PROJECT SEDAN
PNE 240-F

GEOLOGIC STUDY OF THE SEDAN NUCLEAR CRATER

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FRONTISPIECE

Sedan crater.

ABSTRACT

The 100-kt nuclear experiment, Sedan, resulted in a symmetrical, bowl-shaped crater having an apparent volume of 6,550,000 cubic yards, a diameter of 1220 ft, a depth of 323 ft, and an average lip height of 42 ft. The lip varies in height from 14 to 99 ft and consists mainly of permanently uplifted alluvium and overturned alluvium. Fallback accounts for only a few feet of the total lip thickness. The permanently uplifted alluvium exposed in the crater shell is remarkably consistent in elevation and continuity.

The rubble-like debris below the crater bottom and above the detonation point probably collapsed as a unit with the alluvial material maintaining its original stratigraphic order. Only minor amounts of radioactive material were encountered in this zone. Temperature and density variations also exist in this collapse debris.

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GEOLOGIC STUDY OF THE SEDAN NUCLEAR CRATER

INTRODUCTION

Sedan is the code name for a 100 ± 15 kt nuclear cratering experiment conducted at the Nevada Test Site as a part of the AEC Plowshare Program. Detonation occurred on July 6, 1962, 630 ft below a fairly flat surface in desert alluvium at Nevada Grid Coordinates: N 883,995.94 and E 680,999.31 (Fig. 1). The G. Z. elevation was 3686.9 ft above sea level.

The Sedan crater has an apparent depth of 323 ft and an average apparent diameter of 1220 ft. The true crater diameter and depth are 1220 ft and 805 ft, respectively. The approximate volume of the apparent crater is 6,550,000 cubic yards and the approximate volume of the true crater is 13,918,000 cubic yards. The average lip height is 42 ft and is a combination of permanent displacement, overturning, and fallback.

The Technical Director's Plan for Project Sedan states: "The purpose of the experiment was to obtain the scaling exponent for yields in a range of 100 to 200 kt at somewhat greater than optimum depth of burial and to determine exponential parameters applicable to the megaton range. Theory and empirical experience indicate that scaling laws for crater formation are variable depending upon the yield of the detonation. It has been shown that for small detonations, i. e., 1 kt, crater parameters vary as $1/3.4$ power of the yield. Theory indicates that with larger detonations, scaling should gradually change to $1/4$ power. This difference in scaling could represent sizable differences in megaton crater sizes."

The purpose of this study was to map the geology of the crater shell and relate the information gained to shell configuration and cratering mechanics. Hopefully, the data presented will be of use in planning future nuclear cratering experiments.

The geologic investigation consisted of two phases:

Phase I — Geologic mapping of the crater shell.

Phase II — Gathering geologic data from two drill holes drilled from the bottom of the crater and mapping the geology exposed in a lip cut.

This report will deal separately with each phase and conclude with a section on crater characteristics (parameters and symmetry).

PHASE I. GEOLOGIC MAPPING OF THE CRATER SHELL

The major portion of the report is included in this phase and deals with the geology of the crater shell.

PRELIMINARY WORK

Prior to mapping the crater shell, it was necessary to examine the lip, slopes, and bottom for stability and radiation hazards. Using a safety rope and harness, crater entry was made on December 20, 1962, 6-1/2 months after detonation.

Average radiation readings at the time of descent were 50 mR/h on the lip, 5 mR/h or less on the crater slopes and 20 mR/h on the crater bottom. A general reconnaissance of the crater shell indicated that the crater bottom and talus slopes were stable, but the steep walls above the talus slopes were not and should be traversed with care.

Rim-to-rim photographs (Fig. 2) were taken by the LRL-Nevada Photography Group to document the crater appearance prior to disturbance and to aid in mapping. These photographs, and a crater topographic map prepared by American Aerial Surveys, Inc., were used as a base for mapping. To aid in transferring geology from the photographs to the topographic maps, elevations and locations of points on a marker bed within the crater

were established. These points were located using a plane table and telescopic alidade.

PRESHOT GEOLOGY

The Sedan cratering experiment was conducted near the north end of Yucca Valley in an area of fairly flat topography. The maximum relief over the crater area was 14 ft. The alluvium in this area is approximately 1300 ft thick and consists of dry, nearly horizontal, weakly consolidated, interbedded, silt, sand, and gravel. Some post-alluvium faulting does occur in Yucca Valley, but was not apparent in the immediate area of the experiment.

