Manual on the Basic Set of Environment Statistics of the FDES 2013

Version 1.0

INEGI

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Component 1.1.3

Geology

Code and location in the FDES 2013			
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			1. Metamorphic
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Introduction

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On planet Earth, the knowledge of the **geological environment is a source of information about: minerals, oil, gas, rocks, water and natural resources**. Their tireless interaction with endogenous and exogenous processes models the surface where human beings live and perpetrate their activities. Any community interacts with the environment using its resources and subject to the events derived from its phenomenology. **Geology is present in the daily life of man. However, it is uncommon for the population to have a clear perception of this importance and dependence**.

This fact is explained because, with rare exceptions, knowledge of geological environment in most developing countries is addressed only in academic media, that is, geological science hardly reaches the citizen of the street.

As mentioned by Edite Paula B and Maria Filomena A (2002) "Currently research in Geology, is not based only on descriptive and classificatory reasoning. It has moved from the empirical level towards gradually more complex levels of knowledge (explanations) (Engelhardt & Zimmermann, 1988). **Geology as a science, started to be autonomous at the beginning of the 19th century, in the midst of disputes between those who discussed the age and history of the Earth, seeking explanations for what they observed, and those who, in the tranquility of their office, classified rocks, minerals and fossils**. Currently, two different but convergent objectives coexist in geological research: the reconstruction of Earth's past and the interpretation of geological processes."

They also describe "Geological processes are especially associated with the concept of geological time and are, according to Engelhardt & Zimmermann (1988), changes that occur in the natural systems of the Earth, and that are directly observed or reconstructed hypothetically. Its reconstruction is a frequent task in Geology and this makes the concept of process a fundamental category in this field.

Finally, these authors indicate **"Each geological object that is not unique, and that is part of a category, occupies a three-dimensional space subject to alterations, and may undergo modifications over time."**

Geological science also aims to deduce several phenomena that occur in the earth's crust and from this judgment, avoid some human tragedies that are followed by the manifestation of volcanic eruptions, earthquakes, tidal waves, etcetera. In other cases, geology has also made it possible to clarify some unknowns of the history of the planet and of life itself, an event possible thanks to the evidence inscribed on the rocks.

At present, we can speak of a significant similarity with current trends in this area. In these times, there is a significant interest in the development of various sciences in accordance with the interest that, from the economic point of view, generating various theories that explain the most important phenomena in the interior of the Earth.

The theory of tectonic plates establishes that the earth's crust is made up of different plates that "float" on magma or molten rock. **These plates are far from static, that is, they move in different directions, causing in the process separation and collision between them**.

The value of tectonic plates is the fact of explaining a series of terrestrial phenomena that are important. For example, the theory explains the genesis of large mountain ranges (as a consequence of plate collisions) as well as oceanic ridges (as a consequence of the separation of plates and the emergence of magma that solidifies in contact with water).

It is now known that the success and economy of any engineering work can be measured mainly by the degree to which the structure is adapted to the geological environment in which it is built, to the extent that more advanced studies tend to consider the rocky or soil masses, as an integral part of the structure.

The branches of engineering most deeply affected by geological factors are: mining, oil and civil engineering. With respect to the first two, his intervention is obvious, but Civil Engineering, its application is relatively recent and every day of greater importance. **Among the divisions of Geology** that have more application to the problems of Civil Engineering can be noted the **Physiography, Hydrology, Petrography, Stratigraphy, Structural Geology and Economic Geology.**

Paradoxically, geology, being a science responsible for the study of the Earth, has also been used for knowledge or inquiry about phenomena that have occurred on distant planets. Indeed, some processes are of a universal nature and geology can make contributions to understand relevant aspects of other planets similar in some circumstances to the Earth, an example is the research carried out on Mars.

Definitions and description of the statistics

The main statistical variables in this methodological sheet are: **Rock defined as the surface occupied by a type of rocky material**, not included in those covered by urban infrastructure and water bodies.
Geological time that indicates the formation period of the rock unit expressed in Millions of years.
Faults and folds as geological structures that deform the rock units.
Volcanoes Structure formed by volcanic event and manifested on the surface, based on the presence of eruptive manifestations is considered active or inactive.

3 A. Definition of the statistics

3 A. Definition of the statistics

Topic 1.1.1 Genesis and time

1.1.1 Rocks area total

According to the international classification the rocks are classified into:

Igneous rocks surface covered by rocks generated by magmatic events that intrude and when cooled form an intrusive igneous rock and by erosion they appear on the surface and when the magma is spread on the surface (lava) and on cooling it forms an igneous extrusive rock. [1]

1. Journal of the Geological Society, v. 148, i. 5, p. 825-833, Published on October 1991, First Published on September 01, 1991, doi:10.1144/gsjgs.148.5.0825

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Sedimentary rock surface covered by rocks that by erosion-transport-sedimentation and consolidation processes surface on the surface.[2]

Metamorphic rocks covered by rocks that, due to high pressure or temperature processes, modify their mineral composition.[3]

Recent Deposit Disintegrated or altered rock material that covers rocks, may be "in situ" or transported by water or air and deposited away from parent material.[4]

2. GEOLOGY – Vol. II - Sedimentation and Sedimentary Rocks - Alessandro Iannace.
http://www.eolss.net/Sample-Chapters/C01/E6-15-04-01.pdf
3. IUGS Subcommission on the Systematics of Metamorphic Rocks (SCMR).
http://www.ugr.es/~agcasco/personal/IUGS/0_IUGS.htm
4. http://explorock.com/clasificacion-de-los-depositos-sedimentarios/
5. https://es.wikipedia.org/wiki/Tiempo_geol%C3%B3gico

1.1.1 b Time

Geological Time According to the Wikipedia[5] website, Geological Time is divided into time intervals characterized by important events in the history of life on Earth. The units to divide it are of two types: Relative time (Geochronological units) that chronologically order events and those referred to absolute time (geochronometric units, in absolute values) both are expressed in Millions of years and referred "before the present".

The division of geological time (Geochronological) according to the International Chronostratigraphic Letter[6] is:

1. **Precambrian Eon** (Designation of geochronological unit greater than one era) with its divisions of aeons in:

   Hadean It comes from the Greek word Hades (Greek underworld), it is an informal division, first division of the Precambrian. Duration approximately 600 Million years (m.y.), start 4600 million years ago (m.y.a.) and end 4000 m.y.

   Archaic. Name from Ancient Greek that expresses "beginning". Second division of the Precambrian. Duration 1500 m.y., start 4000 m.y.a. and term at 2500 m.y.

   Proterozoic Name of the Greek words próteros (anteced); zoe (being alive) and also related to zoikos (animated life), so it can be interpreted as the first life forms. Third and last division of the Precambrian. Duration 1959 m.y., starts 2500 m.y.a. and culminates at 541 m.y.

