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Abstract submitted to the X ProGEO Symposium

Valleys of Cantabria aspiring Geopark (Spain): a future for the territory

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Keywords: geosites inventory, geomorphological features, geotourism, aspiring UNESCO Geopark, Cantabria

The Atlantic Geoparks Project, funded by the Interreg Atlantic Area Programme, aims to highlight the geoparks of the Atlantic area. In this framework, the Mancomunidad de Municipios Sostenibles de Cantabria (MMS) is promoting the candidacy of Valleys of Cantabria in northern Spain, as aspiring geopark. The aspiring Geopark territory is situated in the eastern part of Cantabria, bordering the provinces of Burgos and Vizcaya, where Miera and Asón rivers shape the landscape of these valleys. The territory included in this proposal is about 800 km2, including 20 municipalities with a stable population of about 61, 000 inhabitants.

From a geological point of view, the future Geopark is located in the eastern sector of the Cantabrian Mountains, in the Basque-Cantabrian Basin, where outcropping Mesozoic materials (Triassic, Jurassic and Cretaceous), and on them a wide variety of quaternary deposits. The combination of tectonic movements and modelling processes by different agents that have acted in the area during the Quaternary has resulted an excellent representation and diversity of environments, processes and morphologies of different genesis. This geopark could be a complement to those already existing in the neighbouring provinces, Basque Coast Geopark and Las Loras Geopark.

In the area, more than 50 geosites, natural elements and cultural points of interest have been inventoried. Geosites are based on criteria as type of interest, intrinsic or scientific value, potential of use, presence of other complementary values or existence of protection figures. Among others, coastal and aeolian, karst and glaciers landscapes can be found, as well as other stratigraphic, tectonic, and paleontological features. From these Geosites, 4 of them are included in the inventory of geological sites proposed by the IGME (Duque and Elizaga, 1983). Location of the main geosites is indicated in Fig. 1.

The coastal area of the future geopark concentrates a high diversity of environments highly representative of littoral zones of medium latitudes. Barjan and longitudinal dunes in an orthogonal framework climbing the mountainside constitute the relevant dune system of Sonabia; also, beach-dune system, subvertical cliffs and marshes are present. The fossil forest of Trengandín beach indicates that between 2,890-4,070 years B.P. (Fig. 2). The sea level was at least 2 m below the current one (Salas et al., 1996); it can be a good example to analyze the sea level changes during the Holocene in northern Spain.

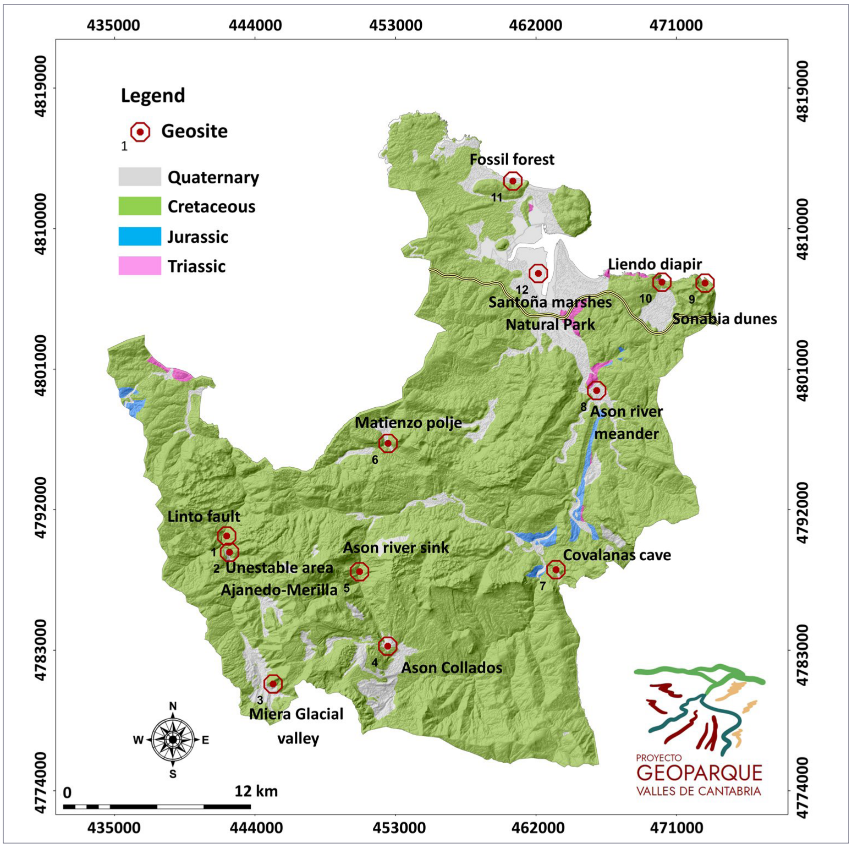

Figure 1 - Geological sketch of the Cantabria Valleys aspiring Geopark territory, including the location of the main geosites of the area.

