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Ciencias del Mar y Limnologia

Curso Intensivo Intersemestral
(Paleo)Bio Inidcadores Neotropicales

Clasificación de sedimentos lacustres, basada en sus componentes

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POSGRADO EN CIENCIAS DEL MAR Y LIMNOLOGÍA

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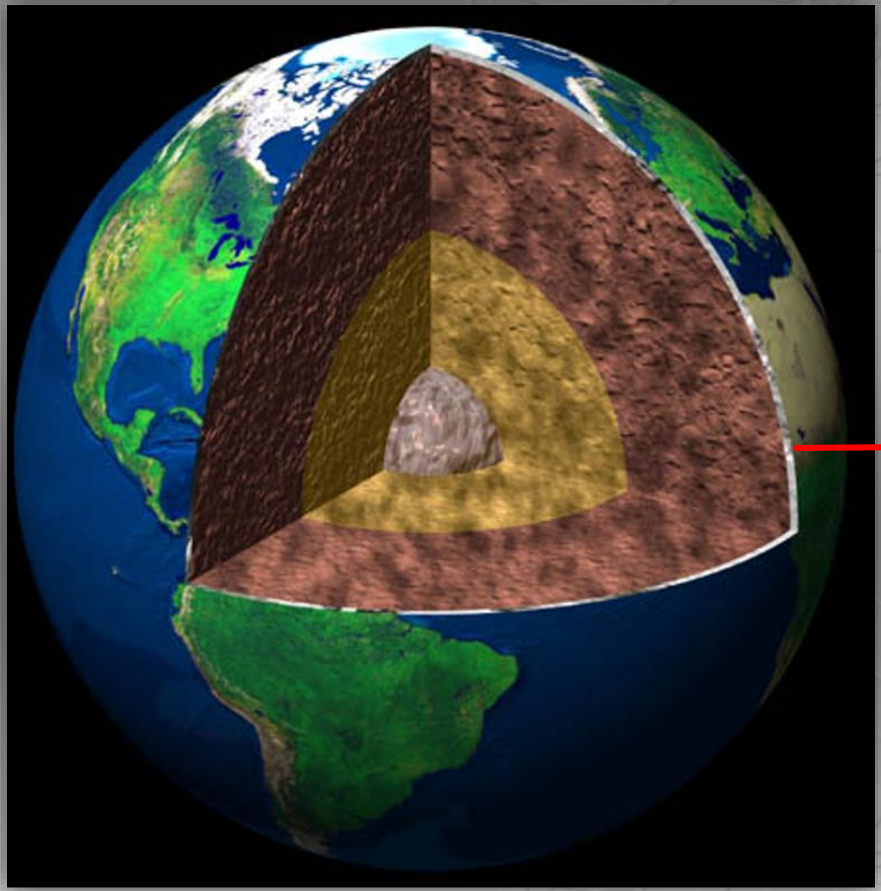
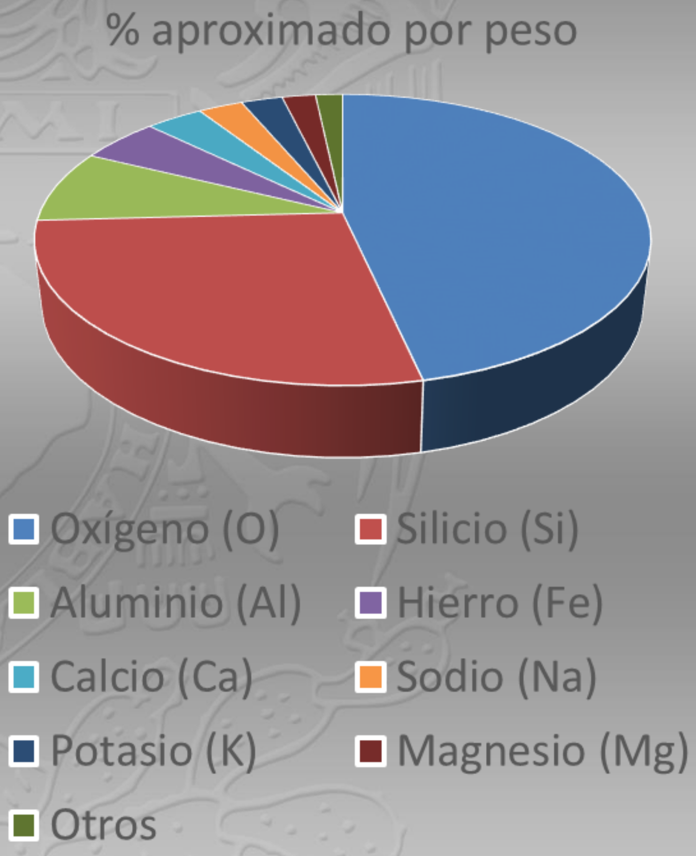
Abundancia de elementos en la corteza terrestre





Clasificación de los minerals

Dada la composición de los elementos de la corteza terrestre, los minerales pueden clasificarse de forma muy general en dos grandes grupos:

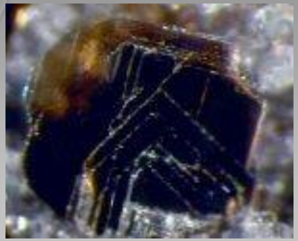
- Silicatos
- No silicatos

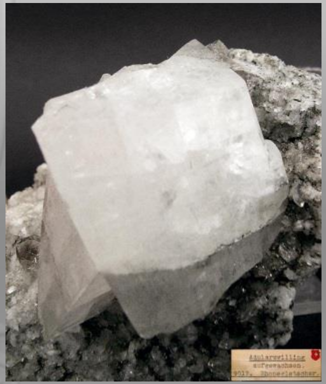
Elemento	% aproximado por peso
Oxígeno (O)	46.6
Silicio (Si)	27.7
Aluminio (Al)	8.1
Hierro (Fe)	5.0
Calcio (Ca)	3.6
Sodio (Na)	2.8
Potasio (K)	2.6
Magnesio (Mg)	2.1
Otros	1.7
Total	100

Mineral		Idealized Formula	Cleavage	Silicate Structure	Contenido de Fe	Contenido de Si
Olivine		$(Mg,Fe)_2SiO_4$	None	Single tetrahedron	Silicatos Ferromagnesianos (oscuros)	- Si
Pyroxene group (Augite)		$(Mg,Fe)SiO_3$	Two planes at right angles	Single chains		
Amphibole group (Hornblende)		$Ca_2(Fe,Mg)_5Si_8O_{10}(OH)_2$	Two planes at 60° and 120°	Double chains		
Micas	Biotite	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	One plane	Sheets		
	Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$			Silicatos No ferromagnesianos (claros)	
Feldspars	Orthoclase	$KAlSi_3O_8$	Two planes at 90°	Three-dimensional networks (expanded view)		
	Plagioclase	$(Ca,Na)AlSi_3O_8$				
Quartz		SiO_2	None			++Si

Figura tomada de Tarbuck, Lutgens y Tasa, 2010.





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(b) **No Silicatos**

Elementos nativos (Au, Ag, Cu)

Óxidos (O_2-) e **Hidróxidos** (OH-) *ej. hematita (Fe_2O_3) y brucita (Mg [OH]2)*

Haluros cloruros (Cl-), fluoruros (F-), bromuros (Br-), yoduros (I-), *ej. halita (NaCl)*

Carbonatos (CO_3 2-) *ej calcita $CaCO_3$*

Sulfatos ($SO_4$2-) *ej. yeso ($CaSO_4$ $2H_2O$),*

Sulfuros y **sulfosales** (S) *ej pirita (FeS_2),*

Fosfatos (PO_4), Arsenatos, Vanadatos y Boratos *ej apatito ($Ca_5(PO_4)_3$ (OH,F,Cl)*

Esquema de la clasificación propuesto por Schnurrenberger et al. (2003):

•Identificación de los componentes mayores y menores del sedimento.

•Estructura macroscópica del sedimento: texturas y estructuras sedimentarias

1. Modificador mayor +
2. Color +
3. Estratificación +
4. Nombre principal +
5. Constituyentes menores

e.g. Arcilla feldespática pardo obscuro rojiza, masiva, con detritos carbonáceos y trazas de fragmentos de gasterópodos.

Modificador mayor: por ejemplo tamaño de grano

Tamaño de partícula	Nombre del sedimento	Nombre de la roca
> 2mm	Grava	Conglomerado o brecha
1/16 a 2mm	Arena	Arenisca
1/256 a 1/16 mm	Limo	Limolita
< 1/256 mm	Arcillla	Lutita

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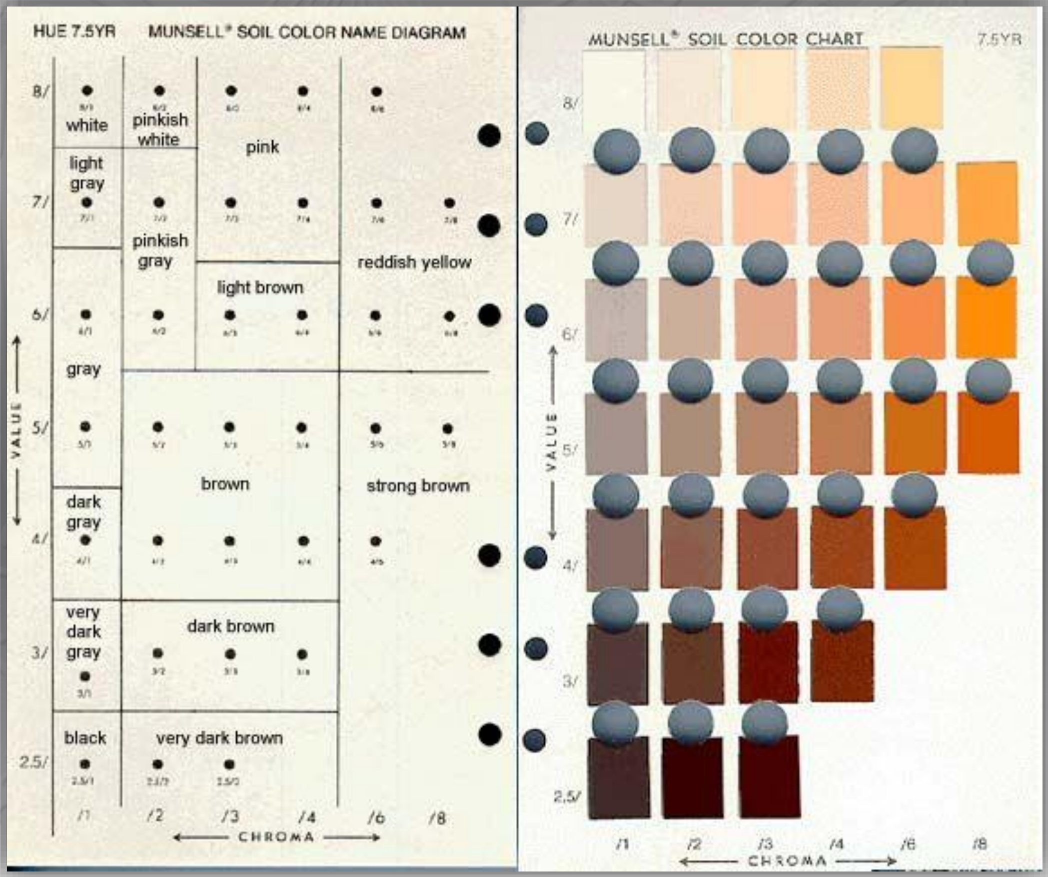
Color:

Utilizando la escala de Munsell, tan pronto como sea posible al colectar y abrir los sedimentos



Espesor de los estratos

Estratos --→ producidos por cambios en el patrón de sedimentación (color, tamaño, mineralogía o componentes). Pueden presentarse como:

Masivos: estratos > 1 m

Capas > 1 cm

- muy gruesas > 100 cm
- gruesas 30-100 cm
- medias 10-30 cm
- finas 3-10 cm
- muy finas 1-3 cm

Láminas < 1 cm

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Tipos de estratificación:

