A light gray map of North America, showing the outlines of the United States, Canada, and Mexico, serving as a background for the title text.

TRANSBOUNDARY AQUIFERS BETWEEN MEXICO AND THE US

Management perspectives and its transboundary nature

Rosario Sanchez

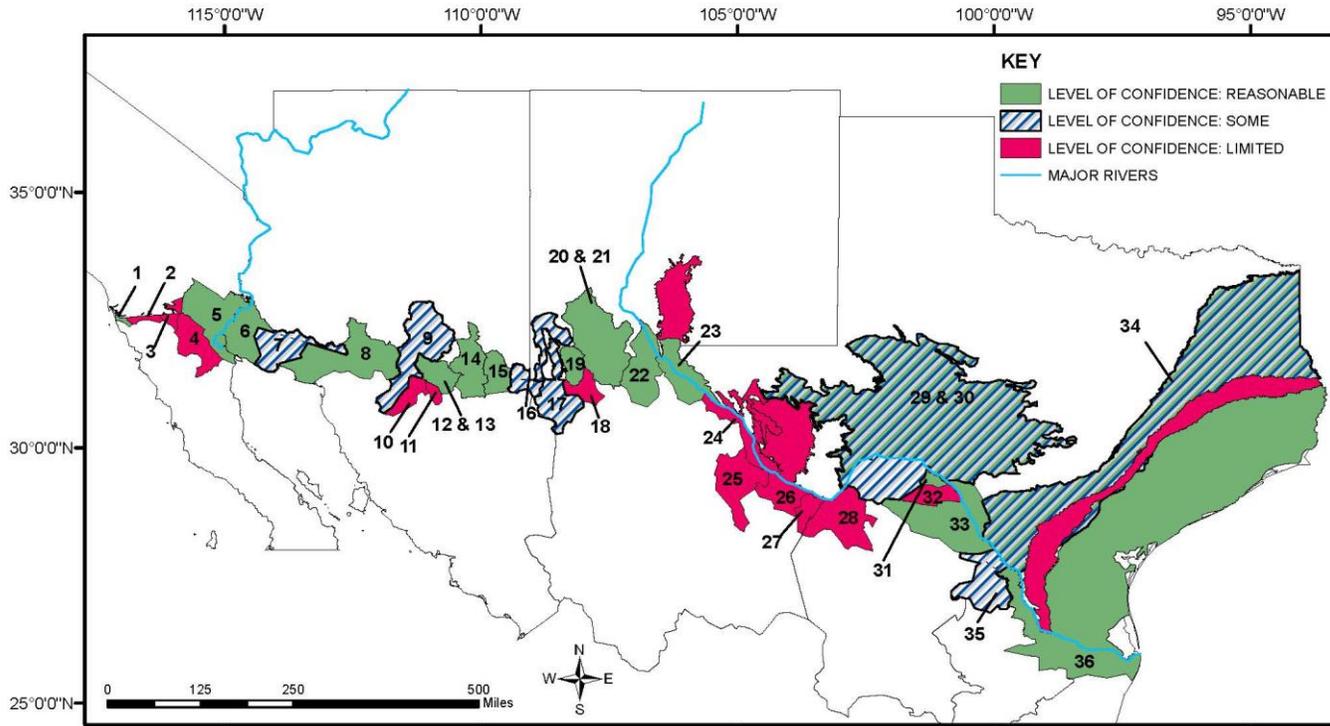
Texas Water Resources Institute, Texas A&M University

Acknowledgement: Laura Rodriguez, Graduate Research Assistant, WMHS, Texas A&M University

ORDER OF THE DAY

- Some transboundary management insights from the Mexico-US border
- Application of the **transboundariness approach**
- Current research on transboundary aquifers between Mexico and Texas: identification, classification and prioritization

THE PROBLEM



16 Confidence Level: Reasonable

- (1) Tijuana/San Diego
-(Tijuana, Otay Sweetwater and Mission system)
- (5) Cuenca Baja del Rio Colorado system:
Valle de Mexicali/ Imperial, Ogilby and Yuma Valley
- (6) Cuenca Baja del Rio Colorado system:
Valle San Luis Rio Colorado/Yuma
- (8) Sonoyta-Papagos system:
Sonoyta-Papagos/San Simon Wash
- (12) Nogales/Santa Cruz (TAAP1)
- (13) Santa Cruz/Santa Cruz-San Rafael (TAAP1)
- (14) San Pedro/San Pedro (TAAP2)
- (15) Rio Agua Prieta/Douglas (INA)
- (19) Los Moscos/ Hachita Moscos
- (20) Josefa Ortiz de Dominguez/Mimbres
- (21) Las Palmas/Mimbres

- (22) Conejos Medanos/Mesilla Bolson (TAAP3)
- (23) Valle de Juarez/Hueco Bolson (TAAP4)
- (31) Presa La Amistad/Edwards
- (33) Allende-Piedras Negras/Local aquifers
- (36) Bajo Rio Bravo/Carrizo Wilcox-Gulf Coast
(Yegua Jackson no data)

8 Confidence Level: Some

- (7) Los Vidrios/Western Mexican Drainage
- (9) Arroyo Seco/Tuscon AMA
- (16) Arroyo San Bernardino/San Bernardino Valley
-San Bernardino basin
- (17) Janos/Animas and Playas acuífer basin
- (29) Serrania del Burro/Edwards
- (30) Cerro Colorado-La Partida/Edwards
- (34) Hidalgo/Carrizo Wilcox
- (35) Lampazos/Anahuac-Carrizo Wilcox

12 Confidence Level: Limited

- (2) Tecate/Potrero Valley and Campo Valley
- (3) La Rumorosa-Tecate/Jacumba Valley and Davies Valley
- (4) Laguna Salada/Coyote Wells Valley
- (10) Rio Altar/Tucson Active Management Area
- (11) Rio Alisos/Santa Cruz
- (18) Ascencion/ Hachita Moscos
- (24) Valle del Peso/West Texas Bolsons
- (25) Bajo Rio Conchos/West Texas Bolsons
- (26) Alamo Chapo/Igneous
- (27) Manuel Benavides/Local aquifers
- (28) Santa Fe del Pino/Local aquifers
- (32) Palestina/Local aquifers

GROUNDWATER MANAGEMENT PERSPECTIVES

The problem

Mexico

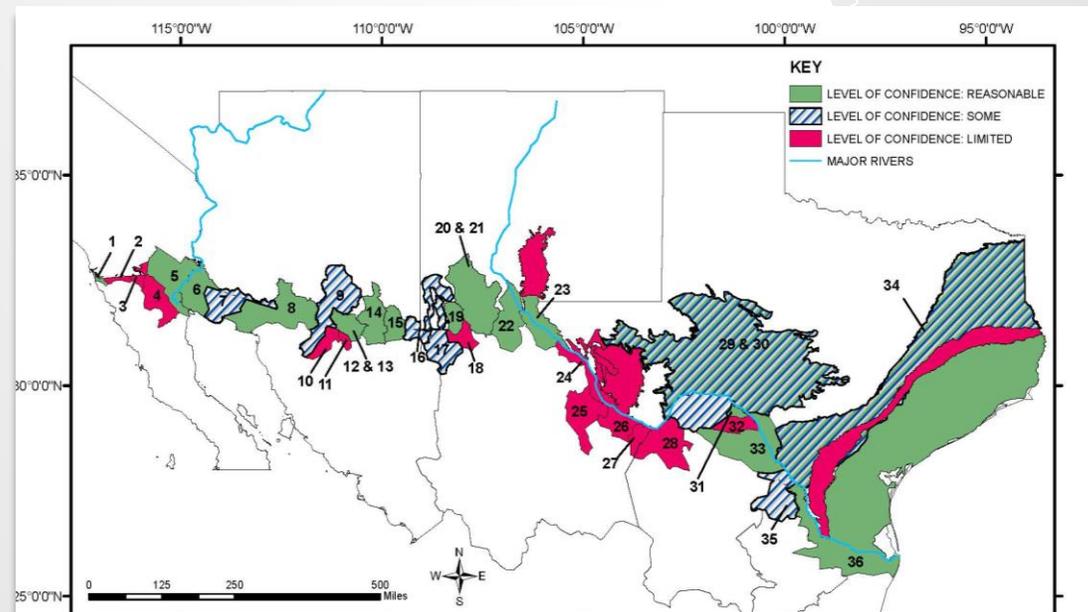
- Federal- one (Basin Councils and Cotas)
- Physical/ administrative boundaries

US

- State-multiple management
- Combination of basin, and geologic boundaries

IBWC/CILA
Not explicit authority

One aquifer, multiple binational management agencies



GROUNDWATER MANAGEMENT PERSPECTIVES

Mexico		U.S	
Veda Restrictions I,II,III	From the pacific coast to Valle de Juarez type III or II, only irrigation districts, type I	California	Management based on prioritization. Only Tijuana basin is considered Type A aquifer category, the rest low priority aquifers
	The rest of the aquifers no veda restrictions (13 aquifers)	Arizona	Groundwater priority regions. AMA areas in Santa Cruz Aquifer and INA in Douglas Aquifer Santa Cruz and San Pedro part of TAAP Los Vidrios/Mexican Drainage and Sonoyta-Papagos/Simon Wash are recognized as trans but not priority
COTAS- limited funding, representation and enforceability	Only two COTAS: Janos/Animas and Playas Aquifer Ascencion/Hachita Moscos Aquifer	New Mexico	Surface & groundwater conjunctively used Priority to water stressed basins: Mined Groundwater Basins and CMA Conejos-Medanos/Mesilla Bolson is CMA Las Palmas/Mimbres aquifer is recognized as trans but not priority
		Texas	Delegates management to GDC's. Regional Planning Groups send recommendations to TWDB. No GDC in Hueco Bolson area. Conejos Medanos/La Mesilla and Valle de Juarez/Hueco Bolson

