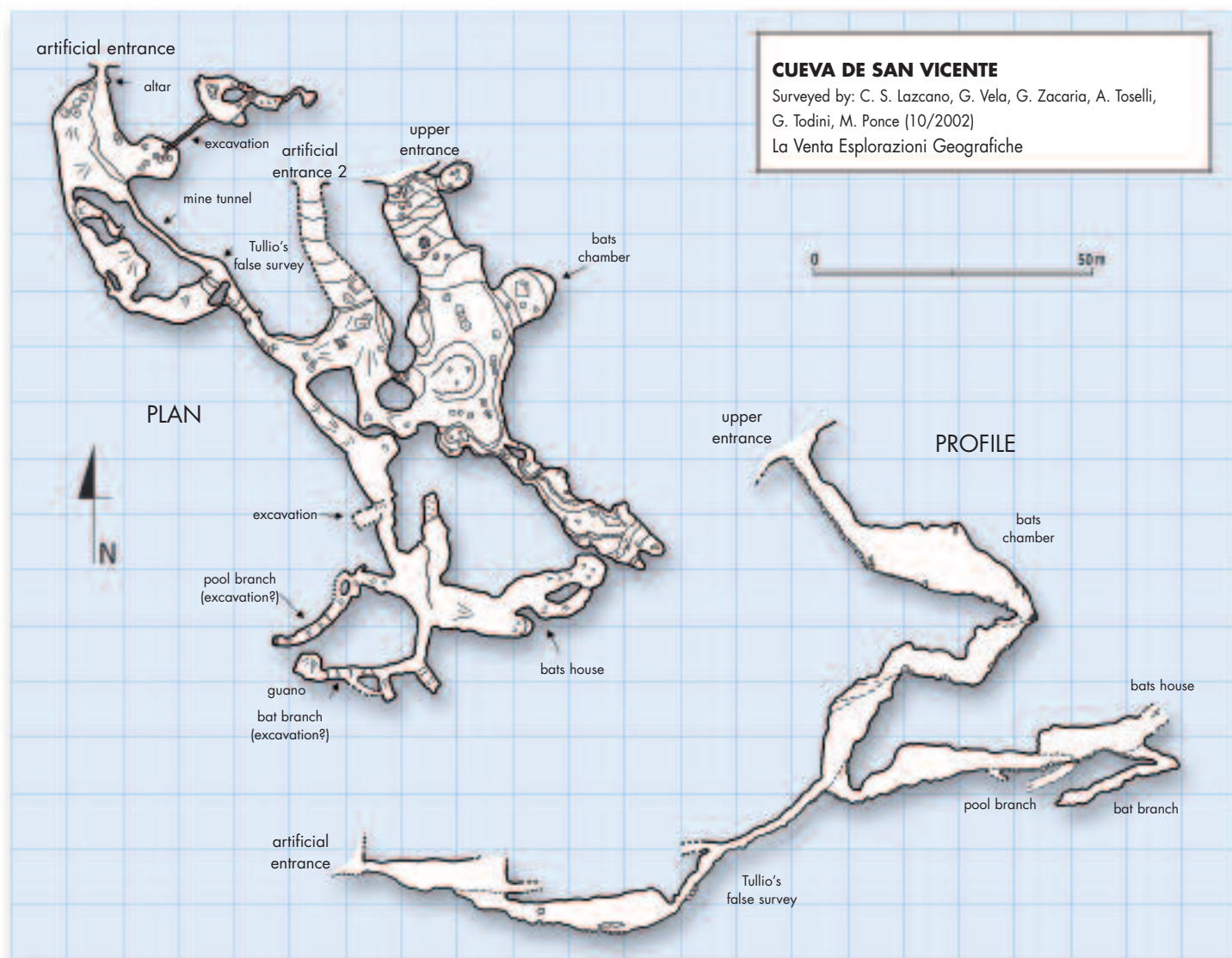


PLAN

Entrance

PROFILE

Entrance



POZA LA CAMPANA

Surveyed by: G. Casagrande, M. Liverani, T. Piovesan (10/2001)

La Venta Esplorazioni Geografiche

Entrance

0 30m



PLAN

Entrance

PROFILE

Cueva de los Murciélagos, Sierra San Vicente







The karst area of Rio Juquila

After the tropical karst in southern Mexico and the semi-desert karst in the north, our attention turns to the mountains to the north of the Sierra Madre del Sur.

It is here that one finds the great Sierra Mazateca systems, among which are the famous Huautla and Cheve systems, respectively 1475 m and 1484 m deep and 56 km and 26 km long. A few dozen kilometres to the west of this ridge is the Sierra Zapoteca. The climate is different, much more arid, as we're further away from the sea. Also, the great depressions and closed basins with their active swallow holes, which characterise Sierra Mazateca are missing here. Nevertheless, caves don't always announce themselves with conspicuous karst phenomena on the surface.

The potential is however considerable, with over 2000 metres between the high parts of the limestone relief and the valley bottoms. A grandiose canyon, known as Juquila (on maps it is also called Xiquila) cuts a vast limestone massif in half, opening a wonderful window on the geology and caves of this area.

The expeditions

Juquila canyon is on the border between the states of Oaxaca and Puebla. Its length is over 40 kilometres, with a drop of over 1000 metres. We detected the canyon in 1998 during a fly over. It seemed to be a wild and almost inaccessible place, with a good chance we

thought, of hiding the accesses to deep and ramified underground systems within its interior.

The few and sketchy bits of information we managed to gather in the following years told of caves spread over the mountains, hours away from inhabited areas and roads. It seemed as though no cavers had taken a serious interest in the area. No indication came from a careful bibliographical search either, apart from one article on Cueva de las Mascaras, near Zapotitlán, where in 1986 some important archaeological remains were found.