Because of problems involved in recovering alluvial core samples, preshot stratigraphic control was not obtained; however, the upper 90 ft of alluvium is very well exposed on the west side of the crater. R. D. Carroll¹ presents some preshot physical properties taken from logs and selected cores.

POSTSHOT GEOLOGY

The Sedan experiment resulted in a bowl-shaped depression having an apparent depth of 323 ft and an average apparent diameter of 1220 ft (Fig. 3 — in back of report). Except for an anomalous sector in the northwest quadrant, approximately 100 ft of weakly consolidated alluvium is exposed in the upper portion of the crater shell (Frontispiece and Fig. 2). Lapping the collapse debris on the bottom and reaching to the exposed alluvium band is a wide, continuously growing talus zone. The debris in the bottom of the crater is characteristically very similar to the preshot surface alluvium and is presumed to be badly broken, collapsed surface material.

There are two predominant structural features exposed in the crater shell. One is the slump area that forms a topographic high in a sector of the northwest quadrant, and the other is an

overtaken synclinal fold or hinge which, except for the above-mentioned slump area, encompasses the crater (Fig. 4 — in back of report). This hinge is the line above which a variable thickness of weakly consolidated alluvium is overturned and inversely repeated.

For mapping purposes, the crater shell is here divided into various zones: fallback, overturned, exposed tilted, slump, cover, and collapsed surface zone (?). These zones are shown on Figs. 4 and 5, and will be discussed in more detail in the following section.

Stratigraphy

The upper 90 ft of alluvium is well exposed as a band from the bottom of the overturned zone to the talus slopes. Although the alluvium consists predominately of interbedded, weakly consolidated silt, sand, and gravel that tends to thicken and thin, excellent marker units are exposed and are helpful in the solution of Sedan geologic problems.

In order to solve structural problems related to foldover, fallback, permanent displacement, and faulting, it was necessary to obtain stratigraphic control, that is, determine the relative preshot positions of various marker units. Roots, rags, and other debris were of invaluable aid in locating the preshot ground surface. In turn, the location of this surface was a key to solving structural problems in the upper part of the crater shell.

To illustrate various geologic features and for mapping convenience, the crater shell is here divided into six mappable zones (Figs. 4 and 5). The following is a detailed discussion of each zone, beginning with the fallback zone outside the crater.

Fallback zone. This zone is defined as the rock and fused material that was ejected beyond the bubble and does not include the material that collapsed into the crater when the gas pressure was relieved. The amount of debris that was blown outside the bubble and then fell back into the crater bottom appears to be minor.

Observation of the crater rim indicates that, except for the anomalous northwest sector where no fallback occurs, the fallback thickness varies from 2 to 4 ft. This depth is remarkably uniform around the rim and probably decreases with distance from the crater.

Two distinct types of fused material were observed in the fallback zone. The predominant type is a light-colored, frothy material that has little or no radioactivity. Large quantities of this type are found on top of the fallback material and up to several hundred feet from the crater rim. Minor amounts are present on the crater bottom. The second type of fused debris is relatively radioactive, more dense and dark colored and was observed at the bottom of the fallback zone, in the crater bottom, and mixed with the light-colored frothy type away from the rim.

Overtured zone. This unit has been folded back over and away from the crater bringing an overtured ground surface in contact with a normal ground surface. The contact between the two surfaces represents the axial plane of the fold or overtured syncline and is exposed in the crater shell as a hinge line (Fig. 6 — in end of report). This overtured area is bounded on the bottom by the axis of the fold and on the top by the fallback material. With the exception of the anomalous slump sector, overturning occurred around the entire crater shell.

Although the crest of the fold in most cases is no longer visible, marker beds in the overtured zone can be correlated with beds in their normal position. In a few areas marker beds can be traced from below the fold, having a dip away from the crater, to a vertical position at the crest and then to an overtured position with the dip again being away from the crater (Fig. 6).

Near the hinge line and the crater rim, the inverted and repeated lithologic unit are similar in thickness and competency

to the units repeated. As vertical distance from the hinge increases and horizontal distance from the rim becomes greater, the repeated units become thinner, less competent, and more difficult to correlate, but they still maintain their relative positions. This feature is well illustrated in Fig. 6. Note that the marker beds near the top of the overturned zone are continuous for at least a horizontal distance of 100 ft from the crater rim.

Radioactive glass was observed within the overturned zone in a sector of the southeast quadrant. This glass is the more dense, dark-colored type and occurs parallel with the bedding as thin (approximately 1 in. thick) discontinuous blebs. The melted material was probably injected during bubble growth.

