

# **Preliminary Strontium Isotope Stratigraphy of the Jurassic Minas Viejas Formation, México\***

**Natalia Amezcua<sup>1</sup>, H. Rochin<sup>1</sup>, and L.E. Martínez<sup>1</sup>**

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<sup>1</sup>Mexican Geological Survey, Pachuca, Mexico ([natalia.amezcua@sgm.gob.mx](mailto:natalia.amezcua@sgm.gob.mx))

## **Abstract**

The Minas Viejas Formation consist of shallow marine evaporite and carbonate rocks, with subordinated siliciclastic, volcanic and volcanogenic beds. This stratigraphic unit mark the beginning of the marine transgression during the middle Jurassic. It overlies conformably and transitionally onto continental siliciclastic syn-rift deposits of the La Joya Formation, likely of Bajocian or pre-Bajocian age. The paleontological content used to determine Minas Viejas stratigraphic position occur in carbonate beds from the middle member of Los Cuervos (e.g. Cross, 2012), to the top of the formation, and indicate an Oxfordian to Kimmeridgian age (e.g. Zell et al., 2015). Strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) ratio data from calcite obtained from shells and whole rock samples from the basal, middle and top carbonate intervals of the Minas Viejas Formation, suggest a reappraisal for an age older than Callovian. Whole rock calcite samples from the basal carbonate, the Tranquitas member, indicate a Bajocian age ( $\approx 169$  Ma). The middle carbonate interval, the Los Cuervos member, yield ages ranging from the Bathonian to Callovian ( $\approx 168$  to  $165$  Ma). Overlying Los Cuervos member and interbedded with gypsum and limestone beds occurs volcanic and volcanoclastic deposits of the La Primavera Member, which youngest zircons yield a U-Pb age of  $164.8 \pm 1.7$  and  $163.3 \pm 2.0$  Ma (Callovian-Oxfordian; Cross, 2012). Fossiliferous carbonate in the Loma Larga member provide a Kimmeridgian age ( $153.85 \pm 1.3/-1.1$ ). The top of the Minas Viejas Formation, marked by the El Potosí member suggest deposition occurred during late Kimmeridgian or early Tithonian ( $151.15 \pm 1.15/-1.3$ ); this age range is assigned based on the error range displayed by the data and because of its stratigraphic position underlying La Caja Formation of the Kimmeridgian (Idoceras zone). Based on the obtained Strontium isotope data, the Minas Viejas Bajocian basal members (e.g. La Nieve and Tranquitas) appear to be older than initially considered. This suggest that just a segment of the evaporite and carbonate

succession of the Minas Viejas Formation (Los Cuervos member) may be coeval with the younger Callovian Louann salt (e.g. Pindell et al., 2019) in eastern Gulf of Mexico. Additional strontium data from evaporite (gypsum, anhydrite and halite) of the whole succession in Minas Viejas Formation, particularly from the basal la Nieve member, is required to better constrain age and timing of marine transgression during the middle Jurassic post-rift deposits in the Gulf of Mexico.

### **References Cited**

Cross G.H., 2012, Evaporite deformation in the Sierra Madre Oriental, northeastern Mexico: Décollement kinematics in an evaporite-detached thin-skinned fold belt, PhD Dissertation, The University of Texas at Austin, 575 p.

Pindell J., Weber B., Elrich W-H, Cossey S., Bitter M, Graham R., Erlich R., 2019, Strontium Isotope Dating of Evaporites and the Breakup of the Gulf of Mexico and Proto-Caribbean Seaway; May 19-22 2019 – 2019 AAPG Annual Convention and Exhibition, San Antonio, Texas.

Zell P., Beckmann S., Stinnesbeck W., Götze M., 2015, Mollusks of the Upper Jurassic (upper Oxfordian- lower Kimmeridgian) shallow marine Minas Viejas Formation, northeastern Mexico; Journal of South American Earth Sciences, 62, 92-18.



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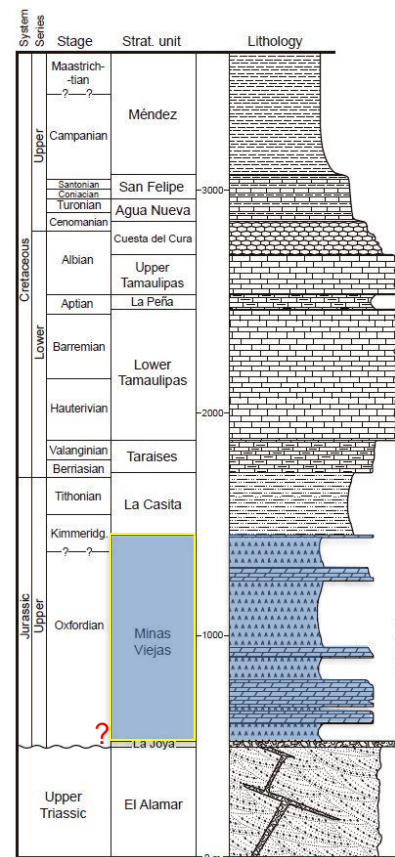
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# Preliminary Strontium Isotope Stratigraphy of the Jurassic Minas Viejas Formation, Mexico