6. http://www.stratigraphy.org/index.php/ics-chart-timescale

2. **Paleozoic**. Also called primary era is the second temporal division, which precedes the Mesozoic. Duration of 290 m.y., starts 541 m.y.a. and ends at 251 m.y. The following periods are subdivided:

Cambrian. Its name comes from Cambria (Latinized form of Cymru) word that the Welshmen name to his country, site where Adam Sedgwick identified fossils in the strata that served to determine the geologic age. First period of the Paleozoic, it precedes the Ordovician, duration 56 million years, starts at 541 m.y. and ends 485 m.y.a.

Ordovician. Name of a Celtic tribe (Ordovicians) that were in the north and center of Wales and site in which Charles Laptworth identified fossil content in the rocks that gave guidelines to the assignment of the geological age. Second Paleozoic period, anticipates the Silurian, duration 42 m.y. starts at 485 m.y. and it culminates at 443 m.y.

Silurian. The name comes from a Celtic tribe the Catfish, which existed in southern Wales and where Roderick Muchirson identified fossils to establish the geological age. Third period of the Paleozoic, anticipates the Devonian, duration 24 m.y. starts at 443 m.y. and it culminates 419 m.y.a.

Devonian. The name comes from a county in southwestern England (Devon), where Roderick Murchison and Adam Sedgwick recognized fossils that served to determine the geological age of the rocks. Fourth period of the Paleozoic, Carboniferous antecedent, duration 61 m.y. starts at 419 m.y. and it ends at 358 m.y.

Carboniferous. Designation by Willian Conybeare and Willian Philips of sedimentary rocks from England, in this period many layers of coal were formed worldwide. Fifth period of the Paleozoic, anticipates the Permian, duration 60 m.y. starts at 358 m.y. and it ends 298 m.y.a.

Permian. The name comes from a Russian city Perm, a region where Roderick Muchirson based on fossil content determined the geological age. Last period of the Paleozoic, which precedes the Mesozoic, duration 47 m.y. starts at 298 m.y. and it ends 251 m.y.a.

3. **Mesozoic**. Also mentioned as secondary was the third temporal division that precedes the Cenozoic. Duration 185 m.y., starts at 251 and ends at 66 m.y. it is made up of the following periods:

Triassic. Name by the three layers found by the geologist Friedrich von Alberti in Germany and northwestern Europe. First period of the Mesozoic, before the Jurassic, duration 50 m.y. starts at 251 m.y. and concludes at 201 m.y.

Jurassic. Name derived from the Jura mountain, located in the Alps, site where Alexander von Humbolt recorded the period. Second of the Mesozoic era, it precedes the Cretaceous, duration 56 m.y. starts at 201 m.y. and it happens up to 145 m.y.

Cretaceous Name from the Latin Crete, established by Jean d'Omalius d'Halloy, based on layers of the basin of Paris, France. Third and last period of the Mesozoic, duration 79 m.y. starts at 145 m.y. and reaches 66 m.y.

4. **Cenozoic.** Previously it was called Tertiary is the fourth and last division of the eras that make up the geological time table. Duration 66 million years to recent. It is made up of periods:

Paleogene. Previously it was known as Tertiary early and is the first period of the Cenozoic, before the Neogene. Duration 43 m.y. starts at 66 m.y. and ends at 23 m.y.

Neogene Previously named as Superior Tertiary, it continues after the Paleogene and precedes the Quaternary. Duration 21 m.y. starts at 23 m.y. and ends at 2 m.y.

Quaternary. Name proposed by Giovanni Arduino, to assign age to the alluvial deposits of the Po river valley in northern Italy, continues after the Neogene. Start 2 m.y. to the present.

1.1.3 Geological Structures

1.1.3.2 Structural

Rocks as a result of tectonic events, respond in a fragile or ductile manner, that is to say that their continuity is broken as a homogeneous body; by the pressure of confinement in depth of the earth's crust, the behavior of the rocks changes gradually from fragile to ductile.[7]

1.1.3.2.a Brittle

A fragile structure is considered a discontinuity in the rock in which there is an opening and displacement.
Observations:

1. **Normal fault** when the blocks of a rock mass move, one downwards with respect to the other. The surface on which the movement occurs (fault plane), indicates the relative direction of the movement and is from vertical to inclined.
2. **Reverse fault** When one of the blocks moves in an ascending way, with respect to the other along the fault plane, which tends to have a low inclination (< 45 °), it is classified as thrusts "if the inclination is less than 10º they obtain the name of landslides, when the displacement is usually of great magnitude.

7. http://www.docentes.unal.edu.co/jmmonteroo/docs/10%20ESTRUCTURAS.pdf

3. **Lateral fault** (of heading) The movement manifests horizontal displacements that cause the lateral sliding of one block with respect to the other, the plane of failure is usually close to the vertical. Depending on the direction of this displacement, we can distinguish the **dextral** tear, in which, situating ourselves on one of the blocks, we would see the other moving towards our right, and the **sinistral**, the movement is opposite to the previous one. They are also called transverse failures.
4. **Fracture separation** of a land surface, without relative displacement of the blocks, on both sides of the plane of the fracture.

***1.1.3.2.b* Ductile**

A ductile structure is considered a folded rock surface in which wavy shapes are distinguished.

Observations:

Anticline structure in which both sides are inclined in different directions, the layers of the rocks are inclined on both sides and on the inside (core) are the oldest units.

Sinclinal structure in which both sides are inclined in different directions, the rock layers are inclined towards the center of the structure and in the core the most recent layers emerge.

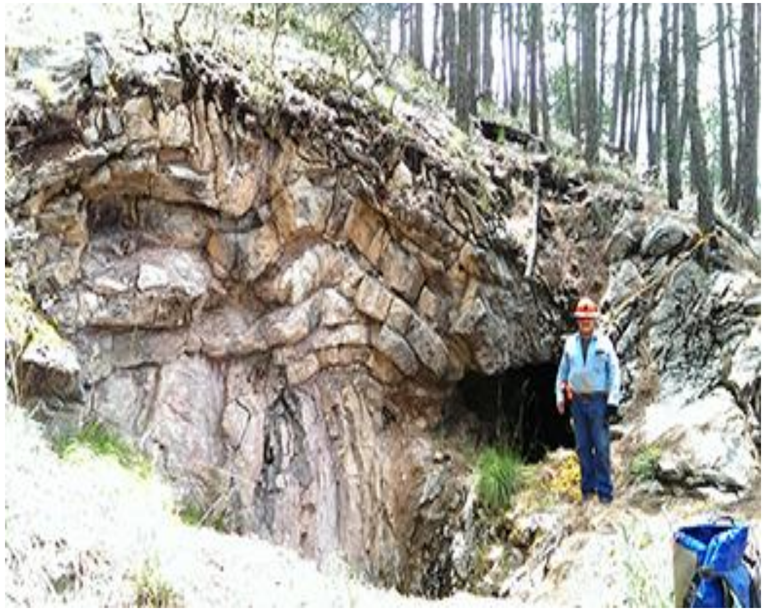
1.1.3.3 Igneous
1.1.3.3 a Volcanoes

Volcano structure formed by hot materials (lava, ash, rocks, gases, vapors) from the interior of the Earth. Some of these accumulate around the place of departure, forming hills or mountains that reach high altitudes. The materials can come out through cracks or through the crater, which is a hole in the top of the hill or volcanic mountain, formed by previous eruptions.[8]

Observations:

1. ACTIVE INDICATES THAT, IN THE LAST 10,000 YEARS, IT HAS RECURRENTLY PRESENTED SOME TYPE OF VOLCANIC ACTIVITY (ERUPTIVE, FUMAROLIC, SEISMIC, CHEMICAL, ETC.) .[9], [10.]
2. INACTIVE IN THE LAST 10,000 YEARS, HAS NOT PRESENTED ANY TYPE OF VOLCANIC ACTIVITY. [9].[10.]

