The combined use of air photographs and free satellite imagery as auxiliary tools in preliminary archaeological exploration: potential and limitations from three case studies in three distinct geo-cultural regions in Mexico

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Abstract: This paper brings into the attention of the academic community a series of methodological aspects that we considered of a possible general interest, deriving from our own practical application of aerial photography and satellite imagery within three distinct archaeological survey projects that we conducted during the last decade on three different geo-cultural regions of Mexico. We try to emphasise what works and what doesn't within the realm of the aerial and satellite imagery employed during pioneering explorations aimed to identify new archaeological sites in natural settings that pose a number of challenges and obstacles to the photo-interpretation. In the ravished jungles of south-western Yucatan Peninsula we identified several Mayan settlements by stereoscopy, as the dominant archaeological feature is the mound. In the mountains and deserts of Aguascalientes, central-northern Mexico, air photos and Google Earth proved almost useless in most of the cases, but precious in valuing landscape changes. In the arid deserts of northern Zacatecas, air photos and satellite imagery acted weakly in the actual identification of hunter-gatherer campsites, but turned crucially important in the identification and monitoring of geo-spatial units and paleo-landforms hosting ancient human occupations probably since the end of Pleistocene.

Rezumat: Acest articol aduce la cunoştinţa comunităţii academice o serie de aspecte metodologice pe care le considerăm de un posibil interes general, pornind de la propria noastră experienţă de teren în folosirea fotografiilor aeriene şi a imaginilor satelitare cu acces liber în trei proiecte de cercetare desfăşurate de noi pe parcursul ultimei deceniu în trei regiuni geo-culturale diferite din Mexic. Încercăm să clarificăm ce funcţionează şi ce nu în cadrul utilizării de imagini aeriene şi satelitare în explorări pioniere în regiuni necercetate în prealabil şi al căror obiectiv este descoperirea de noi situri arheologice în peisaje care pun de la început o serie de obstacole în faţa fotointerpretării. În junglele din sud-vestul Peninsulei Yucatan am reuşit prin simpla stereoscopie să identificăm câteva aşezări Maya necunoscute, dat fiind trăsătura spaţială dominantă - monticulul. În munţii şi deşerturile din Aguascaliente, în Mexicul nord-central, fotografia aeriană şi imaginile Google Earth s-au dovedit practic inutile în majoritatea cazurilor, însă valoroase în evaluarea transformărilor de peisaj. În deşerturile din nordul statului Zacatecas fotografiile aeriene şi imaginile satelitare s-au dovedit ineficiente în identificarea de situri de vânători-culegători, însă au devenit cruciale în identificarea şi monitorizarea unităţilor geo-spaţiale şi vechilor forme de teren care au atestat prezenţa oamenilor încă de la sfârşitul Pleistocenului.

Keywords: Mexico, aerial photography, satellite imagery, Maya, Zacatecas, Aguascalientes, hunter-gatherers.

Cuvinte cheie: Mexic, fotografie aeriană, imagini satelitare, Maya, Zacatecas, Aguascalientes, vânători-colegatori.

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◈ 1. Introduction and methodological statements

This paper is not intended to be any methodological review of the employment of aerial or satellite imagery in the archaeological exploration nor is it any representative compilation of the application of such tools in Mexican archaeology. This is just the synthesis of our own practical application of these obliged technical approaches in three of our research projects recently undertaken in three different geographical and cultural regions in Mexico, a decision justified by the belief that sharing these humble experiences with colleagues from other parts of the world would probably flow into benefit for them, for us and for fellow explorers who probably look at the topic through much more sophisticated and professional glasses. We will also make a brief presentation of the Mexican aerial photography environment from the legal and technical point of views, together with a brief instruction on how to access archives. Before continuing consulting this paper, the reader should know that we are not going to propose any new technique or methodological procedure, not even an outstanding revelation on how to interpret features in Mesoamerican sites; instead, we are going to show what works and what doesn't in using both aerial photography and free access satellite imagery (Google Earth) as basic auxiliary techniques for archaeological surface exploration in three distinct cultural regions with their anthropic manifestations differing drastically one from another, all nested in three very different landscapes, and how their potential in the employment of these techniques varies considerably, asking the researcher to modify the approach accordingly in each specific case.

The methodological discussion we propose in this paper builds up on three case studies situated in Mexico (fig. 1). We prefer not to use the geo-cultural term Mesoamerica in referring to the three cases altogether, because at least one of them might fall out of the traditionally accepted geographical and cultural extent of the concept. The three cases we offer are characterised by very different natural and cultural settings, not entirely similar to what our colleagues in other places like Europe would expect to see on an aerial photograph or a Google Earth image. Without deep organic soils, lacking cereal crops on surface, almost completely lacking plowing, instead with deep jungles, rough terrain, dense shrub vegetation or compact cacti masses - and without the blessing of a long photo-interpreting tradition in archaeology - the use of these mandatory methodological steps is always a challenge and a fascinating duty in our part of the world, a task that gives you the feeling of a 'first-timer' every single time. Nevertheless, these cases do share one common feature: the areas had never been studied before in any systematic manner, and no previous professional archaeological exploration had been completed for the locations in discussion. That means that the utilisation of aerial photographs and satellite images stood as a fundamental tool in the early stages of our preliminary explorations of the newly discovered "lost worlds", as well as during the more advanced phases of analysis and interpretation.

The first case refers to an early exploration we conducted over an almost unknown area on the middle course of the Candelaria River in southwestern Yucatan Peninsula, state of Campeche, at the periphery of the so-called "Tierras Bajas Noroccidentales" ('Northwestern Lowlands'), a subcomponent of the famous Maya site-rich Petén macro-region. In this case, the use of vertical imagery was employed in the initial recognition of the study area, in the definition of the limits of the surveys and the identification of the presence of sedentary Mayan settlements displaying relatively low monumental and domestic mound-based architecture (fig. 2-4). We shall see how this specific environment - dominated by secondary regenerating jungles, mangrove swamps and extensive anthropic savannahs - can affect the use of aerial/spatial imagery. The second case to discuss is settled in the semi-deserts of Aguascalientes, in central-northern Mexico, where societies shifting between nomadic hunter-gatherer and sedentary-agricultural ways of life generated shallow surface archaeological records barely visible on the field or on air photos (fig. 5-7). The third case to be discussed stands even further from 'normal', as it refers to a research still ongoing at the moment of the publication of these pages, set in the cactus-and-shrub dominated rugged semi-desert of northern Zacatecas, dealing with hunter-gatherer archaeology, searching for the earliest traces of human occupation in the area as a particular manifestation of the controversial 'bigger picture' of the peopling of Americas at the end of the Ice Age (fig. 8, 9). In this particular case, the target were nomadic or semi-nomadic hunter-gatherer societies spanning over many centuries of intermittent occupation whose archaeological record usually leaves very thin traces on the surface of the ground, hardly visible when walking on them and even less probable to be seen from the air or from the outer space. Not too encouraging when thinking about the use of aerial/satellite photography to identify this kind of sites on the ground, we will show how it had an immense potential in identifying geo-units of both environmental and cultural relevance and in predicting the presence of old hunter-gatherer sites on the base of the behaviour of these units in space.

◈ 2. The aerial photography in Mexico: institutions, archives, legal frameworks

In Mexico, the National Institute of Statistics and Geography (INEGI, by its Spanish initials) is the federal institution in charge of the generation, processing, storage and diffusion of the aerial imagery for the academic and public use. There are also recently created private companies that can provide specific flights on demand (conventional photographs or LiDAR), but in archaeology we normally employ the data created by INEGI because it is relatively cheap, easily accessible and it has a full national coverage. Along almost four decades, INEGI has built up an archive containing above 800,000 negatives; these files are the base for both black-and-white and colour photographs, normally distributed to the users in printed format of 23x23 cm for stereoscopic use, as well as for specific amplified images of up to 14x and photographic mosaics (INEGI 2009). INEGI's photogrametry department elaborates optically corrected digital versions in the form of ortophotos, which normally cover the territory occupied by eight aerial photographs. The ortophotos can be easily used for horizontal measurements and they come in formats perfectly compatible with most of the GIS softwares. When an internal or foreign scientific project starts on the national territory, it is highly recommended for the researchers to contact INEGI in the first instance and obtain their primary data from this institution before contracting any further flights with private companies. This can be done through their webpage, but it is recommended to better visit their headquarters in the city of Aguascalientes or one of their state offices across the country and have a personal meeting with one of the specialists and get a proper consulting on which flight lines are required, the correct overlaps for the stereoscopic pairs, the right format and scale for ortophotos etc.

In theory, INEGI does flights every two years - although this premise is not at all valid simultaneously for the entire national territory - using a pair of two-engine propeller aircrafts for intermediate altitudes and flying roof situated at around 10,000 metres. These combine with low and medium-fly small jets for flights at around 6,000 metres. The aircrafts bear built-in cameras operated by personnel from INEGI's General Direction of Geography and connected to the plane's computerised systems, and these devices count with movement correction, automatic exposure, low lens distortion and high resolution. The obtained photographs use to be printed in small scale (< 1:50,000), medium scale (between 1:15,000 and 1:50,000) and high scale (> 1:15,000). The organisation of the flights takes into accounts the atmospheric conditions, season of the year and the appropriate time of the day. This last variable tends to follow the height of the sun at 45º above horizon, according to the latitude and time of the year. The cartography produced by INEGI consists of printed and digital topographic charts based on the aerial photography and they are actually just an interpretation of aerial imagery with added layers of information on it but with a disappointing level of detail, as it will be shown further below.

