Eighteen new UNESCO Global Geopark applications to be evaluated in 2024

One area modification <10% for an existing UNESCO Global Geopark to be evaluated in 2024

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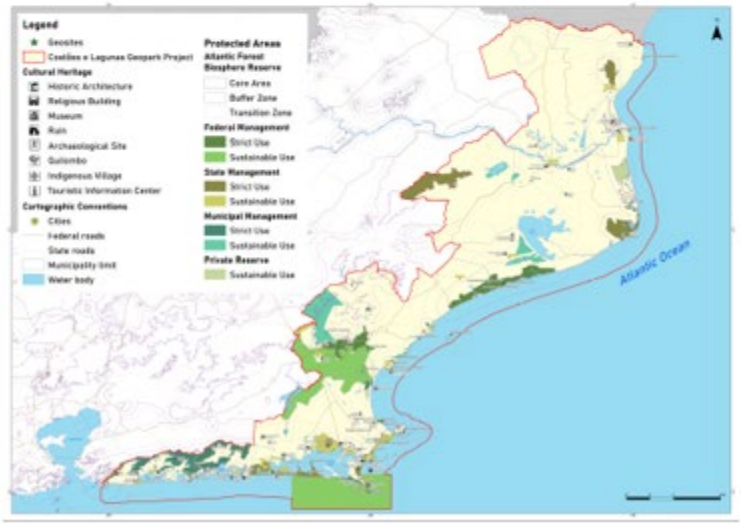
Applicant UNESCO Global Geopark

Costões e Lagunas, Brazil

Geographical and geological summary



1. Physical and human geography

Costões e Lagunas Geopark spans some 14 056 km^2 along the southeast coast of Brazil. Most of the area is semi-arid and has consequently developed unique landscapes such as hypersaline lagoons, dune fields, and endemic vegetation. Some Atlantic Forest exists in the region, forming an important site for biodiversity, and the area is recognized for its rare flora and fauna, with corals forming an important part of the ecosystem along the coast. The geopark is located in the Rio de Janeiro State of Brazil, includes 16 different municipalities, and is inhabited by approximately 1.6 million people. The area around the geopark includes the most productive oil fields in Brazil, and accordingly, is the main industrial driver. The service industry, particularly tourism, is also important, while agriculture remains important in rural areas. Rio de Janeiro is approximately 15 km away from the westernmost point of the geopark, and the area contains numerous highways and roads for access, in addition to several domestic and international airports.

2. Geological features and geology of international significance

Significant geological features in the area span almost two billion years of Earth history, from suites of magmatic rocks that formed ca. 1.98 billion years ago, to modern hypersaline lagoons. An important theme connecting many of the geological features of the geopark is the ancient connection between South America and Africa in the supercontinent Gondwana. The initial collision between South America and Africa occurred ca. 530 million years ago, and unique metamorphic rocks recording this important event are well-exposed in the geopark. The eventual rifting apart of South America and Africa is recorded in a suite of magmatic rocks present in the geopark, and uniquely, a fragment of Africa remains 'attached' to South America in this region. Relatively recent processes have also played a role in shaping the geology of the region, with changes in sea level during the past 2.6 million years resulting in the formation of sea cliffs that are now found inland. Some of the most unique and remarkable features of the geopark are ongoing in modern-day hypersaline lagoons, which may be key environments for understanding the ancient Earth. Some of these lagoons are sites of stromatolite growth (mounds formed by microscopic communities), which are relatively rare on the modern Earth but common in ancient rocks. The mineral dolomite is currently forming in some of these lagoons, which is of great scientific interest because it is very rare in the modern Earth but very common in ancient rocks – referred to as 'the dolomite problem'. Finally, some of the geological units on land in the geopark continue offshore into the actively extracted petroleum basins and are therefore valuable outcrop analogs for understanding petroleum systems.

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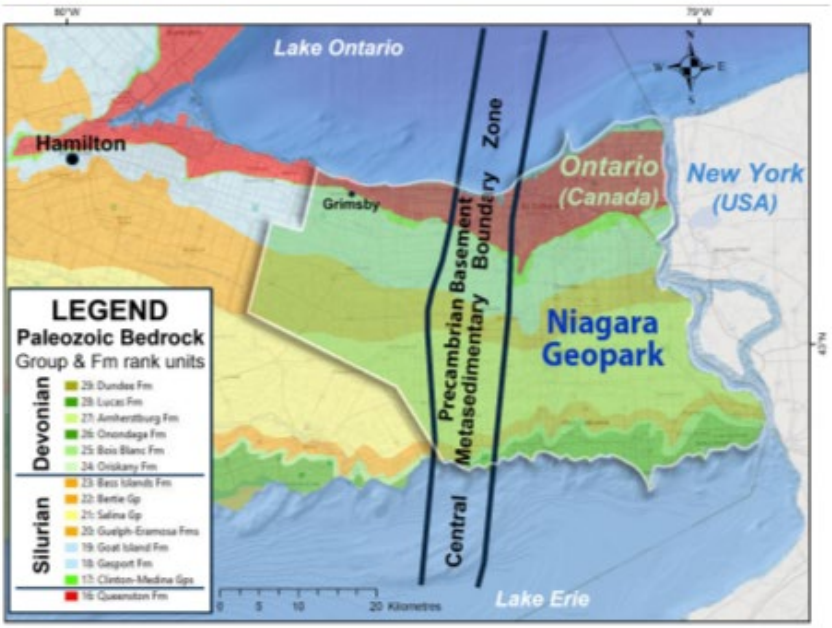
Niagara, Canada

Geographical and geological summary



1. Physical and human geography

The Niagara Geopark is located in the Niagara Region, in the southern part of the province of Ontario, Canada. The geopark is centered on coordinates 43.04248°N, 79.29399°W, with an area of approximately 1 852 km^2. The park is bounded to the north by Lake Ontario, to the south by Lake Erie, and to the east by the Niagara River, which forms the international border between Canada and the United States of America. The geopark is transected by two large escarpments, the most famous being the Niagara Escarpment, which has UNESCO World Biosphere status. The population of the geopark area is approximately 480 000, with tourism comprising a significant part of the economy. The geopark is adjacent to the most populated part of Canada and near several large American cities; fourteen million people live within a two-hour drive, and 36 million within a four-hour drive. The Niagara region is served by road and train, with domestic and international airports located nearby in both Canada and the United States of America.

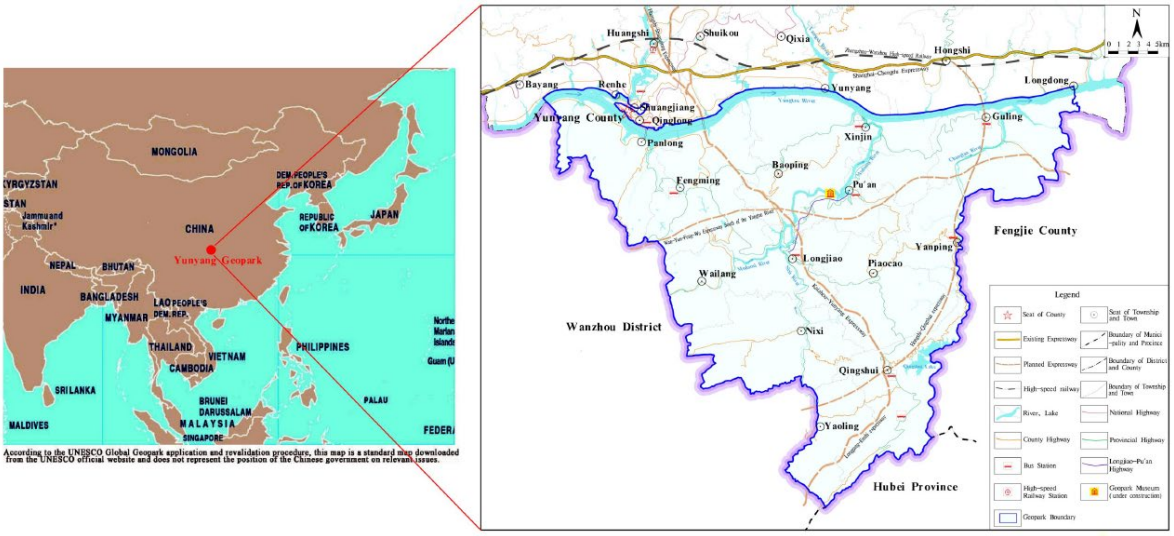
2. Geological features and geology of international significance