8. http://www.cenapred.gob.mx/es/Instrumentacion/InstVolcanica/MVolcan/QVolcan/
9. http://www.inegi.org.mx/geo/contenidos/recnat/geologia/doc/dd_invnacfengeol_250k.pdf
10. http://www.geology.sdsu.edu/how_volcanoes_work/



International sources and recommendations

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4 A. Classification and grouping

According to the International Stratigraphic Guide in its abridged version11 It is indicated that the rock units can be classified based on different properties and each classification needs its own nomenclature the types of formal units known and most widely used are:

- Lithostratigraphic units. Units based on lithological characteristics of rocky bodies.
- Units limited by discontinuities. Rocky bodies limited superiorly and inferiorly by significant discontinuities in the stratigraphic succession.
- Biostratigraphic units. Units based on the fossil content of rock bodies.
- Magnetostratigraphic polarity units. Units based on the orientation changes of the remaining magnetism of the rocky bodies.
- Chronostratigraphic units. Units based on the age of formation of the rocky bodies.

Therefore, it is mentioned that the chronostratigraphic units have been selected for international communication between the stratigraphers since said classification refers to their position in the stratigraphic column.

It also indicates the document "The chronostratigraphic classification is the basis to reach the final objective of the stratigraphy. Chronostratigraphic units, such as divisions of rock bodies based on geological time, are, in principle, global in scope and important in providing a global basis for communication and understanding. "

It is suggested that other features and attributes can be used to classify the rocks and it is possible to use any of them that may be interesting. If this is the case, the unit denominations that will be used must be defined.

4B. Reference schemes for classifications and groupings at an international level.

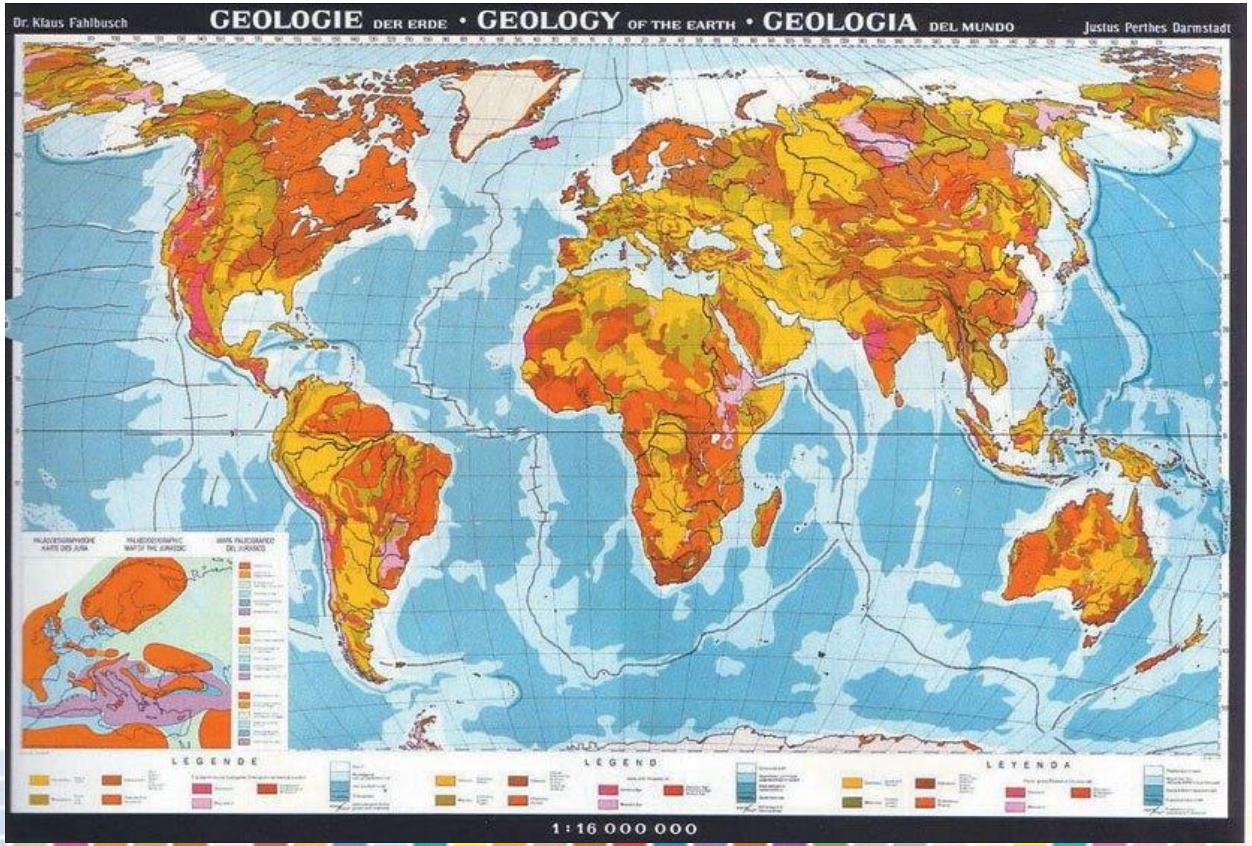
The following sources provide sources of representation of the geological and lithological units worldwide.

- COMMISSION FOR THE GEOLÓGICAL MAP OF THE WORLD [12]
- ONE GEOLOGY[13]
- U.S. GEOLOGICAL SURVEY[14]