Here it is very important to specify a few crucial aspects of our praxis with aerial photography. In Mexico we do not count with a significant archive of aerial photography generated during military situations, like the vast war and espionage-related archives in Europe. There are indeed aerial photographs taken at different moments along the 20th century by the military in Mexico, but they do not cover the entire territory and they are not open archives nor easily available for public access. As archaeologists, when we think of aerial photography, we always refer to INEGI archives. Obtaining military files produced in decades predating the INEGI institutionalised flights would imply a very elaborated and complex project focused exclusively on the aerial photography itself. But, for us, the aerial archives are only an obliged preliminary tool in researches centred on wider questions, so we prefer the photographs to be as recent as possible, although we perfectly understand the immense value and potential of older air photos. The employment of raw aerial archives or photogrametry in combination with topographic charts and maps elaborated on the field form together the usual practice in the country (E. Fernández-Villanueva Medina 2005). A very important task that we admit we haven't accomplished yet, is to obtain the entire aerial photograph archives generated for specific areas during the last half a century or so, and use them to evaluate the degree and rhythm of changes that affected the archaeological monuments of México.

◈ 3. The first case study: the Mayan sites on the middle Candelaria River

The investigation we developed among the swamps and mangroves of the middle Candelaria River in south-western Yucatan Peninsula was aimed to identify, map and explore the Pre-Hispanic occupation in one of the less known regions of the Mayan world (fig. 1). No systematic studies had been undertaken in the area, although a series of pioneering explorations from 1970's and 1980's left notice about the apparent presence of a small number of peripheral Mayan settlements lost among patches of ancient jungles, cleared fields for cattle raising and luxurious mangroves and marshes. That part of the world had been completely emptied of people by the Spaniards in the 17th century when they displaced and concentrated the indigenous nations into crowded settlements on the coast in order to control them better, and it remained covered by dense jungles for almost three centuries until the massive colonisations with immigrants from the northern Mexican desert states during the 20th century as part of a controversial plan led by the federal government and meant to solve severe demographic and agrarian problems of the country. In conclusion, by the beginning of the 21st century, an entire portion of the Mayan territory still stood completely unknown mainly because of a variety of factors that cannot be detailed here fairly. But one of these factors has to do with the fact that the Mayan sites in this part of the Peninsula are not so monumental and architectonically impressive as the huge pyramids of the Petén or the sophisticated decorated façades from the interior Yucatan. For both the public and political mentality, those sites were invisible.

We started the research in the summer of 2003 in order to fill in the gap (C.F. Ardelean 2005, 2006, 2008, 2009). From the previous research done in the area on the level of quick surface reconnaissance, we knew that there were at least three archaeological sites around the main swamps situated on the middle course of the river, where the shape of the water body dilutes into hundreds of small marshy channels and mangrove tunnels. These sites were El Chechén, Las Palmitas and El Astillero, already mentioned in some reports with these names taken from the local ranch toponymy. The information we counted with was extremely poor; the descriptions were not precise and not at all illustrative, while the bidimensional hand-drawn maps of the cores of the settlements were very approximate and incomplete (S. Pincemin 1993).

Therefore, we started from a minimum of information but we had the certainty that there were Pre-Columbian settlements in the area we had targeted for our research. Based on the fact that the previous investigators admitted to have explored only shallowly the area and just for a brief time, we knew that the visited sites had to be much bigger than reported and not the only ones in the area. The initial archaeological project mainly focused on field walks and exhaustive surface explorations and only later, during a second phase, excavations were to be undertaken. The use of cartographic charts, aerial photography and satellite imagery was not only a mandatory methodological step, but a necessary procedure in order to define the range of explorations on the field, evaluate the behaviour of the landscape and potential difficulties, locate the sites mentioned in literature, and identify new settlements.

There is a very important detail to be discussed here. When we talk about Mesoamerican sites in general or Mayan sites in particular, we visualise in our minds the remains of an ancient human settlement manifesting as a more or less organised accumulation of mounds. This is virtually all you can see either on the ground or from the height of a flight. Smaller features like stone alignments (usually remains of thatch-and-pole wall reinforcements or ancient property fences), ceramic sherds or lithic artifacts scattered on the ground and beneath the thick cover of vegetation are not likely to be identified on photographic imagery obtained from a certain elevation. Archaeological sites eager to be seen on aerial photography almost always will look like groups of mounds. Mesoamerican archaeology has not developed enough practice in interpreting any other kind of human-related shapes and colours visible on black-and-white or colour aerial photographs, as it might be the case in the European archaeology, maybe because the regular use for the aerial photography in our part of the world has normally been restricted to the rough identification of the presence of relatively large archaeological settlements dominated by pyramids. The aerial photography is only an auxiliary technique in the exploration of an area and a preliminary stage before the actual on-foot survey of a territory.

Mesoamerican people, from all the cultures that developed within this large and heterogeneous macro-region, built their houses and temples on top of higher or lower platforms, and when the sites got abandoned and these platforms became eroded, they went covered in sediment and vegetation and persisted as montículos (Spanish for 'mounds') until today. In other words, as soon as you saw mounds on the aerial photography, you located a site, you delimited its extension and you felt ready to prepare the field explorations. That is why we have always employed the aerial imagery only in the form of stereoscopic pairs. We almost never use a single aerial photograph or ortophoto by itself in order to look at colour-and-shape patterns, but in stereoscopic superposition with another one, because what we are interested in is the 3D manifestation of the archaeological mounds. We used to believe that any other kind of intended use would render useless. Jungles, regenerating forests or tall pastures for cattle almost always cover the surface of the ground and it is highly improbably to meet proper ploughing fields in your surveys.

On the other hand, another relevant detail consists in the fact that all these mounds look the same across the time and space. No matter how different the architectural units looked like during their active lives, when they become covered by dirt and vegetation they all look the same. That means that we cannot infer any chronological or cultural affinities of the mounds visible in the photographs by just looking at them on the image. We must go out there and collect artefacts from their surface in order to be entitled to propose a tentative chronology and cultural pertinence as a working hypothesis that would later be tested by controlled excavations. If our European colleagues are able to say “Look, there is a Bronze Age enclosure next to a Roman camp on this field”, we can only say “I’ve got another Mayan site”; I can guess that because I am in the middle of the Mayan territory, but I cannot say if the buried ruins are from the Preclassic, Classic, or Postclassic times.

All our explorations were low-budget ones, as many of the pioneering surveying projects in this part of the globe. For our preliminary studies of the marshes of El Chechén we armed ourselves with a minimum of indispensable documentation. We acquired the topographic chart of the area with the national code E15B86 and the related aerial photograph lines in stereoscopic pairs in printed format. We also employed the related ortophotos, in digital format only, at a 1:20,000 scale. The digital ortophotos were visualised in ArcView and were employed only for horizontal measurements, data layer superposition, coordinates references and general landscape visualisation, but not at all as a platform for the identification and characterisation of archaeological features. We did not use Google Earth at the beginning of this exploration, simply because in 2003 this tool – still named Keyhole back then – was still not well known among us and not a free access satellite imagery database. We did not purchase our own flights either, mainly because of lack of money for this service and also because we considered, at that moment, that the INEGI data was sufficient.

From the very beginning of the research we familiarised ourselves with the limitations of INEGI’s topographic charts. Beyond the scale limitations, we realised that the charts had very little detail even on the 1:50,000 scale versions. The charts are almost entirely based on aerial photography and the respective flights are usually very old. Sometimes, the charts that users can buy from INEGI’s offices across the country are not updated and they offer out-of-date information sometimes even twenty or thirty years old. They seem to lack on-field confirmation and the information represented graphically in the chart is usually exclusively an interpretation of features observed in old aerial photography. We learnt it the hard way and we could not rely on the information provided by the charts unless we checked it on the field. The interesting aspect of this limitation is that we can actually consider these topographic charts and the related aerial photographs as proper old archives. Even if we don’t count with considerably older flights, the data in Mexico is sometimes comparable to some. We had to work with data from old flights and related non-actual topographic charts in very fast changing environments, where both landscape and manscape modify quickly over the years, impacting significantly on the potentials and aims of specific archaeological investigations.

The topographic charts lack archaeological information. If it is not a tourist site or a highly important archaeological zone open to public, it simply misses from all maps. The information is supposed to be updated every certain number of years, but in practice that is seldom done. On the other hand, the topographic charts are really useful when starting our research at least because they helped us to locate the names of the sites mentioned in the literature. As the names reflect the local toponymy, this is always represented in the charts, so we managed to find immediately the three sites published with hand-drawn maps. Then we passed to the corresponding aerial photographs and searched for the major features represented in the topographic map, managing to identify the approximate location of the reported archaeological sites.