The modern-day geopark is influenced by geology spanning almost two billion years of Earth history. Although the oldest rocks in the geopark (from 1.85 to 1.2 billion years old) are not exposed at the surface, the ancient plate tectonic processes they record have influenced the orientation of modern-day features, such as the north-south alignment of the Niagara River. Overlying this is a thick package of sedimentary rocks deposited from 470 to 382 million years ago on the shallow and warm margins of an ancient sea; this sequence of rocks forms the two escarpments of the region. More recent geological processes in the area are related to the Laurentide Ice Sheet ca. 23 000 years ago that formed glacial lakes and sedimentary deposits that are today popular sites for vineyards. There are four principal features in the geopark that are of national to international significance. Niagara Falls, beyond being a famous tourist attraction, holds significant geological heritage for informing our understanding of the age of the Earth; as early as 1789, geologists recognized that Niagara Falls must have taken many thousands of years to form, more than possible if the Earth was only 6 000 years old, as was believed at the time. Secondly, the geopark region preserves abundant fossils from the Paleozoic Era from 539 to 359 million years ago, providing a valuable archive of evolutionary processes and changes in ancient environmental conditions. A third significant feature is the geopark's record of mountain belt formation ca. 440 million years ago that contributed to the onset of an ice age and the extinction of ~85% of all marine species. Finally, the Niagara Escarpment forms a unique and beautiful landscape that reflects the underlying geological units and tectonic history, and shapes air-circulation patterns to maintain temperatures ~10°C warmer than surrounding areas during the winter.

Applicant UNESCO Global Geopark

Yunyang, People's Republic of China

Geographical and geological summary



1. Physical and human geography

Yunyang Geopark is located in Yunyang County, Chongqing Municipality, in the southwest of the People's Republic of China. The geopark spans approximately 1 124 km^2 between 30°34'50"N to 30°57'54"N, and 108°36'09E to 109°10'00"E. Characterized by low to medium mountains and hilly landforms, the elevation of the geopark ranges from 139 to 1 625 meters above sea level. The climate is subtropical monsoon, with an annual average temperature of 18.4°C and rainfall exceeding 1 100 mm/year, although climate changes significantly according to altitude. The geopark is within the Yangtze River basin and contains two first-class tributaries. The area is inhabited by approximately 480 000 people, primarily from the Han ethnic group, with a small amount from the Tujia ethnic group. Economically, the area is driven by agriculture, aquaculture, and tourism. There is a domestic airport located approximately 30 km away in Wanzhou, and an international airport approximately 230 km away in Chongqing. The area is also served by national and provincial road networks, with several additional expressways under construction.

2. Geological features and geology of international significance

The geology of the Yunyang Geopark stretches back almost 260 million years in time and records the disappearance of an inland sea and the terrestrial environment that formed afterward. The region is best known for its dinosaur-rich fossil deposits and dramatic karst landforms. Stretching over 18 km across the geopark, a package of sedimentary rocks deposited from 175 to 161 million years ago forms a 'Great Wall' of dinosaur fossils, in addition to plesiosaurs (large swimming reptile), crocodyliforms, testudines, osteichthyes, chondrichthyes, tritylodontidae and labyrinthodontians. In one particularly spectacular outcrop measuring 150 meters wide and 6 – 10 meters high, approximately 5 000 pieces of dinosaur fossils are exposed. The fossils preserved in the geopark are of global significance, as they help to fill a knowledge gap in the evolution of dinosaurs during the Middle Jurassic (175 – 161 million years ago), especially the early part of the period. Yunyang Geopark has a unique karstified landscape that represents the interplay between limestones that formed ca. 250 to 200 million years ago, deformation and folding ca. 100 to 66 million years ago, and finally, dissolution of limestone units in a hot and humid climate. This has resulted in the formation of diverse karst features such as sinkholes, canyons, caves, funnels, peaks, and stone columns. One sinkhole is 335 m deep, ranking fifth globally, and comprising an important research site for understanding karst formation.

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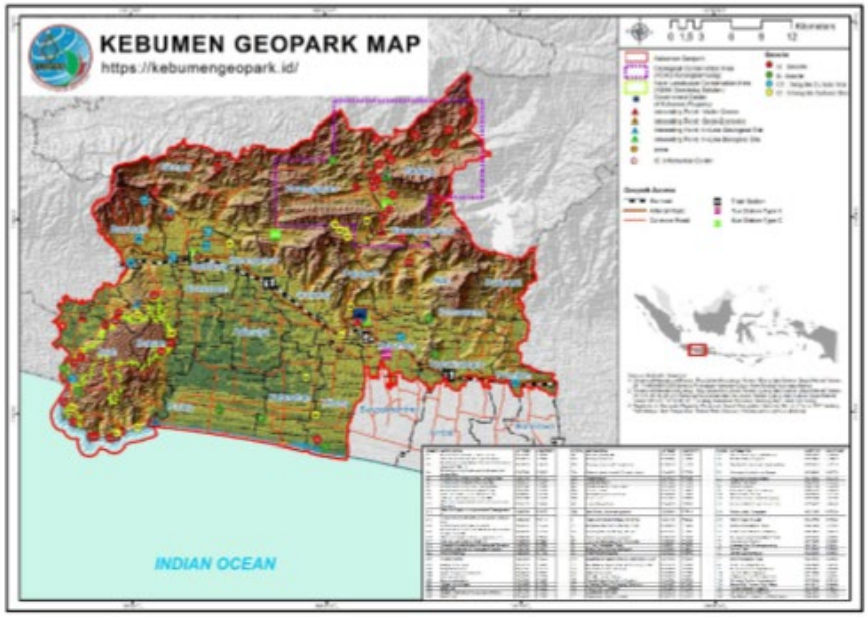
Kebumen, Indonesia

Geographical and geological summary



1. Physical and human geography

Kebumen Geopark is located on the southern coast of central Java Island, Indonesia, spanning from 7.4354°S to 7.7942°S and 109.38148°E to 109.7723°E. It has an area of approximately 1 161 km^2 that spans 22 subdistricts and 374 villages. Steep to rolling hills comprise the landscape of the northern part of the geopark, with conical hills to the southwest, and flat alluvial plains to the southeast that contain rivers draining south into the Indian Ocean. The region has a tropical rainforest climate, with a rainy season from October to April, and total annual rainfall of approximately 3 110 mm per year. The temperature ranges from 26.6 to 33.6°C, with humidity ranging from approximately 60 to 95%. Approximately 1.17 million people live in the geopark, working primarily in agriculture, forestry, and fishing, although the manufacturing and business sectors are also present. Kebumen Geopark is approximately 6 hours from Jakarta by train, and an international airport is one hour away.

2. Geological features and geology of international significance

The common theme among many of Kebumen Geopark's highlights are its record of plate tectonic activities that are widely used as the type-example for tectonic plate subduction. Subduction of the Indo-Australian plate under the Eurasian plate (on which Java is situated) occurred from 119 to 55 million years ago, resulting in the formation of metamorphic rocks and the uplift of rocks from the ocean floor to the surface. From 55 to 25 million years ago, a complex mixture of sedimentary rocks was deposited in basins, representing erosion and redeposition during a period of intense tectonic activity. The continued subduction of the Indo-Australian tectonic plate resulted in the formation of volcanoes from 25 to 16 million years ago. A cessation in volcanic activity between 16 and 10 million years ago, combined with rising sea levels, resulted in the deposition of fossil-rich limestone units. A rejuvenation of volcanic activity from 10 to 2 million years ago resulted in the deposition of alternating packages of volcanic ash and limestone that are still preserved in the geopark. Geological processes occurring during the past two million years have further modified the landscape, for example, through erosion and transportation of sediments by rivers. Significant dissolution of the limestone units deposited between 16 and 10 million years ago has resulted in significant karstification and the formation of dozens of types of karsts and cave structures.