Natalia Amezcua, Hermes Rochin and Luz E. Martínez  
Mexican Geological Survey

[natalia.amezcua@sgm.gob.mx](mailto:natalia.amezcua@sgm.gob.mx)

# Jurassic stratigraphy and the Minas Viejas Formation



(Stratigraphic column from Cross, 2012, after Michalzik, 1988, and others)

Lomas de San Pablo, Galeana, Nuevo León, west flank of Potosí uplift



# Stratigraphy and age of the Minas Viejas Formation

Era	Period	Epoch	Stage / Age	Ma
Mesozoic	Jurassic	Upper	Tithonian	152.1±0.9
			Kimmeridgian	157.3±1.0
			Oxfordian	163.5±1.0
		Middle	Callovian	166.1±1.2
			Bathonian	168.3±1.3
			Bajocian	170.3±1.4
			Aalenian	174.1±1.0
		Lower	Toarcian	182.7±0.7
			Pliensbachian	190.8±1.0
			Sinemurian	199.3±0.3
			Hettangian	201.3±0.2

Fossil taxa  
Well No. 1

## Paleontology:

*Cymatoceras*? Sp. Late Jurassic to late Oligocene  
*Cubaspidoceras*? Sp. Oxfordian?  
*Euaspidoceras*? Callovian –Oxfordian

## Lithostratigraphy:

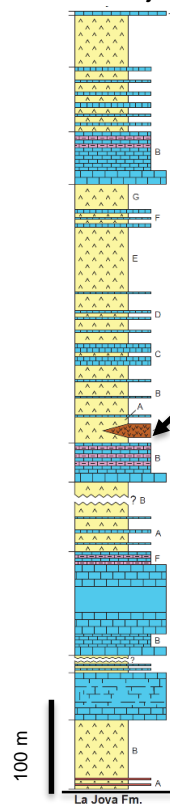
- \*Tot. thickness, carbonate members: 285 m (31%)
- \*Tot. thickness, evaporite dominated members: 635

MinasViejas No. 1 Well



4 500 m  
(López-Ramos, 1979)

Minas Viejas, Galeana\*



920 m  
(\*Cross, 2012)