For the El Chechén Wetlands region we employed the flight lines number 940 through 944, from January 14, 16, and 18 of 1996, with a standard scale of 1:20,000 shot from an altitude of 10,600 feet. That means that at the moment of the commence of our research, the landscape pictured from the air was only seven years old, which is in fact outstandingly recent, although the modifications occurred during this relatively short time were already evident during our first visits on the field. The topographic chart for the area was based on a flight realised in March 1994, just two years before the stereoscopic pairs, so the data in the chart was still very consistent with the information shown in the aerial photos. Using simple stereoscopy we identified the most important mounds from the cores of each of the three sites: El Chechén, Las Palmitas and El Astillero. Besides that, we analysed each photograph extremely carefully searching for other sites and additional cultural manifestations and we managed to identify two completely new sites, never reported before: El Palmar (apparently a sort of a satellite settlement for El Chechén), and Isla Montuy, this last one being a very interesting small settlement formed by three groups of very low mounds, most of them not higher than 1.5 meters, and yet visible in stereoscopy.

The landscape played a crucial role in the amount of benefit we extracted from the employment of aerial photography in the early stage of our research. There are three crucial characteristics of the local environment that interfere with the potential of this technique. The jungle stays in the first place. Most of the original rainforest is gone now, cut down almost completely by the recently arrived colonists in order to make space for the invasive cattle raising needs. Nevertheless, there still are patches of densely packed forests and also the acahuales, a local term referring to regenerating forest after the abandonment of a crop field; peasants abandon previously cleared areas and, subsequently, dozens of species of grasses, trees and bushes fight for gaining the struggle for survival and form a completely impenetrable mass of vegetation that leaves no chance for the identification of archaeological traits either from the air or on the ground by conventional means. The Mayan jungles play, after all, the same limiting role as any other forest when talking about aerial photographs. The detail is that they constantly change their aspect: large patches of forest diminish or disappear, while open spaces can turn into dense acahuales and young rain forests in a matter of few years. In the second place, we have the potreros, the grazing areas of the anthropic savannahs created by deforestation and grass seeding, especially tall grasses imported from other continents. In the third place, the wetlands. The shores of the river channels, marshes, and mangroves are covered by dense and complex vegetation that do not respond to the possible archaeological features underneath, blocking our access to preterit cultural manifestations. In our study area nobody practices agriculture, but in a very reduced scale for family needs and ploughing is never employed.

The cattle raising areas pose very interesting methodological problems that must be taken into account. The reader should remember that the only thing we can expect to identify on an aerial photography from the Mayan Lowlands are mounds: larger or smaller bumps on the surface of the ground, as remains of ancient architectural elements that came down and became covered by sediments. We have no hope to identify them beneath the jungle cover or in the middle of the smooth and even swamps, unless we employ more recent and expensive technologies, like LiDAR. So we have to focus our attention on potreros, on those areas cleared by man in order to seed grasses for cattle, mainly cows and borregos, the tropical sheep. Each one of our sites identified by stereoscopy shows how the specific particularities of the modern use of the land make our job more difficult or much more easier, accordingly to the situation. And the principle is very simple and ironic: the tougher the anthropic destruction of the landscape, the easier to identify archaeological mounds of even tiny dimensions.

El Chechén is the eponym site of the region, although not the biggest. It was the first one to be investigated in 2003 and we managed to identify its main pyramids fairly easily on the aerial stereo-pairs, mainly because the core of the settlement – the same portion originally visited and drawn by S. Pincemin (1993) – is situated close to the house of the ranch and the main cattle enclosures, assuring the grasses stay short for most of the year as the cows continuously graze on them. The surface materials recovered on site indicate a long occupation since the Late Preclassic, but the highest concentrations suggest a cultural peak by the Terminal Classic, perhaps between the 9th and 11th centuries AD. The biggest mounds, some of them 12 metres tall, were clearly visible and that helped us as a reference point for identifying other mound clusters around them and further away in a roughly concentric pattern around the settlement's civic core. Nevertheless, some very large household platforms (as big as 30 meters in diameter and otherwise easily visible from above) were totally invisible on the photographs simply because they were situated in areas maintained as acahuales for reasons only known to the landlord, or covered by patches of trees kept intact in order to provide shadow for the herds and source of timber for the ranch's needs. Analysing the surrounding of the site inch by inch on the stereoscopic pairs, we discovered El Palmar, a very small sector of El Chechén on its northwestern periphery and very close to the wetland limits. It is surprising that we were able to identify it by one of its main mounds no higher than 1.5 m and just a few meters wide. The reason is simple: the soil here is extremely shallow and it stands on a hard surface of limestone and chert outcrops surrounded by flooded areas. The landlord keeps the area cleared, because of the proximity to his house, barns and the main access road.

A very different situation is observed in the site of El Astillero, a few kilometres to the southeast, situated in another cattle ranch with predominant exogenous grasses and very little of the original ecosystem (fig. 2). Here, the biggest pyramidal mounds, from 8 to 12 metres tall, are clearly visible in the landscape no matter how dense the vegetation (fig. 4). But the interesting fact is that the kind of grasses introduced by the farmers (probably of African or Australian origin) behaves very differently from expected. They are very tall grasses that can reach up to 4 metres in height. If they grow on top of a mound or in a depression they simply level de visual aspect of the terrain and do not reflect the surface's modulations. These grasses tend to grow all up to the same height until they all reach the sunlight and atmospheric moisture at the same level, meaning that the plants from a depression will struggle to grow up taller in order to reach those that do not need to grow up too much as they stand on top of a mound. In the aerial photographs you can only see an evenly flattened surface, while on the ground, during the actual exploration and topographic survey, you can miss the structures if working during the wet summer.

Exactly the opposite happened in the small site of Isla Montuy (fig. 3). This one had never been reported before, and we found it only by stereoscopy. It is situated on a small island of limestone and chert outcrop in the middle of swamps and secondary river branches. We managed to identify tiny mounds on the aerial photography mainly because there are virtually no trees nor grasses on this island because of the over-exploitation of it: sheep and goats completely exterminated the vegetation cover allowing us to explore a bold land. A patch of trees kept in the southern part of the site was visible on the aerial photograph and still in place during our field walks on the site, hiding a few mounds beneath. A couple of years later, during another visit, the landlord had completely removed those trees, exposing the mounds to the naked eye, but this landscape modification has not been reflected yet in any new flight, nor Google Earth.

For these specific tropical environments with high modern human incidence, the best moment to take photographs is during the dry season when the vegetation has a slower growing rate, like for example during the Spring. Nevertheless, it is important to know that during the April-May period the locals use to set the fields on fire, causing controlled fires meant to burn and regenerate the grasses for the cattle. This procedure briefly eliminates most of the softer vegetation cover (grasses and bushes), allowing surprising views over the archaeological sites, but adding new stains of dark tones to the surface. This is probably the best epoch of the year for low-altitude specific flights. The project developed field seasons from 2003 to 2005, four in total, and the research was closed by 2008. The aerial photography has only been used during the initial phases of exploration. We used Google Earth later, but only for illustrative purposes and for academic presentations as the surveys had been concluded when this became a common tool in archaeology.

◈ 4. The second case study: discovering new sites in Aguascalientes

The central-northern region of Mexico is a vast territory, which in east-west direction extends from the oriental slopes of Sierra Madre Occidental towards the Pacific Ocean all the way to the western piedmonts of Sierra Madre Oriental, including parts of the states of Jalisco, Guanajuato, Aguascalientes, as well as meridional Zacatecas and western San Luis Potosí (G. Fernández Martinez 2007). The studied area for the project considered for this second case surrounds the valley formed by the Río Verde - San Pedro basin, between the states of Aguascalientes and Zacatecas (fig. 1, 7). This province counts with a large variety of landforms, dominated by flattened large mesas of volcanic origin. The valley is closed on the west side by topographic ramifications diverging from Sierra Madre Occidental in the shape of piedmonts, ravines, plateaus and water courses, all generating specific microclimates rich in vegetal and animal species (J.I. Macías-Quintero 2007).

The archaeological investigations in Aguascalientes are extremely young and the research we resume here is actually the first one to employ systematic surveys for the identification of completely new human settlements (J.I. Macías-Quintero 2006). As mentioned elsewhere, this is another manifestation of the typical behaviour of a national official archaeology interested mainly in monumental architecture sites. Most of the archaeological sites in central-northern part of country, mainly during the Epiclassic period (about 10th-13th centuries AD), lack monumentality, in contrast with most of the Mesoamerican macro-region, and this is seldom interpreted as a manifestation of societies that developed after the collapse of the major leading metropolis of Teotihuacan around the 7th-8th centuries A.D., when a new cultural landscape crystallised upon the reorganisation of new political systems during a short period of the Pre-Hispanic history. By the 10th century A.D., most of these territories occupied by sedentary societies became completely abandoned and emptied because of still mysterious reasons, and that is why the archaeological sites in this area show very brief occupational sequences, and that translated into a very shallow archaeological record on surface, with features that are very difficult to be identified and analysed through conventional aerial photography. The peculiarity of the archaeological record of the area in discussion comes from the strange succession of cultural modes of life: the local societies behaved like hunter-gatherers for over five millennia, then they adopted sedentary agricultural subsistence for less than 500 years, to finally return to the hunter-gatherer way of life again until the Spanish invasion in the 16th century (L. López-Luján 1989).