THE TRANSBOUNDARY NATURE OF AQUIFERS or TRANSBOUNDARINESS

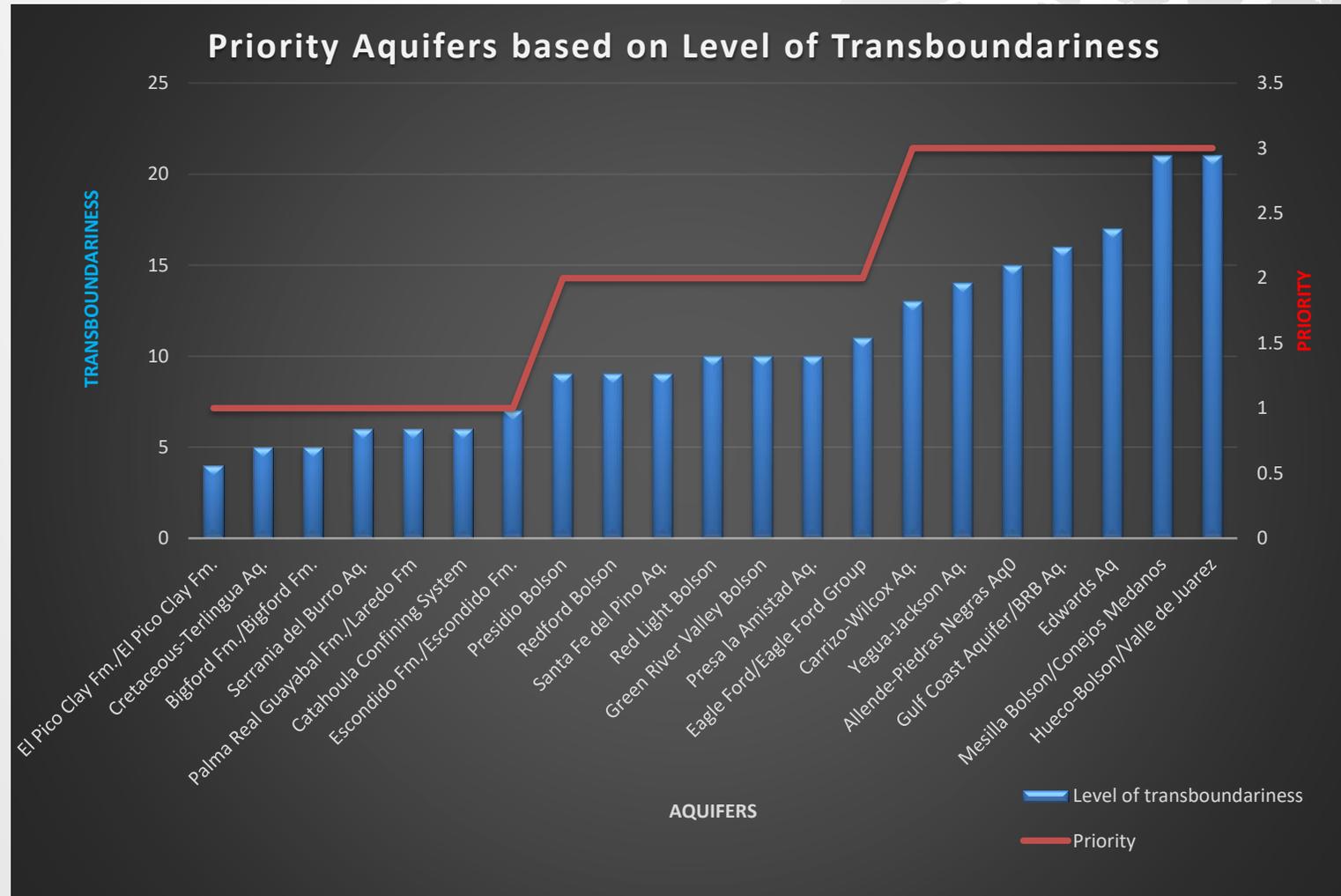
*“**The extent** to which aquifer riparians **prioritize** a particular aquifer over another and recognize **its value in the context** of economic, environmental, social, cultural, and legal institutional criteria”.*

*“A **function of the attention** that aquifer riparians give to a particular border aquifer **rather than a simple geographic or hydrologic exercise**”.*

*“The transboundary **elements related** to the aquifer drive and **extend its limits in different dimensions and at different scales**”.*

*“A **measure of the implications** of having and identifying and **aquifer that happen to be shared** by two or more countries”.*

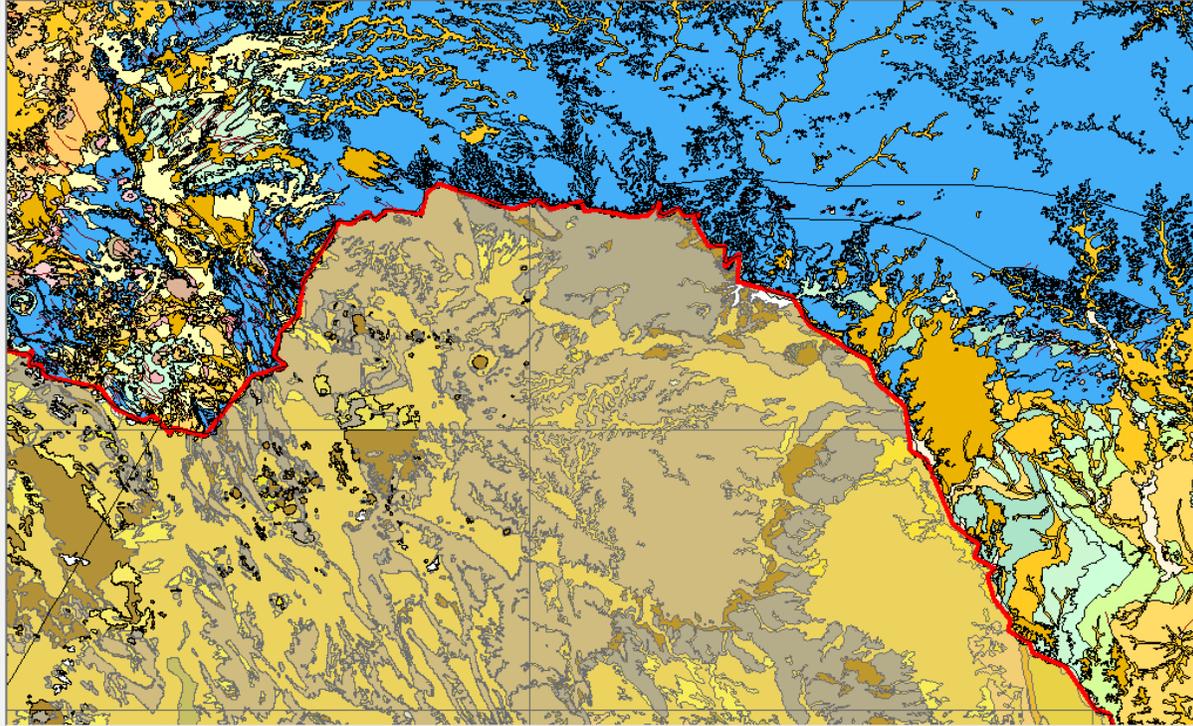
AQUIFER TRANSBOUNDARINESS



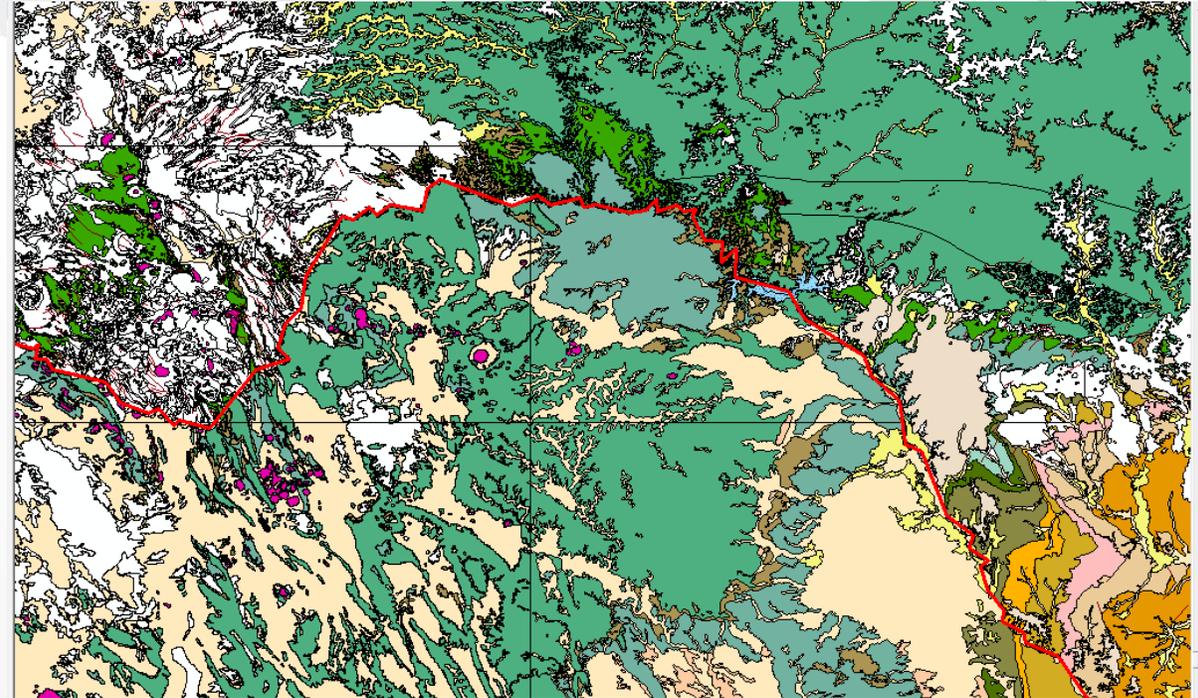
Current Research

Transboundary Aquifers between Mexico and Texas

Before...