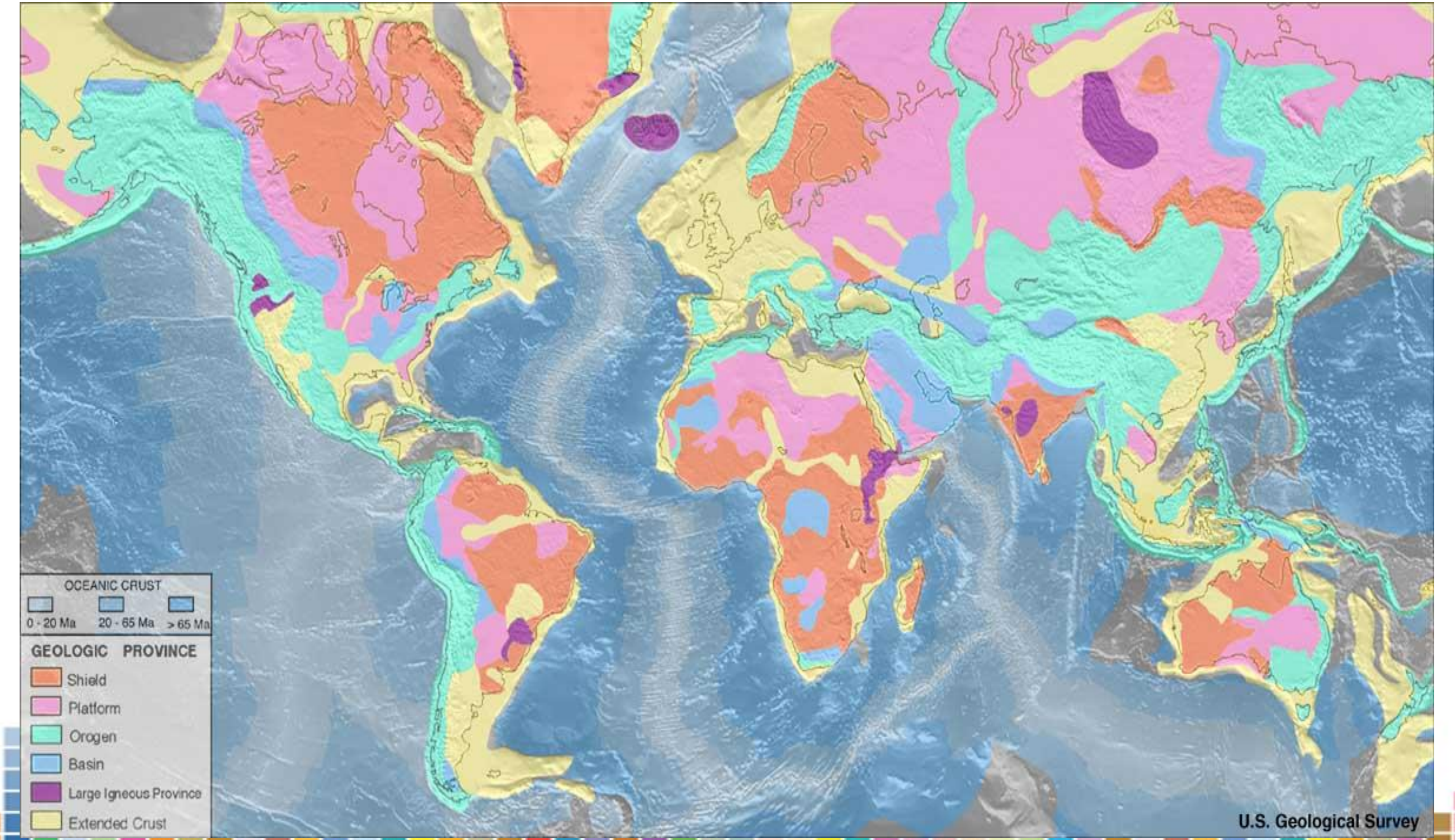
11. *Magazine of the Geological Society of Spain, Vol 14 (3-4), December 2001.*
12. https://ccgm.org/en/home/165-carte-geologique-du-monde-a-l-echelle-de-135-000-000-9782917310243.html
13. http://portal.onegeology.org/OnegeologyGlobal/
14. https://upload.wikimedia.org/wikipedia/commons/a/a9/World_geologic_provinces.jpg

4 C. Global sources of representation

There are some maps that show the geological or lithological characteristics worldwide among the geological ones are:
http://mapshop.com/media/classroom/world/world-geology-15101.jpg



https://upload.wikimedia.org/wikipedia/commons/a/a9/World_geologic_provinces.jpg



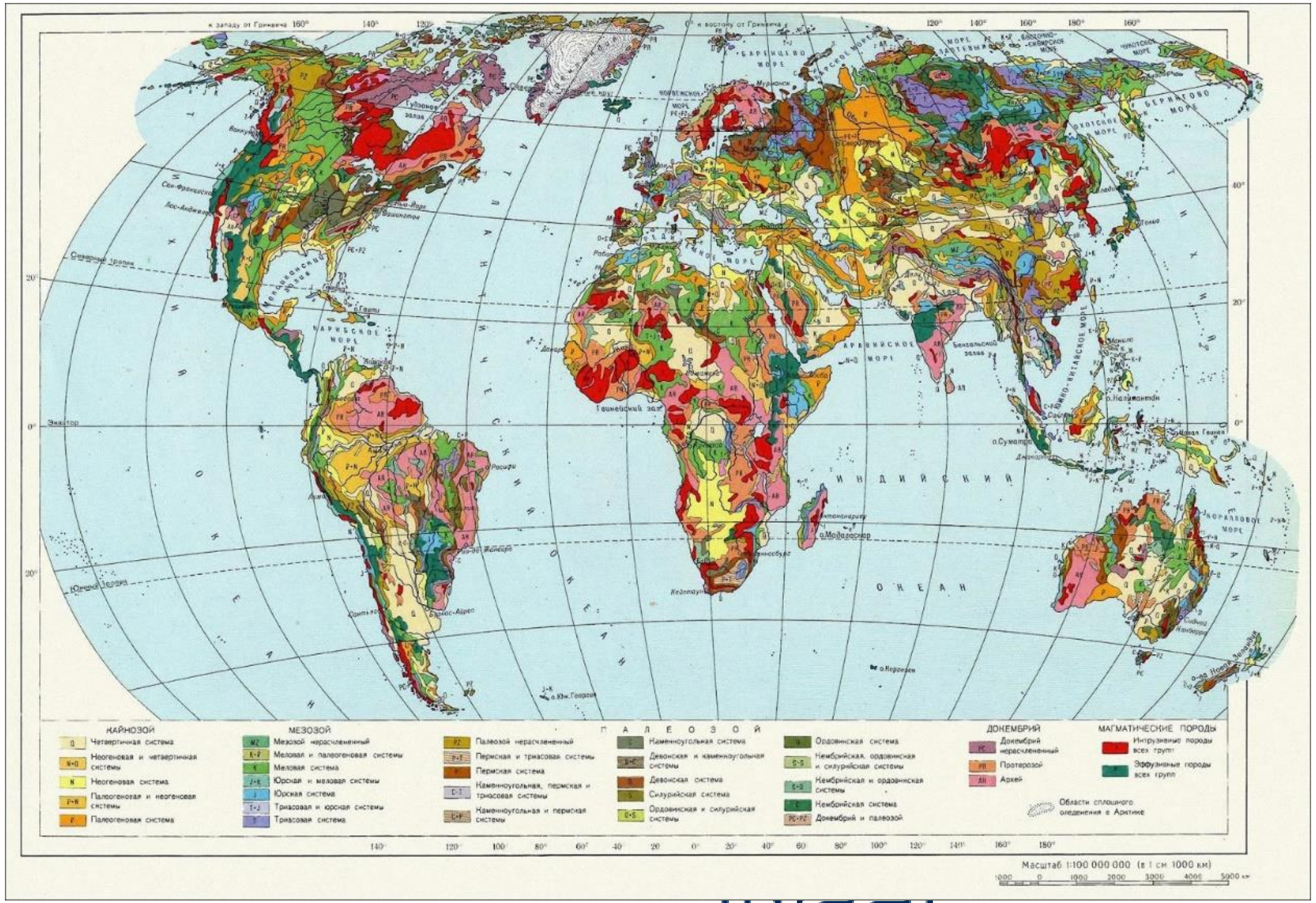
With geochronological representation

There is a classification, considering the geological time factor, from the hierarchy of Aeon, to the hierarchy of Era and Period, in which any type of rock is included.