The typical Epiclassic archaeological site in Aguascalientes' semi-desert is hard to identify on the ground even when standing in the middle of it. The explorer has to adapt the visual capacities to interpret the barely visible features and timid elevations on the surface or the doubtful alignments of raw stones that formerly were foundations for pole-and-thatch walls. In their majority, the sites are built on isolated hills and mesas – although often associated to agriculture-related soils – and the contrast between the pronounced topography of the landforms and the almost invisible human-made features transforms the use of stereoscopy into an almost useless task. When we commenced the surveys, we employed a series of geographical and ecological criteria in order to augment the probabilities of localising sites on surface. Before studying aerial imagery, the distribution of propitious soils, specific landforms, presence of strategic mineral resources and water bodies were crucial aspects to be taken into account. Nevertheless, the challenge was to evaluate if the aerial photography was in conditions to reveal the presence of Pre-Columbian archaeological features.

We explored the region between 2005 and 2006. The data we employed was particularly fresh, as the air photos and ortophotos came from flights done in 2003 and the Google Earth shots dated to 2005. The black-and-white digital ortophotos were preferred in this case at a scale of 1:10,000. In this particular region of study the use of aerial and satellite imagery did not yield the expected results; because of a chain of both natural and anthropic causes, we only detected a few patterns that turned into a positive correspondence with ancient settlements. These factors are to be further explained below, and they can be considered as valid transformation factors for all the cases when typified aerial archives have been employed in the detection and exploration of new archaeological sites.

Human alterations. All the social processes after the European conquest generated a never-ending succession of landscape alterations. The land use dynamics implemented with the introduction of the Spanish-style farms or Haciendas in the 17th century continued in recent times with the accelerated industrialisation and the urban development, with a huge impact on the actual landscape and our interpretation of the aerial photography. In general, the anthropic features we managed to identify in the archive aerial images were all generated by hacienda-related activities from the 17th and 18th centuries, like dams, large scale cultivation areas, cattle fencing, property-marking fences, deforestation, etc. But one of the most notable cases is the apparent presence of a circular pyramid (known as guachimonton) near Calvillo, a structure that normally is characteristic for the Occident of Mexico and its cultural environment, far away from Aguascalientes. It consists of a pattern of multiple circular pyramids of smaller size disposed in a circular pattern and surrounding a bigger pyramid in the middle. Our feature looked exactly the way these architectural monuments used to appear on air photographs. Nevertheless, when we explored the area by foot, we noticed that this was in fact nothing more but a modern feature associated to plowing activities and cleaning of the surface for seeding that resulted in the piling up of stones and debris in the form of a massive mound made by farmers (fig. 6).

Vegetation patterns. The understanding of the botanical spectrum of a region is a key condition in the employment of the aerial photography in the central-northern region of Mexico. The dominant vegetation (subtropical shrubs) is associated to the predominant soil systems of the region, meaning that the areas lacking consistent modern human activities are characterised by abundant patches of original shrub vegetation. The average height of these shrubs oscillates between two and four meters and in occasions they follow natural humidity patterns in the ground giving the impression of the presence of artificial linear features not supported by direct verification on the ground. In an opposite manner, vegetation lines sometimes indicate positive features like platform margins, walls, and stone alignments, of clear archaeological origin (fig. 5, 7).

Geological and soil patterns. As everywhere else, the local geology plays an important role in the detection of cultural manifestations. Igneous rocks outcropping in the form of eroded mesas, with predominance of rhyolites and litosols, mainly form the area (fig. 7). The settlement pattern of the ancient societies in the region has always been linked to inter-mountain areas, so the deforestation and erosion have prohibited the formation of deep and fertile soils, except the deep valleys and canyons. Most of the settlements used the igneous outcrops as foundations for their buildings and space features, and this particular behaviour impacted directly upon the nature of three key indicators in the interpretation of aerial photography: vegetation patterns, shadows and shapes on the ground.

In the areas where vegetation has not been altered, the volcanic rock outcrops - that in turn can design their own long and linear formations sometimes up to three meters high that generate their own pattern of elevation and shadows making themselves erroneously interpreted in the aerial photography as artificial architectural features - condition its concentration or dispersion. The trees grow scarcely and irregularly on the sites, so their shadow is a negligible factor, especially when the air photographs are shot at the correct time of the year and the appropriate hour. In the aerial imagery we employed, even 2-3 m high archaeological mounds could not be identified through their own shadows, only by stereoscopy. Further on, the changes in colour on the surface were explored as potential indicators for the presence of human activities, but, once corroborated on the field, all the assumptions proved wrong as we discovered that the presumed manscape features were in fact totally natural phenomena caused by simple processes. First, the presence of tepetate (a light coloured local rock of conglomerates) erodes out in the form of soft matter that mixes with the matrix of the soils generating significant changes in the hue of the surface layers of soil. Second, the upper layers of clays inside the soils horizons are lighter in colour and tend to be mixed by plough.

Resuming, we have not been able to identify relevant traces of ancient human activity in the air photographs for these sites, except some major architectural mounds easy to discover through stereoscopy. The little success we obtained by using INEGI aerial photographs for the discovery of new archaeological sites does not necessarily mean the technique lacks importance. Its potential is proved by the fact that it actually stands as an excellent archive and historical document useful in the study of progressive changes in the landscape due to past and contemporary human activities. In one of the illustrations we can observe a notable change in the landscape, as the comparison shows for the southern slope of the site of El Zapote (fig. 6). The INEGI flight is from 2004; when we went back in 2005, one of the archaeological mounds (mound F) had been completely destroyed by a bulldozer meant to expand a water tank. In correspondence, the posterior Google Earth satellite image clearly reflects the situation.

◈ 5. The third case study: searching for Pleistocene in the Northern Zacatecas desert

This research is the most recent one and still in full development at the time of the submission of this paper. It commenced in 2010 as a pioneering effort to seek the earliest human occupation at the end of the Pleistocene and the beginning of the Holocene in another completely unknown and unexplored region of Mexico: the semi-desert landscape in the extreme north of the state of Zacatecas, a complex articulation of short mountain chains, valleys, basins and alluvial fans. An area that had never received any attention from scientists before us, in spite of its proximity to large mining centres, urban and rural communities and the easy access through a national motorway and a fairly rich network of roads. As stated repeatedly in this text, the traditional Mexican archaeology has always focused more on large and monumental settlement of the mightiest civilisations and left on secondary positions the ‘peripheral’ sites and prehistoric settlements like the ones the authors of these lines accustom to work on.

In this case, again, the region we chose completely lacked any kind of information, data, reference or allusion about any possible archaeological presence in the area since the earliest times at the end of the Ice Age. Previous shallow explorations yielded no results at all (J.L. Lorenzo, L. Mirambell 1986). We had to start from zero, and the preliminary use of aerial photography and satellite imagery turned vital. The study area had been delimited initially over a large territory around the county capitals of Concepción del Oro and the neighbouring Mazapil, one of the first mining towns on the continent and epicentres of the cruel and long-lasting “Chichimec Wars” that turned the entire second half of the 16th century into a terrifying bloodshed, one of the strongest anti-Spaniard indigenous resistance campaigns. The inhabitants of those territories, all along the Holocene, were hunter-gatherers, and they had the same mode of subsistence at the moment of the European invasion, heavily modified and mutilated during the occupation and genocide commonly known as Colonia.

These people have never erected durable architecture able to resist the transformation processes and persist as perennial features in the landscape. Their sites are somehow 'invisible' to the unadvertised eye, and there are no proper 'ruins' to be admired on the fields, no mounds or platforms, nor pyramids or ancient roads. We knew from historical and documentary investigations, as well as from older oral Mesoamerican traditions, that this region of northern Zacatecas was home for at least three tribe confederations at the moment of the arrival of Spanish invaders and their Central Mexican allies (Ph.W. Powell 1996). They were guachichiles, zacatecos and irritilas. We don't know much about them, nor are we able yet to tell one from another by looking at the archaeological record. But we suspected that the famous demographic concentration noticed during the European colonisation might be the reminiscence of an even more considerable occupation of the region in earlier times. Adopting working hypothesis promoted by other fellow researchers based on data from other parts of North America, we considered that the desert was a relatively recent phenomenon and the desertification started just a few thousand years ago; before that, the region had been covered by grasslands and pine-and-juniper forests and abundant water bodies like lakes, springs, creeks, ponds, under a more humid and more stable climate (E. Johnson et alii 2006). It is obvious that this kind of sites cannot be identified on standard aerial photography, neither by studying Google Earth imagery. The way we approached the remote imagery data is somehow different in this case, and we shall try to resume it here.

To begin with, we simply did not employ aerial photographs in stereoscopic pairs for this research. This may sound strange, but the reasons are strong. In the first place, since the very start of our preliminary procedures, we had decided that the stereoscopic use of aerial photographs in order to identify sites was totally excluded, as there were no archaeological features created by hunter and gatherer societies in America that might be highlighted on surface in third dimension. Second, because for some unknown and unexplained reasons, INEGI had recently suspended the commercialisation of printed aerial images for the public until an undetermined date, so we did not have any access to such documents. The ortophotos were available but of very poor resolution, so we actually started directly on Google Earth.