Applicant UNESCO Global Geopark

Meratus, Indonesia

Geographical and geological summary

1. Physical and Human Geography

The Meratus Geopark is located entirely within the South Kalimantan Province of Indonesia, covering approximately 3 645 km^2. Topographically, the geopark spans from lowlands to highlands, with the highest summit reaching ~1 900 m above sea level. The landscape also contains many valleys, waterfalls, rivers, lakes, and karst landforms. With a topical climate, the area experiences dry and rainy seasons, and is vulnerable to tornadoes, fires, landslides, and floods. The geopark contains six cities/regencies, with a total population of approximately 1.76 million people; approximately 74% of the population belong to the Banjar tribe and a lesser amount to the Dayak tribe. The region has significant natural resource potential, particularly for energy (petroleum and coal), metals (iron ore and gold), and industry (diamonds, chromite, marble, etc.) Access to the region is provided by several domestic/international airports, road networks, and waterways/ferries.

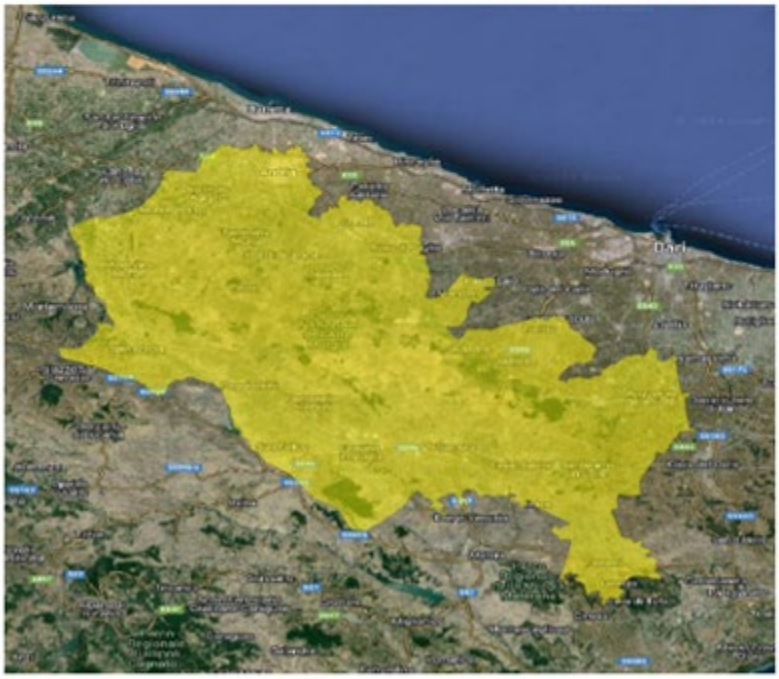
2. Geological Features and Geology of International Significance

The geological features of Meratus Geopark are primarily due to a series of complex tectonic events related to tectonic plate collision and subduction. The Meratus Mountains that make up much of the geopark are composed of ophiolite, rocks that formed on the seafloor approximately 198 million years ago, but were thrust on to land during collision from 137 to 110 million years ago. Ophiolites are globally rare, and although they are found elsewhere in Indonesia, the Meratus Mountains preserve the most complete ophiolite sequence in the country, as well as the oldest. They thus represent an important site for understanding the unusual tectonic processes behind their formation. Limestone was deposited underwater from 36 to 16 million years ago and eventually uplifted onto land because of further tectonic activity. The subsequent partial dissolution of these limestone rocks resulted in dramatic karst landscapes and the formation of large cave structures. Finally, alluvial sediments that formed during the past ~1 million years contain diamonds in concentrations sufficient to sustain artisanal mining. The source of these diamonds remains enigmatic and is a target of ongoing research.

Applicant UNESCO Global Geopark

Alta Murgia, Italy

Geographical and geological summary



1. Physical and Human Geography

The area basically corresponds with the north-western Alta Murgia and the Premurge area of Puglia. The whole area is mainly hilly, with altitudes up to about 680 meters above sea level (Torre Disperata, 686 m; Monte Caccia, 680 m). The Alta Murgia area is characterized by the occurrence of woods, karst caves, sinkholes, escarpments, depressions caused by water erosion (known as “lame” and “gravine”), extensive pastures, architectural elements and towns related to agricultural activity and pastoralism. The area comprises the Alta Murgia National Park, a protected area which covers approximately 68,000 hectares, and includes several Natura 2000 sites. The Premurge area is mainly clay with rounded hills hosting small villages.

The area includes the municipal territory of fifteen towns between the provinces of BA (Bari), BAT (Barletta-Andria-Trani), and TA (Taranto). The total population reaches about 440 000 inhabitants. There is a natural balance between the ancestral landscapes and the traditional houses (farms, jazzi, cisterns, dry stone walls), the agro-pastoral activities (pastoralism and agriculture), traditional food products, medicinal herbs and ancient routes of transhumance, called “tratturi”. The aspiring Geopark area is marked by a rich biodiversity with different types of steppe and sub-steppe habitats, unique in Italy. There are about 124 wild species present, representing about 25% of the 500 recorded for Italy. The avifauna of the Murgia is among the most important of the steppe and semi-arid areas of the Mediterranean basin. Several international, national, and regional laws protect the sites, justified by the richness of the environmental, landscape and historical-cultural components. (Directive 43/92/EEC, Directive 79/409/EEC).

2. Geological Features and Geology of International Significance

The proposed Alta Murgia Geopark is located in the southeast of Italy and comprises the Alta Murgia area, where a Cretaceous sector of the Apulia Carbonate Platform crops out, and the adjacent Premurge area, where the southwestward lateral extension of the same platform turns toward the south Apennines Chain and is thinly covered by Plio-Quaternary foredeep deposits.
The main features of international value to propose the area as a Geopark are:

- The Alta Murgia area represents a virtually undeformed sector of Adria, a continental plate located between Africa and Europe, involved in subduction/collision processes. In the geopark, the crust is still rooted to its mantle, and the Cretaceous evolution of Adria is spectacularly recorded in the Murge area thanks to the limestone succession of one of the biggest peri-Tethyan carbonate platforms (Apulia Carbonate Platform).
- The Premurge area represents the outer south-Apennines foredeep, whose Plio-Quaternary evolution is spectacularly exposed. An “anomalous” regional middle-late Quaternary foreland uplift led to expose a complete foredeep succession in the bedrock.
- The fact of hosting two in-situ paleontological findings of very different age, a Neanderthal skeleton preserved in speleothems and one of the world’s widest surfaces with dinosaur tracks (~25 000 footprints) testify of its uniqueness.
- Water acts as a unifying element between two linked but extremely contrasting territories.

- The use and conservation of water in a karstic area, in addition to archeology, ancestral urban settlements and caves used as traditional religious sites, shows the close relationship between man and geology in the area and represent a good opportunity to disseminate the geological culture to a large and diverse audience.

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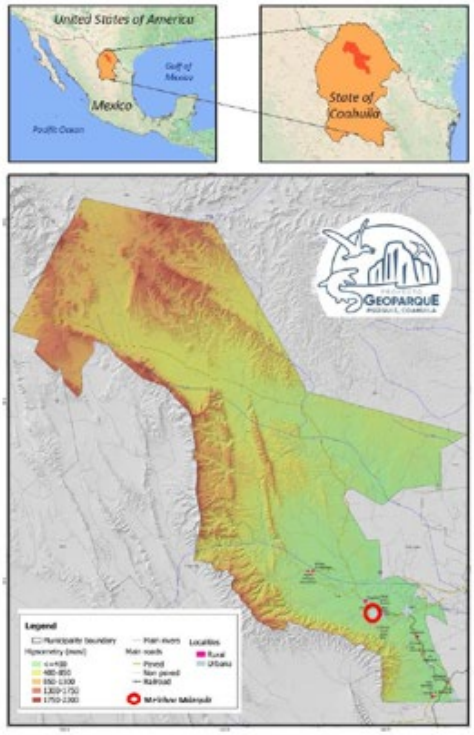
Múzquiz Coahuila, Mexico

Geographical and geological summary



1. Physical and human geography

Múzquiz Coahuila Geopark is located in northeastern Mexico, near the border with the United States of America. It spans approximately 8 288 km^2, mostly in the Sierra Madre Oriental mountain range, with a minor amount located on the Great Plains. For the most part, it is a mountainous area comprised of N-S oriented mountain ranges with steep slopes, separated by valleys and low hills. The climate in the region varies from semi-dry and semi-warm, to semi-dry and temperate, to dry and semi-warm. Annual mean temperatures range from approximately 8 to 36°C, with annual rainfalls of less than 400 mm/year that feed seven hydrological basins within the geopark. The population of the area is approximately 72 000 people, with approximately 1% being indigenous. The area is predominantly rural, with approximately 50% of the population concentrated in the city of Ciudad Melchor Múzquiz. Approximately 6% of employment is in the primary sector (agriculture, forestry, livestock, and fishing), 36% in the secondary sector (mining, construction, electricity, gas, and water), and 58% is in the tertiary sector (commerce, tourism, services, and transportation). The region is one of the main fluorspar mining areas globally, and although coal mining has been historically important, it is now in decline. The geopark is accessible by road, train, and air travel. The third largest city in Mexico, Monterrey, is approximately 350 km away, and highways provide direct access to Texas in the United States of America. Much of the geopark is already protected, and it partly overlaps with a Biosphere Reserve.