After

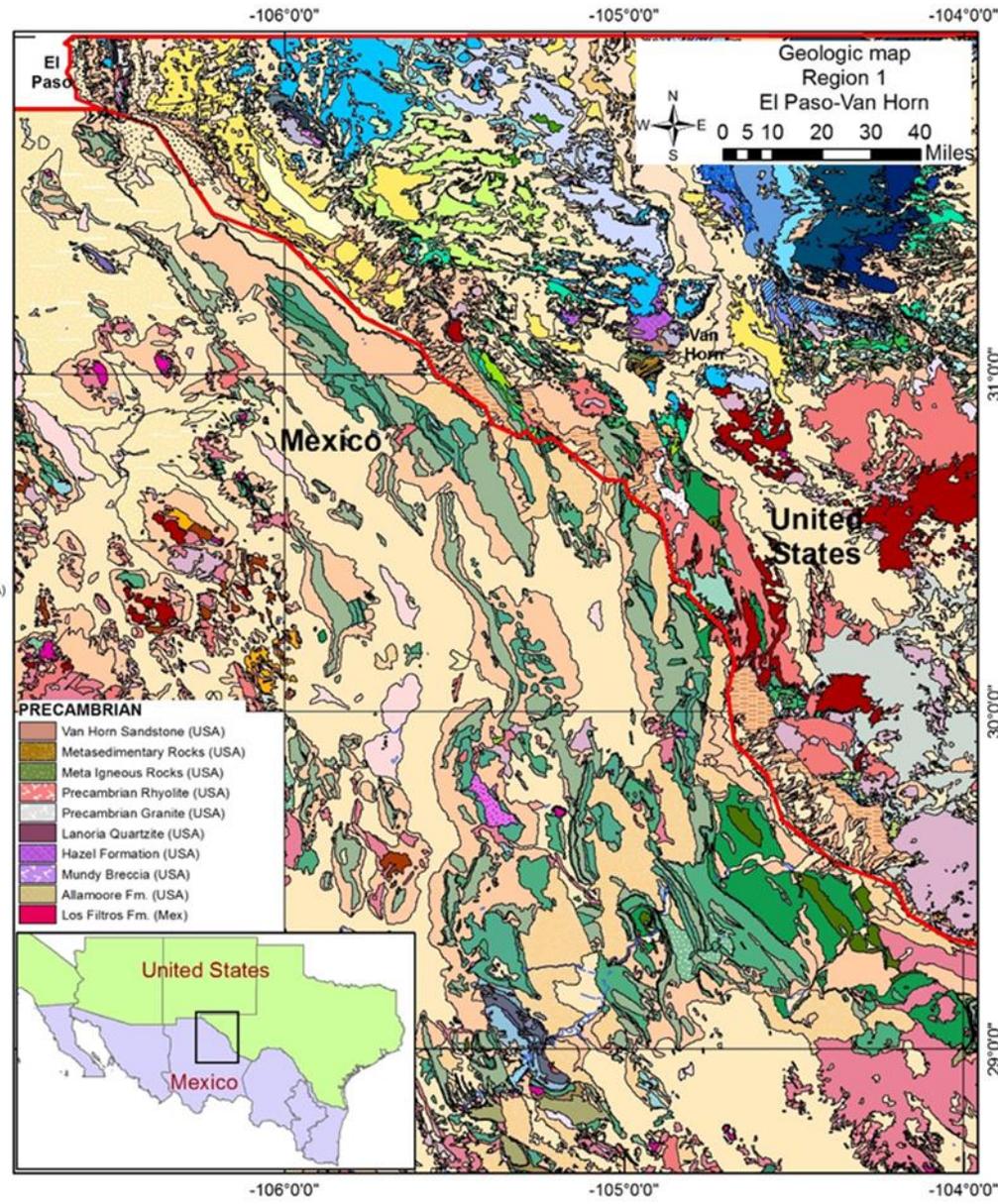


GEOLOGICAL CORRELATION

Mexico/USA Geologic Units

- Water
- Country Boundary
- CENOZOIC**
- Sand dunes/Sand Dunes
- Sand Sheet/Sand Sheet
- Qt Alluvium/Qt Alluvium
- Qt Lacustrine/Qt Lacustrine
- Qt Colluvium/Qt Colluvium
- Qt Eolic/Qt Eolic
- Qt Conglomerates/Qt Conglomerates
- Playa Deposits (USA)
- Quaternary Clay and Mud (USA)
- Gatuna Fm. (USA)
- Toy Limestone (USA)
- Qt to Tertiary Clay and Mud (USA)
- Neogene Conglomerate (Mex)
- Tertiary igneous Rocks/
Tertiary igneous Rocks
- Extrusive Igneous Rocks (USA)
- Dacitic Porphyry (Mex)
- Tertiary Basalts/Tertiary Basalts
- Ash Flow Tuff/Ash Flow Tuff
- Rhyodacite-Rhyodacitic Tuff (Mex)
- Rhyolitic Breccia (Mex)
- Rhyolitic Porphyry/Rhyolitic Porphyry
- Rhyolitic Tuff (Mex)
- Andesitic Porphyry (Mex)
- Trachyte/Trachyte
- Tonalite (Mex)
- Tarantula Gravel (USA)
- Perdiz Conglomerate (USA)
- Chisos Fm. (USA)
- Hogeve Tuff (USA)
- El Uno Formation (Mex)
- MESOZOIC**
- Cretaceous Rocks Undivided (USA)
- Formation not assigned (Mex)
- Cretaceous Conglomerate (Mex)
- Navarrete Fm. (Mex)
- Picacho Fm./Picacho Fm.
- San Carlos Fm./San Carlos Sandstone
- Aguja Fm./Aguja Fm.
- Pen Fm./Pen Fm.
- Upper Tamaulipas Fm. (Mex)
- Georgetown Fm./Georgetown Fm.
- Benigno Fm. (Mex)
- Cuchillo Fm. (Mex)
- Boquillas Fm./Boquillas Fm.
- Eagle Ford Fm./Eagle Ford Group
- Ojinaga Fm./Ojinaga Fm.
- Boracho Limestone (USA)
- Benevides Fm./Benevides Fm.
- Loma de Plata Fm./Espy Limestone
- Buda-Del Rio Fm./
Buda Limestone-Del Rio Clay
- Buda and San Martine Undivided (USA)
- Washita Group/Washita Group
- Sta Elena Fm./Sta Elena Limestone
- Del Carmen Fm./Del Carmen Limestone

- Del Canyon-Telephone Canyon Fm. (USA)
- West Nueces Fm./West Nueces Fm.
- Kiamichi Fm./Kiamichi Fm.
- Edwards Fm./Edwards Fm.
- Finlay Formation (USA)
- Cox Sandstone (USA)
- Yearwood Fm. (USA)
- Bluff Mesa Fm. (USA)
- Campagrande Fm. (USA)
- La Pena Fm./Yucca Fm.
- Shafter Fm. (USA)
- Presidio Fm. (USA)
- Etholen Fm. (USA)
- Torcer Formation (USA)
- Aurora Fm./Glen Rose Fm.
- Cupido-Las Vigas Fm. (Mex)
- Malone Formation (USA)
- La Casita Fm. (Mex)
- Triassic-Jurassic conglomerate (Mex)
- PALEOZOIC**
- Pastor Fm. (Mex)
- Plomosas Fm. (Mex)
- Verde Fm. (Mex)
- Monillas Fm. (Mex)
- Dewey Lake Fm. (USA)
- Rustler-Castile Fm. Undivided (USA)
- Rustler Fm. (USA)
- Castile Fm. (USA)
- Bell Canyon-Brushy Canyon Undivided (USA)
- Brusky Creek Fm. (USA)
- Carlsbad Group (USA)
- Capitan Limestone (USA)
- Bell Canyon Fm. (USA)
- Cherry Canyon Fm. (USA)
- Word Fm. (USA)
- Yates Fm. (USA)
- Goat Seep Limestone (USA)
- Munn Fm. (USA)
- Briggs Fm. (USA)
- Cutoff Shale (USA)
- Mina Grande Fm. (USA)
- Seven Rivers Fm. (USA)
- Ross Mine Fm. (USA)
- Pinto Canyon Fm. (USA)
- Victorio Peak Fm. (USA)
- Bone Spring Limestone (USA)
- Leonardian Rocks Undivided (USA)
- Hueco Limestone (USA)
- Alta Fm. (USA)
- Magdalena Fm. (USA)
- Mississippian and Devonian Rocks/
Mississippian and Devonian Rocks
- Fusselman Dolomite (USA)
- Paleozoic Rocks Undivided (USA)
- Sostenes Fm./Montoya Dolomite
- Cieneguita Fm. (USA)
- Ordovician Undivided (USA)
- Marathon-Dagger Flat Fm. (USA)
- Cambrian-Carboniferous Rocks (Mex)