We consider that this simple tool is just as good as any other professional aerial imagery, sometimes even better than an ortophoto, because, in spite of the lower resolution, we can change the angle, zoom in and out, and see reasonably good colours and even some 3D elements where available. Therefore, the first delimitation of the initial survey area was done on Google Earth. We had a general idea about where to place the core of our research but we had absolutely no clue about where the most important archaeological manifestations might occur. So we decided to design a very large initial survey area formed by many geographical units and ecological niches (mountains, hills, piedmonts, basins, ravines, alluvial fans, etc); in other words, we chose as a complex region as possible. The bigger the initial survey area, the higher the chances to chose a suitable survey sample. We just looked carefully at every spatial component of the envisaged landscape and constantly compared the Google Earth information with the topographic charts of the region. Initially we laid down over 15 topographic maps of a 1:50,000 scale. We tried to include within the polygon the highest number of mini-basins that might have hosted lakes or ponds as the most probable foci of early human occupation. We tried to trace the limits of the main area along modern roads, pathways, agricultural fields or cattle-keeping fences in order to recognise them easily on the field.

Simply placing points on Google Earth and then drawing a polygon between them formed the limits of the survey area. This is how we obtained a huge survey region reaching almost 5,000 sq. miles in surface. The points defining the limit were later identified on the field and corrected by GPS during the preliminary visits on terrain. Such a huge area has never meant to be field-walked and surveyed in totality; we hoped that defining this large area on Google Earth we would be able to sample specific areas to be effectively and exhaustively investigated on the field. We accumulated a large number of topographic charts, as mentioned, because such a large area demanded the acquisition of the corresponding 1:50,000 INEGI maps in both printed and digital formats. But, as in other cases discussed above, these charts were of very little help beyond the simple orientation in space and the consultation of the local toponymy.

Soon after the start of the first field season we decided which component of that huge area would be the real candidate for the intensive exploration. We made the decision by studying the landscape on Google Earth and confronting the finds with the reality on the field simultaneously. A long and narrow endorreic basin formed on a half-graben hosted an evident lake in remote times, which might have survived as a combination of ponds, springs and marshes into post-Conquest times, standing as the core for one of the highest demographic concentrations ever known for hunter-and-gatherer societies in Northern Mexico. The basin is surrounded by long and narrow mountain chains and it has strong geological similarities to other formations recently studied in the north of the country (J. Ortega Ramirez et alii 2004). The field explorations undertaken during several months in the summer and winter of 2010 led to the discovery of more than 30 hunter-gatherer campsites distributed around the contours of the basin, at different altitudes and on distinct ecological niches, principally on the south-western shores of the north-western half of the unit. Such a high density of archaeological sites shows that we have made the right decision when opting for this geographical unit as the sample to be fully investigated on the field.

Such an appropriate decision could not have been taken blindly and only by roaming in jeeps around the basin, mainly because that would have taken too much time only for evaluating the potential. The combined employment of digital ortophotos and Google Earth imagery was absolutely decisive and practically the only platform to rely on before any physical exploration of the land; doing this before going out to the field saved us a lot of time and money. The difference between the use of aerial imagery in the other projects and its employment in this case is that in the previous studies we identified cultural features in the aerial photographs, like mounds, while in this last case we identified natural features, geographical and geological units with potential for hosting hunter-gatherer campsites (fig. 8). We had to follow certain “guess-like” logic in formulating ad-hoc working hypothesis for each kind of landscape units that called our attention while studying the basin on Google Earth. We couldn’t have just bet that certain unit was propitious for archaeological manifestations; we had to assume it temporarily in terms of a short-termed hypothesis, then go back and check the assumption on the field and evaluate its objective potential and then, if our beliefs proved right, we felt confident to further search in Google Earth or on the ortophoto for similar units that might offer a similar kind of archaeological record. This archaeological project had been launched as a systematic search for the Pleistocene occupation in northern Zacatecas, and we can assure that the discoveries we have achieved so far were possible thanks to a systematisation enhanced by the use of this simple on-line tool.

The ortophotos we employed for the area were 11 years old, based on flights from 1999. The satellite images from Google were considerably younger, meaning shots not older than 5 years. Nevertheless, the changes in landscape reflected independently in the two sorts of data were not significant. We constantly preferred the use of Google Earth over the INEGI’s ortophotos, because it was easier to access, it was obviously easier to zoom out to larger geographic scales and also the colours helped a lot in the identification of our ‘favourite’ geo-units. We consider that the resolution was very similar. The pixels started to manifest in both documents more or less at the same magnifications. As a final and definitive argument, Google Earth allowed us to have a fast general view of the entire geographical region all the time at our disposition, while this is not possible with an ortophoto beyond the physical space limits reflected in the digital file you bought.

We learnt important things about paleo-landscapes by surfing across Google Earth and watching ortophotos. In the first place, we identified the bottom of the ancient lake that occupied the depression (fig. 8). As soon as you approach the main survey area, you notice the greyish tone of a finely delimited shape: the flattened bottom of the depression clearly differentiating from the slightly inclined surrounding terrain that forms the shores in the form of alluvial fans and colluvial accumulations. That feature is not clearly understandable from the ground level, but using the coordinates obtained from the tip of the cursor we could follow by foot the exact limit on the inflexion angle between the bottom and the shores and we learnt how to recognise it on the field without further aid from the computer. In a second stage, we noticed a very strange pattern of rounded shapes covering the entire former lake bottom, mainly on its north-western half, just west of the Highway 54, while the opposite half seemed having a higher altitude and more greenish and yellowish tones. Later on the field we realised that the large figures where huge hardened dunes apparently composed of carbonates, sand and maybe inner layers of gypsum, with forms shaped by particular phenomena that could be both aquatic and wind-blown in origin (fig. 8, feature A). This part of the depression was completely naked of any vegetation excepting rare patches of dwarf bushes and small grasses adapted to highly saline environments. Walking on the opposite half of the basin we learnt that the tones observed in Google Earth reflected very specific vegetation related to particular soil chemistry.

The paleo-beaches were the most important discovery (fig. 9). At the beginning, we noticed the presence of whitish cleared areas, fairly wide, framed by areas with vegetation, running in parallel patterns along the ancient shores of the playa-lake, almost exclusively along the meridional margins, where the slope is smoother and sediments shallower and more evenly distributed. Corroborating the data on the field, we acknowledged that those geologic features represented ancient beaches indeed, covered by wind-blown loess in more recent times perhaps after the drying out of the lake. Walking on these opened spaces covered by fine loess and water-worn sand allowed us discover the earliest archaeological sites from this region, probably of Paleoamerican age dating back to the end of the Pleistocene, although this is still an unconfirmed working hypothesis. There are two or three phases of paleo-beaches, probably dating to different epochs and they look from above like a sort of wide irregular white stripes in parallel relationship, separated by accumulations of vegetation, closer or further away from the marked line of the playa-lake's bottom (fig. 8). We discovered very soon that the beach with archaeological evidence is only the middle one (numbered II in fig. 8), with an average altitude of 1665 metres above the sea level. This is about 10-15 metres higher that the average altitude of the flat bottom. Once we learnt how to recognise them and which altitude to choose, we used to consult Google Earth regularly and plan our future field explorations based on these specific conditions.

Then, there were the tree lines. Towards the northwestern end of the beaches we discovered a curious pattern of parallel dark lines running along the culturally active beach and very close to the reference altitude marker of 1665 masl. Studying these features on Google Earth and ortophotos, in the office, we concluded that they are trees or bushes disposing in nine or ten parallel lines, around 50 metres apart and about 2 km long each (fig. 8, feature B). They seemed to be following some natural buried elements that allowed water to accumulate underground in such a predictable formation, and that moisture supported permanent vegetation. Following the coordinates, we visited that place on the field in a couple of occasions and we confirmed that they indeed seemed to be natural patterns of linear stripes made of mezquite trees and grasses which probably lived on buried moist sediments whose origin - we believe - could be related to the progressively retrieving water levels during the transition from the wetter Terminal Pleistocene to the drier Holocene. This spectacular phenomenon could teach us a lot about human adaptations around the basin when we shall be in conditions to study it properly through remote sensing and controlled stratigraphic excavation in the near future. Further east to the opposite extreme of the valley, in a gorge forming the access between two adjacent basins, around a shallow ravine, we observed extensive and deep white carbonate-based sediments while driving our trucks in that direction. They turned out to be Pleistocene sediments containing considerable amounts of extinct megafauna bones. Looking at the digital archives and seeing how this kind of sites should look like from above, we were able to identify other two similar sites on the ortophoto and Google Earth and locate and verify them on the field. But all these discoveries, mainly related to environmental manifestations and directly linked to the cultural-archaeological dimension, would not have been possible without the use of remote imagery.

◈ 6. As a conclusion

The air photographs can be considered as archives even if they are not several decades old and even if it has not been shot under very different historical and social circumstances compared to the present. Same principle should apply for the satellite images like those available through free public access database like Google Earth. As long as the images have been produced under a separate institutional framework and as consequence of flight planning that are distinct from those in which the images are being used for scientific purposes in the archaeological investigation, we are definitely speaking of archive photographs. In this article we discussed three concrete investigations in which we used images taken from the air and from space in the preliminary stages of particular archaeological projects dedicated to the exploration of territories that had remained completely unknown to our discipline. The air photos we used were images obtained regularly by a federal institution on a national scale and turned into archives as they get stored as negatives that can be later commercialised in the form of printed stereoscopic pairs, digital ortophotos or complex photographic mosaics as requested by the client. The time that elapsed between the date of the flight and the moment the photographs are used within a scientific investigation is always sufficient for the landscape and manscape to change and the discrepancy between the information provided by the image and the new reality on the field can act in favour or in disadvantage of an accurate preliminary study.