2. Geological features and geology of international significance

Múzquiz Coahuila Geopark records the most recent 145 million years of Earth history, including the formation of the Gulf of Mexico and later deformation by plate tectonic collision. The geology of the area is comprised largely of sedimentary rocks (e.g., shale, sandstone, limestone), with smaller amounts of volcanic and magmatic rocks present. Much of the strata of the area has been strongly deformed, and the geopark contains excellent examples of topographic highs and lows (horsts and grabens) created through tectonic faulting of the region. The geopark is of international interest primarily for its remarkably diverse and well-preserved fossil deposits that include fish, dinosaurs, turtles, crabs, ammonoids (extinct spiral-shelled animals similar to nautiloids). Fossil sites in the geopark are considered ‘lagerstätten’, meaning that in some cases three dimensional structures, articulated skeletons, and soft tissue such as tendons and muscle tissue are fossilized, rather than just bones or teeth. Many fossils were first discovered within the boundary of the geopark, such as Muzquizopteryx coahuilensis, a type of pterosaur (i.e., a flying dinosaur). In addition, this is one of the few areas in the world where correlation between ammonoids and inoceramidae (extinct animals similar to bivalves) is possible. Beyond fossilized animal remains, the geopark also contains a wealth of fossilized botany, including wood, leaves, and fruits.

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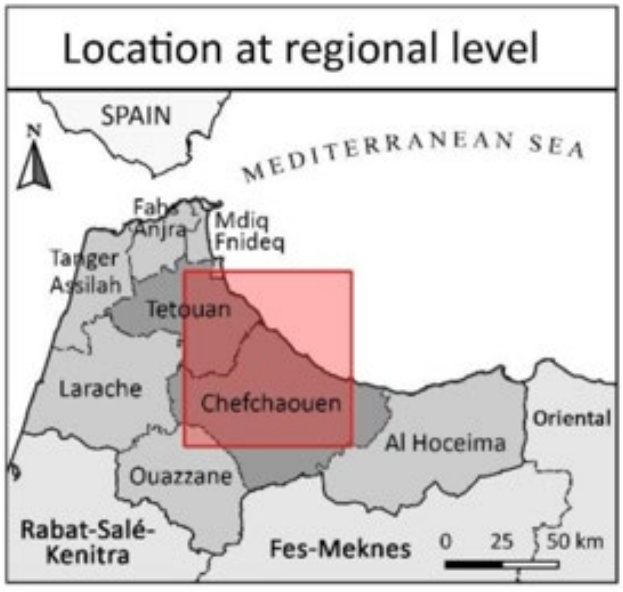
Chefchaouen, Morocco

Geographical and geological summary



1. Physical and human geography

The Chefchaouen Geopark covers an area of 1 940 km^2 and is centered on coordinates 35°13'30.92"N and 5°8'26.13"E, in the provinces of Chefchaouen and Tétouan, northwestern Morocco. The landscape of the proposed geopark is dominated by the Rif Mountains, which are crossed by large rivers and valleys. Although the rivers are now dry for the most part, old fluvial terraces are present, and they have eroded gorges with waterfalls through the prominent limestone massifs. The coastal regions of the geopark are largely composed of steep cliffs falling into the Mediterranean Sea, separated by small beach areas that contain both active and 'fossil' sand dunes. Some trees are endemic to the region, and there is a wide variety of animal life. There are approximately 139 000 residents in the geopark area, spread between thirteen communes. The Ghomara Coast is a World Heritage Site, and Chefchaouen Geopark is part of the Mediterranean Intercontinental Biosphere Reserve.

2. Geological features and geology of international significance

Chefchaouen Geopark contains a rich and complex geological history beginning approximately 539 million years ago. The strata of the area has been complexly deformed by a series of plate tectonic processes, which divides the geopark into three distinct tectonic complexes. The most notable tectonic event recorded in the area is the collision between the African and European tectonic plates from 251 to 66 million years ago; this formed the Alpine mountain belt, which includes the Alps in Europe and the Rif and Atlas mountains in Morocco, among others. Research focusing on this area has therefore contributed significantly toward international understanding of ancient continent configurations and the formation of mountains spanning large parts of Africa and Europe. The rocks within the geopark are predominantly composed of limestone that formed on the margin of an ancient ocean, of which the Mediterranean Sea is a small remnant. These sedimentary rocks have been a valuable archive for scientists studying changes in ancient ocean environments, fossils and animal evolution, and tectonic processes. These limestone rocks are also vulnerable to karstification, which has resulted in the formation of a wide variety of karst features, such as different types of sinkholes and caves. Sedimentary rocks deposited hundreds of millions of years ago are now important aquifers to the inhabitants of the geopark, with water flowing through fracture networks created by the tectonic events.

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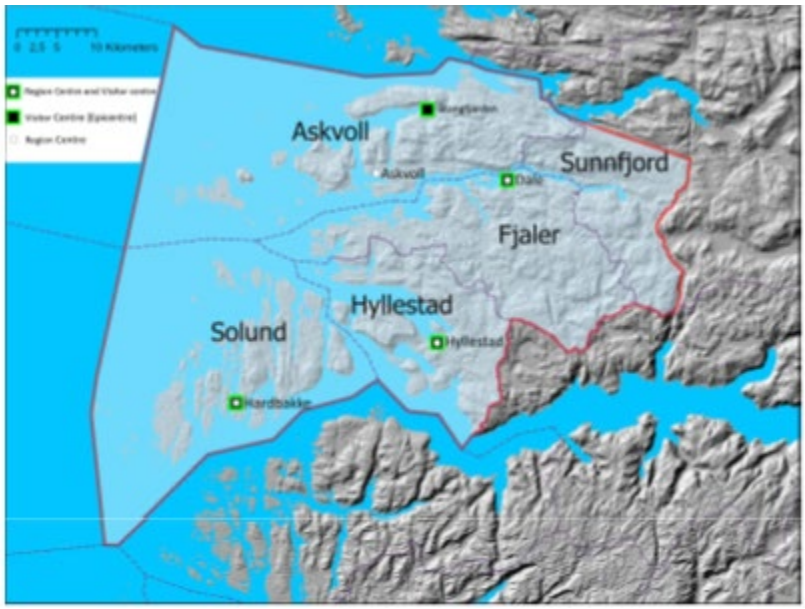
Applicant UNESCO Global Geopark

Fjord Coast Regional and Geopark, Norway

Geographical and geological summary



1. Physical and human geography

The Fjord Coast Regional and Geopark is spread over ~1 480 km^2 of land and ~3 020 km^2 of sea along the western coastline of Norway. The Geopark is situated at the mouth of Norway's longest and deepest fjord, Sognefjord, and includes a diversity of stunning geographic and topographic features, such as mountains, glaciers, waterfalls, fjords, islets, islands, and skerries. The highest mountain peak in the Geopark, Blægja, stands 1 304 meters above sea level, and more than 2500 meters above the deepest part of Sognefjord. Heathlands are found on the islands of the Geopark and are important for grazing of wild sheep; some of these areas have been deemed nationally significant or preserved territories. The Geopark area is home to some 9 000 people across five municipalities, and is approximately 130 km by car and ferry from Bergen, the second most populous city in the country. Fisheries and aquaculture are the primary industries in the region, supplemented by the service industry, tourism, and public services. Significant potential exists for expansion of tourism.