Planar
Ondulada
Curva

Paralela
No-paralela
Discontinua

Y las combinaciones entre ellas

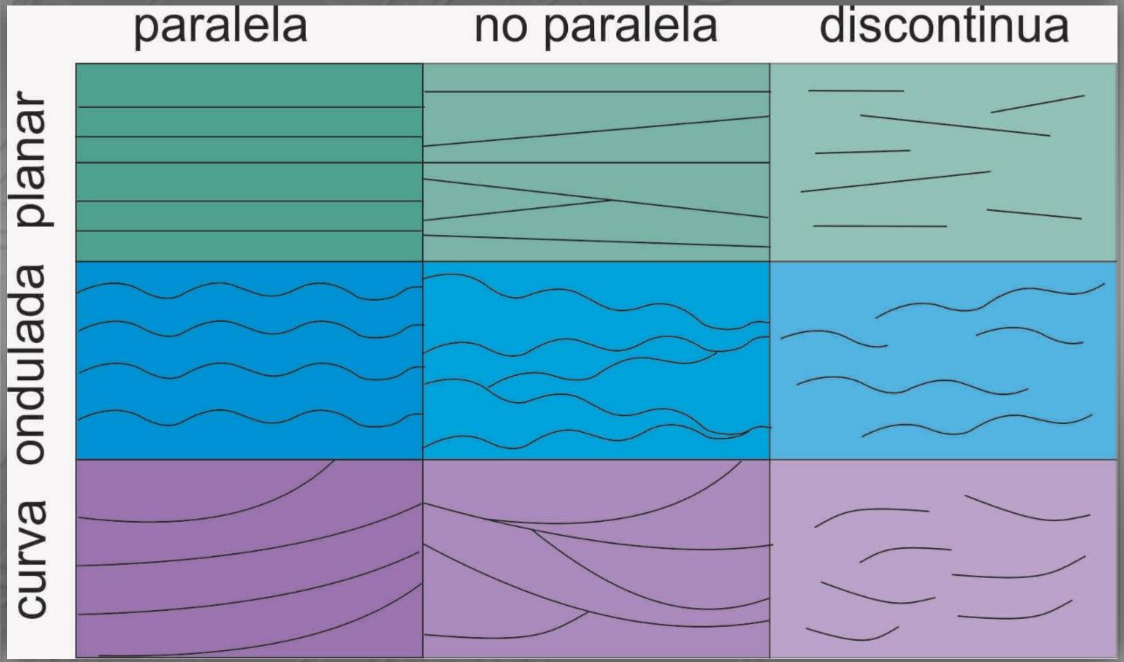

Figura modificada de Tucker 2011

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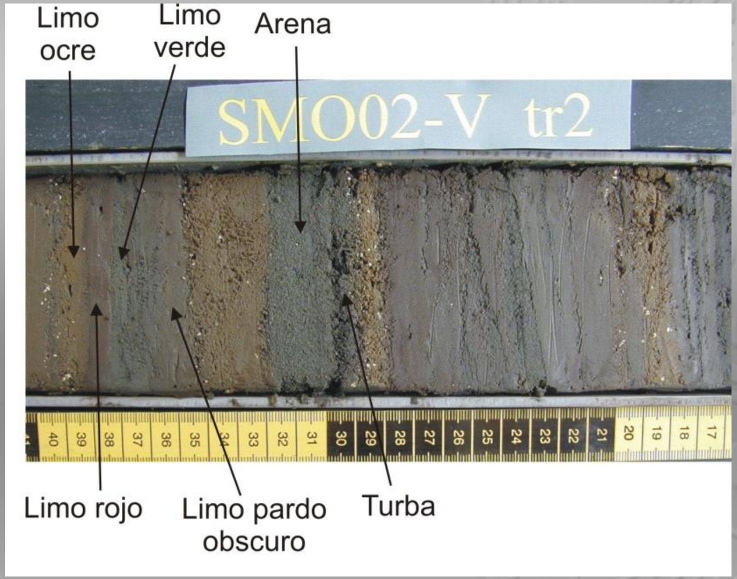
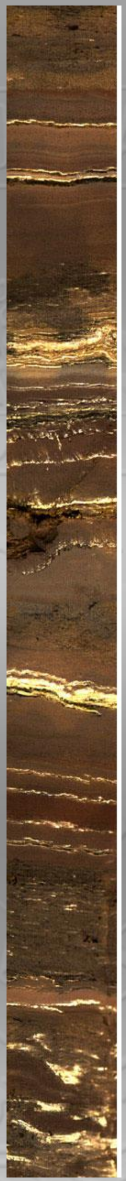
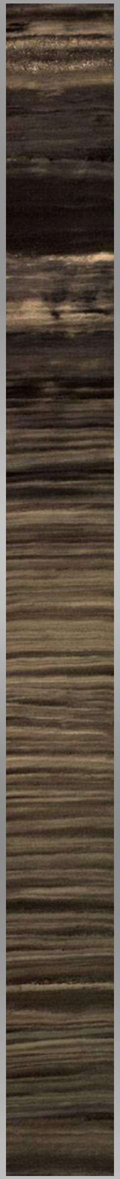
Laminaciones, capas menores a 1 cm de espesor




Santa Ma. del Oro, Nayarit, México


Lago Titicaca, Peru-Bolivia


Lago Bush, Montana EEUU

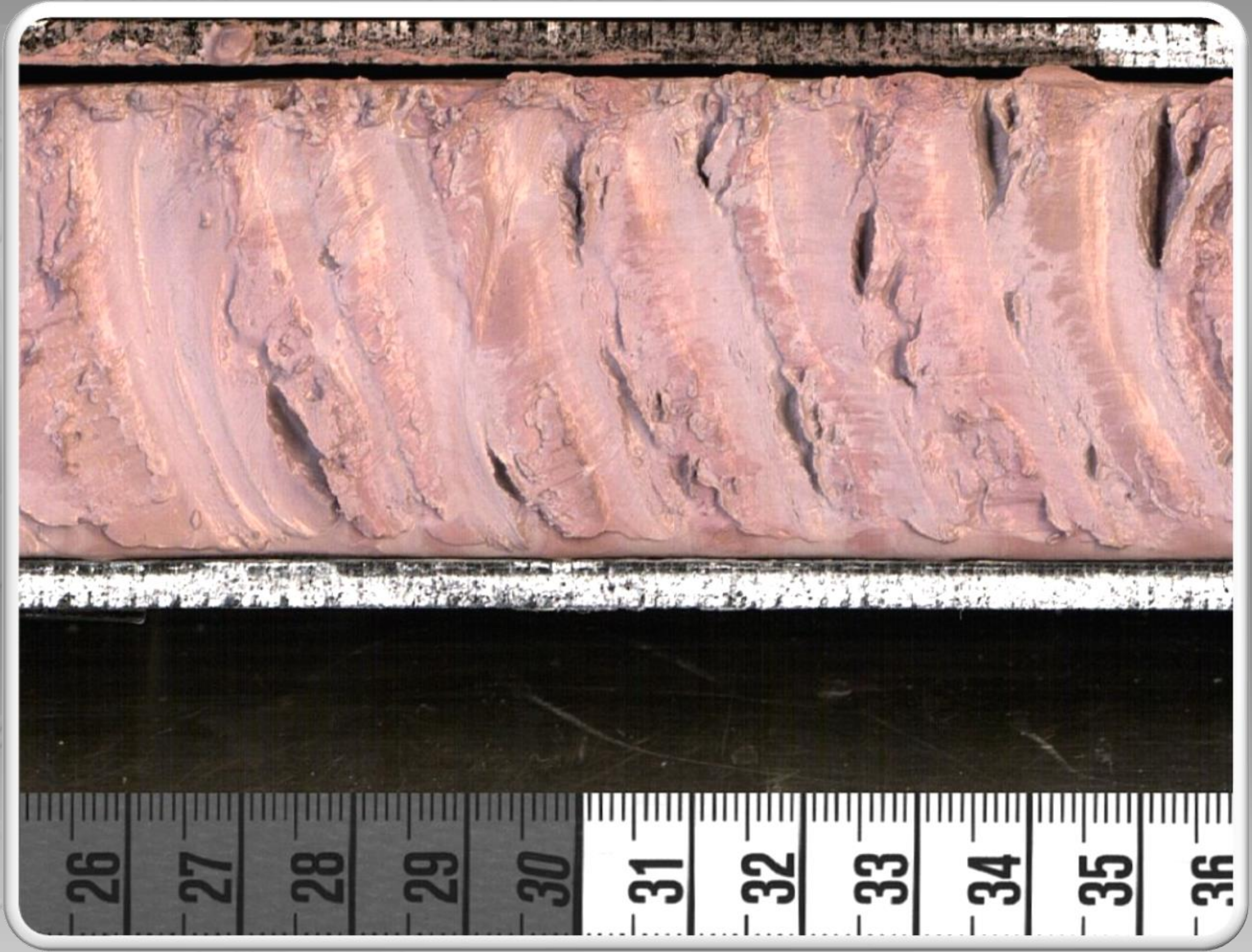

Lago Hvitarvatn, Islandia

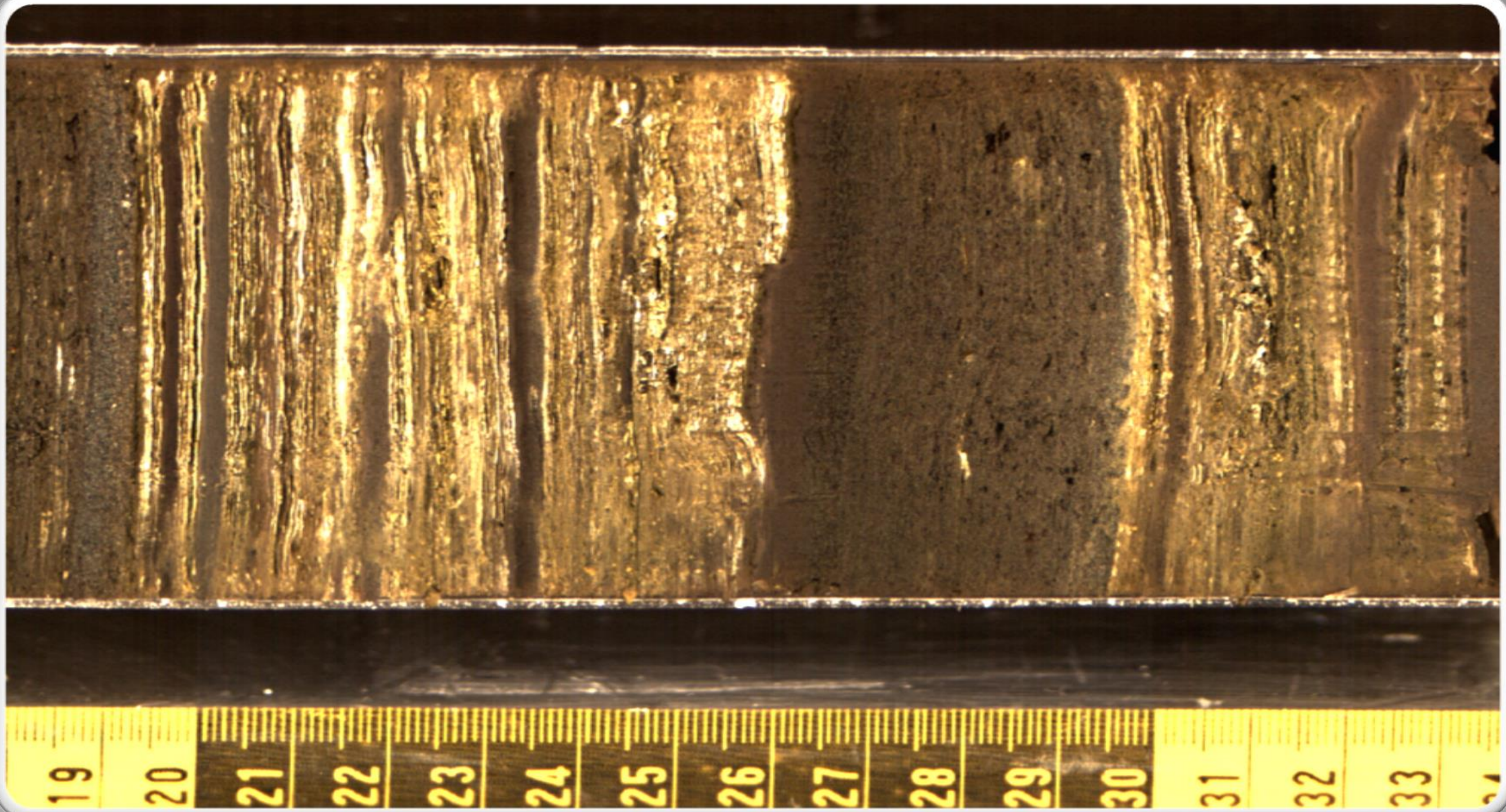
Conjunto de capas

Grupos repetitivos cíclicos o rítmicos: varvas y “ritmitas”.

Varvas glaciales, Swiftcurrent Lake

https://tmi.laccore.umn.edu/coreFace/list

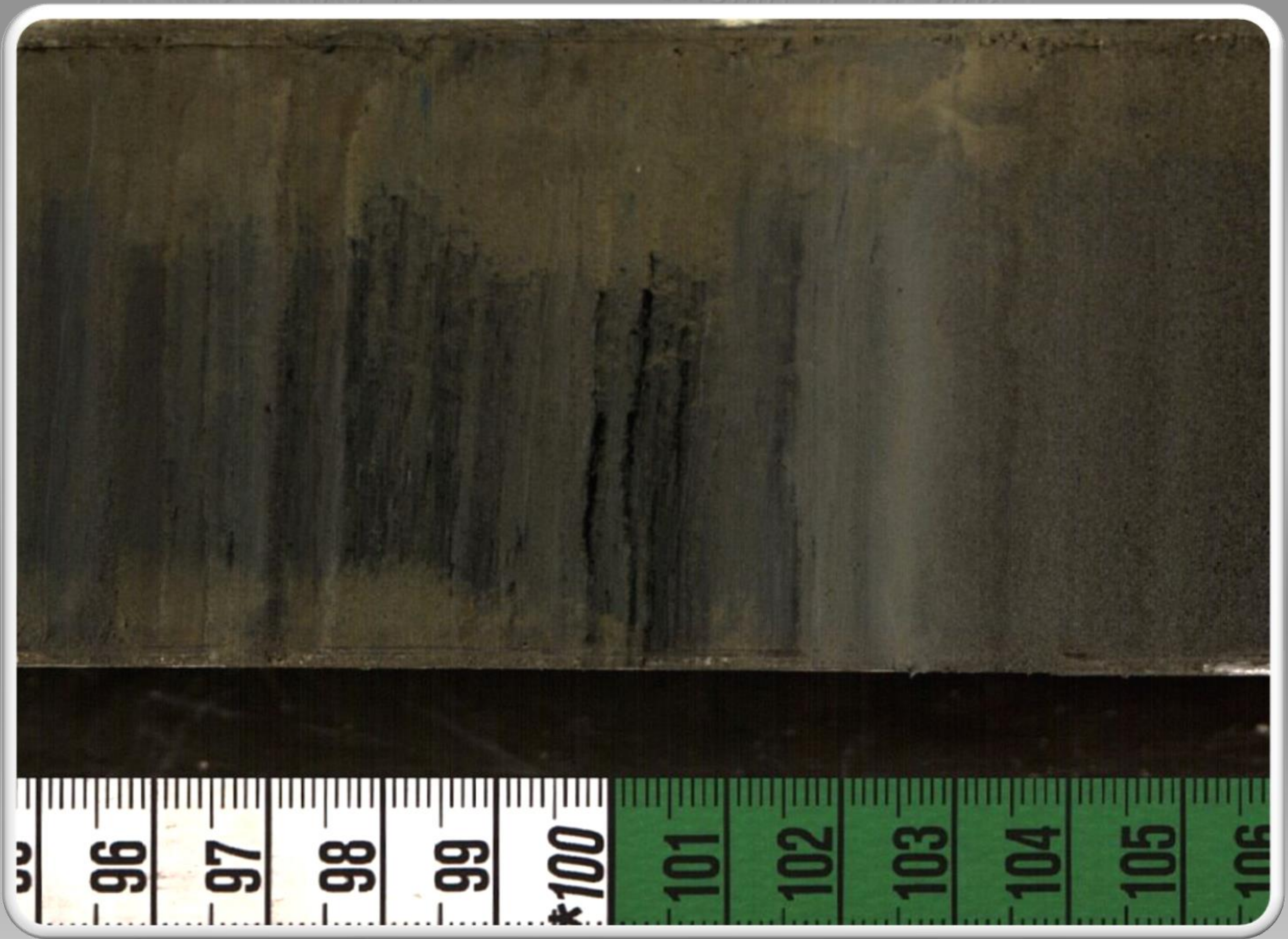




Sedimentos laminados del lago Santa Ma. del Oro, Nay.