We used the standardised air photographs only, without the additional purchase of on-purpose low-altitude flights, but in constant combination with satellite imagery on Google Earth, both only as auxiliary and preliminary tools at the very beginning of archaeological exploration in new regions not explored before. We learnt that the use of air photos for the identification of non-monumental archaeological sites lacking major earth-works and significant perennial structures is highly dependant on the particularities of the landscape, useless without immediate confrontation with the terrain and mainly applicable as stereoscopy. Nevertheless, it turned clear that even in the realm of the earliest prehistory and the study of the most “invisible” surface archaeological record, the air images in the form of digital ortophotos and Google Earth present an immense potential for the identification and study of specific landforms and geological units that could represent the remains of ancient ecological niches propitious for the installation of hunter-gatherer campsites.

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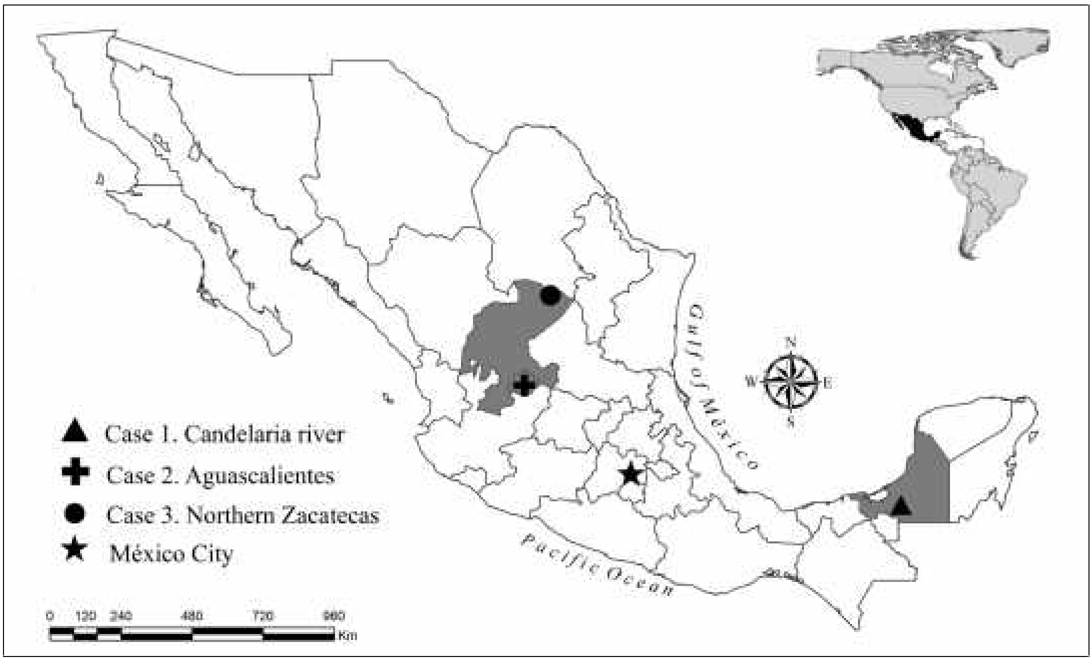

Fig. 1. General map of Mexico (with its location on the continent in the inlay), showing the geographic position of the three case studies analysed in the text.
Harta generală a Mexicului (cu localizarea sa pe continent), arătând poziţia geografică a celor trei studii de caz analizate în text.

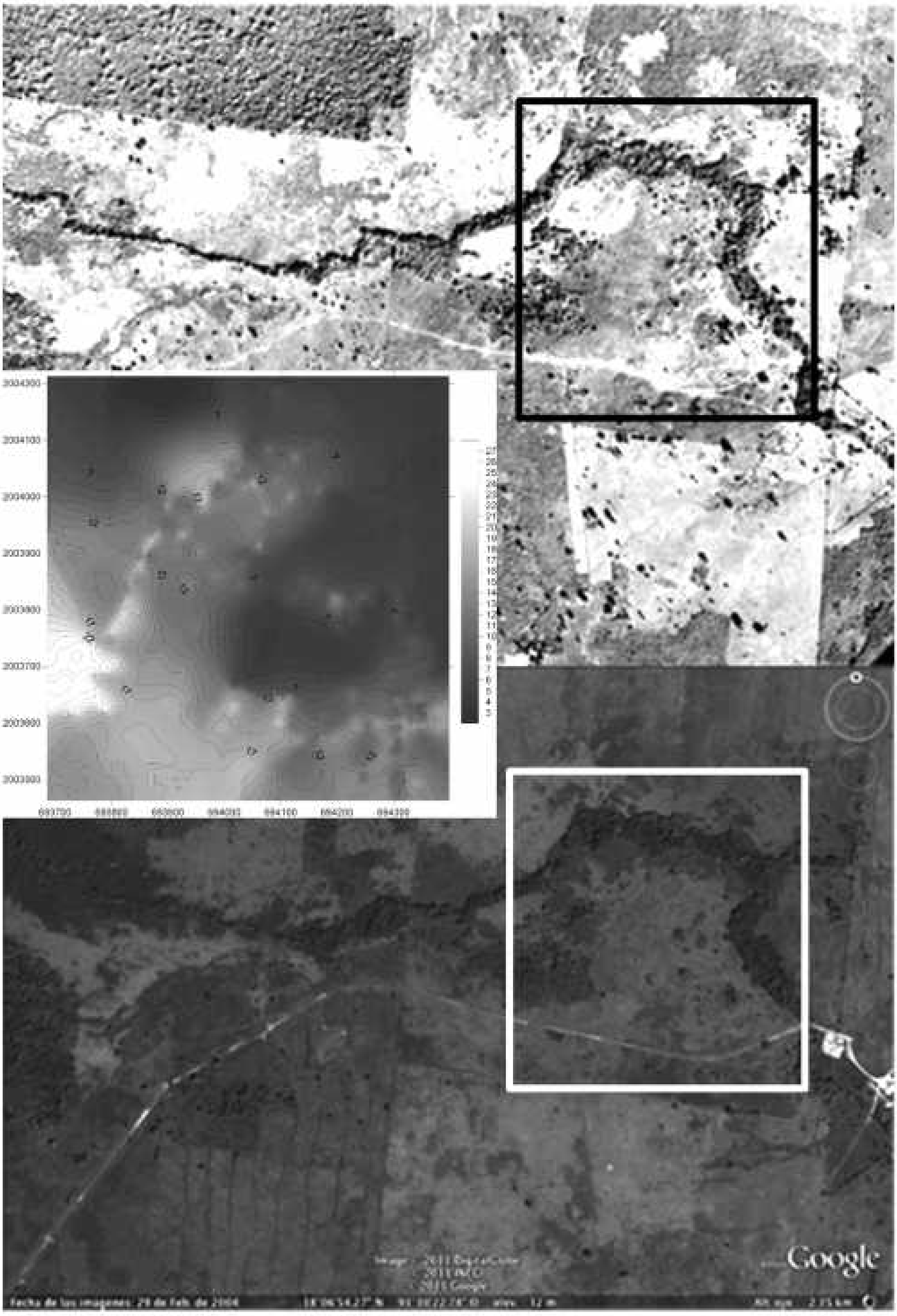

Fig. 2. The setting of the Mayan archaeological site of El Astillero; its urban core, originally identified by stereoscopy, is framed on the air and satellite images, while the inlay on the left contains the topographic survey we realised on the field, with the ancient ruins appearing as mounds on the surface. Substantial changes in landscape and manscape can be observed by comparing the archive air photo (above, by INEGI, 1996) and the more recent Google Earth picture (below, 2004).
Contextul sitului arheologic maya El Astillero; nucleul său urban, iniţial identificat prin stereoscopie, apare marcat pe imaginile aeriene şi satelitare, în timp ce imaginea din stânga conţine ridicarea topografică realizată de noi pe teren, cu vechile ruine apărând ca monticuli în suprafaţă. Schimbări substanţiale în peisajul natural şi antropic pot fi observate comparând fotografia aeriană de arhivă (sus, INEGI, din 1996) şi imaginea mai recentă de pe Google Earth (jos, 2004).

