

October 30, 2013, GSA – Denver, CO

Sequential history of salt structures and related features in the Paradox Basin, USA

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AGE	SERIES	GROUP	FORMATION
Cretaceous		Mesaverde	Castlegate SS (north)
			Point Lookout SS (south)
		Mancos	Blue Gate Sh
			Ferron SS
			Tununk Sh
		Dakota	Dakota SS
			Cedar Mountain Fm / Burro Canyon Cong
Jurassic		San Rafael	Morrison Fm / Mbrs / Bluff SS
			Summerville Fm / Wanakah Fm
			Curtis Fm / Moab Tongue SS
			Entrada SS / Carmel Fm / Page SS
		Glen Canyon	Navajo SS
			Kayenta Fm
			Wingate SS
Triassic			Chinle Fm / Moss Back & Shinarump Moenkopi Fm / Sinbad Mbr
Permian	Guadalupian		Kaibab LS
	Leonardian		White Rim, Coconino & DeChelly SSs Organ Rock Fm
	Wolfcampian	Hermosa	Cedar Mesa SS
Pennsylvanian	Virgilian		Elephant Canyon Fm
	Missourian		Halgaito Fm
	Desmoin./Atokan		Honaker Trail Fm
	Morrowan		Paradox Fm
			Lower Hermosa Fm
Mississippian	Chesterian		Doughnut Fm
	Meramecian		Humbug Fm
	Osagean/Kinder.		Leadville Fm
Devonian			Ouray LS
			Elbert Fm / McCracken Mbr
			Aneth Fm
Cambrian			Lynch Fm
			Ophir Sh
			Muav Fm
			Bright Angel Sh
			Tapeats SS / Tintic SS / Ignacio SS
Precambrian			Undifferentiated strata
			Metasediments and Igneous Rocks

Paradox
salt



Penn – Perm
Boundary →

SYSTEM	SERIES	GROUP	FORMATION	LOCAL NAME (Informal)	HITE'S SALT #	PREVIOUS CYCLE NAME	CURRENT CYCLE NAME	EVAPORITE TYPES	CARBONATE HIGHSTAND SYSTEMS TRACTS (HST) DISTRIBUTION WITHIN CYCLES	EVAPORITE LOWSTAND SYSTEMS TRACTS (ELST) DISTRIBUTION WITHIN CYCLES	SILICICLASTIC TRANSGRESSIVE LOWSTAND SYSTEMS TRACTS (TLST) DISTRIBUTION WITHIN CYCLES
PENNSYLVANIAN	PERMIAN	WOLFCAMPIAN	ELEPHANT CANYON/CEDAR MESA				CY-W13? ?				
							CY-W12? ?				
	VIRGILIAN						CY-W11? ?				
							CY-W10 A				
MISSOURIAN							CY-W09 A				
							CY-W08 A				
							CY-W07 A				
							CY-W06 A				
HERMOSA							CY-W05 A				
							CY-W04 A				
							CY-W03 A				
							CY-W02 A				
DESMOINESIAN							CY-W01 A				
							CY-V08 A				
							CY-V07 A?				
							CY-V06 A				
ATOKAN							CY-V05 A				
							CY-V04 A?				
							CY-V03 A?				
							CY-V02 A				
MORROWAN							CY-V01 A				
							CY-M12 A?				
							CY-M11 A				
							CY-M10 A				
LOWER HERMOSA							CY-M09 A?				
							CY-M08 A				
							CY-M07 A				
							CY-M06 A				
							CY-M05 A				
							CY-M04 A				
							CY-M03 A				
							CY-M02 A/H				
							CY-M01 A				
							PX0A A				
							PX0B A/H				
							PX1 A/H/P				
							PX2 A/H/P				
							PX3 A/H/P				
							PX4 A/H/P				
							PX5 A/H/P				
							PX6A A/H/P				
							PX6B A/H/P				
							PX7 A/H/P				
							PX8 A/H/P				
							PX9A A/H/P				
							PX9B A/H/P				
							PX10 A/H/P				
							PX11 A/H/P				
							PX12 A/H/P				
							PX13 A/H/P				
							PX14 A/H/P				
							PX15 A/H/P				
							PX16 A/H/P				
							PX17 A/H/P				
							PX18 A/H/P				
							PX19 A/H/P				
							PX20A A/H/P				
							PX20B A/H/P				
							PX21 A/H/P				
							PX22A A/H/P				
							PX22B A/H				
							PX22C A/H/P				
							PX22D A/H/P				
							PX23 A/H/P				
							PX24 A/H/P				
							PX25 A/H/P				
							PX26 A/H/P				
							PX27A A/H/P				
							PX27B A/H/P				
							PX28 A/H/P				
							PX29 A/H/P				
							PX30 A/H/P				
							PX31 A/H/P				
							PX32 A				
							PX33 A				
							PX34 A/H				
							PX35 A				
							PX36 A				
							PX37 A				
							PX38 ?				
							PX39 A				
							PX40 ?				
							PX41? ?				

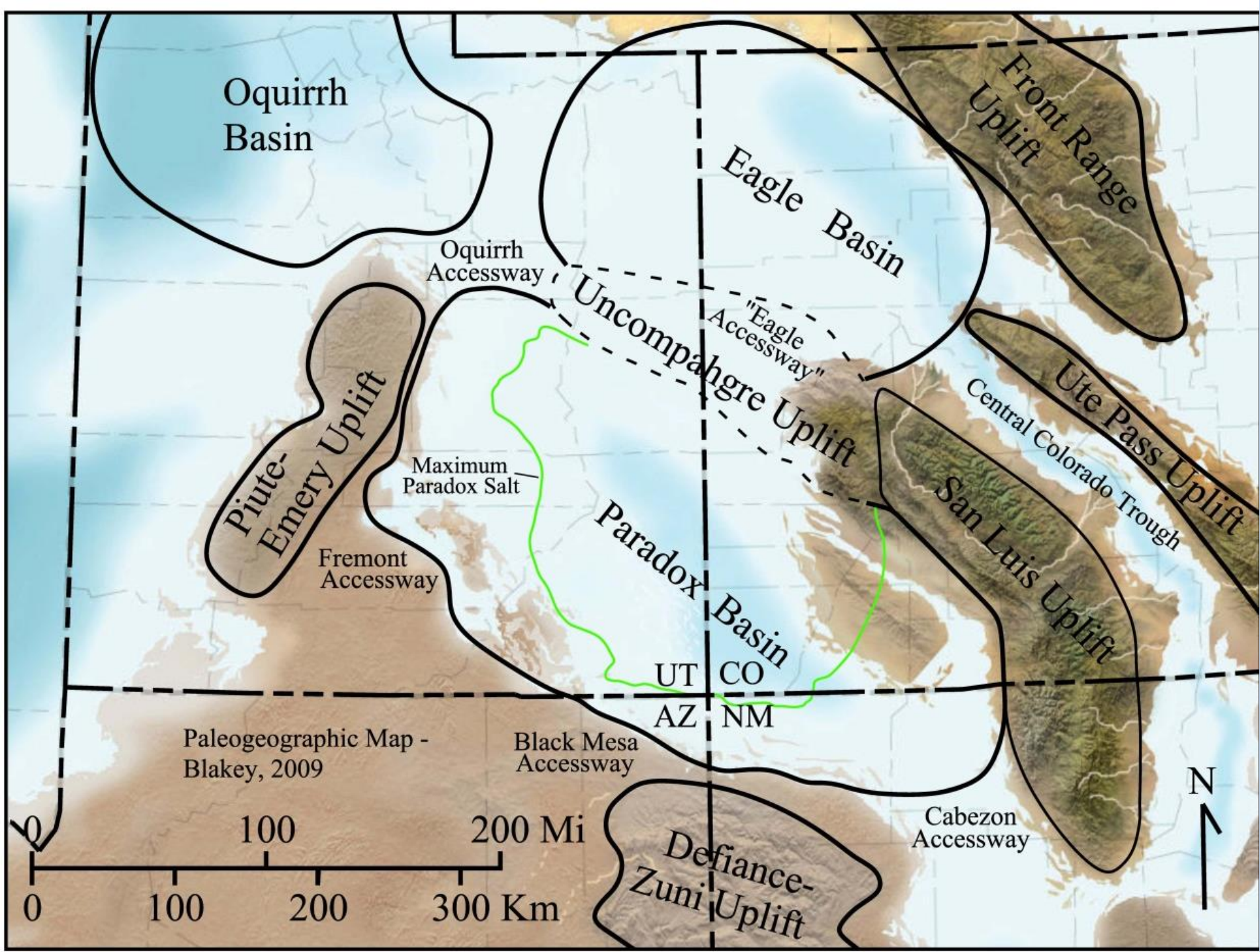
81 cycles –
Transgressive
shales shown
by dashed
lines.