It was more than enough to justify scheduling a first reconnaissance.

The first expedition took place in April 2002. The take-off point was Tehuacán, in the state of Puebla, a pleasant town of about 100,000 inhabitants. It was also the headquarters of the Tehuacán-Cuicatlán Reserve, where we obtained the permits to explore inside the protected area. The expedition was made up of two independent groups. The first had the goal of descending the canyon by entering its upper part, the second to reach the central part by ascending from the bottom or descending from the plateau. The two groups should meet in an area partially cultivated with bananas, where there are the most important karst springs of the entire area.

The first group moved from Tehuacán to the town of Tepelmeme and then on to Puerto Mixteco where the

*Dwarf palm trees and agaves frame the Tehuacán plain,
shrouded in the morning mist*

track ends. It's here that the descent into the canyon began, starting down a dry tributary. After a few hundred metres, the group found itself before the Puente Colosal, or Puente Mixteco, or Ndaxagua, a natural tunnel over 250 metres long and 50 metres high, well known to the locals and noted for numerous and well-preserved pre-Spanish Mixtecan cave paintings. If this was the prelude to the area's underground world, then there was a lot to look forward to.

As the group moved on into the canyon the surroundings become more and more spectacular with limestone walls up to 500 metres high. The descent turned out to be more difficult than expected but allowed us to

*Panoramic view of the limestone highlands
cut through by Rio Juquila*



take note of many caves in the walls, especially on the left hand side.

In the area of the springs, called La Huerta, where the second team had set up the base camp, several caves were found, one of which was almost a kilometre long. After four days the two groups were reunited. Just below the camp the river entered a wide tunnel, followed by a series of waterfalls and springs which joined the main branch between extensive travertine deposits and luxuriant vegetation, creating totally unexpected surroundings in a semi desert area like this. The results of this first visit were more than encouraging.

The second speleological expedition took place in November 2003. Unlike the previous one, this mission's main goal was getting acquainted with the high areas, spread around the massifs which surround the canyon's long incision. Eleven Italians and five Mexicans from the Universidad Nacional Autónoma de Mexico (UNAM) participated.

After renewing the agreement with the Reserve, we established a base at Tepelmeme, the township which includes the most interesting areas. Here we had to spend a few days convincing the local authorities to grant us permission to carry out speleological research. In the entire Mexican state of Oaxaca the indigenous population is rather distrustful of the presence of outsiders. In the end the difficulties were resolved and we could begin the external sweeps that were based mainly on reports of pits and caves. We were accompanied by local guides.

In the first few days we divided into small groups of 3-4 people and carried out the first reconnaissance of the western zone (Cerro Tequelite and the Mahujzapán area) to the left of Rio Juquila, and in the eastern zone to the right, on the vast plateau which culminates in the



Juquila: A diary

Tullio saw the canyon for the first time in 1998, while on a fly over.

The place emanated a really intense charm. Completely isolated, it must never have been travelled from end to end. We therefore decided to investigate. In many ways it was reminiscent of the first descent of the Rio La Venta in Chiapas, many years earlier. An expedition aimed at verifying whether it was passable, as well as also finding entrances and springs.

However, four years had to pass. A long wait but compensated by a real adventure journey, like we had not done for a long time...

The idea is to divide ourselves into two groups of six people. The first will enter the upper section of the canyon through the Rio Grande and the second will reach the central part by descending from the plateau. Base camp will be set up at the meeting point of the two groups, an area partially cultivated with bananas and having lots of springs.

From Tehuacán we move on to the village of Tepelmeme and then to Puerto Mixteco, where the dusty track which leads to the Rio Grande ends. It is here that the first group's long descent begins. It's late afternoon by the time we enter the Puente Colosal, or Puente Mixteco, or Ndaxagua, a natural tunnel over 250 metres long and 50 high, well known to the locals and noted for numerous and well-preserved Mixtecan pre-Spanish cave paintings. Some are large and disquieting and overlook the dry riverbed where we set up camp. We plot out the topographic survey, lashed by a strong and constant wind coming from down the valley and whose force is increased by the tunnel which acts like a funnel. It is a wind which won't leave us even at night and quickly consumes the last embers of the evening fire.

We wake up to birdsongs, amplified by the canyon walls and the tunnel. We begin the long descent loaded with extremely heavy backpacks. We have little water but know where to find some, several kilometres down the valley and many metres lower, at the confluence with the Juquila canyon. However, our hopes of reaching it without any snags quickly fade. Ugo feels bad and stops. While descending a short stem climb, Italo slips and badly sprains his knee. The group slowly picks its way through the vertical drops which break the inclined line of the Rio Grande, Ugo and Gaetano remaining high, Tullio, Alex and Italo in the lower part, trying to reach the water, while I go back and forth, maintaining contact between the two groups. After many hours of effort and thirst, we finally reach Juquila's crystalline waters and I can return to my uphill companions loaded with water. We spend the night separated into two groups, listening to the lullabies of a thousand sounds which can be heard in the dark. The next day the group reunites and we begin the long descent.

At times it seems as though we are in Rio La Venta. Cave entrances peer out everywhere

Dressing a wound at the base camp after a fall during the descent of a rock pitch



from the sheer walls above. Some are really gigantic, ancient resurgences or galleries cut through by the deepening canyon. We would like to climb up and explore them, but can only note their position with the GPS. Instead, we visit a small cavity at river level, whose floor and ceiling are completely covered with calcite crystals.

We continue through spectacular surroundings where blocks as big as houses alternate with flooded sections which have to be swum, ferrying the backpacks on tiny boats. The canyon continues in a similar fashion the next day as well, and it was while climbing down a small drop that I kept my appointment with fate. Only a few metres, inclined, the double rope I hold in my hand should be enough. But the backpack's weight plays a dirty trick and unbalances me. I'm fully aware of what's happening, but can do nothing about it. My feet lose their grip and slip away, my forehead violently hits the rock face and I drop. I fall into the water, bleeding and with hands burned from trying to hold on to the rope.