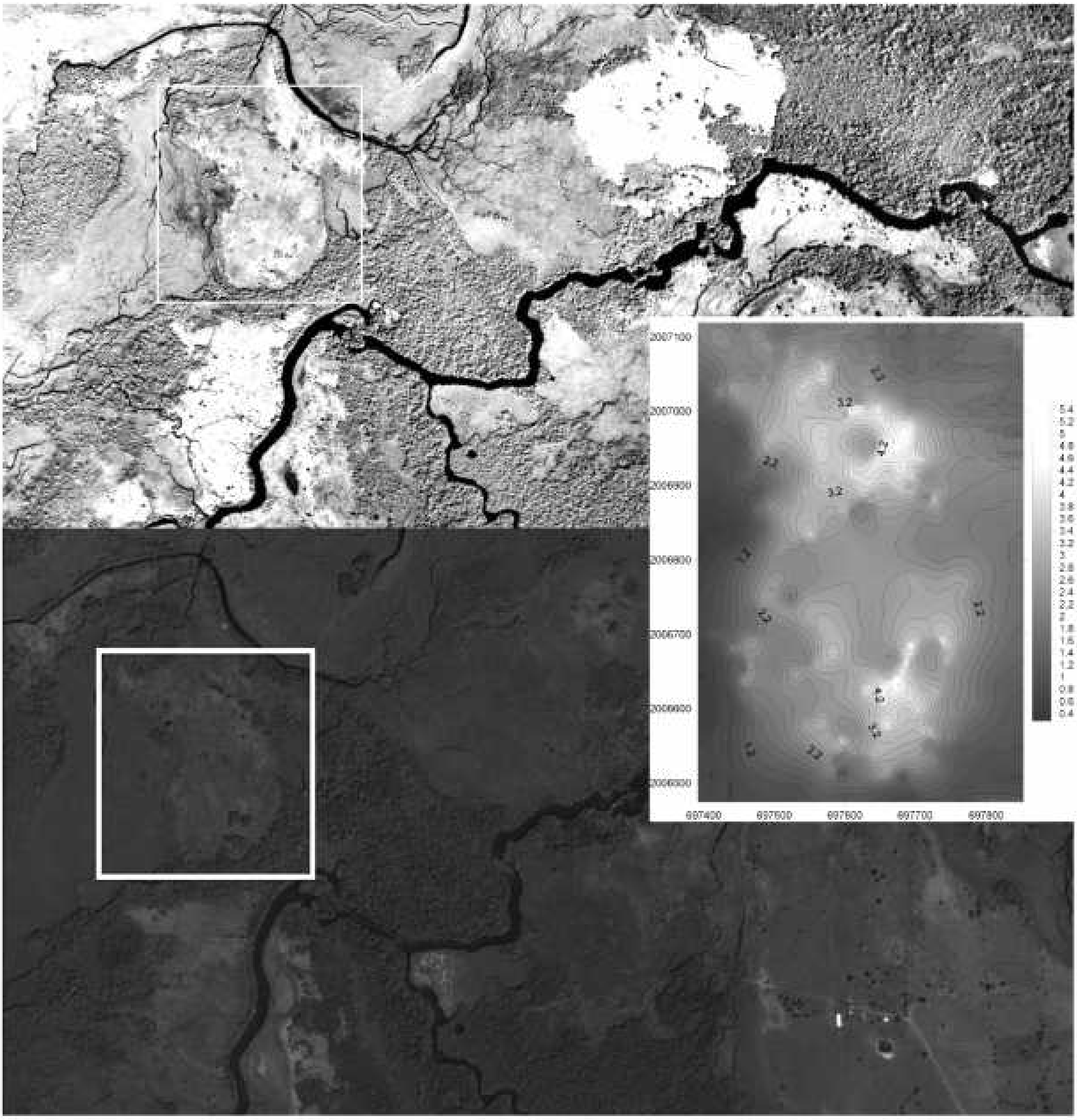

Fig. 3. The swamps and mangroves along the Middle Candelaria river, Campeche, with the small domestic site of Isla Montuy framed on both images; its topographic survey is in the inlay to the right. Comparison between an air photograph (above, by INEGI, 1996) and a Google Earth image (below, 2004).

Mlaştini şi mangrove de-a lungul cursului mijlociu al râului Candelaria, Campeche, cu mica aşezare de pe Insula Montuy, marcată în cele două imagini; ridicarea sa topografică se află în imaginea din dreapta. Comparaţie între o fotografie aeriană (sus, INEGI, 1996) şi o imagine Google Earth (jos, 2004).

Fig. 4. One of the tall mounds from the core of the Terminal Classic Mayan site of El Astillero, Campeche, Mexico (IX-XI A.D.), covered by the anthropic savannah vegetation in the middle of cattle-raising fields (photo: C.F. Ardelean).
Unul dintre monticulii mai înalţi din centrul sitului maya El Astillero, Campeche, Mexic, datat în perioada Maya a Clasicului Final (secolele IX-XI A.D.), acoperit de vegetaţie proprie savanei antropice în mijlocul unor păşuni pentru vite (foto: C.F. Ardelean).

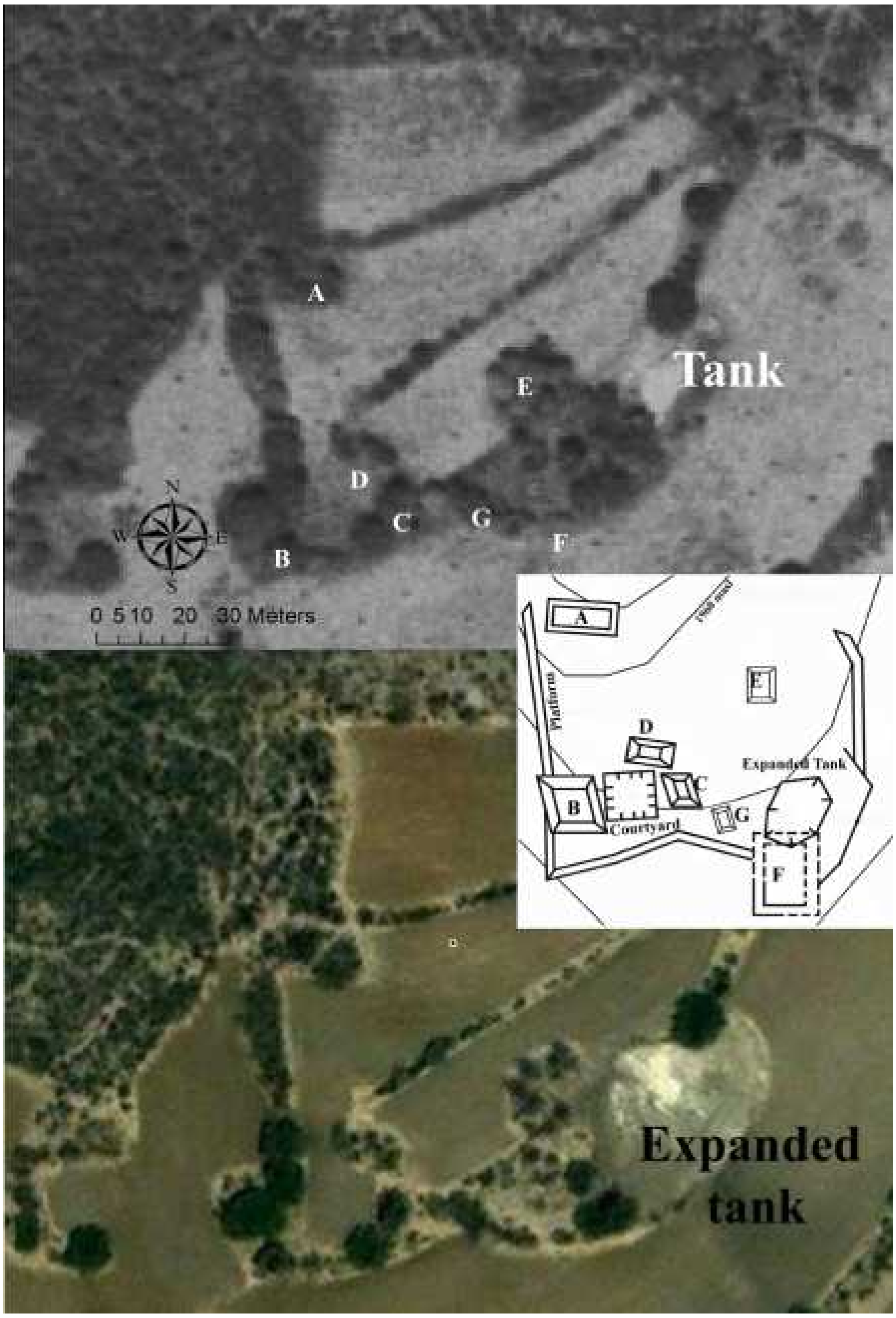

Fig. 5. The Pre-Columbian archaeological site of El Zapote, in the Laurel Mountains, Aguascalientes, discovered in 2005. The bi-dimensional map (inlay) is the on-field interpretation of the architectural features found on the digital ortophoto above (by INEGI, 2004), where the dark vegetation lines (trees and bushes) indicate not negative, but positive features, like platforms and walls. The area had been cleared and deforested for agricultural use, but the farmers could not clean those features off with heavy machinery because of the stones. Nevertheless, the Google Earth view (below, 2005) shows that only one year later the locals had managed to destroy part of the site by amplifying a water tank.
Situl arheologic precolumbian El Zapote, în Munţii Laurel, Aguascalientes, descoperit în 2005. Harta bidimensională (centru dreapta) reprezintă interpretarea pe teren a elementelor arhitectonice identificate pe harta ortofoto (sus, INEGI, 2004), unde liniile întunecate de vegetaţie (copaci şi arbuşti) nu indică trăsături negative, ci pozitive, precum platforme şi ziduri. Aria a fost curăţată şi defrişată pentru uz agricol, însă ţăranii locali nu au putut să înlăture elementele arheologice din cauza pietrelor. În ciuda acestui fapt, imaginea Google Earth (jos, din 2005) arată că, doar un an mai târziu, localnicii reuşiseră sa distrugă o parte din sit prin lărgirea zonei rezervorului.

