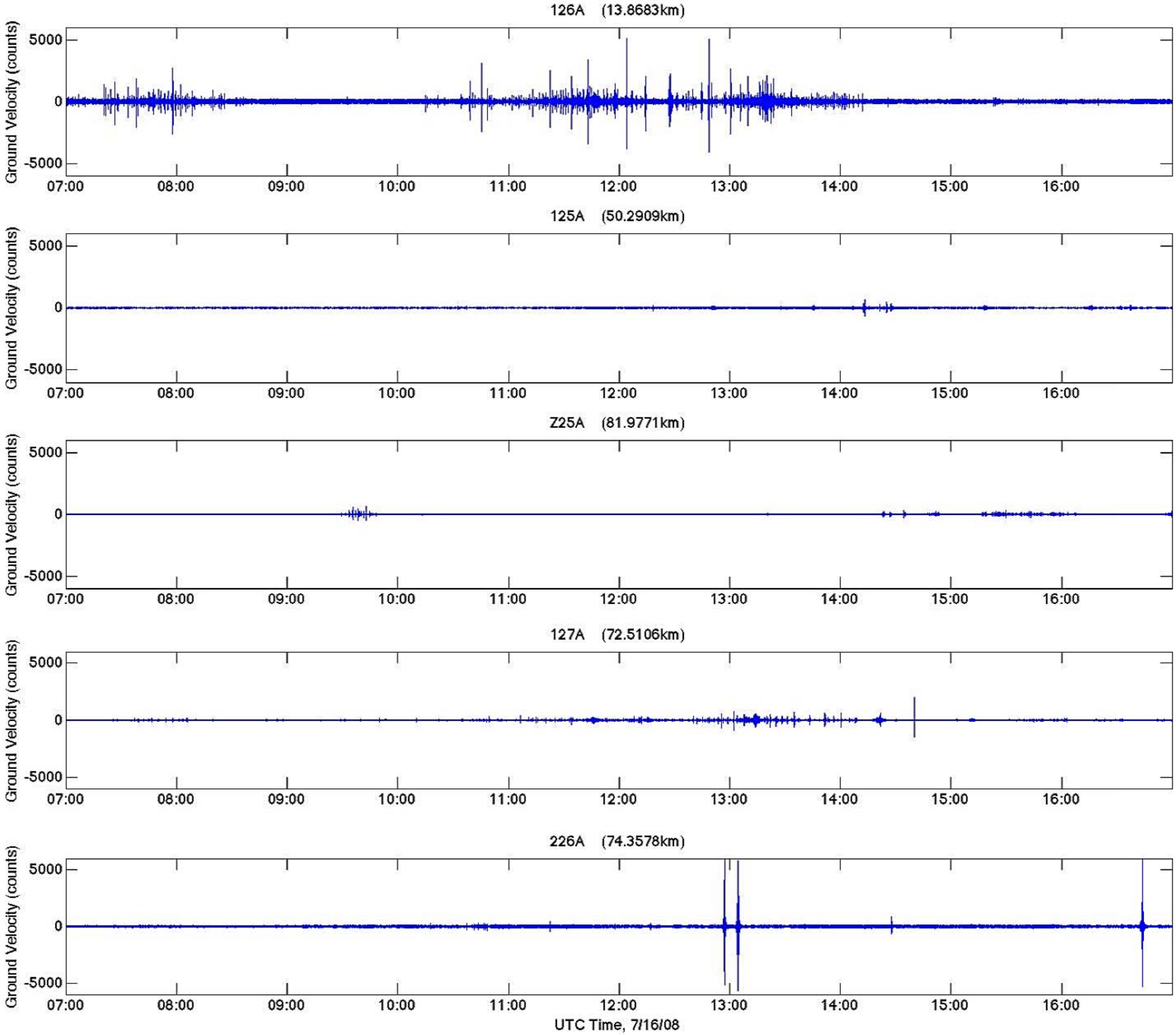
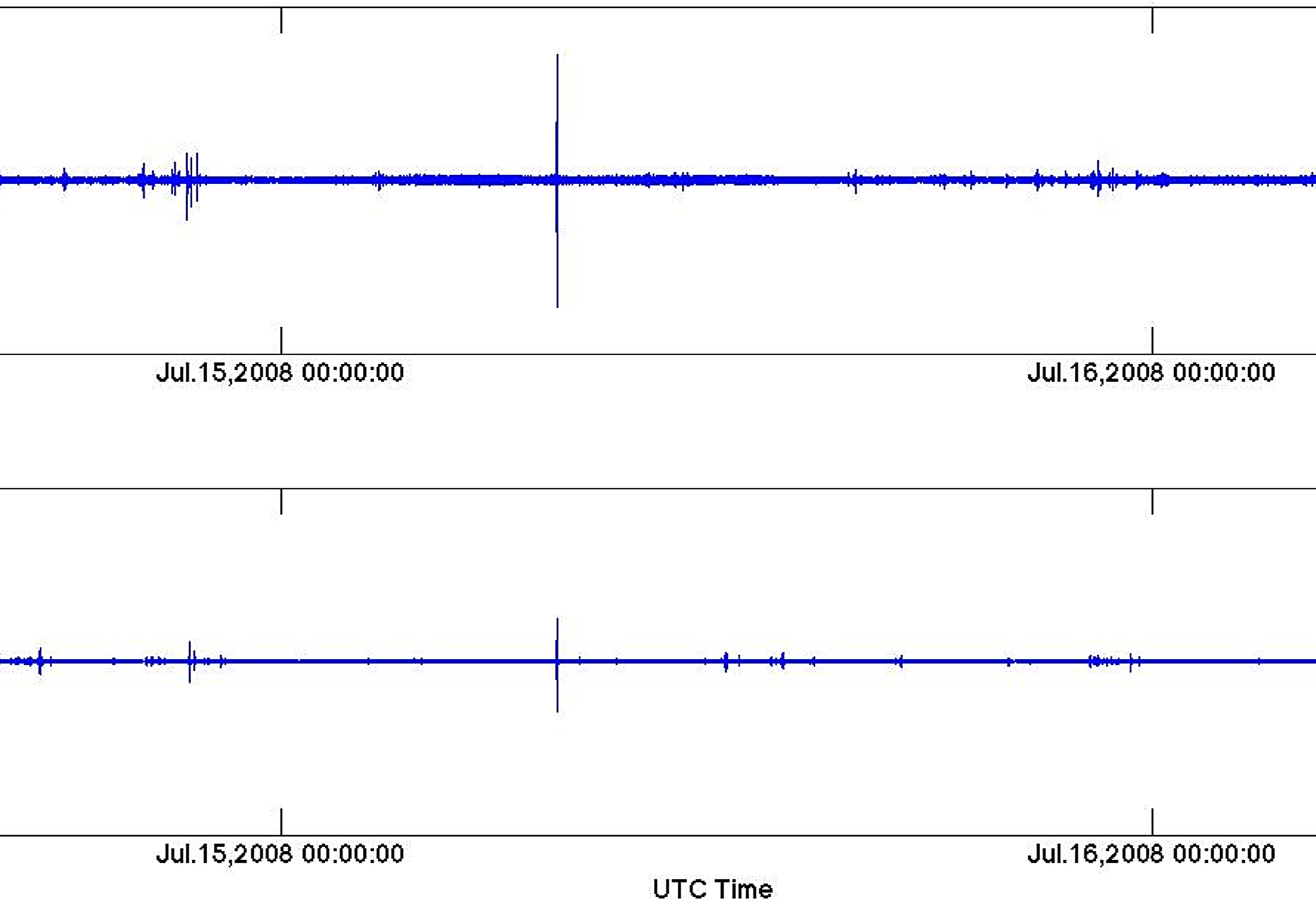
BW - ___005_____

BRINE WELL COLLAPSE


126A (13.8683km)
125A (50.2909km)
Z25A (81.9771km)
127A (72.5106km)
226A (74.3578km)
Ground Velocity (counts)
5000
0
-5000
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
UTC Time, 7/16/08


Jul.15,2008 00:00:00
Jul.16,2008 00:00:00
Jul.15,2008 00:00:00
Jul.16,2008 00:00:00
UTC Time

Field Activity Report

Jim's Water Service Brine Well (BW-005) Collapse

by Jim Griswold

Visited site on afternoon of 7/30/08 to undertake preliminary radiation survey. Used Ludlum meter outfitted with scintillation probe on loan from Radiation Bureau of NMED. Device last calibrated in Sept. 2007. No calibration standard available but scanned mildly radioactive rock specimen (thorium sulfate) to ensure meter was indeed responding. All readings taken within or immediately above visible concentric cracks in soil approximately equidistant (40 feet) from edge of sinkhole

Background radiation (outside fenced area) at site:	0.40 milliRoentgens/hour (mR/hr)
Service road leading SE from sinkhole ~60ft. from edge	0.40
~30 ft clockwise from SE road	0.35
~60 ft clockwise from SE road	0.45
~100 ft clockwise from SE road	0.45
South of sinkhole	0.40
Road leading SW from sinkhole	0.30
~30 ft clockwise from SW road	0.35
~60 ft clockwise from SW road	0.35
Within surface drainage	0.35
West of sinkhole	0.45
~30 ft clockwise from west	0.50
~60 ft clockwise from west	0.45
NW of sinkhole	0.25
~30 ft clockwise from NW	0.50
~60 ft clockwise from NW	0.40
~100 ft clockwise from NW	0.45
North of sinkhole	0.50
Road leading NE from sinkhole	0.30
~30 ft clockwise from NE road	0.35
~60 ft clockwise from NE road	0.35 mR/hr

No sidewall collapse events noticed during visit (~45 minutes on site). Sidewalls now appear to be angling inward as opposed to vertical or undercut walls during last visit on 7/24/08. Vertical uplifting of trailing edge of fractured soil blocks of 6 to 8 inches. Crack widths vary from <1 inch to 4 inches. Lobbed several rocks over edge and did not hear any splashes in water, but rather light "thuds" as if hitting soil.

Field Activity Report

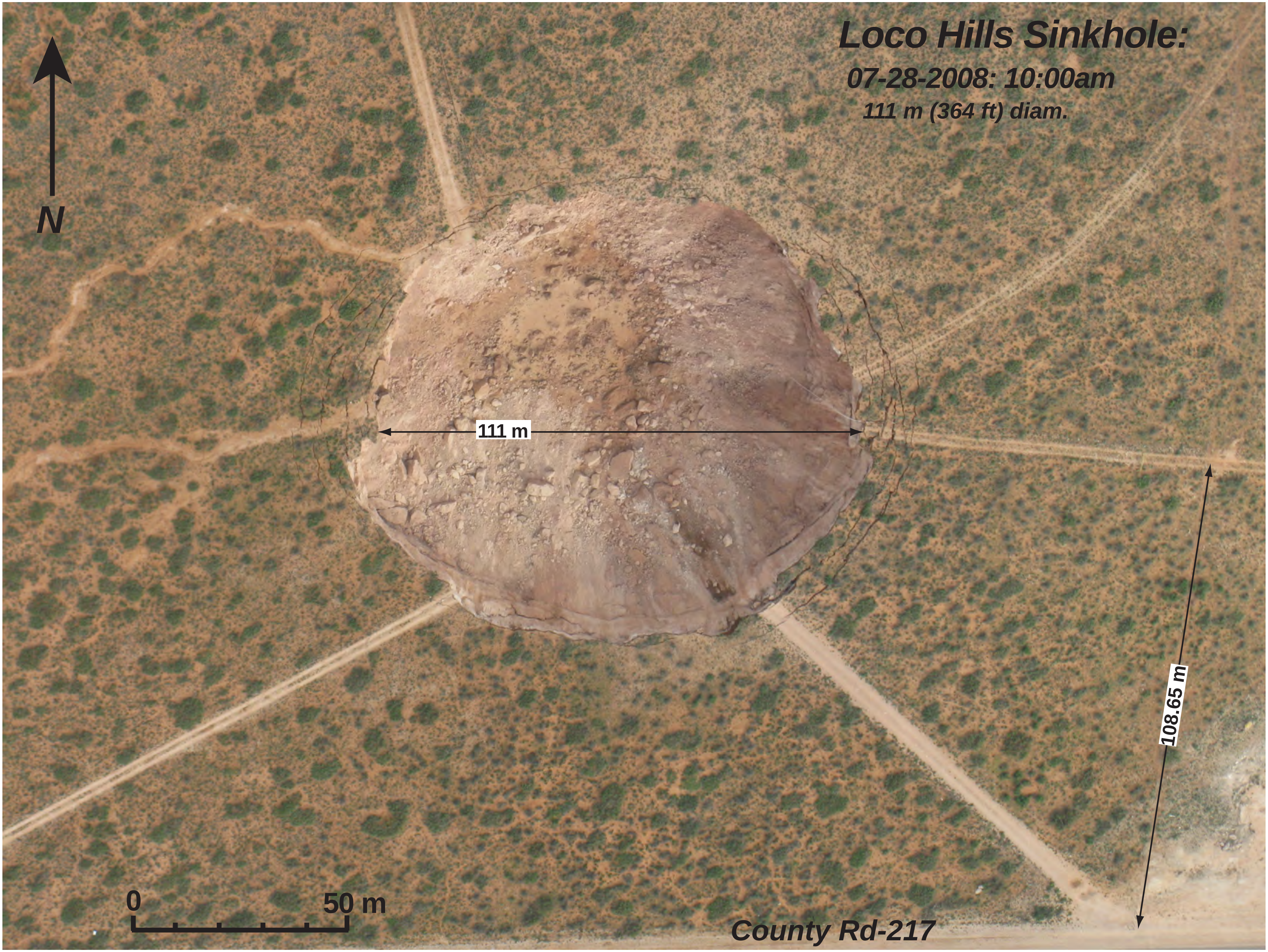
Jim's Water Service Brine Well (BW-005) Collapse

by Jim Griswold

Visited site on afternoon of 7/30/08 to undertake preliminary radiation survey. Used Ludlum meter outfitted with scintillation probe on loan from Radiation Bureau of NMED. Device last calibrated in Sept. 2007. No calibration standard available but scanned mildly radioactive rock specimen (thorium sulfate) to ensure meter was indeed responding. All readings taken within or immediately above visible concentric cracks in soil approximately equidistant (40 feet) from edge of sinkhole

Background radiation (outside fenced area) at site:	0.40 milliRoentgens/hour (mR/hr)
Service road leading SE from sinkhole ~60ft. from edge	0.40
~30 ft clockwise from SE road	0.35
~60 ft clockwise from SE road	0.45
~100 ft clockwise from SE road	0.45
South of sinkhole	0.40
Road leading SW from sinkhole	0.30
~30 ft clockwise from SW road	0.35
~60 ft clockwise from SW road	0.35
Within surface drainage	0.35
West of sinkhole	0.45
~30 ft clockwise from west	0.50
~60 ft clockwise from west	0.45
NW of sinkhole	0.25
~30 ft clockwise from NW	0.50
~60 ft clockwise from NW	0.40
~100 ft clockwise from NW	0.45
North of sinkhole	0.50
Road leading NE from sinkhole	0.30
~30 ft clockwise from NE road	0.35
~60 ft clockwise from NE road	0.35 mR/hr

No sidewall collapse events noticed during visit (~45 minutes on site). Sidewalls now appear to be angling inward as opposed to vertical or undercut walls during last visit on 7/24/08. Vertical uplifting of trailing edge of fractured soil blocks of 6 to 8 inches. Crack widths vary from <1 inch to 4 inches. Lobbed several rocks over edge and did not hear any splashes in water, but rather light "thuds" as if hitting soil.


Loco Hills Sinkhole:
07-28-2008: 10:00am
111 m (364 ft) diam.
N
111 m
108.65 m
0
50 m
County Rd-217

2008 Brine Well Collapse Eddy County, New Mexico

Glenn von Gonten
Senior Hydrologist
Oil Conservation Division
Environmental Bureau

New Mexico Energy, Minerals and Natural Resources Department

STATE OF NEW MEXICO

OIL CONSERVATION DIVISION

BRINE WELL COLLAPSE OVERVIEW

- Jim's Water Service BW005
- State 24 No. 1
- API No. 30-015-0236
- Unit Letter "J", Section 24, Township 18 South, Range 28 East.
- 17.3 miles east-southeast of Artesia, NM.

BRINE WELL COLLAPSE OVERVIEW

- Initial collapse occurred at approximately 8:15 AM on July 15, 2008
- Jim’s Water Service reported the collapse of its Brine Supply well to the OCD District Office in Artesia on the morning of July 16, 2008.
- Photos and information from OCD staff revealed that the former site of the Brine Well had collapsed into a sinkhole that was several hundred feet across and an unknown depth.

BRINE WELL COLLAPSE OVERVIEW

- OCD Artesia District staff visited site with the Operator on July 16, 2008, and relayed information to Santa Fe office on Wednesday afternoon.
- Eddy County Emergency Management Services and State Police shut down a three mile stretch of Hagerman Road and set up an EMS Mobil Command Center.


ROAD
CLOSED
SINKHOLE
DANGEROUS
CONDITION


EDDY COUNTY

BRINE WELL COLLAPSE INITIAL RESPONSE

- The initial objectives where to secure the area and to determine whether the sinkhole posed a risk to CR 217.
- The routine was to observe the growth of the sinkhole and to keep the public out of the area.
- Respondents walked around the perimeter of the still active sinkhole, keeping a safe distance away from the edge, to observe the cm-scale ring fractures.
- This continued until JWS had a barbed wire fence and gates installed around the site. This allowed the surface leasor to bring in his cattle and for OCD and SLO to close the incident command center.

BRINE WELL COLLAPSE INITIAL RESPONSE

- OCD, SLO, Eddy Co. EMS, BLM, JWS and the National Cave and Karst Institute (NCKRI) staff all observed the sinkhole development from the Emergency Command Center which was manned 24 hours a day.
- Aerial photos were obtained at relatively frequent intervals, mostly by NCKRI.

BW005

- Jim’s Water Service (JWS) was permitted to operate a salt solution mining (UIC Class III) well (BW005).
- The Nix and Curtis Gulf-State No. 2 was a test of upper to middle Permian formations and was drilled to a total depth of 3909 feet with cable tools in 1955. This well was P&A’d.
- Permian Brine Sales and Service reentered the well and completed it as a brine well in 1978.
- In 1983 the brine well was sold to B&E, Inc. who operated it from 1983 to 1992 when it was sold to Jim’s Water Service.

BW005 OPERATIONS

- For 30 years, the various operators injected fresh water into the Salado Formation, a late Permian (Ochoan) bedded salt formation, which occurs over parts of southeast New Mexico (Eddy, Lea, Roosevelt, Chaves Counties), and west Texas.
- Fresh water was circulated in an underground cavern until it reached saturated brine conditions of greater than 200,000 mg/l chlorides (>300,000 mg/l TDS) and was sold as "*ten pound brine*".
- SLO owns the land and has leased it to JWS.
- OCD has issued JWS a permit to operate Class III UIC brine well.