Limos sulfídicos laminados, Wallowa Lake, Oregon

https://tmi.laccore.umn.edu/coreFace/list



Contactos entre capas

Naturaleza de la transición entre las capas:
Rectos o curvos
Abruptos o difusos
Gradacionales (normales o inversos)

Los contactos rectos y abruptos a menudo evidencian etapas de erosión o no-depósito

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Contactos entre capas

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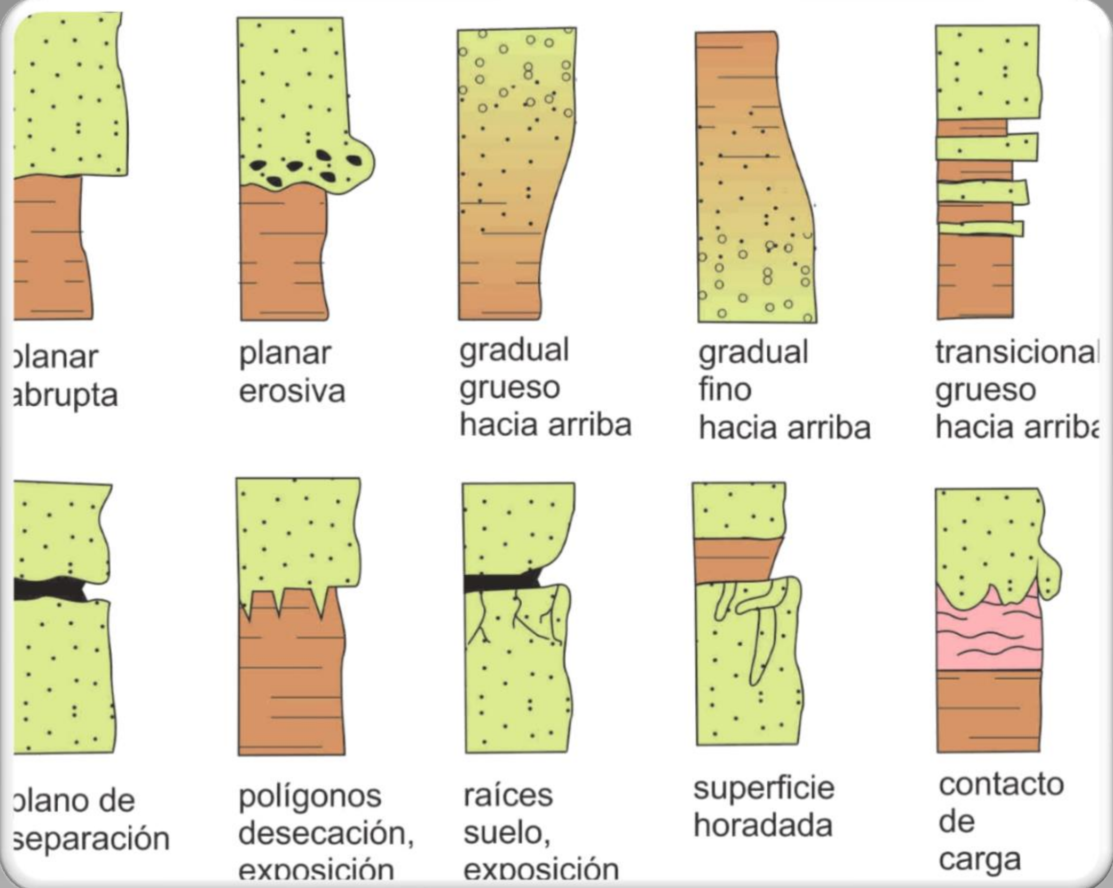

Figura tomada de Tucker (2011)

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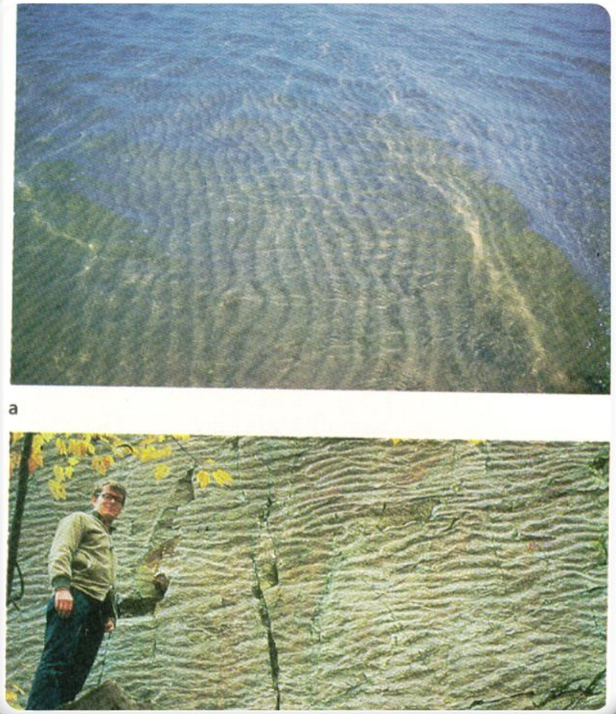
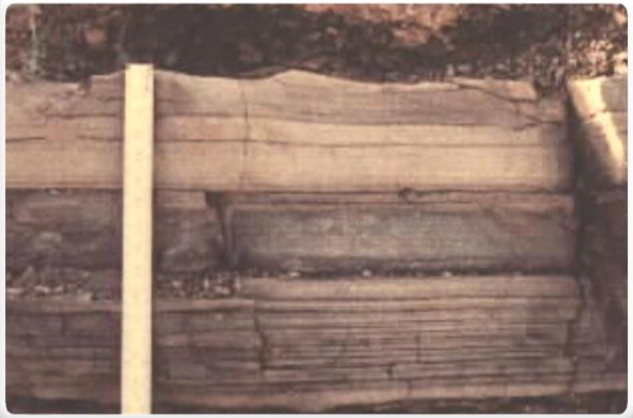
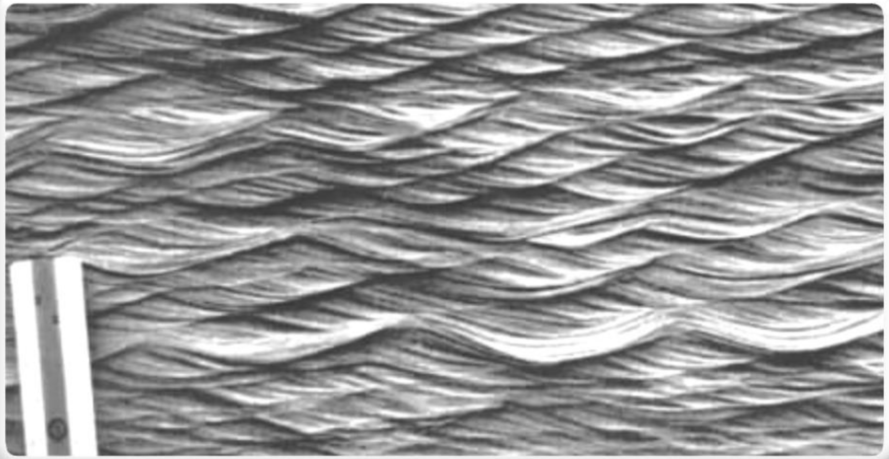
Estructuras sedimentarias

Aquellos rasgos formados durante la acumulación (primarias) o después del depósito de los sedimentos (secundarias).

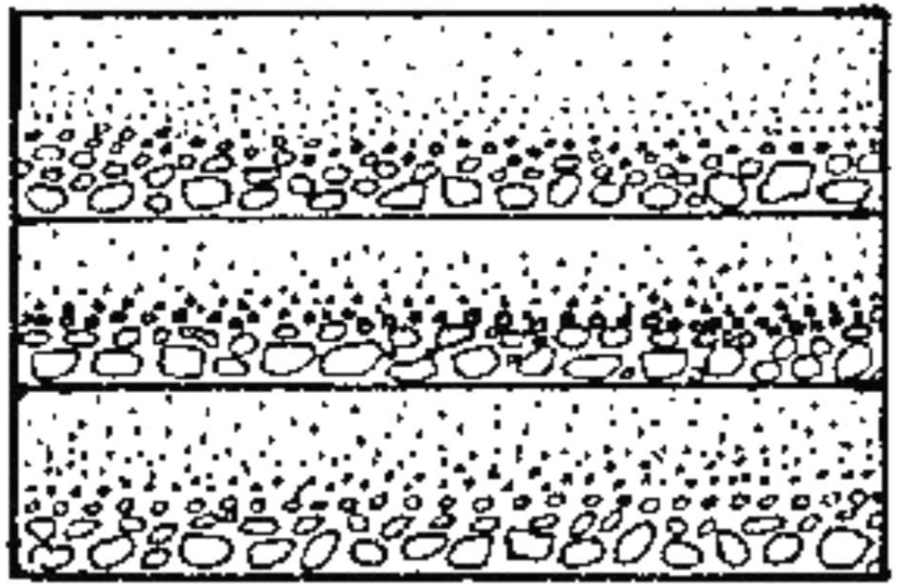




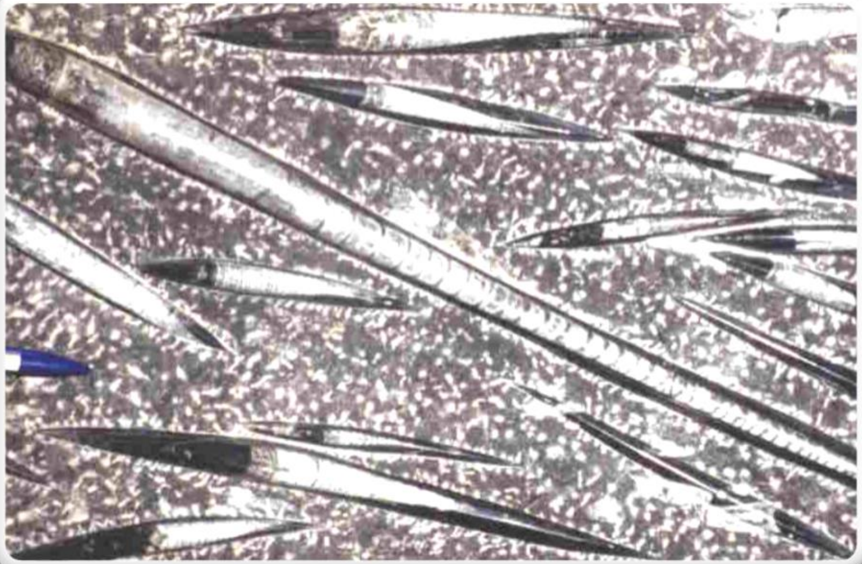


Rizaduras

Gradación



Imbricación

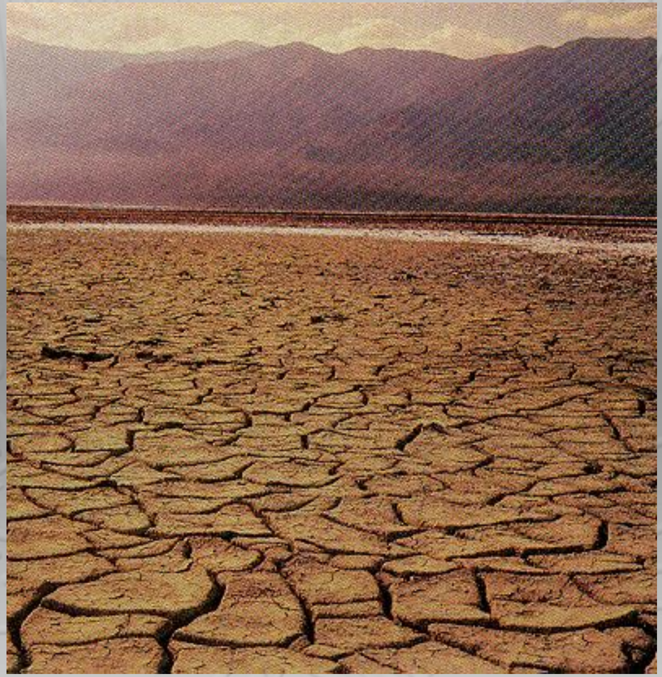


Huellas

de lluvia

Burbujas

Grietas de desecación



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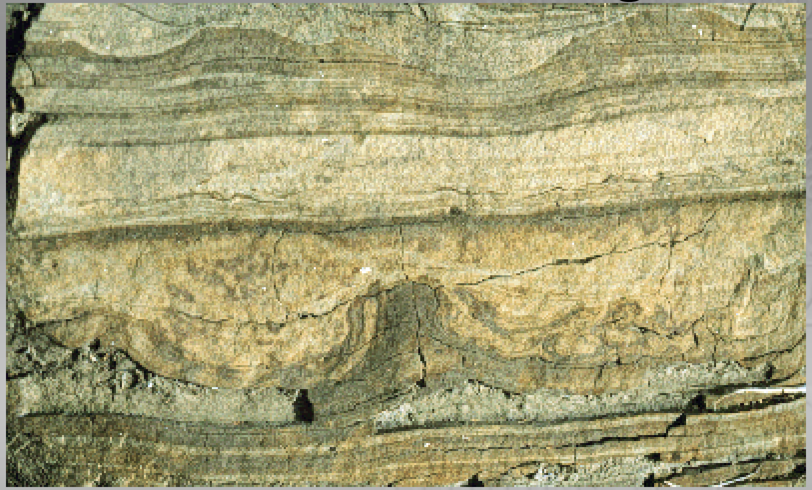
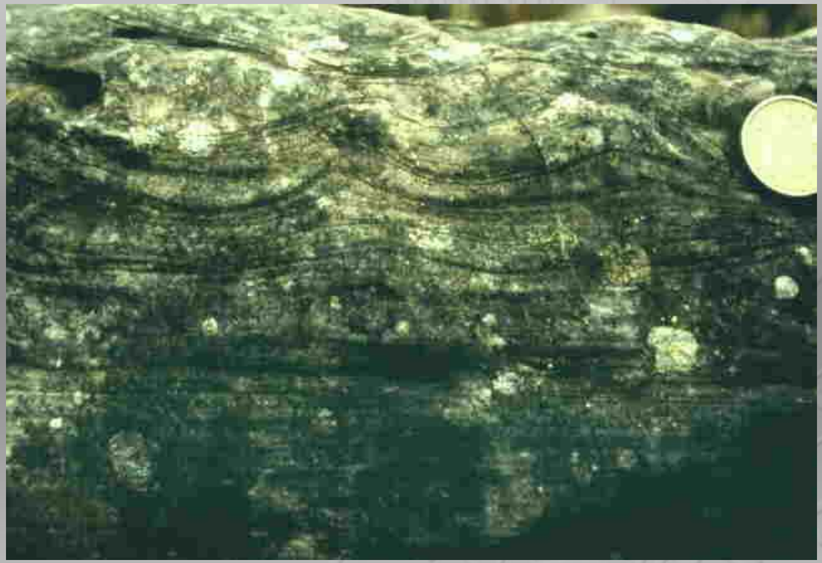
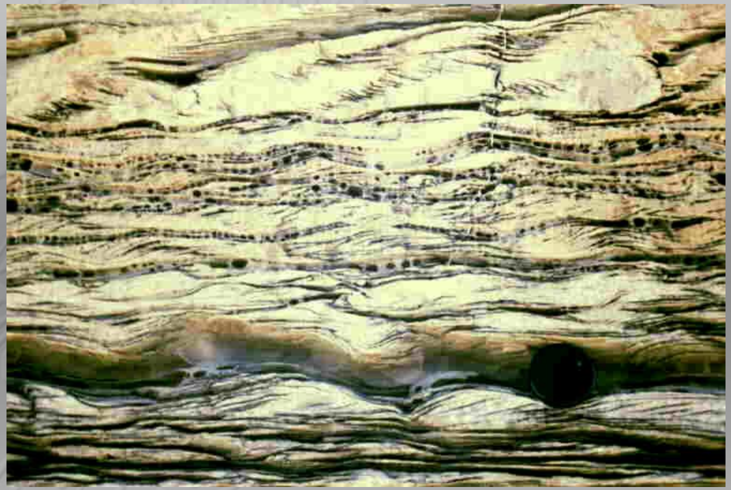
Estructuras de carga