The Urgonian complex, formed by large outcrops of massive limestones has undergone intense karstification, resulting in a great diversity of karstic forms, both in surface and in depth; so endokarstic forms, with kilometric developments, can be found underground. The Asón Valley is internationally recognized for its varied and rich underground heritage with more than 4,000 caves explored. Some of these caves have been used as shelters, at least, during the last 45,000 years (remains paintings of Covalanas Cave, World Heritage of UNESCO, have been dated in about 20,000 years).

Figure 2 - Detail of the Trengandin fossil forest. A paleontological-paleoclimatic-geomorphological Geosite A trunk can be seen inside a clay-muddy material.

Glacier morphogenetic system, located in the upper part of the territory, consists of five main units among the regions of Cantabria and Castilla-León. They present different conservation states and development, coexisting forms (cirque, valleys, moraines) built in different glacial phases, which are attributed to both the MIS6 and MIS2-3 glaciations. The glacial maximum development of this area occurred between 44,000 and 29,000 years B.P. (Serrano et al., 2013). Glacial remains appear at heights around 600 m.a.s.l. constituting one of the lowest in the Iberian Peninsula. The Miera glacier valley is one of the best examples of the glacier morphologies in the world (Fig. 3).

The declaration as UNESCO Global Geopark constitutes a great opportunity to promote the geotourism and development of the territory; but also, an occasion to preserve these Geosites, of great importance to knowing the changes occurred during the Holocene.

Figure 3 - View of the Miera glacier valley in which the typical "U" shape is observed, as well as different well-preserved morrenic deposits.

Acknowledgements

This is a contribution for the INTERREG project Atlantic Geoparks - EAPA_250/2016.

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Abstract submitted to the X ProGEO Symposium

Formation of the "Altyn-Emel"geological park in the Ili depression area (South-East Kazakhstan)

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Introduction

The territory of South-East Kazakhstan is an open-air geological and paleontological museum, where geological deposits and structures formed in geological epochs from the Paleozoic to the present day, rich in ancient biota remnants, are presented in a relatively compact territory. One of the most attractive in geological and cultural-historical terms is the territory of the Altyn-Emel national park. There is a large number of interesting geotopes (geosites) outside the national park as well. The rich geological heritage and the active initiative of the National Park administration provide an ideal base for setting up a new geopark.