Carbonates -
blue

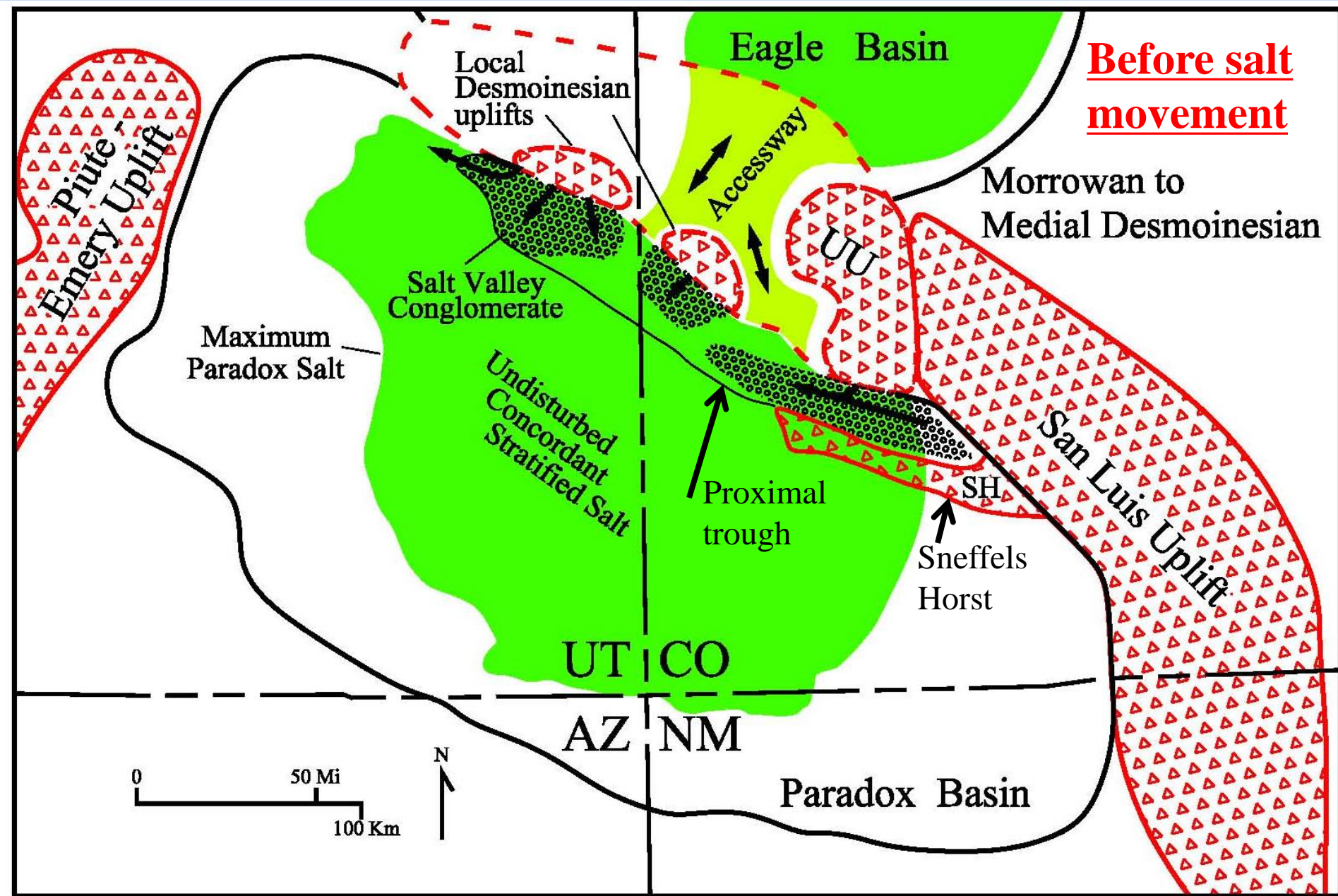
Anhydrites -
magenta

Halite - green

Siliciclastics -
yellow

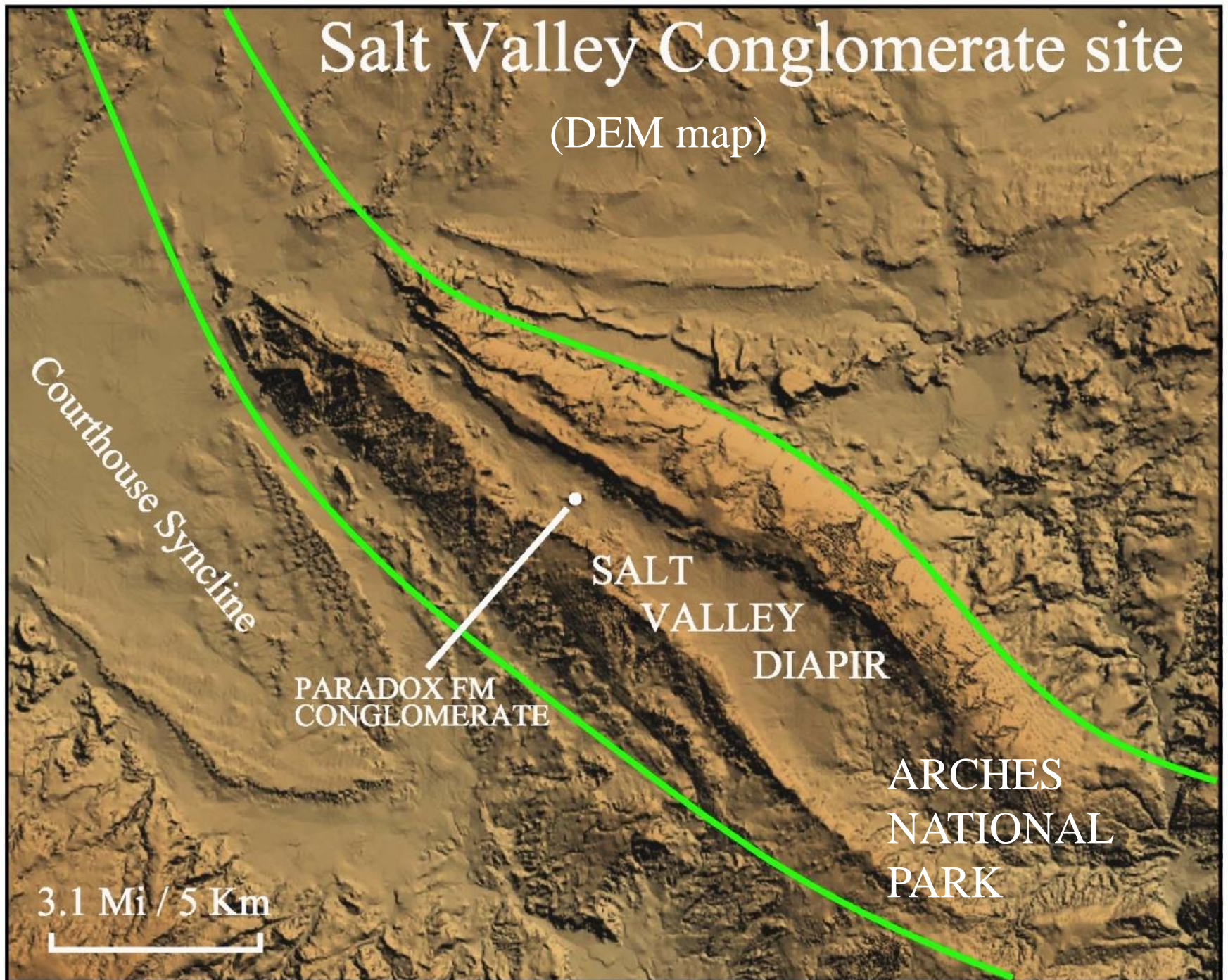


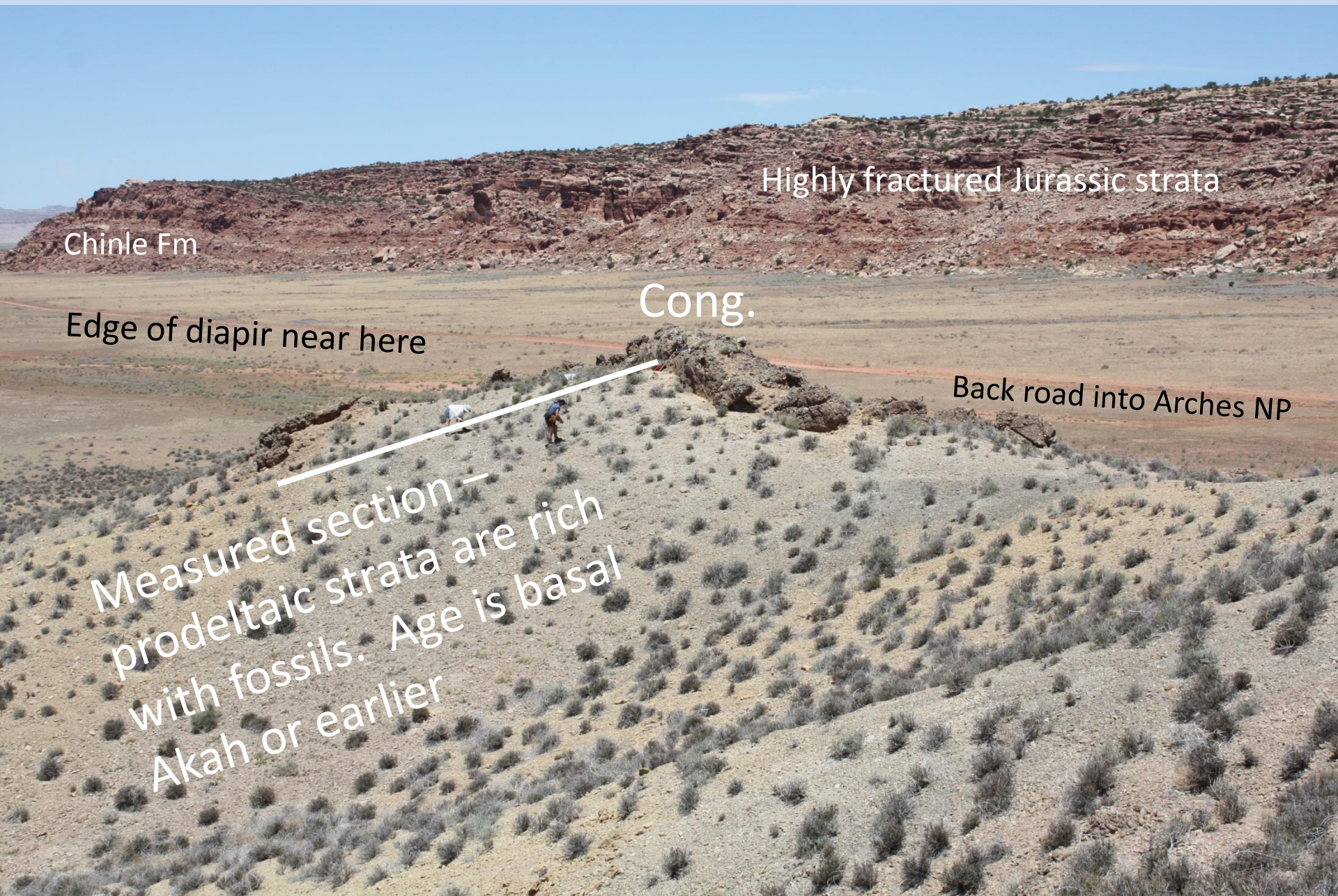
Before salt movement




Salt Valley Conglomerate site

(DEM map)





Vertically folded conglomerate within Salt Valley Diapir – looking north

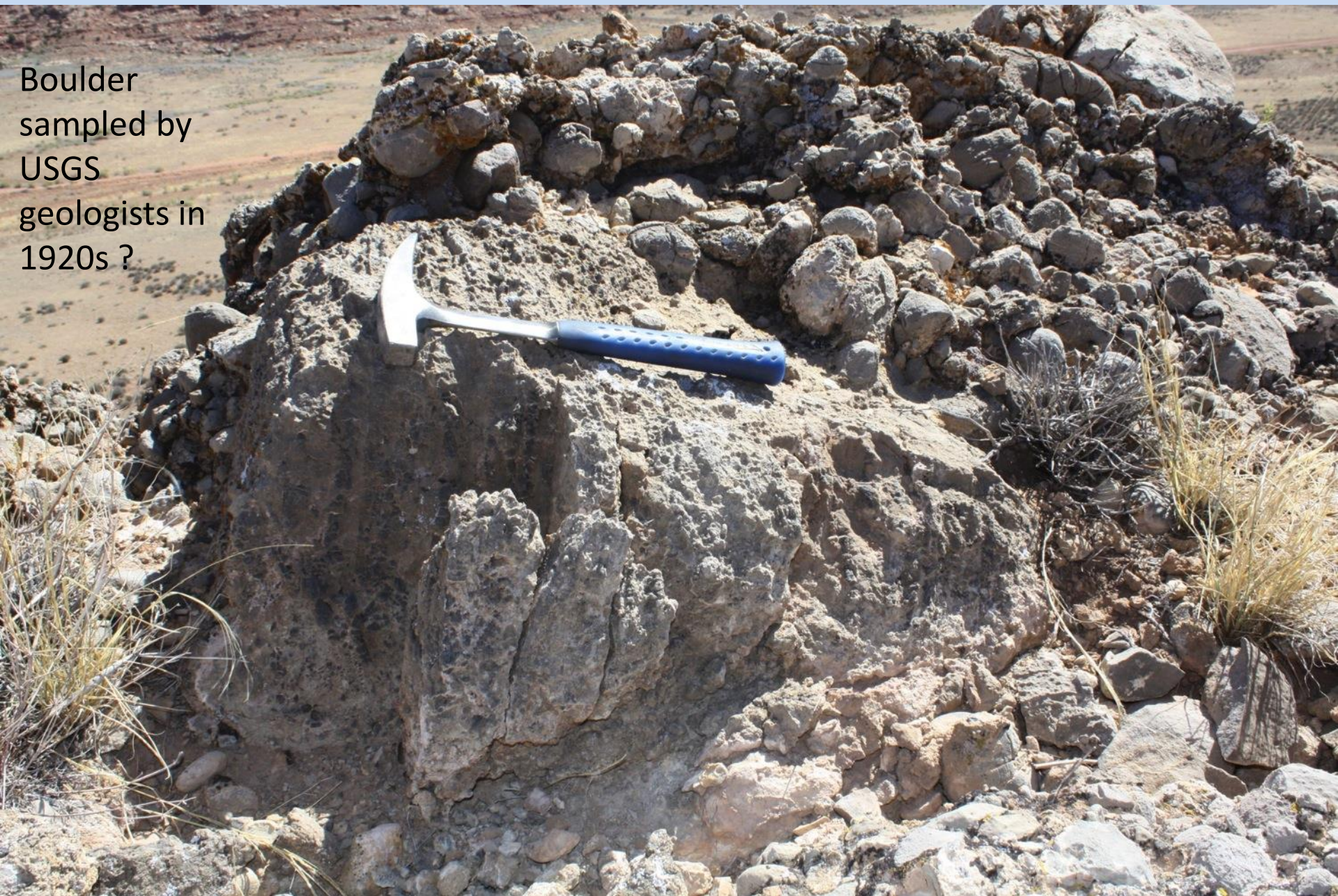
A photograph of a conglomerate rock outcrop. The rock is composed of numerous small, rounded clasts of varying sizes, primarily light-colored limestone, embedded in a darker matrix. The surface is covered with patches of orange and yellow lichen. A geological hammer with a blue handle and a silver head is placed against the rock for scale. The background shows a dry, hilly landscape under a clear blue sky.