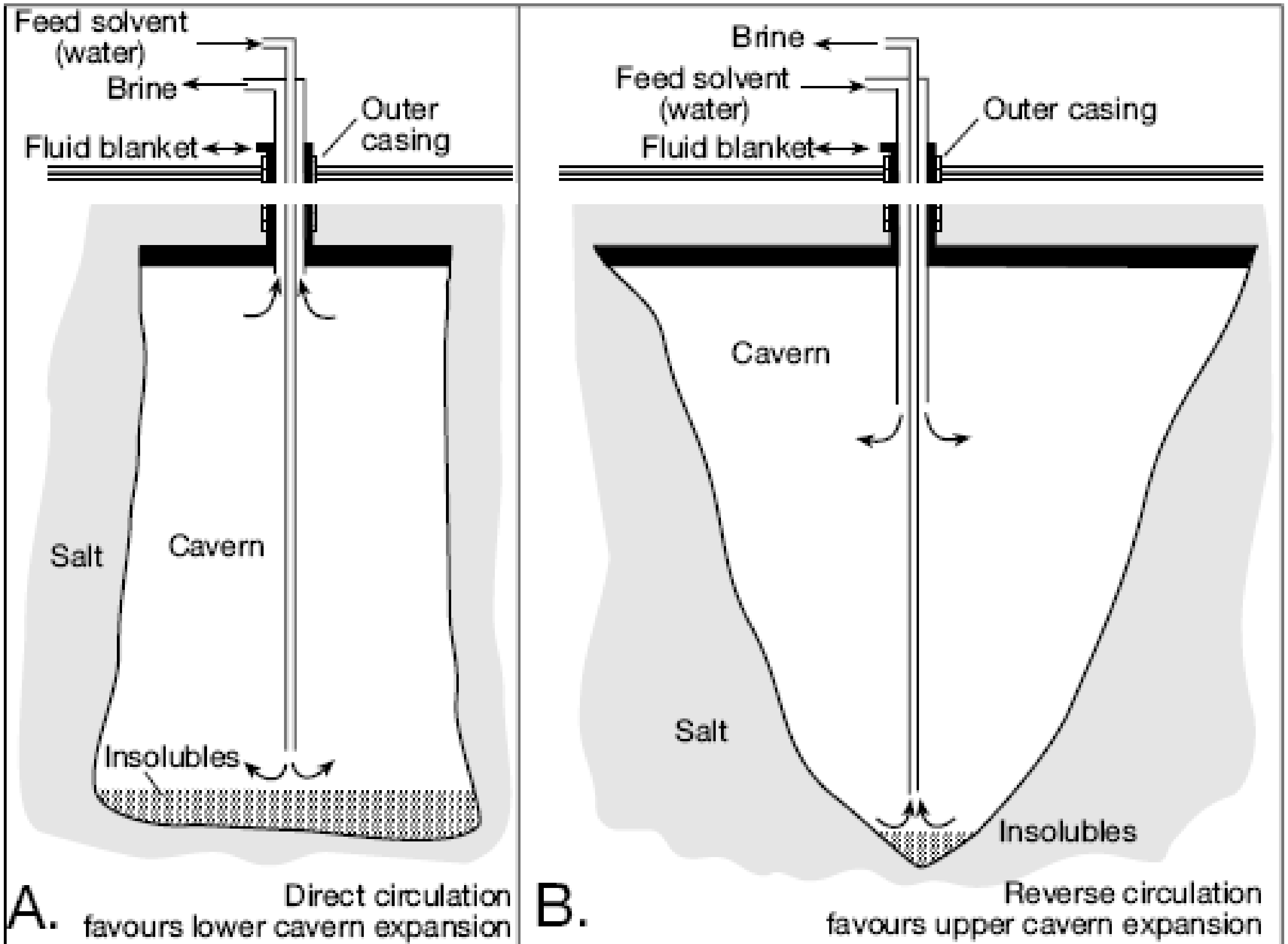
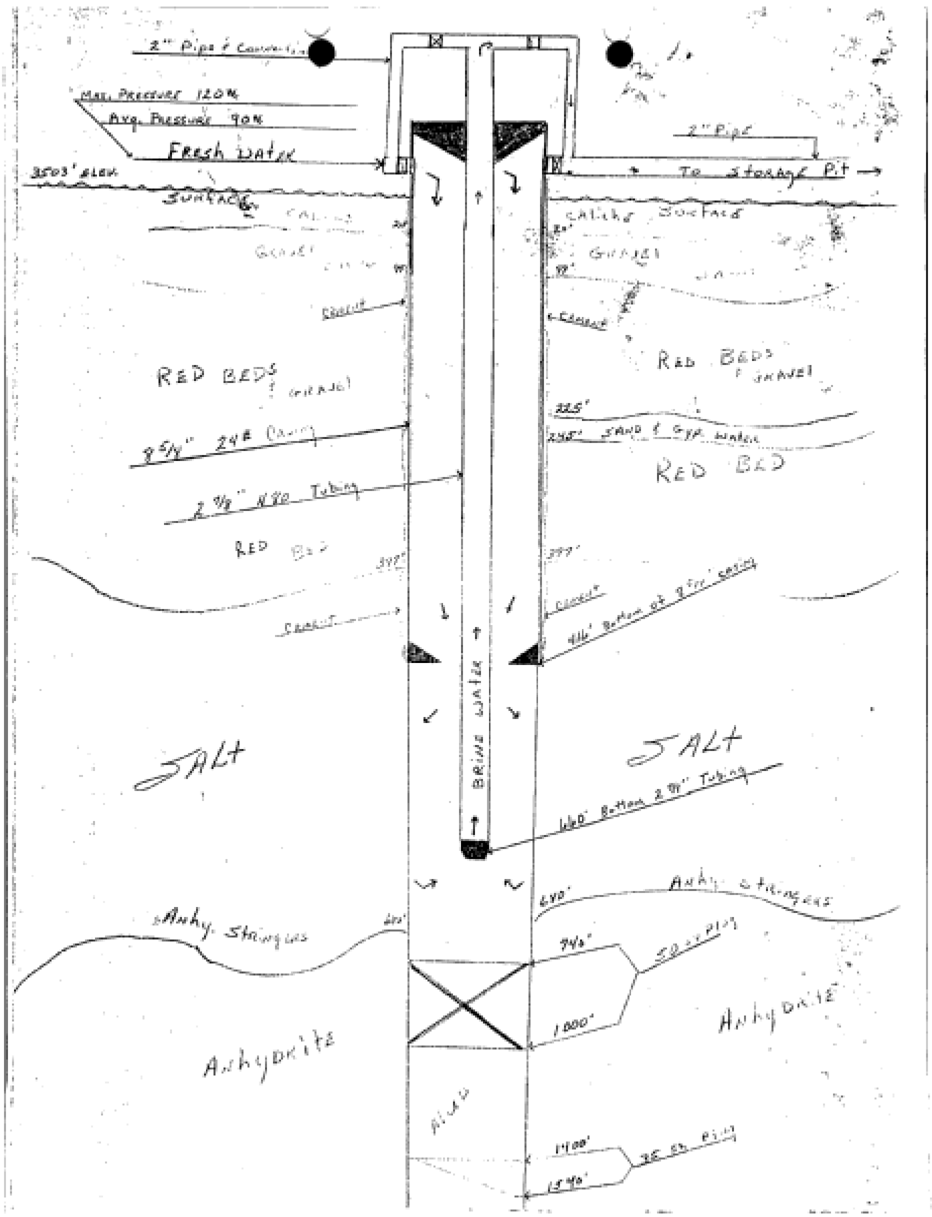
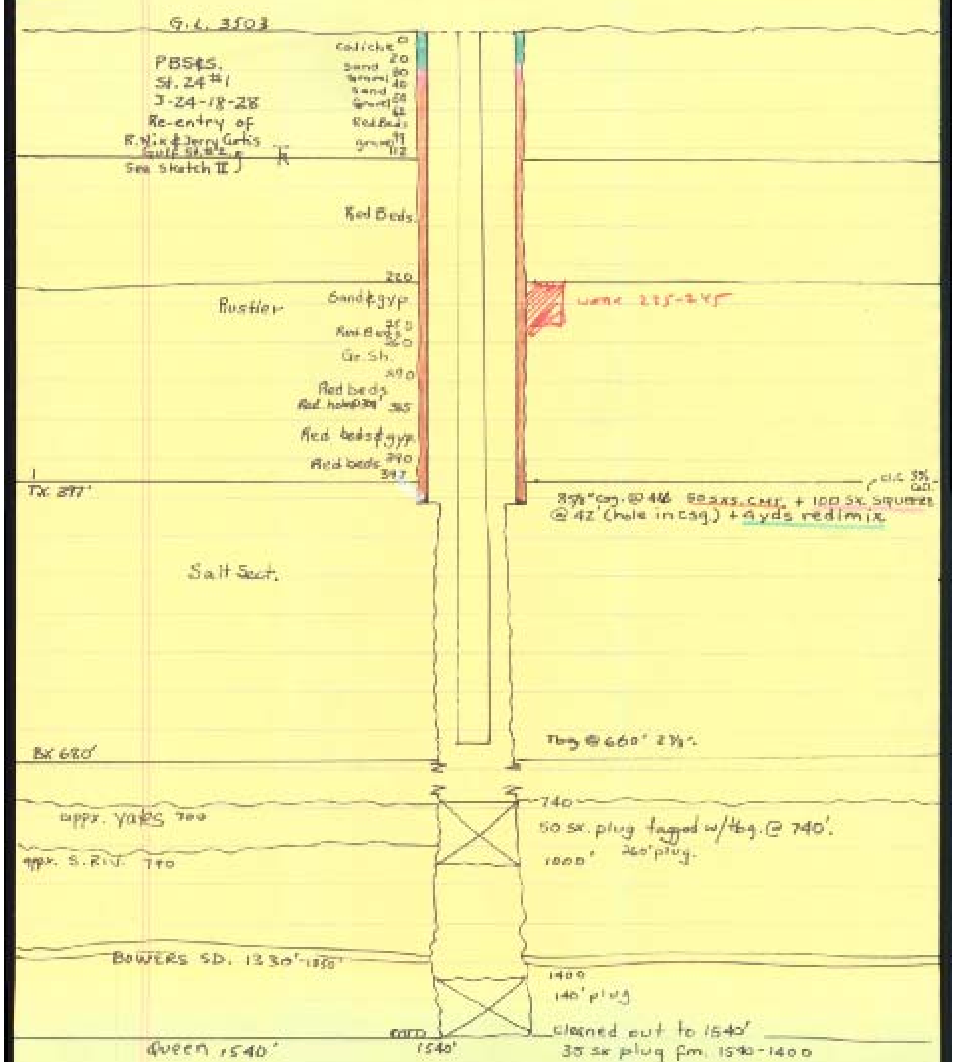


Figure 12.3. The solution mining process. A) Direct brine circulation where feed solvent is injected through the tubing string and brine is withdrawn through the annular space between the tubing string and the final casing. Cavern shape tends toward cylindrical with slightly expanded lower section. B) Reverse-circulation where the feed solvent enters the cavity through the annulus and brine is withdrawn through the tubing string. Cavern tends to be wider at top than base ("morning glory"). In both cases the outermost casing allows feed of the blanket solution into the uppermost part of the cavern, so protecting the cavern roof. Varying the volume of blanket in the cavern can be used to help shape the cavity.

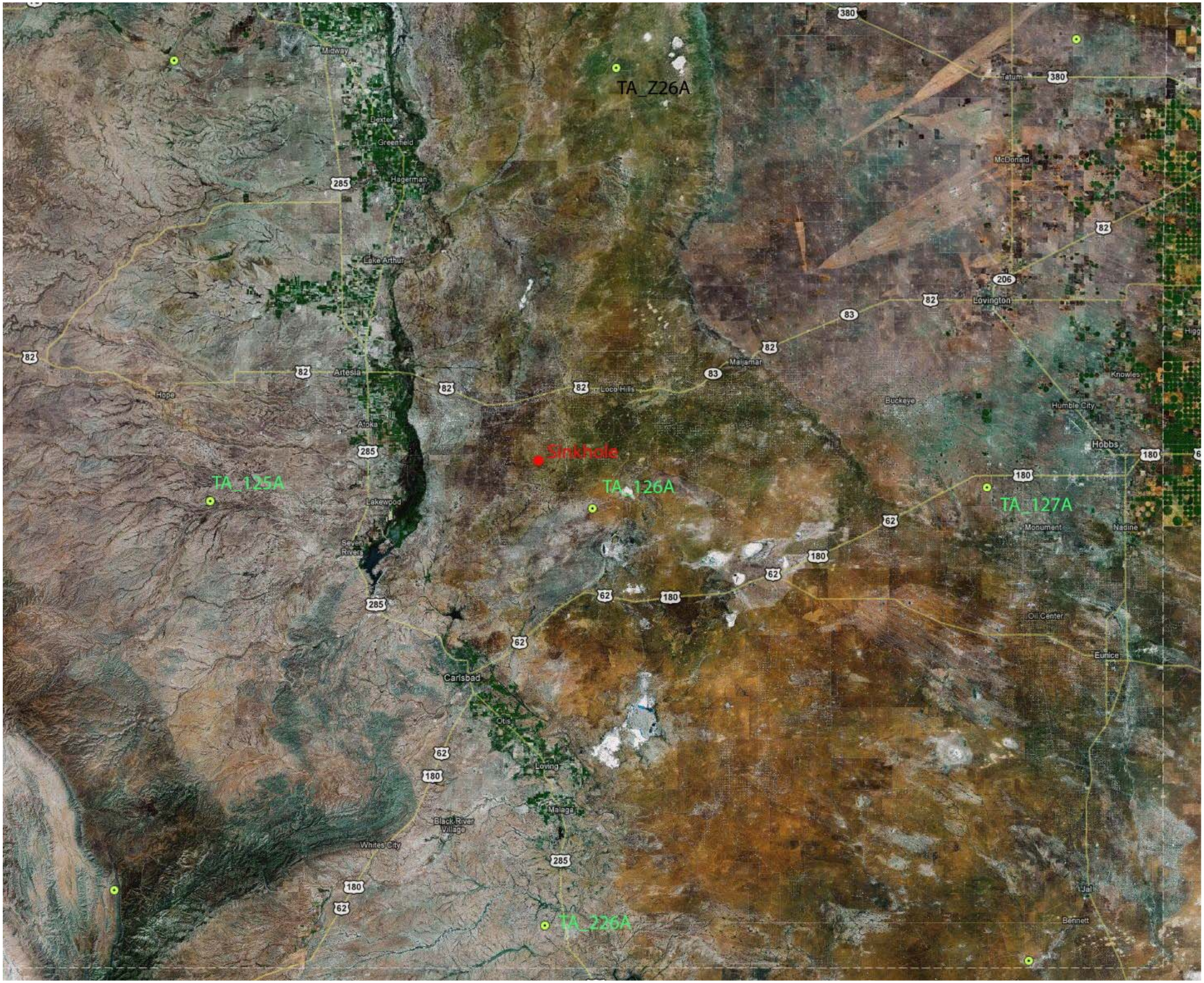


2" Pipe & Connection
Max. Pressure 120#
Avg. Pressure 90#
Fresh Water
3503' Elev.
Surface
2" Pipe
To Storage Pit
Caliche Surface
Gravel
Cement
Red Beds & Gravel
225'
245' Sand & Gyp. Water
Red Bed
8 5/8" 24# Casing
2 7/8" N80 Tubing
Red Bed
399'
Cement
416' Bottom of 8 5/8" casing
Brine Water
Salt
Salt
660' Bottom 2 7/8" Tubing
690'
Anhy. Stringers
Anhy. Stringers
940'
50 sx Plug
1000'
Anhydrite
Anhydrite
Mud
1400'
25 sx Plug
1540'

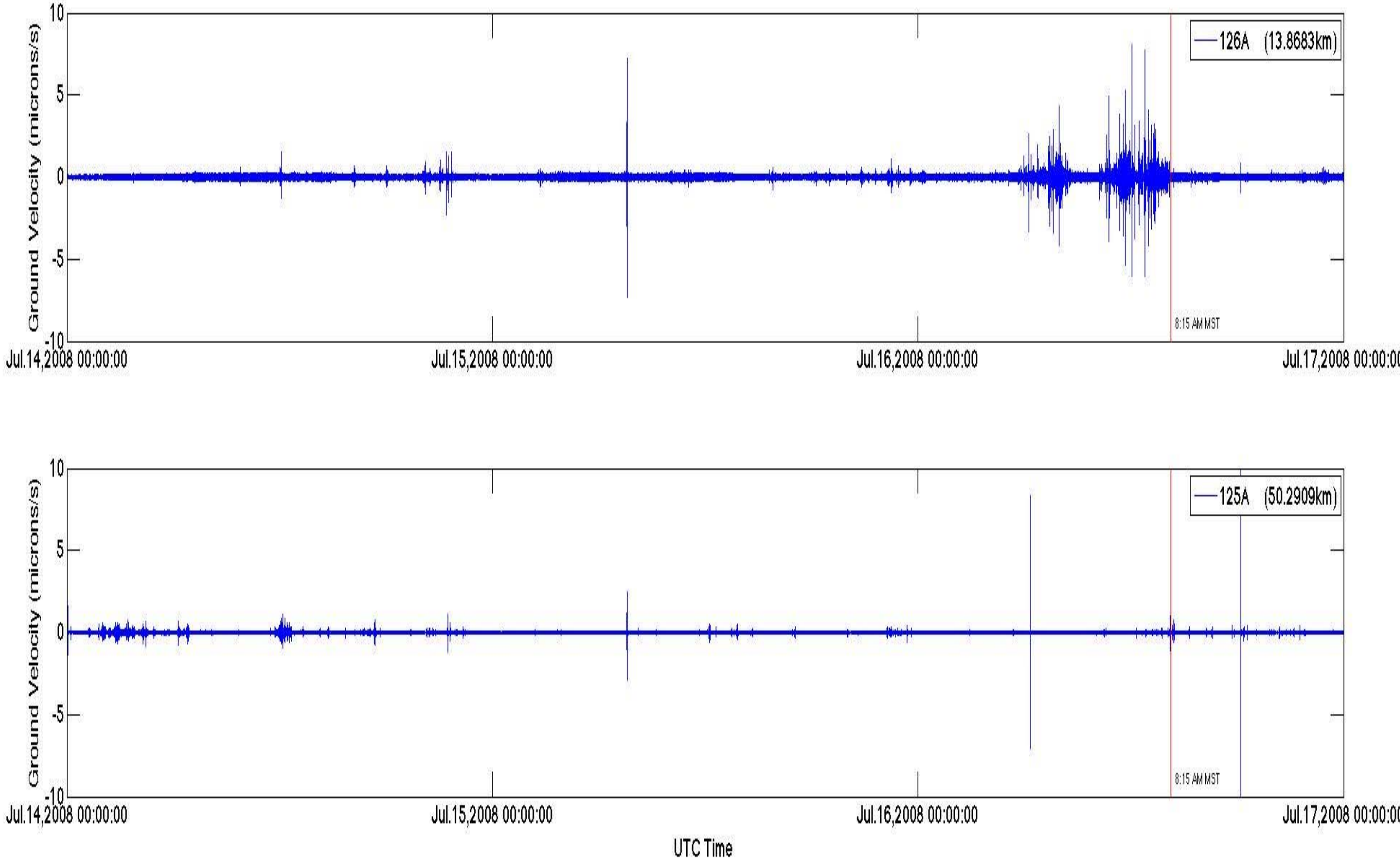
Attac. I


G.L. 3503
PBS&S.
St. 24 #1
J-24-18-28
Re-entry of
R. Nix & Jerry Curtis
See sketch II
Caliche 0
20
Sand
40
Sand
Red Beds
112
Red Beds
220
Rustler
Sand & gyp.
Red Beds
Gr. Sh.
Red beds
Red beds & gyp.
Red beds
TX 397'
8 5/8" csg. @ 416 + 100 SX. squeeze
@ 42' (hole in csg.) + 4 yds redimix
Salt Sect.
Tbg @ 660' 2 3/8".
BX 680'
740
appx. Yates 700
50 SX. plug tagged w/tbg. @ 740'.
appx. S.R.V. 790
1000'
260' plug.
BOWERS SD. 1330'-1350'
1400
140' plug
cleaned out to 1540'
Queen 1540'
1540'
35 SX plug fm. 1540-1400

THE COLLAPSE
JULY 16, 2008



TA_Z26A
Sinkhole
TA_125A
TA_126A
TA_127A
TA_226A
Midway
Dexter
Greenfield
Hagerman
Lake Arthur
Artesia
Hope
Atoka
Lakewood
Seven Rivers
Carlsbad
Otis
Loving
Malaga
Black River Village
Whites City
Loco Hills
Maljamar
Tatum
McDonald
Lovington
Buckeye
Knowles
Humble City
Hobbs
Monument
Nadine
Oil Center
Eunice
Jal
Bennett



Ground Velocity (microns/s)
10
5
0
-5
-10
126A (13.8683km)
8:15 AM MST
Jul.14,2008 00:00:00
Jul.15,2008 00:00:00
Jul.16,2008 00:00:00
Jul.17,2008 00:00:00
Ground Velocity (microns/s)
125A (50.2909km)
8:15 AM MST
UTC Time