Estratificación convoluta





Slumping (derrumbe)

Almohadilla

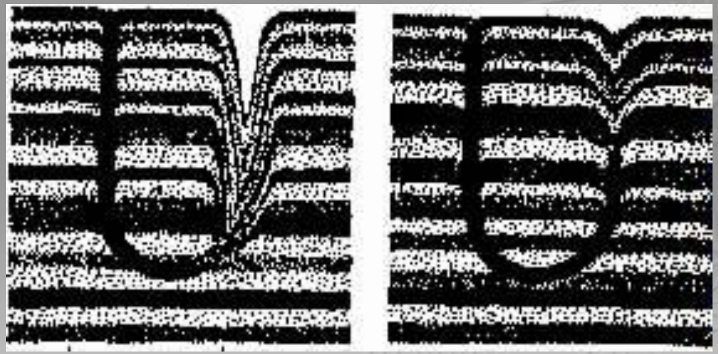
Huellas de disolución

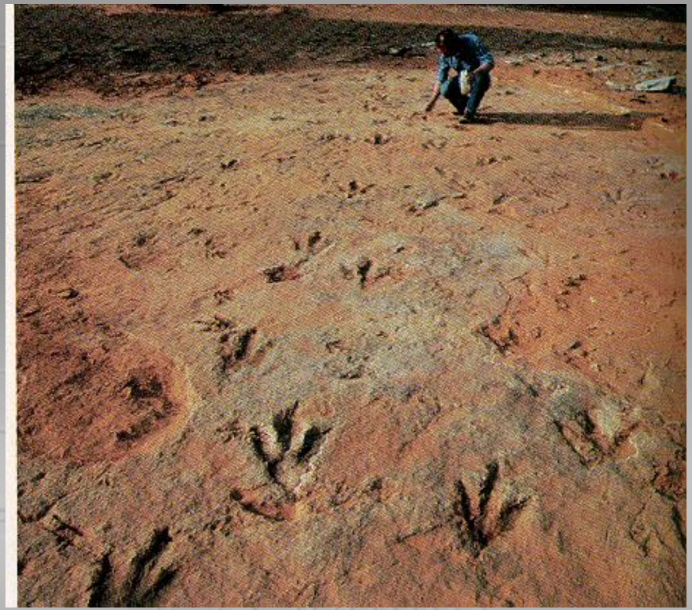
estilolitas

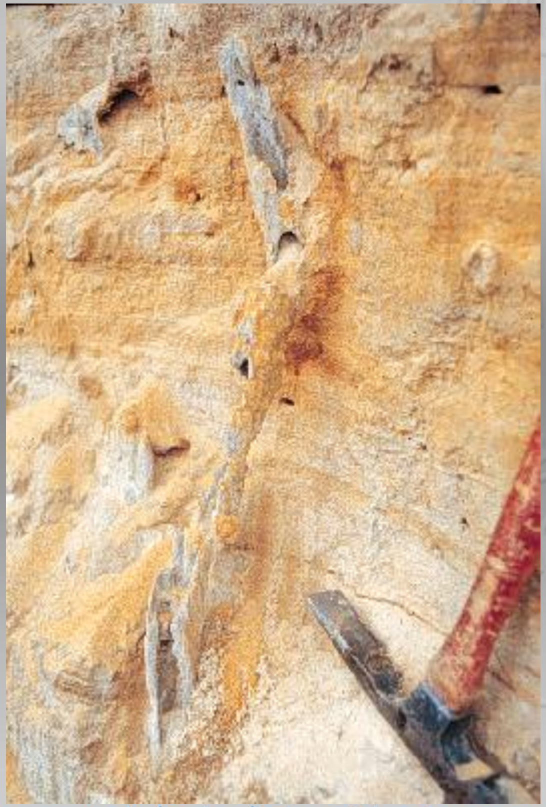
cristales de sal

cristales de hielo

Bioturbación







Componentes:

1)Sedimento clástico
2)Sedimento químico
3)Sedimento biogénico

1. Compuesto de granos de minerales, fragmentos de rocas, vidrios volcánicos, de origen alóctono. Depositado por procesos físicos aéreos o superficiales.

2. Compuesto de materiales inorgánicos autóctonos,
formados dentro del cuerpo de agua por procesos químicos inorgánicos o biológicos: precipitación por solución o recristalización (calcita, halita, pirita, yeso, etc.)

3. Abarcan una amplia variedad de mienralogías, pero son esencialmente restos fósiles de organismos (diatomeas, ostrácodos, foras, radiolarios, moluscos, materia orgánica amorfa, etc.)

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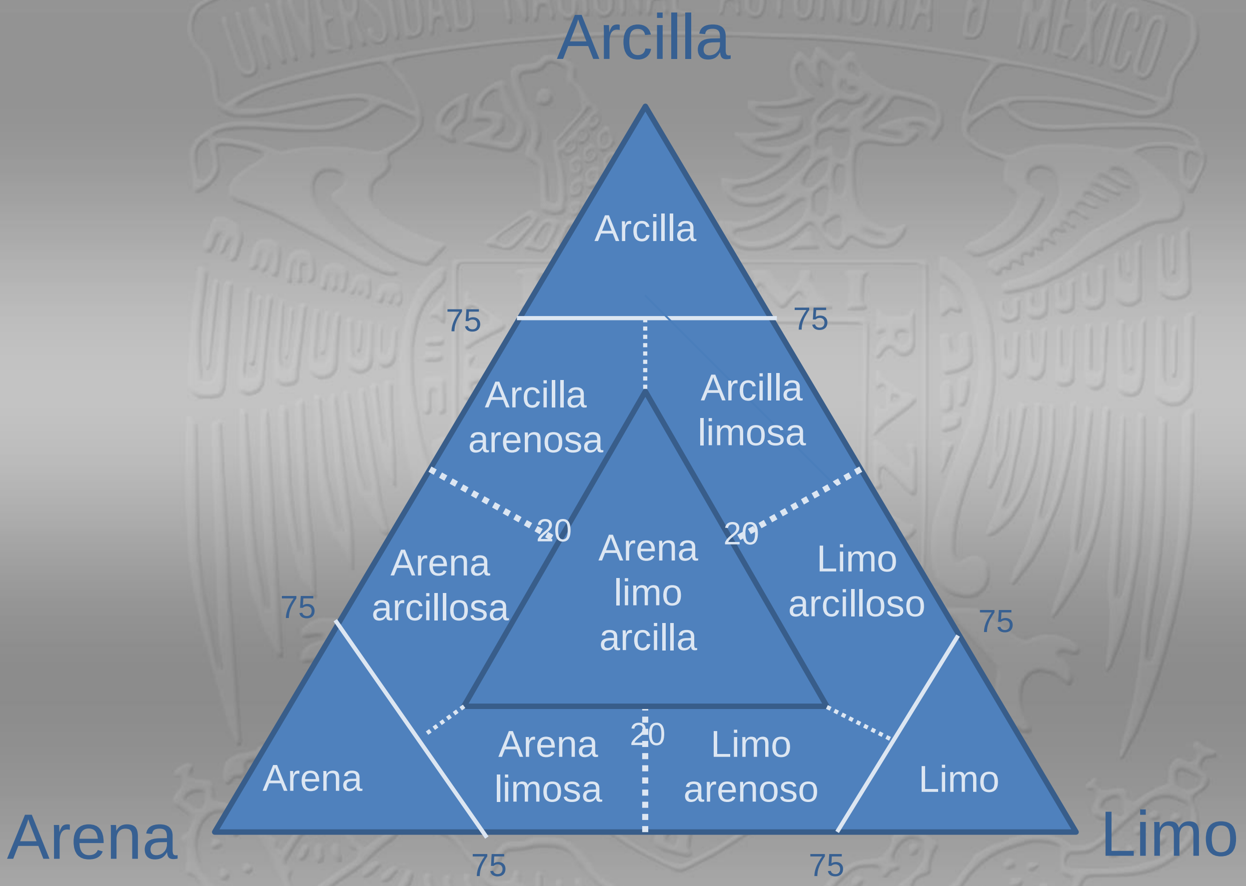
Clase de sedimento	Subclase	Serie	Nombre principal	Modificador mayor
Clástico			Arena Arena arcillosa Arena limosa Limo Limo arenoso Limos arcilloso Arcilla Arcilla limosa Arcilla arenosa Arena-limo-arcilla	Tamaño de grano, Redondez, Clasificación, Fábrica.
Químico	Evaporitas Carbonatos		Yeso Caliza Dolomía Lodo calcáreo	Mineralogía, Tamaño Fábrica Mineralogía, Tamaño, Fábrica % carbonato
Biogénico	Carbonáceo Fosilífero	Carbón Sapropel	Antracita Bitumen Lignito Turba Sapropel Ooze Coquina	 Taxón de planta, y grado de fragmentación. Clase de organismos

Clásticos


Arcilla
Arcilla
75
75
Arcilla arenosa
Arcilla limosa
20
20
Arena arcillosa
Arena limo arcilla
Limo arcilloso
75
75
20
Arena
Arena limosa
Limo arenoso
Limo
Arena
Limo
75
75

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La composición de los granos clásticos puede ser descrita por la mineralogía utilizando modificadores tales como cuarzo, feldespato, micas, zeolitas, fragmentos líticos, vidrios, fragmentos calcáreos, yesíferos o sapropélicos (para clastos detríticos de carbonato de Ca, yeso y materia orgánica, respectivamente).

Un gran número de propiedades sedimentológicas o mineralógicas pueden ser observadas en ejemplares particulares (alteración de feldespatos). En esos casos, el observador deberá aplicar su propio criterio.

Sedimentos dominados por componentes clásticos, ejemplos

- Conglomerado matriz-soportado, en capas medias, compuesto de grava angular cuarzo feldespática
- Arena limosa cuarcítica masiva, subredondeada, con feldespatos y ocasionales granos de anfíboles.
- Arcilla limosa diatomeácea blanca a moteada (máculas blancas), masiva en capas de hasta 5 cm espesor.

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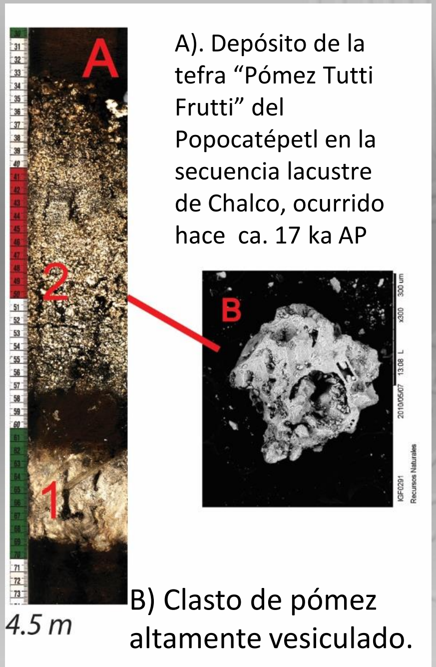
Sedimentos volcaniclásticos

- En ambientes volcánicos activos, pueden preservarse intercalados con los sedimentos lacustres productos de caída de actividad explosiva (tefras), o materiales retrabajados (volcaniclastos en general).



A). Depósito de la tefra "Pómez Tutti Frutti" del Popocatépetl en la secuencia lacustre de Chalco, ocurrido hace ca. 17 ka AP

B) Clasto de pómez altamente vesiculado.

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Químicos.

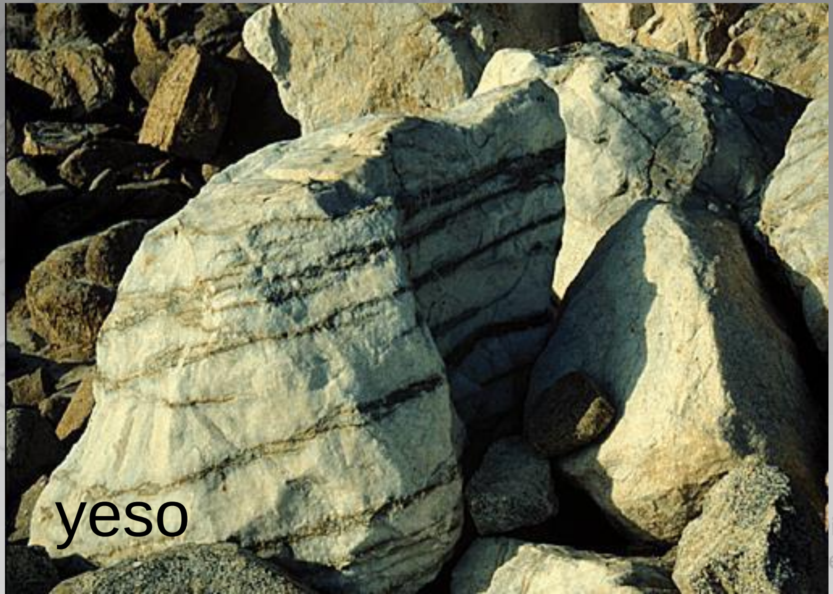
Esta categoría contienen la más amplia variedad de tipos de sedimentos, ya que es amplio el rango de precipitados químicos.
Se utiliza el término de “lodo” (mud), como el principal nombre que describe precipitados microcristalinos.

Distingue dos clases principales:

•Evaporitas
•Carbonatos

- Evaporitas

Los depósitos evaporíticos pueden formase a gran escala, al evaporarse el agua de los océanos, o a escala más pequeña, en cuencas epicontinentales.