CONGLOMERATE:
Predominantly limestone clasts.
Igneous and metamorphic clasts
and arkose absent, but there are
a few mica flakes.



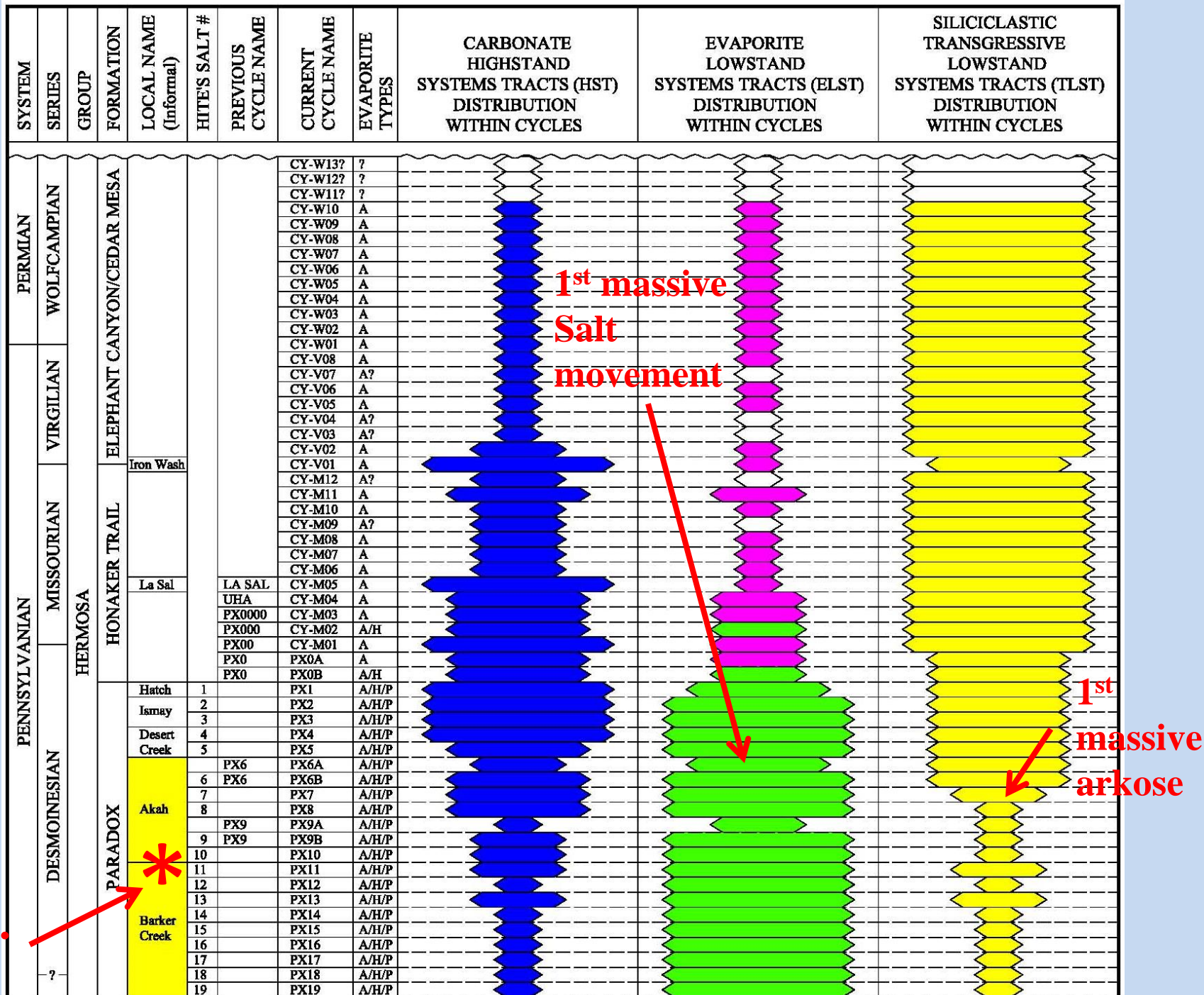
Flute casts at base of vertical conglomerate

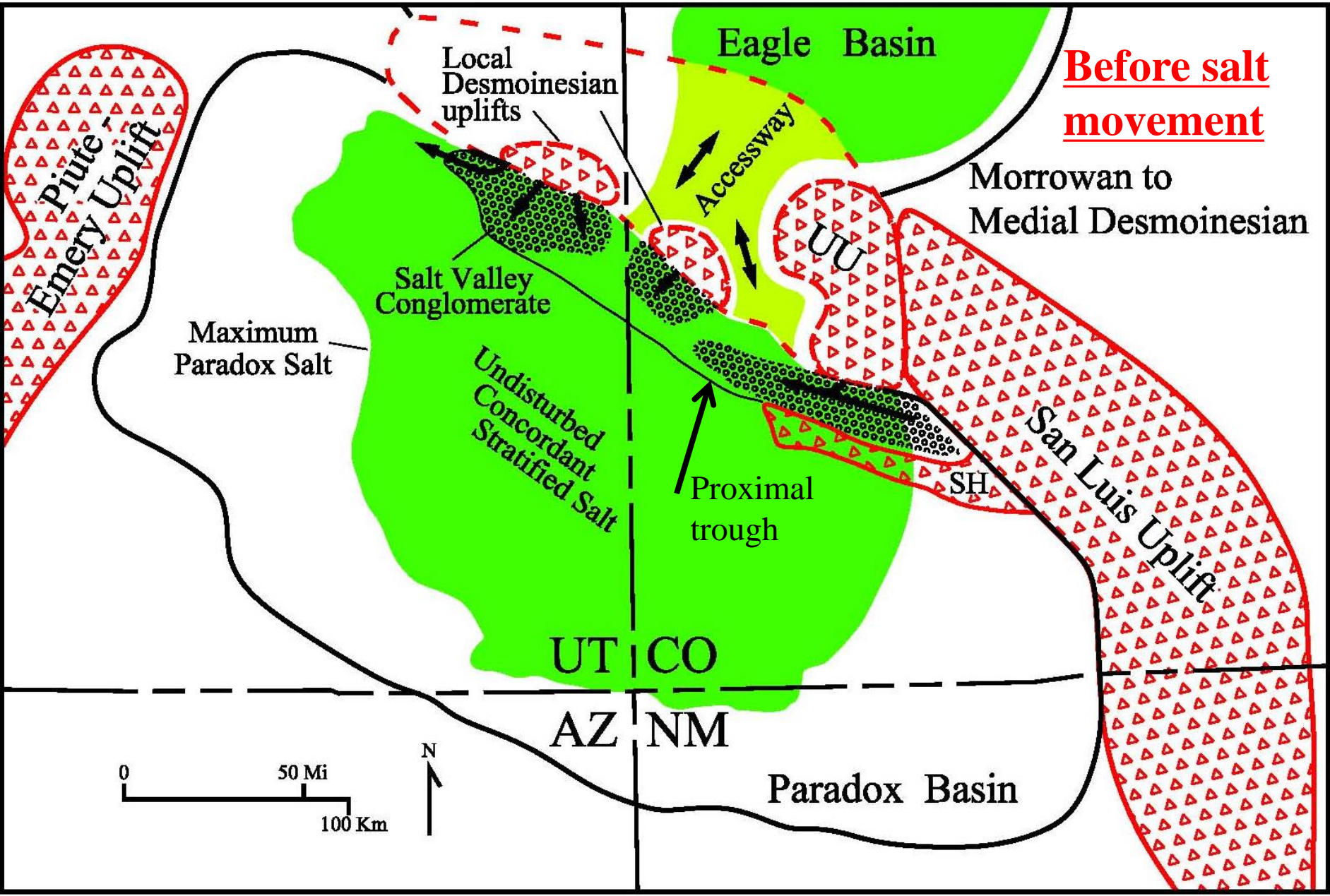
Boulder
sampled by
USGS
geologists in
1920s ?



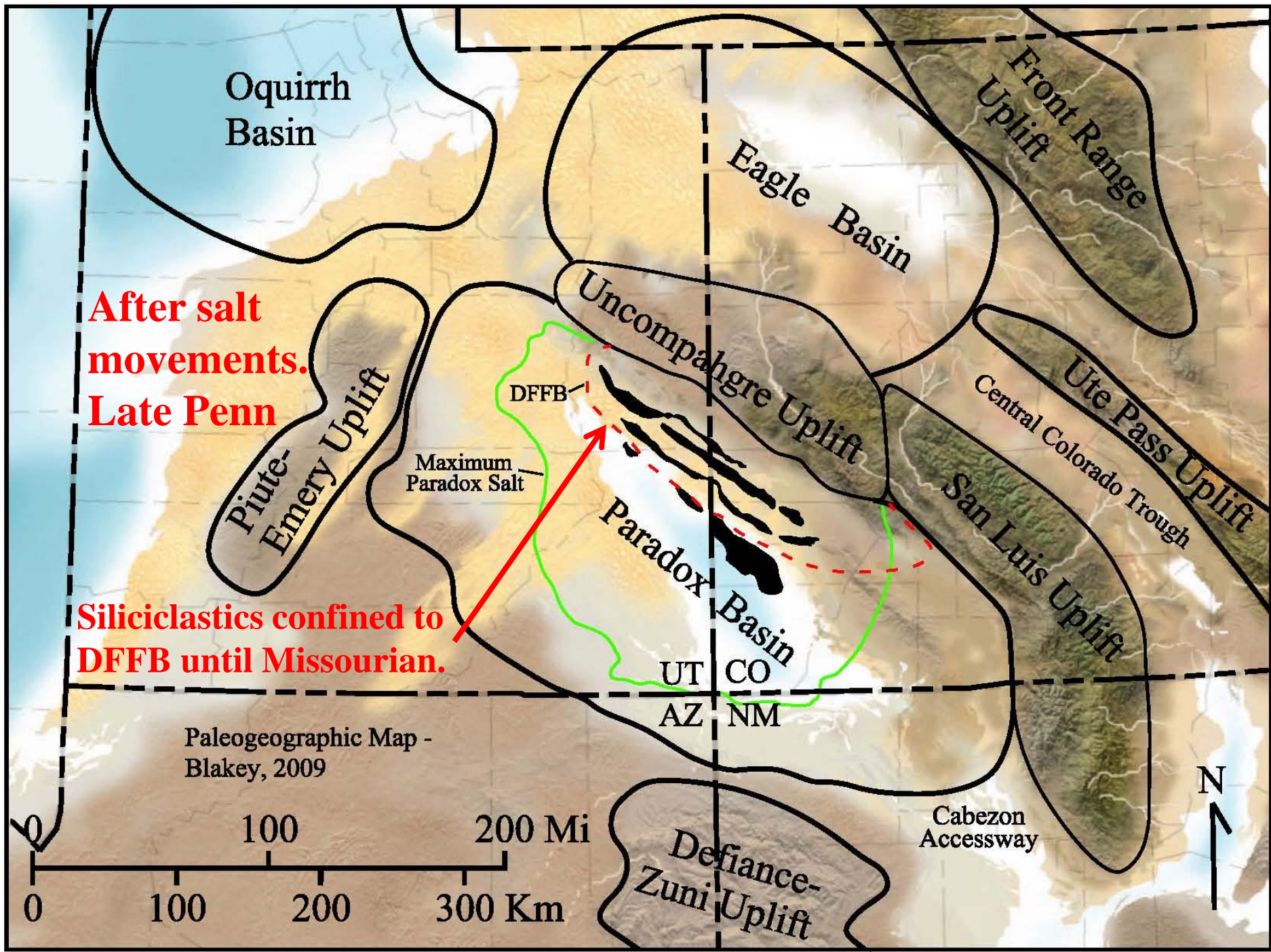
Very large boulder with Mississippian invertebrate macrofossils

Cong.