J.M. Pelle. RGB Color Code according to the Commmission for the Geological Map of the World (CGMW), Paris, France. 2012

Clasification	Code	Color Code (RGB)[1]
Precambrian	Pϵ	247/67/112
Paleozoic	P	153/192/141
Cambric	ϵ	127/160/86
Ordovician	O	0/146/112
Silurian	S	179/225/182
Devonian	D	203/140/55
Carboniferous	C	103/165/153
Permian	Pe	240/64/40
Mesozoic	M	103/197/202
Triassic	TR	129/43/146
Jurassic	J	52/178/201
Cretaceous	K	127/198/78
Cenozoic	C	242/249/29
Paleogene	Pa	253/154/82
Neogene	Ne	255/230/25
Quaternary	Q	249/249/127

Another proposal http://www.200stran.ru/images/maps/1244308220_de9212.jpg



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It is a representation by units of geological time (systems), and differentiated by tones, thus grouping those corresponding to the Holocene, Neogene-Holocene, Neogene, Paleogene-Neogene and Paleogene; Cretaceous-Paleogene, Cretaceous, Cretaceous-Jurassic, Jurassic, Jurassic-Triassic and Triassic (Mesozoic); Triassic-Permian, Permian, Triassic-Permian-Carboniferous, Permian-Carboniferous, Carboniferous, Devonian, Siluric, Siluric-Ordovician, Ordovician, Silurian-Ordovician-Cambrian, Ordovician-Cambrian, and Cambrian (Paleozoic); The oldest units are represented by the eras: Precambrian, Proterozoic and Archaic. In the case of igneous rocks, they are integrated into the group of intrusive rocks and group of extrusive rocks.

The most important initiative is the one that shows the Commission of the Geological Map of the World (CGMW); that comes from the old organization created in the International Geological Congress (IGC) in 1978 and in 1910 proposed the formation of the Commission and formed in 1913. Since 2014 UNESCO recognizes it as a non-governmental organization of rank A (NGO).

They have been responsible for publishing geological issues at small scales: Geological, tectonic, mineral deposits, natural resources, etcetera. It also plans to have a leading role in the development of international standards. The CGMW actively participates in the One Geology initiative.

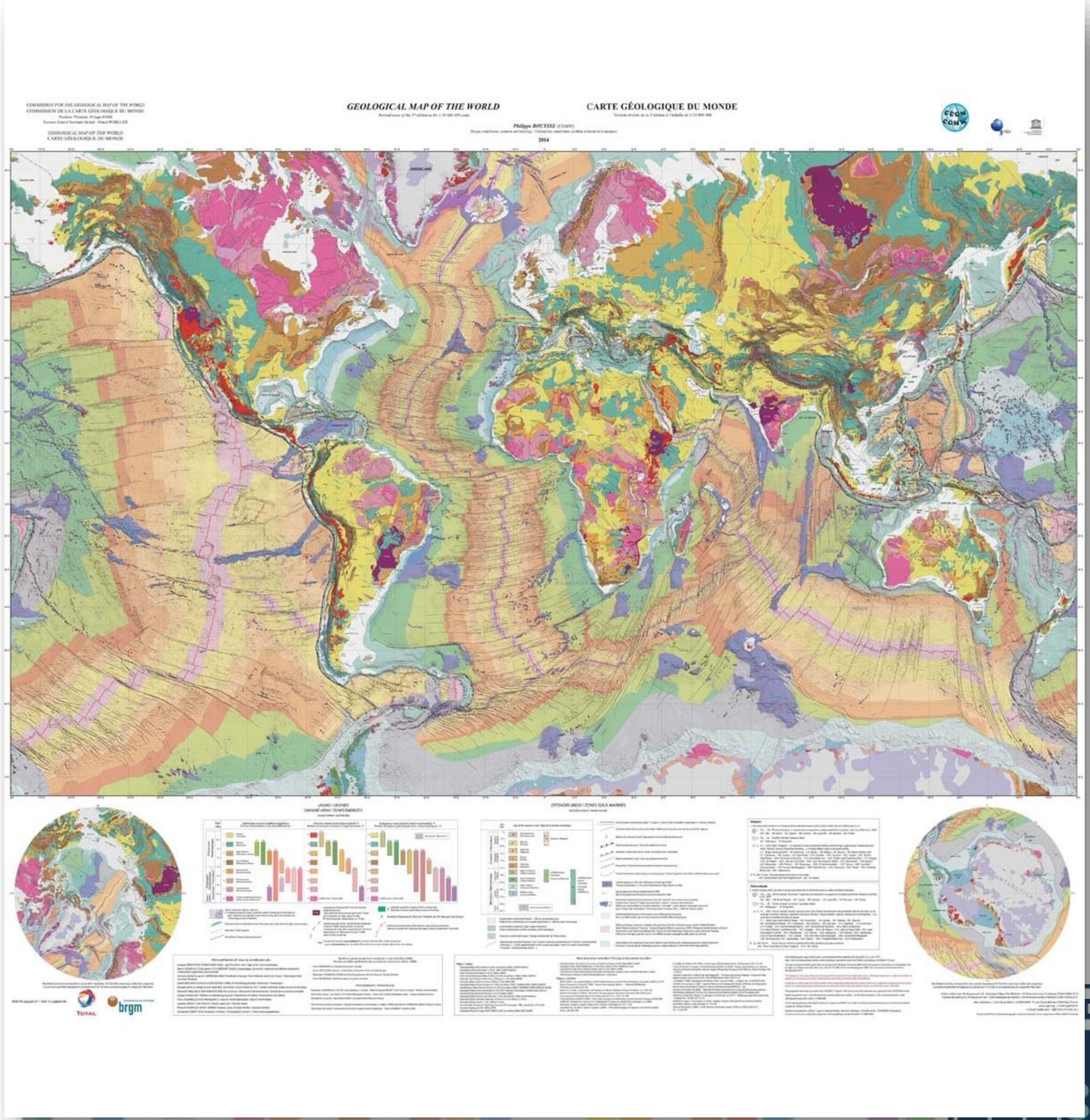
Of the Geological and Lithological maps made by the CGMW, they include explanatory notes in which the characteristics are broken down.

In the case of the geological map, it is explained that it is a compilation with the pedagogical objective, trying to represent in a simple way the geology of the world, including the oceanic funds.

