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BS Geology, Clemson University (1974)

MS Geology, Eastern Kentucky University (1976)

Post Graduate Study, University of New Mexico (1976)

Mobil Oil Co., Exploration Geologist (1977-1980)

Tenneco Oil Co., Geological Supervisor, Division Geologist (1980-1987)

CNG Producing Co., Exploration Manager (1988-1992)

Writer/Author (1992-Present)

The following document summarizes the general geology in Sandoval County and the risk of contamination of the main drinking water aquifers in and around the Albuquerque Basin compared to the San Juan Basin.

All stratigraphic columns, maps, and cross sections are available online through public documentation by the New Mexico Bureau of Geology & Mineral Resources. [geoinfo.nmt.edu/]

In general, risk of contamination of drinking water aquifers by horizontal drilling and fracking of the Mancos Shale and other organic-rich rocks is:

- 1) Low risk in the northwestern portion of Sandoval County (San Juan Basin)
- 2) High risk in the Albuquerque Basin proper.
- 3) Extremely high risk on the eastern side of the Albuquerque Basin (such as Placitas, NM, and other similar communities).

Donald T. Phillips
November 11, 2017

TALKING POINTS FOR PLACITAS PRESENTATION

Image 1: Geologic Map of New Mexico

- This is a geologic map of the entire state of New Mexico.
- The varying colors represent the rocks that are on the surface of the land.
- Notice:
 - Outline of Sandoval County
 - Outline of the San Juan Basin
 - Outline of the Albuquerque Basin
 - Location of Cuba, Los Alamos, Santa Fe, Albuquerque, Bernalillo, and Placitas

Image 2: Enlargement of Geologic Map of New Mexico

- Let's look first at the San Juan Basin (upper left)
- In the San Juan Basin, rocks at the surface are spread out – with few or any faults.
- In the Albuquerque Basin, rocks at the surface are close together, more varied – with many major faults.
- Obviously, the geology of the Albuquerque Basin (where Placitas is located) is much more complex than in the San Juan Basin.

Image 3: Stratigraphic Column of the San Juan Basin

- Main drinking water aquifer is at the top (yellow)
- Mancos Shale (target for horizontal drilling and fracking) is deep below the surface (gray)
- Notice:
 - Mancos Shale is thousands of feet below the drinking water aquifer.

Image 4: Cross-Section of the San Juan Basin

- Drinking water aquifer (yellow) near the surface
- Mancos Shale (gray) deep below the surface.
- Major oil and gas producing reservoirs are immediately above, below, and within the Mancos.
- Notice:
 - Rocks are mostly horizontal in nature with few, if any faults.
 - At no point is the Mancos Shale in contact with the freshwater drinking aquifer.
- Interpretation
 - **Horizontal drilling and fracking of the Mancos Shale in the San Juan Basin is:**
 - **Relatively safe and straightforward**
 - **Poses little risk for contamination of main freshwater drinking aquifer**

Image 5: Enlargement of Geologic Map of New Mexico

- Now let's take a look at the Albuquerque Basin and Placitas in particular (center)

Image 6: Stratigraphic Column of the Albuquerque Basin (Placitas and surrounding areas)