- Evaporitas

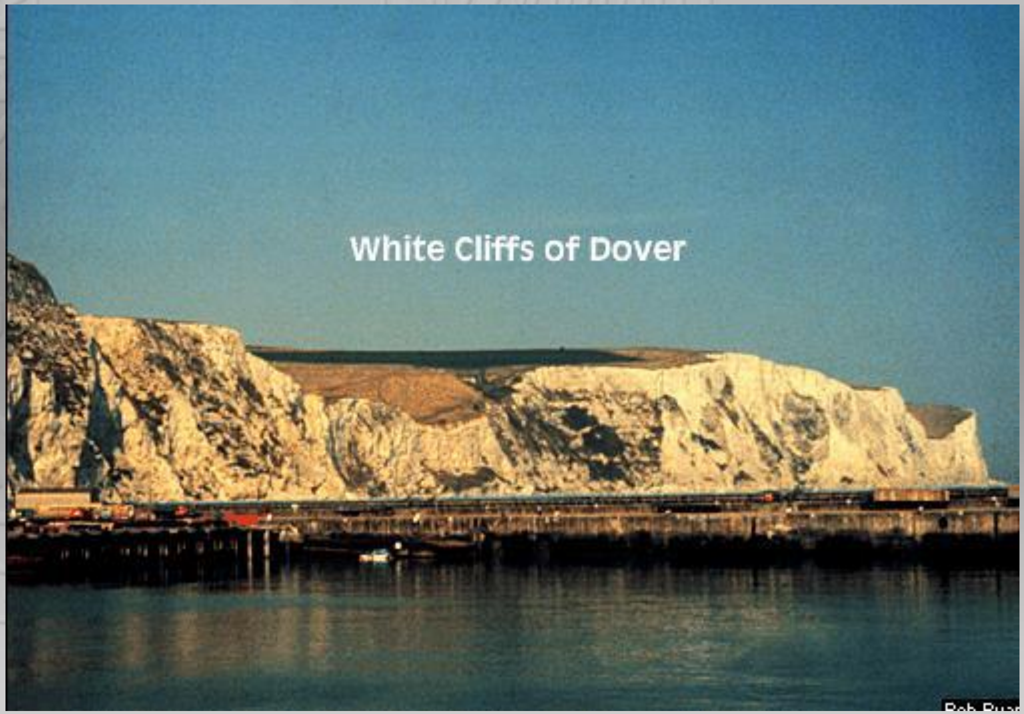
Fosforita o roca fosfatada. Se forma a partir de acumulaciones de hueso o excremento de vertebrados o a partir de conchas de invertebrados.

Son importantes porque:

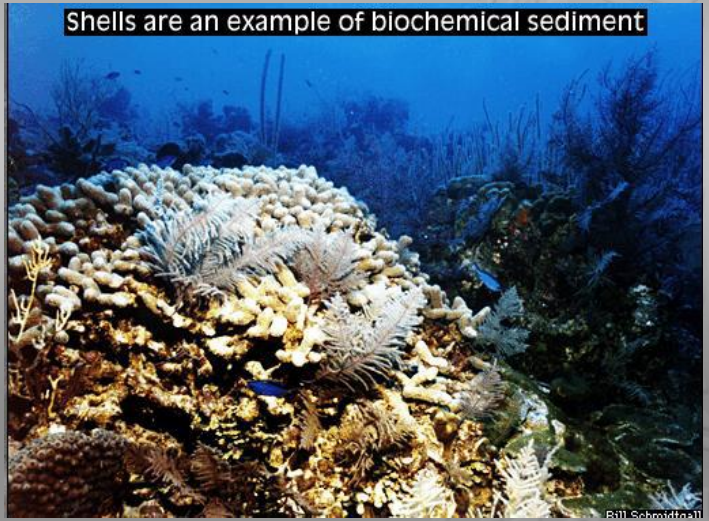
- P es el 10˚ elemento más abundante en la corteza.
- Elemento esencial de valor nutritivo
- Usado como fertilizante

- Carbonatos

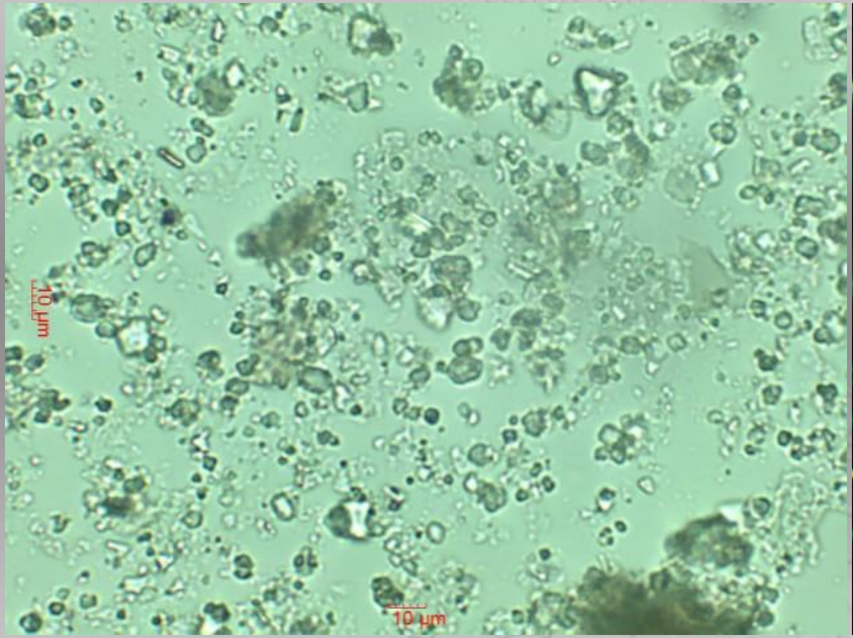
La creta (chalk) está hecha de restos calcáreos de organismos microscópicos

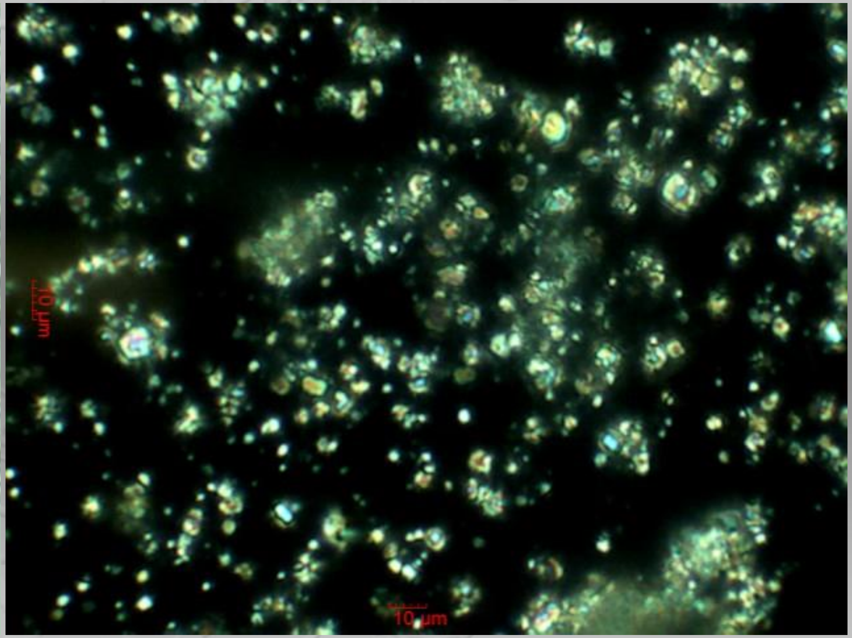


Precipitación inorgánica



Cristales de siderita ($FeCO_3$)





Pedernal.
Es cuarzo criptocristalino y se presenta en una amplia variedad de formas y colores. Puede ser fácilmente distinguido de otros componentes por su dureza, ausencia de clivaje y ausencia de reacción al HCl.

Sedimentos dominados por componentes químicos, ejemplos

- Caliza gris claro laminada (con capas de 0.75-1.0 cm), con ostrácodos con raros Charastemas. Contactos nítidos.

- Calcita micrítica (o lodo calcáreo micrítico) pardo claro, masiva, húmeda, con frecuentes arcillas feldespáticas y frústulas de diatomeas.

Biogénicos.

Puede estar compuesta de bien preservados a altamente degradados restos de organismos.

Distingue dos clases principales:

- Carbonáceos
- Fosilíferos, u oozes o lumaquelas

Partícula de carbón

Sedimentos dominados por componentes biogénicos, ejemplos

1. Ooze diatomeáceo sapropélico negro (10YR 3/2), masivo, con límites distintivos hacia capas supra y sobreyacientes.

2. Ooze diatomeáceo.
3. Ooze de *Phacotus*
4. Lumaquela de ostrácodos

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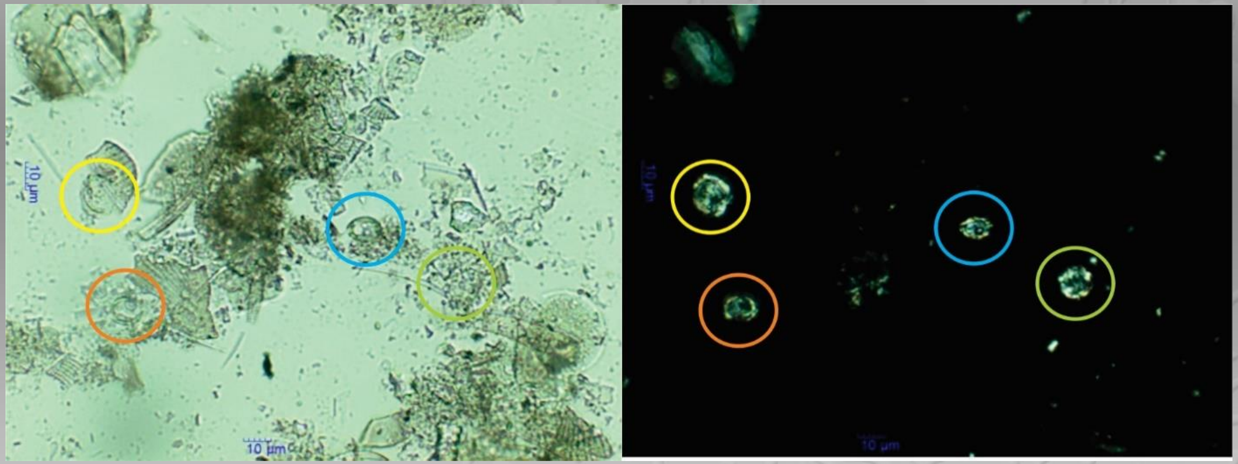
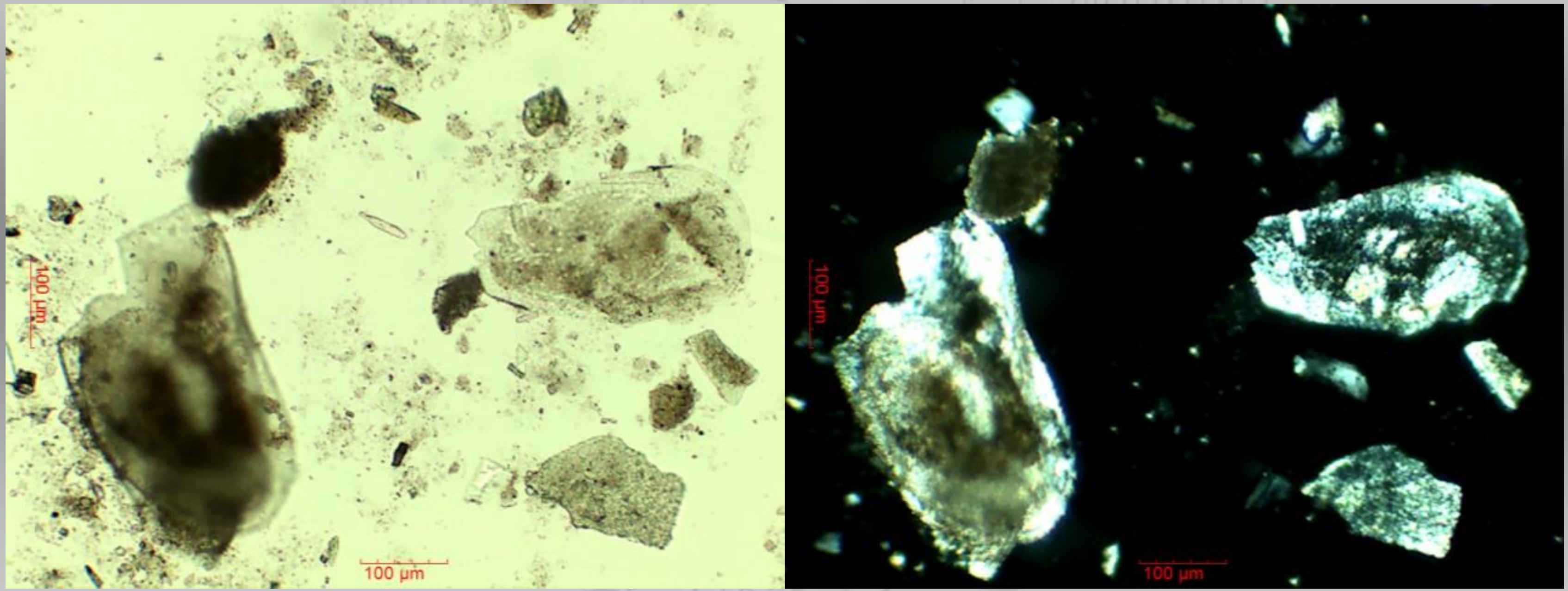
Ooze diatomeáceo



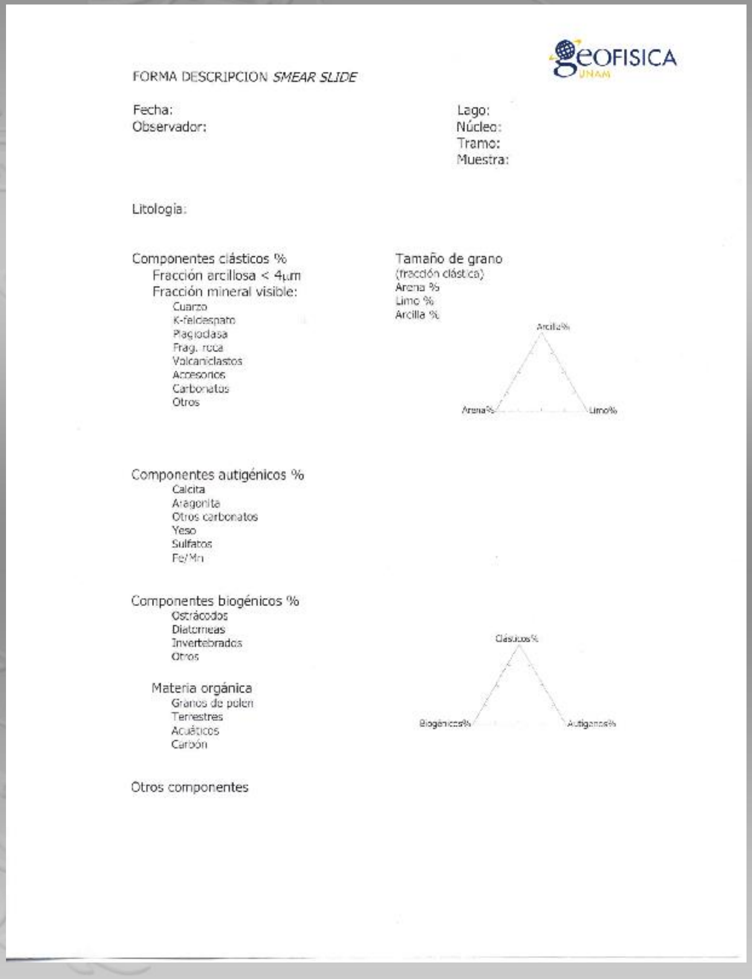
Ooze de *Phacotus*

Lumaquela de ostrácodos



Descripción microscópica del sedimento (elaboración de *frotis*)

Formato para la descripción inicial de los componentes sedimentarios en frotis.