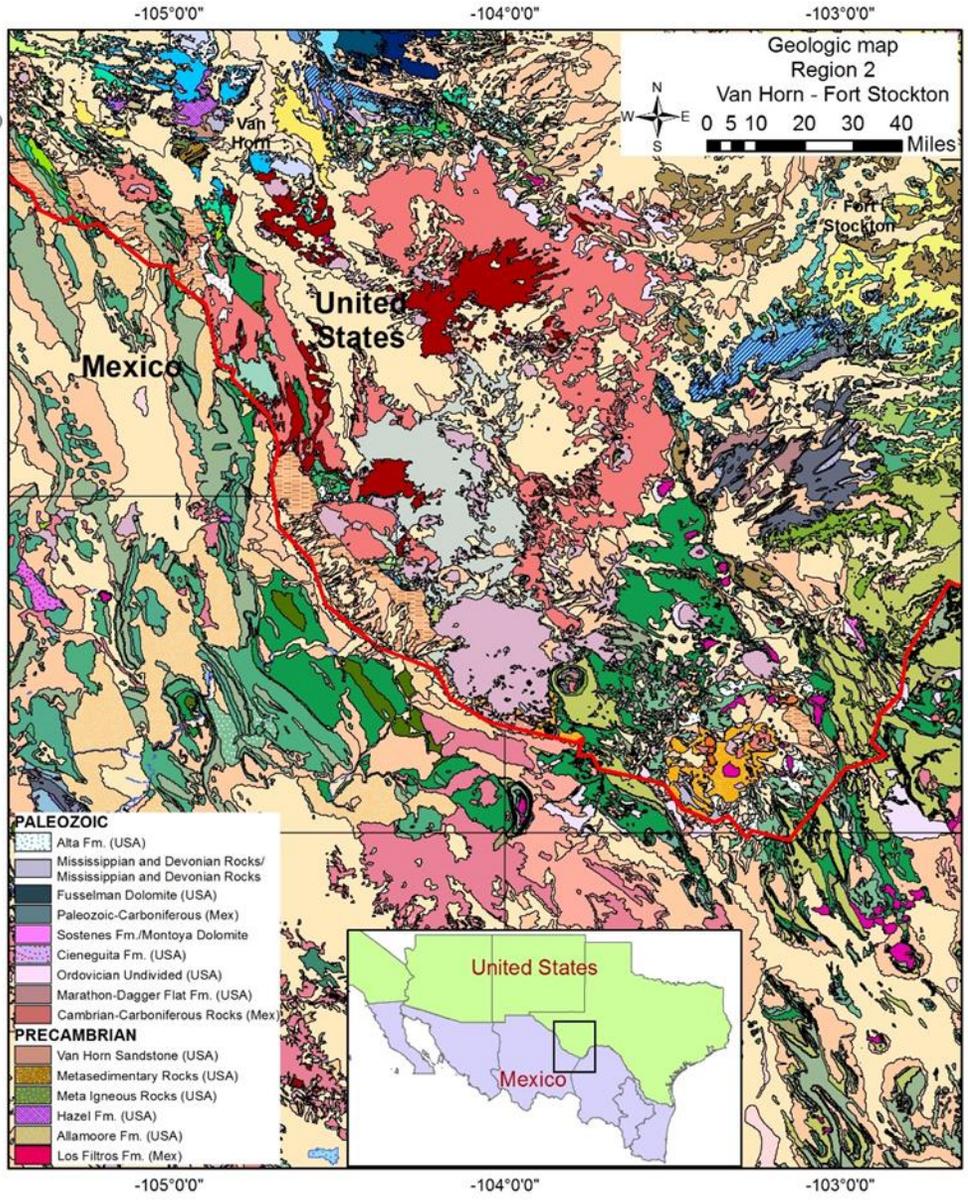


GEOLOGICAL CORRELATION

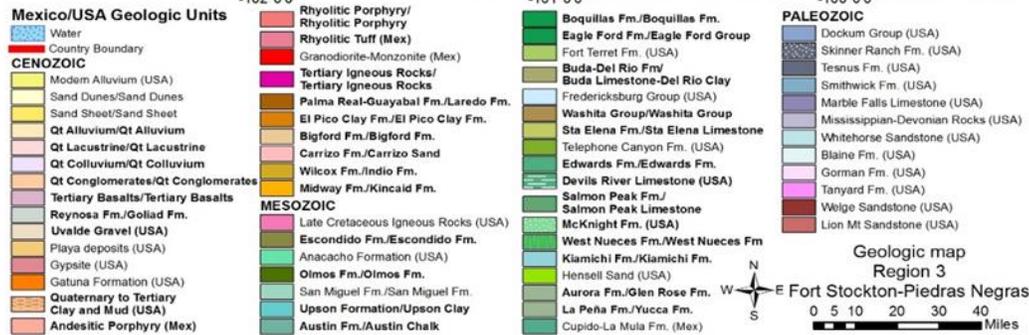
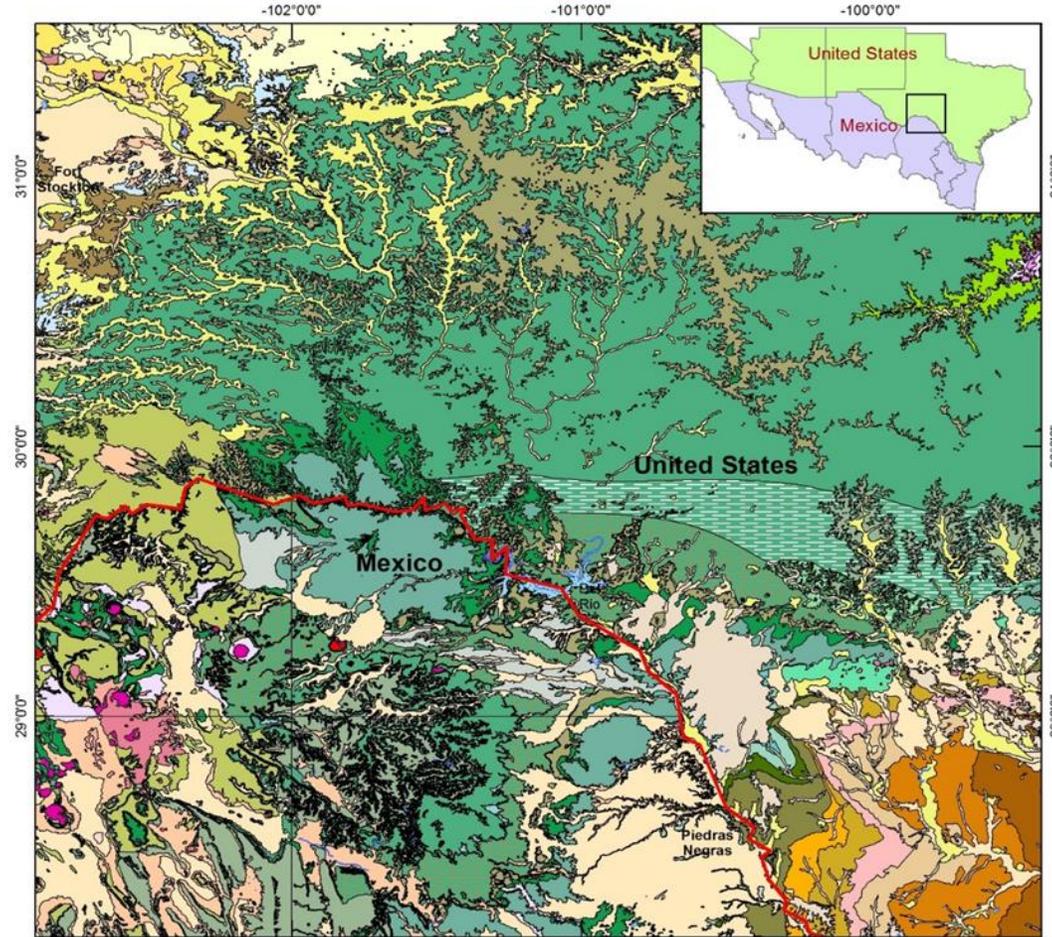
Mexico/USA Geologic Units

- Water
- Country Boundary
- CENOZOIC**
- Modern Alluvium (USA)
- Sand dunes/Sand Dunes
- Sand Sheet/Sand Sheet
- Qt Alluvium/Qt Alluvium
- Qt Lacustrine/Qt Lacustrine
- Qt Colluvium/Qt Colluvium
- Qt Conglomerates/Qt Conglomerates
- Playa Deposits (USA)
- Quaternary Clay and Mud (USA)
- Evaporites (USA)
- Gypsite (USA)
- Tahoka Fm. (USA)
- Gatuna Fm. (USA)
- Toy Limestone (USA)
- Qt to Tertiary Clay and Mud (USA)
- Neogene Conglomerate (Mex)
- Tertiary Igneous Rocks/ Tertiary Igneous Rocks**
- Extrusive Igneous Rocks (USA)
- Dacitic Porphyry (Mex)
- Tertiary Basalts/Tertiary Basalts**
- Ash Flow Tuff/Ash Flow Tuff
- Rhyodacite-Rhyodacitic Tuff (Mex)
- Rhyolitic Breccia (Mex)
- Rhyolitic Porphyry/Rhyolitic Porphyry
- Rhyolitic Tuff (Mex)
- Andesitic Porphyry (Mex)
- Trachyte/Trachyte
- Quartzmonzonite (Mex)
- Fingers Fm. (USA)
- Tarantula Gravel (USA)
- Perdz Conglomerate (USA)
- Chisos Fm. (USA)
- Hogeys Tuff (USA)
- Hannold Hill Fm. (USA)
- Black Peaks Fm. (USA)
- MESOZOIC**
- Javelina Fm. (USA)
- Cretaceous Rocks Undivided (USA)
- Formation not assigned (Mex)
- Cretaceous Conglomerate (Mex)
- Navarrete Fm. (Mex)
- Picacho Fm./Picacho Fm.
- San Carlos Fm./San Carlos Sandstone
- Aguja Fm./Aguja Fm.
- Pen Fm./Pen Fm.
- Austin Fm./Austin Chalk
- Upper Tamaulipas Fm. (Mex)
- Georgetown Fm./Georgetown Fm.
- Benigno Fm. (Mex)
- Cuchillo Fm. (Mex)
- Boquillas Fm./Boquillas Fm.
- Eagle Ford Fm./Eagle Ford Group
- Ojinaga Fm./Ojinaga Fm.
- Boracho Limestone (USA)
- Benevides Fm./Benevides Fm.
- Loma de Plata Fm./Espy Limestone