Ugo stitches my brow back together. An hour later we are underway again. One of us limping, one close to exhaustion, and one with a patch over his left eye... We've almost finished our food, we've punctured the dinghy and we don't know how much longer it will take us to reach our friends downstream...

But it doesn't take much to raise morale again. That evening, at the camp we afterwards named Refosco, a bottle of that Friulian wine carried all the way in great secrecy by Tullio, removes the fatigue and warms our hearts. As an extra, Ugo manages to receive the Italian news broadcast transmitted by RAI International on his small radio despite being at the bottom of the canyon. It makes us feel a little bit at home.

April 22 sees us engaged in climbing around jammed boulders, negotiating rope traverses and crossing lakes. We're exhausted. Around three in the afternoon we reach an area having springs on the left hand side, beautiful. Pools and lakes result in constant ferrying, but the radio contact with our friends climbing up from downstream tells us that by now there isn't much further to go. We soon see them. We descend the last 20 metre drop and we're all together again.

Another hour and a half's walk along ancient canals, still being used for transporting water, brings us to La Huerta where our companions have made camp. They arrived after a murderous 12 hour march under a blazing sun, thanks to the precious help of Don Enrique e Don Elpidio, 64 and 72 years old respectively, both indefatigable and having a perfect knowledge of the area. Just below the camp, the river enters a wide tunnel, followed by a series of waterfalls and springs which join the main branch, between extensive travertine depositss and luxuriant vegetation. We pass the last days exploring and surveying the springs which collect the water all the way from the sinks on the plateaus, over 1500 metres higher up.

One day, perhaps, we'll come out from one of them, after a long and deep underground voyage.



A drop along the course of Rio Juquila

Cerro Grande (2520 m a.s.l.). At the same time a group again descended into the canyon, passing through the Puente Colossal, to explore some caves seen during the previous expedition. Within a few days many caves had been found but in most cases they were cavities having only a few dozen metres of development. The exceptions were two deep pits found on the Cerro Grande, which were to become the main goal in the second part of the expedition.

The first pit named Pozo de la Laguna Prieta, turns out to be a 200 metre drop, followed by a gorge and then another 35 metre pit. From there another short pit ended on a floor of debris and organic matter at 280 metres depth. The second pit, which we called Pozo de la Vaca Ladra, continued after a first pit of 12 metres with a 100 metre cylindrical pit just a few metres in diameter, unfortunately closed at the bottom with mud and debris. The autumn of 2004 saw us again engaged in this area. This time it was only a small group of three people, who carried out a quick reconnaissance of the areas around Cerro Verde's peak. The indications we had collected the previous year turned out to be correct and we found several cavities, mainly pits, which were only partly descended due to a lack of time.

In the meantime, a University of Florence student, in the context of a thesis on karst in the Tehuacán-Cuicatlán Park, carried out some geological research in the Zapotitlan area, also finding some interesting caves including some that had already been visited by speleologists from Puebla.

We returned in February 2006 with the aim of exploring this new area which, because of its altitude (almost 2800 m), was the one with the best potential. Unfortunately the situation wasn't favourable. The Tepelmeme administration placed serious obstacles to accessing these

zones and the permits were delayed.

We therefore decided to move to the Santa Maria Ixcatlan area for a few days. This lies to the south of the areas seen in 2003. Here the welcome was much better. We soon set up a camp in the area called Terrero San Antonio and over the course of five days, accompanied by local guides, we found about twenty caves. Although there was no lack of caves here, none of them turned out to be of interesting length. The best result was a vertical cave 135 m deep. Of note however was the discovery of traces of human presence within several caves, not to mention the ruins of what seemed to have been a large settlement.

The Puente Colossal, a karst tunnel that gives access to the central section of the canyon



*One of the final drops in the deepest part
of Rio Juquila*



At the beginning of 2007, after a long negotiation, we finally managed to get a three year exploration permit for the Tepelmeme municipality. The agreement included the donation by La Venta of a computer with a printer, as well as some cans of paint to repaint the village community hall. In November 2007 we therefore set off on a new expedition. We finally had at our disposal local guides who had been forewarned of our arrival. We divided into three groups, two of which dedicated themselves to the exploration of caves in the highest reaches of the mountains (Cerro Verde and Mauizapán); the other had the task of descending the entire canyon, including the part above Puente Colossal which wasn't descended in 2002 for lack of time. This section of the gorge turned out to be much longer and more demanding than had appeared on the flyovers, with deeply sunken tracts and lakes hundreds of metres long. In the course of the descent, many caves were noted and explored, almost all containing traces of human presence including paintings and other archaeological finds. Some caves were not completely explored for lack of time; others were only positioned and photographed. After eight days and over 27 km of canyon with no possibility of radio contact, this group reached the Huerta area where they rejoined the Mauizapán group. Meanwhile, the reports of caves on the mountains were very many, even if in most cases they were only short pits blocked by debris. A cave occupied by a large bat colony, the Cueva de los Murciélagos, was descended to 80 metres depth, while a nearby cave full of archaeological relics was also explored. In the Mauizapán area, several interesting blowing caves lying vertically above the Huerta resurgences were found but despite the many reports, we were unable to find a usable entrance at high altitude while the area of the slopes near the resurgences





Downstream of La Huerta spring, the canyon presents an underground tunnel where the river flows inside a narrow gorge

seemed to be much more promising. The relationship with the local community finally began to thaw. We gained the trust of the inhabitants of those lonely mountains and at the end of the expedition were warmly invited to return in the following years to keep searching for the access to Juquila's heart.