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FORMA DESCRIPCION *SMEAR SLIDE*

Fecha:
Observador:

Lago:
Núcleo:
Tramo:
Muestra:

Litologia:

Componentes clásticos %
- Fracción arcillosa < 4μm
- Fracción mineral visible:
  - Cuarzo
  - K-feldespato
  - Plagioclasa
  - Frag. roca
  - Volcaniclastos
  - Accesorios
  - Carbonatos
  - Otros

Tamaño de grano
(fracción clástica)
Arena %
Limo %
Arcilla %

Arcilla%
Arena%
Limo%

Componentes autigénicos %
- Calcita
- Aragonita
- Otros carbonatos
- Yeso
- Sulfatos
- Fe/Mn

Componentes biogénicos %
- Ostrácodos
- Diatomeas
- Invertebrados
- Otros

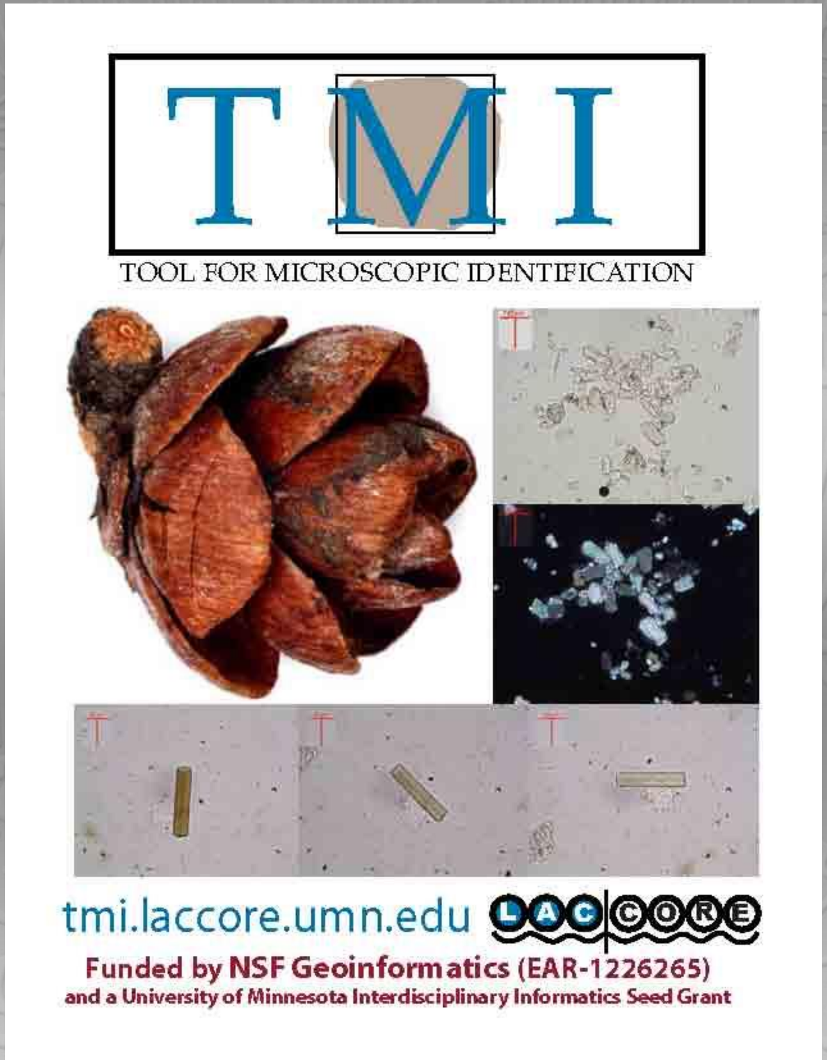
Materia orgánica
- Granos de polen
- Terrestres
- Acuáticos
- Carbón

Clásticos%
Biogénicos%
Autigenos%

Otros componentes

Recursos educativos

http://lrc.geo.umn.edu/laccore/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TOOL FOR MICROSCOPIC IDENTIFICATION
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LAC CORE
Funded by NSF Geoinformatics (EAR-1226265)
and a University of Minnesota Interdisciplinary Informatics Seed Grant

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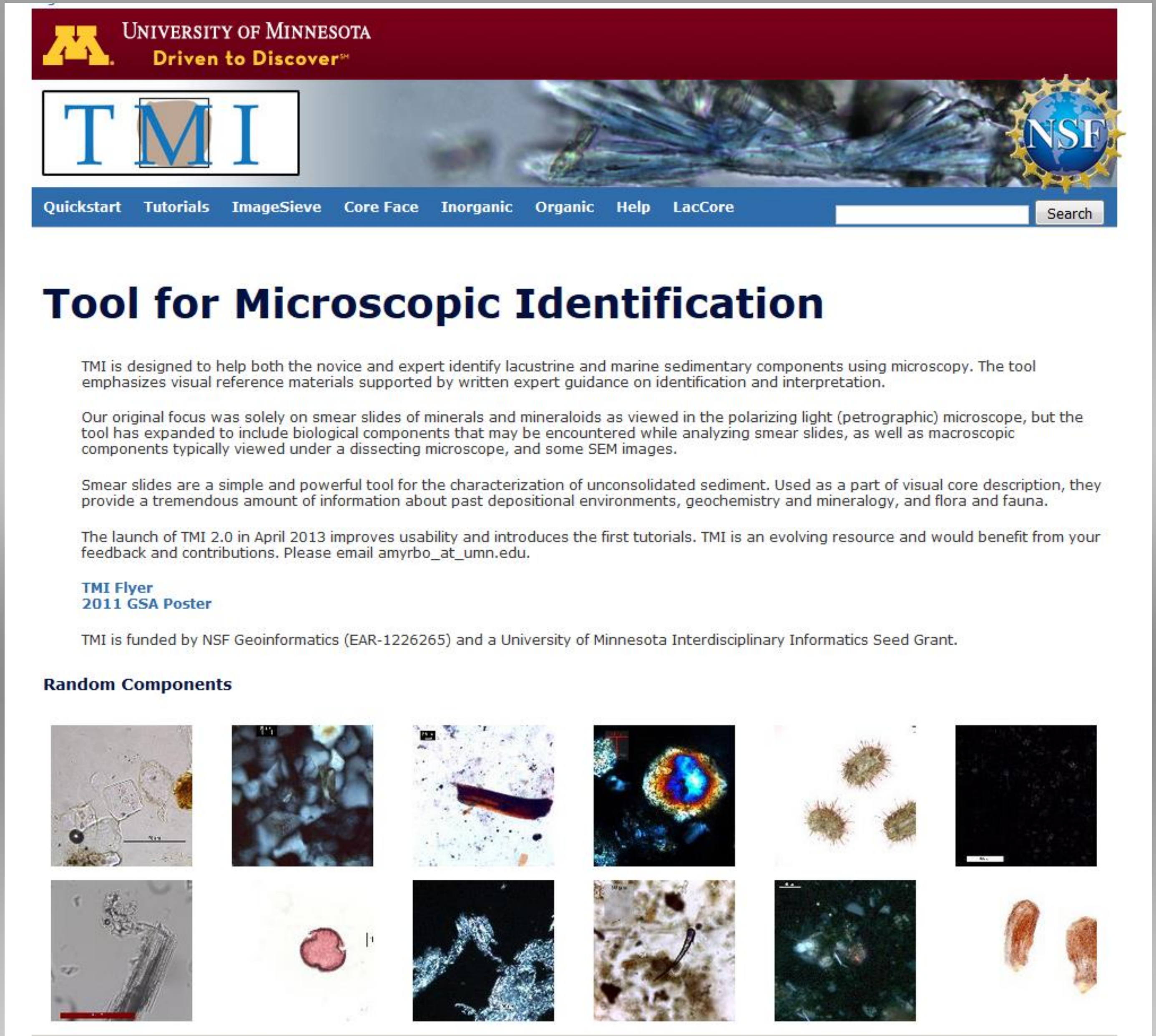
University of Minnesota
Driven to Discover℠

TMI

NSF

Quickstart Tutorials ImageSieve Core Face Inorganic Organic Help LacCore Search

Tool for Microscopic Identification

TMI is designed to help both the novice and expert identify lacustrine and marine sedimentary components using microscopy. The tool emphasizes visual reference materials supported by written expert guidance on identification and interpretation.

Our original focus was solely on smear slides of minerals and mineraloids as viewed in the polarizing light (petrographic) microscope, but the tool has expanded to include biological components that may be encountered while analyzing smear slides, as well as macroscopic components typically viewed under a dissecting microscope, and some SEM images.

Smear slides are a simple and powerful tool for the characterization of unconsolidated sediment. Used as a part of visual core description, they provide a tremendous amount of information about past depositional environments, geochemistry and mineralogy, and flora and fauna.

The launch of TMI 2.0 in April 2013 improves usability and introduces the first tutorials. TMI is an evolving resource and would benefit from your feedback and contributions. Please email amyrbo_at_umn.edu.

TMI Flyer
2011 GSA Poster

TMI is funded by NSF Geoinformatics (EAR-1226265) and a University of Minnesota Interdisciplinary Informatics Seed Grant.

Random Components

Login

Campuses: Twin Cities Crookston Duluth Morris Rochester Other Locations

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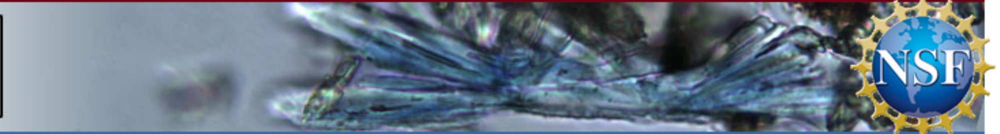
TMI



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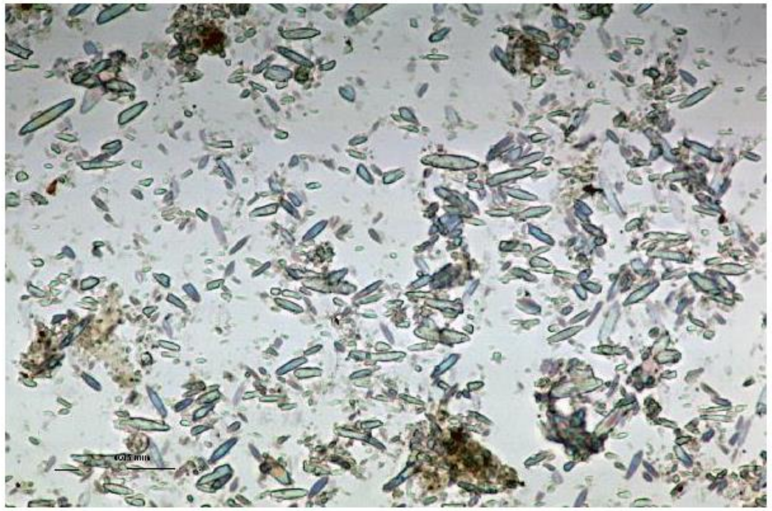
Principal Nuevo UniqueIdentification

Inorganics

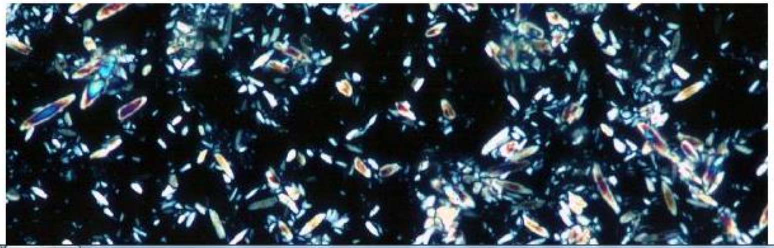
Id	Identification Type	Name	Description	Distinguishing Features	Tags
107	Mineral	Albite	Clear to pale yellow. Nonpleochroic. Low birefringence. Euhedral laths possible in volcanic settings, generally subrounded/subangular in shape. High relief. Can be distinguished from quartz by its 90 degree cleavage. Polysynthetic (albitic, simple) twinning is diagnostic. Sodium endmember of plagioclase solid solution series. See also feldspar. "Elongate prisms in multiple domains" -Smoot	polysynthetic-twinning	feldspar silicate plagioclase
21	Mineral	Amphibole	Transparent colorless to green, brown, red, yellow, depending on mineralogy within the amphibole group. Strongly pleochroic. Moderate birefringence may be masked by color. Anhedral to euhedral prismatic grains. High relief. Hornblende-series minerals the most common detrital amphiboles.	Pleochroic Subhedral Prismatic	ferromagnesian high-relief green silicate transparent green
62	Mineral	Apatite	Usually transparent colorless. Nonpleochroic. Weak birefringence (white-gray). Prismatic, six-sided crystals may be euhedral or subhedral. Moderate relief. May occur as either detrital grains (derived from felsic igneous rocks) or authigenic/diagenetic crystals in phosphate-rich environments.	Prismatic Moderate-relief Colorless Transparent	low-birefringence anisotropic euhedral phosphate heavy-mineral
37	Mineral	Aragonite	Transparent colorless. Nonpleochroic. Extreme birefringence. Distinguished by small (~10 um) acicular (needle-like) or rice-like grain morphology. Moderate relief, varying by direction. Twinning may be common. Organisms such as pteropods, most mollusks, and some corals produce biogenic aragonite.	Rice-shape Acicular Elongate High-birefringence	Carbonate salt transparent colorless
180	Contaminant	Backer rod			contaminant
175	Lithofacies	Banded carbonate mud			
22	Mineral	Biotite	Occurs as flakes larger than surrounding material, green to brown transparent, may be pleochroic. Low to moderate relief. Cleavage planes frequently visible as platy layers. Classic bird's eye extinction (mottled, pebbly texture) not always present in smear slide. Very low apparent birefringence (pseudo-isotropy) because flakes settle with {001} in the plane of the slide. However, by tilting the slide very slightly (e.g., by slipping another slide under the slide) one can evaluate the true birefringence (thanks to Frank Brown, U. Utah, for the tip). Biotite has strong birefringence; chlorite, which may form as an alteration product or a metamorphic mineral, can look similar to biotite in plane light but has weak birefringence.	Flaky Pseudo-isotropic Pleochroic bird's-eye-extinction	brown green layers ragged silicate mica transparent