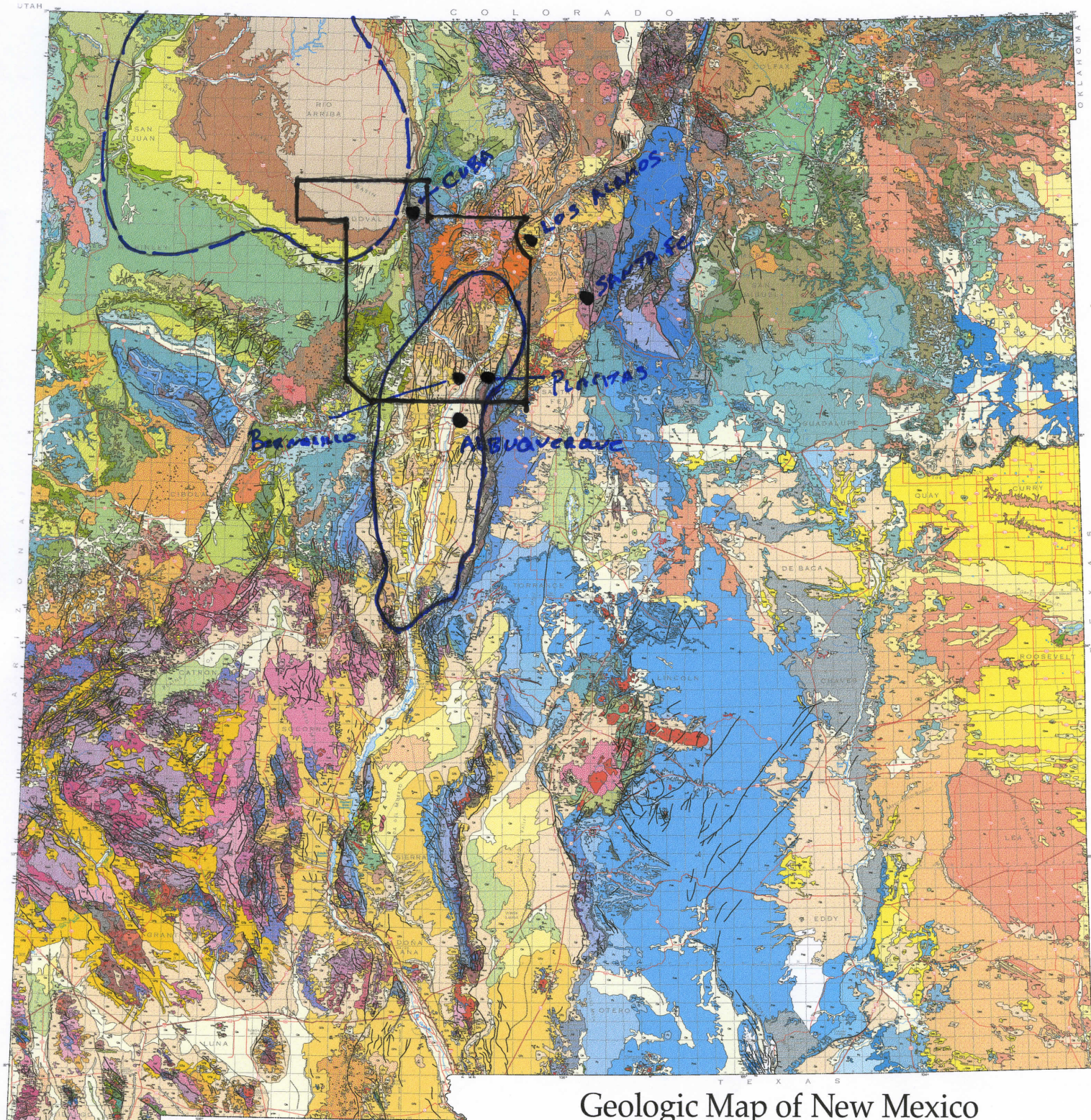
- This is the aquifer for: Vista de la Montana Sur, Placitas Trails, Placitas Trails North, Tierra Madre, La Mesa, and Sundance Mesa.
- Mancos Shale (target for horizontal drilling and fracking) is deeper below the surface (gray)
- Other local drinking water aquifers (yellow) are also located in and around the Mancos Shale.

Image 7: Geologic Map of the Bernalillo and Placitas Quadrangles

- The larger geologic map of the State of New Mexico is put together from more detailed mapping by quadrangles.
 - Each quadrangle is approximately 50 square miles.
- Notice:
 - Location of Placitas
 - Location of Cross-Sections
 - A-A'
 - B-B'
 - C-C'
 - Cross-Sections show the subsurface geology