Hagerman Rd
217
Image NMRGIS
© 2008 Tele Atlas
978 ft
©2007 Google™


N
217
Image NMRGIS
© 2008 Tele Atlas
452 ft
©2007 Google™

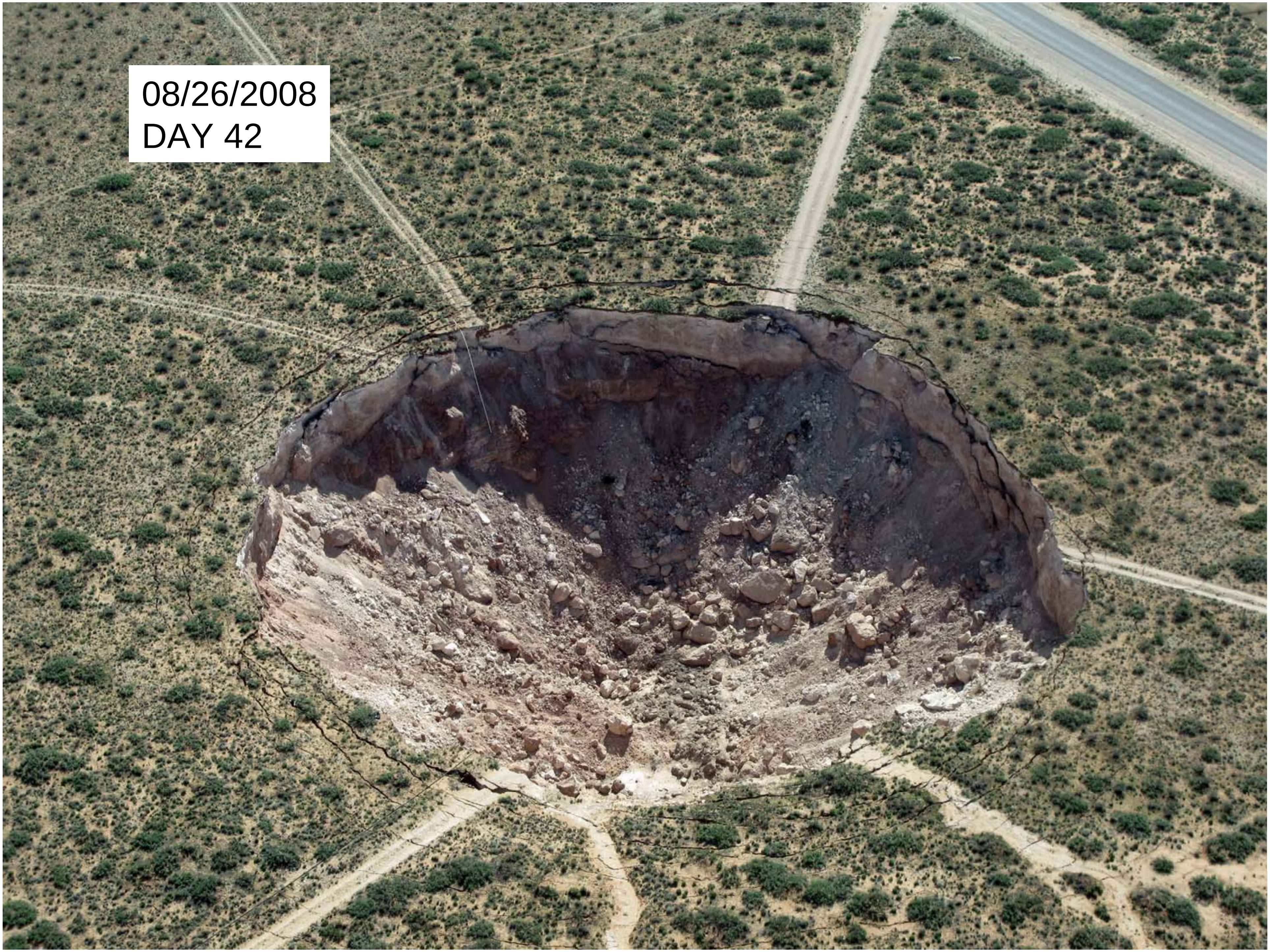

Pre-collapse
N
217
Image NMRGIS
© 2008 Tele Atlas
455 ft
©2007 Google™


07/20/2008
DAY 5
N
217
455 ft
Image NMRGIS
© 2008 Tele Atlas
©2007 Google™

07/26/20008
DAY 11
217
455 ft
Image NMRGIS
© 2008 Tele Atlas
©2007 Google


07/27/2008
DAY 12
N
217
455 ft
Image NMRGIS
© 2008 Tele Atlas
©2007 Google™


07/31/2008
DAY 16
217
455 ft
Image NMRGIS
© 2008 Tele Atlas
©2007 Google™


08/26/2008
DAY 42

OBLIQUE AERIAL PHOTOS

VIEW TO THE SOUTHEAST


07/16/2008

07/18/2008

07/19/2008

07/20/2008


07/21/2008

07/25/2008

07/27/2008

07/28/2008

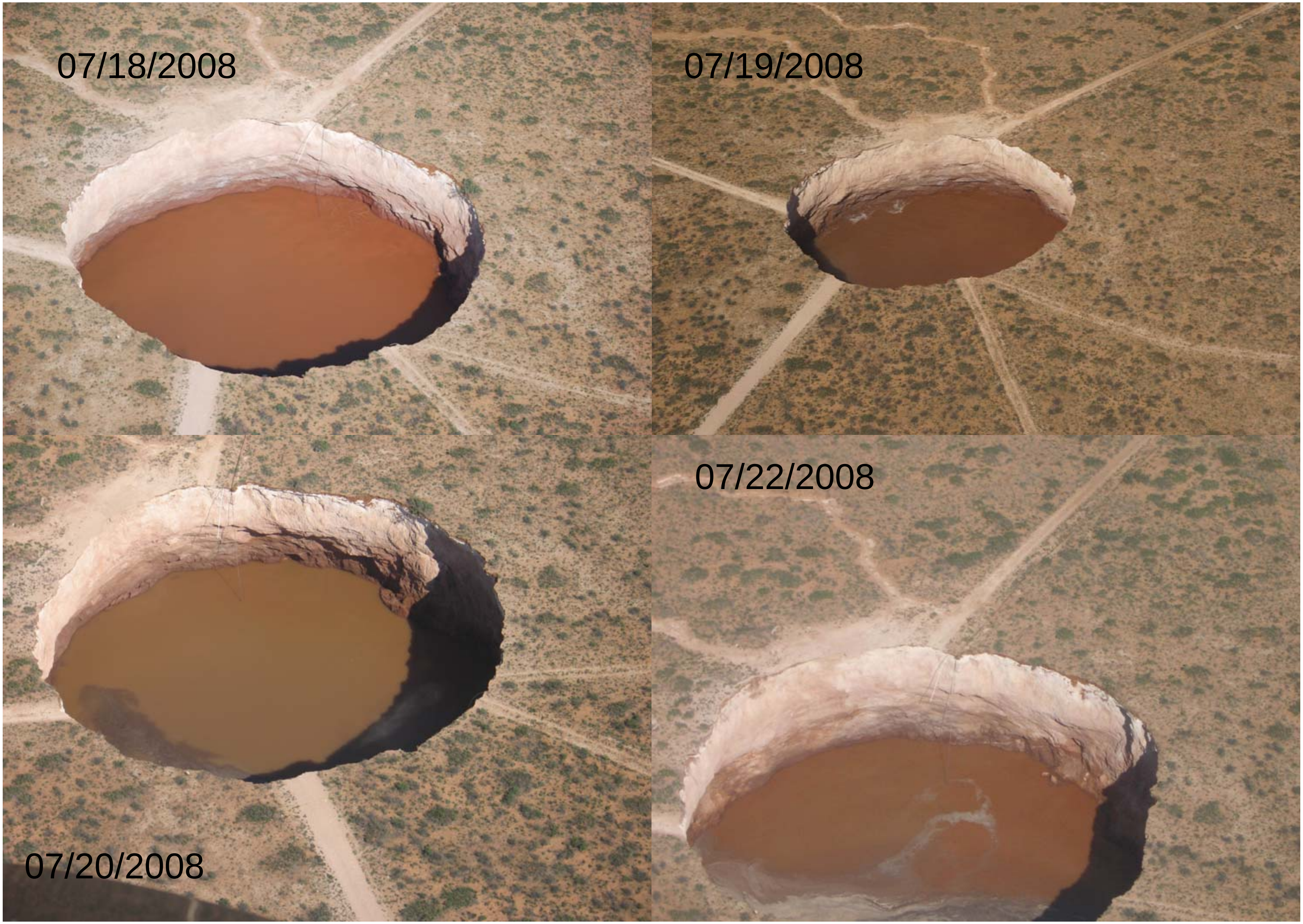

07/31/2008


08/15/2008


08/26/2008

OBLIQUE AERIAL PHOTOS

VIEW TO THE NORTHWEST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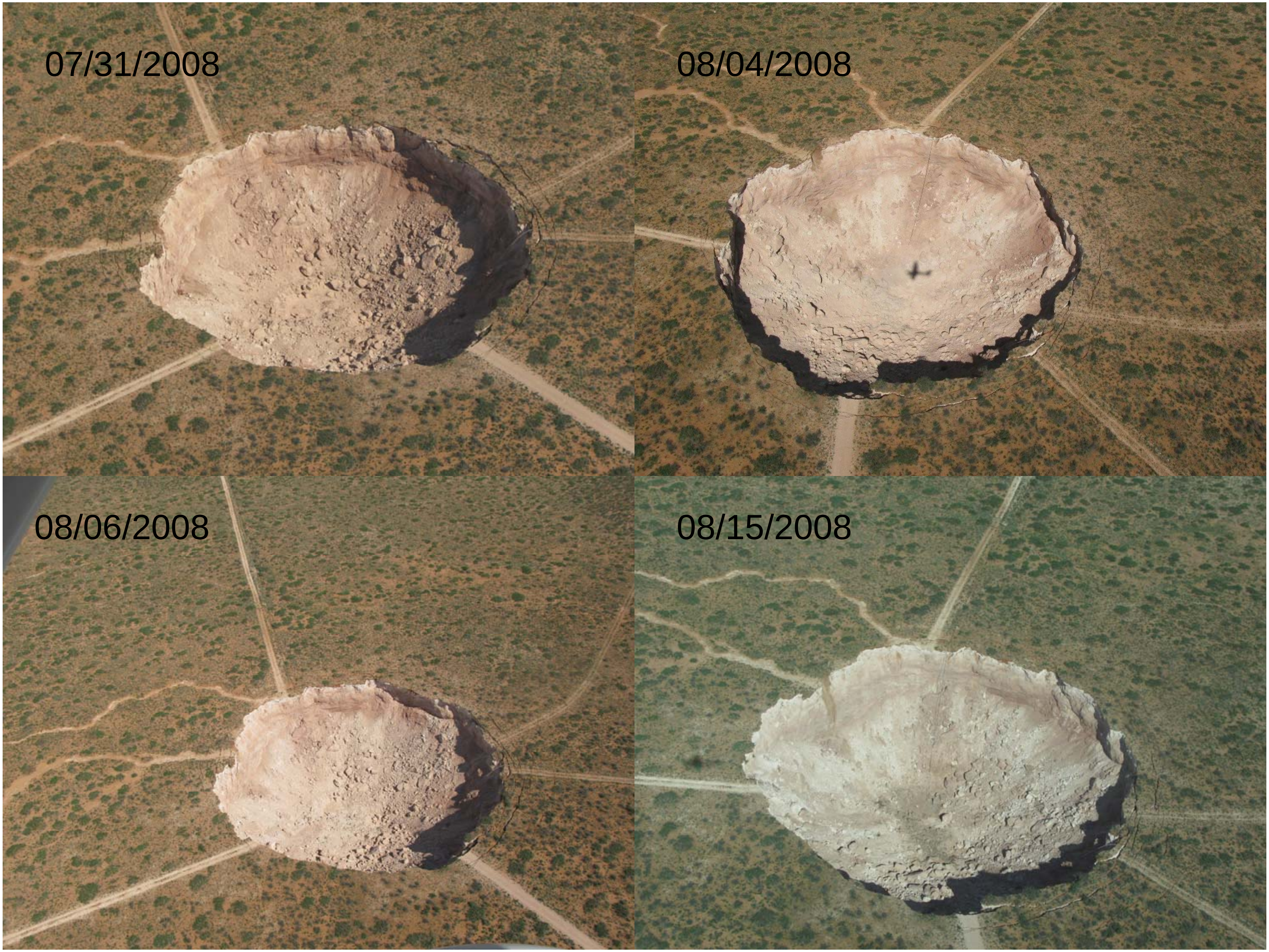
07/19/2008
07/20/2008
07/22/2008


07/25/2008

07/26/2008

07/27/2008

07/28/2008


07/31/2008
08/04/2008
08/06/2008
08/15/2008

DETAILS FROM THE GROUND

SMALL SCALE FRACTURES

LOCAL GEOLOGY

FIG. 5–Index map showing significant geologic features.

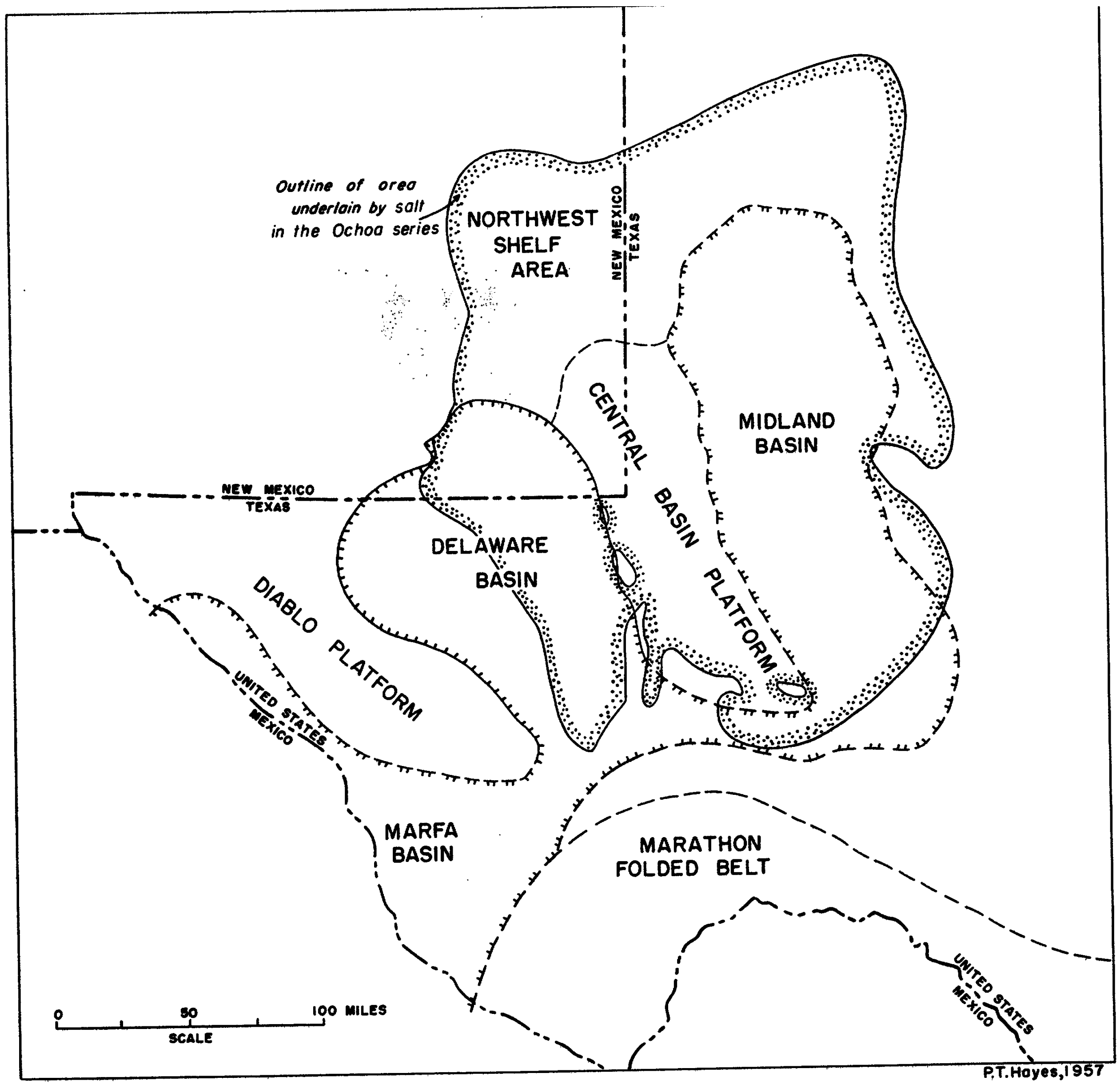
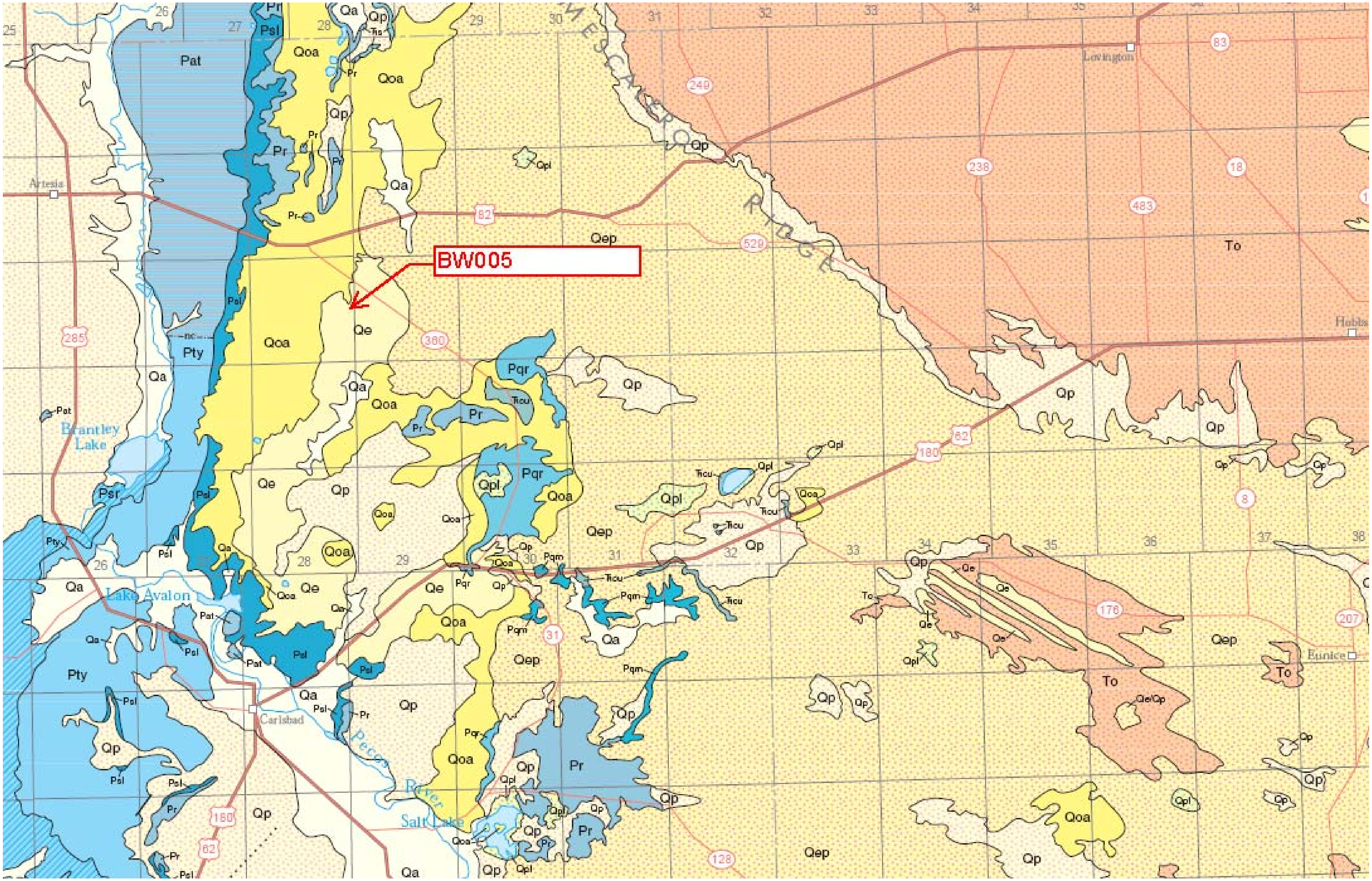


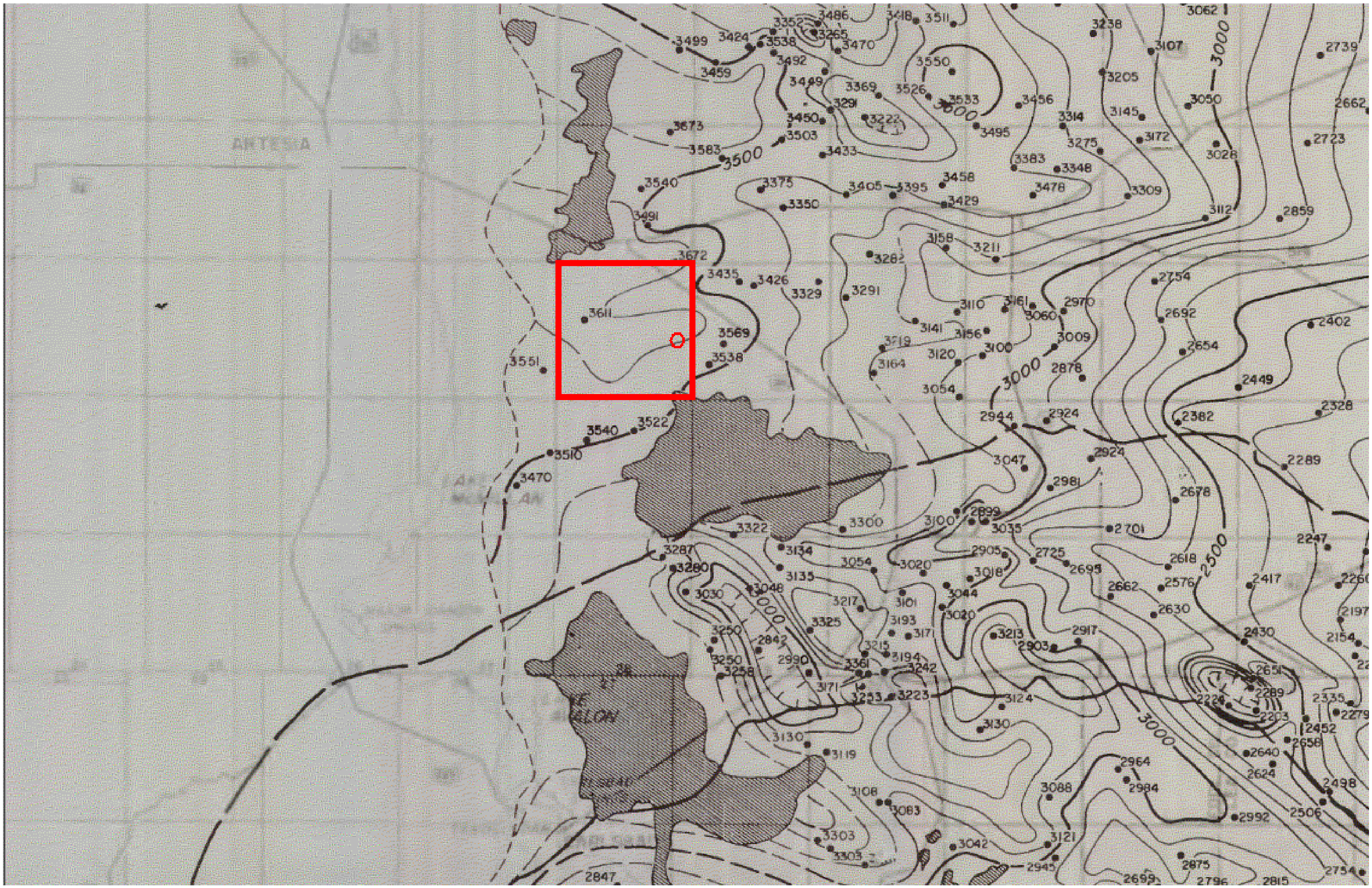
Fig. 1. Index map showing outline of area underlain by salt in the Ochoa series in relation to late Permian basins and shelf areas. (Adapted from King, 1948).