The physical environment

The area is in the state of Oaxaca, about 50-60 kilometres south of Tehuacán and includes a sector of the Sierra Zapotitlán, part of the Sierra Mixteca-Zapoteca which lies within the Tehuacán-Cuicatlán biosphere reserve.

More precisely, the area investigated was the territory of the Rio Juquila (or Xiquila) basin, a tributary of the Rio Salado, the river which follows the Tehuacán valley towards the south to join the Rio Grande. The most promising karst areas, among those identified, are found in the terrain surrounding the Zapotitlan area, to either side of the Rio Juquila's terminal section.

Currently, the Tehuacán Basin and the terrain to the southwest of it are characterised by a semi-arid climate, with precipitations which vary between 250 and 500 mm according to altitude, concentrated in the months of June and September. Precipitation is scarce mainly because of the barrier effect caused by the mountains to the east of Tehuacán, which block the humid air currents arriving from the Gulf of Mexico. Due to the lack of rain gauges it isn't possible to make more accurate precipitation estimates, but it is probable that in the higher parts of the Sierra the rains reach 500-600 mm per year.

In the ridge areas, there is the interesting phenomenon of 'hidden' precipitation caused by the interception by tree leaves of the fog which occurs mainly with easterly

winds. This phenomenon could explain the presence of *Quercus* genus forests, which normally require higher precipitation than that which the current climatic conditions provide.

The mean annual temperature varies between 18 and 20 °C in the valleys, while they should be around 12-15 °C in the mountainous areas. However, we are lacking accurate data also regarding temperatures.

Like in other parts of Mexico, it is thought that in some periods of the Quaternary the climate could have been wetter and characterised by less seasonal variation. The transition to the current climatic conditions probably occurred about 10,000 years ago, triggering the desertification processes which in recent times has accelerated due to deforestation, the spread of sheep herding, and the over-exploitation of the water table.

As far as the geological composition is concerned, the Zapotitlán Sierra is mainly made up of a Lower Cretaceous limestone sequence, about a thousand metres thick, characterised by prevalently detrital and bioclastic facies which lie on marly-clay rocks, also from the Cretaceous. Above the limestone formation, we find a terrigenous Tertiary sequence (Paleocene-Oligocene) principally made up of marls and sandstones which outcrop mainly in the south-western parts of the basin.

Extensive volcanic phenomena from the Late Tertiary have left trachytic lava flows and pyroclastic deposits. Over the entire area, superficial degradation and alteration processes have produced extended mantles of debris which are responsible for the regularisation of the slopes and the levelling of the relief's low energy inner zones. The slope debris takes the form of well-cemented strata typical of the modelling of limestone regions in semi-arid climatic conditions having high

relief energy.

The structural arrangement is all in all rather simple. The layers are slightly inclined, prevalently towards the western quadrants. The limestone block is cut by many faults, mainly directed around NNW-SSE, parallel to the normal fault system of the Tehuacán *graben*. Other faults are oriented approximately E-W. Many of these faults correspond to the major incisions of the fluvial network, which therefore has a mainly angular arrangement.

The karst phenomena

Karstification manifests itself in different forms. Surface forms include several types of dissolution sculptures, mostly grooving and water furrows, or rounded furrows covered with soils or red earth. In areas without soil there are also karren landscapes, with accentuated karst trenches and crevices. Forms of localised infiltration such as sinkholes or karst pits, are fairly rare and are mainly concentrated on ridges and more generally, in the highest parts of the relief.

Along the slopes, karst forms are likely to have undergone a dismantling process due to physical degradation phenomena. Dolines or sinkholes, when present, have been cut off and/or filled with debris and only faint traces remain of them, manifested as shallow rocky hollows with scanty or absent vegetation.

The cavities which are encountered, especially on the ridges, are relict caves, cut off by erosion during the slope modelling process.

This situation is particularly evident in the left hand sector which leads up to Cerro Verde and Cerro Tequelite. The right hand sector, the long rounded N-S oriented ridge which culminates in the Cerro Grande plateau, has better preserved surface forms due to infiltration.



So far, 31 caves have been explored, especially in the Juquila canyon's central sector and in the Cerro Tequelite and Cerro Grande areas, while another dozen remain to be investigated.

In the high areas, most of the explored cavities are pits varying from a few metres to a maximum of 35 m, blocked by debris and organic matter which came in through the entrance. The exceptions are the two largest caves found in the Cerro Grande area, made up of a vertical sequence of pits including very deep ones. Their depths are 280 and 134 metres.

In the S. Maria Ixcatlan area, apart from other vertically oriented caves which are at most 135 metres deep, some caves were found which had forms typically tied to the convective circulation of thermal water, such as limestone crusts covering typical dome shaped chambers. These are the first hydrothermal karst phenomena reported in this area.

Because of the altitudes at which these caves open, they are evidently very ancient phenomena, restarted by the circulation of meteoric water and exposed by the plateau's erosion.

The situation of the caves present in the canyon is quite different. They are for the most part segments of conduits cut off by the deepening of the river and which probably made up an ancient phreatic network. Many of these cavities are filled with materials brought in by the river, as well as with large accumulations of speleothems which are now completely inactive and are often broken by local slope release processes.