Image 8: Cross-Sections of the Bernalillo and Placitas Quadrangles

- General geology is considerably different than the San Juan Basin (in which rocks are mostly horizontal with few, if any, faults).
 - Heavily faulted strata – intensity increases to the East toward the mountains.
- Notice:
 - Location of Placitas (projected)
 - Location of main Placitas drinking water aquifer (yellow) near the surface
 - Location of Mancos Shale (gray)
 - Appears at various depths due to being offset by major faults.
 - Don't forget other secondary drinking water aquifers near Mancos Shale
- Notice:
 - In several cross-sections, the Mancos Shale is actually **in contact** with the main drinking water aquifer. [B-B' and C-C']
 - The difference in the cross-sections between A-A' and C-C', which are parallel and very close to each other.
 - **This demonstrates the extremely complex nature of the faulting and the high unpredictability of what may be encountered by oil and gas drilling.**
- Notice:
 - Moving west toward the Bernalillo Quadrangle (cross-section A-A')
 - Headed away from the mountains and more toward the center of the Albuquerque Basin and the Rio Grande River.
 - Mancos Shale is deeper
 - Major faulting is still present
- Interpretation
 - **Horizontal drilling and fracking of the Mancos Shale in the Albuquerque Basin:**
 - **Unconventional and highly complicated**
 - **Poses high risk for contamination of main freshwater drinking aquifer in the Placitas area – and deeper secondary aquifers (note locations in stratigraphic column) elsewhere in the Albuquerque Basin area.**
 - **In Sandoval County**
 - **Generally, the risk for contamination of drinking water aquifers increases from the Northwest (risk is low in the San Juan Basin) to the Southeast (high risk in the Albuquerque Basin; highest risk near Placitas and surrounding areas).**



Geologic Map of New Mexico

New Mexico Bureau of Geology and Mineral Resources

Celebrating 75 Years of Service

A DIVISION OF NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

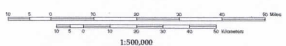
Peter A. Scholle, State Geologist

2003



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9/11



Boca Ratón

CUBA

LOS ANGELES

PUEBLA

ABUQUERQUE

RIO ARRIBA

SAN JUAN

ODVAL

CIBOLA

TORREON

PATRO

LINCOLN

GONZA

SAN JUAN BASIN

AGE	SW	FORMATION OR GROUP	NE	
TERTIARY		San Jose Formation		
		Nacimiento Formation		
		Ojo Alamo Sandstone		
CRETACEOUS	LATE	Kirtland Shale (Farmington Sandstone Member)		
		Fruitland Formation		
		Pictured Cliffs Sandstone		
		Lewis Shale		
		Mesaverde Group	Cliff House Sandstone	
			Menefee Formation	
			Point Lookout Sandstone	
			Upper Mancos Shale	
			Gallup Ss. (Torrivio Mbr.)	Tocito Ss. Lentil
			Lower Mancos Shale	Greenhorn Limestone
		Dakota Sandstone		
	EARLY	Burro Canyon Formation		
	JURASSIC		Morrison Formation (Todilto Limestone Member)	
		Wanakah Formation		
TRIASSIC		Entrada Sandstone		
		Chinle Formation		
PERMIAN	Cutler Group	De Chelley Sandstone		
		Organ Rock Shale		
		Cedar Mesa Formation and related rocks		
		Halgaito Formation		
PENNSYLVANIAN	Hermosa Group	Rico Formation		
		Honaker Trail Formation		
		Paradox Formation and related rocks		
	Pinkerton Trail Formation			
MISSISSIPPIAN		Molas Formation		
DEVONIAN		Leadville Limestone		
		Ouray Limestone		
CAMBRIAN		Elbert Formation		
PRECAMBRIAN		Ignacio Quartzite		