## Geochronology

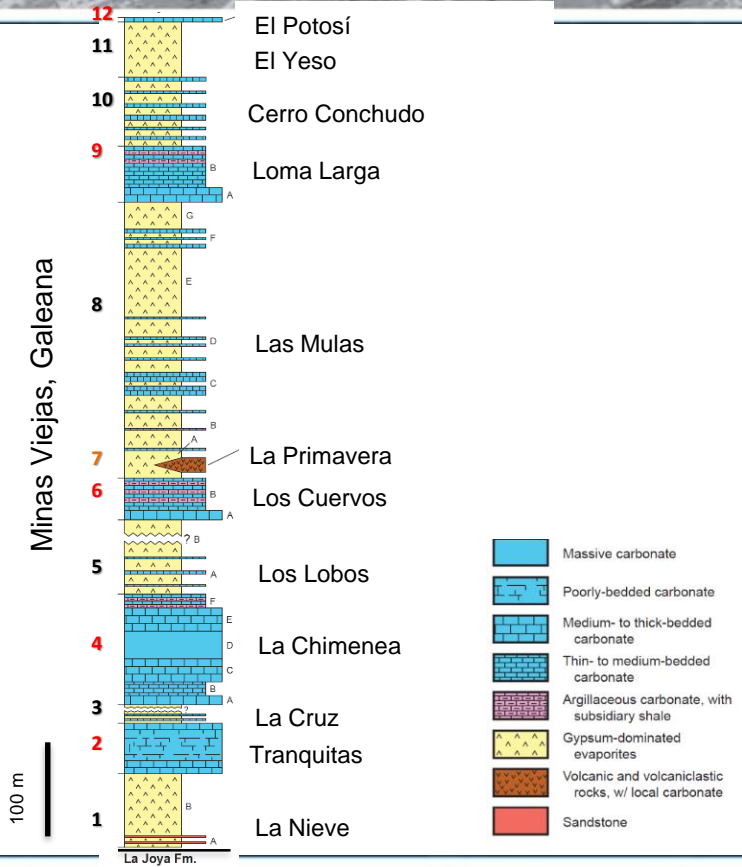
El Potosí Mmbr.  
U-Pb 164.8 Ma

Los Cuervos  
Mmbr. Fossil  
taxa

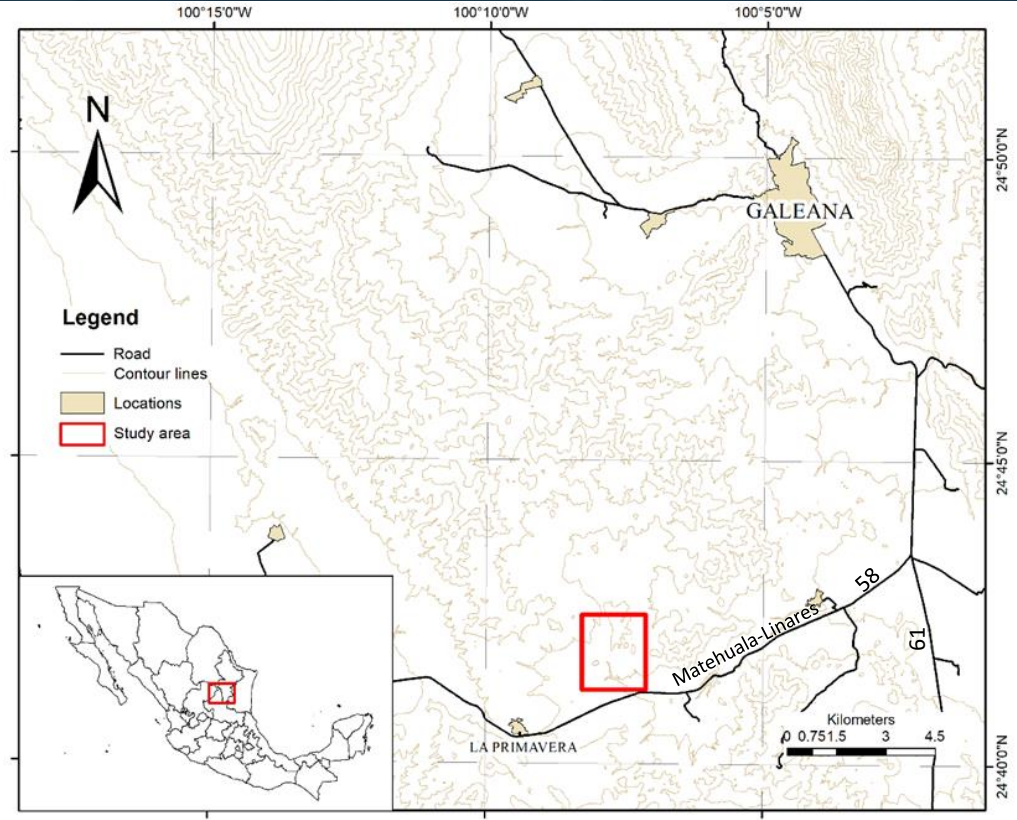
?

Middle Jurassic

# Stratigraphy and age of the Minas Viejas Formation



(Cross, 2012)