2. Geological features and geology of international significance

The mountains that form this Geopark are the result of the Caledonian orogeny from 425 to 395 million years ago and are considered one of the best analogs for Himalayan-type mountain-belt formation. The rocks exposed at the surface in this geopark therefore provide an invaluable archive for researchers to understand the processes happening deep underground in the modern-day Himalayas, all within a relatively compact area. This includes fragments of ancient continents and their margins, pieces of the ocean floor, and volcanic/magmatic rocks that were complexly deformed during the tectonic events entailed by mountain-building and are now exposed at the surface of the Earth. While some of these rocks are relatively 'pristine' (i.e., reflecting their original formation), others have been extensively metamorphosed and recrystallized into new minerals/rock types during mountain formation. Due to complex faulting and movement of bedrock, rocks that formed on the seafloor as lava flows, or as intra-montane alluvial fans and lake deposits ca. 400 million years ago, are found adjacent to rocks that formed contemporaneously ~50 – 100 km below Earth's surface. The geological framework of this region has been crucial for developing an understanding of how deeply buried rocks can be uplifted and exposed on Earth's surface, and the model developed in this region has been applied more widely around the world. The mountains in this region underwent another growth phase during the Cenozoic (starting ca. 66 million years ago) during the formation of the North Atlantic Ocean and the Norwegian-Greenland Sea when Greenland separated from Scandinavia. More recently, numerous ice ages have reshaped the surface topography and resulted in the formation of one of the world's deepest and longest fjords. The area has significant geological heritage and provided key evidence for the identification of ice ages, the classification of metamorphic rocks, and the description of geological units that remain relevant today.

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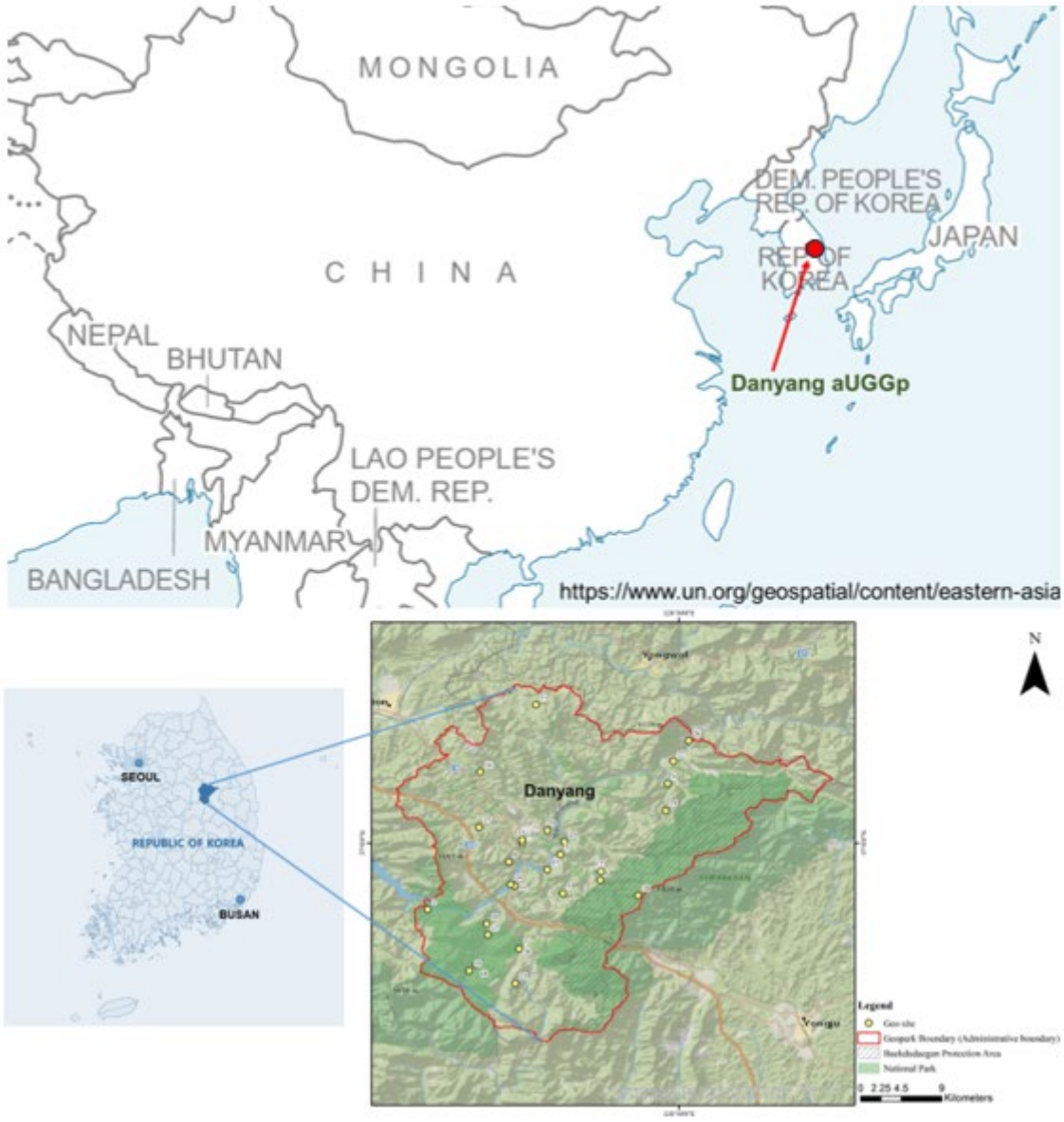
Danyang, Republic of Korea

Geographical and geological summary



1. Physical and human geography

Danyang Geopark is located near the center of the Republic of Korea, centered on 39.680°N and 128.339°E. The boundary of the Geopark follows that of Danyang County. The Geoparkcovers 781 km^2. Temperature variations in the area are moderate, from 6.6 to 17.5°C (average of 11.5°C), and the area receives a total of approximately 1 100 mm of precipitation per year. The area of the geopark includes two pre-existing national parks and is within the Baekdu Daegan mountain range that spans the entirety of the Korean Peninsula. A significant number of cultural relics from prehistoric times as well as the Stone Age have been found in the geopark area, some from limestone caves. Although the total population of the area is approximately 28 000, it is experiencing depopulation like many other rural areas in the Republic of Korea. Limestone quarrying and cement manufacturing were historically important industries in the area, although tourism has become an increasingly important part of the local economy. The geopark is approximately 180 km from Seoul and can be accessed by expressway (~3 hours) or rail (~1.5 hours); it can also be accessed using the national road network and local roads.

2. Geological features and geology of international significance

The geology of the region is varied, spanning from from 1.87 billion years ago to ca. 66 million years ago, in addition to the development of more recent geological features such as cave systems. The sedimentary rocks that were deposited underwater in this area from 540 to 420 million years ago, and from 252 to 66 million years ago, form a particularly valuable record for understanding the changes in the ancient Earth and the prevalence of different marine environments through Earth history. These rocks were subsequently deformed through plate tectonics, and combined with their fossil assemblages and paleomagnetic data (i.e., recording changes in plate tectonic location), they provide important information on the tectonic history of the Korean Peninsula and East Asia. A distinct geochemical signature known as the ‘middle Darwillian carbon isotope excursion’ is recorded in the sedimentary rocks of the geopark and is crucial for the correlation of sedimentary rocks in the geopark with other units of the same age around the world. The first discovery of this geochemical signature in the Sino-Korean craton was found in the geopark, providing another aspect of geological heritage to the area. The more recent geological history of the area is evidenced through the formation of karst topography and cave systems, as limestone rocks were dissolved during variations in the ancient climate. Prominent research articles on these limestone cave systems have yielded important information for understanding large climatic variations in ancient East Asia.

