

## Geosites of interest as a geophertage of Jalisco, Mexico. Progress

## Geosítios de interés como geopatrimonio de Jalisco, México. Avances

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### Abstract

Conserving the geological heritage in Jalisco implies, identifying, classifying and substantiating the importance of geosites in Jalisco and its subsequent dissemination through geotourism. The above can contribute to the creation of geo-park (s), according to the definition and methodology of UNESCO, with the consequent economic benefit to the inhabitants of these regions. The disclosure of geological information encourages an appreciation and care of abiotic resources (rocks, minerals, fossils, morphology, soil and water), especially prior to productive activities, minimizing their damage or avoiding building in areas with geological hazards. Jalisco has a great geo-diversity, compared to other states, its history begins approximately 200 million years ago, recorded in the Sierra Madre del Sur and in the Jalisco Block, the most recent volcanic and tectonic activity is recorded in the Volcanic Belt Mexican. The previous provinces, together with the Sierra Madre Occidental and the Central Plateau, contain a wide range of rocks, fossil areas of economic and cultural importance (most of 70 places) and relate the geological history and its dynamics. Geothermal activity, is present in 400 locations.

### Geological Heritage, Geotourism, Jalisco

### Resumen

Conservar el patrimonio geológico en Jalisco, implica, identificar, clasificar y fundamentar la importancia de geosítios en Jalisco y su posterior divulgación mediante el geoturismo. Lo anterior puede contribuir a la creación de geo-parque(s), de acuerdo a la definición y metodología de la UNESCO, con el consecuente beneficio económico hacia los pobladores de estas regiones. La divulgación de la información geológica, propicia un aprecio y cuidado de los recursos abióticos (rocas, minerales, fósiles, morfología, suelo y agua), previo a las actividades productivas, minimizando su daño y limitando construir en zonas con amenazas geológicas. Jalisco tiene una gran geo-diversidad, en comparación con otros estados, su historia inicia aproximadamente hace 200 millones de años, registrada en la Sierra Madre del Sur y en el Bloque Jalisco, la actividad volcánica y tectónica más reciente se registra en la Faja Volcánica Mexicana. Las anteriores provincias, conjunto con la Sierra Madre Occidental y la Meseta Central, contiene una amplia gama de rocas, zonas fosilíferas de importancia económica y cultural (más de 70 sitios) y relatan la historia geológica y su dinámica. La actividad geotérmica, está presente en 400 localidades.

### Patrimonio Geológico, Geoturismo, Jalisco

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## Introduction

In coordination with the “International Geosciences and Geoparks Program”, developed by UNESCO, recognized since 2015, responsible for promoting and establishing guidelines and requirements for the creation of Geoparks. It is proposed to develop geo-tourism in Jalisco, prior identification and classification of geo-sites of interest in Jalisco, so that these, in the future, become part of the entity's natural heritage and later consolidate a proposal to form a geopark.

The Global Network of Geo-parks is integrated (June 2020), by 147 in 41 countries on five continents, in the case of Mexico we have two Geo-parks recognized by UNESCO; Comarca Mining, Hidalgo and Mixteca Alta, Oaxaca. Recently in Mexico, the Huasteca Potosina (San Luis Potosí) and Peña de Bernal, Querétaro have been proposed. So that, get recognition.

The Secretary General of the United Nations, António Guterres on World Tourism Day (<https://www.telesurtv.net/news/onu-antonio-guterres-turismo-mensaje-dia-mundial-20200927-0012.html>), shares in his speech on tourism; “The pandemic that we are currently experiencing has forced us to limit mobility, especially traveling as tourists, which has indirectly damaged the economy of the tourism industry (which employs one in 10 people on Earth), return, It must be planned with greater security, to visit safe places, such as the open country, rather than cities or places with crowds”, so that national or international tourists can be offered an alternative, such as geotourism and take him to visit sites of geological interest and disseminate the importance of abiotic resources. In this regard, the same secretary indicates that; In this difficult year, let's focus on the importance of tourism to people living in rural areas, so that we can deliver on the promise of the Sustainable Development Goals to leave no one behind.

The national geoparks are examples of the attractiveness of geotourism for the national and international community, and obviously of the resulting benefit for the inhabitants of the place, due to the economic spillover generated. In Jalisco there are places that are visited by; landscape, culture, crafts, thermal spas and gastronomy, among other topics, for people who like geo-adventure (see figures 1, 2 and 3).



**Figure 1** Landscape. Nevado de Colima, overlooking the Fuego volcano, Mexico



**Figure 2** Mining; Diatom (left) and Opal (right) mines



**Figure 3** Unique formations. Las Piedrotas and sales of crafts and gastronomy, Tapalpa Jalisco

## General objective

Identify relevant geosites in the state of Jalisco.