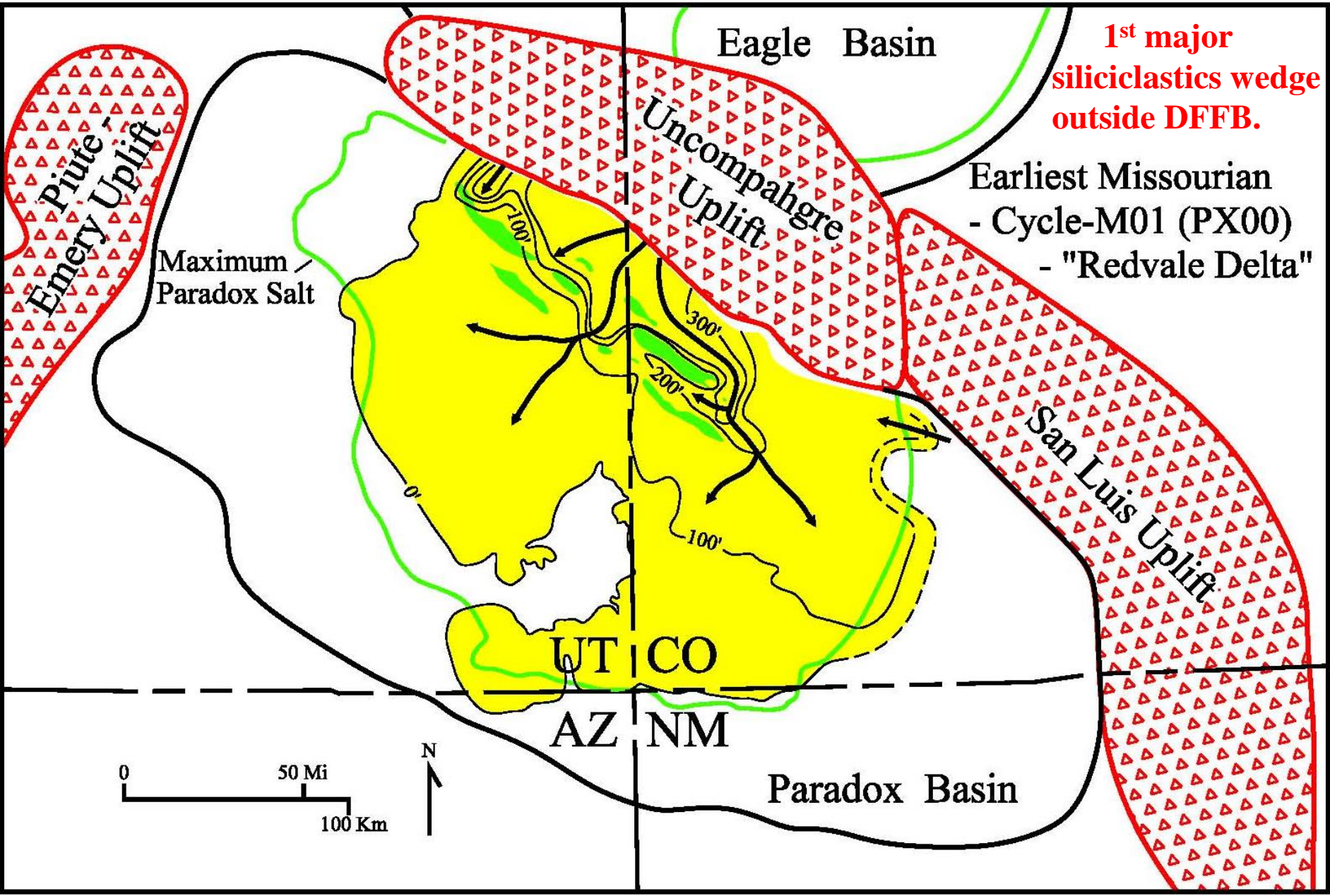
Before salt movement

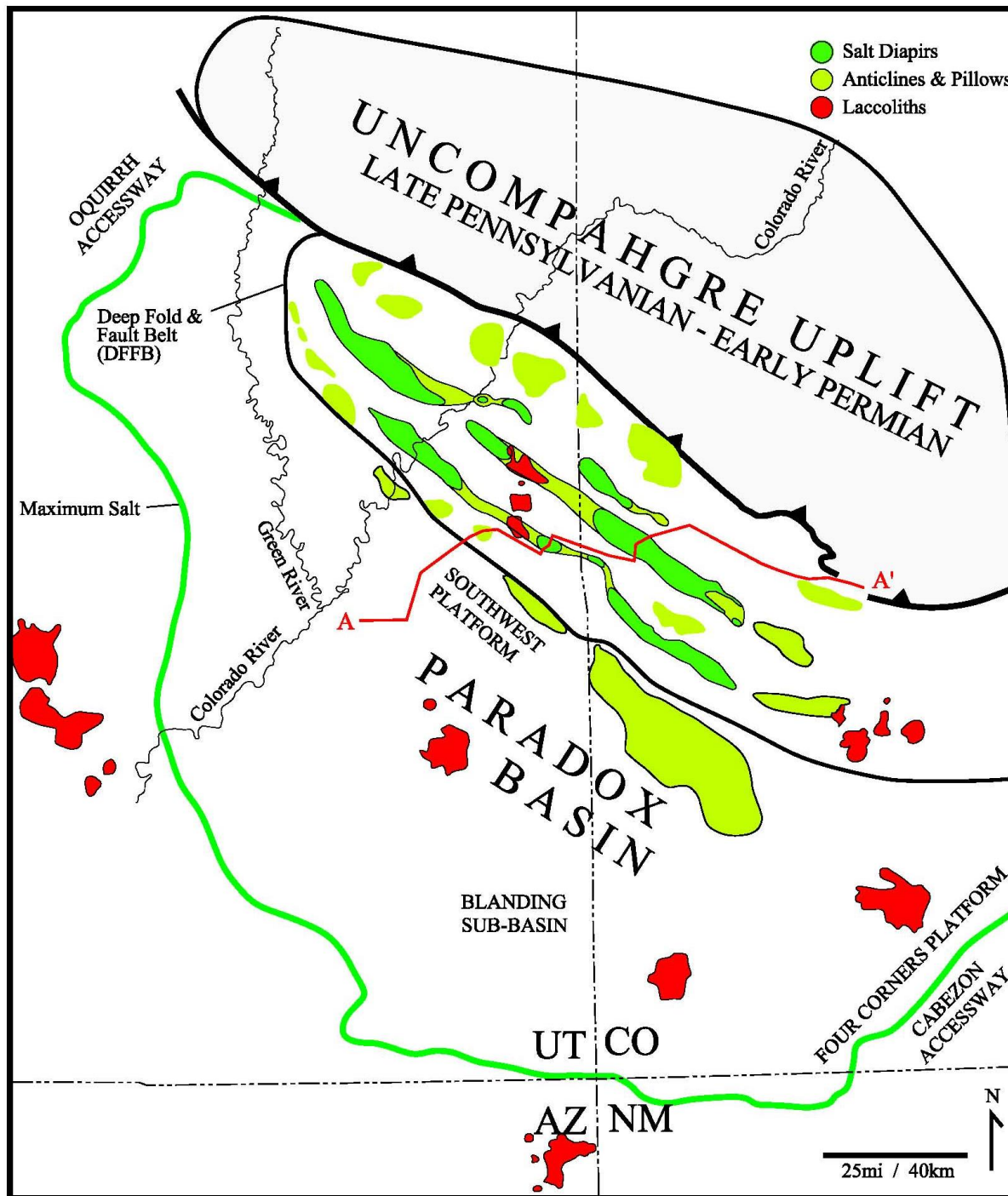


**After salt
movements.
Late Penn**

**Siliciclastics confined to
DFFB until Missourian.**

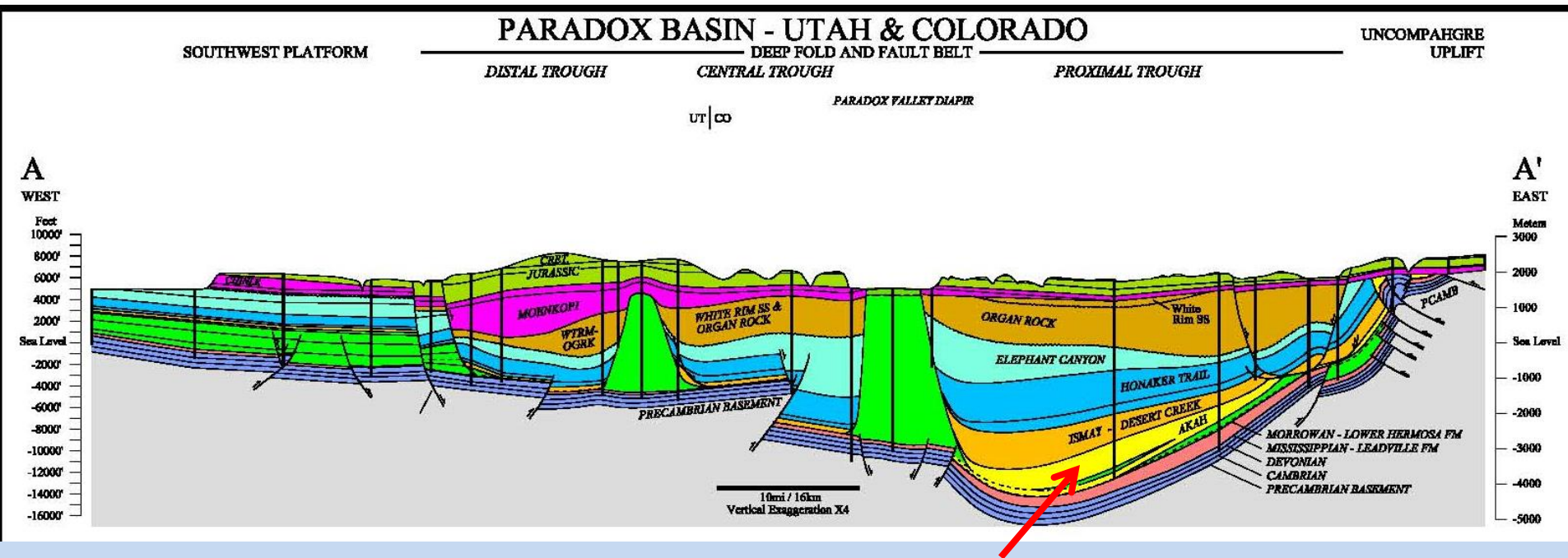
Paleogeographic Map -
Blakey, 2009



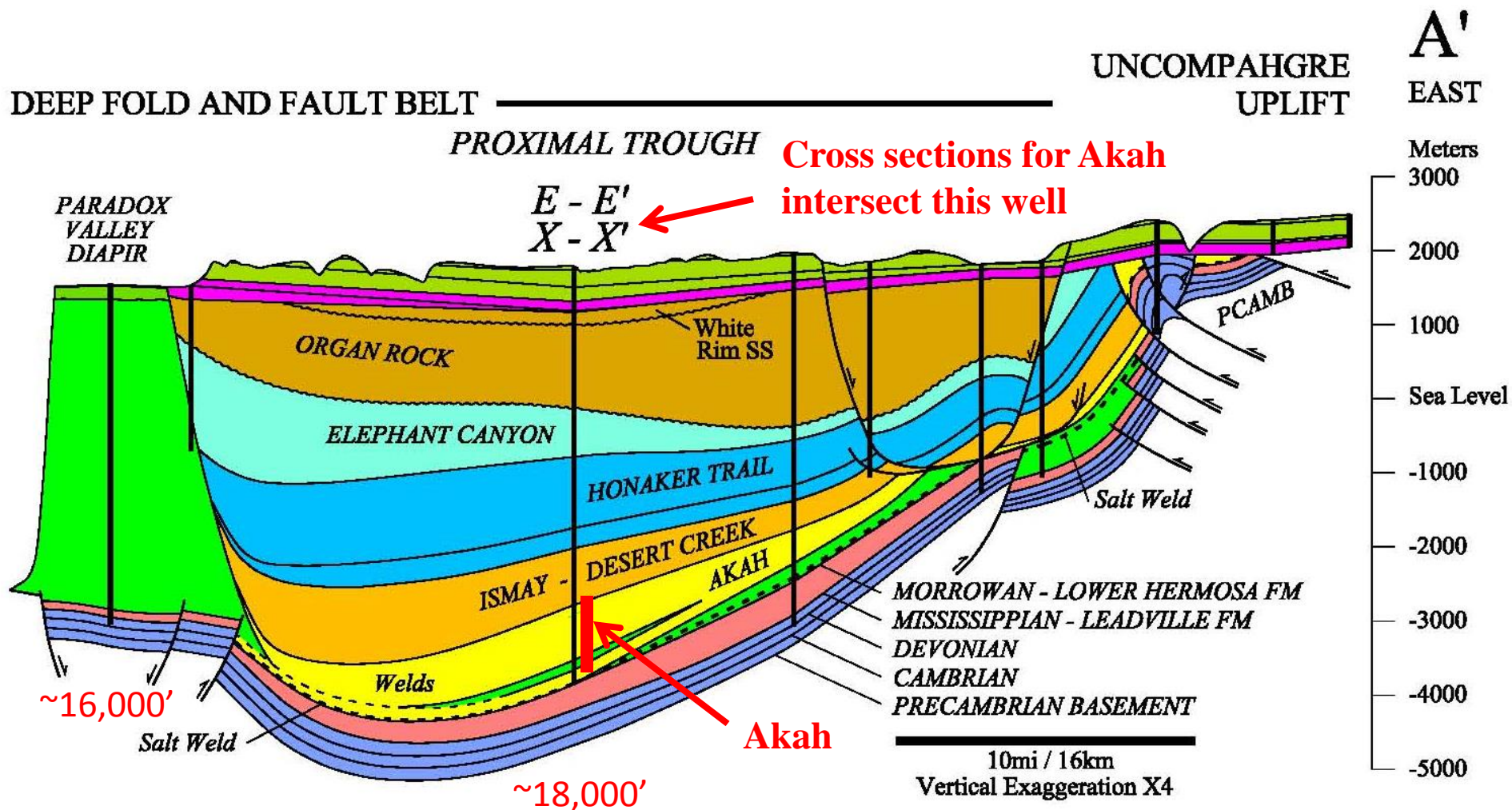


**Present
major salt
structures.**

**Diapirs
Anticlines
Pillows**



Akah – Cycles 7, 6b & 6a with thick siliciclastics at bottom of Proximal Trough and above salt weld, with Lower Hermosa and older strata below weld. These Akah strata caused 1st major salt movements of salt into rolls, anticlines and eventually diapirs along the distal margin of the Proximal Trough.

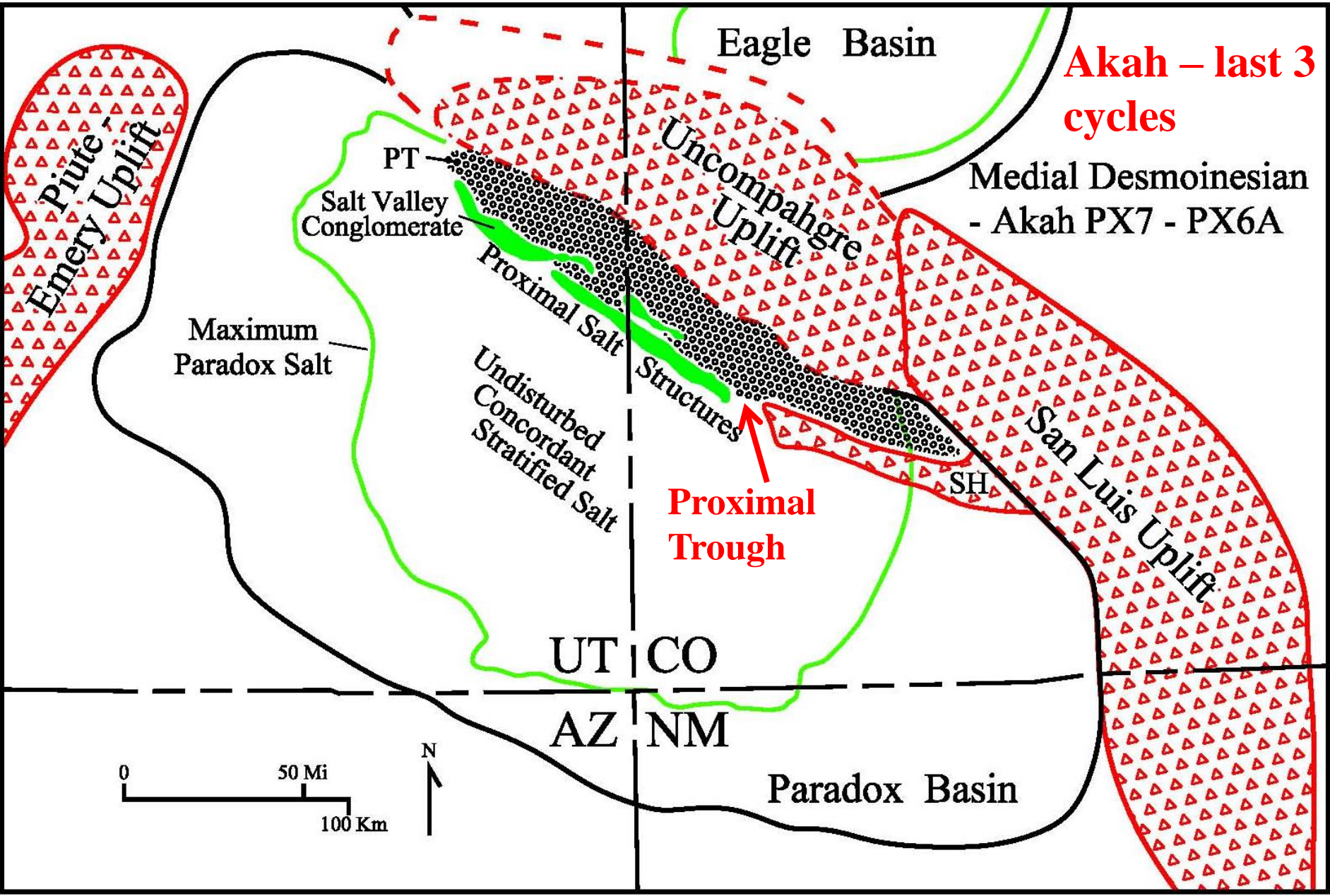


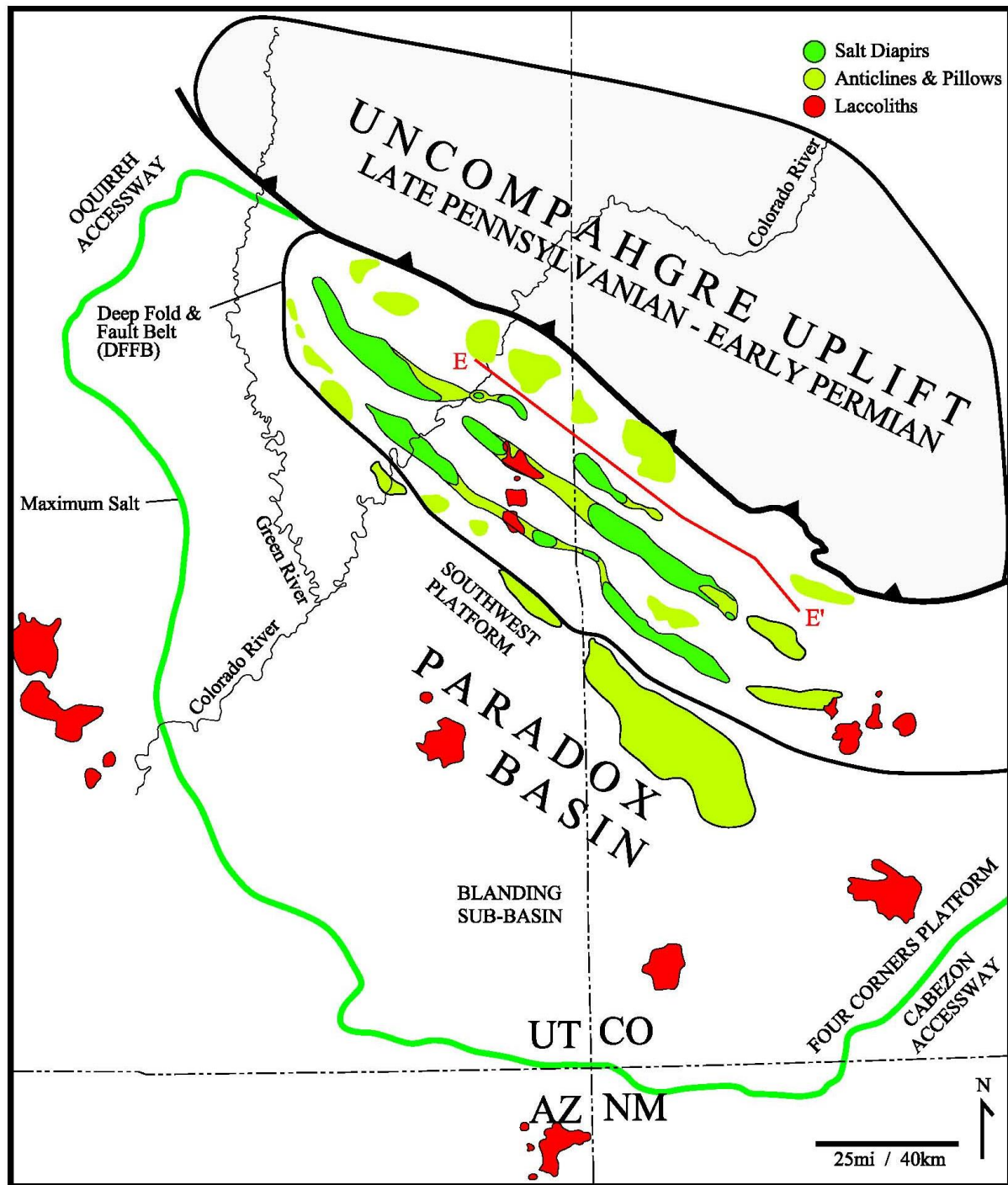
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PENNSYLVANIAN	PERMIAN	WOLFCAMPPIAN	HERMOSA	ELEPHANT CANYON/CEDAR MESA	Iron Wash		CY-W13?	?			
							CY-W12?	?			
							CY-W11?	?			
							CY-W10	A			
							CY-W09	A			
							CY-W08	A			
							CY-W07	A			
							CY-W06	A			
							CY-W05	A			
							CY-W04	A			