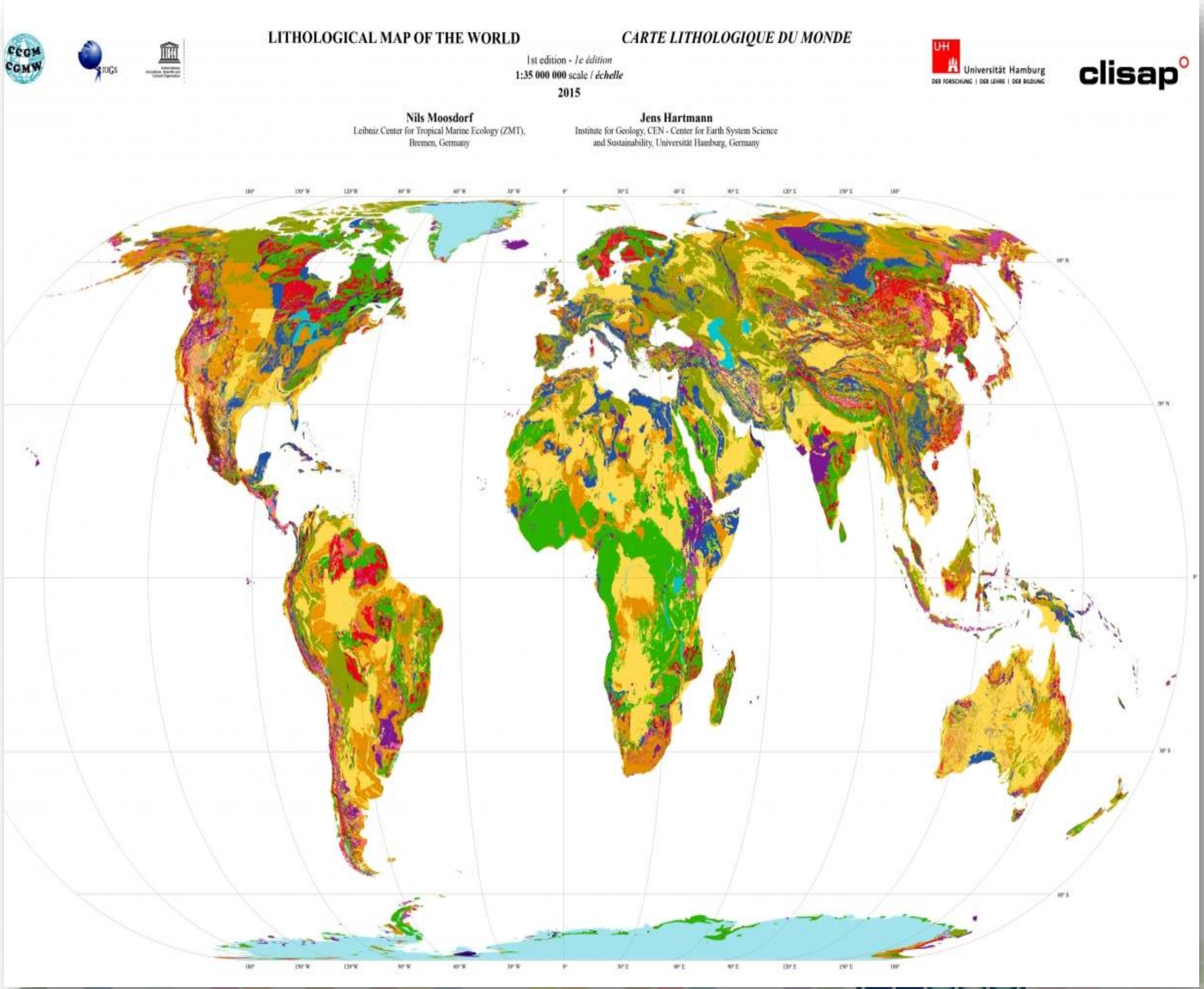
The representation of chronostratigraphic units in eight units is shown. 1 = Cenozoic; 2 = Mesozoic; 3 = Upper Paleozoic; 4 = Lower Paleozoic; Neoproterozoic; 6 = Mesoproterozoic; 7 = Paloeproterozoic and 8 = Archaic.

They specify that two exceptions were made: one with respect to the Cenozoic volcanism, represented with an intense blue tone, with the purpose of being visible and related to the active volcanism generated by the subduction zones.

The other is with reference to the oldest units (Archaic), which were not differentiated.



For the case of the Lithological Map of the World, it is made from the V 1.1 of the Global Lithological Map database (Hartmann and Moosdoorf, 2012) the types of rock that surface on the continental surface are represented, using 1 235 400 integrated polygons of 92 regional geological maps, converting the information into lithological units with the support of additional geological literature. According to the World Lithological Map, the total area of the continents and islands are covered by: 64% correspond to sedimentary rocks, 13% metamorphic rocks, 7% intrusive igneous rocks, 6% volcanic rocks and 10% cover them or ice.



- Transformation of data into environmental statistics

This section describes the procedures necessary to transform geological data at the national level into environmental statistics series, in support of the management and decision making of the geological environment

Transforming data into environment statistics

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5 A. Collection of data and data sources

This section identifies national sources and types of data collection for each group of statistics related to geology.

The wide range of geological statistics contained in this MS originates from sources of primary national data including geological institutions, universities and research institutes. These institutional partners generally collaborate to produce geology and statistics on rocks. In case a country wishes to consult international data sources, it is advisable to consider global statistics.

The types of sources by which the basic data of the statistics contained in this methodological sheet are collected include:

- Remote sensors (for example: rocks and geological structures)
- Thematic maps
- Surveys
- Scientific research

As the institutions that produce primary geological data and the type of sources vary according to the specific geological statistics of FDES, the following table 5.1. presents the types of sources and main institutional participants by subject of environmental statistics at national level.

Table 5.1. Geological statistics, institutional participants and types of sources

FDES Topic	Environment statistics	Type of data source	Institutional source
1.1.3 Geology	Types of rocks and geological age	Remote sensors Thematic maps Scientific research	National geological service Research institutions Universities Other
	Geological structures		
	Volcanism		

Source: Own elaboration

Many countries build geological inventories. But because they are expensive, they usually do it at infrequent intervals, in most countries with limited resources. On the other hand, facilitating access to remote sensing images has allowed recent assessments of the geological cover. As mentioned above, in developing countries it would facilitate the geological inventory and produce data on geological coverage every 10 years and in some countries even less frequently.

On the other hand, in the absence of geological inventories, countries may depend on geological coverage estimation procedures to determine the extent of the rocks, based on expert knowledge and observation, which could also be with the help of field validation. sample or specific aerial photography.

Ideally, the geological primary data is produced with a national level coverage or those areas that are covered by different types of rock. But sometimes in remotely sensed inventories or interpretations, they can produce partial data of national coverage. In terms of spatial considerations, the data may not cover the entire territory of a particular country for very large nations. In this case, the data may be available only for parts of the country area at any given time.