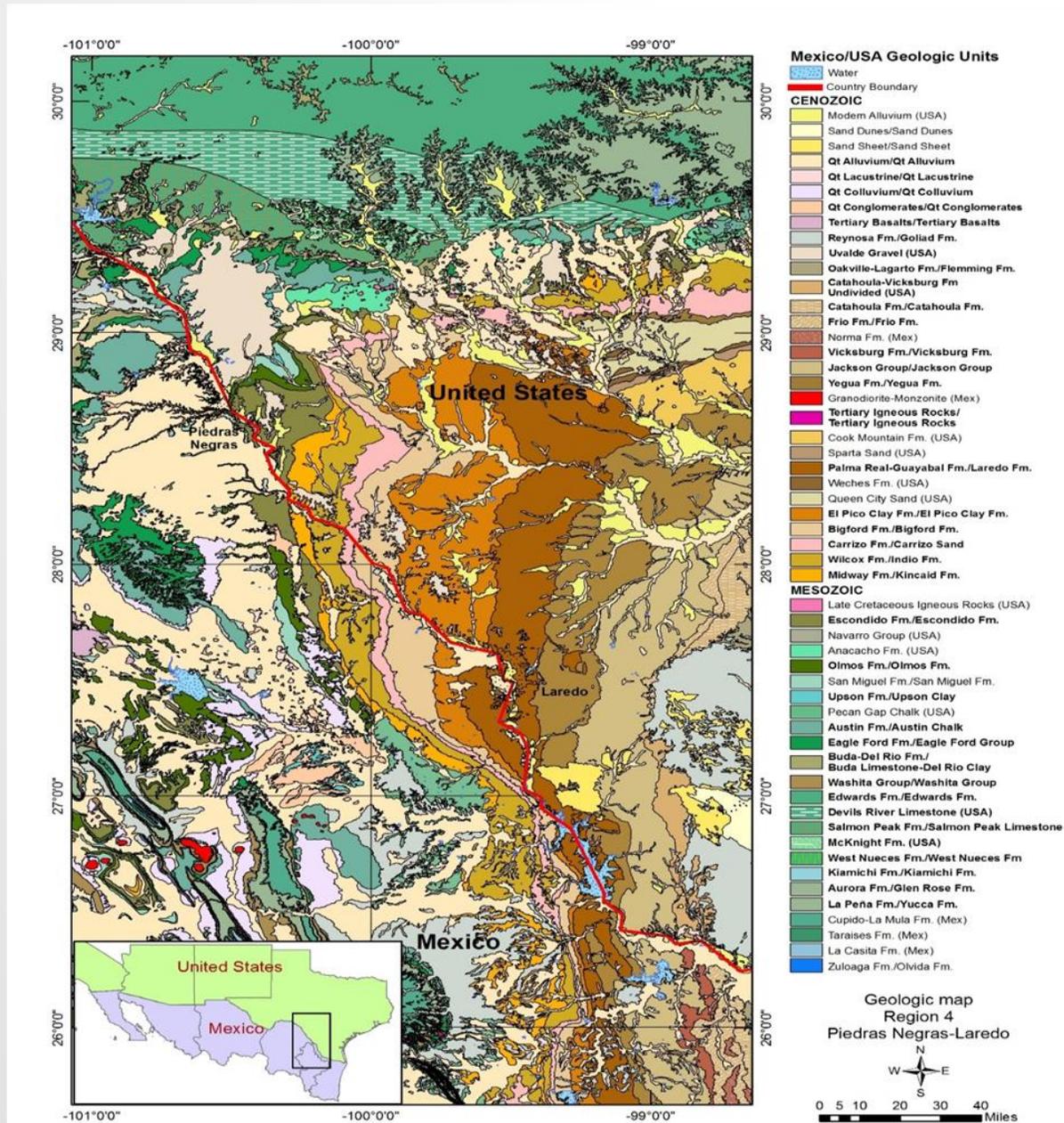
- Buda-Del Rio Fm./ Buda Limestone-Del Rio Clay
- Buda and San Martine Undivided (USA)
- Washita Group/Washita Group
- Sta Elena Fm./Sta Elena Limestone
- Del Carmen Fm./Del Carmen Limestone
- Del Canyon-Telephone Canyon Fm. (USA)
- West Nueces Fm./West Nueces Fm.
- Salmon Peak Fm./ Salmon Peak Limestone
- Kiamichi Fm./Kiamichi Fm.
- Edwards Fm./Edwards Fm.
- Finlay Formation (USA)
- Fredericksburg Group (USA)
- Fort Terret Member (USA)
- Puerto Rico Fm. (Mex)
- Cox Sandstone (USA)
- Yearwood Fm. (USA)
- Bluff Mesa Fm. (USA)
- Campgrande Fm. (USA)
- La Pena Fm./Yucca Fm.
- Shafter Fm. (USA)
- Presidio Fm. (USA)
- Aholen Fm. (USA)
- Aurora Fm./Glen Rose Fm.
- Trinity Group Undivided (USA)
- Bissett Conglomerate (USA)
- Cupido-Las Vigas Fm. (Mex)
- La Casita Fm. (Mex)
- Dockum Group Undivided (Mex)
- PALEOZOIC**
- Pastor Fm. (Mex)
- Plomosas Fm. (Mex)
- Verde Fm. (Mex)
- Monillas Fm. (Mex)
- Dewey Lake Fm. (USA)
- Skinner Ranch Fm. (USA)
- Rustler Fm. (USA)
- Castile Fm. (USA)
- Capitan Limestone (USA)
- Bell Canyon Fm. (USA)
- Cherry Canyon Fm. (USA)
- Tansill Fm. (USA)
- Tessey Limestone (USA)
- Word Fm. (USA)
- Yates Fm. (USA)
- Cathedral Mountain Fm. (USA)
- Nealranch Fm. (USA)
- Gaptank Fm. (USA)
- Haymond Fm. (USA)
- Dimple Limestone (USA)
- Tesnus Fm. (USA)
- Munn Fm. (USA)
- Cutoff Shale (USA)
- Mina Grande Fm. (USA)
- Seven Rivers Fm. (USA)
- Ross Mine Fm. (USA)
- Pinto Canyon Fm. (USA)
- Victorio Peak Fm. (USA)
- Bone Spring Limestone (USA)
- Hueco Limestone (USA)
- PALEOZOIC**
- Alta Fm. (USA)
- Mississippian and Devonian Rocks/ Mississippian and Devonian Rocks
- Fusselman Dolomite (USA)
- Paleozoic-Carboniferous (Mex)
- Sostenes Fm./Montoya Dolomite
- Cieneguita Fm. (USA)
- Ordovician Undivided (USA)
- Marathon-Dagger Flat Fm. (USA)
- Cambrian-Carboniferous Rocks (Mex)
- PRECAMBRIAN**
- Van Horn Sandstone (USA)
- Metasedimentary Rocks (USA)
- Meta Igneous Rocks (USA)
- Hazel Fm. (USA)
- Allamore Fm. (USA)
- Los Filtros Fm. (Mex)