							CY-W03	A			
							CY-W02	A			
							CY-W01	A			
							CY-V08	A			
							CY-V07	A?			
							CY-V06	A			
							CY-V05	A			
							CY-V04	A?			
							CY-V03	A?			
							CY-V02	A			
MISSOURIAN	VIRGILIAN		HERMOSA	HONAKER TRAIL	La Sal		CY-V01	A			
							CY-M12	A?			
							CY-M11	A			
							CY-M10	A			
							CY-M09	A?			
							CY-M08	A			
							CY-M07	A			
							CY-M06	A			
							LA SAL	CY-M05	A		
							UHA	CY-M04	A		
							PX0000	CY-M03	A		
							PX000	CY-M02	A/H		
							PX00	CY-M01	A		
							PX0	PX0A	A		
							PX0	PX0B	A/H		
							Hatch	PX1	A/H/P		
							Ismay	PX2	A/H/P		
							Desert	PX3	A/H/P		
							Creek	PX4	A/H/P		
DESMOINESIAN			HERMOSA	PARADOX			PX5	A/H/P			
							PX6	PX6A	A/H/P		
							6 PX6	PX6B	A/H/P		
							7	PX7	A/H/P		
							8	PX8	A/H/P		
							PX9	PX9A	A/H/P		
							9 PX9	PX9B	A/H/P		
							10	PX10	A/H/P		
							11	PX11	A/H/P		
							12	PX12	A/H/P		
							13	PX13	A/H/P		
							14	PX14	A/H/P		
							15	PX15	A/H/P		
							16	PX16	A/H/P		
							17	PX17	A/H/P		
							18	PX18	A/H/P		
							19	PX19	A/H/P		
							Barker Creek				