## Specific objectives

- Categorize the geosites of Jalisco
- Organize the Jalisco geosites according to their characteristics.

## Methodology

UNESCO is responsible for establishing guidelines and requirements for the creation of Geoparks. Following the proposed methodology, we begin by reviewing the literature on geology and geomorphology within the Mexican Republic. Jalisco stands out in geodiversity due to the following characteristics;

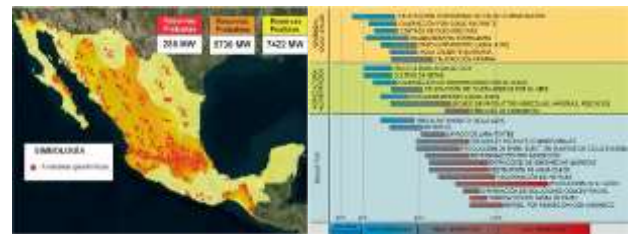
Location within four geological provinces; Sierra Madre Occidental (Nieto, 2000), Mexican Volcanic Belt (De la Fuente and Verma, 1993, Ferriz and Mahood 1986, and Ferrari and Rosas-Elguera, 2000), Central Plateau and Sierra Madre del Sur, each with features Specific lithological, tectonic and chronological, which give a common lithological diversity in a state (see figures 4 and 5).

Paleontological wealth (Amezcuca, 2000, Montellano, 1997, Morales, 1996, Carranza, 1980 and Maciel 2006) (figure 5), which show climatic changes (Maciel 2006), geodynamic (Michaud, Bourgois and Parrot, 1992, Rosas-Elguera, Urrutia Fucugauchi, & Maciel-Flores 1989, Rosas-Elguera, Nieto, and Urrutia-Fucugauchi 1993 and Maciel and Rosas Elguera 2006<sup>a</sup> and Mahood, 1980) and habitats (Gama-Castro, Palacios -Mayorga and Alcalá Martínez 1990, Jáuregui, 1997 ) that have occurred throughout the geological history of the state.

From an economic point of view (SGM 2018) we have natural resources, such as mining (figures 4 and 5) and geothermal (see figure 6), (Venegas, Herrera, and Maciel 1985, Kruger, Aragón, Maciel-Flores, Lucio and Villa 1988, Maciel and Rosas Elguera 1992) or groundwater (Maciel 2014).



**Figures 4 and 5** Left Collection of Rocks, Minerals and Fossils (CRMF) in the University Center of Biological and Agricultural Sciences of the University of Guadalajara and collection (by students of the geophysics career of the UdeG), of diatoms in mine of San Andrés Figueroa (right)



**Figure 6** Geothermal Resources of Mexico Potential and Geothermal Uses (Secretaría de Energía 2013)

Publications on geology have been prepared by national and international universities and institutions, such as the Federal Electricity Commission, Petróleos Mexicanos, the Mexican Geological Service, and private mining companies.

On the subject of geopark, geosites, geological heritage and geotourism at the national level; highlights the book published by Palacio et al (2018), “Geoparques. Guide for the formulation of projects; De la Peña G. 2006. Indigenous cultures of Jalisco. The popular cultures of Jalisco; Maciel-Flores, Maciel-Tejeda and Rosas-Elguera (2015). Biodiversity in Jalisco. State Study; De la Fuente-G., J. and Verma, S. P., (1993), Catalog of volcanic devices of the central-western part of the Mexican Volcanic Belt; López-Ramos E. (1995), Geological Chart of the States of Jalisco and Aguascalientes; Lugo Hubp José and Córdova Carlos (1990). Geomorphological regionalization of the Mexican Republic; Montellano B. M. (1997), New locality of Late Hemphillian vertebrates in Teocaltiche, Jalisco, Mexico.

At the international level, those presented by; UNESCO, (1972) Convention on the Protection of the World Cultural and Natural Heritage; Brilha J. (2016). Inventory and quantitative evaluation of geo-sites and geo-diversity sites: a review; Carcavilla Lu. (2012). Geoconservation. Ross K. et al (2010). Global Geotourism Perspectives; Tourtellot, J.B. (2009). Geotourism for your community; Wimbledon W, et al (1999). Geological World Heritage: GEOSITES - A comparative global inventory of sites to enable prioritization of conservation.

In this document we will define geological heritage as the places or points of geological interest commonly referred to as geosites (Wimbledon et al., 2000), which can be promoted through geotourism, which according to the geological perspective is defined as a form of tourism of natural areas that specifically focuses on geology and landscape.