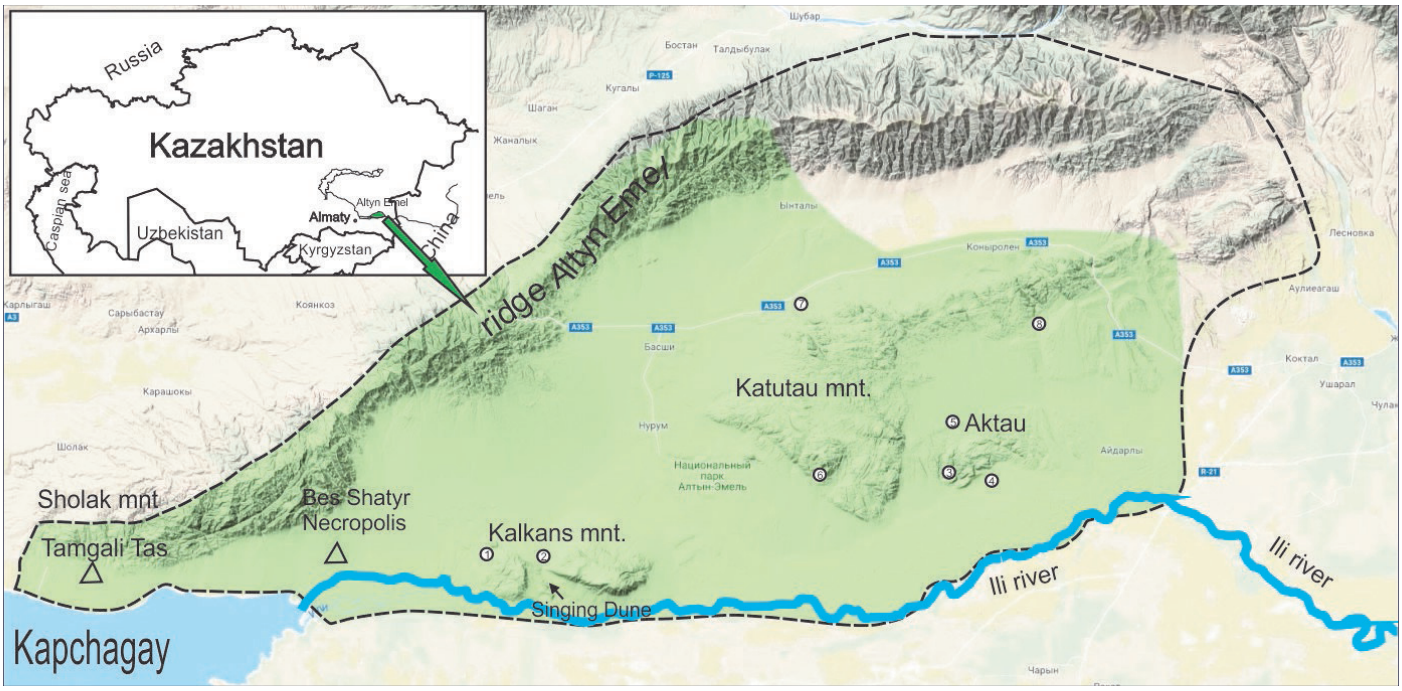
The initiative

In May 2017, after a series of meetings and negotiations, the National Park Directorate and scientists from the Satpaev Institute of Geological Sciences (at the Satpaev University) approached the Tourism Administration with suggestion to initiate officially the formation of the geopark. An action plan was developed, including scientific expeditions, a geological exposition, scientific and organizational documents, information boards and other operational activities. At present, the area of the geopark has been determined, the main bulk of scientific and expeditionary work is been implemented, a geological excursion guide has been developed, student internships, geological excursions, training of guides and staff are being conducted, and the management structure is being defined. It is planned for 2020 to design routes supplied with information boards, meet the locals in order to train guides and arrange master classes on making souvenirs.

Location and the landscape

The geopark is situated in South-East Kazakhstan, in the area of the Ile depression (South Dzungaria). The Park borders the south-western spurs of the Altyn-Emel ridge in the north, and in the south, part of the Kapchagai water reserve and the Ile river alluvial plain. It is only 250 km away from the largest city in the region, Almaty, with an international airport.

There are landscapes of amazing beauty in the territory of the park: piedmont deserts with characteristic flora and fauna, relict tugai poplar groves (flood-plain forests), springs, varicoloured volcanic mountains with traces of the tectonic processes, and whimsically carved canyons.



The outline of the geosite

The eastern part of the Ile depression, which inherited its deflected position from the Upper Paleozoic, is one of the alpine structures of South Kazakhstan, with a virtually continuous section of sediments developed from the Lower Paleozoic to modern sediments. Here is the location of the reference section of Cainozoic deposits and of a number of sites with fossil flora and fauna of different age.

The modern appearance of this area began to take shape in the Neogene, when the Alpine cycle of tectogenesis, occupying the last 50 million years of the geological history, resulted in the emergence of mountain structures of the Ile and Dzungarian Alatau and the intermountain Ile depression.

Geomorphological features

The Altyn-Emel mountain structures – the Altyn-Emel range and the adjacent mountains of Sholak, Degeres, Matai, Kalkans, Katutau and Aktau – are the outcome of the lifting of tectonic blocks (horsts), which keep moving today. Erosion and denudation activities conditioned the formation of the negative relief. Valleys adjacent to mountains (grabens) at a depth of more than three kilometers were filled with Neogene Quaternary sediments, mainly clayey, well exposed in the Aktau canyons (mountains).

Several morphogenetic relief types can be distinguished in the territory of the park: the alpine erosion-denudation sculptural strongly dissected type, the middle-mountain erosion-denudation type, the low-mountain denudation type, the steeply-sloping hilly relief of foothill plains and intermountain valleys, the cuesta type, the accumulation type and the aeolian one.

Geological features

The most interesting objects, both for geologists, paleontologists and tourists interested in nature, are the mountains of the Ulken (Big) and Kishi (Small) Kalkans with the "Singing barchans" in between, the Katutau mountains and the Aktau canyons.