Exposed tilted zone. This unit includes the alluvium exposed above the talus slopes and below the preshot ground surface or hinge line. Where the hinge line is covered by the crest of the folded material the contact is dashed and coincides with the axis of the overturned syncline. The top of the zone represents the top of the permanently uplifted rock.

By comparing the pre- and postshot location of the ground surface, the amount of permanent displacement can be computed. This displacement varies from a minus 10 to a plus 99 ft (Fig. 5 — in end of report). The negative displacement is probably a result of drag along the faults that border the anomalous slump sector. The maximum displacement of 99 ft occurs in the anomalous sector.

Marker bed "D" exposed near the top of the talus slopes (Fig. 4) was mapped to determine degree of alluvium deformation near the bottom of the exposures. This marker bed is exposed around the entire crater shell (except in the anomalous sector) and is remarkably consistent in elevation and continuity. Faulting of this bed is very minor.

Slump zone. This zone includes the material that settled into the crater after the bubble collapsed. It spread laterally and covers part of the overturned and permanently displaced zones.

In the northwest sector, the preshot ground surface has slumped vertically over 300 ft into the crater. In this sector the preshot ground surface forms small terraces at various elevations (Fig. 4).

Cover zones. Continuous erosion of the exposed alluvium has resulted in talus slopes that cover the major portion of the crater walls. These slopes and a part of the crater bottom comprise the cover zones.

The talus slopes have an angle of repose of 34 to 35° from horizontal and are stable. Eroded material from above the talus rolls over these slopes and collects near the bottom at a somewhat lesser angle. Only a few large boulders have had enough momentum to roll beyond the bottom of the talus slopes into the center of the crater.

A few inches of soft, silty debris covers the flat portion of the crater bottom. This cover, which includes a small amount of both types of fused material, is probably a veneer covering the badly broken, collapsed surface zone. Although excavation in the crater bottom shows that the bottom is stable, the veneer is soft and silty.

Collapsed surface zone (?). The area mapped in the crater bottom as Collapsed Surface Material (?) is bounded by talus and almost completely encompasses the flat bottom of the crater. The general appearance of this crater bottom material is that of badly broken, preshot surface silt and alluvium. A small area within this zone contains roots and was mapped as preshot surface. Minor amounts of both types of glass are scattered over this zone.

Structure

Two major structural features are apparent in the crater shell. One is the anomalous slump zone which is located in a 60° sector of the northwest quadrant; the second is an overturned synclinal fold which, except for the slump zone, encompasses the entire crater (Figs. 4 and 5). Early rupture of the developing dome and points of gas pressure release are possible factors that influenced these features and the over-all lip symmetry.

Photographs at detonation show that as the gas bubble grew, the alluvium above G. Z. was lifted as a dome (Fig. 7). This figure shows a definite break in the rising arch with one sector lagging during early dome growth. Near-horizontal gas release over this lagging area resulted in the anomalous 60° sector. This sector was not thinned and spread as intensely as the rest of the dome, and resisted overturning.

The break between the lagging area and the rising arch occurs approximately 240 ft northwest of G. Z. A flash occurred at this break just as the ground started to rise, indicating early communication of the initial cavity gases with the atmosphere.

Figure 6 is a sequence of illustrations using cuts from high-speed films of the Sedan event. The drawings below the photos are schematic, showing possible gas bubble development. Observations of these photos afford additional information concerning cratering mechanisms.

Following is a discussion of the individual illustrations in Fig. 7:

Photo 1. This photo shows the ground-surface arrival of the first shock wave at approximately zero time plus 0.2 sec. The cavity has not fully developed.

Photo 2. This photo (approximately zero time plus 0.9 sec) shows a second shock wave encountering the rising ground surface. This wave is possibly due to the rising gas bubble.

Brief communication of the bubble with the atmosphere is evidenced by a brief flash at an anomalous break 240 ft from surface zero. Note the surface is rising as a dome, resulting in maximum stress along the slopes.

Photo 3. First major fireball release occurs at this time (approximately zero time plus 2.0 sec). The outer limit of the fireball is approximately 240 ft horizontally from surface zero and coincides with the zone of maximum stretch of the rising dome. At this time the ground surface has risen 240 ft and the dome shape is still apparent.

Photo 4. This illustration (approximately zero time plus 2.2 sec) shows the fireball release at a second break. The material escaping from this break has a nearly horizontal trajectory and is probably related to the earlier developed anomalous area. The horizontal trajectory is probably one factor which accounts for the absence of fallback and foldover in this area. The lowest points on both breaks are at approximately the same elevation.