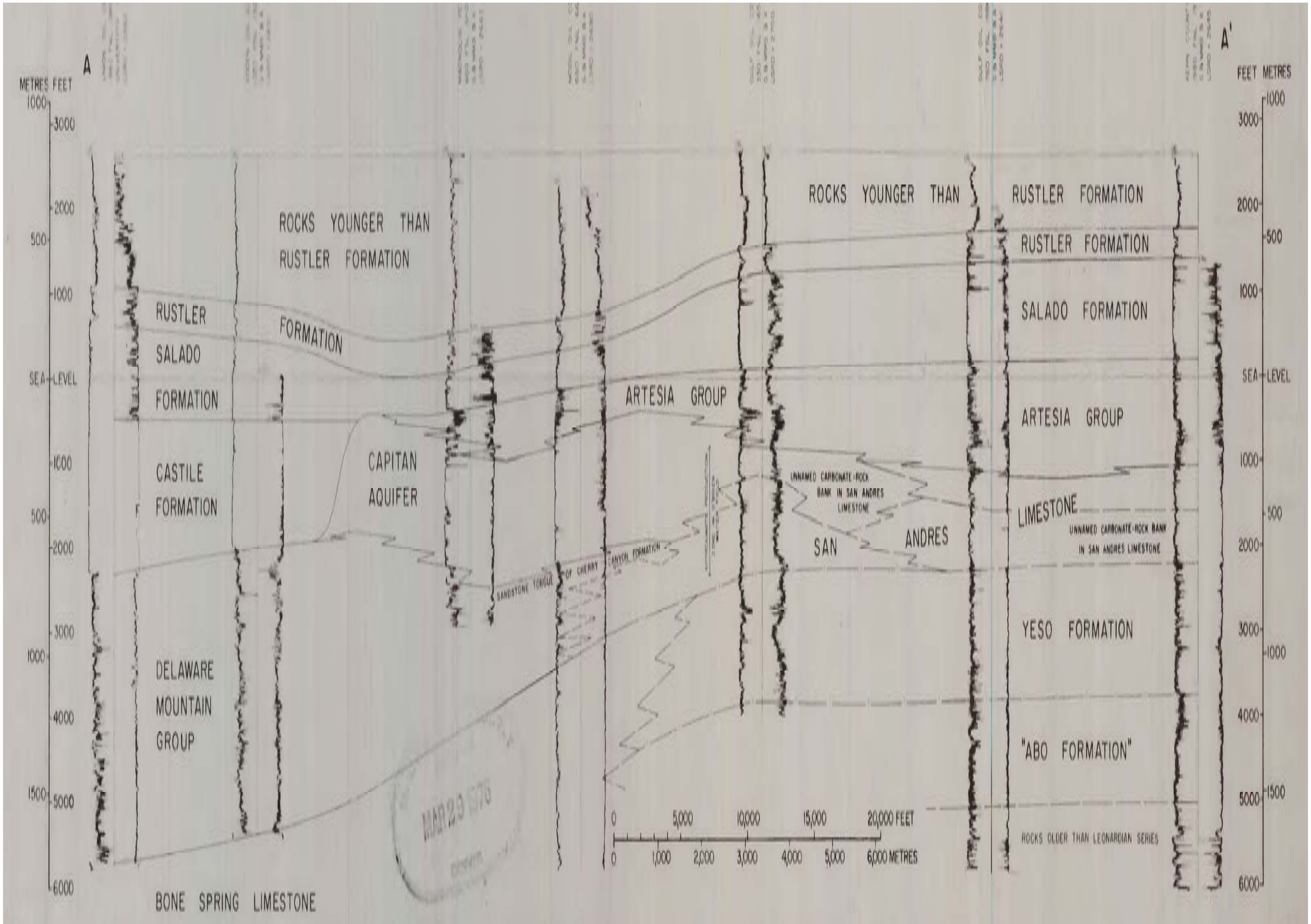

BW005
Artesia
Lovington
Hobbs
Eunice
Carlsbad
Brantley Lake
Lake Avalon
Salt Lake
Pecos River
MESCALERO RIDGE
Pat
Pty
Psl
Psr
Pr
Pqr
Pqm
Qoa
Qa
Qe
Qp
Qep
Qpl
To
Qe/Qp
285
82
380
529
249
238
483
83
18
180
62
31
176
207
8
128

Qe	Eolian deposits (Holocene to middle Pleistocene)	
Qoa	Older alluvial deposits of upland plains and piedmont areas, and calcic soils and eolian cover sediments of High Plains region (middle to lower Pleistocene)—Includes scattered lacustrine, playa, and alluvial deposits of the Tahoka, Double Tanks, Tule, Blackwater Draw, and Gatuña Formations, the latter of which may be Pliocene at base; outcrops, however, are basically of Quaternary deposits	
TRs	**Santa Rosa Formation** (Carnian)—Includes Moenkopi Formation (Middle Triassic) at base in most areas	**Dockum Fm.**
TRcu	**Upper Chinle Group, Garita Creek through Redonda Formations, undivided**	
Pqm	**Quartermaster Formation** (Upper Permian)—Red sandstone and siltstone	**Dewey Lake red beds**
Pqr	**Quartermaster and Rustler Formations** (Upper Permian)	
Pr	**Rustler Formation** (Upper Permian)—Siltstone, gypsum, sandstone, and dolomite	
Psl	**Salado Formation** (Upper Permian)—Evaporite sequence, dominantly halite	
Pc	**Castile Formation** (Upper Permian)—Dominantly anhydrite sequence	
Pat	**Artesia Group** (Guadalupian)—Shelf facies forming broad south-southeast trending outcrop from Glorieta to Artesia area; includes Tansill, Yates, Seven Rivers, Queen and Grayburg Formations (Guadalupian). May locally include Moenkopi Formation (Triassic) at top	

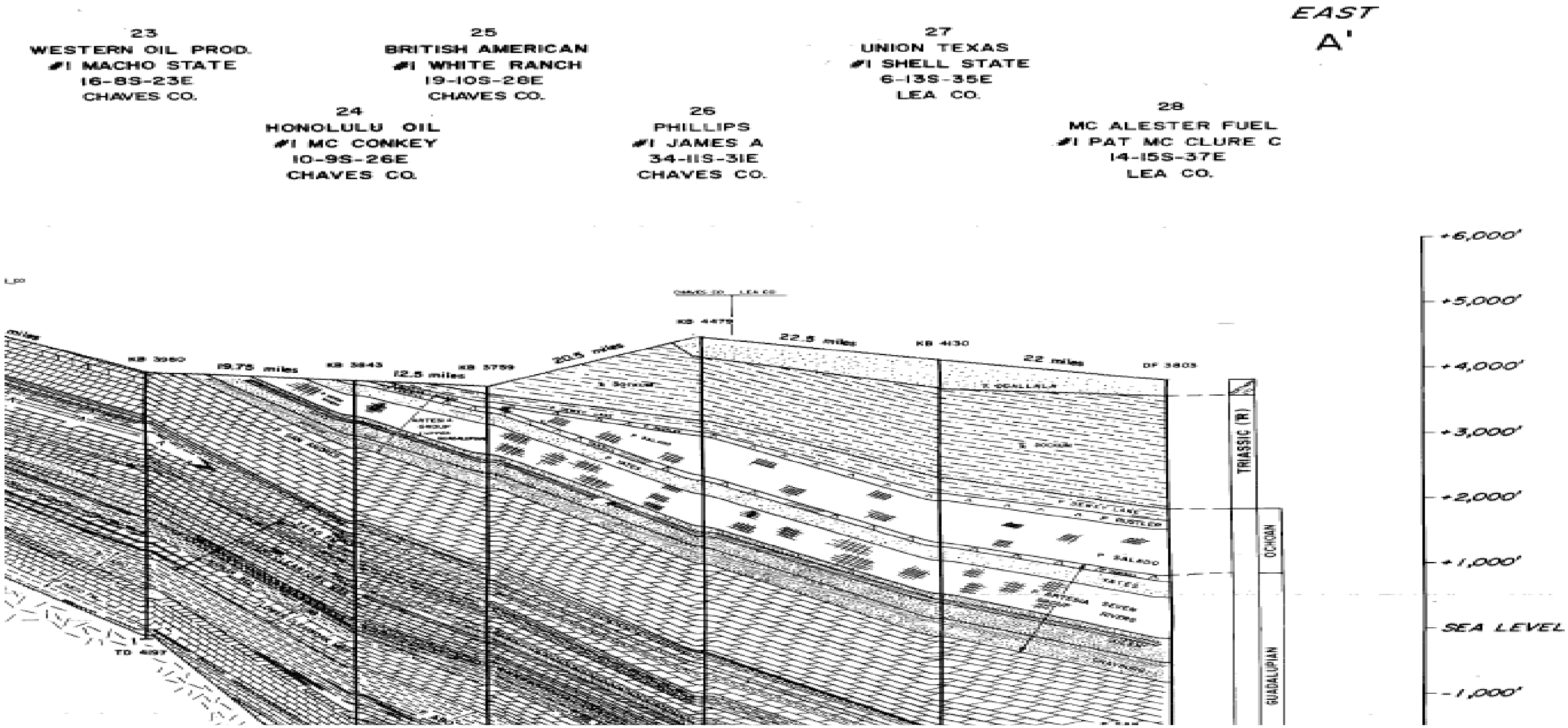
SYSTEM/ Series		Group	Formation	Members
QUATERNARY	Holocene		surficial deposits	
TERTIARY	Pleistocene		Mescalero caliche	
	Pliocene		Gatuña	
	Miocene			
TRIASSIC		Dockum	Santa Rosa	
	Ochoan		Dewey Lake	
PERMIAN			Rustler	*Forty-niner* *Magenta Dolomite* *Tamarisk* *Culebra Dolomite* *Los Medaños*
			Salado	*upper* *Vaca Triste Sandstone* *McNutt potash zone* *lower*
			Castile	

TOP OF RUSTLER FORMATION





TRANSVERSE STRATIGRAPHIC SECTION A-A' SHOWING THE POSITION OF THE CAPITAN AQUIFER ALONG THE EAST MARGIN OF THE DELAWARE BASIN


EAST
A'
23
WESTERN OIL PROD.
#1 MACHO STATE
16-8S-23E
CHAVES CO.
24
HONOLULU OIL
#1 MC CONKEY
10-9S-26E
CHAVES CO.
25
BRITISH AMERICAN
#1 WHITE RANCH
19-10S-28E
CHAVES CO.
26
PHILLIPS
#1 JAMES A
34-11S-31E
CHAVES CO.
27
UNION TEXAS
#1 SHELL STATE
6-13S-35E
LEA CO.
28
MC ALESTER FUEL
#1 PAT MC CLURE C
14-15S-37E
LEA CO.
19.75 miles
12.5 miles
20.5 miles
22.5 miles
22 miles
TRIASSIC (R)
OCHOAN
GUADALUPIAN
+6,000'
+5,000'
+4,000'
+3,000'
+2,000'
+1,000'
SEA LEVEL
-1,000'

OTHER SOLUTION MINING COLLAPSES

Location	Timing and Size	Explanations and implications	Reference
Haoud Berkaoui oilfield, near Ouarlaga, Algeria	In October 1986 a crater 200 metres in diameter, 75 metres deep formed. It has expanded until now when the cavity is more than 230 by 600 metres across. Its outward progression is still continuing at a rate of 1 metre per year (Thought by environmentalists to be the "largest anthropogenic sinkhole in the world").	In 1978, an oil exploration well with a 2500 m Ordovician target was abandoned because of stability problems in Triassic salt at a depth around 650 metres. The well was abandoned without casing near the bottom of the well. A second well was drilled in 1979 located 80 metres from the previous well. In March 1981, the lining of this well broke because of cavity formation at around 550 metres, which is the level of salt. In October a surface crater formed, centred on these two wells. Dissolving salt may be salinising the crossflowing artesian waters, leading to undocumented, but possible, degradation of freshwater oases in the region.	Morisseau, 2000
Wink Sink, Texas, and Whitten Ranch Sink, New Mexico	On June 3, 1980 the Wink Sink formed a 110 m wide and 34 m deep collapse crater. It was centered on the Hendrick 10 A well in the Hendrick oil field. Whitten Ranch Sinkhole or collapse crater formed sometime between August 31 and September 5, 1998 and was up to 23 m wide and 33m deep.	It appears likely that the natural processes of salt dissolution, cavity growth and resultant chimney collapse atop the Permian Capitan reef were accelerated by oil drilling and extraction activity in the immediate area of the sinkholes in the early part of last century. Large water filled sinkholes (as in the "Bottomless Lakes" of New Mexico) are a natural part of the landscape in the region and were collapsing long before the arrival of man.	Baumgardner et al., 1982 Powers, 2000 Johnson, 2001
Panning Sink, Kansas	It formed in April 1959 with a diameter of 90 metres and had a water surface more than 18 metres below the sinkhole lip.	Formed by subsidence and collapse around an already tilted and abandoned salt-water-disposal (SWD) well - Panning 11A.	Walters, 1978, 1991

Lake Peigneur, Jefferson Island Louisiana	On November 20, 1980, Lake Peigneur disappeared in hours as it drained into an underlying salt mine cavern. Within hours, a collapse sinkhole 0.91 km^2 in area developed in the SE portion of the lake and in 12 hours the underlying mine had flooded and 2 days later the lake had refilled with water.	An oil well being drilled from barges and platforms in lake intersected an abandoned part of an active salt mine in the salt dome that underlies the lake. Water from the lake and the intervening natural collapse features entered the mine workings. The Lake itself is a natural dissolution depression.	Autin, 2002 Thoms, 2000b Thoms and Gehle, 1994
Sinkhole atop Weeks Island, storage facility, Louisiana	An active sinkhole some 10 metres across and 10 metres deep, first noted near the edge of the SPR facility in May 1992. A second, much smaller sinkhole was noticed early February 1995, but it lay outside the area of cavern storage.	The sinkhole led to the decision to drain the facility of its hydrocarbons. Drainage and remediation was completed in 1999 at a cost of US $100 million. This facility was not purpose built but was an old salt dome mine facility. In hindsight, based on an earlier event, one might fault the initial DOE decision to select this mine for oil storage. A groundwater leak in the mine in 1978 may have been a forewarning of events to come. Injection of cement grout into the flow path controlled the leak at that time, but it could just as easily have become uncontrollable and formed a sinkhole.	Neal and Meyers, 1995 Bauer et al., 2000
Mont Belvieu sinkhole, Texas	July 30, 1993 a sinkhole crater formed between two brine storage wells. The crater stabilized in a few hours with a diameter of 12 metres and a depth of 6 metres. It was filled with sand a few days later.	Large volumes of brine are periodically cycled in and out of the brine cavern in the caprock. It is used to drive the withdrawal of the stored hydrocarbons in other deeper storage caverns. Using a system that stores saline brine in a caprock, even without the possibility of the collapse of a brine well, means there is a possibility of groundwater contamination from leaked storage brines.	Cartwright et al., 2000

Table 12.4. Events associated with oil wells or storage (see text for full description).

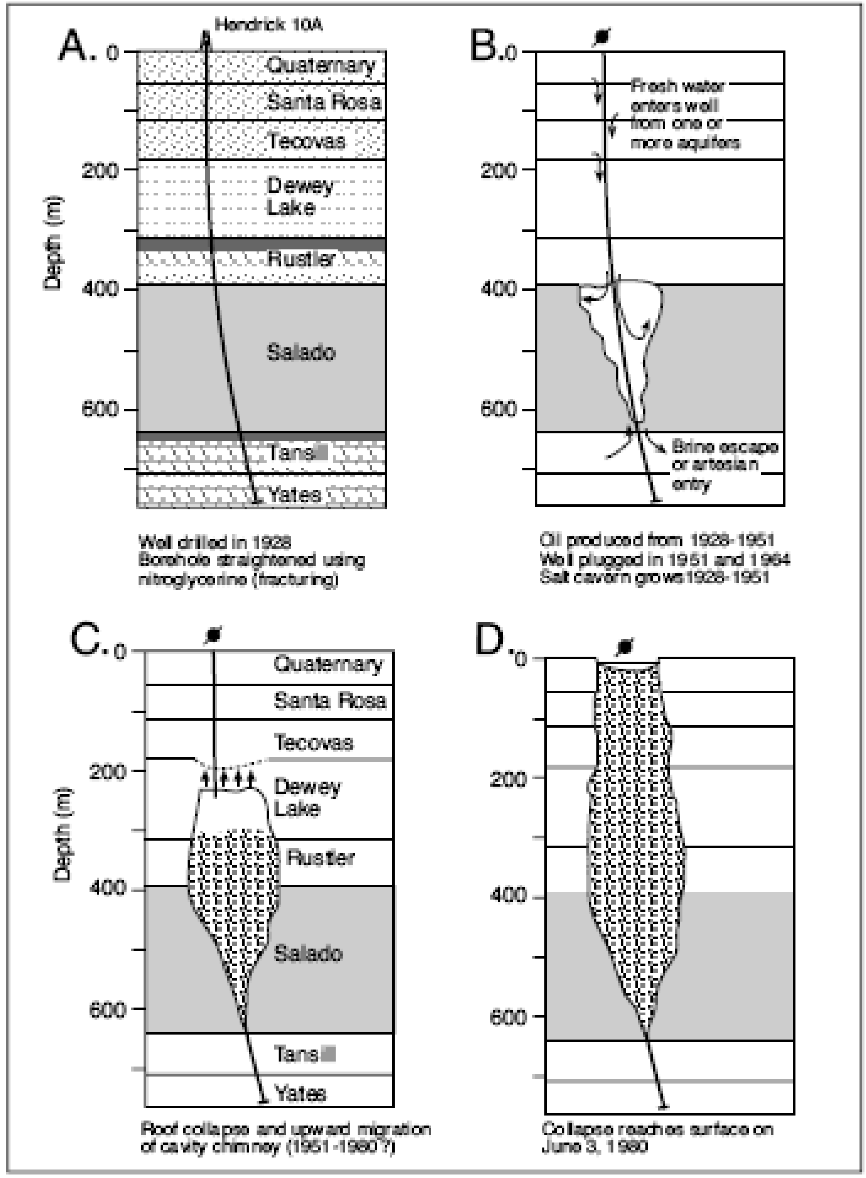


Figure 12.23. East-West section through Hendrick well 10-A in Wink Sink, west Texas (after Johnson, 1987). Undersaturated meteoric and artesian water circulated along borehole margins to dissolve the salt and create a salt cavern, which migrated to the land surface by successive roof failures ("chimneying"). See Figure 7.9 for location of the Wink Sink.