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Applicant UNESCO Global Geopark

Gyeongbuk Donghaean, Republic of Korea

Geographical and geological summary

1. Physical and human geography

Gyeongbuk Donghaean Geopark is located in the eastern coast of the Republic of Korea, centered on 36.36°N and 129.40°E. It overlaps with Gyeongju City, Pohang City, Yeongdeok County, and Uljin County. The Geopark area is primarily rural, with 735 000 residents in 63 towns and villages. Inhabitants are mostly concentrated in the cities of Gyeongju and Pohang in the southern part of the park, although the region is experiencing overall population decline. The area of the Geopark is 2 630 km^2, of which 263 km^2 are sea. The Geopark is in the eastern part of the Nakdongjeongmaek mountain range, the longest high mountain range in the Republic of Kora. The landscape is highly varied, from mountain peaks, to gorges, cliffs, limestone caves, coastal terraces, and sand dunes. The southern region is famous for its bays and inlets that have served as natural harbours since ancient times. The climate is temperate, averaging 13.5°C and ranging from 9.0 to 18.6°C. Gyeongju was the capital city from 57 BC to 918 AD, and contains several World Cultural Heritage sites with geological connections. Agriculture (particularly rice and vegetables), as well as fisheries, aquaculture, mining, and steel production are historically the main industries of the area. Activities related to tourism (outdoor activities, hospitality industries, crafts, and tour guides) are emerging in the area with the development of geotourism. The Geopark is approximately 300 km from Seoul, and can be accessed by road, high-speed train, air travel, or passenger ship.

2. Geological features and geology of international significance

The Geopark contains rocks that are important for understanding the geological history of East Asia. The oldest rocks in the park, formed more than two billion years ago, are related to similar rocks in the People's Republic of China and document the evolution of the Korean Peninsula in the broader context of East Asia. A diverse suite of younger magmatic rocks, notably different types of granite, record a series of continental collision and subduction events from ca. 257 to 57 million years ago, informing on the geological history and tectonic processes occurring during that time. The geopark contains the best record of sedimentary rocks in the Republic of Korea related to the formation of the Sea of Japan, starting 23 million years ago. These sedimentary rocks also serve as a model for this type of tectonic rifting process, making them of international significance. The fossil record in the geopark documents the changes in environmental conditions during opening of this sea, illustrating the relationship between geological and biological processes. Further, because the sedimentary rocks of the area record a wide variety of fossil types, some of which are related to extant species, they are illustrative for understanding the processes behind evolution. Finally, Gyeongbuk Donghaean Geopark contains the roots of an ancient volcanic complex that are important for understanding the behaviour of magmatic systems underground.

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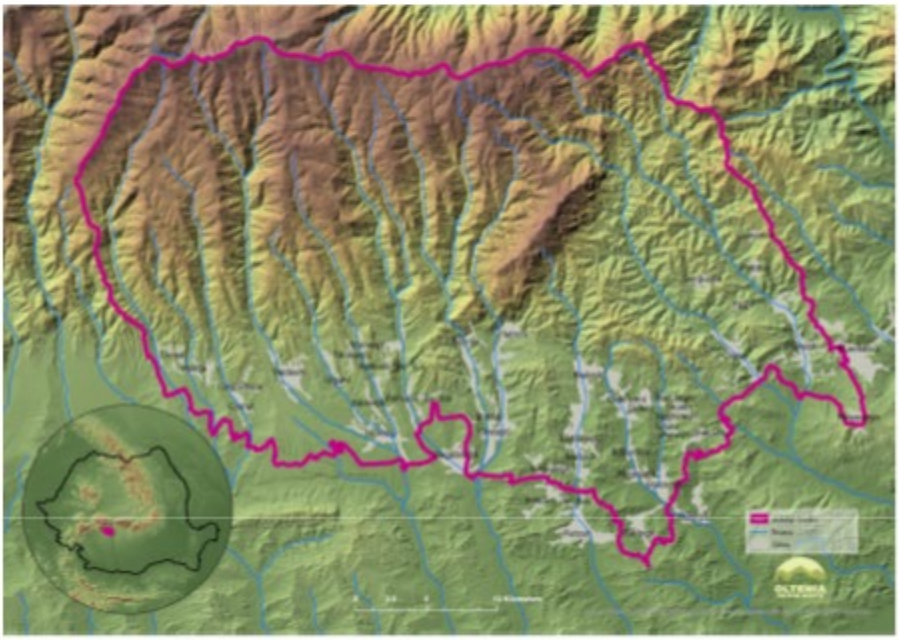
Oltenia de sub Munte, Romania

Geographical and geological summary



1. Physical and human geography

Oltenia de sub Monte ('Oltenia under the mountain') is located in Vâlcea Country in southwestern Romania, between the Danube and Olt rivers, and the South Carpathian Mountains. It is centered on coordinates 45.24105°N and 23.98868°E, covering approximately 636 km^2 at the foot of the mountain range. The terrain is predominantly forested, and hilly to mountainous, with elevations ranging from ~200 to 2 130 meters above sea level; local relief can vary by as much as 740 m, with the average elevation of the geopark being 450 m above sea level. The middle part of the geopark is dominated by the prominent Buila-Vânturarița Massif and a karsted landscape, with 5 canyons and over 100 caves. The ~23 000 inhabitants of the geopark live in the southern 10% of the region near the foot of the mountains. The 90% of the geopark that is uninhabited is primarily forested (80%), with some mountain pastures (10%) that are composed of pasture lands, fruit trees, and berry plantations. Nonetheless, the geopark is relatively close to 6 major cities, with three international airports relatively close (Bucharest, 190 km; Sibiu, 120 km; Craiova, 110 km). The nearest train station is in Râmnicu Vâlcea, approximately 10 km from the geopark. Subsistence agriculture and animal husbandry are the main economic drivers in the area, with tourism as an emerging industry. The geopark area includes one national park/Nature 2000 site, a second Natura 2000 site, and 15 natural reserves.

2. Geological features and geology of international significance

The geology of the Oltenia de sub Monte geopark is of international significance because it is representative of the geological processes that took place in the South Carpathian Mountains in central Europe. Consequently, the geopark records 350 million years of Earth history in its metamorphic and sedimentary rocks. In the northern portion of the geopark, metamorphic rocks are found that formed at the limit between Earth's mantle and crust, an important boundary in the interior structure of the Earth. The central part of the geopark is composed of limestone sedimentary rocks that were deposited ca. 201 to 100 million years ago in the ancient Tethyan Ocean. These sedimentary rocks include fossilized coral reefs, which are important for researchers studying the environmental conditions of this ancient ocean and reef systems that lived within it. These limestones, in addition to overlying clastic sedimentary rocks, are very rich in fossils. Dissolution of limestone rocks by rainwater and rivers has, over time, resulted in a strongly karstified landscape; the geopark contains five canyons and over 100 documented caves, which have created environments for the evolution of unique troglobite (underground-living) species. In the southern portion of the geopark are salt mines and 'trovants', unusual spherical rocks that formed through cementation of sandstone and now outcrop dramatically.

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Salma, Saudi Arabia

Geographical and geological summary

1. Physical and human geography

Salma Geopark is located in north-central Saudi Arabia, covering approximately 3 145 km^2 in the Hail Governorate. The geopark is centered on coordinates 27°05'17"N, 42°18'26"E, and is located approximately 80 km southeast of Hail, 112 km north of Breda, and 500 km northwest of Riyadh. This area includes the Salma mountains and volcanic craters, with the highest point rising 1 469 meters above sea level. Approximately 9 000 people live within the geopark, split between rural and urban environments. The geopark can be accessed by several different highways and expressways.

2. Geological features and geology of international significance

The geological features of the Salma Geopark span more than 700 million years of Earth history, and record tectonic uplift and rifting, volcanic/magmatic events, flooding of the Arabian tectonic plate during sea level rise, and weathering/erosion processes. The geology of the area has been divided into five themes, the first focusing on the crystalline basement of the Arabian Shield, which composes the oldest 'bedrock' in the region. Formed by volcanic and magmatic processes starting approximately 740 million years ago, these rocks are also crosscut by fractures and magmatic intrusions from more recent events. Parts of the Arabian Shield bedrock formed deep underground but are now found at the surface, making them both valuable and accessible archives of deep Earth processes. The second theme focusses on Neoproterozoic super-eruptions and their mega-calderas, collectively representing the plumbing systems and associated volcanic debris that was erupted. These features represent important sites for understanding how magma systems develop in very old continents. Paleozoic volcano-sedimentary packages and Mesozoic sediments that formed ca. 545 to 250 million years ago form the third theme, representing flooding of the Arabian tectonic plate at equatorial latitudes on the margin of the ancient Gondwana supercontinent. The ca. 2-million-year-old Hutaymah volcanic field, with at least 119 vent sites and 77 volcanoes, is the fourth theme of the geopark. Some of the volcanoes have unique 'maar' craters that are characterized by broad, shallow shape, and are internationally important study sites. Other volcanic sites are unique for containing many spherical volcanic 'bombs.' Finally, Quaternary (less than 2.6 million years old) river, lake, and aeolian systems have created recent geological features that characterize much of the landscape, such as valley systems and dried lake beds. Recent weathering and erosion have altered the appearance of many geological units, resulting in distinct weathering profiles such as 'onion skin' (i.e., spheroidal or concentric) weathering.