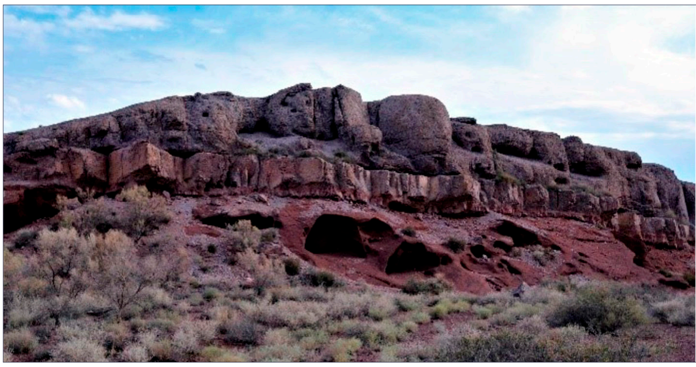
The Kalkans represent a symmetrical anticline fold, the core of which is composed of effusive and granitoid rocks, and the wings are composed of steeply-falling Cretaceous rocks and interchangeable Neogene rocks disagreeable with the Cretaceous ones. The sediments of sandstones and conglomerates revealed bones of reptiles and debris of petrified wood, indicating the Late Cretaceous age of conglomerates. This dating was also confirmed by imprints of the Late Cretaceous flora, studied on the northern slope of the Ulken mountain. Later, a flora-bearing layer was found at the western and eastern foothills of the mountain, in quartz feldspar uneven-grained sands with lenses of ferrous sandstones and siltstones.

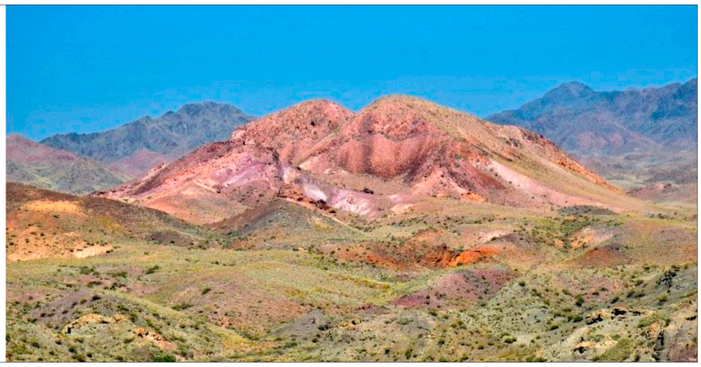
On the southern slopes of the Ulken Kalkan there is a strong zone of the South Kalkan fault, along which the southwest part of the Kalkan volcano had shifted, forming the mountains known as the Kishi Kalkan. This new corridor, like a wind tunnel, pulled the sands that lay at the foot of the volcano, forming huge dunes during the late Quaternary - Modern time. The most popular among tourists is the large southern barchan, representing a mountain of pure quartz sand without vegetation, with a steep slope. With a slight change in atmospheric pressure causing moves in the air, the grains of sand make long, loud sounds similar to the singing or hum of an airplane. This is why they were named "Singing Duns".

Kalkans mountain and Singing Duns".

The Katutau mountains (1630 m) are stretching from the southwest to the northeast in the form of a narrow steeply-sloping hilly ridge with plateau-like peaks. The slopes are dissected by numerous waterless gorges. The mountains are composed of coastal-marine sediments of the Carboniferous epoch containing the famous amphibian, foraminifera and algae imprints, as well as Permian volcanic rocks which look very spectacular. The layers of pink, lilac, red-brown and chocolate-colour volcanic tuffs and lava are stretching for many kilometres along the ridge. Some of them contain agate and quartz geodes. There is small manifestation of copper in the western part of the Katutau ridge. Here, in the rock debris, malachite admixtures are visible on cracks and rock surfaces.

There is a large Permian volcano in the middle part of the ridge; upon subsidence of the volcanic cone, a system of radial andesite dikes was formed converging to the centre of the volcano; its crater part is composed of large boulder tuffs. In the eastern part of the ridge, occur layers of black vitrophyres, or vitreous lava of the main composition, and to the south, there are yellow-red vast fields of ancient thermal springs, solfataras, containing fine gold.

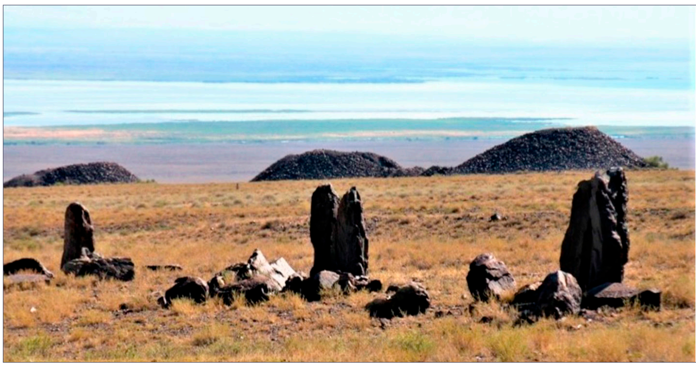




The Katutau mountains

Archaeological monuments related to geology

The Geopark territory is rich in historical and architectural monuments. The most interesting are monuments of rock art of the Early Middle Ages – the Tamgaly Tas with engravings of three Buddhas in classic Tibetan style and different animals. There is a cave in the Altyn-Emel mountains, which attracts Paleolithic researchers. There is a Bronze Age necropolis named Bes-Shatyr on the Ile river bank. 86 kurgans (mounds) of different sizes are surrounded by huge stone blocks – mengirs - pulled from the Sholak mountains. One of the kurgans has been reconstructed with complete restoration of the funeral ceremony decoration. In addition, there are settlements of the Bronze Age in the park area, where a large number of petrified wood artefacts, abundant at the foothills of the mountains, were found.