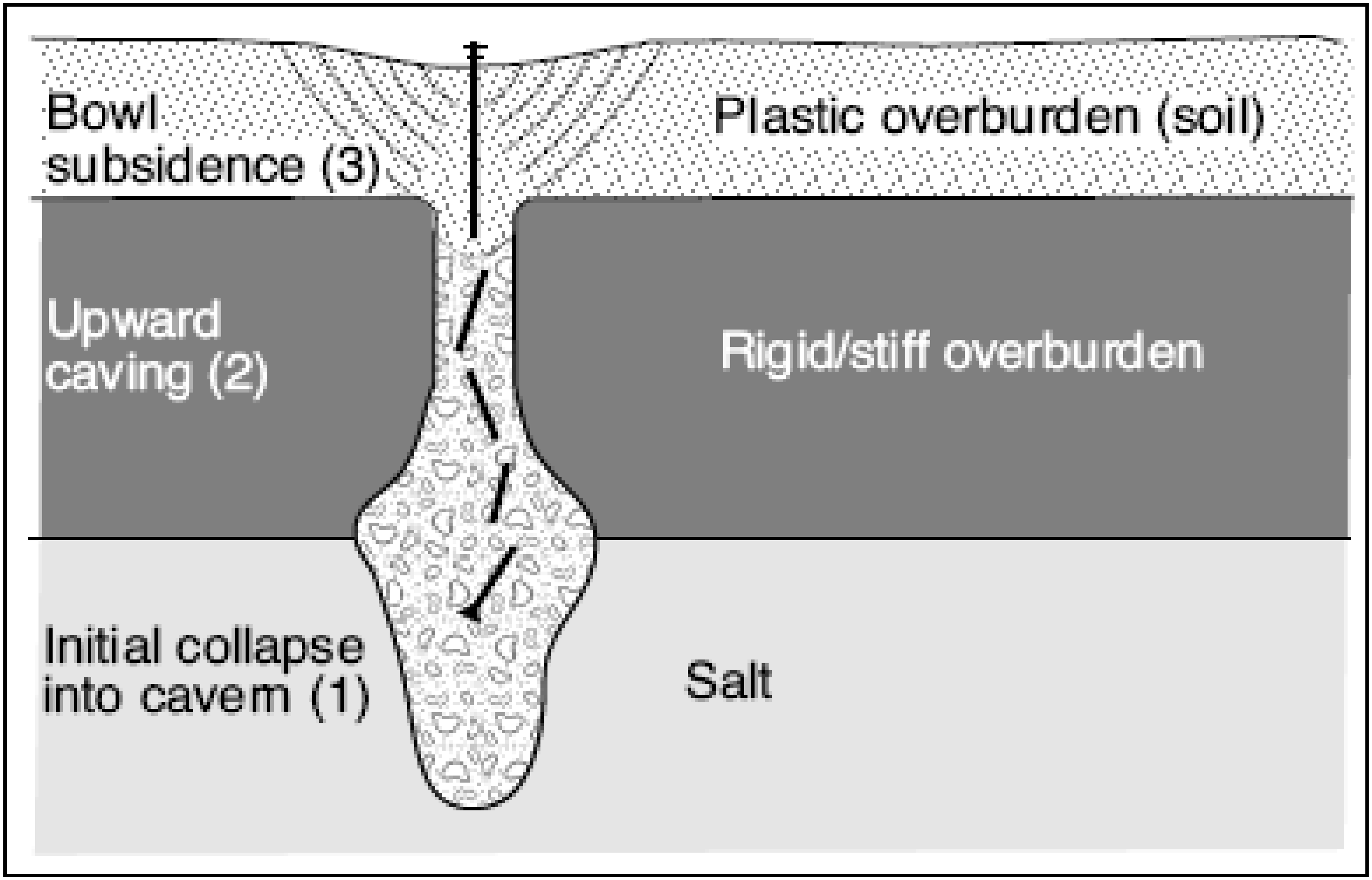
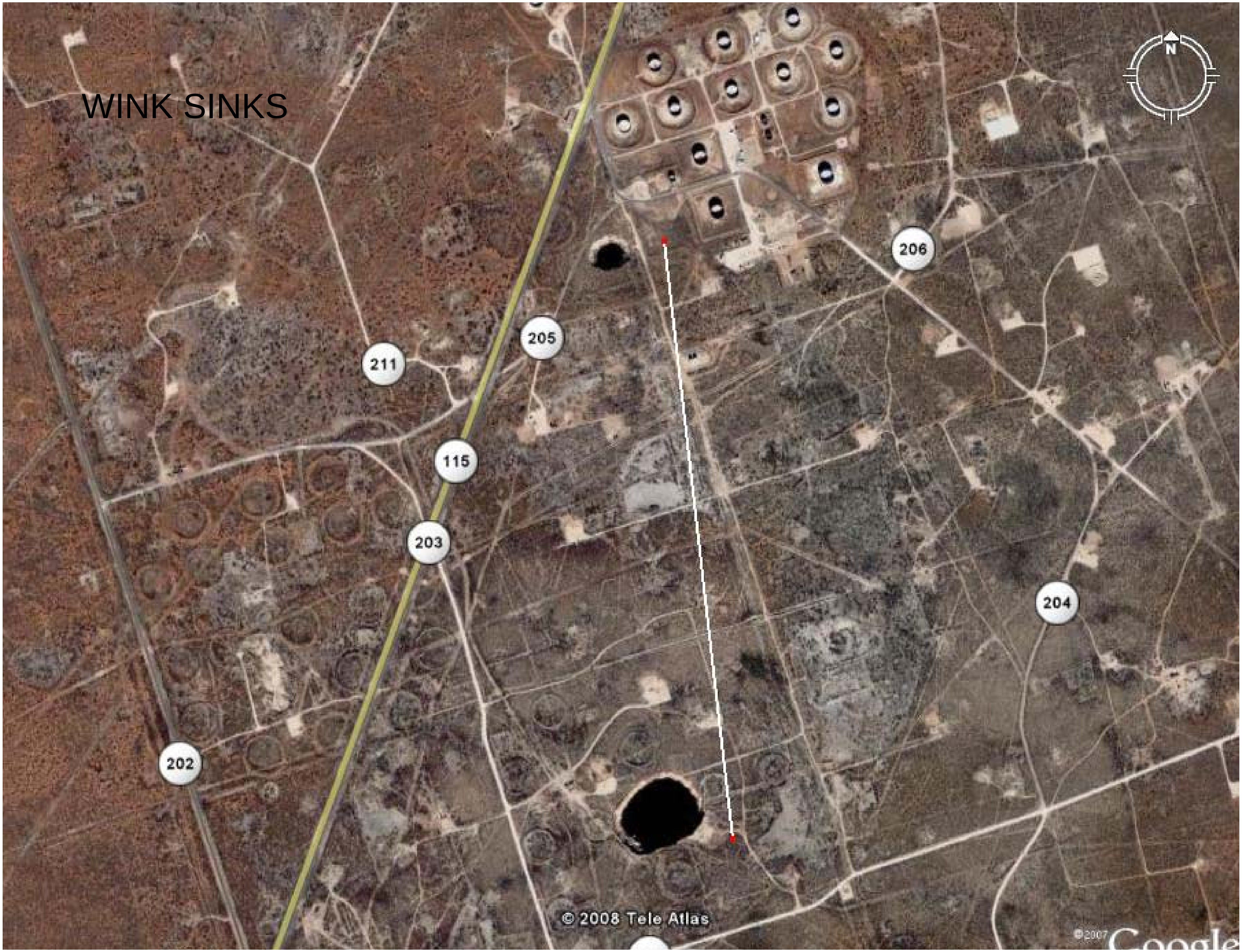


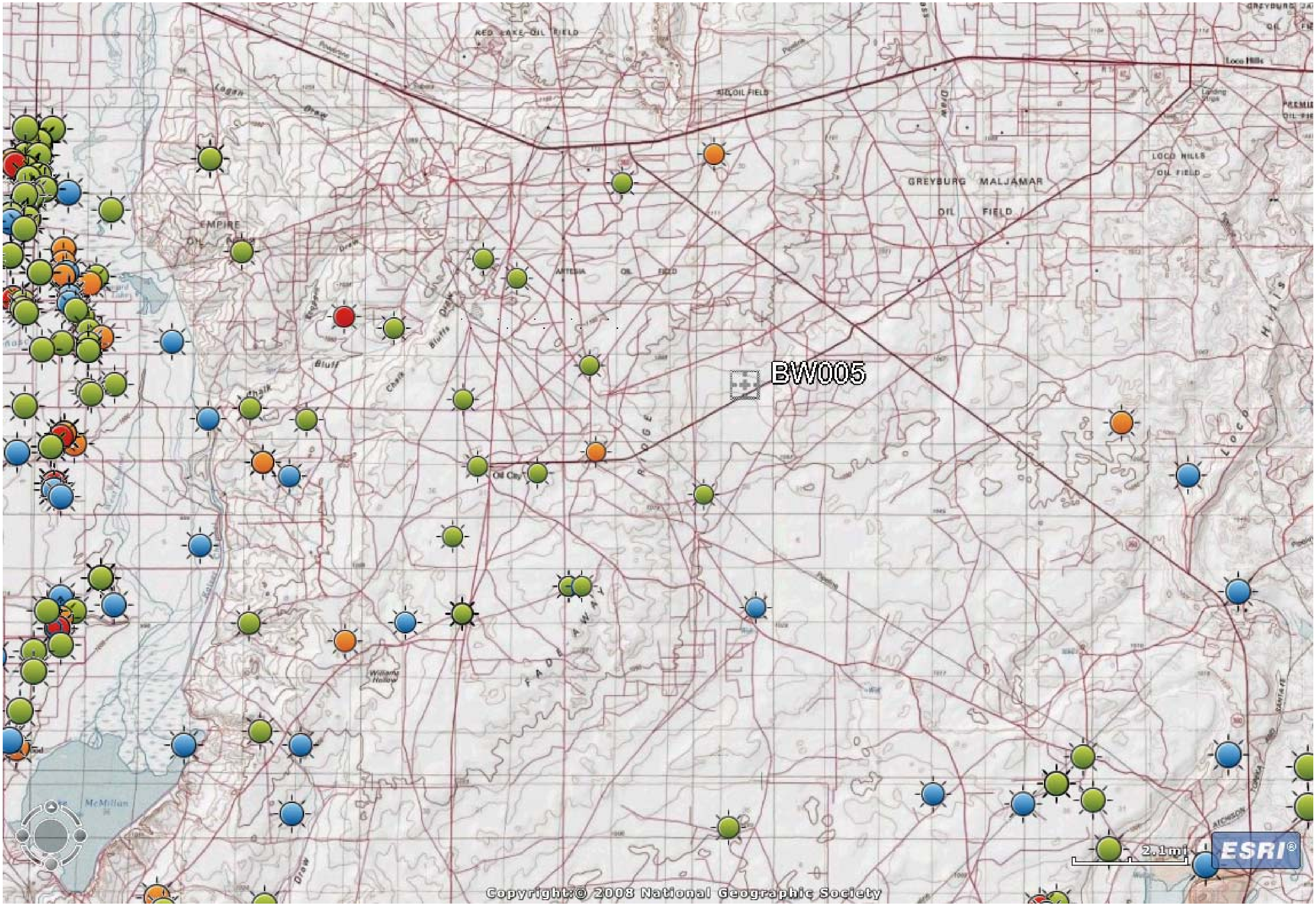
Figure 12.33. Three stages of cavern collapse and sinkhole growth (after Thoms, 2000).


Jal Sinkhole
N
© 2008 Tele Atlas
©2007 Google


WINK SINKS
N
206
205
211
115
203
204
202
© 2008 Tele Atlas
©2007
Google


N
© 2008 Tele Atlas
©2007

PROTECTABLE GROUND WATER

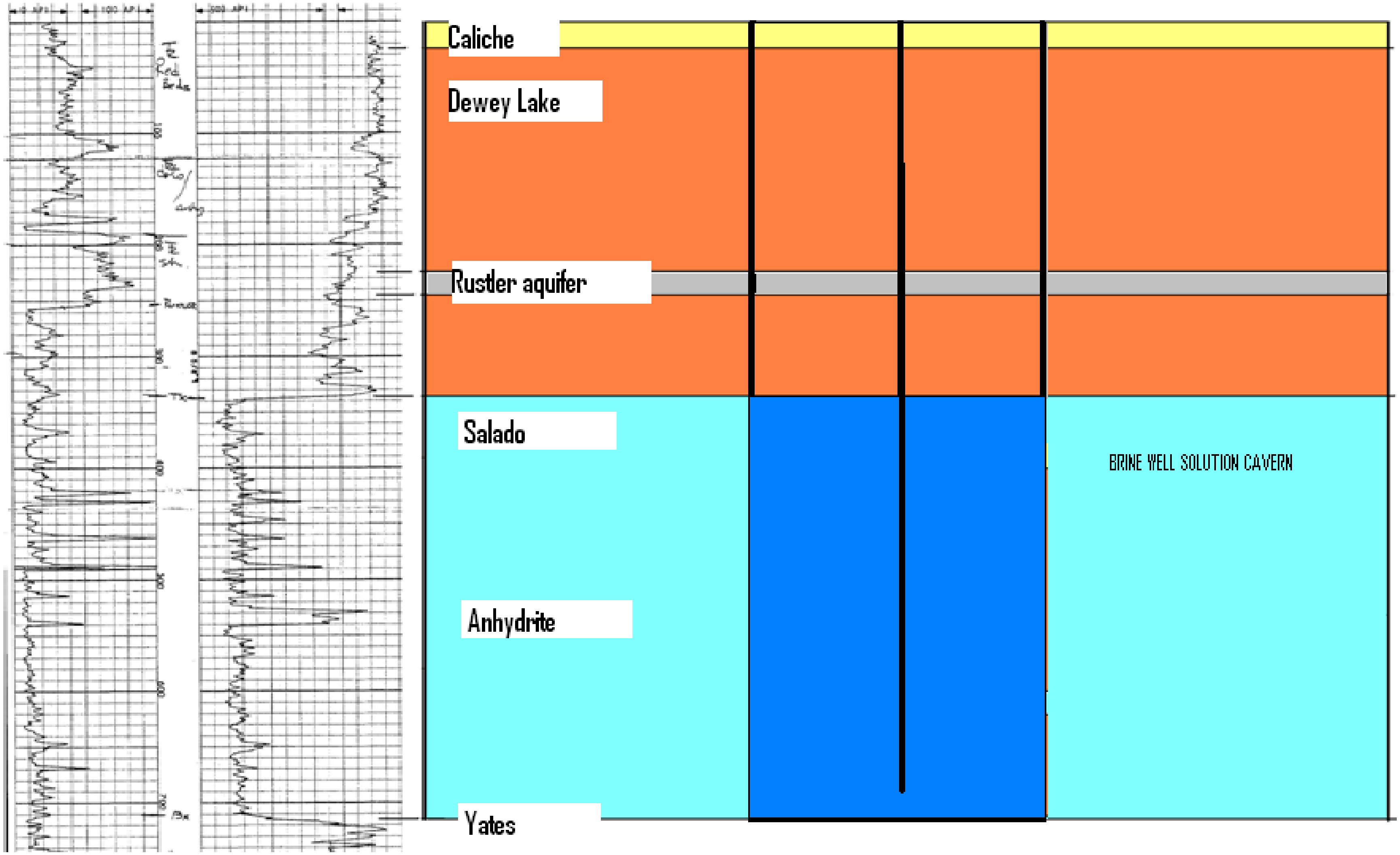


RED LAKE OIL FIELD
Loco Hills
GREYBURG MALJAMAR
OIL FIELD
LOCO HILLS
OIL FIELD
EMPIRE
ARTESIA OIL FIELD
BW005
Oil City
2.1mi
ESRI
Copyright:© 2008 National Geographic Society