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North Riyadh, Saudi Arabia

Geographical and geological summary

1. Physical and human geography

The North Riyadh Geopark is located in the east-central Arabian Peninsula, in the Thadiq Governorate of Saudia Arabia. The geopark has coordinates 25.296219°N, 45.864502°E and covers an area of approximately 3 221 km^2. The geography of the geopark is characterized by Tuwaiq Mountain, valleys, and cliffs, and can be divided into several broad zones: a western and northern side of gently sloping basins filled by aeolian sediments, a rugged escarpment along the central axis, and a relatively smooth eastern side with dendritic river valleys. North Riyadh Geopark is approximately 150 km northwest of Riyadh, approximately 1.5 hours by car.

2. Geological features and geology of international significance

The North Riyadh Geopark has three central themes that highlight its internationally significant geology. First among these themes is geomorphology, with the Tuwaiq Mountain imposing over much of the geopark. This is a globally significant escarpment that spans approximately 800 km across the Arabian Peninsula. The flat-top of this escarpment, combined with the steep cliffs and flat valley floors, indicates an erosional regime that is controlled by differences between rock types that were deposited tens to hundreds of millions of years ago. Other recent to modern geological/morphological features include sand dunes reaching up to 100 m in height, alluvial fans, and calcrete cementation of sands/soils to a depth of one meter, owing to low rainfall and high evaporation in the area. The second theme of the geopark reflects its valuable record of Jurassic to Cretaceous (i.e., ca. 201- to 66-million-year-old) shallow marine limestone deposits. The geopark is the ideal environment for studying the deposition and environmental architecture of passive margin (i.e., tectonically inactive) environments, making it important from a geological perspective. Further, because passive margin environments are highly sensitive to environmental change, and because the geopark is rich in fossil material (including shelled animals, corals, and microscopic animals), it is a valuable site for studying the evolution of marine life and ecosystems. Finally, the geopark establishes an important link between the geology of the region and the petroleum geology of Saudi Arabia. The geological units that are exposed in steep escarpments in the geopark are related to major petroleum reservoirs, thereby representing important ‘outcrop’ analogs of reservoir rocks. This provides important information for understanding how petroleum forms, is transported, and trapped, and further, makes a strong geoheritage link to the modern economic growth of Saudi Arabia.

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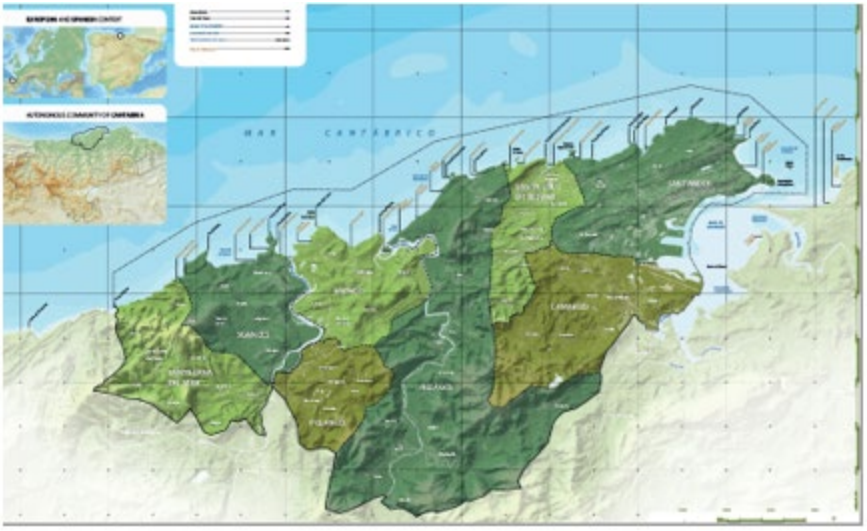
Costa Quebrada, Spain

Geographical and geological summary



1. Physical and human geography

Costa Quebrada Geopark spans 345 km^2 of rolling hills and river valleys on the central coast of Cantabria, in northern Spain. The lower stretches of the Pas and Saja rivers meander through this area and well-developed estuary systems as they drain into the Bay of Biscay. The highest point in the Geopark is El Tolío Hill, 246 meters above sea level. The oceanic climate results in mild summers and winters, and relatively large amounts of rain, ~1 100 mm/year. Much of the landscape is now meadow or agricultural, due to livestock farming and agriculture, although these industries have been overtaken by tourism and the service industry in importance. The eight municipalities within the Geopark are inhabited by ~266 000 people, with the most densely populated area being in the eastern region around Santander, the capital of Cantabria. The Geopark can be accessed by car, bus, and train, and the region is served by international ferry service. An international airport is located within the geopark.

2. Geological features and geology of international significance

The geological history of Costa Quebrada spans from approximately 240 million years ago to modern-day and is characterized by periods of sea level rise and fall that resulted in erosion and deposition of sedimentary rocks. The oldest rocks in the area, deposited in shallow marine-influenced environments ca. 240 to 200 million years ago, contain domes of salt minerals that formed due to intensive evaporation of seawater. From ca. 200 to 150 million years ago, the region underwent flooding that resulted in the deposition of deepwater sedimentary rocks and the preservation of noteworthy fossils, such as crabs preserved in pyrite crystals (i.e., ‘fools gold’). From ca. 55 to 5 million years ago, the Alpine Orogeny mountain-building event resulted in tectonic uplift of the area. During this time, and particularly during pauses in uplift, erosion occurred and resulted in the development of wave-cut platforms and beaches. As uplift resumed, the coastline migrated further away, resulting in stranded ‘raised beaches’ as much as 220 m above sea level. Geological processes continue to occur in the modern park area and are strongly influenced by the ancient geology of the area. For example, as the sea erodes the different geological units along the shoreline, a wide variety of coastal landforms are created, including inlets, coves, capes, islets, and tombolo (isthmus of sand), among others. Importantly, the landform type that is created depends on the type of rock that is being eroded and the orientation/tilt of the rock units, all of which are the result of processes that occurred tens to hundreds of millions of years earlier. The dynamic geology of the area is further evidenced by landslides and rockfalls, as well as the dissolution of limestone to form karsts that characterize the relief of the landscape. Some of the karst caves that formed through mineral dissolution are sites of prehistoric occupation and contain important archaeological remains and are listed as UNESCO World Heritage sites.

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Global Geoparks

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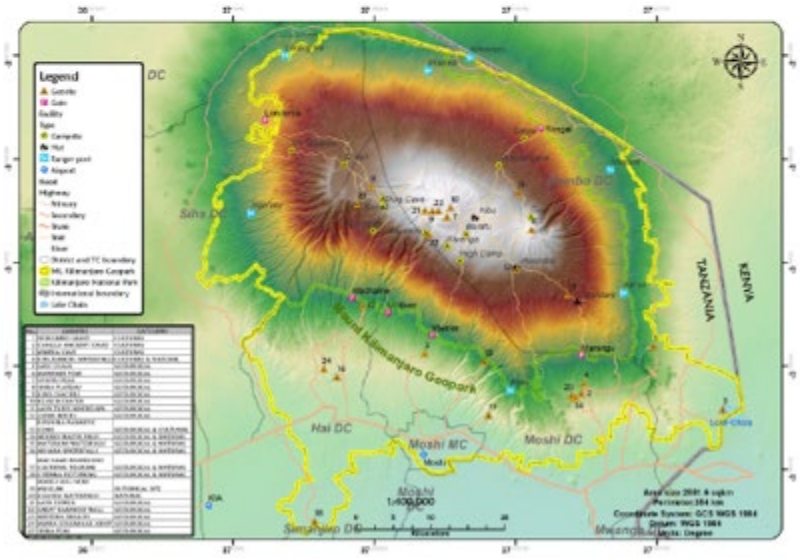
Mount Kilimanjaro,