Fig. 6. In the Google Earth image below (2007), from the site of Plazuelas, Guanajuato (not mentioned in the text), we can appreciate how a 'guachimonton' usually looks like from above. A 'guachimonton' is a characteristic round pyramid surrounded by smaller ceremonial platforms in a circular pattern. An almost identical feature appears in the upper image (Google Earth, 2005), indicating a 'guachimonton'-like pyramid at Calvillo, Aguascalientes. But the verification on the ground proved that it was just a recently made huge pile of debris and stones gathered in circular form by farmers' heavy machinery in order to clean a plowing field.

Pe imaginea Google Hearth de jos (2007), din situl Plazuelas, statul Guanajuato (nemenţionat în text), putem aprecia cum arată de obicei, de sus, un 'guachimonton'. Un 'guachimonton' este o piramidă circulară înconjurată de platforme ceremoniale mai mici, de asemenea într-un model circular. Un element aproape identic apare în imaginea de sus (Google Earth, 2005), sugerând o piramidă asemănătoare unui 'guachimonton' lângă Calvillo, Aguascalientes. Însă, verificările noastre pe teren au arătat că de fapt este vorba de o îngrămădire recentă de resturi şi pietre adunate în formă circulară de către ţărani în urma curăţării unui teren pentru arătură.

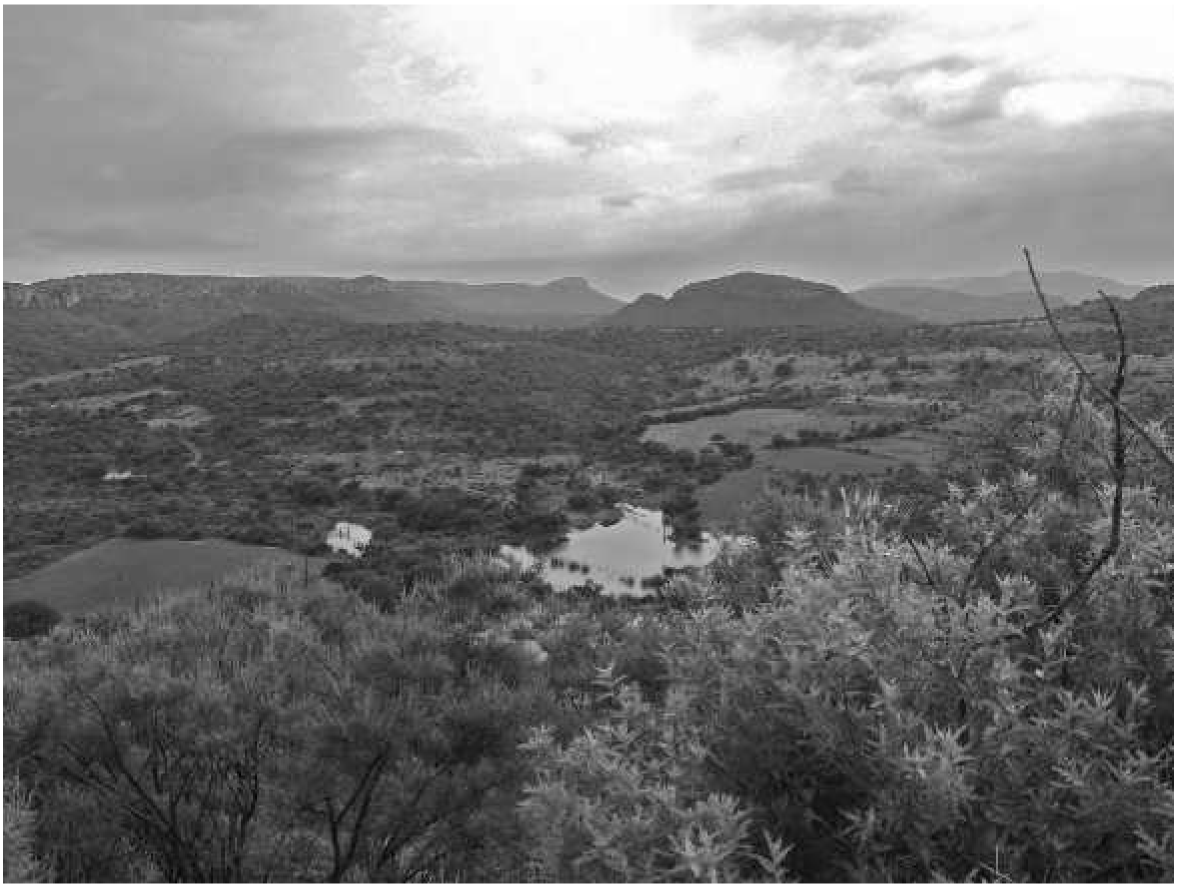

Fig. 7. The landscape of the study area in Aguascalientes, Mexico, during the rainfall season. It highlights the abundance of volcanic hills and the vegetation disturbed by modern farming (photo: J.I. Macías-Quintero).
Peisajul zonei de studiu din statul Aguascalientes, Mexic, în timpul sezonului ploios. Se evidenţiază abundenţa de ridicături de origine vulcanică şi vegetaţia modificată prin activităţi agricole (foto: J.I. Macías-Quintero).

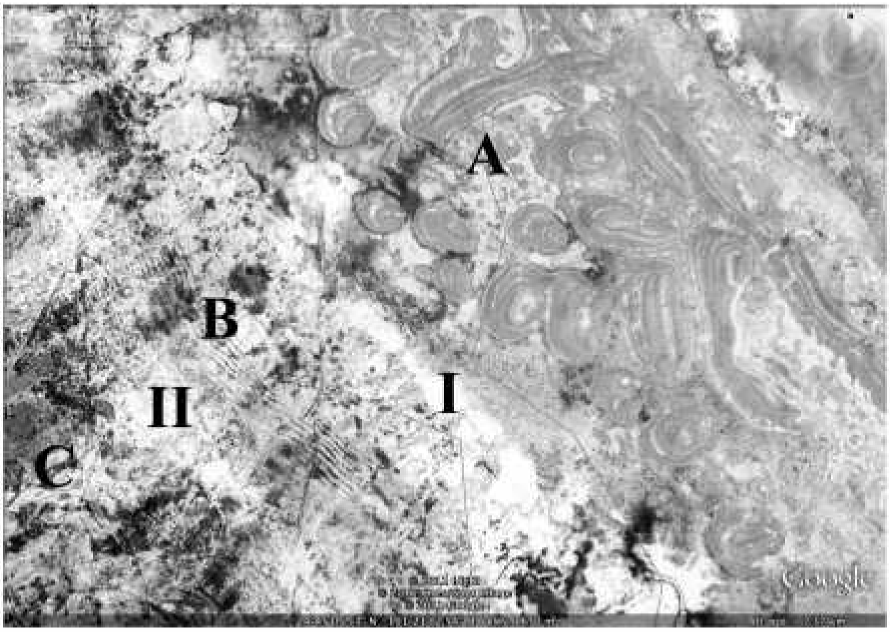

Fig. 8. A Google Earth Image (above, 2005) and an ortophoto (below, by INEGI, 1999) showing two distinct sectors of the endorreic basin of Concepción del Oro, Zacatecas, where hunter-gatherer shallow surface features cannot be identified on aerial imagery. In spite of that, we learnt to search for geological units which could lead us to the identification of preferential areas for human occupation. On the images we can observe the bottom of the paleo-lake with its significant hardened dunes (A), two palaeo-beach horizons (I and II), strange tree-lines probably marking the retrieving margins of the ancient water body (B), and alluvial fans (C).
O imagine Google Earth (deasupra, 2005) şi o ortofotografie (jos, INEGI, 1999) arătând două sectoare diferite ale bazinului endoreic din Concepcion del Oro, Zacatecas, în care elementele arheologice de suprafaţă ale vânătorilor-culegători nu pot fi identificate pe imaginile aeriene. În ciuda acestui fapt, noi am învăţat să identificăm acele unităţi geologice care ne-ar ajuta să descoperim ariile preferate pentru locuirea umană. Pe imagini putem observa fundul unui paleo-lac cu dunele sale solidificate caracteristice (A), două orizonturi de paleo-plaje (I şi II), ciudate distribuţii liniare de copaci probabil marcând contururile de retragere ale marginilor vechiului corp de apă (B) şi acumulările aluviale (C).

Fig. 9. General landscape characterizing the environment of the site of Dunas de Milpa Grande, on the margins of the playa-lake dominating the endorreic basin of Concepción del Oro, Zacatecas (photo: by C.F. Ardelean).
Vedere generală ce caracterizează mediul înconjurător al sitului preistoric Dunas de Milpa Grande, pe marginile unui ‚playa-lake' ce domină bazinul endoreic din Concepcion del Oro, Zacatecas (foto: C.F. Ardelean).