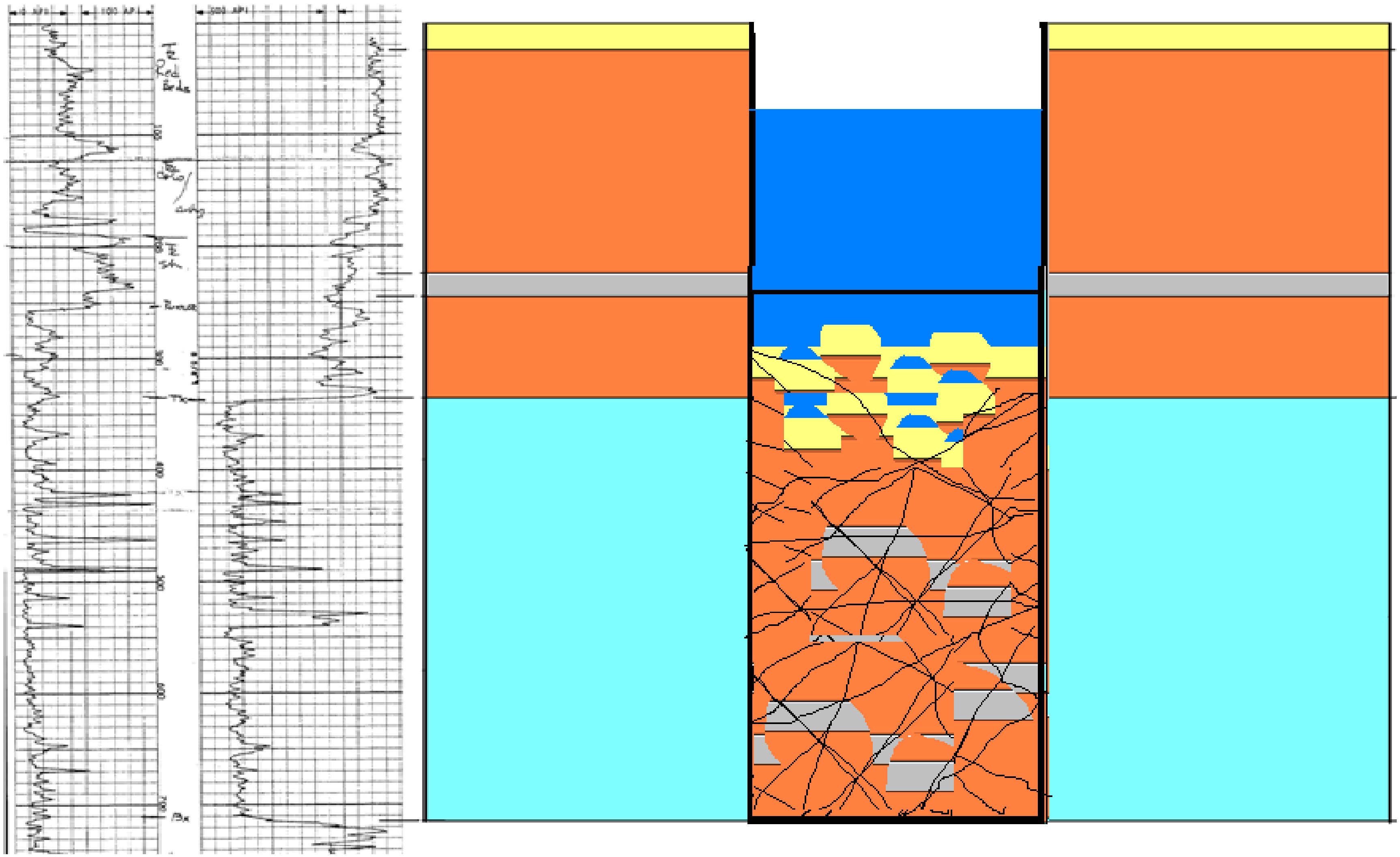

BW005
Palmilla
1829ft
ESRI
Copyright: © 2008 National Geographic Society

INTERIM MODEL FOR BW005 COLLAPSE

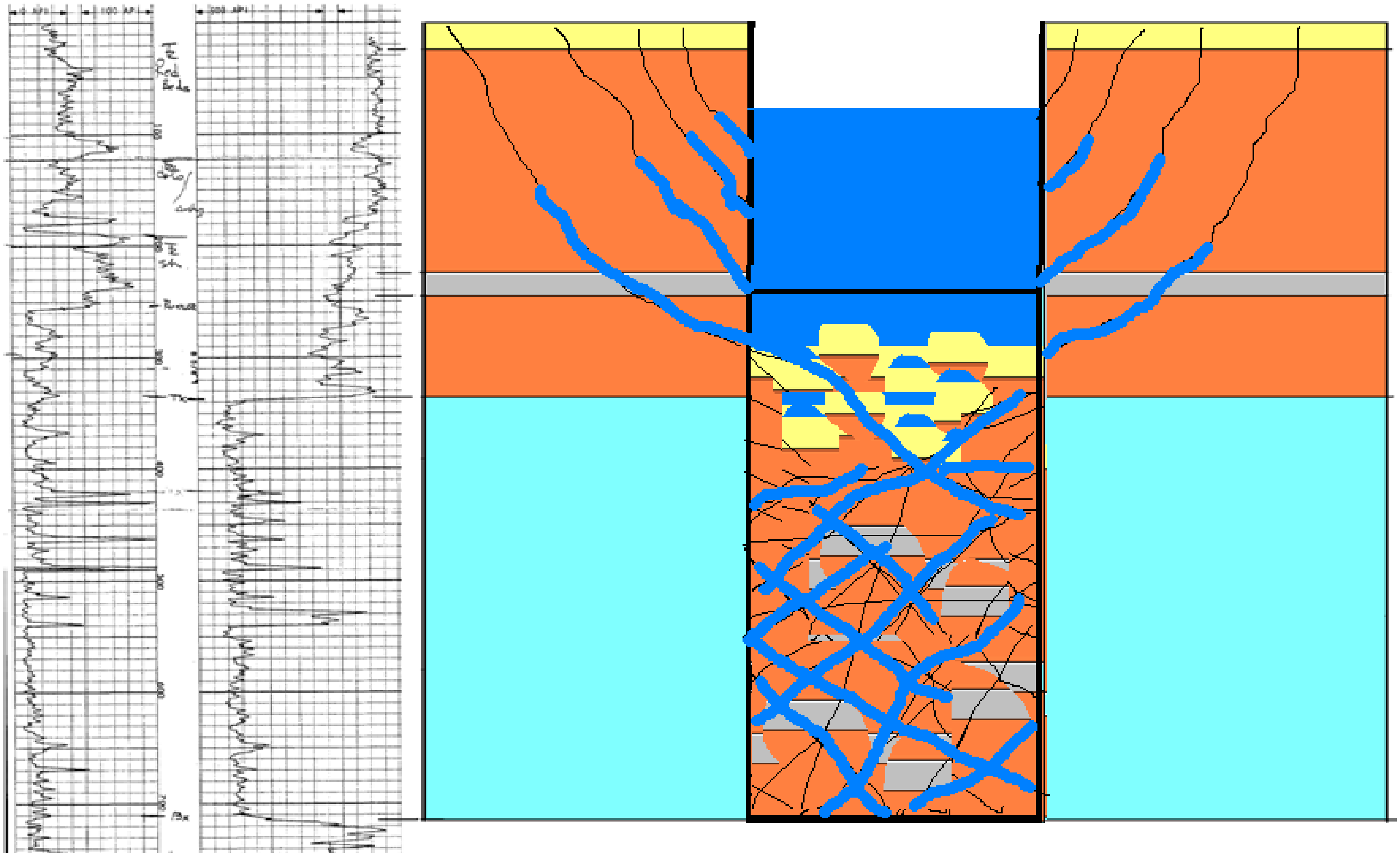
DAY 1: STAGE 0
PRECOLLAPSE CONDITIONS



DAY 1 – JULY 16, 2008: STAGE 1
CATASTROPHIC VERTICAL COLLAPSE
BRINE FILLED SINKHOLE

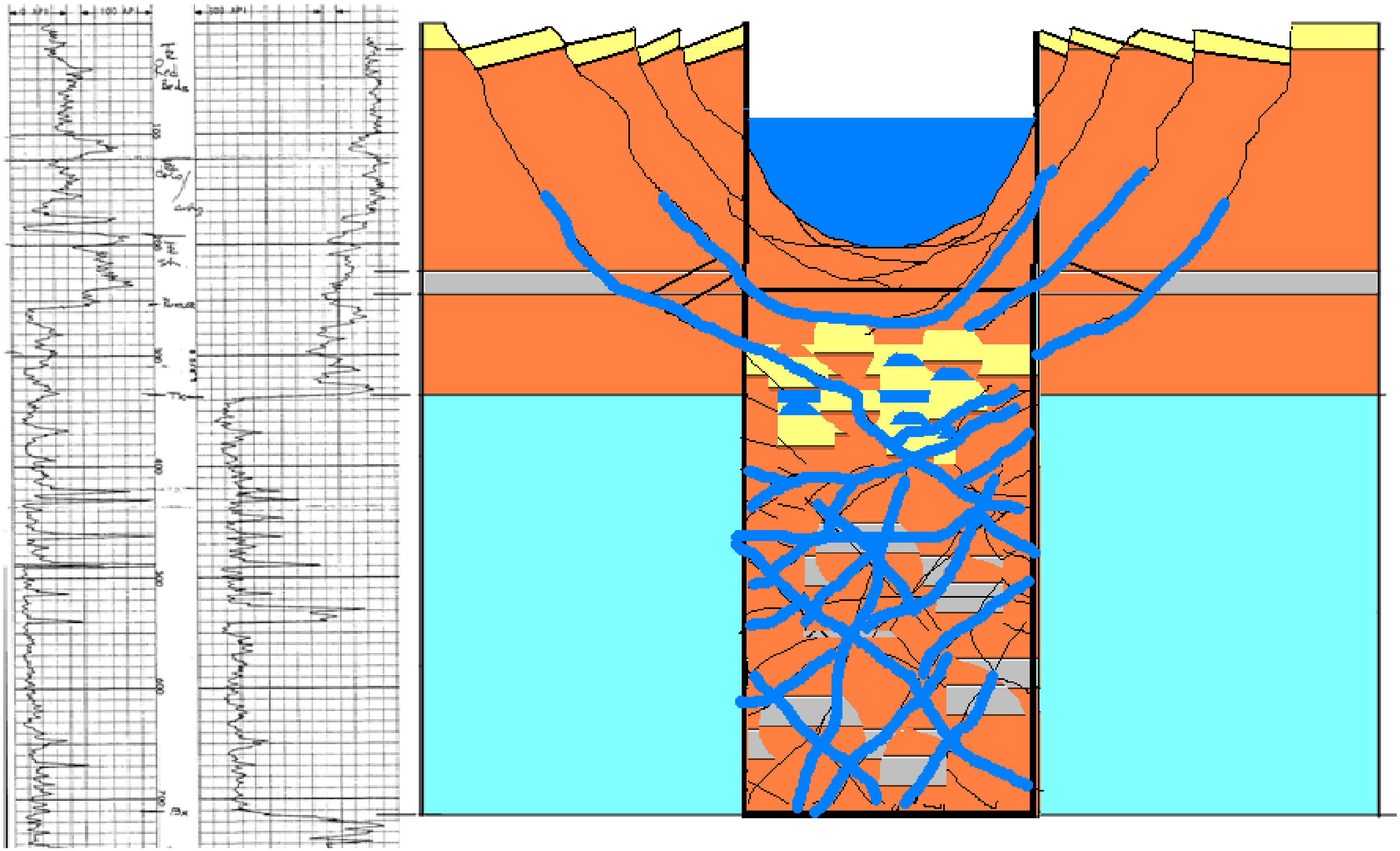


DAY 8 – JULY 24, 2008: STAGE 2
CONTINUED GROWTH OF BRINE FILLED SINKHOLE, WATER BEGINS TO DROP, SMALL SCALE FRACTURES

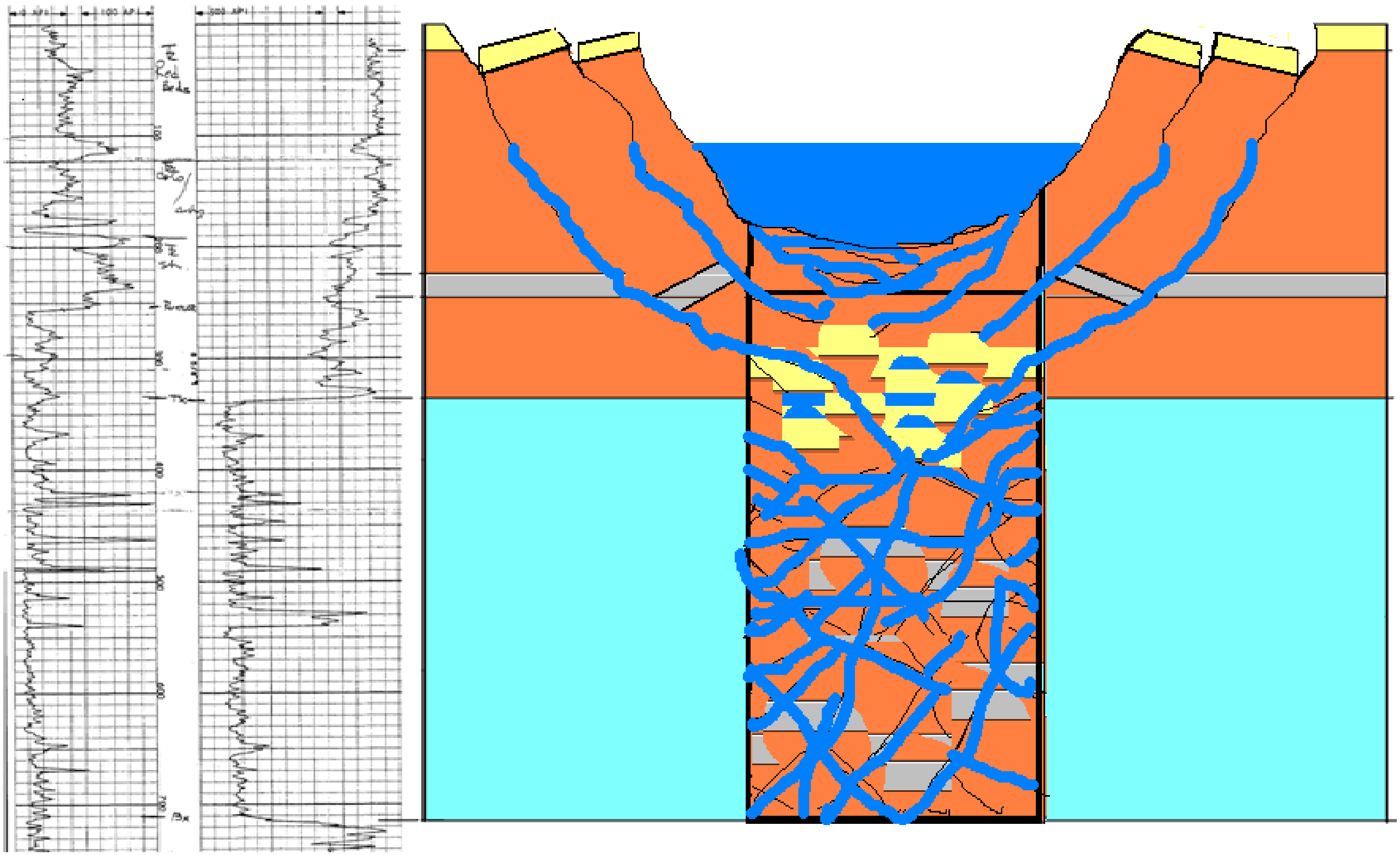


DAY 10: STAGE 3

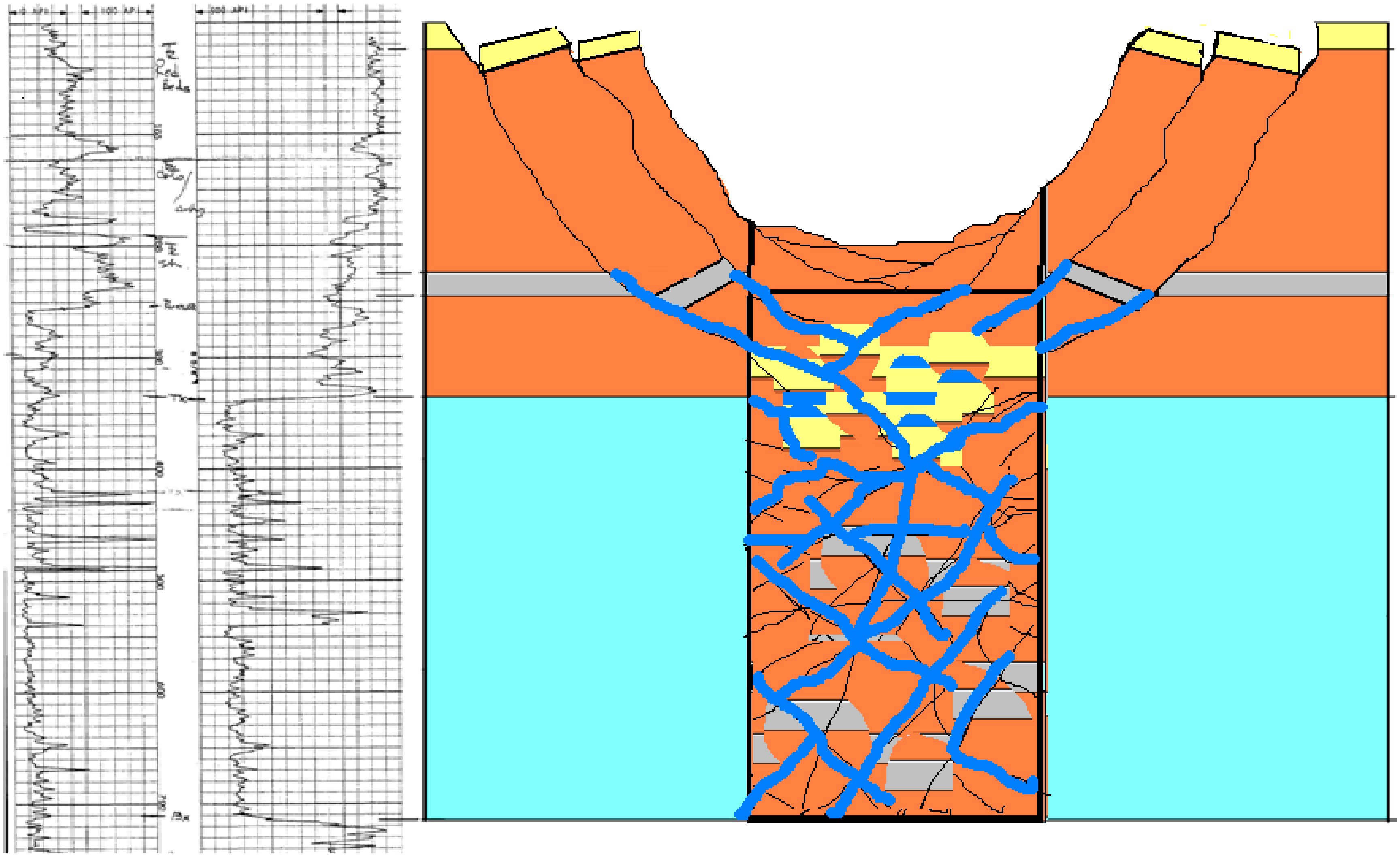
MAJOR RING FRACTURES, WATER LEVEL DROPS, BEGIN BOWL FORMATION



DAY 11: STAGE 4
WATER DRAINS, CONTINUED BOWL SUBSIDENCE, LARGE SCALE RING FRACTURES



DAY 12 TO PRESENT: STAGE 5
SLOW BOWL ENLARGEMENT



ADDITIONAL RESPONSE

- EMNRD Secretary Prukoff has announced that OCD will review its brine well regulations to determine what revisions to make in response to this collapse of a permitted brine well. To date, OCD has sent out a brine well survey form to the brine well operators. After all surveys have been submitted, OCD will review the forms to determine what additional data is needed. It will then review the data and determine its next steps. OCD has a draft Initial Response Plan. It will form a response team of qualified persons and organizations to consider what revisions to its rules are appropriate.

ftp://164.64.106.20/Public/OCD

RECEIVED
2008 SEP 3 PM 3 05

LIVINGSTON RESEARCH CORPORATION
R223 North l3th Street
Artesia, New Mexico 88210

28 September 2008

Jim's Water Service

New Mexico Oil Conservation Division:

Dear Sirs:

Livingston Research Corporation (LRC) makes the following offer to alleviate the problems caused by the cave in of the Jim's Water Service (JMS) Brine Water Production Site . (BWPS).

1. LRC will pay JMS five percent .5% of the profit made by LRC's oil field disposal procedures. This will start 3 months after the disposal operation is established and "IF": a profit has been developed. Costs and procedures have not been established. This lease will be automatically renewed by JMS, and the OCS. and can only be canceled by LRC.

2. LRC agrees to proceed as profitable as possible, but in all new ventures unexpected problems will occur

3. LRC agrees to limit the amount of potential contaminants added to the disposal area. different methods may be used. The primary ingredient will by drill stem cuttings and brine water.

The Oil Field Conservation Division agrees to:

1. Establish simple guide lines for the operation, and limits of the extent of the possible danger.

2. Provide a fence around the danger zone, that protects both, animals and human from access.

3. Agrees that additional contamination of fresh water is impossible, with the limited amount of fluids to be added to the fill. The subject hole is full of brine water from the bottom up,.left there from dissolving pre historic oceans..

4. That there is no recoverable un polluted water in the hole..

PROPOSAL IS RESPECTFULLY SUBMITTED:

Wm H Livingston

Wm. H. Livingston, BS/DVM
President LRC .

PS Request specific answers and proof from the OCD: Why. this proposal can not be approved. Please do not quote your regulations, because they do not apply. Because this was a brine production well approved by the OCD, and created under the supervision of all the OC D personal since its inception.

Please respond immediately..

RECEIVED

LIVINGSTON RESEARCH CORPORATION
R223 North 13th Street
Artesia, New Mexico 88210

2008 SEP 15 PM 3 20

September 11, 2008

N.M. OCD
1220 South Francis Drive
Santa Fe, NM 87505

Director New Mexico Oil Conservation Division

Sir:

A. Reference LRC letter dated: September 11, 2008.

1. LRC proposed to utilize the brine water hole in Eddy County by disposing of drill cuttings and waste brine water in it. This will help stabilize the hole and make it safe.

2. LRC will use consultants from the salt mines in Carlsbad, N. M. We believe LRC with this help can fill the hole safely.

B. The work will be experimental at first, and may be slow developing but will go faster as soon as safe and proper techniques are developed.

C. LRC proposes to donate 50% of the profit from filling the hole with oil field waste to the Cerebral Palsy Fund of New Mexico.

THIS WILL BE A DIRECT GIFT FROM GOD AND THE OCD FOR THE CRIPPLED CHILDREN OF NEW MEXICO.

Sincerely,

Wm. H. Livingston

Wm. H. Livingston BS/DVM
President: Livingston Research Corporation

Distribution:
1. OCD
2. United Press of New Mexico

New Mexico Energy, Minerals and Natural Resources Department

Oil Conservation Division
Environmental Bureau

Brine Well Collapse Evaluation Report

June 18, 2009

EXECUTIVE SUMMARY

In 2008, New Mexico experienced two sudden and catastrophic brine well cavern collapses within a four-month period that led to the formation of massive sinkholes. The first, at Jim's Water Service, occurred on July 16, 2008. The second, at Loco Hills Water Disposal Company, occurred on November 3, 2008.

On November 14, 2008, Secretary Joanna Prukop of the Energy, Minerals and Natural Resources Department (EMNRD) ordered the Oil Conservation Division (OCD) to examine the causes of the brine well collapses and to provide a report with recommendations for a safe path forward (See Appendix 1 - November 14, 2008 Press Release). Secretary Prukop directed OCD to work with the Environmental Protection Agency, other states, technical experts, and oil and gas industry representatives.

OCD formed an Underground Injection Control (UIC) Class III Brine Well Evaluation Work Group (Work Group). The Work Group included OCD staff, representatives from the Bureau of Land Management, the State Land Office, the New Mexico Bureau of Geology and Mineral Resources, the Environmental Protection Agency, the Sandia National Laboratory, the National Cave and Karst Research Institute, the Solution Mining Research Institute, and industry representatives. OCD staff met with the Work Group in Santa Fe for a two-day session March 26-27, 2009. Other experts who could not attend the meeting submitted comments via email, including participants from Texas, Louisiana, New York, and Kansas (see Appendix 2). The Work Group examined the available data on the two collapses and examined data on other brine wells in New Mexico to evaluate their collapse potential. During the course of its review OCD and the Work Group identified an existing brine well located within the city limits of Carlsbad that shares features with the two wells that collapsed and that is itself in serious danger of collapse. OCD hired RESPEC, Inc., a company with expertise in brine wells, to provide technical assistance in evaluating the status of the Carlsbad brine well and to propose mitigation strategies.

OCD is continuing to review the two collapses that occurred last year and to evaluate existing brine wells for subsidence and collapse potential. OCD sent out a Brine Well Information Request form to all brine well operators on August 1, 2008, that required operators to provide OCD with general information, siting information, well construction information, operations history, monitoring information, an estimate of the total volume of brine produced, and the volume of the cavern.

A brine well will collapse when the cavern created by the brine production becomes too large to support the roof. In 2008, a study on subsidence, sinkholes, and craters above salt caverns quantified this concept, concluding that a salt cavern generally will not collapse if the ratio between the cavern diameter and the cavern depth (d/h) is significantly smaller than 2/3.

Based on the information available at this time, OCD has concluded that the following factors may have contributed to the two collapses that occurred in 2008 by creating a brine well cavern that could not support its roof:

- Operation of brine wells in shallow salt zones;
- Placement of the casing shoe near the top of the salt zone;
- Use of the “reverse” circulation configuration; and,
- Overproduction of brine, creating a large cavern.

OCD recommends taking the following actions:

- OCD should complete its review of all existing brine wells, including plugged and abandoned wells, shut-in wells, and operational wells, in light of the 2/3 ratio and prioritize the wells in terms of collapse potential.
- Based on its findings, OCD may require appropriate corrective actions. This may include changes in operation requirements, closure of active wells, monitoring of sites, and/or site remediation measures.
- OCD should re-evaluate existing permit terms, including: use of “reverse” circulation; use of a diesel oil blanket or pad to prevent dissolution from occurring at the top of the brine well cavern; plug and abandonment requirements; and financial assurance requirements.
- OCD should evaluate siting, drilling, construction, operation, monitoring, and closure requirements for new brine wells.

1 INTRODUCTION

1.1 Geology

Much of southeast New Mexico is underlain by bedded salt. The principal salt-bearing formation is the Salado Formation, which is part of the late Permian Ochoan Series (approximately 251 - 260 million years ago). Other formations, including the Rustler and the Castile Formations, also contain bedded salt, but the Salado Formation is the thickest and most widespread of the salt-bearing formations. The Salado Formation is the geologic formation into which nuclear waste is disposed at the Waste Isolation Pilot Project (WIPP). The Salado Formation ranges in thickness from zero feet at the western edge of the Delaware Basin to approximately 2,400 feet in thickness in the central part of the basin. The Salado Formation is laterally continuous throughout much of southeast New Mexico and operators must drill through it to reach oil and gas producing zones. Drilling through the Salado Formation using a fresh water mud system is problematic because the fresh water mud will dissolve the salt zone and cause the operator to lose circulation. Operators drill through the Salado and other salt bearing formations using a saturated brine mud that will not dissolve the salt.

1.2 Brine Well Operations in New Mexico

A UIC Class III injection well (brine well) is a solution mining operation in which fresh water is injected into the salt zone, dissolving the salt, thus creating highly saturated brine. The brine is produced from the brine well and sold for use in oil and gas drilling operations. Over time, the salt zone dissolves, resulting in an underground cavern.

New Mexico has permitted 43 brine wells at 32 brine well facilities. Ten brine wells are presently active; four were never installed; one was completed but never operated; 26 are presently plugged, and two have collapsed. All are located in Eddy and Lea Counties (see Figure 3).

Brine well operators employ solution mining techniques to generate the saturated brine that it sells to the oil and gas operators. Either a new well is drilled for brine operations, or an old oil and gas well which has been abandoned and which the operator deems to be salvageable for brine well operations is reentered. Casing is most often set near the top of the salt, usually the Salado Formation, the drill hole is advanced to near the bottom of the salt, and tubing is set near the bottom of the hole. Several wellbore configurations have been utilized, including: single well, single tubing; single well, dual tubing; dual well; and, cased-hole, single tubing systems (see Figure 4). In a single well system using either a single tubing or dual tubing configuration, fresh water is pumped into the well bore and brine is extracted. In a dual well system, fresh water is injected down the tubing in one well and brine is extracted from the tubing in a second well.

Two circulation methods may be used in dual tubing configurations. In the "normal" circulation method, fresh water is injected down the tubing and brine is extracted through the annulus, or outer tubing. In the "reverse" circulation method, fresh water is injected down the annulus and the brine is extracted through the tubing. The reverse circulation method is more protective of any fresh water zones above the Salado Formation because in the event of a casing leak, fresh water would leak into the fresh water zone rather than brine.

The configuration and circulation method used affect the shape of the cavern created by the brine well operation. A single well system will create a single cavern. A dual well system will generally create two, linked caverns. Generally, normal circulation leads to a cylindrical cavern, whereas reverse circulation leads to a cavern that is broad at the top and narrow at the bottom of the cavern: an inherently weaker structure (see Figure 4).

1.3 Regulatory Overview

Brine wells are classified as "Class III injection wells" by the federal Environmental Protection Agency (EPA), which has established minimum federal requirements for state and tribal underground injection control (UIC) programs under the Safe Drinking Water Act (see 42 U.S.C. 300f *et seq*.). States and tribes may apply to EPA for primacy to administer the UIC program. To obtain primacy, they must demonstrate that their regulations meet or exceed federal requirements (see 42 U.S.C. 300g-2).

In 1983, EPA granted primacy over Class III brine wells in New Mexico (except for those on Indian land) to the Water Quality Control Commission (WQCC), the Environmental Improvement Division (now the New Mexico Environment Department), and OCD (see 40 CFR 147.1601). In granting New Mexico primacy, EPA specifically referenced New Mexico's Water Quality Act (Chapter 74, Article 6 NMSA 1978). EPA reviews New Mexico's UIC programs annually.

New Mexico's regulations addressing UIC Class III brine wells specified at 20.6.2.5000 *et seq.* NMAC, were promulgated pursuant to the Water Quality Act, which gives broad powers to the WQCC to adopt regulations to prevent or abate water pollution, specifically including regulations requiring persons to obtain permits for the discharge of any water contaminant. The WQCC has delegated regulatory authority over Class III brine wells to OCD.