The necropolis Bes-Shatyr and Budda's petroglyph

Conclusion

The territory of the Ile depression, including the Altyn-Emel national park, is a great curiosity area of geological, geomorphological, biological, landscape and cultural value. The geopark is well accessible, situated only 250 km from Almaty, the cultural centre of Kazakhstan. A proper modern highway leads to the park, with sufficient number of hotels and hostels. Added to high popularity of the National Park, the development of the Geopark will contribute to the awareness of visitors and give a new impetus to the development of the region's economy. Moreover, by joining to the UNESCO geosite global network, it is possible to improve the international reputation and attract geotourists from other countries.

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Abstract submitted to the X ProGEO Symposium

Unique geosites “Bozzhyra tract and Western Chink Ustirt” on the Great Silk Road (Mangistau oblast, Western Kazakhstan)

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Keywords: Chink plateau Ustirt, unique geosites, fantastic landscapes, geotourism, mosque Beket Ata

Introduction

From the point of view of the study of geological and geographical features, the territory of Mangistau has a number of undoubted advantages. In the Mangistau region, their entire spectrum is unusually widely and expressively represented, which serves as an excellent basis for the development of tourism.

Plateau Ustirt is almost ideal desert plain or gently sloping and represents the largest item geomorphology earth’s surface, which, like the Great Barrier Reef, is clearly visible from the space. However, by its nature and mysterious geological history Ustirt much more interesting, than the famous Australian structure. In old times, ancient caravan routes passed through the plateau, including the Great Silk Road, which is reminded of the ruins of caravan-serais, ancient cities and fortresses.

Location

The proposed geosites is located in Western Kazakhstan in the eastern part of the Mangistau oblast within the limits Chink plateau Ustirt. One of the numerous pearls plateau Ustirt there is the Bozzhyra tract with the same name of the mountain, which is the highest part plateau with abs. elev. 287m. The Bozzhyra tract with its isolated hills is located in the northwestern part plateau Ustirt, and is part of the Zhabayushkansk State Reservation (Fig.1). The nearest settlement Zhanaozen, which is located southwest of Bozzhyra Mount about 100 km, distance from Zhanaozen to Aktau city - 124 km. In addition, from the city of Aktau to Zhanaozen can be reached by train (179 km).

Geological characteristic of unique geosites

1.1. Bozzhyra tract. Picturesque Bozzhyra tract represent the ridges, hills with almost smooth contours, also a huge valley, surrounded on three sides by an amphitheater of isolated hills. The brand identity of Bozzhyra tract are two limestone peaks called for the shape – fangs (Fig.1, photo 1). The rocks form amazingly diverse forms: these are mountain-tower, the mountain-castles, mountain-table, domes with flat roofs, yurt, peaks, canyons and etc (Fig.1, photo 2). All this is a magnificent complex of the white mountains at the bottom greatest canyon of the West Chink Ustirt and leaves a deep impression. The terrain of the Bozzhyra tract is incredibly beautiful. The rocks are rich in organics - echinoidea (sea urchins), mollusca, shark teeth and microfauna. Isolated hills of Bozzhyra tract are composed of Cretaceous-Paleogene sediments. Cretaceous sediments are represented by white chalk, chalky marls of the Upper Cretaceous (K2). White writing chalk visually represents a white soft rocks, significant part of which (60-70%) are organic residues of animal plankton (foraminifers) and calcite residues marine planktonic algae (coccolithophorids). Paleogene sediments are represented by light brown silt clay with an abundance of fish scales, with interlayers of dense clay of dark gray, brownish, marly pack marls of white, gray, grayish-green, dense, layered.