Based on the above information it seems that fractures developed as a result of shock waves and cavity growth. These weaknesses, plus the initial cavity size, strongly influenced the shape of the developing dome and the areas of early gas release.

An overturned synclinal fold encircles the crater and is terminated by the slump feature. This fold closely resembles similar folds discussed by Shoemaker² for the Meteor Crater in Arizona and the Teapot Ess nuclear crater.³ In most cases the fold crest is missing and the axial trace becomes a hinge line (Fig. 6). The axial plane dips steeply away from the crater near the crater wall. This dip decreases sharply with distance from the wall.

Normal faulting and much slumping are evident in the upper portion of the crater shell, and probably occurred at various stages of crater development.

Two major normal faults are inferred as separating the slump area from the overturned synclinal feature (Fig. 4). These faults have approximate vertical offsets of 80 ft and are a result of the slump sector rising at a slower rate than the remaining dome. The slump sector lagged both during the growth stage of the dome and later during the collapse stage. During the collapse stage, the slump block dragged the adjacent preshot ground surface 30 ft below its preshot elevation. Lateral slumping of the slump block of 150 to 200 ft obscures these faults and covers part of the overturned feature.

Two small normal faults were mapped as offsetting marker bed "D" (Fig. 4). The upthrown sides of both faults are adjacent to high lip areas, indicating development during the dome growth stage. Small normal faults occur along the rim and are related to slumping of the rim into the crater.

One fault was mapped in the crater "cut" (Fig. 6). This fault has an apparent offset of 10 ft and because of its present attitude might be considered a thrust type. However, it probably occurred as a normal fault at the time of maximum domal growth when the alluvium beds were standing almost vertically. At this time, the upper block moved down the fault plane and away from the crater. Subsequent collapse brought the fault plane to its present position.

PHASE II. GATHERING DATA FROM TWO DRILL HOLES AND LIP CUT

As Phase I of the Sedan exploratory program neared completion, Phase II was initiated. This phase consisted of gathering data from below the apparent crater using drilling techniques, and mapping the geology exposed in the lip cut. This cut was excavated for crater access.

The objectives were:

1. Locate the true crater edge below the collapse material.
2. Determine the radioactivity distribution in the collapse material.
3. Compare pre- and postshot densities of the alluvium.
4. Study temperature variations in the collapse material.
5. Map the geology exposed in the lip cut.

The original program for crater exploration called for five drill holes. These holes were to be drilled from the crater bottom rather than the rim. The consensus of opinion was that the cost of lowering equipment to the crater bottom would be more than offset by the reduction in drilling costs. An extensive coring program was planned for the five holes. Due to high overhead expenses related to crater entry, the drilling program was necessarily reduced to two drill holes (Fig. 3) and the coring program was cut to a small zone in hole "B." Following is a summary of the data gathered from the two drill holes. A more complete analysis of the drill holes follows the summary.

SUMMARY OF DRILL-HOLE DATA

1. The radius of the initial cavity below G. Z. is approximately 175 ft.
2. Only minor amounts of radioactive material were encountered in the drill holes. No radioactive material was recovered by coring.
3. Definite temperature variations exist in the collapse material. The highest temperature logged was 157°F and occurs approximately 85 ft above the initial cavity edge. The rock below the cavity edge is cooler than the

collapse material with a rapid decrease in temperature occurring at the boundary of the collapse material and the underlying rock.

4. (a) Average preshot density of alluvium between surface ground zero and ground zero was 1.8 g/cc. (b) Average postshot density of collapse material is 1.4 g/cc. (c) Average postshot density of alluvium below and within 25 ft of the initial cavity edge is 1.95 g/cc.

DATA DERIVED FROM DRILLING PROGRAM

This section includes an analysis of the core, geophysical logs, and physical property information used in obtaining the numbers presented in the preceding section. Figure 3 illustrates the position and inclination of the two postshot holes.

Drill Hole "A" was drilled vertically to a total depth of 530 ft. Lane Wells' caliper, density, temperature, and gamma-ray logs were run to various depths that hole conditions would permit.

Drill Hole "B" was inclined 20° from vertical and drilled to a total depth of 483 ft. Continuous coring was attempted from 388 to 483 ft and an LRL gamma survey was run to a depth of 390 ft. Sloughing condition of the alluvium due, in part, to hole inclination precluded additional logging.

Initial Cavity Radius Below G. Z.

Using core data from hole "B" in conjunction with temperature and density logs from hole "A," an initial cavity radius below G. Z. of 175 ft was established.