# Minas Viejas Formation, carbonate sampled locations





# Minas Viejas Formation evaporite members





# Minas Viejas Formation evaporite members

## Stromatolites in Las Mulas Member





# Minas Viejas Formation carbonate members





# Samples for strontium isotope analysis



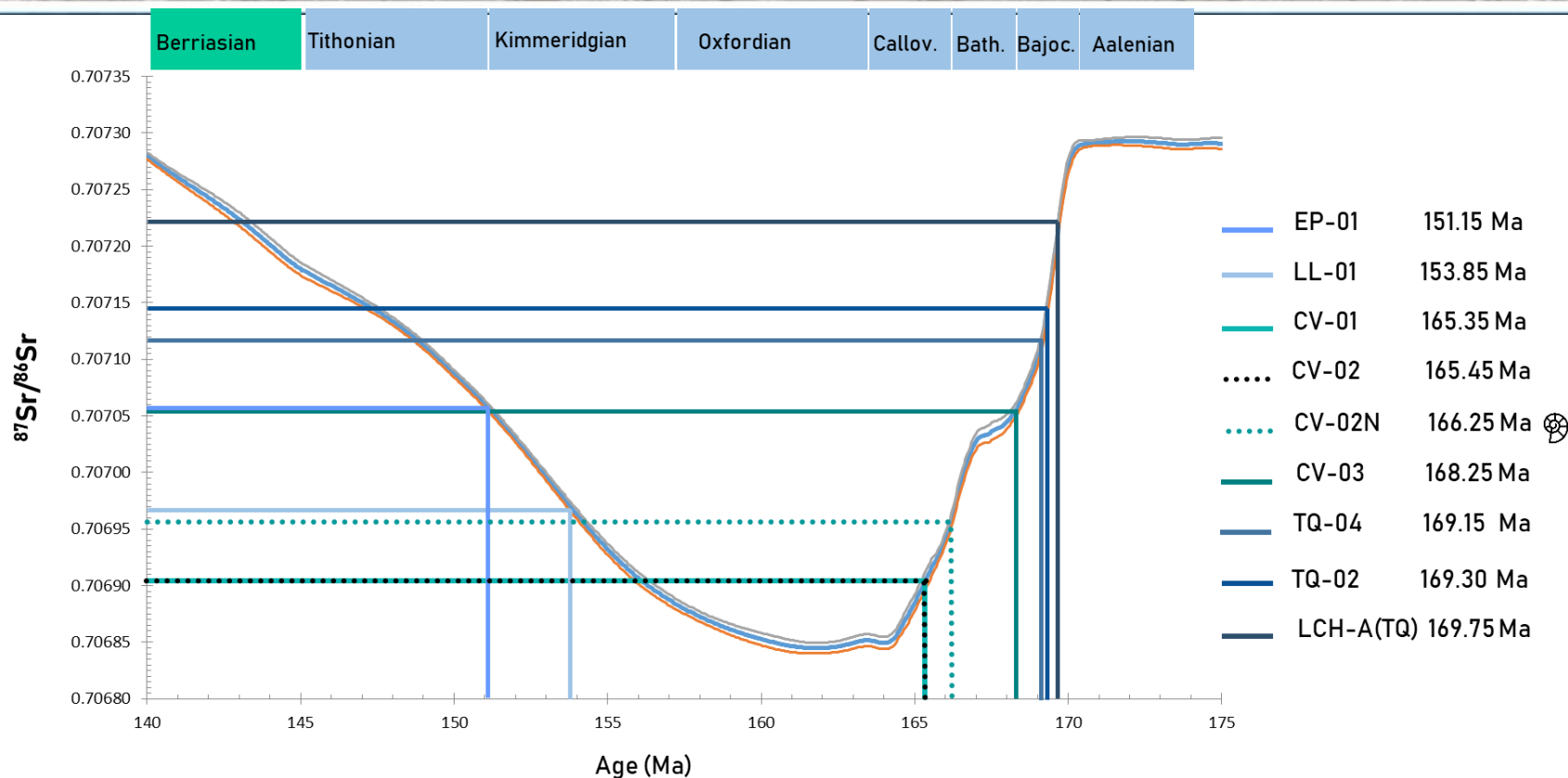
# $^{87}\text{Sr}/^{86}\text{Sr}$ analysis in carbonate samples of the Minas Viejas Formation

Sample	ID Code (LUGIS)	Material	Weight (g)	$^{87}\text{Sr}/^{86}\text{Sr}$	1 sd*	2 SE(M)	n	Ma	Error	Age
<b>TQ-02</b>	6182 HR CR	Limestone matrix	0.11926	0.707146	25	7	58	169.3	+0.2/-0.2	Bajocian
<b>TQ-04</b>	6184 HRCR	Limestone matrix	0.13764	0.707117	32	8	57	169.15	+0.2/-0.45	Bajocian
<b>LCH-A (TQ)</b>	6186 HR CR	Limestone matrix	0.12776	0.707233	31	8	56	169.75	+0.25/-0.2	Bajocian
<b>CV-03</b>	6190 HRCR	Shell calcite	0.37692	0.707055	26	7	59	168.25	+0.55/-1.9	Bathonian
<b>CV-01</b>	6187 HR CR	Shell calcite	0.26617	0.706904	27	7	57	165.35	+0.6/-0.65	Calloviaian
<b>CV-02N</b>	6189 HR CR	Shell calcite	0.11552	0.706963	26	7	57	166.25	+0.3/-0.4	Calloviaian
<b>CV-02</b>	6188 HRCR	Shell calcite	0.2558	0.706912	32	8	57	165.45	+0.65/-0.70	Calloviaian
<b>LL-01</b>	6191 HR CR	Limestone matrix	0.14344	0.706968	35	9	58	153.85	+1.3/-1.1	Kimmeridgian
<b>EP-01</b>	6192 HR CR	Limestone matrix	0.21046	0.707056	32	8	57	151.15	+1.15/-1.3	Kimm./Tithonian

Mass spectrometer TRITON PLUS. Laboratory standard NBS987:  $0.710254 \pm 12^* n = 84$ .  $n$  = number of relations measured per run (run-in ratio). 1 sd = 1 standard deviation. 2 SE(M) =  $2sd/\sqrt{n}$ . Results from the Laboratorio Universitario de Geoquímica Isotópica (LUGIS), UNAM.