EPA's primary concern under the Safe Drinking Water Act is the protection of underground sources of drinking water. The federal requirements for injection wells, including brine wells, focus on "pathways of contamination" - specifically, ways in which fluids can escape the well or injection horizon and enter underground sources of drinking water. EPA's UIC program provides standards, technical assistance and grants to state governments to regulate injection wells in order to prevent them from contaminating drinking water resources. In general, EPA requires the operators of Class III wells, including brine wells, to:

- Site the well in a location that is free of faults and other geological hazards;
- Drill to a depth that allows the injection into formations that do not contain water that can potentially be used as a source of drinking water and that are isolated from any formation that may contain water that may potentially be used as a source of drinking water;
- Case and cement brine wells to prevent the migration of fluids into an underground drinking water source;
- Never inject fluid between the outer-most casing and the well bore; and
- Test the well casing for integrity at the time of completion and every five years thereafter; and,
- Monitor to assure the integrity of the well.

2 BRINE WELL COLLAPSES

2.1 Jim's Water Services (BW-005)

The Jim's Water Services brine well (BW-005) collapsed on July 16, 2008 (See Figure 4). An employee driving to the well to perform a site check observed a dust cloud in the area of the well. When he got out of his truck he noticed a surface crack open and progress toward him. He immediately left the site as the cavern began collapsing. The initial sinkhole was approximately 40 feet wide. By that afternoon, the surface collapse was approximately 180 feet in diameter. As of April 2009, the sinkhole was approximately 400 feet across and 120 feet deep. The sinkhole continues to grow.

BW-005 is located on state trust land approximately 17.3 miles southeast of Artesia in Eddy County. It is sited about 400 feet north of Hagerman Road (CR 217) and 2.4 miles southwest of State Highway 360. BW-005 was originally drilled as an oil and gas exploration and production well in 1955 with cable tools to a total depth of 3909 feet. The well was plugged and abandoned in 1955. The well was reentered and recompleted as a brine well in 1978.

The Salado Formation was encountered at approximately 397 feet below ground surface (BGS). BW-005 was operated as a single well system with a single tubing configuration using normal circulation until 1986, when it was switched to reverse circulation. No sonar surveys were ever run to map the cavern. Based on incomplete production data, OCD estimates that the total brine production at BW-005 was approximately 8 million barrels and that the cavern volume was approximately 1.3 million barrels.

BW-005 had passed an EPA 5-Year Mechanical Integrity Test (MIT) of the casing in 2007 and had passed an annual formation MIT of the cavern in 2008. The operator had not noticed any surficial cracks or fractures before the collapse. The well was active at the time of the collapse.

After the collapse, OCD contacted New Mexico Tech to determine if their seismic array had picked up signs of the collapse. A seismograph (TA126), located approximately 8 miles southeast of BW-005, recorded seismic activity approximately six hours before the surface collapse occurred. The seismic signals are believed to be associated with subsurface spalling and upward stoping of the brine well cavern roof.

2.2 Loco Hills Water Disposal Service (BW-021)

The Loco Hills Water Disposal Service (BW-021) brine well collapsed on November 3, 2008 (see Figure 5). Workers noticed surficial cracking or fracturing near the well at about 11:30 AM and immediately prevented access to the area. The collapse occurred at approximately 1:30 PM. The operator reported that the initial sinkhole was approximately 50 feet across and approximately 30 feet deep. As of May 2009, the sinkhole was approximately 291 feet across and as much as 200 feet deep.

BW-021 is located on state trust land 150 feet east of County Road 217 near Loco Hills, approximately 25 miles east of Artesia in Eddy County. BW-021was originally drilled as an oil and gas exploration and production well and was converted into a brine production well approximately 25 years ago. It was operated as a single well system with a single tubing configuration using reverse circulation. The casing shoe was set at 415 feet BGS above the salt which occurs at 470 feet BGS. (It is not clear whether the salt was part of the Rustler or Salado Formation, or both). The production tubing was set at 900 feet BGS. The last sonar log of the well was completed on February 7, 2001. Based on incomplete production information, OCD estimates that the total brine production at BW-021 was approximately 8 million barrels and that the cavern volume was approximately 750,000 barrels.

BW-021 was plugged and abandoned at the time of the collapse and was being visually monitored for subsidence. The well had failed an annual formation MIT on June 18, 2008 and OCD had ordered the operator to plug and abandon the well. The well had previously passed a 5-year MIT of the casing in 2006.

After the collapse of BW-021, OCD again contacted New Mexico Tech to determine if their seismic array had picked up signs of the collapse. The same seismograph (TA126), located approximately 14 miles south-southwest of BW-021, did not detect any seismic activity before the well collapsed.

3 FACTORS CONTRIBUTING TO COLLAPSE

3.1 General

A brine well cavern will collapse when the cavern becomes too large to support the roof. This can be expressed in terms of a ratio between the cavern diameter and the thickness of the overburden or roof. Cratering does not occur when the relation between cavern diameter and the thickness of the roof is significantly smaller than 2/3 (See Karimi-Jafari, M., P. Berest, and B. Brouard, 2008, *"Subsidence, Sinkholes and Craters above Salt Caverns,"* Solution Mining Institute (SMRI) Spring 2008 Technical Conference, Porto, Portugal).

3.2 Cavern Size

Sonar should be used to map the actual cavern size and location. Where sonar mapping is unavailable, or impractical, approximate cavern size may be calculated by determining how much of the salt zone had to be dissolved to create the brine produced by the well. A well with a long productive life is more likely to have a large cavern than a well with a short productive life.

3.3 Weak Overburden

Shallow salt zone: The salt bearing formations in the Delaware Basin of southeastern New Mexico occur at very shallow depths (less than 250 feet BGS) at the western edge of the basin and dip toward the east in the central part of the basin where the salt occurs at depths of more 2000 feet BGS. Brine production techniques that dissolve the upper portion of the salt zone, such as "reverse" circulation, result in a thinner, weaker overburden.

Placement of the casing shoe: In the two brine wells that collapsed, the casing shoe was set near the top of the salt zone, rather than being advanced into the salt by a certain amount, such as 100 feet into the salt.

"Reverse" circulation: The two brine wells that collapsed employed "reverse" circulation using a single tubing configuration. Injection of fresh water down the annulus generally creates a cavern that is broad on top and narrow at the bottom, an inherently weak configuration. Injection of the fresh water into the upper part of the cavern, rather than near the bottom of the cavern, will laterally dissolve the salt, aggressively increasing the size of the roof of the brine well cavern. Using "reverse" circulation in a well where the casing shoe is placed near the top of the salt zone, especially where the salt zone is shallow, tends to create a broad, thin, weak overburden.

3.4 Additional Concerns

Lack of Warning: The two cavern collapses in 2008 occurred with little or no advance warning.

Well Siting: The two cavern collapses were located in remote areas. No injuries or loss of life occurred in the collapses. If a well is located in a populated or developed area, a collapse will have greater potential for injury, loss of life, and property damage.

Remediation: OCD is continuing to work with its consultant on what can be done to prevent collapses from occurring in wells that are at risk for collapse and what corrective measures will be required from operators.

4. RECOMMENDATIONS

OCD recommends the following actions, based on its evaluation of brine well operations in New Mexico, the two brine well collapses in 2008 and the information gained during the Brine Well Work Group sessions.

4.1 OCD should complete its review of all existing brine wells, including plugged and abandoned wells, shut-in wells, and operational wells, in light of the 2/3 ratio and prioritize the wells in terms of collapse potential.

4.2 OCD should evaluate existing information on all brine wells in order to determine cavern size, shape, and depth, and then prioritize the wells in terms of collapse potential. OCD should require additional information from operators to complete this study, either through existing permit terms or by modifying permits to add the following requirements:

- Operators should conduct sonar testing through the full extent of the cavity from top to bottom within six months of permit modification to document the size and configuration of the cavern.
- Operators should submit comprehensive historical injection and production reports with monthly and annual production totals and estimate the volume of the cavern within six months of permit modification to compare with the sonar surveys.
- Operators should propose criteria that will enable them to determine the "Maturity" of their brine operations to determine when they must stop production and either modify or terminate their permit.
- Operators should precisely monitor the actual injection volume of fresh water versus brine produced on a daily basis and notify OCD if the differential exceeds an amount to be determined to complement the annual MITs and to help identify a potential leak in the system.

4.3 Require Corrective Actions on Wells

OCD will examine each brine well on a case-by-case basis to determine if corrective action is required. Corrective action may include changes in operation, closure of active wells, monitoring of sites, and/or site remediation measures.

OCD should require operators to cease operations if they cannot demonstrate that the brine well has a certain width to overburden thickness ratio; for example, less than or equal to 0.50 at any time during the operation of the well. For example, the cavern associated with a well with its casing shoe set at 1000 feet BGS, shall not exceed a diameter of 500 feet. In addition, OCD should not allow the maximum cavern roof diameter to exceed 200 feet.

OCD has already taken action on one brine well, which it determined posed the greatest risk of collapse, located within the city limits of Carlsbad. After the first collapse, OCD convinced the operator to cease it brine well operations on July 22, 2008. On April 22, 2009, the Carlsbad operator ceased its trucking operations at the site after discussions with OCD. OCD and its contractor are in the process of installing a subsidence monitoring system and early warning system and are investigating methods for mapping the cavern and possible remediation.

4.4 Re-evaluate Existing Permit Terms

OCD may consider modifying existing permits. Possible modifications include:

- Requiring “normal” circulation. OCD has already contacted operators using “reverse” circulation and requested that they switch to “normal” circulation.
- Specifying technical standards to prevent dissolution from occurring at the top of the brine well cavern, such as cavern configuration, casing, tubing, and requiring a diesel oil blanket or pad.
- At time of closure, OCD may require operator to keep the cavern full of brine fluid and to monitor the pressure head for anomalous pressure changes. OCD may require operators to implement a post-closure subsidence monitoring program. OCD will examine its previous plugging and abandonment requirements in light of the research conducted by the Solution Mining Research Institute.
- Increase financial assurance requirements to better address monitoring and remediation issues.

4.5 Consider Siting, Drilling, Construction, Operation, Monitoring and Closure Requirements for New Brine Wells.

Operational issues that would impact new brine wells include:

- Siting and setbacks;
- Area of review to assess the potential for “thief” zones and the potential for accidental de-watering;
- Establishing minimum depth to top of salt;
- Establish minimum depth for setting the casing shoe;
- Specify maximum brine production volume and life-of-well limits; and,
- Establish minimum distance between brine well caverns.

5.0 CONCLUSIONS

The UIC program which regulates brine wells is designed to protect underground sources of drinking water. The issue of subsidence and/or collapse of a brine well cavern has not been recognized by OCD or EPA as a major problem. Therefore, OCD must change its focus and address issues for which it does not yet have answers. For example, with the situation that exists in Carlsbad, OCD finds itself confronted with a major challenge that the UIC program does not address. First, and most importantly, OCD must attempt to mitigate any catastrophic collapse at the Carlsbad brine well facility to protect human life and property. OCD should also identify other brine well facilities that pose a risk for catastrophic subsidence or collapse and address these sites individually.

In the future, OCD must evaluate the dual issues presented by permitting brine wells so as to protect ground water quality as required by the UIC program while preventing brine well subsidence and/or collapse. To move forward, OCD must strike an appropriate balance between protecting water quality and ensuring that brine well operations do not pose a risk to human life and property.

APPENDIX 1

PRESS RELEASES

New Mexico Energy, Minerals and Natural Resources Department

Bill Richardson
Governor

Joanna Prukop
Cabinet Secretary
Reese Fullerton
Deputy Cabinet Secretary

Mark Fesmire
Division Director
Oil Conservation Division

November 14, 2008

NEWS RELEASE

Contact: Jodi McGinnis Porter,
Public Information Officer 505.476.3226

Energy, Minerals and Natural Resources Cabinet Secretary Prukop Orders a Six Month Moratorium on New Brine Wells

Oil Conservation Division to Investigate Brine Well Collapses and Provide Recommendations

SANTA FE, NM – Secretary Joanna Prukop today ordered the Oil Conservation Division to place a six month moratorium on any new brine well applications located in geologically sensitive areas. Secretary Prukop's action comes following the second brine well collapse in less than four months in southeastern New Mexico. The Secretary has also directed the Oil Conservation Division to work with the Environmental Protection Agency, other states, technical experts and oil and gas industry representatives to examine the causes of recent collapses, and provide a report with recommendations to the Oil Conservation Commission for a safe path forward. The report should be completed by May 1, 2009.

"I am deeply concerned by these two serious incidents and we are taking action to ensure the safety of our citizens and to protect the environment," stated Secretary Prukop.

Brine wells are an essential part of the oil and gas drilling industry, particularly in the southeastern part of the state. Oil and gas operators use brine water in the drilling process. Brine is saturated salt water which can be more salty than sea water. Brine is created by injecting fresh water into salt formations, allowing the water to absorb the salt and then pumping it out of the well. This method creates an underground cavity.

"The moratorium will provide time to properly evaluate the causes of the recent collapses and to discuss the development of new rules or guidelines to ensure the safety and stability of brine well systems," added Secretary Prukop.

The moratorium will only affect new wells and will not impact existing wells and facilities.

Below are photographs of the two recent collapses:

Loco Hills brine well collapse, morning, November 7, 2008, sinkhole with fresh water pond in foreground.
Photo courtesy of Oil Conservation Division

Loco Hills brine well collapse, morning, November 7, 2008 sinkhole.
Photo courtesy of Oil Conservation Division

Loco Hills brine well collapse, morning, November 7, 2008 status of fresh water pond.
Photo courtesy of Oil Conservation Division

Artesia brine well collapse, morning, July 20, 2008 at 10:44 am.
Photo courtesy of National Cave and Karst Research Institute

Artesia brine well collapse morning, July 22, 2008
Photo courtesy of National Cave and Karst Research Institute

#30#

The Energy, Minerals and Natural Resources Department provides resource protection and renewable energy resource development services to the public and other state agencies.

Oil Conservation Division
1220 South St. Francis Drive ▪ Santa Fe, New Mexico 87505
Phone (505) 476-3440 ▪ Fax (505) 476-3462 ▪ www.emnrd.state.nm.us/OCD

APPENDIX 2

OCD MEETING AGENDA AND WORK GROUP MEMBERS

(Updated: 3/31/2009)

New Mexico Oil Conservation Division
UIC Class III Brine Well Evaluation Work Group
Porter Hall (Wendell Chino Bldg.)
1220 South St. Francis Drive, Santa Fe, NM 87505
March 26-27, 2009
(8:00 a.m. – 5:00 p.m.)

FINAL AGENDA

Thursday, March 26, 2009

8:00 - 8:10 a.m. **Welcoming remarks:** OCD Director Mark Fesmire or EMNRD Secretary Joanna Prukop.

8:10 - 8:15 a.m. **NMOCD introduction:** OCD Environmental Bureau Jim Griswold states purpose and goal of the work group.

8:15 - 8:30 a.m. **Work group members introduction:** Members briefly state interest in serving on the work group; and what he/she hopes to bring to the table.

8:30 - 8:50 a.m. **Shallow geology & hydrology of the Delaware/Permian Basin in SE NM (Glenn von Gonten- OCD/ Richard Beauheim- SNL)**

8:50 - 9:05 a.m. **A history of brine well operation & regulation in NM (Jim Griswold- OCD)**

9:05 - 10:00 a.m. **Recent brine well collapses in NM & case studies (Jim Griswold- OCD)** Jims Water Service SE of Artesia on 7/16/2008 & Loco Hills Disposal E of Artesia on 11/3/2008

10:00 – 10:15 a.m. **Break**

10:15 – 10:35 a.m. **Federal discussion (Ray Leissner- EPA)**

10:35– 11:15 a.m. **Potential impacts to the WIPP Site? (Chuck Byrum- EPA & Russ Patterson- DOE)** Slide show of subsurface facilities relative

	to the oil field activities in the region; associated regulatory requirements; and any other relevant issues.
11:15 – 11:45 a.m.	**Sonar Testing in Bedded Salt (Jason McCartney- SOCON Sonar Well Services, Inc.)**
11:45 - Noon	**Developing a research plan to evaluate existing brine wells & to assess potential risk of collapse (George Veni (NCKRI)**
Noon – 1:00 p.m.	**Lunch (on your own)**
1:00 – 1:30 p.m.	**Potash Well Siting, Construction & Operation (Richard Miller- Intrepid Potash)**
1:30 – 2:00 p.m.	**Class II Hydrocarbon Storage Wells- Western Refining L.P.** Siting, construction & operation. Should these types of wells be considered similar to Class III brine wells for potential collapse?
2:00 – 3:00 p.m.	**Current OCD discharge permit requirements for Class II HC Storage & Class III Brine Wells (Carl Chavez- OCD)** Display of OCD discharge permits and current requirements
3:00 – 3:15 a.m.	**Break**
3:15 – 4:00 p.m.	**Brine well strategy/talking points (Carl Chavez- OCD)** Brainstorming
4:00 – 4:30 p.m.	**Miscellaneous (Work Group)**
4:30 – 5:00 p.m.	**Work Group Summary**

Friday, March 27, 2009

8:00 – 9:00 a.m. **Siting Criteria (Work Group)**

Proximity of populated development
Proximity of public roadways
Proximity of utilities including water supply wells
Oil & gas production
Potash mining (Hugh Harvey)
Other brine wells/caverns
Easements
WIPP (Chuck Byrum)
Other infrastructure
Disposition of protectable ground water
Thickness of salt ore layer
Interbedding

9:00 – 9:30 a.m. **Construction Characteristics (Loren Molleur)**

Re-entry of former oil and gas wells
Thickness and lithology of overburden
Borehole geophysical logging
Well Materials
Casing penetration into salt
Cementation of casing
Multi-well operation

9:30 – 10:00 a.m. **Operations (Mark Cartwright)**

Tubing placement
On-site pumping of fresh water
Modes of fresh water injection/brine extraction
Production pressures and rates
Operational lifetime
Closure including possible backfilling of cavern with solid materials

10:00 – 10:15 a.m. **Break**

10:15 – 10:45 a.m. **Monitoring (Work Group)**

Subsidence monitoring
Mechanical integrity testing of casing and cavern (Wayne Price)
Surface assessment
Geophysical methods for determination of cavern size and geometry (Andreas Reitze)
Groundwater quality monitoring

10:45 – 11:15 a.m. **Plug & Abandonment (Work Group)**

Fill brine cavern w/ brine water & cement casing to surface

11:15 – Noon	**Collapse Response (James Rutley- BLM)** Pre-positioning of emergency materials Immediate public safety Longer term restriction of access Property damage (Thaddeus Kostrubala) Groundwater contamination (Lewis Land) Backfilling
Noon – 1:00 p.m.	**Lunch (on your own)**
1:00 – 1:30 p.m.	**NM Class III Brine Well Regulations (Carl Chavez- OCD)** WQCC 20.6.2 NMAC
1:30 – 2:00 p.m.	**TX Class III Brine Well Regulations (Jim Griswold- OCD)** Chapter 3: Oil and Gas Division, Rule 3.81
2:30 – 3:00 p.m.	**KS Class III Brine Well Draft Regulations (Jim Griswold- OCD)** Article 46 - Underground Injection Control Regulations
3:00 – 3:15 p.m.	**Break**
3:15 – 3:45 p.m.	**Suggestions for NM Regulations or Guidelines based on WQCC 20.6.2 NMAC (Work Group)**
3:45 – 4:00 p.m.	**Work Group Members from Industry w/ Work Group**
4:00 – 4:15 p.m.	**Work Group Members from the Federal Government w/ Work Group**
4:15 – 4:30 p.m.	**Work Group Members from the State of NM w/ Work Group**
4:30 – 5:00 p.m.	**Work Group Summary & Thank you** (Work Group members who provided e-mail addresses will be included on any draft electronic draft documents, regulations, report, etc. that may follow from our meeting.

Work Group Biographies

Richard Beauheim (WIPP): Richard Beauheim is a Distinguished Member of Technical Staff at Sandia National Laboratories, and is currently Lead Hydrologist for the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico. From 1984 to 1996, he was the Principal Investigator for the hydrogeological characterization of the WIPP site. He is now coordinating and directing hydrogeologic field studies and hydrology-related performance assessment activities related to the recertification of WIPP. He is an expert on the geology and hydrology of the Delaware Basin, and has several decades' experience with drilling and testing of wells in that area.

Chuck Byrum (EPA): is an environmental scientist with the EPA Office of Radiation and Indoor Air in Washington, DC. He has been involved with WIPP performance assessment in multiple capacities, including waste characterization and WIPP technical lead as well as conducting other general technical reviews of WIPP and regulations development since 1993. Since the WIPP certification decision, he has been the Technical Lead working on WIPP performance assessment, WIPP site continued compliance of Subpart A, and monitoring programs and is leading the effort to prepare for the second re-certification in 2009. Before coming to EPA he worked for almost fifteen years in oil exploration, first will Shell Oil and finally with Meridian Oil.

Carl Chavez (NMOCD): is an Environmental Engineer (August 2005 to present) with the Environmental Bureau, Oil Conservation Division, Energy, Mineral & Natural Resources Department in Santa Fe, New Mexico. He graduated from New Mexico State University with a bachelor's degree in Geological Sciences and a minor in Economics in 1986. He attended the California State Polytechnic University in Pomona, California, in the Mechanical Engineering-Petroleum Option Program. He has been the permit writer and inspector for oil & gas refineries in New Mexico. He led the NMOCD's primacy initiative for the NPDES and storm water program. He served as the NMOCD's Quality Assurance/Quality Control Officer and as inspector for the NMOCD UIC Program in New Mexico. He has provided technical assistance and testified as an expert witness at NMOCD environmental regulatory hearings.