← MAIN FW AQUIFER

← Shale Play

San Juan Basin #1

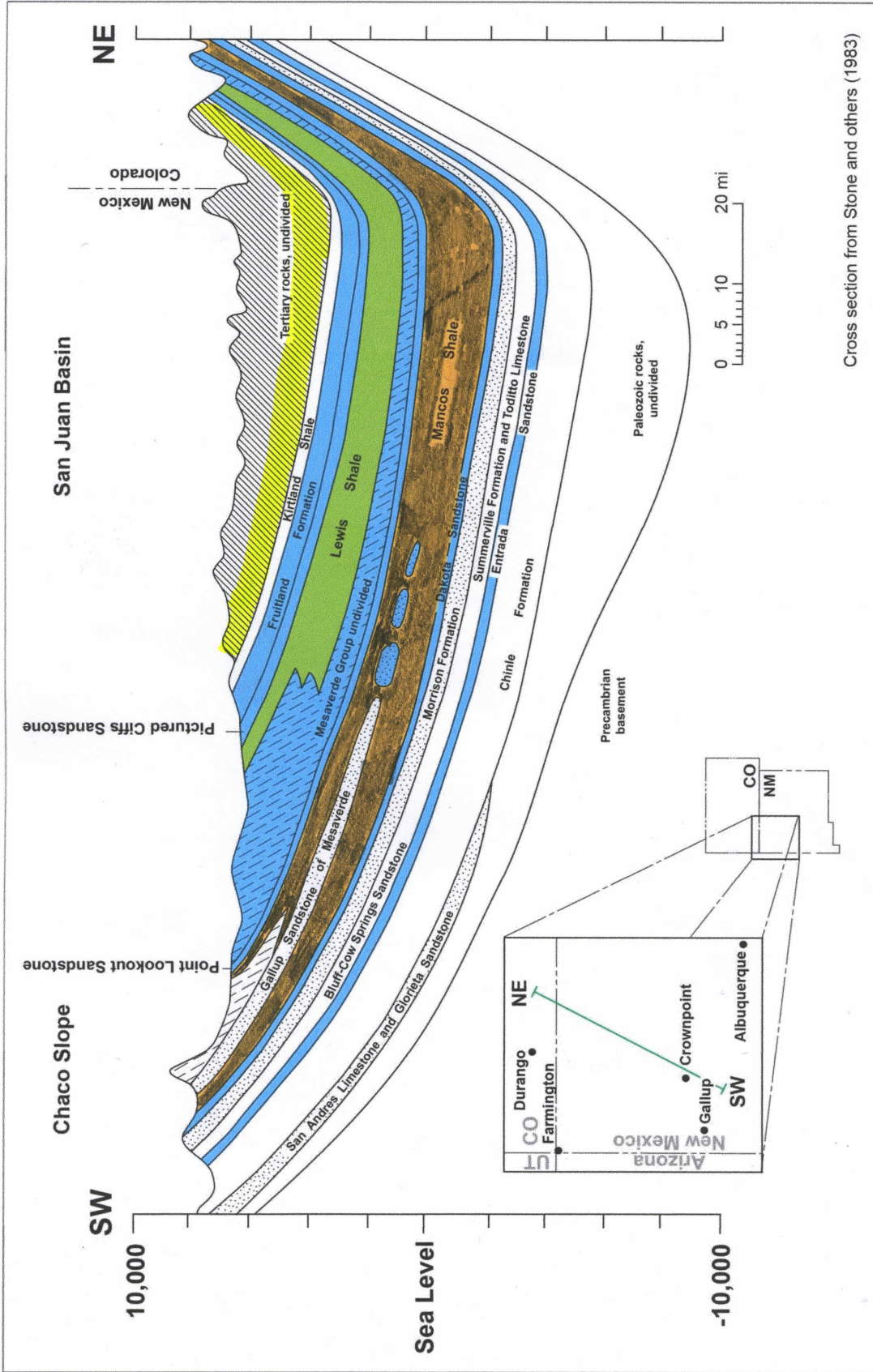


Figure 4. Southwest-northeast structural cross section through San Juan Basin. Mancos Shale is shown in orange. Major productive non-Mancos strata are blue. Modified from Stone et al. (1983).



CUBA
LOS ANGELOS
PUEBLA
BUENAVISTA
ABUAVERAUC

SAN JUAN

RIO ARRIBA

ODVAL

CIBOLA

CATROT

TORREALE

LINCOLN

MAJOR FW
AQUIFER

Figure 5. Composite stratigraphic chart for the **Placitas** area (after Anderson et al., 1995)