1.2. West Chink (Chink* - local name (turkmen lang.) - cliff dropping steeply to the shore) plateau Ustirt. Chink Ustirt represents denudation cliff, clearly visible all over. Chink Ustirt has a meandering shape in plan. On the slopes of the Chinks there are numerous grooves eroding karst rocks. Steep cliffs, limiting plateau, give the landscape a unique beauty. Especially picturesque the West Chink, which reaches a height of 340 meters. The southern part of the Western Chink Ustirt is characterized by an abundance of grottoes, caves, various niches. Along the of Chink Ustirt one can observe magnificent aprons of Cretaceous sediments (Fig.1, photo 3). The many colored cliffs, canyons and natural tracts here create a special, bizarre, and sometimes fantastic labyrinth (Fig.1, photo 4). In some areas, can to observe the so-called carras (= sphinxes), reminiscent of architectural elements. Most of the springs used by animals as watering places are located on the slopes of the Chink.

The border of the plateau Ustirt is sharply delineate by high (150 - 200 m) strongly dissected cliffs, which have meandering outlines. On the slopes of Chink there are numerous karrens (so-called sphinx), erosion karst rocks. Limestones lying on a clay “substrate” form beautiful columnar forms, often forming in such places caves and niches. Northern part of the Western Chink is characterized by block ravine-landslide slope with dissected pseudo-terraces, which form almost the entire lower part of the Chink.

In the central part of the Western Chink Ustirt in the Cretaceous deposits is traced a powerful globular nodules. Such nodules horizons can be found also to south of the famous and widely visited by pilgrims of the holy place for the local population underground mosque Becket-Ata (Fig.1).