General considerations and future possibilities

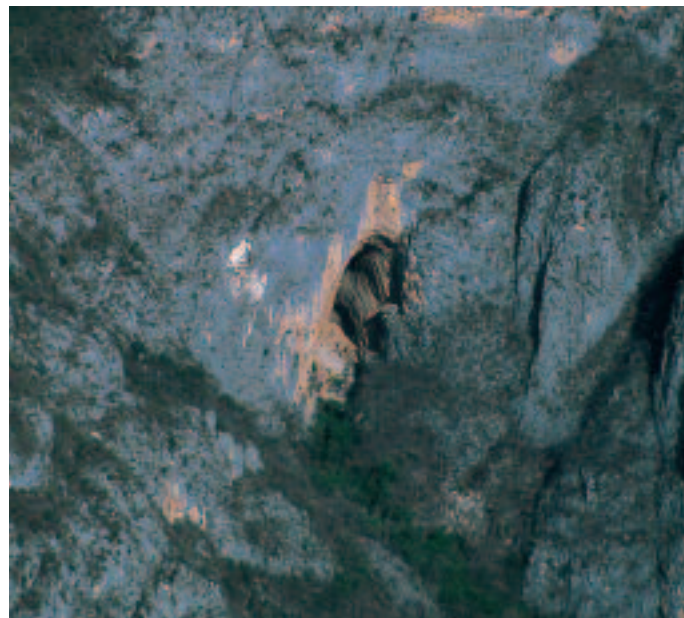
The karst potential of the area is without doubt remarkable. There are over 300 km² of limestone outcrops with an altitude difference of almost 2000 metres between the absorption areas and the springs.

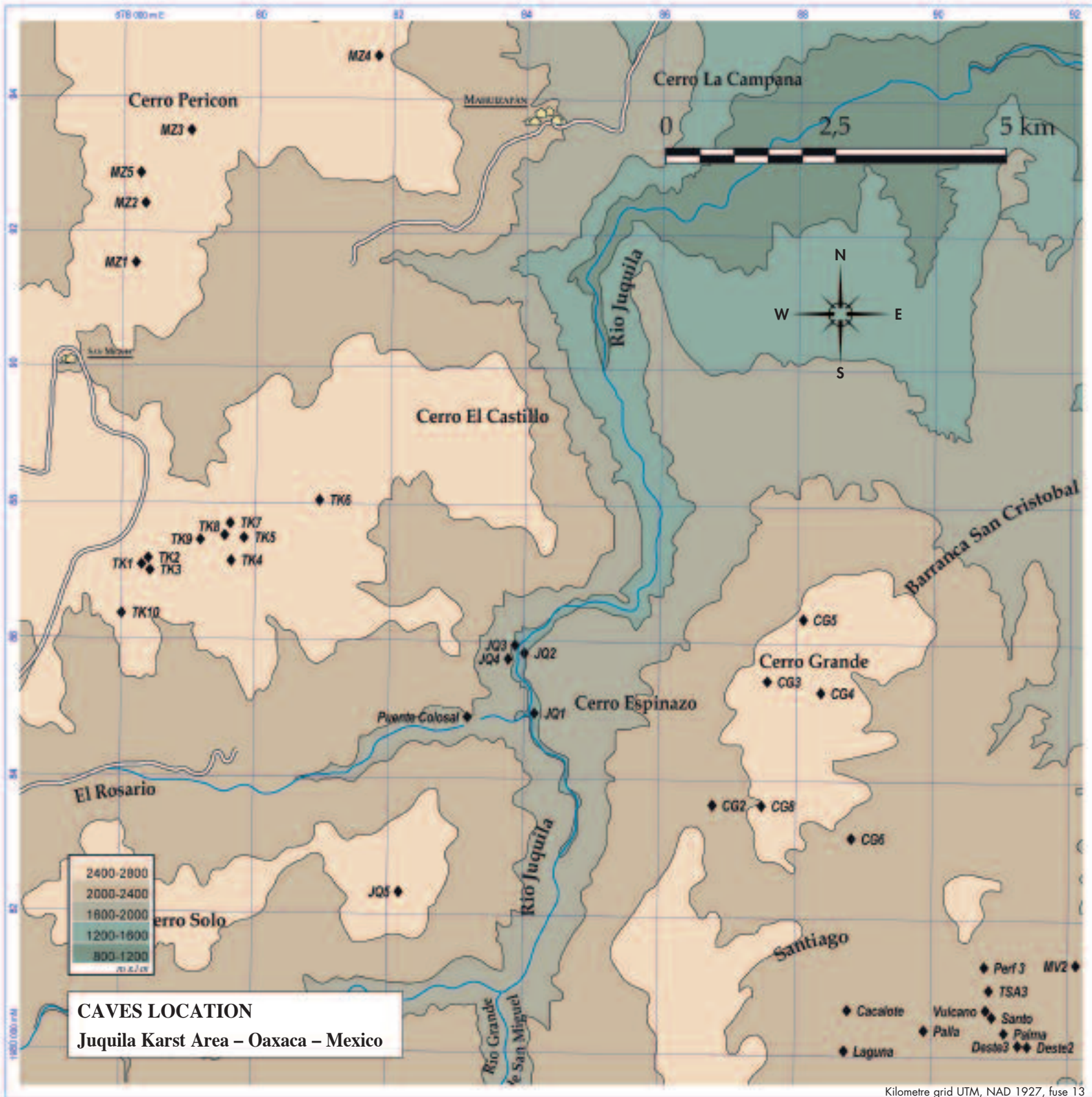
The caves found in the plains, on the high ridges, and in the canyons, as well as the numerous springs, prove the existence of well developed karst systems.

However, many of the explored caves are relict cavities, tied to ancient karst cycles which developed in morphological and even climatic conditions which were very different from those of today.

The oldest caves are probably those of hydrothermal origin found in the S. Maria Ixcatlan area. These caves are situated on a fault and probably precede the rising which formed the limestone ridge and at the same time created the Tehuacán tectonic basin. Their age could therefore go back to the late Tertiary (Pliocene?).

Aerial view of the great downstream portal of







The cavities present in the canyon appear to be relics of a vast deep system, developed in phreatic conditions, which preceded the canyon's incision.