Akah

1st

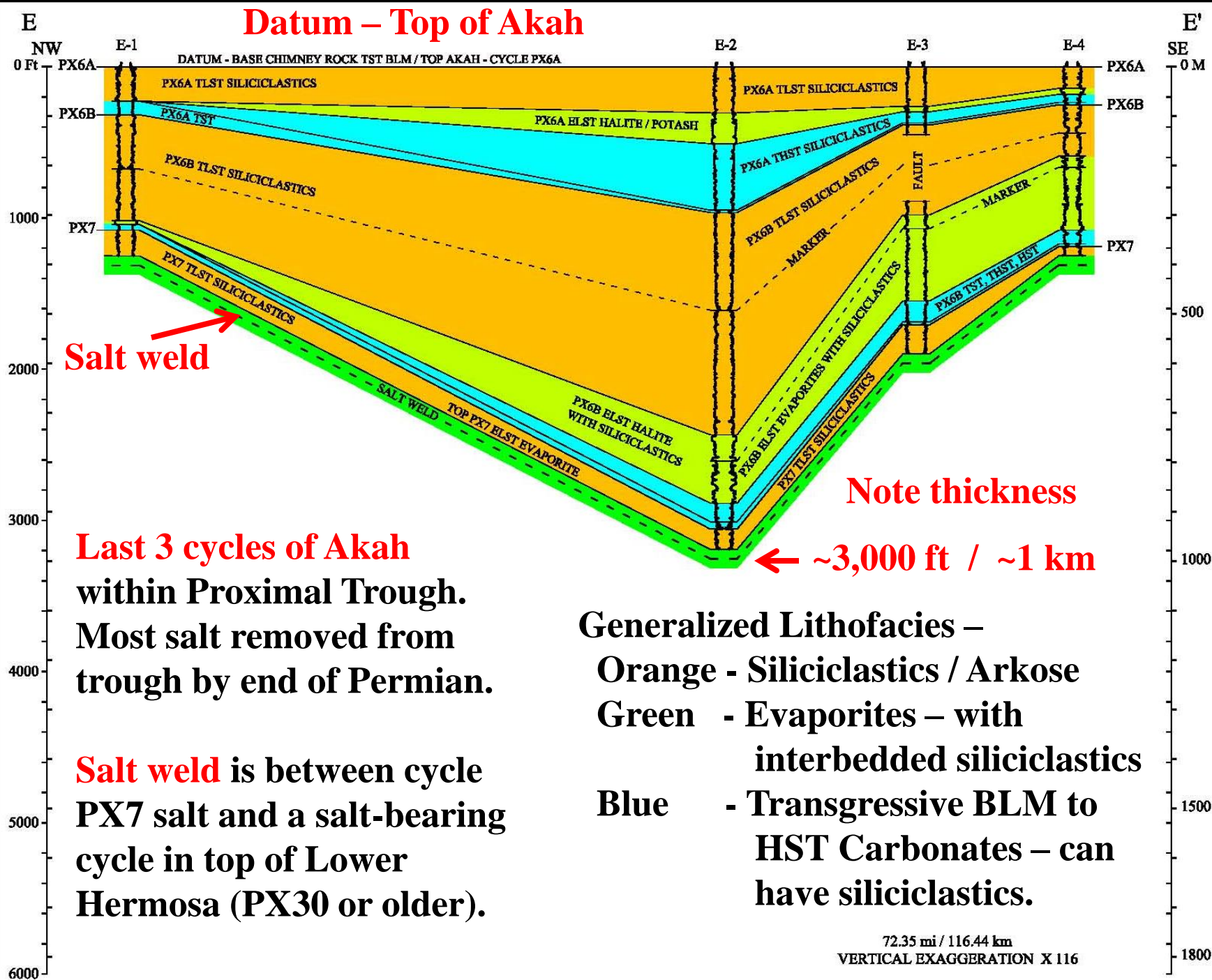
1st

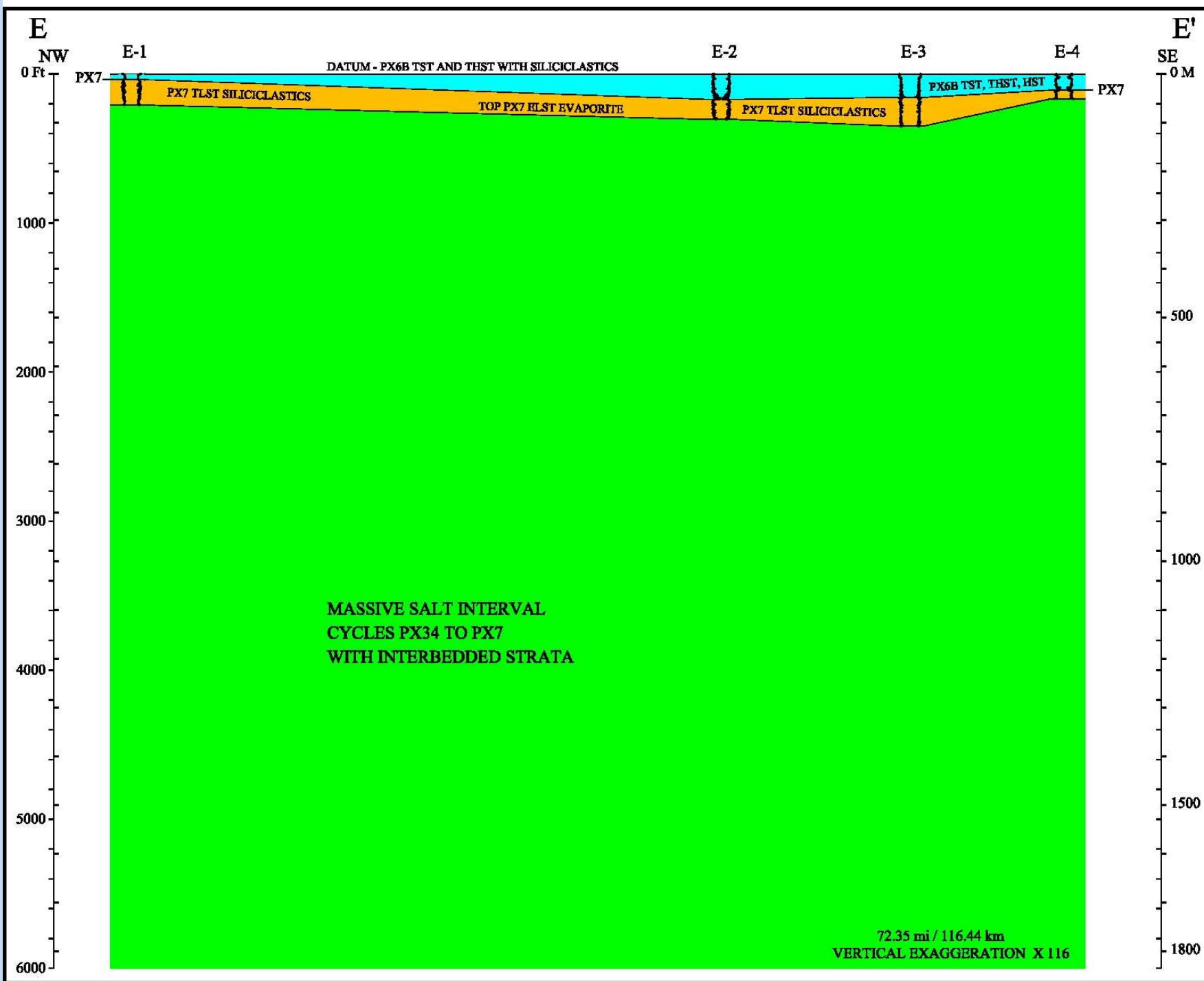


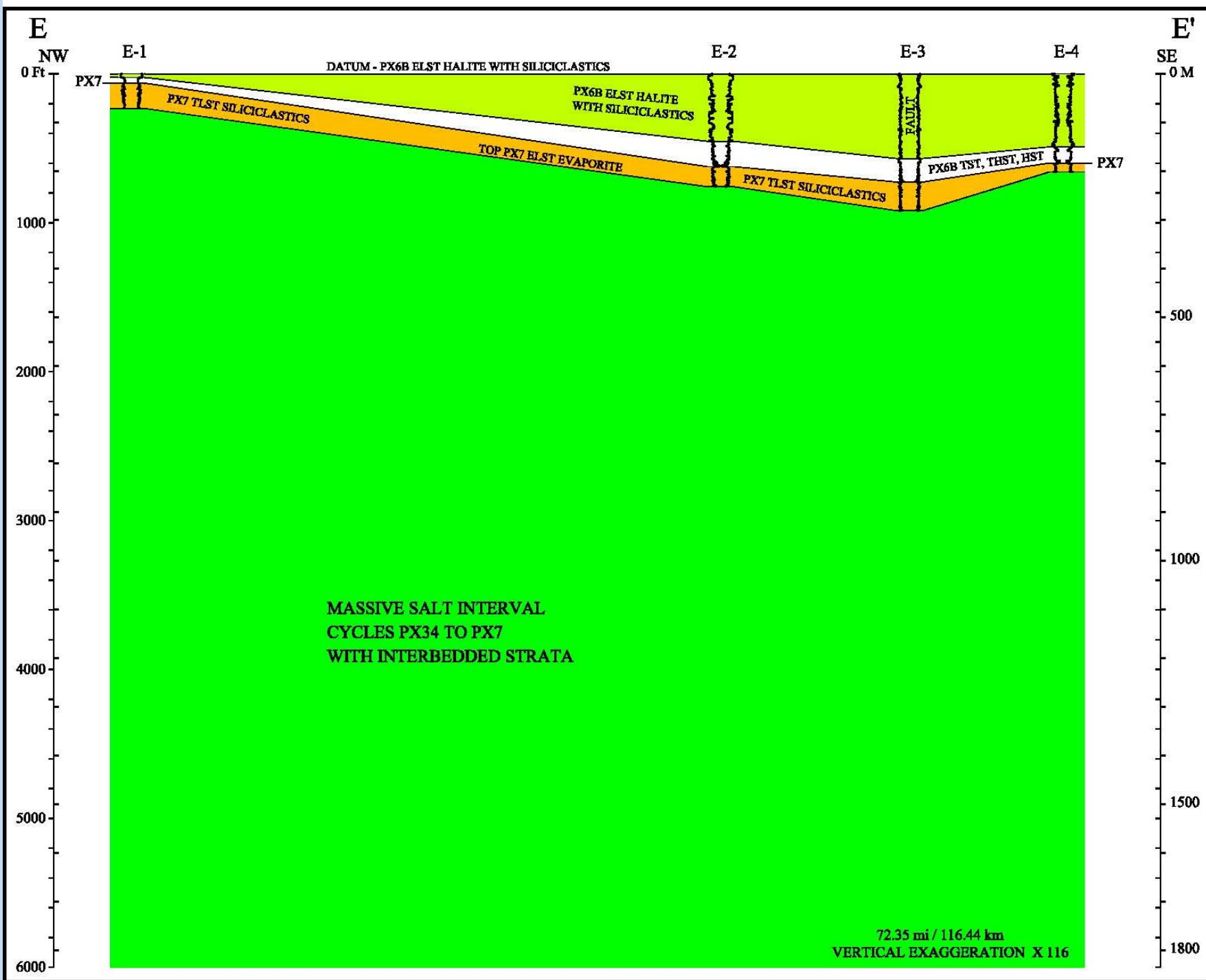


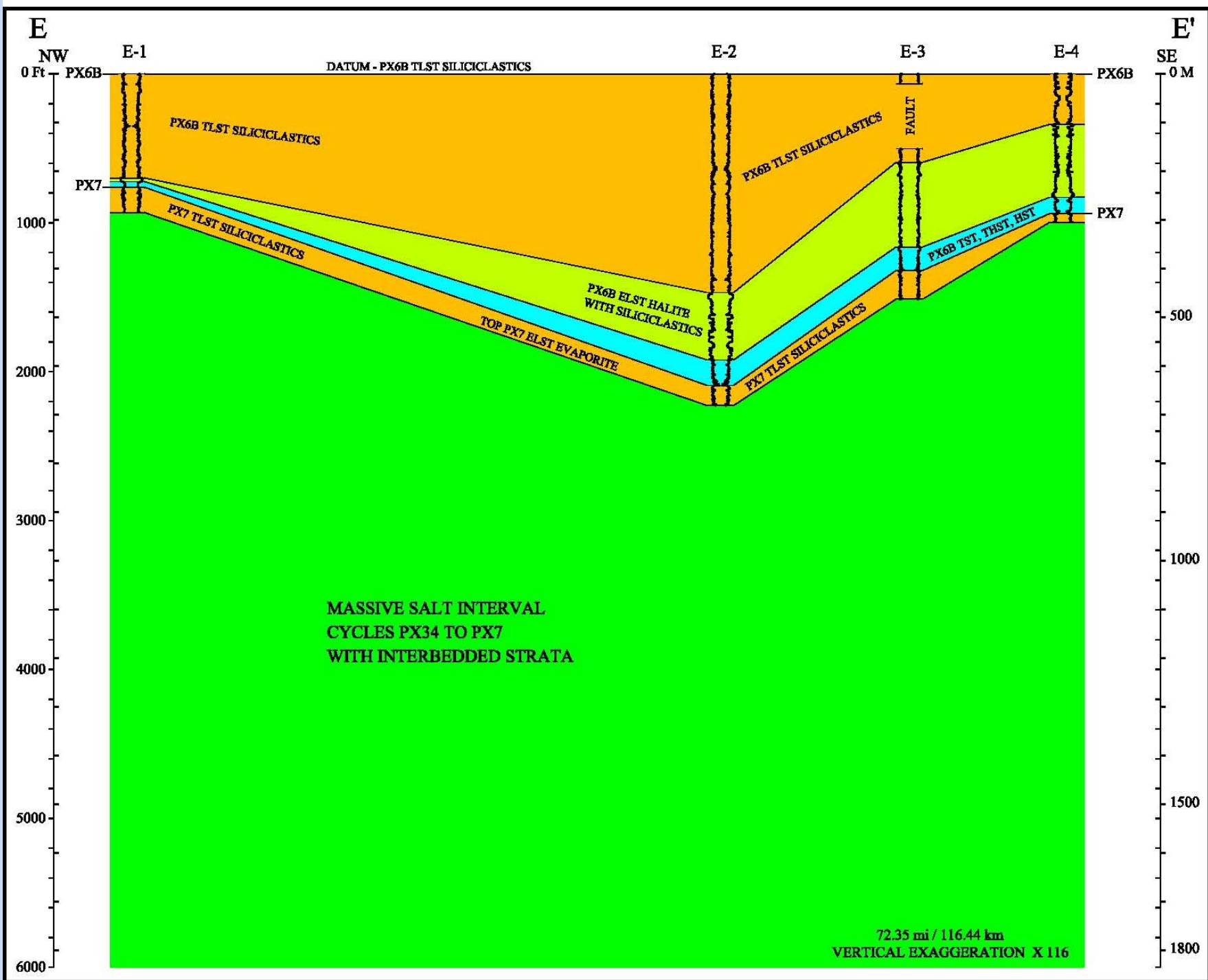