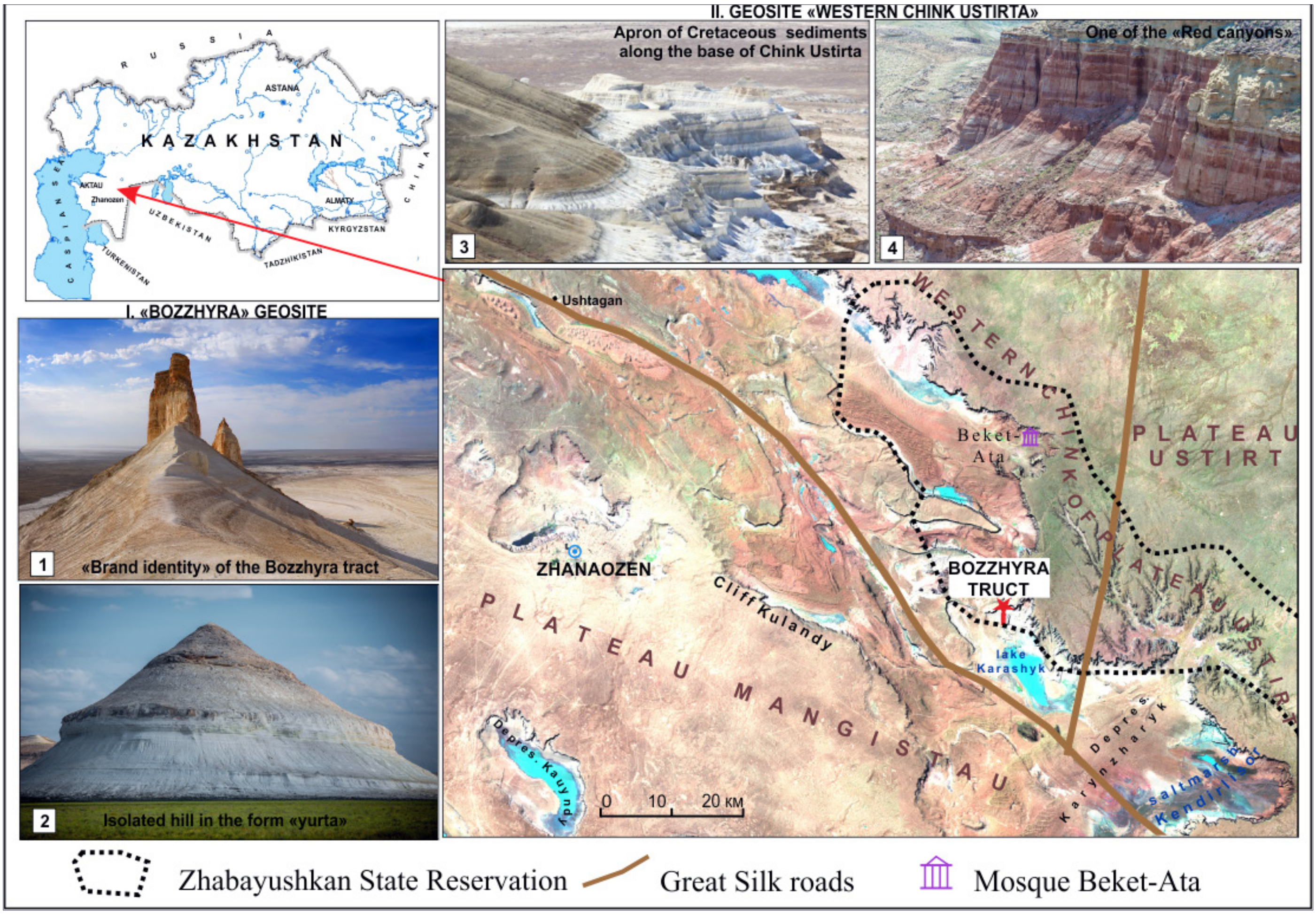

Figure 1- Unique geosites on the Great Silk roads in Mangistau oblast

Conclusion

From the point of view of the study of geological and geographical features, the territory of Mangistau has a number of undoubted advantages. In the Mangistau region, their entire spectrum is unusually widely and expressively presented, which serves as an excellent basis for the development of tourism.

In this region, it is possible to organize landscape research tours for the general public on the basis of morphological picturesque diversity, including such features as Kendirlisor, Zhabayushkan, Karamaya, UshBatyr tracts and much more in addition to the above objects.

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Virtual tour of the Serra das Russas's mylonites, Pernambuco, Brazil: a database tool based on graphical interactivity for interpreting the geosite

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Keywords: mylonites, 3D model, unmanned aerial vehicles, virtual tour, Brazil

The milonites of Serra das Russas (Brazil)

The main objective of this work is to make available a virtual visit of the mylonites geosite of Serra das Russas. Geologically, the Serra das Russas Mountain is inserted in the Borborema Province as a faulted massif with an irregularly folded structure due to an intense tectonic action, followed by the erosive reactivation of folds, accompanied by the formation of fractures and failures, in addition to successive flattening. The Pernamnbuco Leste shear zone was developed in the Neoproterozoic - Brazilian Cycle (Neves & Mariano, 1999) (Fig. 1).

This portion of the Serra das Russas is characterized as a low temperature range of the Pernambuco Shear Zone. Pre-existing faults largely promoted the formation of erosion surfaces in the folding belt, forming flattened surfaces at different altitudinal levels (Cristofoletti, 1974). Along road BR-232 (high-traffic highway) that connects the coast to the hinterland of Pernambuco, this area shows deformed rocks (low T mylonites to ultramilonite of granitic composition), with folds developed during the transpressive (dextral transcurrent E-W compression) forces that gave rise to a shear zone. This site was described by Santos (2016).

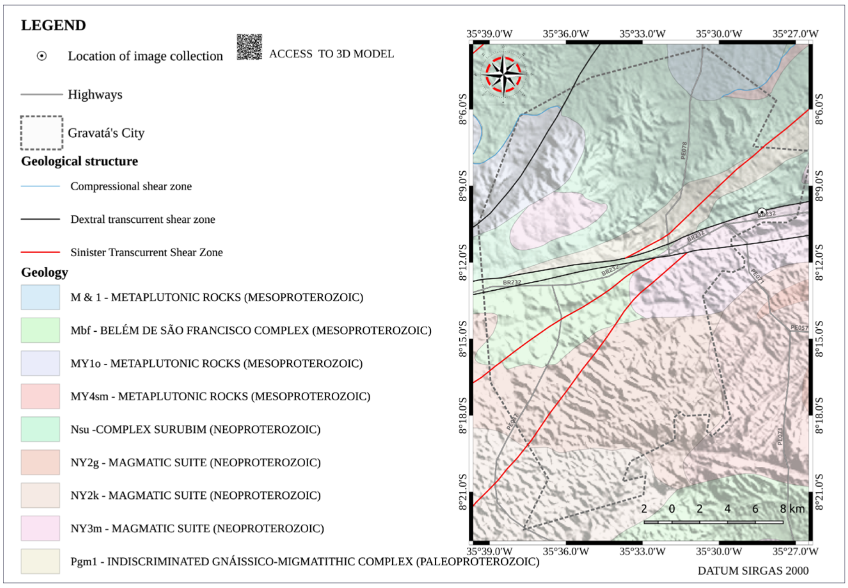

Figure 1 - Simple geological map of Gravatá City.

Methods and results

Image data, acquired with unmanned aerial vehicles (UAVs) was subsequently processed using photogrammetry techniques and multimedia technologies. A well-exposed folded zone, with hectometric scale, was chosen to collect field data, and we produced a virtual tour coupling interactive panoramic images with accurate 3D models of two folds. This virtual tour allows an overall view of the surroundings of the object of study, in this case, the natural landscape, the geological structures (meter-scale folds), as well as a view of parts of the study area as interactive 3D objects. This base was built using structure from motion (SfM) technology (Westoby et al., 2012) adapted to visualize geological objects by Santos et al. (2018).