Mostar UniqueIdentification

Id	37
Identification Type	**Mineral**
Name	Aragonite
Distinguishing Features	Rice-shape Acicular Elongate High-birefringence
Description	Transparent colorless. Nonpleochroic. Extreme birefringence. Distinguished by small (~10 um) acicular (needle-like) or rice-like grain morphology. Moderate relief, varying by direction. Twinning may be common. Organisms such as pteropods, most mollusks, and some corals produce biogenic aragonite.
Tags	Carbonate salt transparent colorless
External Resources	**Aragonite on MinDat**
Imposters	
Images	



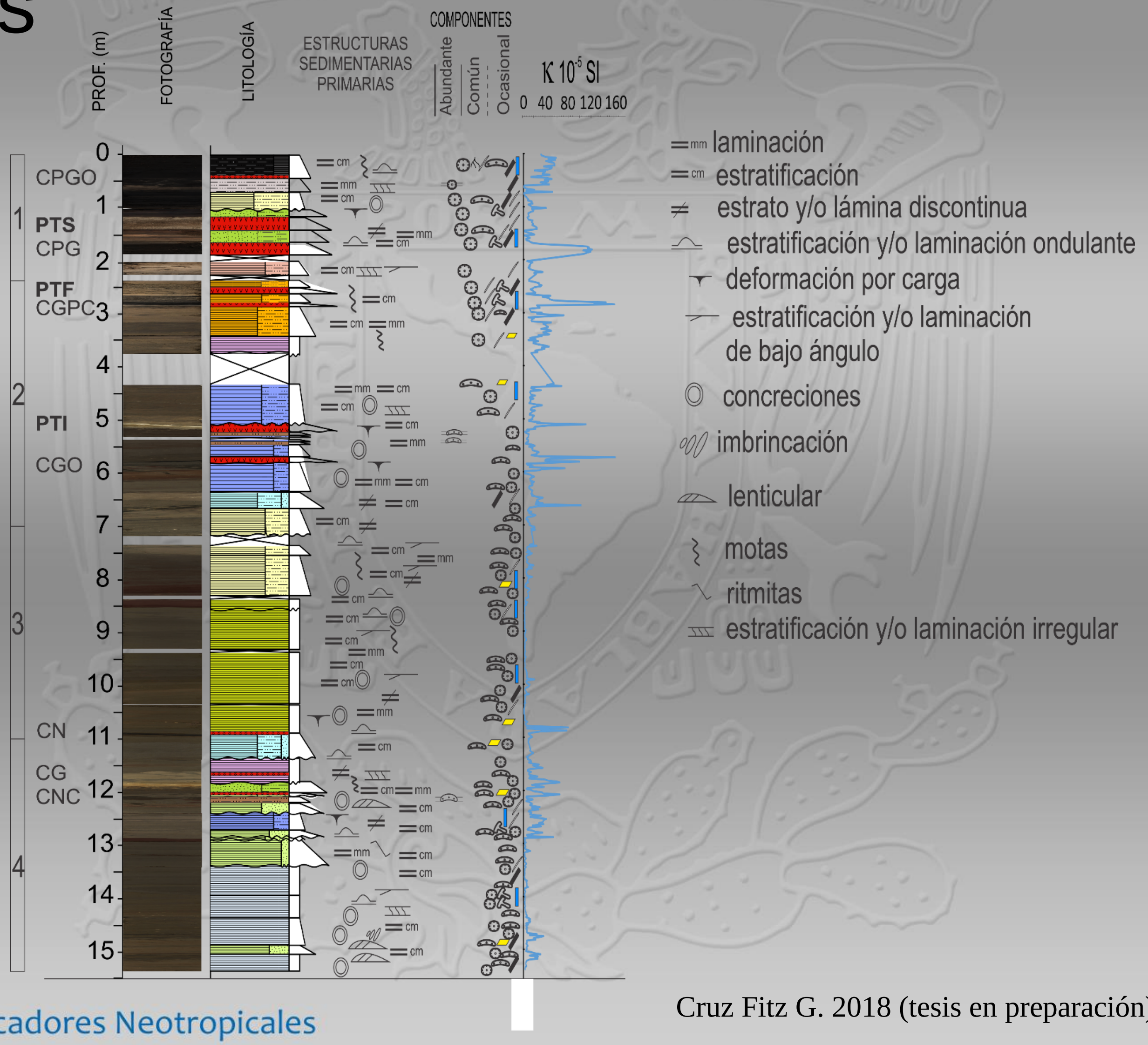
Unique Identification: Aragonite
Site name: Black Sea (43 00.29 N, 36 00.68 E)
Light type: Plane-Polarized Light
Magnification: not specified
Submitted by: Guy Rothwell
Notes: High power view of tritiform aragonite grains, resembling grains of rice or wheat, tritiform
Image Tags: none



Unique Identification: Aragonite
Site name: Black Sea (43 00.29 N, 36 00.68 E)
Light type: Cross-Polarized Light
Magnification: not specified
Submitted by: Guy Rothwell
Notes: tritiform
Image Tags: none

Figura tomada de Tucker 2011

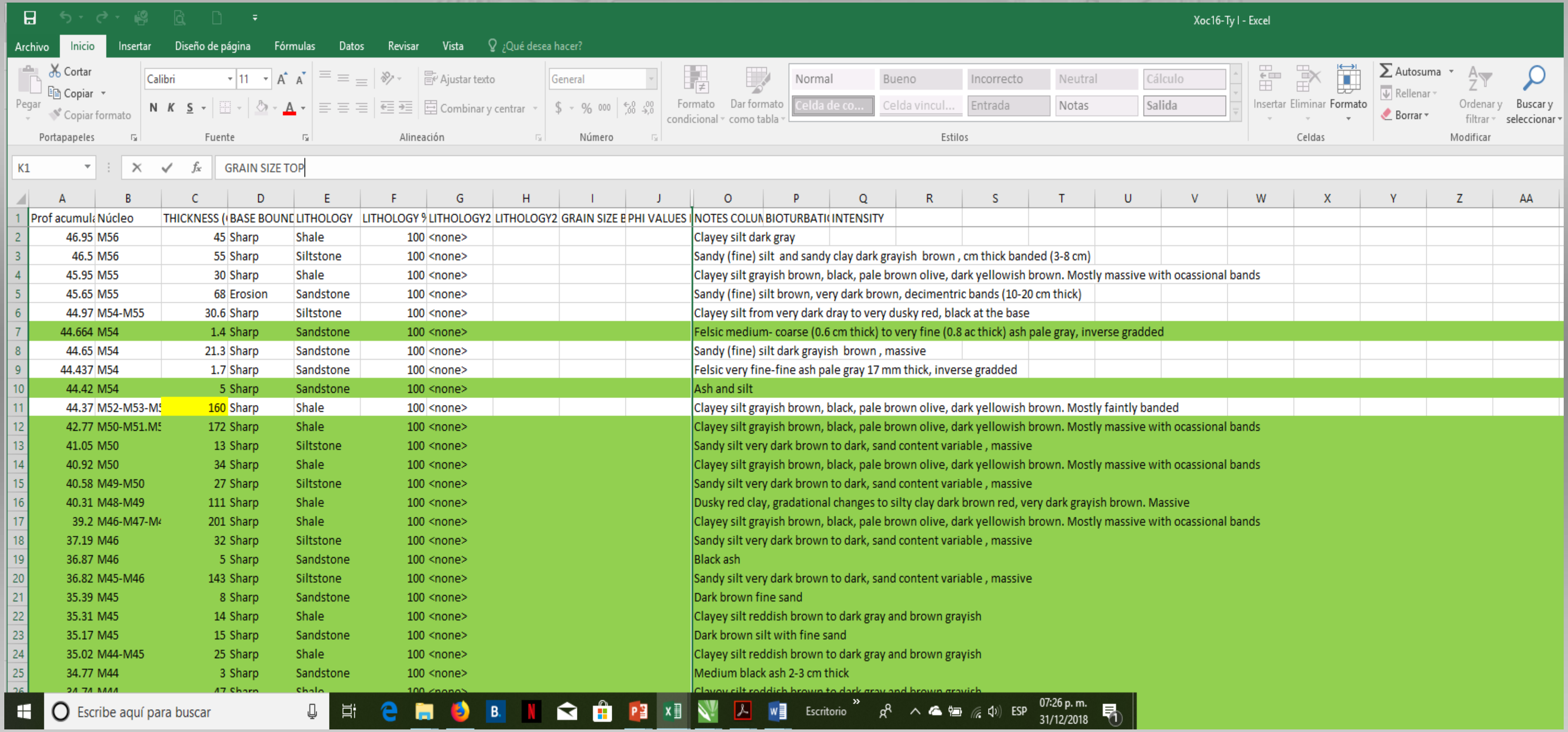
Elaboración de columnas estratigráficas, ejemplos



Cruz Fitz G. 2018 (tesis en preparación)

Sedlog, un software de libre distribución para la elaboración de columnas estratigráficas

http://sedlog.rhul.ac.uk/download.html



Xoc16-Ty I - Excel

K1 | GRAIN SIZE TOP

	A	B	C	D	E	F	G	H	I	J	O	P	Q
1	Prof acumula	Núcleo	THICKNESS (	BASE BOUND	LITHOLOGY	LITHOLOGY %	LITHOLOGY2	LITHOLOGY2	GRAIN SIZE B	PHI VALUES	NOTES COLUM	BIOTURBATIO	INTENSITY
2	46.95	M56	45	Sharp	Shale	100	<none>				Clayey silt dark gray		
3	46.5	M56	55	Sharp	Siltstone	100	<none>				Sandy (fine) silt and sandy clay dark grayish brown , cm thick banded (3-8 cm)		
4	45.95	M55	30	Sharp	Shale	100	<none>				Clayey silt grayish brown, black, pale brown olive, dark yellowish brown. Mostly massive with ocassional bands		
5	45.65	M55	68	Erosion	Sandstone	100	<none>				Sandy (fine) silt brown, very dark brown, decimentric bands (10-20 cm thick)		
6	44.97	M54-M55	30.6	Sharp	Siltstone	100	<none>				Clayey silt from very dark dray to very dusky red, black at the base		
7	44.664	M54	1.4	Sharp	Sandstone	100	<none>				Felsic medium- coarse (0.6 cm thick) to very fine (0.8 ac thick) ash pale gray, inverse gradded		
8	44.65	M54	21.3	Sharp	Sandstone	100	<none>				Sandy (fine) silt dark grayish brown , massive		
9	44.437	M54	1.7	Sharp	Sandstone	100	<none>				Felsic very fine-fine ash pale gray 17 mm thick, inverse gradded		
10	44.42	M54	5	Sharp	Sandstone	100	<none>				Ash and silt		
11	44.37	M52-M53-M5	160	Sharp	Shale	100	<none>				Clayey silt grayish brown, black, pale brown olive, dark yellowish brown. Mostly faintly banded		
12	42.77	M50-M51.M5	172	Sharp	Shale	100	<none>				Clayey silt grayish brown, black, pale brown olive, dark yellowish brown. Mostly massive with ocassional bands		
13	41.05	M50	13	Sharp	Siltstone	100	<none>				Sandy silt very dark brown to dark, sand content variable , massive		
14	40.92	M50	34	Sharp	Shale	100	<none>				Clayey silt grayish brown, black, pale brown olive, dark yellowish brown. Mostly massive with ocassional bands		
15	40.58	M49-M50	27	Sharp	Siltstone	100	<none>				Sandy silt very dark brown to dark, sand content variable , massive		
16	40.31	M48-M49	111	Sharp	Shale	100	<none>				Dusky red clay, gradational changes to silty clay dark brown red, very dark grayish brown. Massive		
17	39.2	M46-M47-M4	201	Sharp	Shale	100	<none>				Clayey silt grayish brown, black, pale brown olive, dark yellowish brown. Mostly massive with ocassional bands		
18	37.19	M46	32	Sharp	Siltstone	100	<none>				Sandy silt very dark brown to dark, sand content variable , massive		
19	36.87	M46	5	Sharp	Sandstone	100	<none>				Black ash		
20	36.82	M45-M46	143	Sharp	Siltstone	100	<none>				Sandy silt very dark brown to dark, sand content variable , massive		
21	35.39	M45	8	Sharp	Sandstone	100	<none>				Dark brown fine sand		
22	35.31	M45	14	Sharp	Shale	100	<none>				Clayey silt reddish brown to dark gray and brown grayish		
23	35.17	M45	15	Sharp	Sandstone	100	<none>				Dark brown silt with fine sand		
24	35.02	M44-M45	25	Sharp	Shale	100	<none>				Clayey silt reddish brown to dark gray and brown grayish		
25	34.77	M44	3	Sharp	Sandstone	100	<none>				Medium black ash 2-3 cm thick		