Such caves, whose altitudes are between 1400 and 1700 m, could be correlated to the Tehuacán-Cuicatlán basin's lacustrine phase, dating back to the Pliocene-Lower Quaternary and preceding the incision of the Tecomavaca Canyon which presumably caused the lake to empty into the Gulf of Mexico and led to the deepening of the current canyons.

The formation of the Puente Colossal tunnel could also be tied to this phase of rapid deepening of the hydrographical network, following the underground losses of a valley left suspended after the incision of the canyon. Also the caves found in the high areas, although prevalently vadose in origin, show evident signs of senility. They are almost always cavities brought to light by the erosion of the slopes, not closely correlated with the current morphological situation and seem to be in a 'fossilising' phase, that is, subject to being filled up by debris and eroded soils.

Exceptions are the two deepest caves, which still function as temporary sinkholes, and can be related to the current karstification phase even though they are also subject to infilling processes.

The main springs in the area are found in the canyon at about 800 metres altitude and certainly collect the infiltration waters to the West of the main valley. On the other hand, the destiny of the waters absorbed in the Cerro Grande area is still unclear, although they could flow directly into the Rio Salado basin to the east. Concerning the springs, it should be noted that these waters, rich in calcium carbonate, are particularly encrusting and have formed large travertine deposits below the resurgences. From collected data, it seems that these springs have small flow variations, even dur-

The entrance of Cueva Dos Ojos, the longest cave explored in the canyon



ing the dry season, which here lasts up to 5 or 6 months. These characteristics do not fit well with a circulation through well developed karst conduits, which usually involves low carbonate contents and a large flow variation.

In other words, the aquifer which currently feeds the La Huerta springs seems to be more of a 'dispersed in fractures' type rather than one involving large karst conduits.

This apparent contradiction with the evidence of a well developed deep karst could be explained by a relatively recent lowering of the base level. This could have

caused the plane of well developed karst conduits to be left behind and initiated direct draining through the lower parts of the aquifer which are fractured but not very karstified, perhaps through a tectonic or stratigraphic horizon characterised by good permeability. The current state of research is still too limited to give a picture, even a rough one, of the karst's characteristics

and its evolutionary phases. The results obtained bode well, even if the possibility of accessing vast and deep systems seems tied to the discovery of high entrances of active cavities large enough not to have been subjected to infilling processes.

Tullio Bernabei, Leonardo Piccini, Francesco Sauro

Puente Colosal is a typical karst tunnel, still occasionally taking water during particularly bad storms



EXPEDITION MEMBERS

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The pit

One, 2, 3, 4 seconds, still silence... 5, 6, 7, a first thump reaches our ears, 8, 9, other thumps, rumbles far below. I turn to my companions who, like me, are silently listening to the answer of the large rock thrown into the pit. More silence, then we break the spell with a chorus of yells. It's a '*signor pozzo*', a real monster pit, one of the many here in Mexico, but this one hasn't been descended yet.

It was the second day that we'd been wandering around the Cerro Grande's upper plateaus, to the west of Juquila canyon, searching for caves. Our local guide had spoken of deep pits but, as we all know, locals always tend to exaggerate. How many times had they led us to the edges of "bottomless pits", which turned out to be only a few dozen metres deep! This time the account was accurate. Even too much so. There is no use trying with the 100 m of rope we had brought with us on this reconnaissance. The pit must be at least two or three times that so we'll have to come back. That evening, at the camp, we decide to descend again to Tepelmeme, meet up with our companions who are searching the Cerro Tequelite area and climb back up with all the rope we have.

Three days later, we are all camped at Laguna Prieta again, a muddy pool where horses and cattle drink. Some friends from Mexico City have also joined us, fortunately arriving with all the rope they had managed to round up.

Loaded up like a mule, armed with a drill, 20 karabiners with hangers and 350 m of rope threaded into two sacks, I approach the pit again. The entrance isn't large, about 4 m in diameter, at the bottom of a wide funnel over which gigantic centenarian trees lean. A large pit never fails to arouse emotions and questions. How deep could it be? What could be waiting for us at the bottom?

The first part is along the wall and I have to re-belay often. In any case it's better not to have very long pitches, to break up the ascent and avoid long waits. After about twenty metres I swing over a bit, moving out of the vertical and aiming for a terrace I see a little way below.

There isn't much light. The walls are dark and covered with moss. The bottom isn't visible, but one perceives that the pit widens towards it. After descending about forty metres the pit opens up behind me, the walls recede. Finally, after about 100 metres from the start, my feet brush against the wall in front of me again. After a few dozen more metres I manage to anchor myself to a rock projection and decide to plant a bolt. The pitch above me is already almost 80 m long and it's time to re-belay. From here the descent continues against the wall. After another 40 m I re-belay again, as the rope risked touching the rock. I think I see the bottom.

Indeed, after a few dozen metres more, about 170 m below the start, I land on a terrace of boulders.

The descender is extremely hot and the water drops that hit it sizzle as though they were on a hot pan. I quickly release myself, move a few metres, entering a niche off to one side, then shout for Cesco to come down. Francesco is half my age, but is already a real expert. When he reaches me, I see the typical exploring speleologist's gleam in his eyes. I hand over all the equipment and invite him to continue the descent. He doesn't need to be asked twice. We need to move over a few metres and then the pit continues, beneath some enormous suspended blocks. Towards the bottom, it narrows. I see Francesco re-belay twice more. Finally the '*libera*' tells me that the pit has finished. 240 m. Not bad, although I have to admit that it had seemed deeper.