**Cross section E-E'
within Proximal
Trough.**

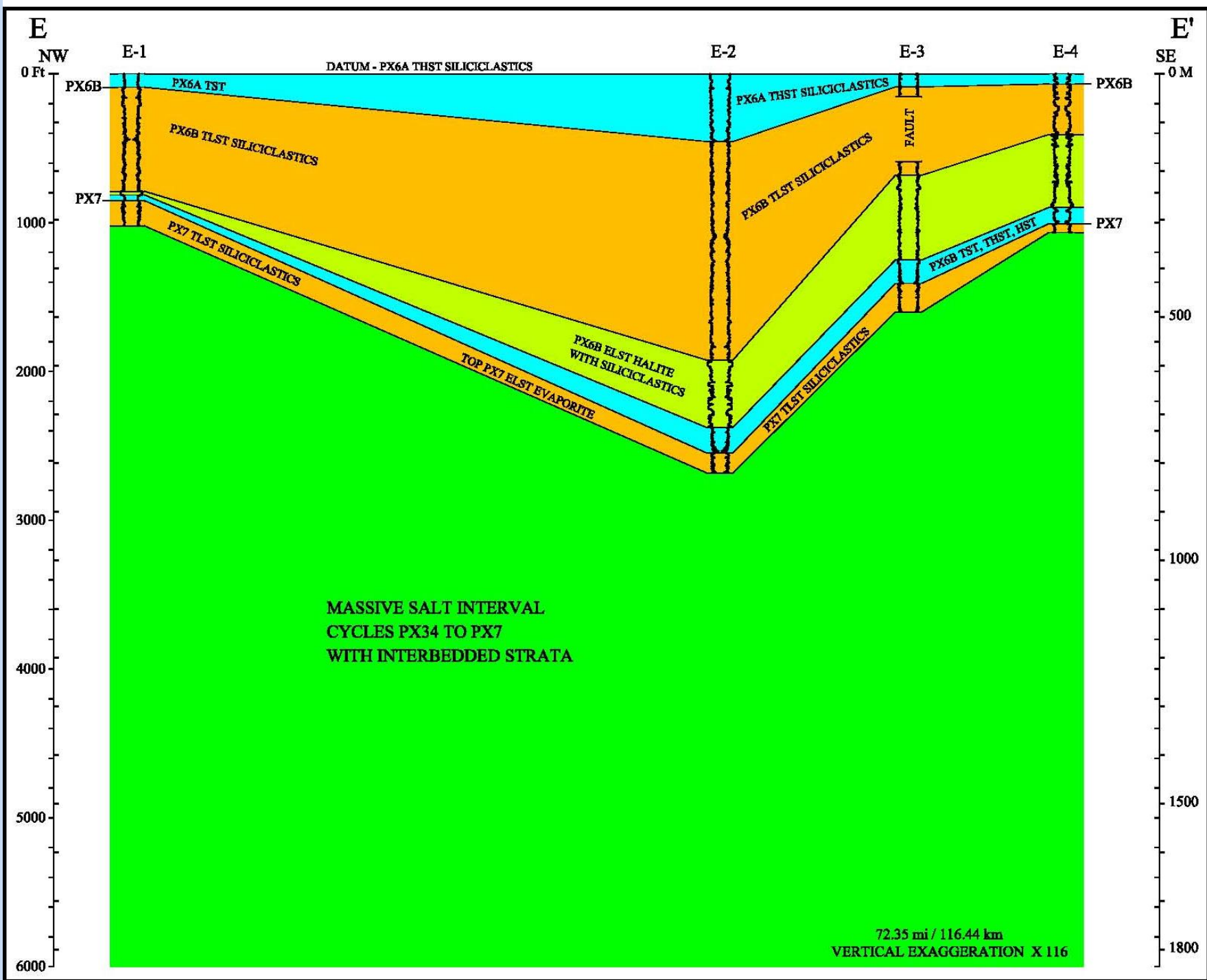
**Late Akah -
Massive deposition
from Uncompahgre
Uplift, then NW
toward Oquirrh
Accessway.**