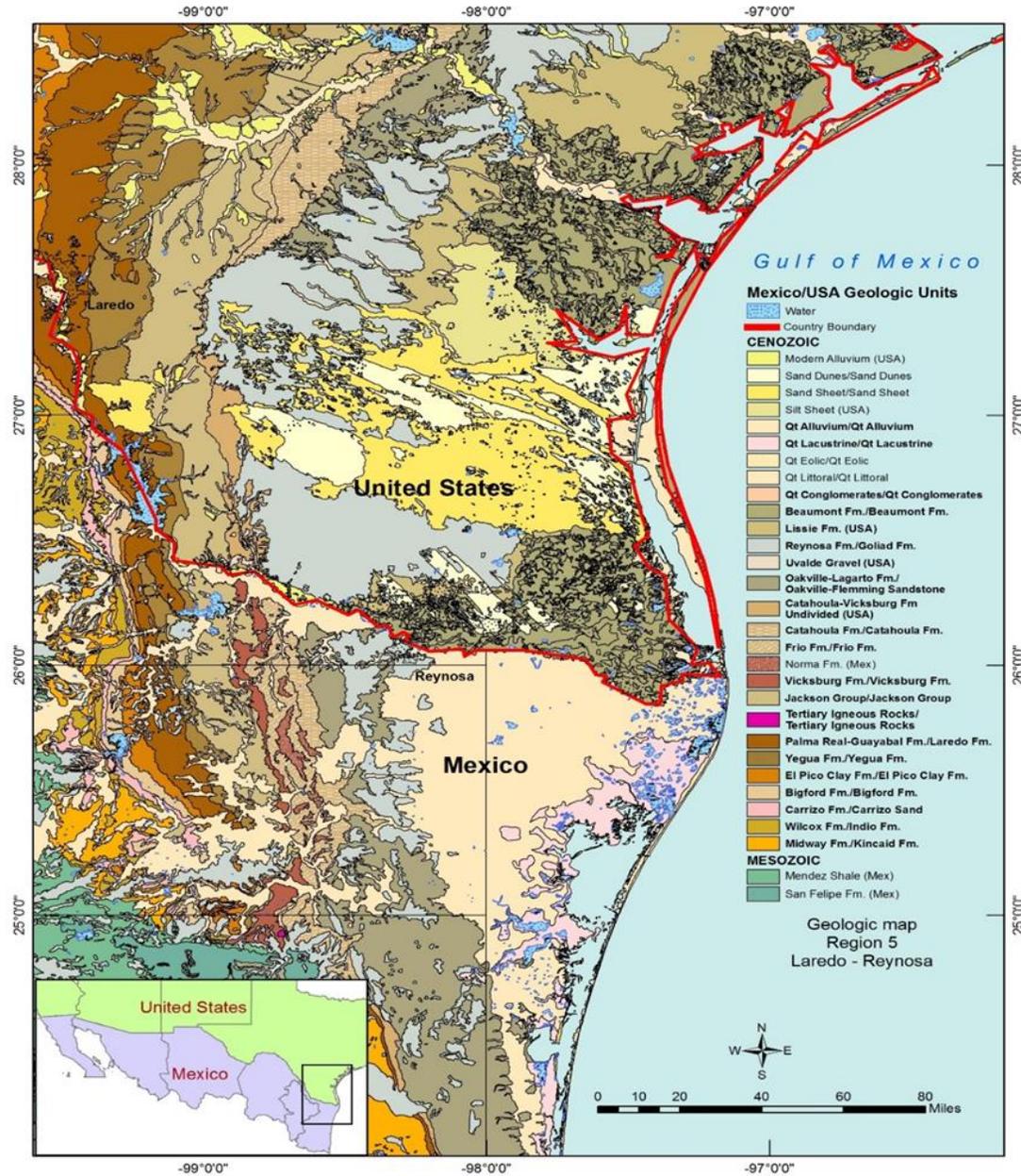
GEOLOGICAL CORRELATION



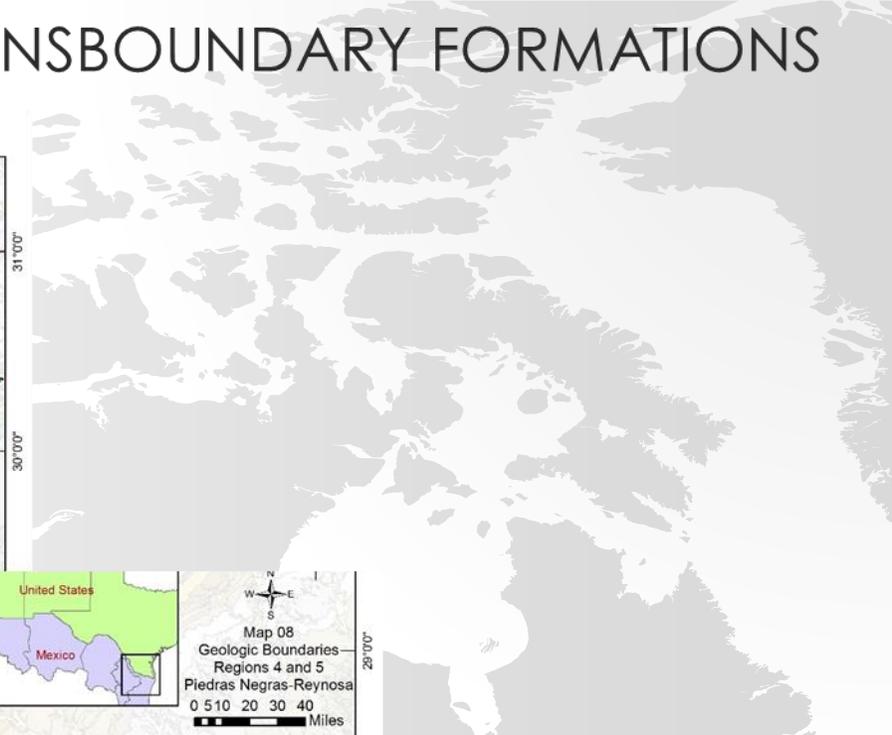
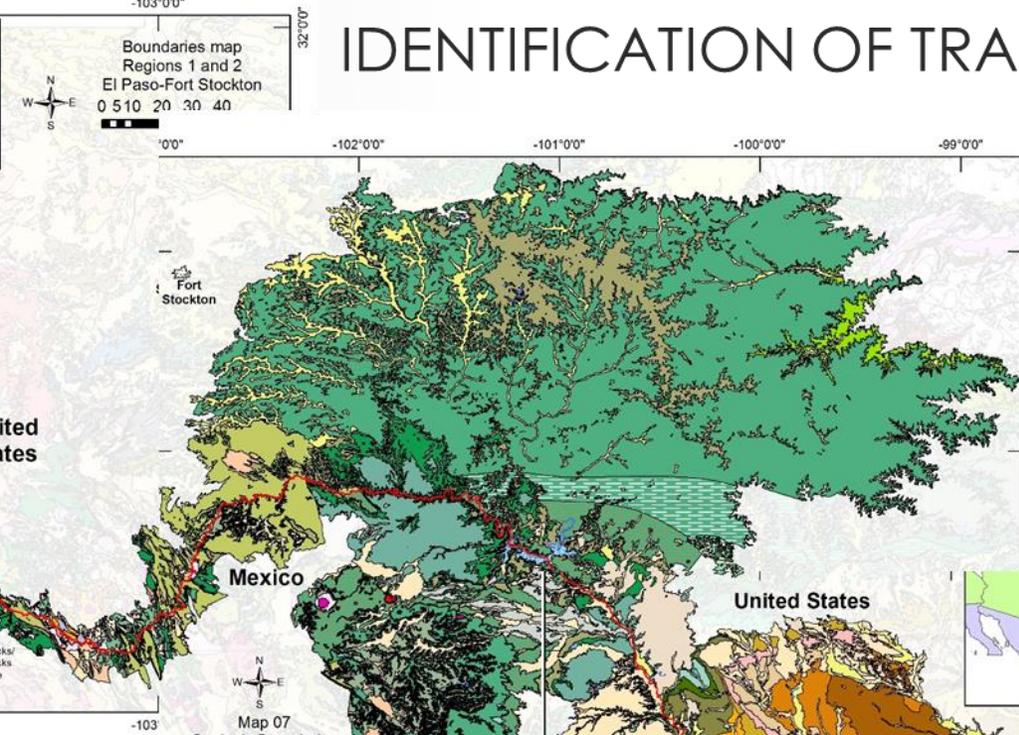
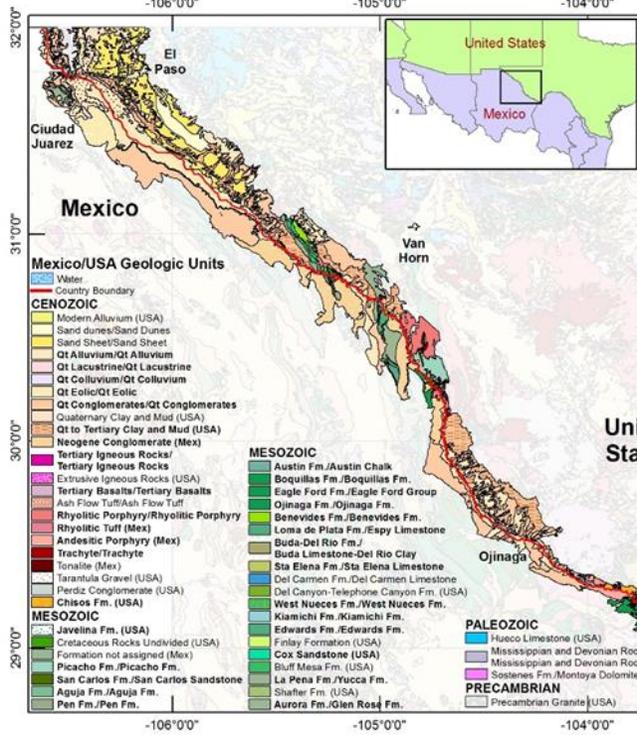
GEOLOGICAL CORRELATION



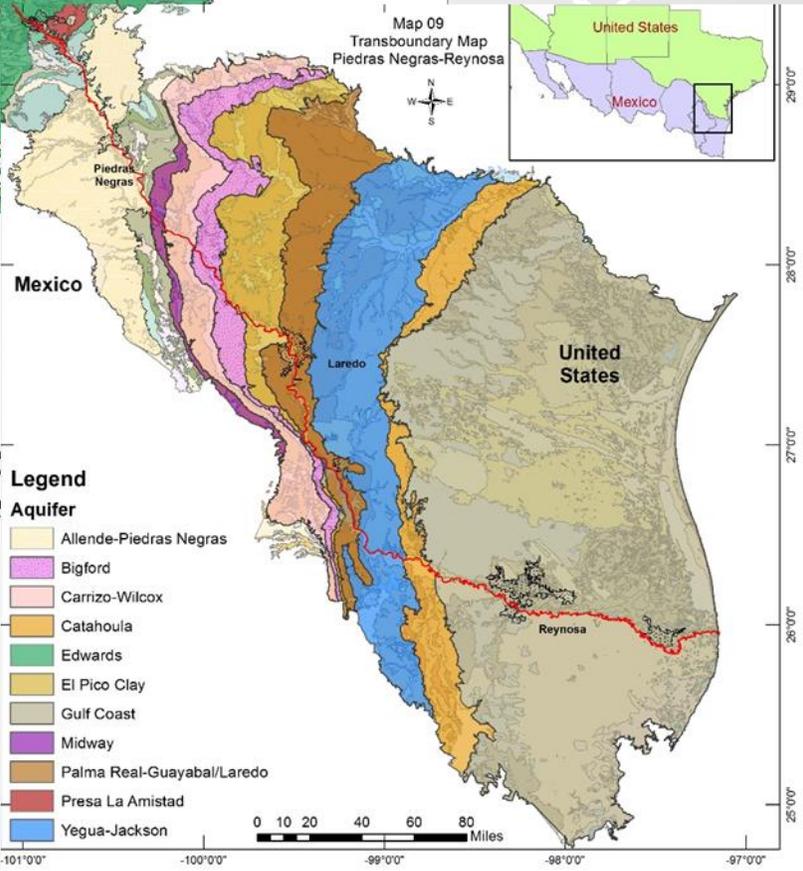
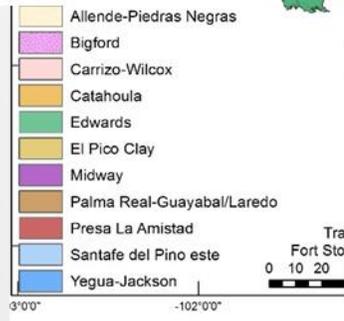
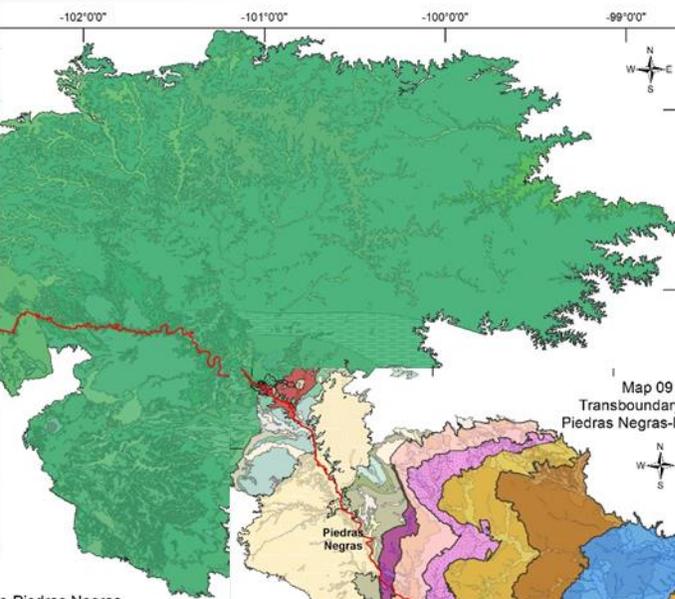
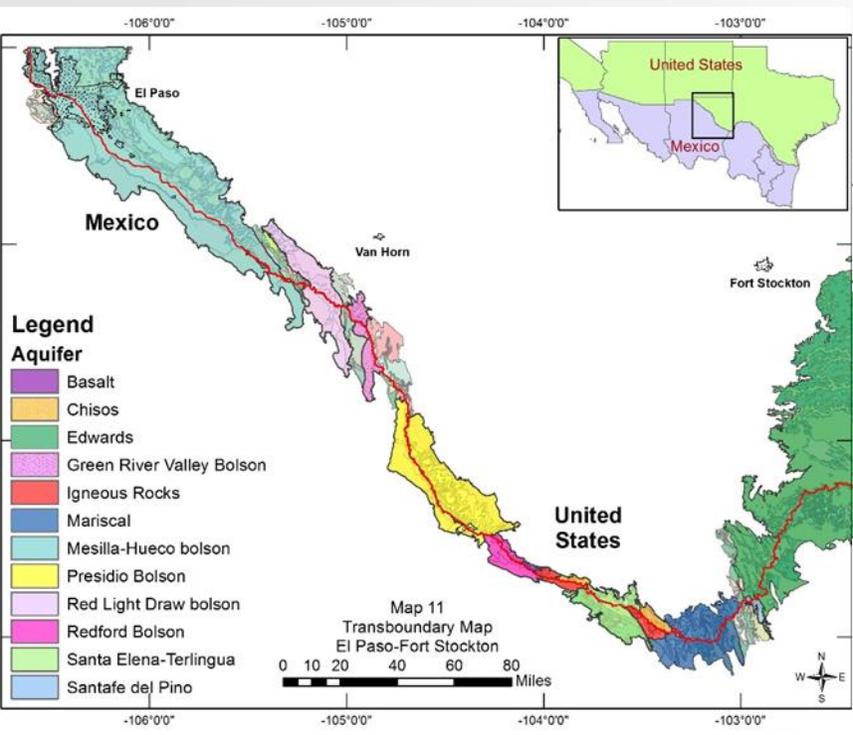
GEOLOGICAL CORRELATION