However, the cave continues. We still have rope. In the meantime Javier also reaches us. We continue along a gorge, interrupted by brief climb-downs, to the edge of what seems to be another fair sized pit. The drill's battery is empty and we have to resort to the old handheld rock drill. It's Francesco's turn again. Shortly after, we are all three at the bottom of the pit, about 30 m deep. The rope is finished, the cave isn't. We ascend quickly, lightly. We return two days later. Unfortunately the cave ends shortly afterwards, with a leaf and silt plug which blocks what appears to be a large gorge. Evidently the entrance collects too much debris and vegetation. The large karst systems which almost certainly exist down here aren't yet ready to be explored.

Leonardo Piccini

The paintings of Tepelmeme's Puente Colosal

In the course of the 2002 Juquila expedition, a particularly significant example of the recurring association between karst environments and ancient human activities was observed. Inside Tepelmeme's Colossal Bridge there are numerous cave paintings which show how the spectacular tunnel had repeatedly kindled the interest of the indigenous groups which lived in the area in Pre-Hispanic times. The paintings are also of excellent technical and aesthetic quality, to the point of being among the best examples of Mexican cave painting.

Traditionally known of by the local inhabitants, the Tepelmeme paintings have been adequately described in scientific literature only in the last few years. In the mid 1960s, they were observed by Ross Parmenter, who was also given a feline bone decorated with complex engravings by a local man who had found it in the tunnel. However, Parmenter's report remained unpublished and only in the mid 1980's was a better description of the paintings published by the archaeologist Carlos Rincón Mautner. Finally, in 2004, Javier Urcid carried out a detailed research project during which the paintings were surveyed and many archaeological remains were found, both inside the Puente Colosal and in its surroundings. The results of these researches indicate that the first ancient traces at the *Puente* probably date back to the Archaic period (7000-2000 B.C.). It was however during the Late Classic period (6th -9th Centuries) that the majority of the *Puente*'s paintings were painted by *ñuiñe* groups, belonging to a cultural tradition typical of the Lower Mixteca and whose exact linguistic affiliation is still unknown. The Puente Colosal's *ñuiñe* paintings consist mainly of calendar glyphs accompanied by numbers. In all likelihood they are calendar names (that is, the names which Mesoamericans adopted based on their day of birth) and their placement suggests that the different glyph groups should be interpreted as genealogical records. That is, as genealogical sequences which attest to the noble pedigree of some individuals. The most spectacular glyph group, for example, could be read as "1 Grass is son of 11 Rain, in his turn son of 10 Owl". The heterogeneous stylistic characteristics of the *ñuiñe* paintings, like the many instances of overlapping, indicate that the paintings were executed at different times, the majority of which at the end of the Classical period, a time during which several settlements near the Puente Colosal were thriving. Among the paintings not having a genealogical nature, the figure of a naked prisoner with tied arms and losing blood from his penis, stands out and alludes to the 'fertilizing' characteristic of sacrificing prisoners of war. The later and less striking paintings are instead dated to the Early Postclassic (900-1250 A.D.), the era to which the previously mentioned engraved bone also belongs. The last Pre-Hispanic evidences at the Puente Colosal (Late Postclassic, 1250-1500 A.D.) are not paintings but turquoise mosaics, small jade

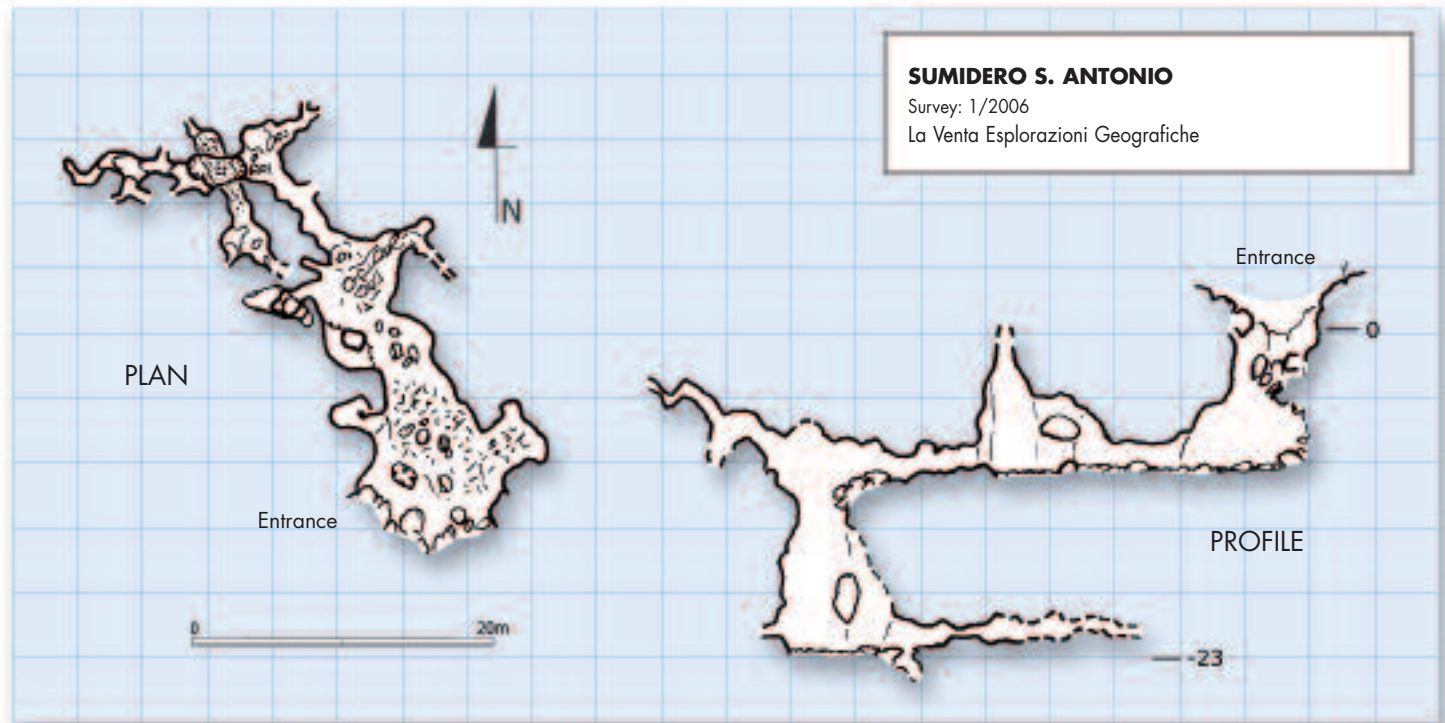
beads, copal fragments, and the remains of offerings placed inside the tunnel. According to local testimonies collected by Urcid, in the past some wooden masks covered with turquoise mosaics were found in the tunnel, unfortunately they were burned as they were considered the work of the Devil. The Puente Colosal's paintings and offering remains indicate that ancient indigenous groups perceived that spectacular karst environment as a place having a sacred nature and being associated with the underground world of fertility and ancestors. As they did with most caves, the natives interacted with these cosmic environments through ritual behaviour, whose material residues are those which we can still observe today within the Puente Colosal.