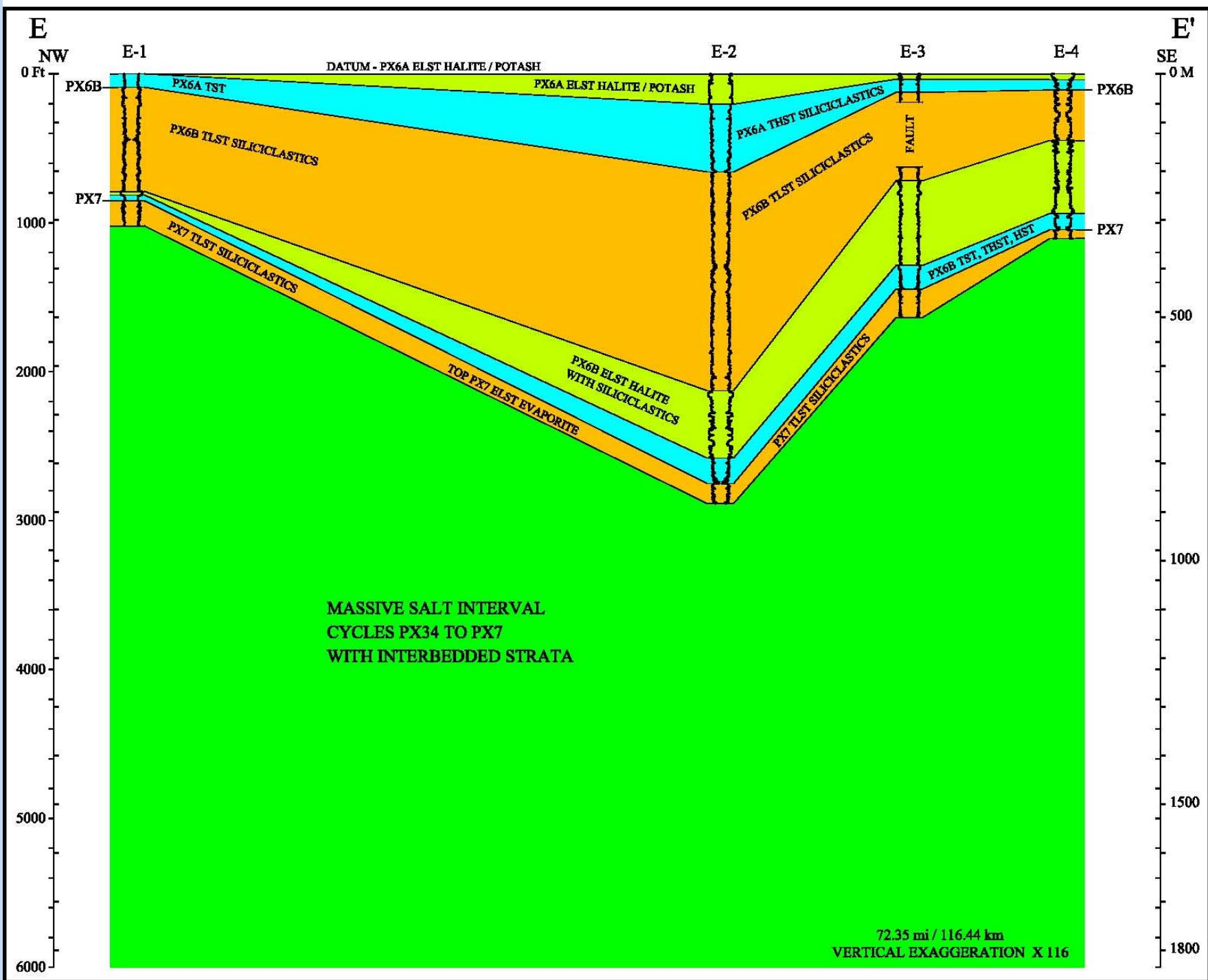


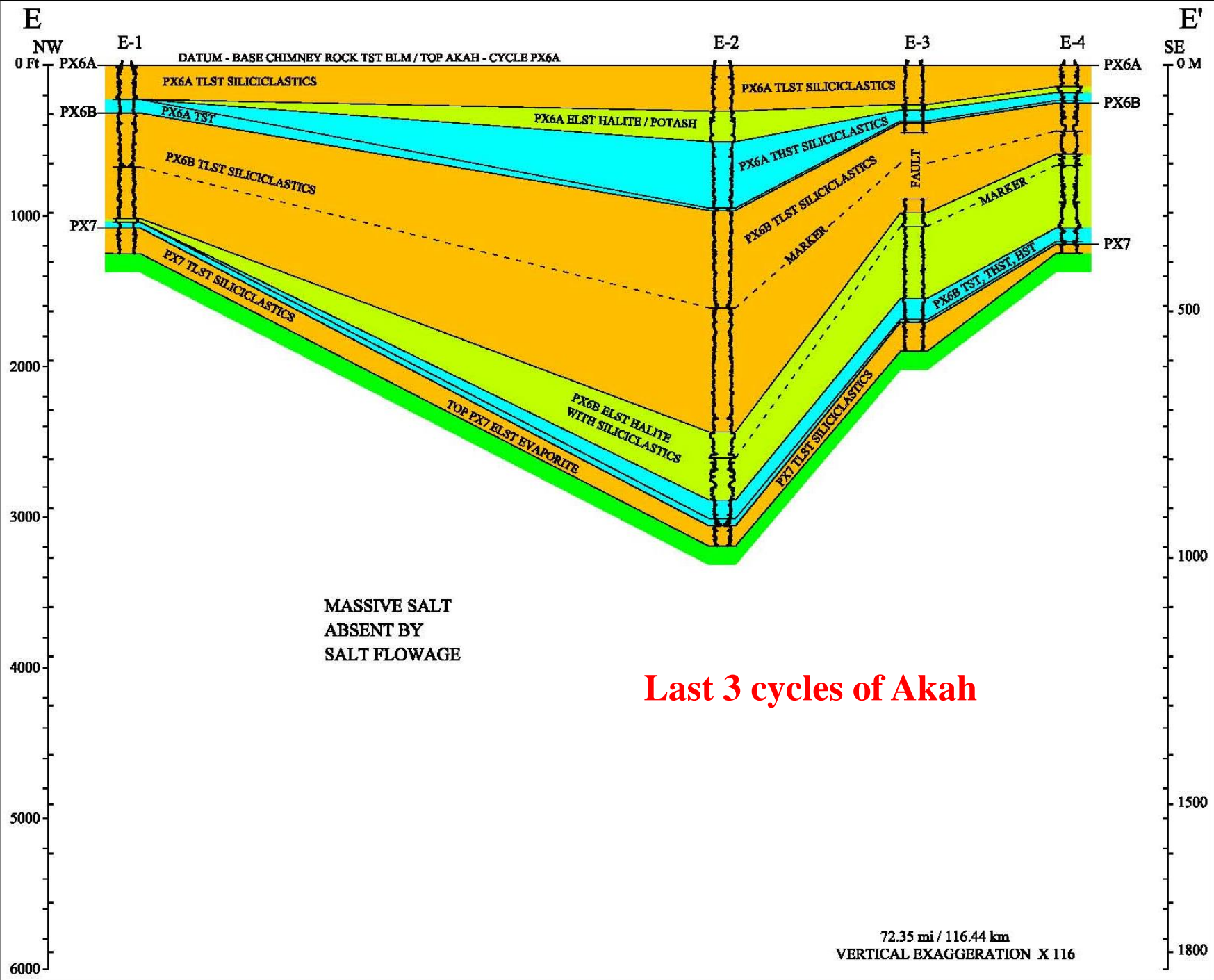


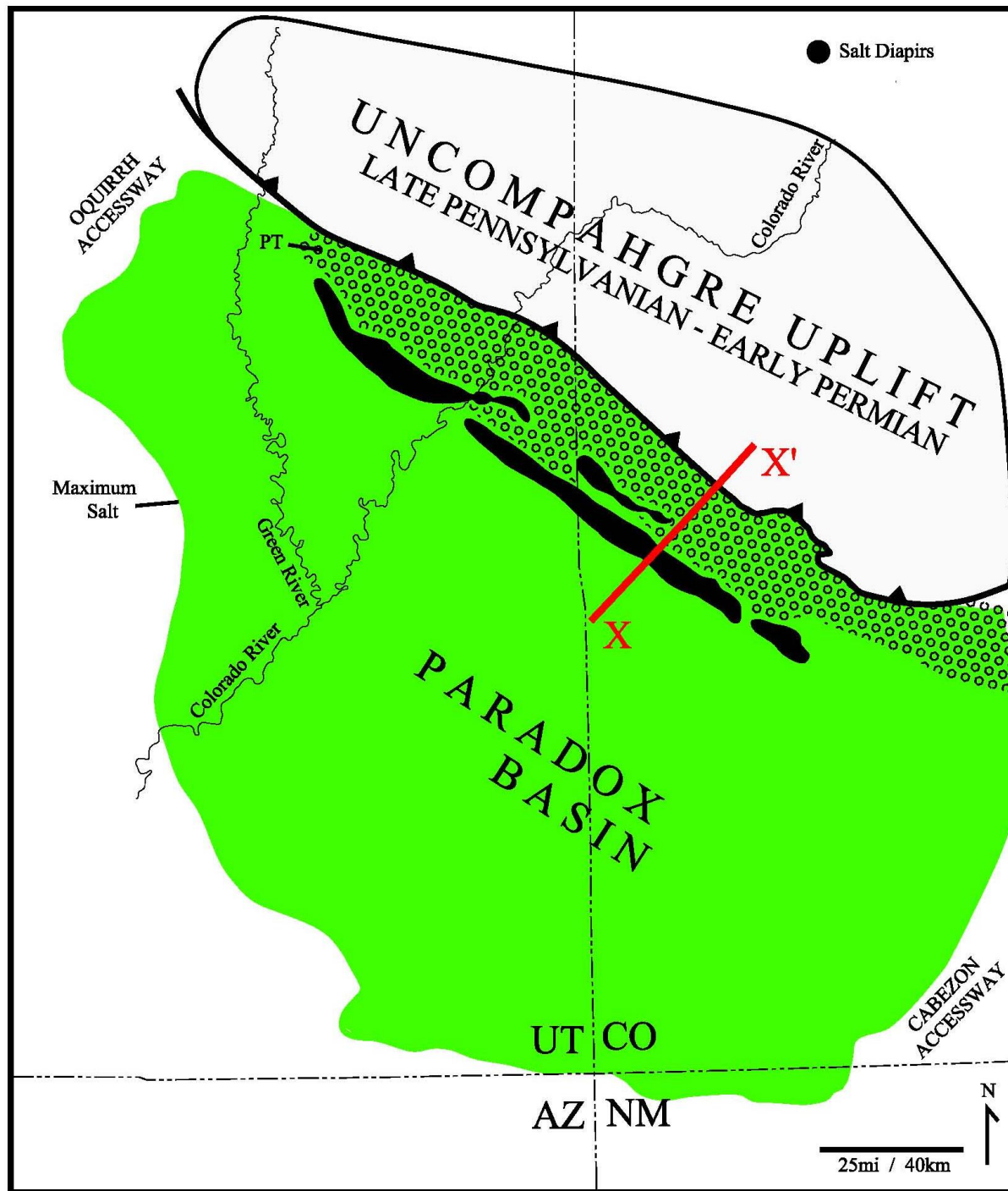










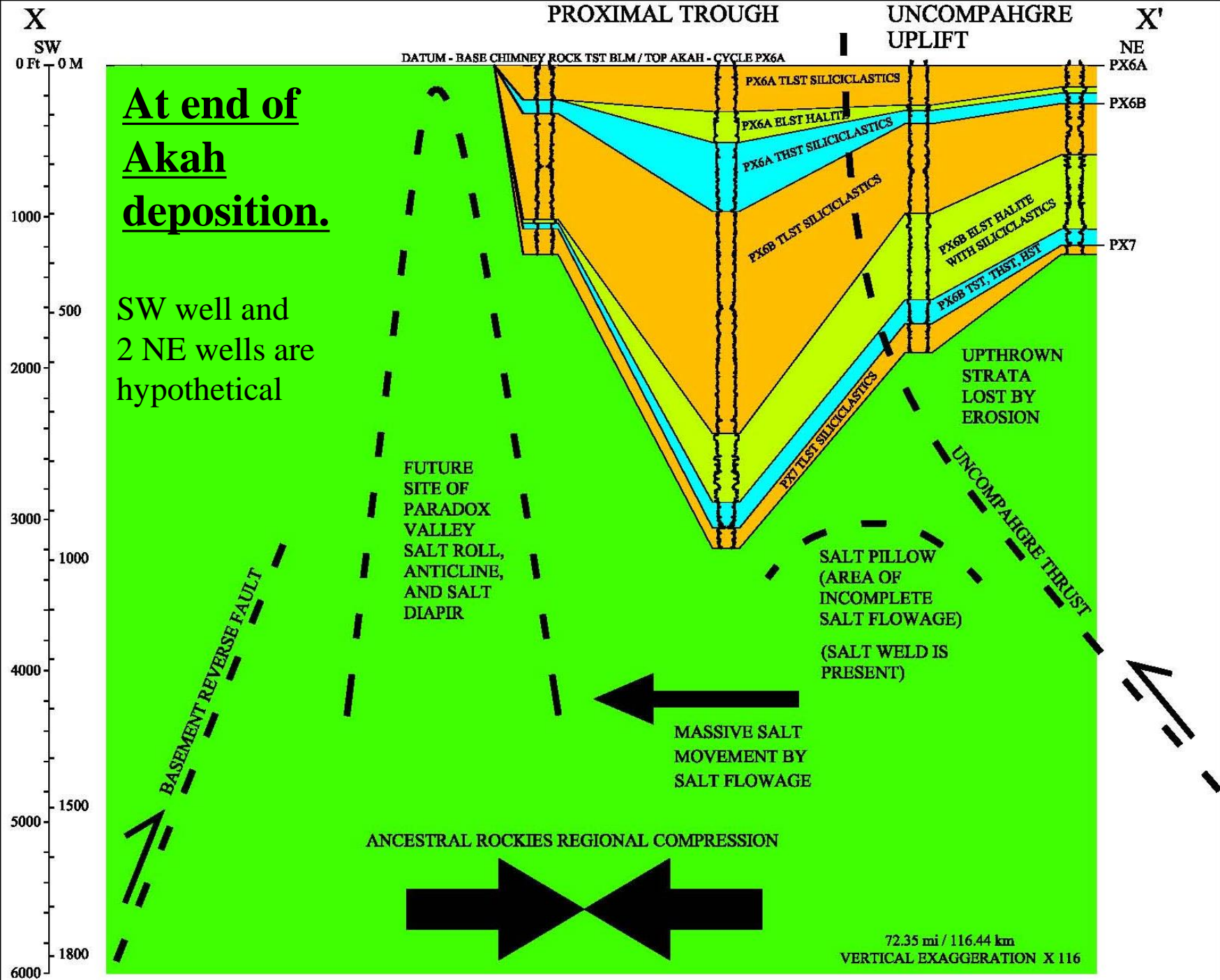


End of Akah deposition.

Previous cross section E-E' rotated to cross Proximal Trough, and redrawn to become X-X'.

ARM thrusting of uplift was ~ 15 km to SW.

No salt structures beyond those shown here.





Collared Lizard – *Crotaphytus collaris*
(near Gateway, Colorado)

Thanks for your attention