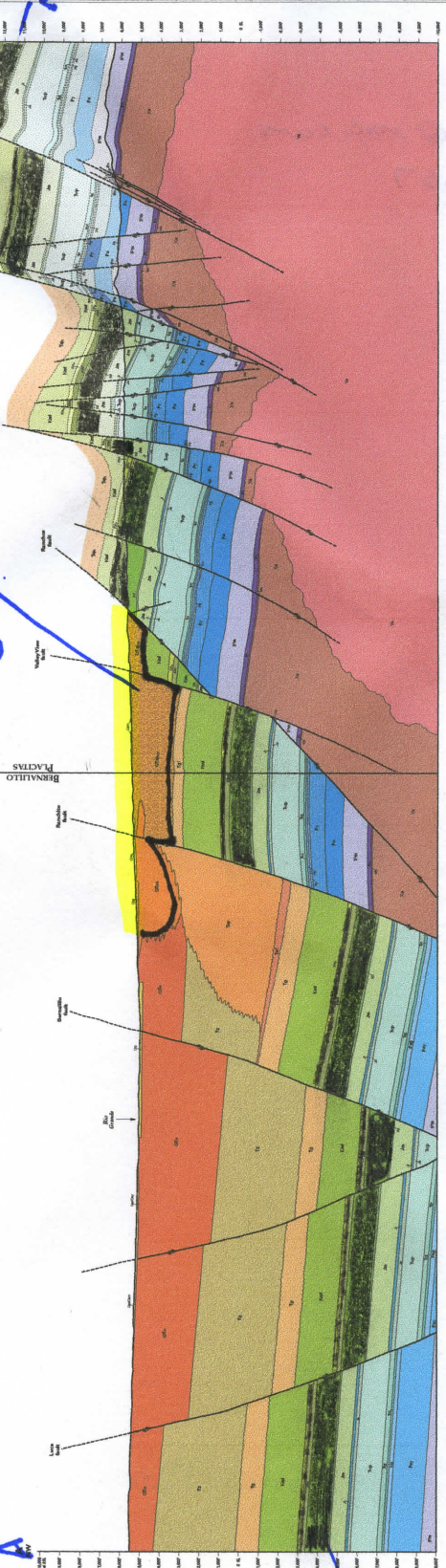
Age (ma)	Period	Epoch	Stratigraphic Units	Approx. Thickness (ft)	Location of Measured Section in Figure 6 (T.R.S.1/4,1/4,1/4)	Thickness Data Source		
0.01	Quaternary	Holocene	Valley-fill alluvium-Qal, Qv	0-20	none	Connell et al., (1995)		
0.25		Pleistocene	late	Piedmont-slope alluvium- Qaf, Qf, Qp			0-120	
0.7			middle					
1.6	Tertiary	Pliocene	Upper Santa Fe Group QTsa, QTst, QTspcs, QTspc	600-4000	none- not exposed	Smith et al., (1991)		
5.3			Miocene	Lower Santa Fe Group Tsp, Tspcs, Tspc			~400-2400	
23.7		Oligocene	Espinaso Fm. Te	≤1300				
36.6		Eocene	Galisteo Fm. Tg	≤2800				
57.8	Paleocene	Diamond Tail Fm. Td	Mafic Dike, Tmi	≤1450	none- not exposed	Lucas et al., (1997)		
66.4								
Cretaceous	Upper	Mesa Verde Grp.	Upper Menelee Fm.	740	13.5.33.110	Menne, 1989		
			Harmon Sandstone	140				
			Lower Menelee Fm.	324				
			Point Lookout Sandstone Kpl	240-315			13.5.32.220	Menne, 1989; Picha, 1982
			Upper Mancos Shale Km ₂	240-360			12.4.1.120; 13.6.32.220	Menne, 1989; Picha, 1982
			Hosta Dalton Sandstone Khd	210-370			13.5.32.210; 13.6.32.320	Menne, 1989; Picha, 1982
Lower	Dakota Fm. Kd		Lower Mancos Shale Km ₁	850-1850	12.4.1.120; 13.6.32	Menne, 1989; Picha, 1982		
				25-75	12.4.1.240	Picha, 1982; Menne, 1989		
				70				
Jurassic	Upper	Morrison Fm. Jm	Jackpile Sandstone Mbr.	240	13.5.32.430	Menne, 1989		
			Brushy Basin Mbr.	215				
			Westwater Cyn/Saltwash	215				
			Recapture Sh/Summerville	325				
Middle	San Rafael Grp.		Todilto Fm. Jt	50-65	12.5.6.320; 13.5.24.140	Picha, 1982; Menne, 1989		
			Entrada Fm. Je	120	12.5.6.320	Menne, 1989		
Triassic	Upper	Chinle Grp.	Petrified Forest Fm. Rcp	1590	13.5.24.140	Picha, 1982		
			Agua Zarca Fm. R _z	220	12.5.6.330	Menne, 1989		
			Moenkopi Fm. Rm	45-100	12.4.5.320; 12.6.19.200	Menne, 1989; Picha, 1982		
Permian	Guadalupian		San Andres Fm. Ps	80-130	12.4.5.320	Menne, 1989; Picha, 1982		
			Glorieta Ss. Pg	50	West of Pomecerro Cyn	Menne, 1989		
	Leonardian	Yeso Fm. Py	San Ysidro Mbr.	680	13.5.26	Picha, 1982		
			Meseta Blanca Mbr. Lower Yeso Mbr.					
Wolfcampian		Abo Fm. Pa	1070	Cuchilla de San Francisco	Picha, 1982			
Pennsylvanian	Upper	Madera Fm. IPm	Upper Arkosic Ls.	614	Crest of Montezuma	Picha, 1982		
	Middle		Lower Gray Ls.	646				
	Lower		Sandia Fm. IPs	193			Crest of Montezuma	
Mississippian			Arroyo Peñañco Grp Ma.	103	13.5.34.140	Menne, 1989		
Proterozoic	Middle		Sandia Granite	-	none			
	Early		Various Supracrustal Rocks	-	none			