United Republic of Tanzania

Geographical and geological summary



1. Physical and human geography

Mount Kilimanjaro Geopark lies between 2.85° to 3.47°S and 37.05 to 37.71°E, and is located in the Kilimanjaro region of northeastern part of the United Republic of Tanzania, near the border with Kenya. Mount Kilimanjaro, the centerpiece of the geopark and the tallest mountain in Africa, has a maximum elevation of 5 895 meters above sea level and almost 4 900 meters above the surrounding savanna plains. The landscape is dominated by the three major volcanoes that comprise the mountain, and ecological zones change markedly as the elevations increase, from savanna, to bushland and cultivated areas, to montane forest, to heath/moorland, alpine desert, and finally arctic desert above 5 000 meters elevation. Mount Kilimanjaro is capped by eight ice sheets and glaciers that cover approximately 1.8 km^2. The region is drained by a network of rivers, predominantly on the southern side of the mountain, that feed the Pangani basin and ultimately drain into the Indian Ocean. The Geopark can be accessed by road from nearby major cities of Moshi (within the Geopark), Arusha (~55 km), and Dar es Salaam (~425 km), as well as directly from Kenya (Nairobi is ~180 km away). The Kilimanjaro International Airport is only 84 km from Marangu, where the Geopark headquarters are located. Administratively, the geopark is within the districts of Moshi, Rombo, and Hai, and contains 92 villages that are inhabited primarily by the Chagga tribe. Most inhabitants work in agriculture, pastoralism, and/or tourism. Kilimanjaro National Park, which significantly overlaps with the geopark, is a UNESCO World Heritage Site.

2. Geological features and geology of international significance

Mount Kilimanjaro is a giant stratovolcano and one of the largest volcanoes on Earth, and accordingly, many of the dramatic geological features of the geopark are related to this. Formed by the tectonic processes that drive continental rifting, the geology of Kilimanjaro records evolving tectonic and volcanic processes that began approximately 2.5 million years ago and continue to the modern-day. This includes an array of different volcanic rock types, both explosive and non-explosive, in addition to different styles of magmatic plumbing systems that fed volcanic activity. Although there are three major volcanoes that collectively form Mount Kilimanjaro, there are also approximately 250 smaller ‘parasitic’ volcanic cones present, in addition to volcanic plugs, craters, and calderas. The youngest and tallest of the volcanic peaks, Kibo, was most recently active approximately 150 000 years ago, and still vents hot, volcanic gasses. Glacial erosion has formed cirques on some of the summits, highlighting the interplay between mountain building activities (e.g., volcanism) and erosion (e.g., glaciers), although the surface areas of the glaciers has decreased dramatically during the past century. The Chemka Hot Spring attests to the history of volcanism and related geothermal activity underground in the Geopark.

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Global Geoparks

Applicant UNESCO Global Geopark

Arran, United Kingdom of Great Britain and Northern Ireland

Geographical and geological summary

1. Physical and human geography

Arran Geopark is located at 55°34'39"N and 005°15'08"W, in the United Kingdom of Great Britain and Northern Ireland. It encompasses 947 km^2 spread across three islands (Isle of Arran, Holy Isle, and Pladda), of which 70% is designated for biology and/or geology. Although relatively small, the islands contain coastal lowlands, mountainous highlands, forests, rivers, and small lakes. There are a number of villages in the geopark, totaling ~4 600 people, and the nearest sizable towns are Ardrossan (16 km) and Campbeltown (22 km). Glasgow and Edinburgh are approximately 60 and 130 km away, respectively. The main industry in the geopark is tourism (~250 000 to 300 000 visitors per year), particularly for hiking, cycling, and wildlife watching. There is a ~100 km 'ring road' around the island, with additional access provided by two roads that bisect the island N-S and E-W, and the islands are accessible by ferry. The climate is mild-oceanic, with large amounts of rain (>1 500 mm) and mild temperatures (~6 to 16°C).

2. Geological features and geology of international significance

Arran records a remarkably broad suite of geological features within a small area, including all three rock types (sedimentary, igneous, and metamorphic), unique and noteworthy fossils sites, and glacial features. Cumulatively, these features span approximately 600 million years of Earth history. The oldest rocks in the park, Dalradian metasediments, were formed deep in the ancient Iapetus Ocean almost 600 million years ago and represent underwater landslides. The 'Highland Boundary Fault' is present in Arran and represents a collision between two continents as part of the Caledonian orogeny mountain-building event. Following the Caledonian Orogeny, a series of sedimentary rocks were deposited from approximately 420 to 250 million years ago, and represent ancient river systems, lush, tropical forests that eventually turned into coal deposits, and hot, dry deserts. Remarkable fossils are preserved in Arran, including sites of fossilized lightning strikes, and footprints from dinosaurs and giant millipedes ca. 350 to 200 million years ago. The plumbing system of an ancient volcano in Arran records the formation of the North Atlantic Ocean starting approximately 60 million years ago and represents the separation of Europe and North America. The most recent series of geological events to shape Arran started ca. 2.5 million years ago, when a series of glaciations sculpted the landscape of the area. As the glaciers retreated, an enormous weight of the ice was removed and the land underwent 'post-glacial rebound', resulting in migration of the shoreline and the creation of 'raised beaches' that were stranded far from the receding shoreline. A noteworthy site of geological history is 'Hutton's Unconformity', a key outcrop that contributed toward the understanding of geological processes and the age of the Earth. Many sites in Arran are already subject to statutory protection against inappropriate development.

Applicant UNESCO Global Geopark

Lang Son, Viet Nam

Geographical and geological summary

1. Physical and human geography

Lan Song Geopark is located at 21°51'24"N, 106°45'58"E, in the Lan Song province of northeastern Viet Nam, bordering the People's Republic of China. Most of the area is characterized by low mountainous terrain (~250 meters above sea level) separated by valleys that contain numerous rivers, streams, lakes, and reservoirs, in addition to rice fields, swamps, and forests. The geopark occupies a geographically unique location in the transitional area from the Red River delta and the Chinese lowlands. The average elevation is approximately 250 m above sea level, and the highest point is the summit of Mount Mau Son, at 1 541 m above sea level. With a humid subtropical climate and four distinct seasons, the annual temperature ranges from approximately 17 to 23°C, although it varies significantly due to the complex terrain. The geopark spans approximately 4 849 km^2 and is inhabited by approximately 611 000 people. The population is comprised largely of seven different ethnic groups, and the local economy is comprised primarily of agro-forestry, handicraft, trades and services. The geopark is approximately 100 km from Hanoi and can be accessed by both car and train from either Viet Nam or the People's Republic of China.

2. Geological features and geology of international significance

The Lan Song Geopark is located between two fragments of the ancient Gondwana supercontinent and provides a geological record dating back 485 million years. The region has a rich and complex history of tectonic processes, and notably, is located at the site of ancient plate tectonic collision between the Indochina and South China plates ca. 245 million years ago. More recent tectonic activity is recorded by the formation of sedimentary basins ca. 56 to 34 million years ago, related to the formation of the South China Sea. The rocks preserved here thus record important information for understanding and reconstructing tectonics events responsible for the current configuration of Southeast Asia. Beyond tectonic activity, the geopark contains a highly complete archive of sedimentary rocks from ca. 245 million years ago to modern times. Hundreds of fossil sites have been identified across the geopark, and many fossil types were first described for the first time ever in the region. The sedimentary basins that formed during tectonic rifting ca. 56 to 34 million years ago record a very diverse set of fossils representing vertebrate and invertebrate animals, as well as the flora of ancient tropical forest, river, lake, and swamp environments. The mammal fossils preserved in these sedimentary basins highlight the importance of Southeast Asia as a source for different mammals that spread along the margins of an ancient continent. Much of the bedrock in the geopark is composed of limestone, which has been subjected to strong dissolution and karstification by the subtropical climate, resulting in a dramatic landscape and large cave systems.

UNESCO Global Geopark Extension <10%

Mëllerdall UNESCO Global Geopark, Luxembourg

Old area: 256 km²

New Area: 271 km²