Representative examples of geo-sites are; The type localities that describe a geological formation and the stratotypes and global boundary points, known as "golden nail" sites (Global Boundary stratotype Section and Point, GBSSP; see [www.stratigraphy.org/gssp](http://www.stratigraphy.org/gssp)), among others. Sites of exclusively scientific interest derived from geological processes and that are located in their original place (in situ) must be included; for example, exemplary landforms, paleontological sites, collections of rocks, fossils or minerals displayed in a museum.

The values of geological heritage Geological heritage and geoheritage refer to certain elements of geodiversity that contain values that make their conservation desirable. The fundamental value that every geosite must have to be considered heritage is the scientific or intrinsic value, to which is added another series of values, also known as added or additional values, among which the educational, the tourist and the cultural stand out (Gray , 2004 and Brilha, 2016).

Geotourism is a relatively new form of sustainable tourism basically of an educational nature, focused on scientific dissemination. It is tourism with a primary focus on experiencing the geological features of the Earth in a way that encourages environmental and cultural understanding, appreciation and conservation and is also locally beneficial (Dowling, 2010).

Geotourism has two orientations: one geological, based on the identification, valuation and promotion of the geological - geomorphological heritage as a tourist attraction and another, of a geographical nature, focused on the promotion of said features based on their relationships with biological and human elements. , which together give meaning and structure to a territory. Due to its characteristics, Geo-tourism can be framed within "Tourism in contact with nature" or "Tourism based on nature"; It arises from the consideration of geological and geomorphological features as a tourist attraction and their educational and scientific value.

Geotourism approaches As mentioned, geo-tourism has been conceptualized from two different aspects: geological and geographical (Carcavilla et al., 2012). According to the geological perspective, it is made up of two elements: geology (which includes forms and processes) and tourism (tourist visits, learning, appreciation and attraction in geosites), being conceived then as:

A form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geo-sites and the conservation of geo-diversity and an understanding of Earth sciences through appreciation and learning. This is achieved through independent visits (self-guided, without the intervention of guides / interpreters) to geological features, use of geological paths and vantage points, tour guides, geoactivities, and sponsorship of geosite visit centers (Newsome and Dowling, 2010).

Promote tourism to geosites and the conservation of geodiversity and an understanding of Earth sciences through appreciation and learning, one of the important factors is the spilling of foreign exchange to rural communities. This is achieved through independent visits (self-guided, without the intervention of guides / interpreters) to sites with geological characteristics, use of geological paths and vantage points, tour guides, geoactivities and sponsorship of geosite visit centers (Newsome and Dowling, 2010).

A study developed by the United Kingdom National Commissions for UNESCO, 2012, Winder Value of the UNESCO to the UK, concludes that geoparks have a greater economic impact when compared to world heritage and biosphere reserves. They are the geo-parks with an annual spill of 2.9 million pounds sterling, followed by world heritage with 2.2. and finally biosphere reserves with 0.38.

### Contribution

The census of geo-sites of interest in Jalisco has begun, to start with this new activity in the state and to register the geosites that are identified as natural heritage. To date, there is a preliminary census of about 70 geosites of tourist, cultural and academic importance and about 400 hot springs.

They have been organized by topic; Volcanoes; Colima, Tequila, Mascota, Apaxtepec and La Primavera

Tectonics; Unión Triple (Grabens de; Chapala, Colima and Tepic-Chapala) and active faults.

Rocky formations; Coasts with sandy and rocky beaches. Waterfalls of San Sebastián, El Caballo, El Salto. Piedras Bola, Las Piedrotas, El Diente, Giant Pumice, Black Pumice, Islands. Hydrological; Mineral waters of Mixtlán. Lagoons and Paleolagos; La Primavera, Río Santiago, Ameca, Zapotlán, Juanacatlán, Villa Corona, Chapala, San Marcos, Sayula, La María.

Landscapes; La Bufa in San Sebastián, Mascota, Mazamitla, Agavero.

Fossiliferous areas; Río Santiago, Chapala, San Marcos, Cocula, Sayula

Localities with geological risks (tectonic and volcanic); Colima volcano and the Chapala graben.

Museums and archaeological sites; 50 museums, Guachimontones, Ixtépéte, churches and farms.

Geothermal, 400 locations with possibilities of non-electric use, SPA and spas.

It remains to integrate other attractions, know and also promote gastronomic culture, crafts, archaeological sites, museums and landscapes, in order to have an inventory of geosites and places of interest in Jalisco, to bring them together to function as trails or networks, considering A starting point.

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