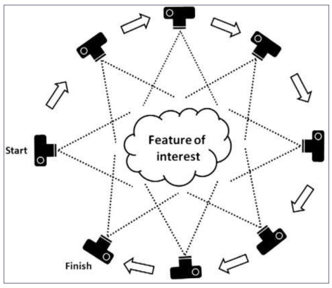

Figure 2 - Structure form motion, adapted from Westboy et al. (2012).

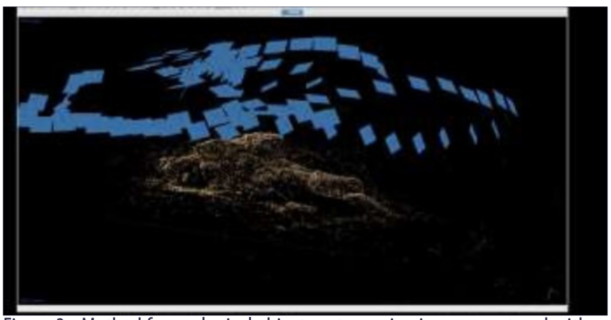

Figure 3 - Method for geological object capture using images captured with a Phantom 4 Pro UAV and processed with Agisoft Photoscan application.

Through the creation of 3D models of two folds, obtained by the digital treatment of images collected by UAV's, it was possible to solve some of the main impasses that make the fieldwork in this place difficult (Santos et al., 2018). The first is accessibility, since the site is located along the margin of a high-traffic highway that only has a narrow stripe for field lessons and data collection for research, posing a high risk of traffic accident. Intense fracturing associated with micro-vibrations due to the proximity of the highway, also can induce rock falls at any moment.

The 3D model also has the advantage of providing more points of view for the analysis of the geological structures, which is impossible to achieve from the ground. Finally, these 3D models constitute a digital archive with all the textural and structural aspects observed in the field, properly oriented. This is an important resource to study structures that are not easily accessible, or which are at risk of degradation or loss. It is very important to record and retain data for the interpretation, monitoring of places that are difficult to access or that have a risk of degradation or loss, as may be the case. Considering monitoring purposes, this type of record can be done at different time intervals to keep track of possible changes. The collected material is also important for the record of geological heritage and for educational, scientific and tourist purposes, using online or offline multimedia technologies. Raw materials can be accessed from:

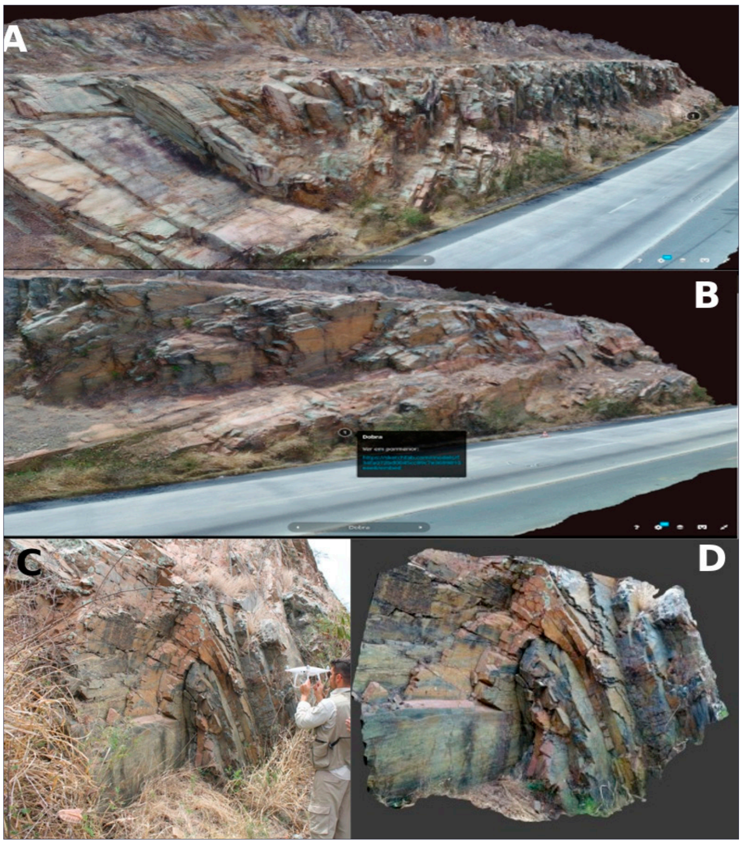

Figure 4 - A and B - General view of the three-dimensional model of the Serra das Russas rocky outcrop, located on the BR-232 road; C – small fold; D- Three-dimensional model of the fold in image C.

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