De la descripción de componentes al establecimiento de facies sedimentarias

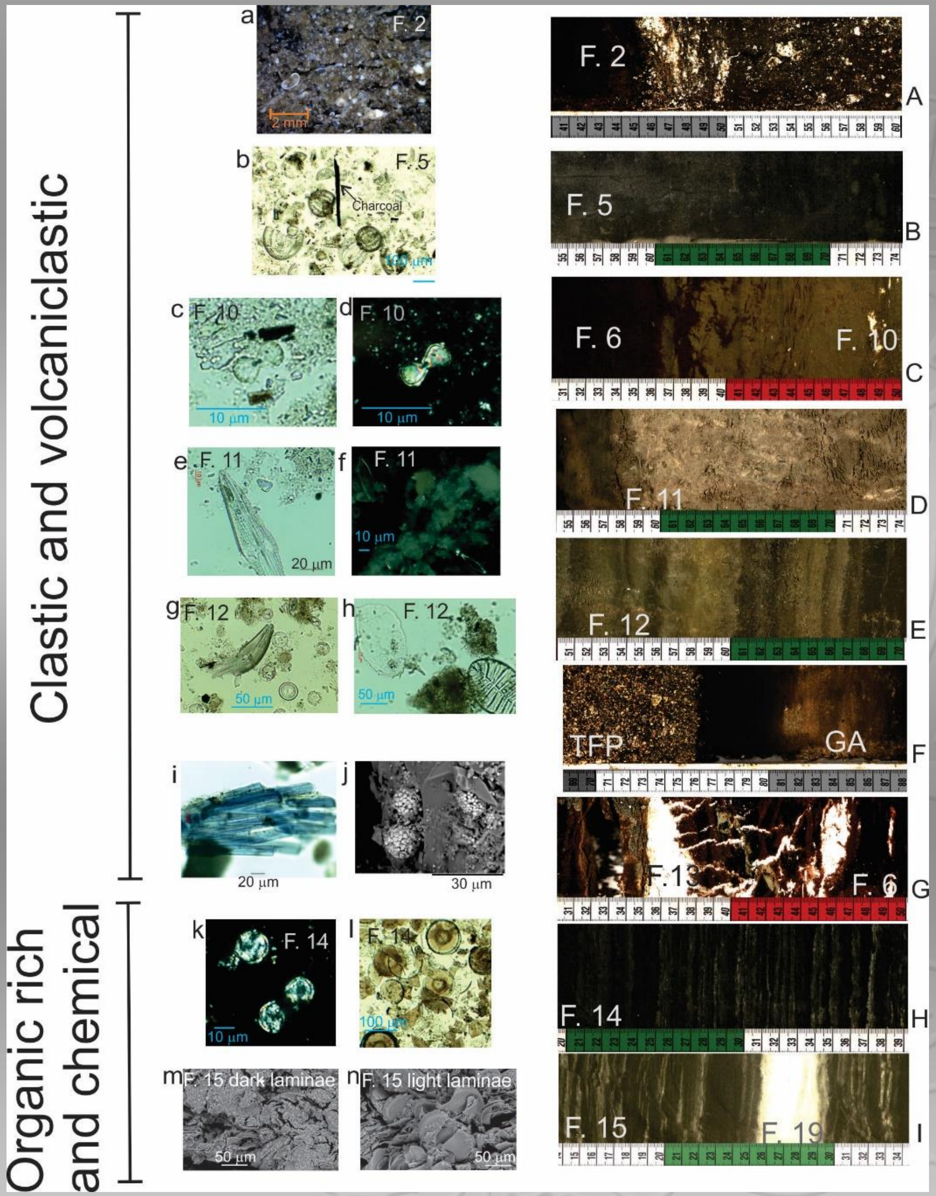
Facies—A Working Definition

The most useful modern working definition of the term “facies” was given by Middleton (1978), who noted that:

“the more common (modern) usage is exemplified by de Raaf et al. (1965) who subdivided a group of three formations into a cyclical repetition of a number of facies distinguished by “lithological, structural and organic aspects detectable in the field”. The facies may be given informal designations (“Facies A” etc.) or brief descriptive designations (“laminated siltstone facies”) and it is understood that they are units that will ultimately be given an environmental interpretation; but the facies definition is itself quite objective and based on the total field aspect of the rocks themselves… . The key to the interpretation of facies is to combine observations made on their spatial relations and internal characteristics (lithology and sedimentary structures) with comparative information from other well-studied stratigraphic units, and particularly from studies of modern sedimentary environments”.

The term facies can be used in both a descriptive and an interpretive sense. The definition above defines only the descriptive facies. However, it may be useful, as a quick means of communication, to tell a friend that you worked on a “fluvial facies”. It is understood that you have made an interpretation of the rocks you worked on, and that the term “fluvial facies” encompasses a constellation of features including (in the fluvial example) sharp-based fining-upward successions with lags at their bases, thin siltstones with root traces, abundant trough and planar tabular cross bedding, and the absence of marine indicators. It is normally obvious from the context whether the term facies is being used in a descriptive or an interpretive sense.

Walker (2006).



Ortega Guerrero et al., 2017.

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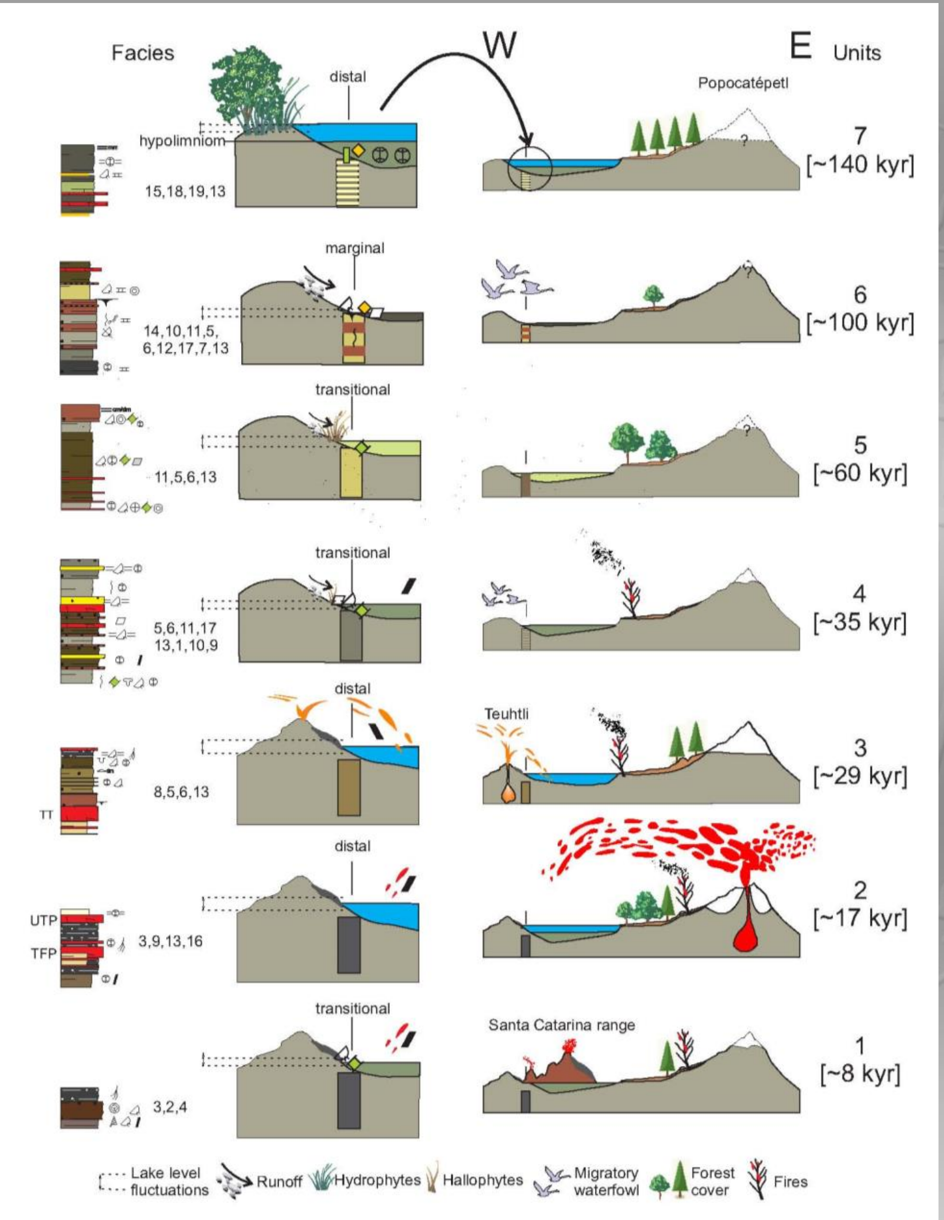
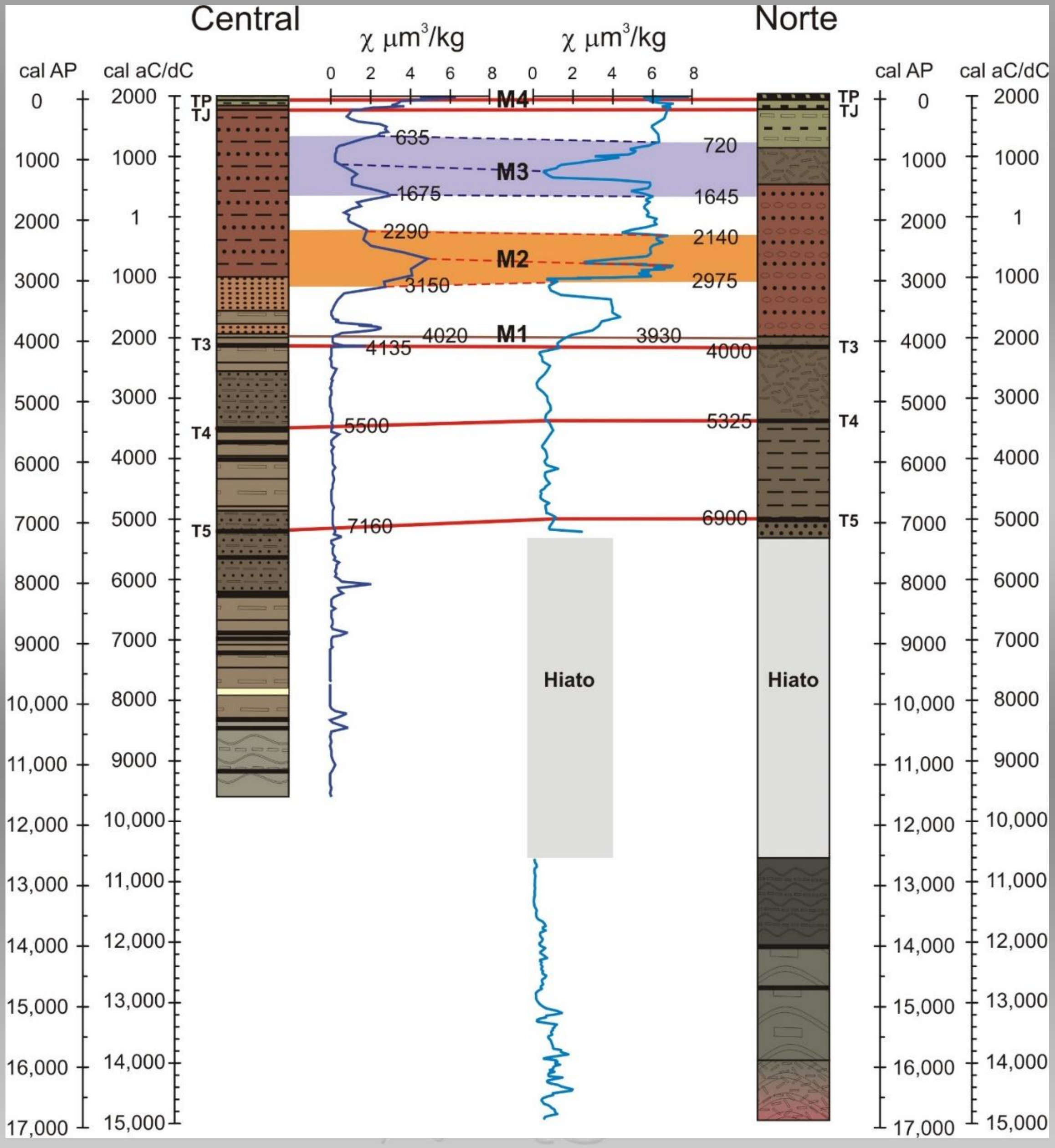
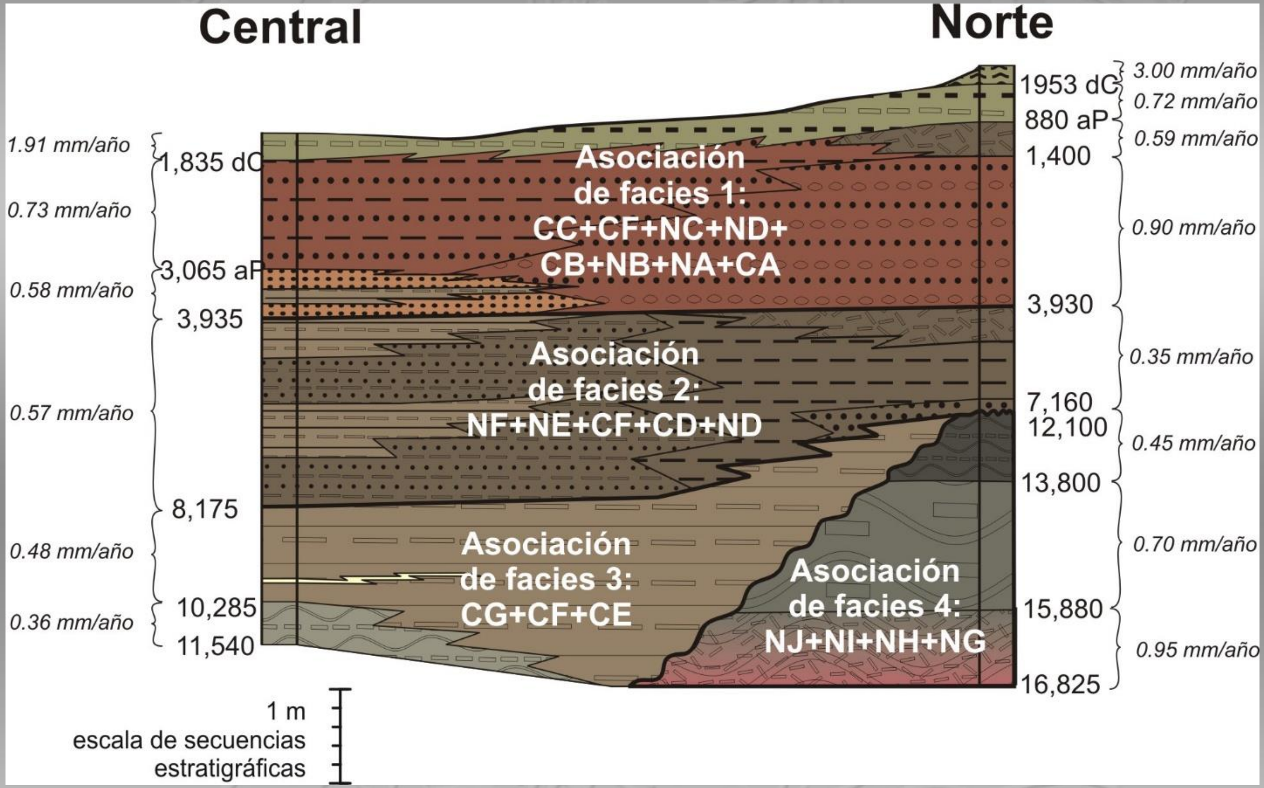


Ortega Guerrero et al., 2017.



Vázquez et al, 2010



Vázquez et al, 2010

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