Statistical unit

The statistical unit for geological data from remote sensing is the area covered by rock. The FDES statistics using this statistical unit include the FDES topics of geology area (topic 1.1.3).

5 B. Data compilation (procedures and instruments) and transformation environment in statistical series.

The main objective of environmental statistics is the construction of a series of statistics on rocks, using the outcrops on the surface (possibly adding the types of rock or geological age.

If this is feasible, quantitative information on the outcrops can be constructed so that the percentages or km2 of the types of rock cover can be established.

The primary data is complete in terms of rock coverage and geological time. It is feasible that very specific rock units (for example Ophiolites) can be included in the relevant variables sought to produce the statistical series.

The environmental statistician will compile, validate, describe and structure these rock outcrops and promote statistical series that will be disseminated.

Quality and data validation

The quality of the data of the geological inventories, should be evaluated taking into account criteria such as the methodologies used, the definition, types of rock and / or geological time that were used, coverage and periodicity, as well as the analysis of the comparability between different geological inventories produced at specific times or periods and / or covering different territories, as necessary.

In addition, the quality of the data from remote sensing should be evaluated taking into account criteria such as image interpretation procedures and validation processes involving field sampling or field verification (ie determining the type of rock and the geological time of its formation.

Spatial considerations should take into account the spatial coverage of inventories over time for the assessment of comparability, as they may not cover the entire national and / or relevant territory, often due to insufficient resources.

It is also important to pay due attention to the definition used to decide what type of rock really emerges. Although there is an internationally agreed and clear definition of rocks, it is feasible that in some countries this definition does not apply.

Aggregation and disaggregation

If basic data on rock cover is produced by remote sensing and / or geographically, these series can usually be aggregated at the national level and disaggregated for regions by rock type or geological time. If the data allow it, another possible disaggregation of the statistical series that is relevant is to differentiate the rocky area by subtype for example in sedimentary rocks in clastic or calcareous.

Transformation in series of environmental statistics

The situation of each country is very unique in terms of data availability and periodicity of the production of primary data around geological statistics. However, the following considerations could be useful since they synthesize the general attributes of the most important and common environmental geological statistics in the FDES.

Table. Presents a summary of the main considerations to take into account when transforming geological data into environmental statistical series.

Table. Main considerations for transforming the primary geological data into some examples of statistics

FDES Topic	Environment Statistic	Category of Measurement	Unit of measure	Recommended periodicity	Potential aggregations and disaggregations
1.1.3.1	Types of rock genesis and geological time	Area	Hectarea (ha) and Percentage (%)	Every 10 years	By type of rock or by geological age and distribution.
1.1.3.2	Structural	Length	Kilometer (Km)	Every 10 years	Fragile Ductile
1.1.1.3	Volcanoes	----	------	Every 10 years	Assets Inactive

Source: self made

Other concepts

1.- Length of borders.

Componente	Subcomponente	Km
Longitud de frontera	Norte (Estados Unidos de Norteamérica)	3,175[1]
	Sureste (Guatemala)	959.6[1]
	Sureste (Belice)	266[1]
	Golfo de México	2, 429[1]
	Mar caribe	865[1]
	Océano Pacífico	7, 828[1]
	Total	15, 522.6

[1]Secretaría de Relaciones Exteriores, Comisión Internacional de Límites y Aguas (CILA) Norte (http://cila.sre.gob.mx/). Comisión Internacional de Límites y Aguas (CILA) Sur

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Extensión de Los Estados Unidos Mexicanos

INEGI. Marco Geoestadístico Nacional 2010.

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2.- Area.

Componente	Subcomponente	Km^2		
Superficie	Continental	1,159 248[2]		
	Insular	5 127[2]		
	Territorial	1, 164 375		

[2] *INEGI. Anuario estadístico y geográfico de los Estados Unidos Mexicanos 2017.*

INEGI. Anuario estadístico y geográfico de los Estados Unidos Mexicanos 2017.

3.- Number of islands.

Por región	Número de elementos	Proporción del territorio insular
Océano Pacífico Norte	498[3]	12.1%
Océano Pacífico Sur	412[3]	10.0%
Golfo de California	1,003[3]	24.4%
Golfo de Tehuantepec	137[3]	3.3%
Golfo de México	1,216[3]	29.6%
Mar Caribe	845[3]	20.6%
Total	4,111[3]	100%

[3]*Subgrupo del Catálogo de Islas Nacionales del Grupo Técnico para la Delimitación de las Zonas Marítimas Mexicanas. 2014. Catálogo del Territorio Insular Mexicano. INEGI, SEGOB, SEMAR,* SEMARNAT, SRE, SCT, INECC, CONANP, UNAM. Aguascalientes, Ags., 245 pp.

4.- Area of the islands.