Wall paintings at Puente Colosal



Davide Domenici

Appendix



POZO DE LA LAGUNA PRIETA

Survey: 11/2003

La Venta Esploraciones Geografiche

PLAN



Entrance

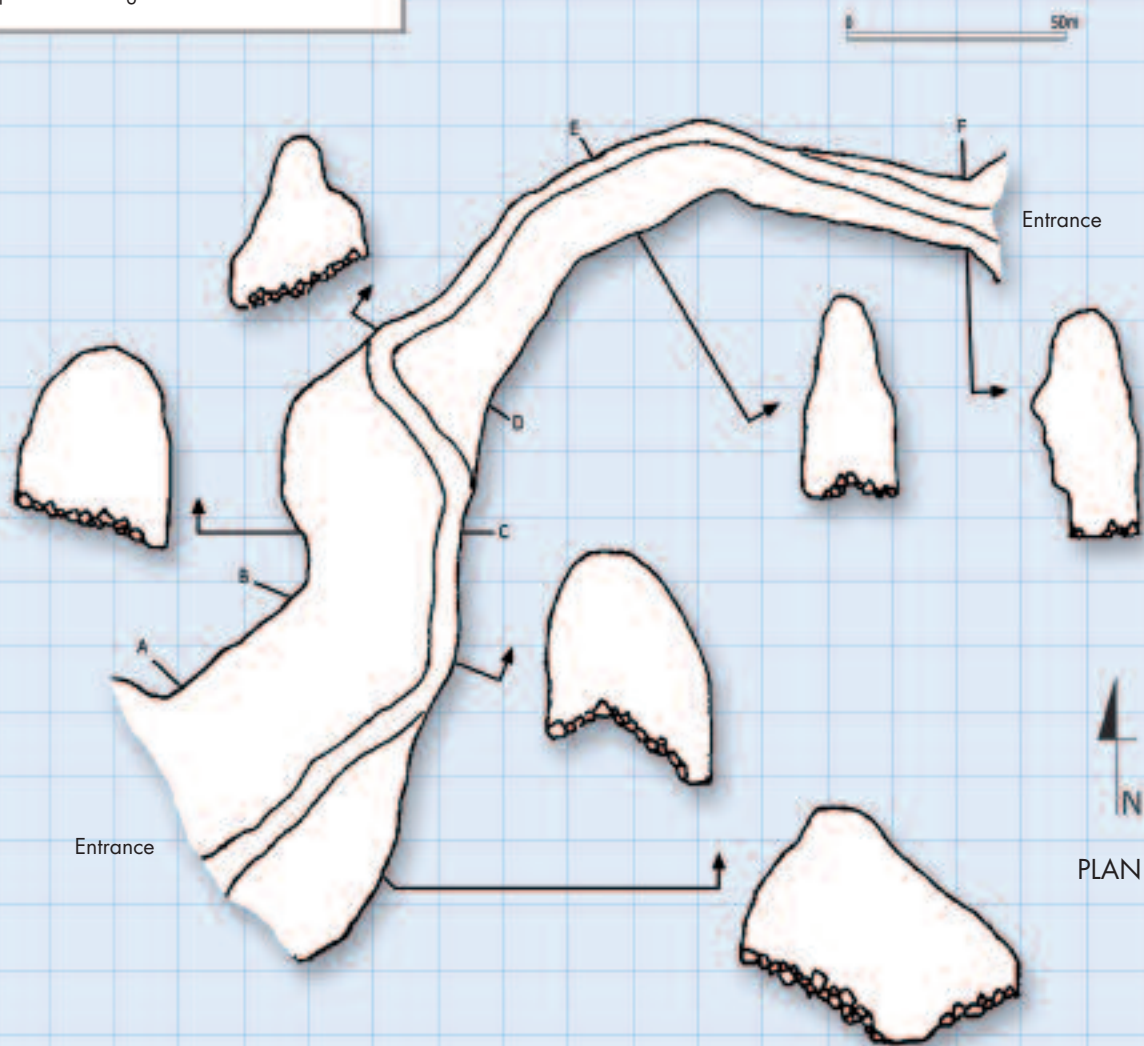




PUENTE COLOSAL

Surveyed by: A. De Vivo, U. Vacca (4/2002)

La Venta Esplorazioni Geografiche



CUEVA PERFECTO 3

Survey: 2/2006

La Venta Esplorazioni Geografiche

PROFILE

PLAN

0 10 m

N

Entrance

Entrance

*Swimming along the Snakes' Bottleneck,
Rio Matanzas*



The main gallery of Cueva Dos Ojos





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