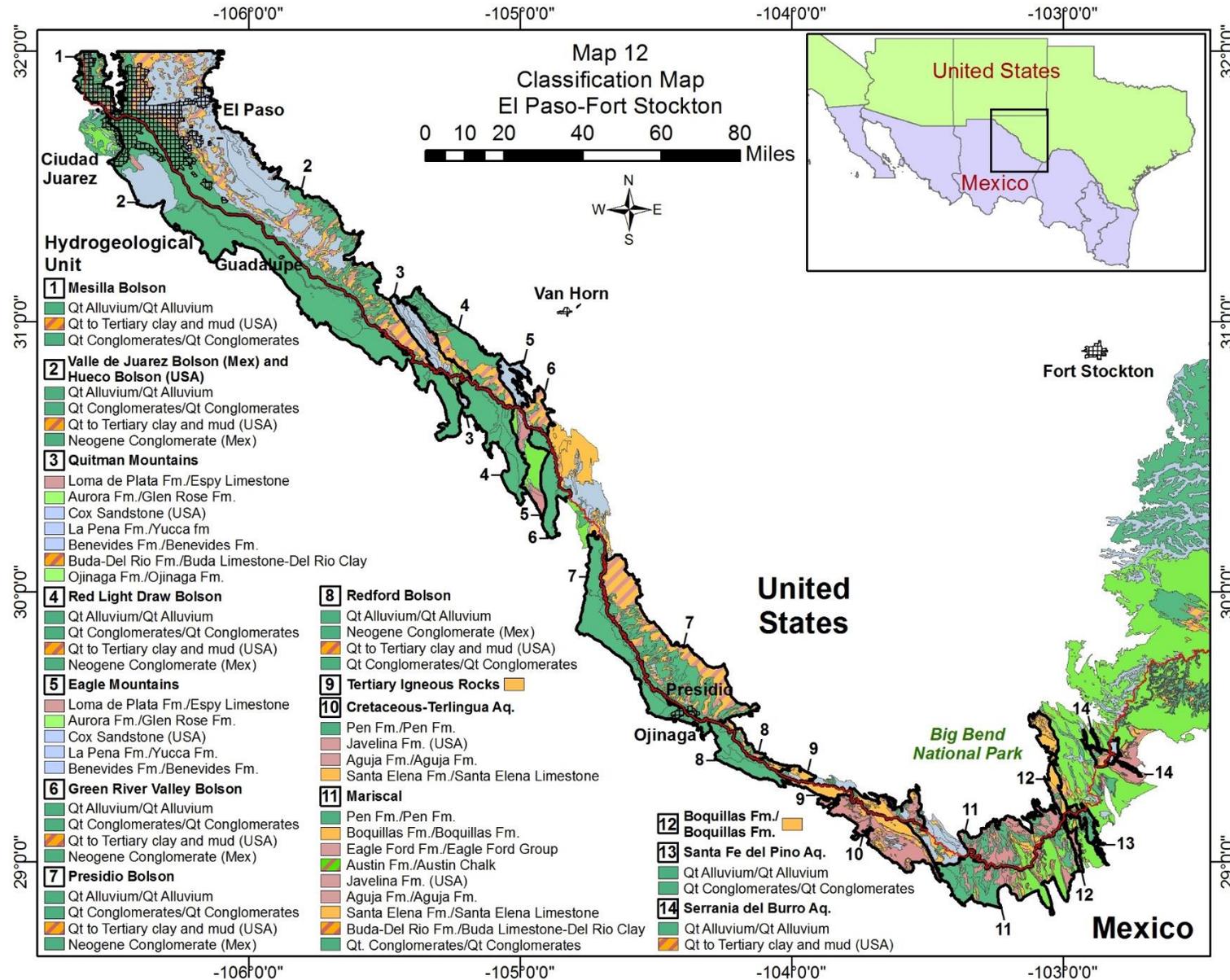
IDENTIFICATION OF TRANSBOUNDARY FORMATIONS