He worked as an Environmental Scientist/Specialist (March 2004 to August 2005) for the New Mexico Environment Department, Hazardous Waste Bureau, Waste Isolation Pilot Plant (WIPP) Group in Santa Fe, New Mexico. He evaluated hydrogeologic and/or ground water detection monitoring reports from WIPP for compliance with the WIPP Permit; EPA ground water monitoring requirements; and RCRA hazardous waste regulations. He lead comprehensive groundwater monitoring evaluations of field environmental sampling procedures and methods; five-year regulatory review of the WIPP Permit and ground water monitoring program; assessments, investigations and cleanup actions; evaluations of air ventilation monitoring reports, head space gas sampling of waste drums and other technical permit related projects. He participated in RCRA waste characterization audits/inspections with the USEPA and Carlsbad Technical Assistance Group at hazardous waste generator facilities across the U.S. to confirm compliance with hazardous waste provisions of the WIPP Permit, i.e., Waste Analysis Plan, Waste Acceptance Criteria, etc.

He spent from 1989 to 2004 working for the Michigan Department of Natural Resources-DNR (which later became the Department of Environmental Quality-DEQ) in Lansing, Michigan.

Mike Cochran (Chief Geologist for Kansas Department of Health and Environment): has been instrumental and provided information regarding the state of Kansas' issues with sodium brine well failures and remediation efforts.

Daniel Ferguson (DOE): Oversees the activities related to the hydrology program at the Waste Isolation Pilot Plant (WIPP) Site. Provides technical oversight of the hydrology program to ensure the integration and coordination of work activities of the management and operating contractor and Sandia National Laboratories.

Jim Griswold (NMOCD):

David Herrell (BLM): I was born in Carlsbad, NM in 1955. Graduated from Carlsbad High School in 1973, and New Mexico State University, with a Bachelor of Geological Science, in 1980. Served in the United States Army and attended Officer's Candidate School where he received a commission as a 2nd Lieutenant. He served in various staff and command positions and retired as a Lieutenant Colonel after 26 years of service. After retirement from the military, he was employed by the State of New Mexico as a patrolman with the New Mexico State Police, where he served for 8 years. While in the New Mexico State Police, he served as an Emergency Response Officer (ERO) and handled numerous hazardous materials spills and other incidents. He is now employed by the Bureau of Land Management as the Hazardous Materials Specialist and Safety Officer for the Carlsbad Field Office. I was involved in the Incident Command Center at both of the recent brine well collapses in southeast New Mexico. He has an understanding of the basic geology of the area and the processes associated with these collapses.

Courtney Herrick (SNL): I am in the technical lead for the geotechnical / rock mechanics group down here at Sandia National Laboratories Carlsbad Field Office, 4100 National Parks Highway, Carlsbad, NM. I have been working here at WIPP for 4 years. We are presently poking around with some rock mechanics models.

Dave Hughes (Washington Regulatory and Environmental Science- WRES): has an extensive knowledge of the Delaware Basin of New Mexico and West Texas and maintains the Geographic Information System for the Department of Energy's Waste Isolation Pilot Plant. Also attached is the background information for Mr. Russ Patterson with the DOE Carlsbad Field Office.

Brad Jones: (NMOCD): is an environmental engineer with the Oil Conservation Division's Environmental Bureau since July 2006. My primary duties include the review of permit applications, permit modifications, and closure plans under Part 17 (the pit rule) and Part 36 (the surface waste management rule); review of ground water and hydrostatic test discharge permit applications, modifications, and renewals under the Oil and Gas Act and Water Quality Control Commission regulations; and training and outreach on Part 17, Part 36 and discharge permits. Currently, my focus has been in the creation of rules and policies and training staff, operators, consultants, and the public of the implementation of new environmental rules. He holds a Bachelor of Science degree in Environmental Health Science from the University of Georgia. He has over 10 years of environmental regulatory experience, mainly as a regulator but also some in industry.

Prior to joining the Oil Conservation Division (OCD) he worked as an Environmental Specialist in the Solid Waste Bureau – Permit Section of the New Mexico Environment Department for approximately four years. He was involved in the permitting of landfills, solid waste facilities. He oversaw ground water monitoring programs and investigations for those facilities. Prior to that he worked as an Environmental Specialist I in the Florida Department of Health, where he designed, permitted, inspected and approved on-site sewage systems. For a short period, He worked as an Environmental Scientist for Redemption Environmental, Inc., a small consulting firm in Tampa, Florida where he performed site investigations, remediation programs, and cleanups of underground storage tank contamination sites. He worked as an Environmental Health Specialist II for the Island County Health Department in Coupeville, Washington, under a state granted funded position that involved overseeing solid waste programs, voluntary cleanup programs, investigations of contaminated sites, and the cleanup of meth lab sites. He worked as an Environmental Specialist I at the Florida Department of Health where I oversaw the implementation of several environmental programs.

Ross Kirkes (DOE): Mr. Kirkes provides environmental consulting services, primarily to DOE contractors and laboratories. He supports the development of compliance demonstrations and applications and he has provided significant input to the implementation of programs to ensure ongoing compliance with the provisions of environmental regulatory approvals. Mr. Kirkes has over 15 years negotiating compliance issues with various environmental regulatory agencies for the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. Mr. Kirkes was instrumental in the development and production of the demonstration of compliance that led to the U.S. Environmental Protection Agency (EPA) certification of the WIPP. Mr. Kirkes combines his regulatory experience and knowledge of the regional petroleum industry to ensure that future human activities such as petroleum and potash exploitation are accurately represented in WIPP performance demonstrations and assessments.

Ray Leissner (EPA): Graduated from Sam Houston State University with a B. S. in Ag Business in 1976. Ray entered the field of underground injection control in 1984 working for the Railroad Commission (RRC) of Texas in Austin while attending class at the University of Texas. Ray graduated with a B. S. degree in Petroleum Engineering from the University in 1986 and worked full time at the RRC until 1988 wherein he accepted a position with the Environmental Protection Agency, Region 6, Dallas. Initially working in the Region's direct implementation UIC program for the Osage Mineral Reserve in Osage county Oklahoma, Ray is now senior program manager in the Region's State UIC oversight program. This position involves him with all of the state UIC programs in the Region and he directly oversees the RRC.

Lewis Land (NCKRI & New Mexico Tech.): Is a hydrologist with the New Mexico Bureau of Geology and Mineral Resources, and the National Cave and Karst Research Institute in Carlsbad, NM. He has an extensive background and publication record in sinkhole research. He recently completed a manuscript documenting geophysical records of the Loco Hills brine well collapse, which will be published later this spring in a conference proceedings volume of the Symposium on the Application of Geophysics to Engineering and Environmental Problems. He has been conducting aerial surveys of the two collapsed sinkholes and has accumulated a large number of photographs displaying their growth over the past few months.

Richard Miller (Intrepid Potash): Has worked for Intrepid Potash in Denver with Hugh Harvey since 2001. His duties include assisting Hugh with design, permitting, construction, and operation of 12 Class III injection wells in Moab that are used for injection/extraction of solution mining fluids.

Loren R. Molleur (Key): Grew up in Tatum, New Mexico. Graduated from high school in 1966. Attended New Mexico Junior College in Hobbs, New Mexico in 1968-1969. Worked for Amoco Production Company from 1970-81. Started with Amoco in Artesia, New Mexico in 1970 working in the Empire Abo Gas Plant. Transferred to Hobbs, New Mexico in 1973 and worked for the production group until transferring to Andrews, Texas in 1976. While in Andrews, I worked with the production group as well as the drilling and work over group. I retired from Amoco in January of 1981 and went into the trucking business. Was co-owner of L & L Trucking Company from 1981 until it was sold in October of 1997   Work for Key Energy managing their trucking business in the Permian Basin and New Mexico for the past 7-8 years.

Russ Patterson (DOE): Is the Compliance Certification Manager and works closely with the Environmental Protection Agency and is very knowledgeable about the geology of the Delaware Basin and also EPA's Environmental Regulations.

Wayne Price (NMOCD): Is the Environmental Bureau Chief of the Oil Conservation Division, Energy, Minerals & Natural Resources Department in Santa Fe, New Mexico (1993-present). He earned a Bachelor of Science Degree in Electrical Engineering from New Mexico State University in 1969. He worked in the NMOCD Hobbs District office as an environmental engineer, witnessing and evaluating mechanical integrity tests (MIT's) for EPA Class II and III wells, maintained files for discharge permits, processed C-141 spill reports, and C-138 waste management approvals. He inspected NMOCD-regulated facilities, collected soil and water samples, performed well logging, processed APDs, analyzed lab reports, reviewed and evaluated remediation plans, and provided training to industry on NMOCD rules, regulations and guidelines. As the Environmental Bureau Chief, he has managed bureau staff in their duties: oversight, inspection, and permitting of the state's oil refineries, crude oil pump stations, EPA UIC Class I (oilfield exempt, non-exempt non-hazardous waste disposal well), II (hydrocarbon storage), III (brine well), and V (geothermal well), gas plants, gas compressor stations, oilfield service companies, and the management of over 400 active remediation and abatement plans throughout the state. He has served as a technical expert witness concerning environmental and regulatory issues including evaluation and use of vadose zone and ground water modeling.   He has served in the New Mexico Water Quality Control Commission that presides over the state's water rules and regulations.

He worked for Unichem International from 1983 to 1993 where he was manager of engineering and environmental projects for Unichem's domestic operations. He provided project oversight, maintained cost controls, prepared budgets and supervised technical employees for engineering and environmental operations throughout the continental United States. Projects included the design, construction, start-up of chemical plants, abatement of contaminated sites, and environmental permitting. He implemented environmental best management practices and waste management policies for Unichem's company-wide operations. He also created a permit tracking system for all ground water discharge, air quality, NPDES, storm water, SPCC, RCRA, and local permits. He also worked in the oil field as a roustabout and drilling rig roughneck during summers when he was not attending college.

James Rutley (BLM): I was born in Detroit, Michigan in 1964. Graduated from Roswell Goddard High School in 1983 and New Mexico State University in 1989 with a Bachelor of Science in Geology. Worked two years in the Permian Basin as a mud logger before beginning a career in potash. After 15 years, resigned from Mosaic as a Surface Production General Foreman to pursue work at the BLM. Works as a BLM geologist in the Carlsbad Field Office and am responsible for performing potash mine inspections and sodium site inspections. Wrote mineral reports and permit APD's in the potash basin. After the first sink hole on Hagerman Cutoff, Dave Herrell and I began researching all federal sodium wells both abandoned and current- mapping their relationship to municipal and transportation systems. Identified several potential wells that could have catastrophic consequences because of their proximity to both systems.

Dan Snow (Lotus L.L.C.): sdfc

George Veni (NCKRI): is the Executive Director of the National Cave and Karst Research Institute (NCKRI) and an internationally recognized hydrogeologist specializing in caves and karst terrains. He received his Master's degree from Western Kentucky University in 1985 and his Ph.D. from the Pennsylvania State University in 1994. Prior to NCKRI, he owned and served as principal investigator of George Veni and Associates for more than 20 years. Much of his work has been in Texas, but he has also conducted extensive karst research throughout the United States and in several other countries. He has served as the Executive Secretary of the National Speleological Society's Section of Cave Geology and Geography for 11 years and President of the Texas Speleological Survey for 13 years, and has served as a member of the governing board of the International Union of Speleology since 2002 and as Chairman of the 15th International Congress of Speleology. He serves as a doctoral committee advisor for geological and biological dissertations at The University of Texas and teaches karst geoscience courses as an adjunct professor for Western Kentucky University. Three cave-dwelling species have been named in his honor. He has published and presented over 170 papers, including four books, on hydrogeology, biology, and environmental management in karst terrains.

Glenn von Gonten (NMOCD): is a Senior Hydrologist with the Environmental Bureau, New Mexico Oil Conservation Division, Energy, Minerals and Natural Resources Department. He has a B.S. in Geology from Texas A&M University and a M.S. in Geology from the University of Texas at Arlington. He has more than 30 years of experience as a geologist and has worked as an environmental regulator responsible for the investigation and remediation of contamination sites for the past 14 years. His responsibilities with the NMOCD include: supervising, reviewing, and approving professional hydrogeologic investigative work plans and reports to determine actual or potential threats to ground water from the past, current or proposed activities of oil and gas industry; supervising, reviewing, and approving remediation and abatement plans and reports; and, performing professional hydrologic, geologic, and engineering work related to the NMOCD's environmental protection efforts under the Oil and Gas Act and NMOCD rules and regulations.

From 1999 to 2005, he supervised staff in permitting and overseeing corrective action at RCRA regulated U.S. Department of Defense (DOD) installations and sites in the Hazardous Waste Bureau of the New Mexico Environment Department. From 1993 to 1999, he issued RCRA permits with corrective action requirements in the Virginia Department of Environmental Quality. From 1977 to 1991, he worked in the oil and gas industry as a geologist.

Veronica Waldram was raised in Carlsbad, NM. Earned a Bachelor of Science degree in Environmental Management from College of the Southwest (now named, University of the Southwest). Currently a Regulatory Compliance Specialist for Navarro Research and Engineering. Navarro is a technical assistance contractor to the Department of Energy, Carlsbad Field Office. Review the managing and operating contractor's regulatory reports and documents for environmental compliance. Before Navarro, worked as a subcontractor to Los Alamos National Laboratory-Carlsbad Operations. Was a member of the Site Generator Interface Team that assisted the National TRU Program with their activities at 23 DOE facilities throughout the United States. We assisted in certifying the characterization, treatment, packaging and transportation programs of TRU waste destined for disposal at WIPP.

Gary Wallace (CRI- Hobbs, NM): sdsd

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FIGURES

Figure 1: Jim's Water Services brine well (BW-005) on August 26, 2008.
Photo courtesy of the National Cave and Karst Research Institute.

Figure 2: Loco Hill's Water Disposal Company (BW-021) on November 18, 2008. Photo courtesy of the National Cave and Karst Research Institute.

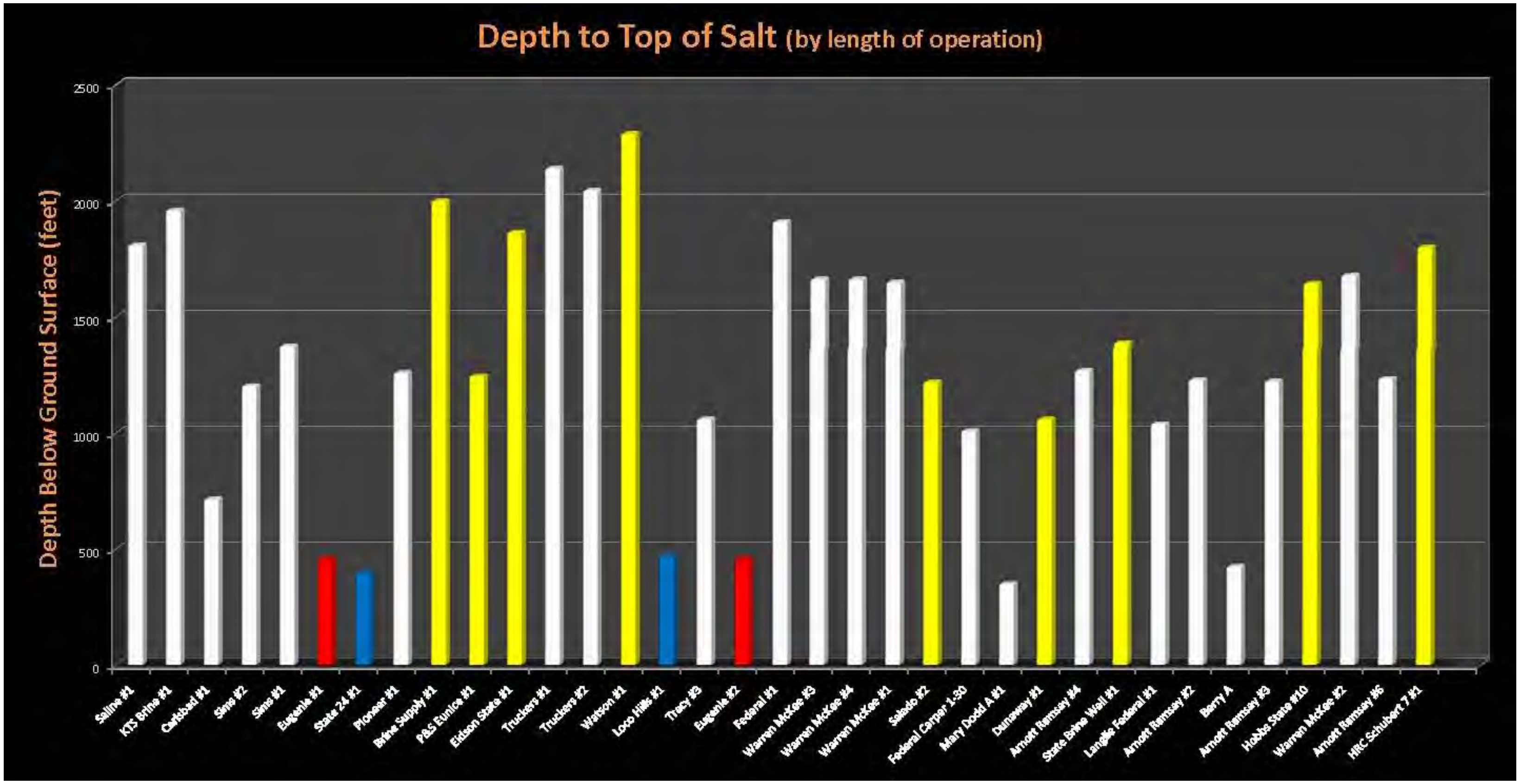

Figure 3: Brine Wells in New Mexico sorted by depth to top of salt and length of operations.

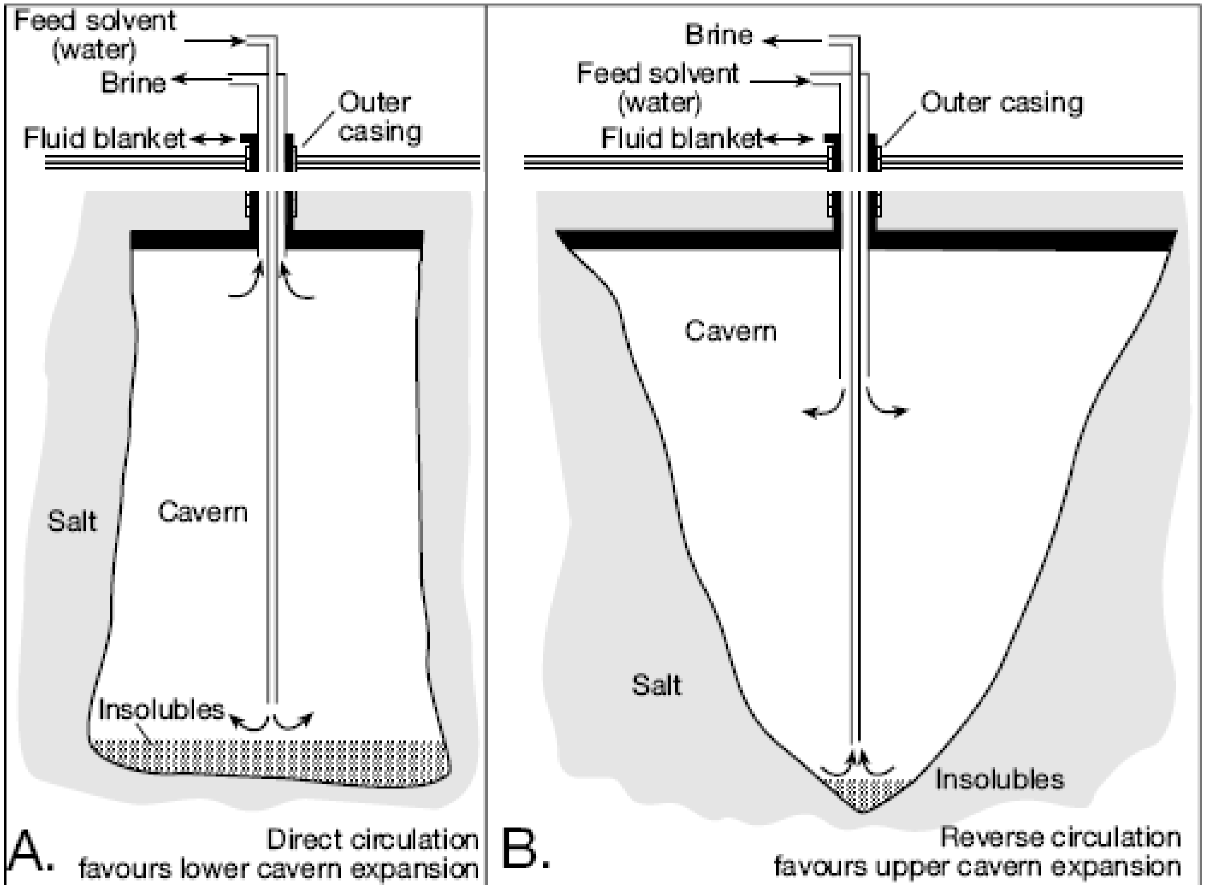

Figure 12.3. The solution mining process. A) Direct brine circulation where feed solvent is injected through the tubing string and brine is withdrawn through the annular space between the tubing string and the final casing. Cavern shape tends toward cylindrical with slightly expanded lower section. B) Reverse-circulation where the feed solvent enters the cavity through the annulus and brine is withdrawn through the tubing string. Cavern tends to be wider at top than base ("morning glory"). In both cases the outermost casing allows feed of the blanket solution into the uppermost part of the cavern, so protecting the cavern roof. Varying the volume of blanket in the cavern can be used to help shape the cavity.

Figure 4: Normal vs. Reverse Circulation.