# $^{87}\text{Sr}/^{86}\text{Sr}$ isotopic ratios from carbonates in the Minas Viejas Formation



Marine  $^{87}\text{Sr}/^{86}\text{Sr}$  calibration curve, McArthur et al., 2012. Strontium Isotope Stratigraphy, The Geologic Time Scale Vol. 1&2, pages 127-144.

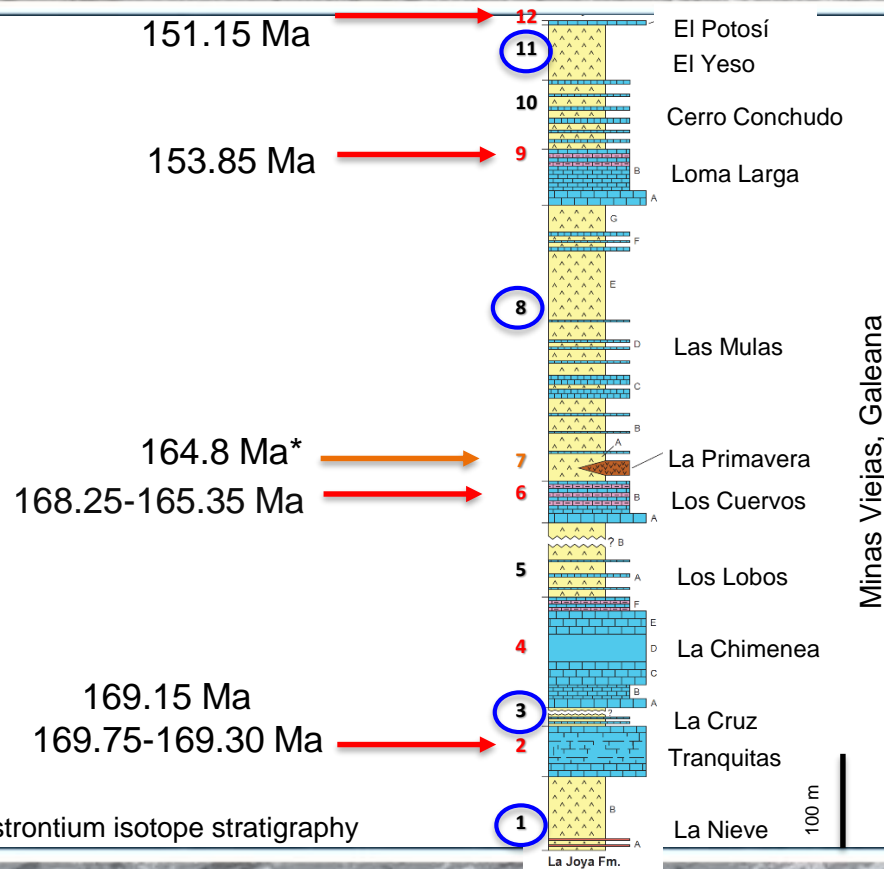
# $^{87}\text{Sr}/^{86}\text{Sr}$ Strontium Isotope stratigraphy of Minas Viejas

Concordant with other data

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			Hettangian	201.3±0.2
	TR.			

Fossil taxa

Strontium data



○ Gypsum samples for strontium isotope stratigraphy

(\*Stratigraphic column and U-PB dating from Cross, 2012)



## Final remarks

- Preliminary  $^{87}\text{Sr}/^{86}\text{Sr}$  isotope dating from carbonates at the base of Minas Viejas Formation, in Galeana region, are coeval with strontium values of Bajocian seawater.
- The age obtained by strontium isotopes is concordant with both paleontological and U-Pb zircon geochronological data within this sedimentary succession.
- The Bajocian age of the Minas Viejas Formation has potential implications to constrain the paleographic and geodynamic evolution of the Gulf of Mexico region.

## Final remarks

- Marine connections?
- Complementary strontium isotope data of the four gypsum dominated members in Minas Viejas will be compared and contrasted with results obtained from the carbonates.





[natalia.amezcua@sgm.gob.mx](mailto:natalia.amezcua@sgm.gob.mx)