Main geomorphologic aspects of the islands

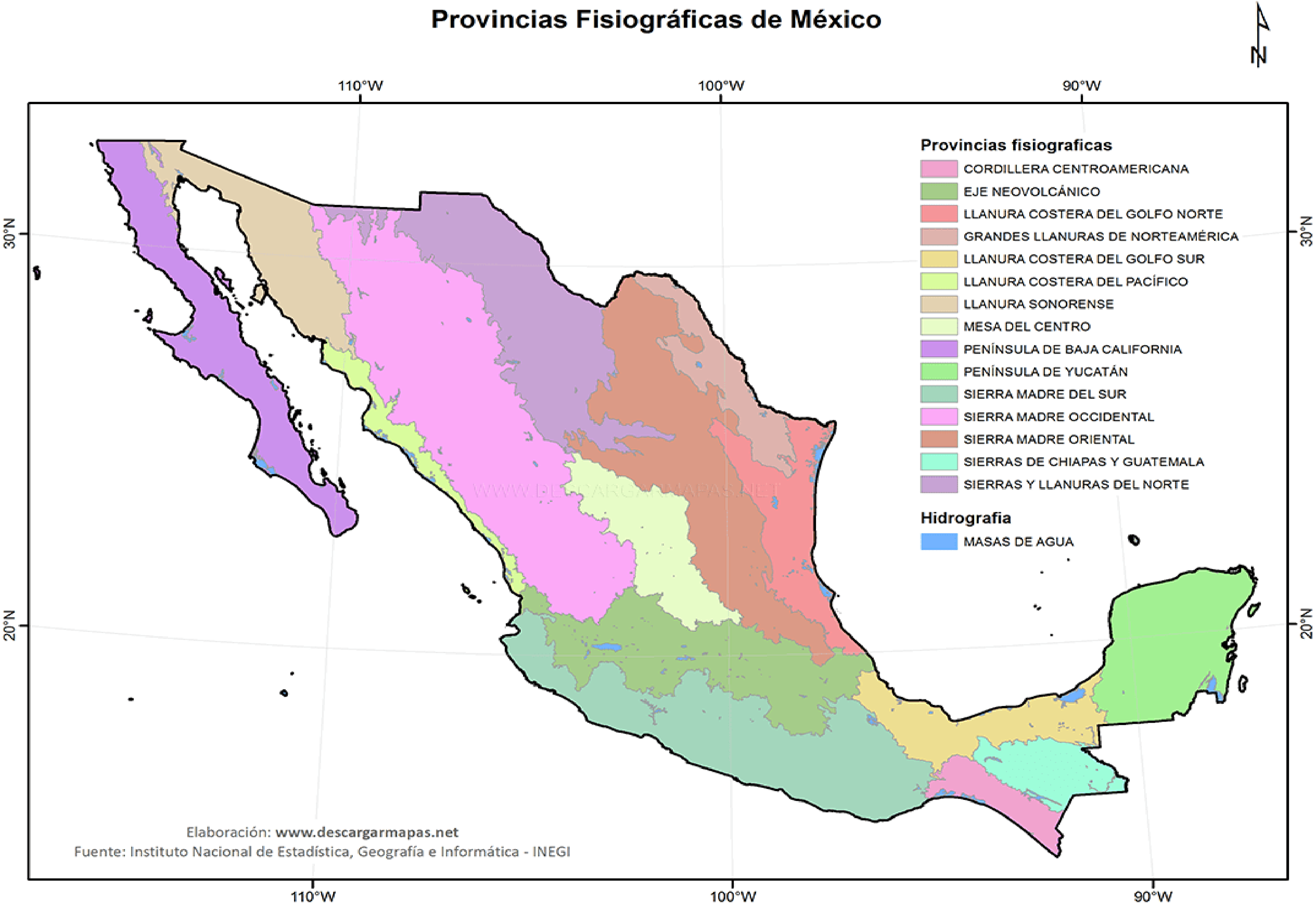
Generic term	Definition
Island	Natural extension of land surrounded by water that is above level of high tide. It includes small portions of land surrounded by water permanently, as well as steep massive structures that are emerged permanently.
Reef	Insular Subclass. Rocky structure, often of coral origin which emerges from the surface of the sea, or that is very shallow. Usually located near the coast.
Cay	Insular Subclass. Area of land surrounded by the seawater, which is located above the level of the maximum high tide, with flat topography, derived from the accumulation of unconsolidated materials of chalky, sandy, or rocky texture, with a cover of tropical vegetation, that develops in the warm waters of the Caribbean Sea and Gulf of Mexico, and whose dynamics of formation is closely linked to coral reef systems. They are also considered within this concept to the features of insular aspect formed by aggregations of aquatic vegetation (mainly mangrove) surrounded by seawater, which develop on soft sediment with flooding and muddy soil banks, sometimes below the maximum tide level, common on the coasts and lagoons of the Gulf of Mexico and Caribbean Sea.

6.- Spatial distribution of the land relief…

Componente	Subcomponente	Tópico	Descripción
Distribución espacial del relieve terrestre	Provincia	Fisiográfica.	Conjunto estructural de origen geológico unitario, de gran extensión, con morfología propia y distintiva.
		I, Península de Baja California[4]	
		II, Llanura Sonorense[4]	
		III, Sierra Madre Occidental	
		IV, Sierras y Llanuras del Norte[4]	
		V, Sierra Madre Oriental[4]	
		VI, Grandes Llanuras de Norteamérica[4]	
		VII, Llanura Costera del Pacífico[4]	
		VIII, Llanura Costera del Golfo Norte[4]	
		IX, Mesa del Centro[4]	
		X, Eje Neovolcánico	
		XI, Península de Yucatán[4]	
		XII, Sierra Madre del Sur[4]	
		XIII, Llanura Costera del Golfo Sur[4]	
		XIV, Sierras de Chiapas y Guatemala[4]	
		XV, Cordillera Centroamericana[4]	

[4] http://www.inegi.org.mx/geo/contenidos/recnat/fisiografia/default.aspx

Provincias Fisiográficas de México



7.- Landforms.

Componente	Subcomponente	Tópico	Condiciones geomorfológicas
Geológico	Condiciones Físicas	Geológico-Geomorfológico	Características
			7.a. Llanuras
			7.b. Mesetas
			7.c. Lomeríos
			7.d. Montañas
			7.e. Dunas

7.a. Plains

Definition

A large area of flat land with few undulations

Large area of flat land or with slight undulations. Plains can be found in the lowlands. They are also found in plateaus, at altitudes higher than 500 m and at higher elevations, in high plateaus.

7.b. Plateaus

Definition

An area of relatively level high ground…

An extensive plateau located at certain altitude above the mean sea level (more than 500 m) caused by tectonic forces, by erosion of the surrounding terrain, or by having emerged from a submarine plateau. It is also generated by the convergence of the tectonic plates.

MESETA ASOCIADA CON MALPAÍS
MESETA BASÁLTICA
MESETA BASÁLTICA CON CAÑADAS
MESETA BASÁLTICA CON CAÑADAS Y MALPAÍS
MESETA BASÁLTICA CON LLANURAS
MESETA BASÁLTICA CON LOMERÍO Y MALPAÍS
MESETA BASÁLTICA CON MALPAÍS
MESETA BASÁLTICA CON SIERRAS

7.c. Hills

Definition

A naturally raised area of land, not as high or craggy as a mountain…

Elevation of the terrain of low height, usually of rounded form, that comes to be the first degree after the plain…

- LOMERÍO ALTO
- LOMERÍO BAJO
- LOMERÍO BAJO CON HONDONADAS
- LOMERÍO BAJO CON LLANURAS
- LOMERÍO COMPLEJO
- LOMERÍO COMPLEJO CON BAJADAS
- LOMERÍO COMPLEJO CON CAÑADAS

7.d. Mountains

Definition

Topographical elevation (natural raising of the terrain) with more tan 700 m from his base

MONTAÑA	ALTITUD	LATITUD	LONGITUD	ESTADO
Pico de Orizaba	5610	19° 02' 00"	97° 15' 42"	Veracruz de Ignacio de la Llave y Puebla
Popocatépetl	5500	19° 01' 23"	98° 37' 19"	México, Puebla y Morelos
Iztaccíhuatl	5220	19° 10' 44"	98° 38' 29"	México y Puebla
Nevado de Toluca	4680	19° 06' 05"	99° 46' 00"	México
Sierra Negra	4580	18° 59' 00''	97° 19' 00''	Puebla
Malinche	4420	19° 13' 45"	98° 01' 55"	Tlaxcala y Puebla
Nevado de Colima	4260	19° 33' 45"	103° 36' 31"	Jalisco
Cofre de Perote	4200	19° 29' 39"	97° 08' 51"	Veracruz de Ignacio de la Llave

7.e. Dunes

Definition

A mound or ridge of sand or other loose sediment formed by the wind, especially on the sea coast or in a desert…

Sand accumulation, in deserts or littoral, produced by the wind, so that the dunes have smooth and uniform layers. Can be produced by changes in the wind or by variations in the amount of sand. Granulometry of the sand that forms the dunes, also called wind sand, is around 0.2 mm of diameter.

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