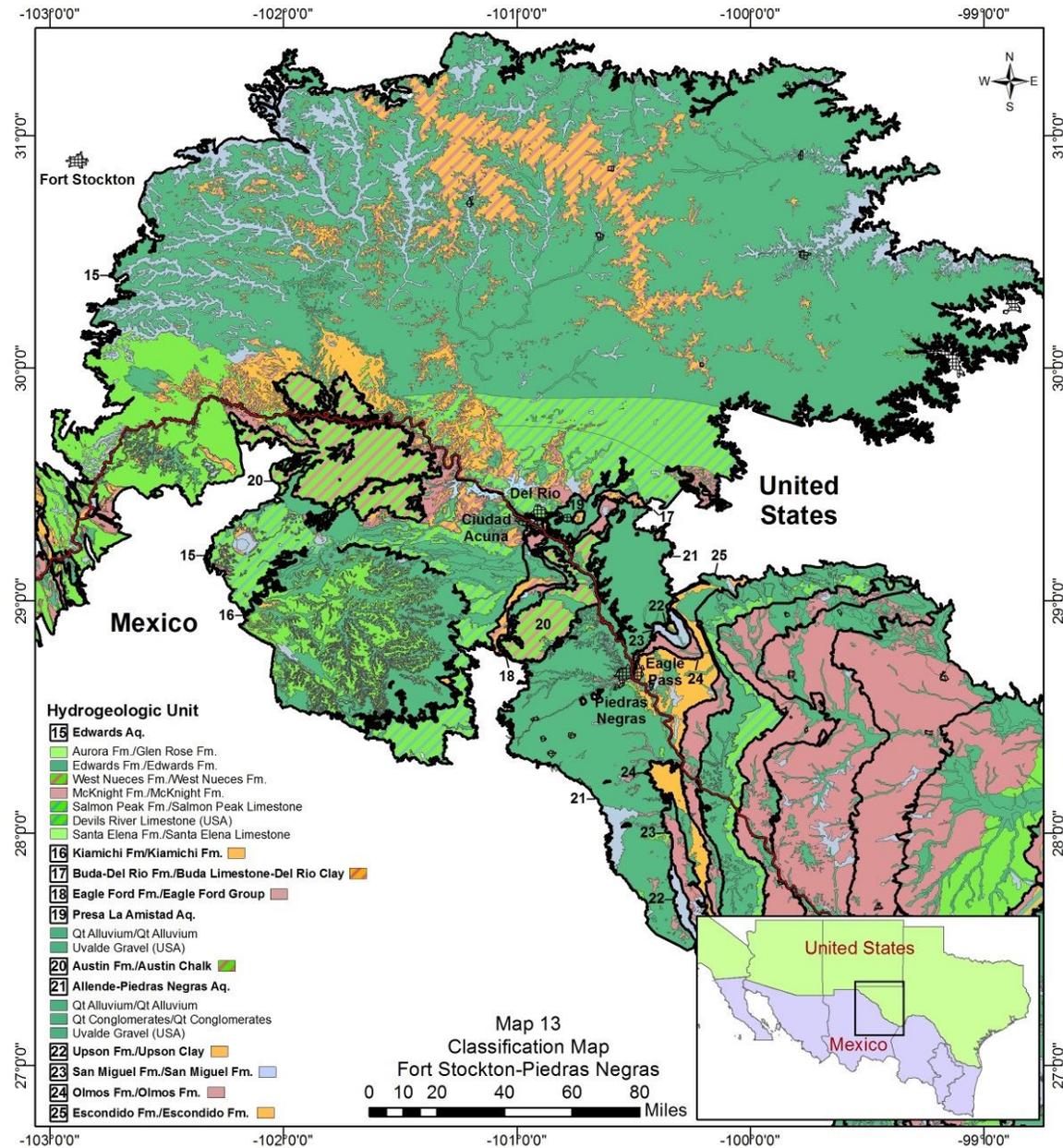
IDENTIFICATION OF HYDROGEOLOGICAL UNITS



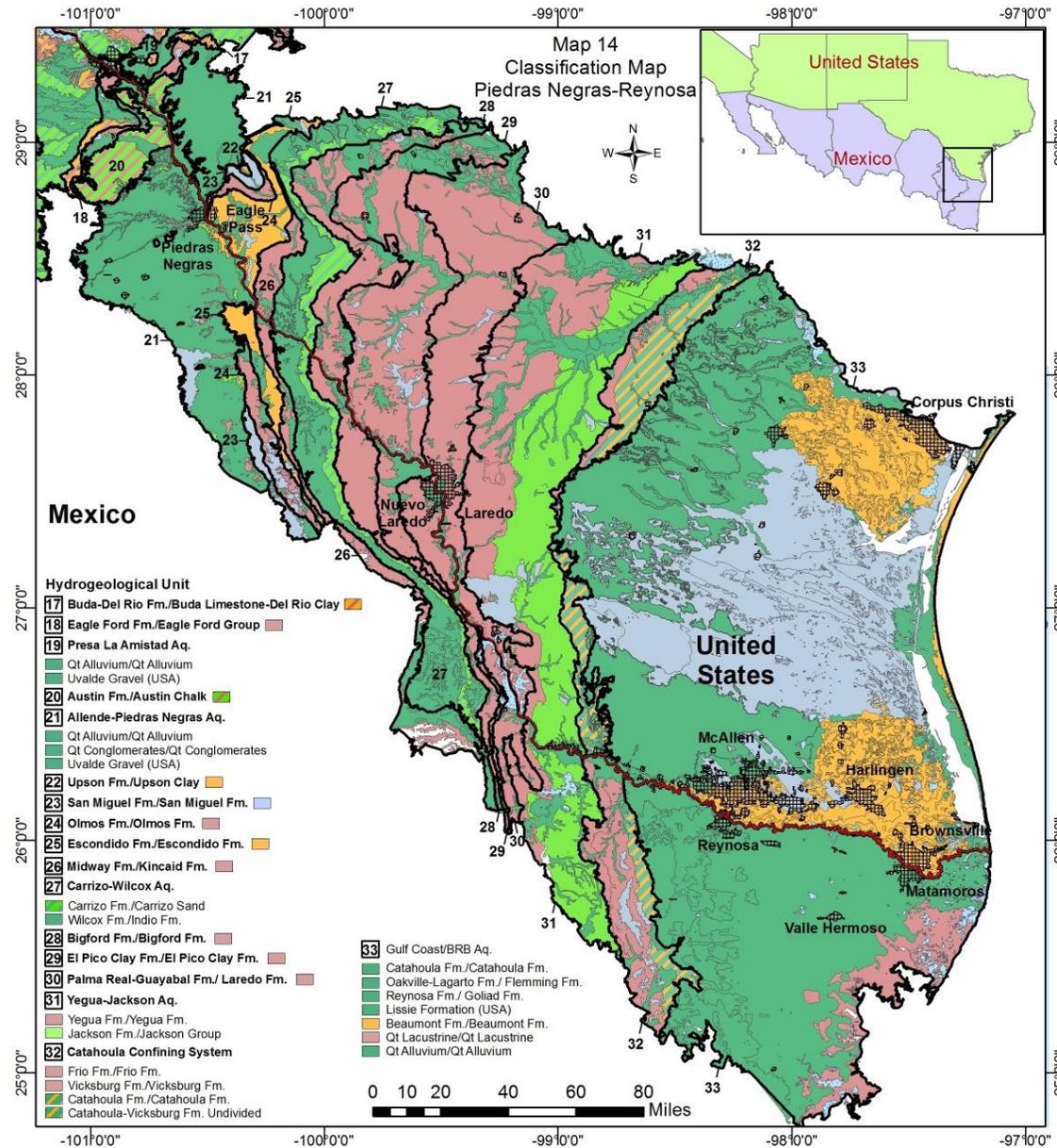
CLASSIFICATION OF HYDROGEOLOGICAL UNITS



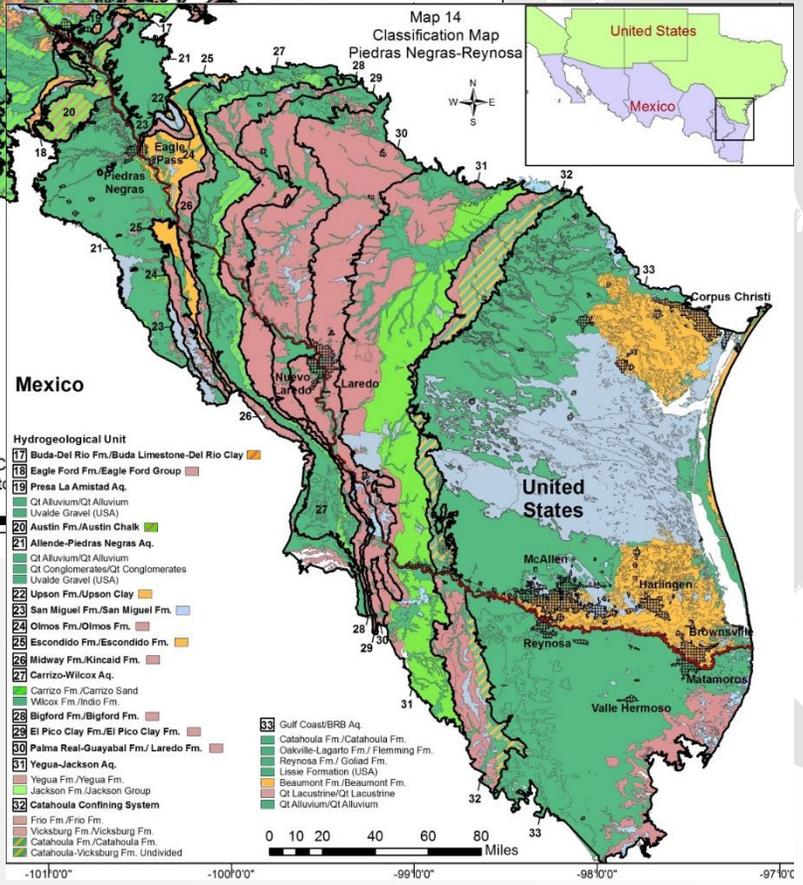
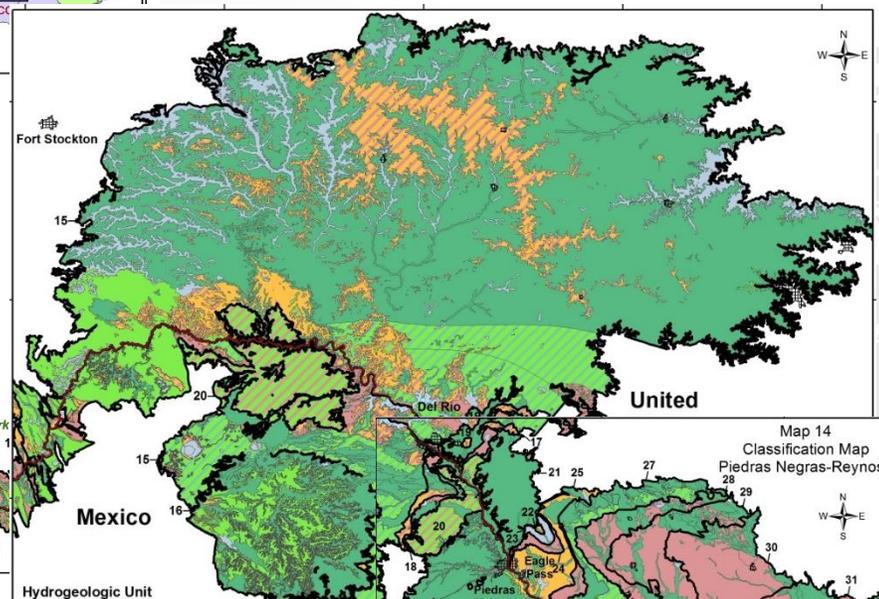
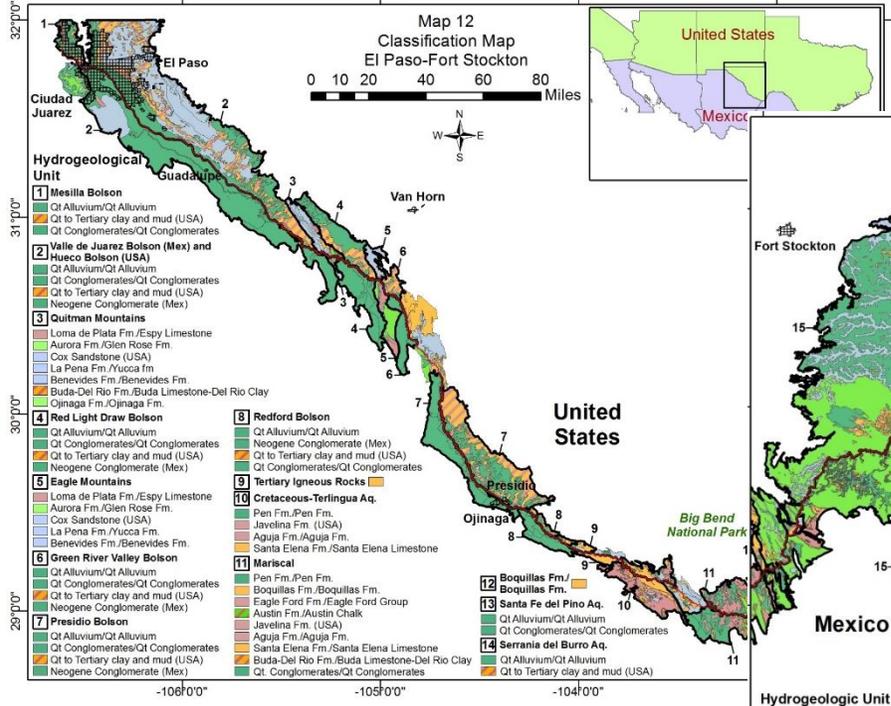
CLASSIFICATION OF HYDROGEOLOGICAL UNITS



CLASSIFICATION OF HYDROGEOLOGICAL UNITS



CLASSIFICATION OF HYDROGEOLOGICAL UNITS



Formation Classification		Water Quality				
		Good	Regular	Poor	No Info	
		1	2	3	4	
Aquifer Potential	Good	A	A1	A2	A3	A4
	Middle	B	B1	B2	B3	B4
	Poor	C	C1	C2	C3	C4
	Aquitard	D	D1	D2	D3	D4
	No Info	E	E1	E2	E3	E4

WHAT DOES THIS MEAN?

- New approach for aquifer identification, delineation and categorization
- New transboundary management alternatives
- Improve groundwater research on the border
- Improve transboundary water relationships between Texas and Mexico
- Promote cooperation & data exchange

Thank you.



TRANSBOUNDARY AQUIFERS BETWEEN TEXAS AND MEXICO

IDENTIFICATION, CLASSIFICATION AND PRIORIZATION

Rosario Sanchez

Texas Water Resources Institute, Texas A&M University

Acknowledge: Laura Rodriguez, Graduate Research Assistant, WMHS, Texas A&M University