Mancos
shale
PLAY

CROSS - SECTIONS

046
MIGRATION along FAULT LINES

Placitas Aquifer for Groundwater



A

NEW MEXICO GEOLOGICAL SOCIETY OF AMERICA AND UNIVERSITY OF NEW MEXICO
 Dr. Paul W. Moore
 Program Director

NEW MEXICO GEOLOGICAL SOCIETY OF AMERICA AND UNIVERSITY OF NEW MEXICO
 Dr. Peter A. Skelton
 Director and State Geologist

Geology of the Bernalillo and Placitas quadrangles, Sandoval County, New Mexico

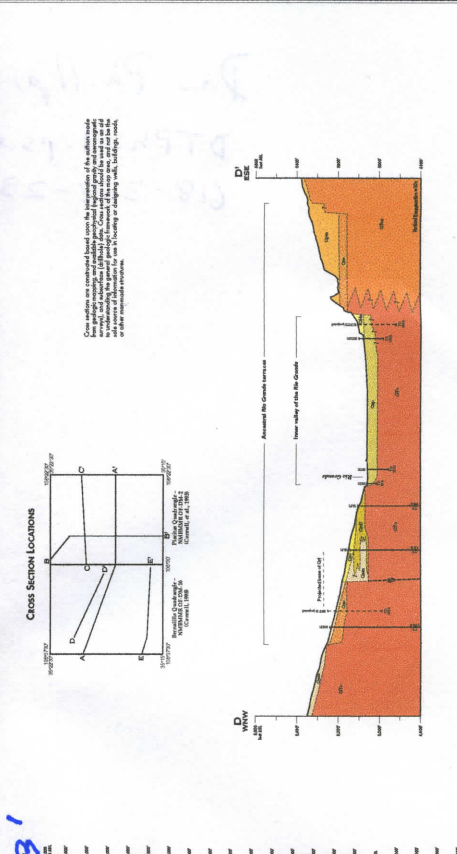
PLATE II of III.
 GEOLOGIC CROSS SECTIONS
 1:24,000

17 February 2008 Revision

Bernalillo quadrangle
 NUMBER GP-DM-56
 May 1998
 Sean D. Connell

Placitas quadrangle
 NUMBER GP-DM-52
 June 1998
 Sean D. Connell, Steve M. Collier, Bradley J. Chris Anderson, Adam S. Reed, Paul W. Bauer, and Peggy S. Johnson

With Major Revisions of Adams and Johnson, Science, 1987, 1992.
 State of New Mexico Department of Geology and Mineral Resources, Science, 1987, 1992.
 Department of Geology and Mineral Resources, University of New Mexico, 1992, 1998.

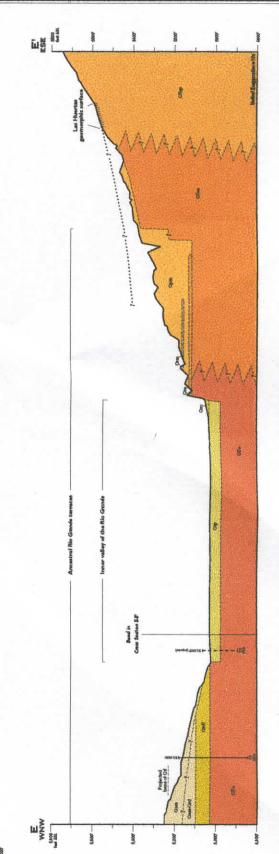


B

LOWER AQUIFERS ABOVE AND BELOW MARCOS SH

Placitas Aquifer

MARCOS SHALE



C

Placitas Aquifer

MARCOS SHALE