The density log curve (Appendix 1) from hole "A" fluctuates erratically from the top of the hole to a drill depth of 485 ft. From this depth to 510 ft the curve becomes more constant and indicates a compacted zone having a density of 1.95 g/cc. The initial cavity edge was picked on this log at a drill depth of 485 ft.

The temperature log (Appendix 2) from hole "A" indicates a continuous temperature rise from the surface to a depth of 495 ft. At 495 ft the temperature peaks at 157°F then decreases with increased depth. The cavity edge is picked at the sharp break in the curve at 485 ft.

The core data from hole "B" (Appendix 3) substantiates the temperature and density information.

Summarizing the lithologic core log:

The core recovery from 388 to 421 ft was poor and is a mixture of unconsolidated silt, sand, and gravel. No core was recovered from 421 to 428 ft. Percent core recovery increased sharply from 428 ft to total depth and consisted of compact alluvium showing definite bedding planes. On the basis of this information, the cavity edge is picked between 421- and 428-ft drill depths. The radial distance from G. Z. to this interval is 175 ± 3 ft.

Radioactivity Distribution in Collapse Material

Four attempts were made to gather gamma-ray radioactivity data in the drill holes, two by LRL and two by Lane Wells. LRL was successful in logging radioactivity from the surface to a depth of 423 ft in hole "B," but unsuccessful in logging hole "A." Lane Wells ran high- and low-range radioactivity logs in hole "A" with limited success.

The LRL radioactivity log (Appendix 4) and Lane Wells low-range log (Appendix 5) indicate an irregular distribution of radioactivity throughout the collapse material. The logs indicate that the upper portion of collapse material contains the greatest amount of radioactivity, the central zone an intermediate amount, and the bottom section of the hole contains a minor quantity. This observation is somewhat substantiated by the core recovered from the lower zone which contains no material with above background (0.3 mR/h) readings.

Density Variations In Shot Environment

Pre- and postshot density data were difficult to obtain due to the weakly consolidated nature of the alluvium, drilling technique, washed out hole, and low core recovery.

The following general summary is made using preshot information by Carroll¹ and postshot core data obtained from drill hole "B" and a density log from hole "A":

1. The preshot density of the alluvium in the Sedan area increases with depth. An approximate average preshot density between surface zero and the work point was 1.8 g/cc.
2. The density of the collapse material tends to increase with depth from the surface (Appendix 1). An approximate average density for this material is 1.4 g/cc.
3. The average postshot density of the alluvium below the lower cavity edge (428 to 488 ft) is 1.95 g/cc. Data from the general area indicates that the preshot density at this depth is less than 1.9 g/cc and probably between 1.75 and 1.85 g/cc.

Temperature Variations

One down-hole Lane Wells temperature survey was made in hole "A" during the postshot drilling phase. Definite temperature variations were encountered. A steady rise in temperature is illustrated by the log (Appendix 2) from a drill depth of 10 ft (85°F) to 395 ft (157°F). From 395 to 520 ft, the temperature decreases to 120°F. The temperature curve tends to flatten opposite excessively caved areas.

GEOLOGY EXPOSED IN LIP CUT

To make the crater bottom accessible to drilling equipment, it was necessary to make a fairly large cut through the lip. The resultant trench has a maximum depth of 38 ft (below the rim) and

is located on a bearing of north 58° west of G. Z. This cut clearly exposes several significant features illustrated in Fig. 6.

Permanent Vertical Displacement of Preshot Ground Surface

The maximum permanent vertical displacement of the preshot ground surface as exposed in the cut is 17 ft and occurs below the crater rim. As Figs. 3 and 6 illustrate, permanent displacement decreases with distance from the crater rim. One hundred feet from the crater edge and 705 ft from surface zero, the permanent displacement has decreased to less than 1 ft.

Overturning and Repetition of Lithologic Units

The alluvium between the permanently displaced preshot ground surface and the fallback material has been overturned and inversely repeats the normal stratigraphic section exposed below the preshot ground surface. This overturned zone is 12 ft thick in the cut.

The uppermost overturned lithologic units are remarkably continuous from the crater rim to the end of the cut (100 ft). Although the overturned units are thinned, their relative positions are maintained.

Fallback Material

The fallback is approximately 3 ft thick in the cut below the rim. Early excavation in the general area of the trench destroyed the original fallback surface away from the rim, making it impossible to trace the true thickness beyond the crater edge.

Included in this fallback are scattered lenses of radioactive fused material. These lenses are variable in size, easily broken, dark colored, and occur at the base of the fallback material.

A well exposed normal (?) fault was mapped in the cut. The maximum apparent offset along this fault displaces the preshot ground surface 10 ft. Lower units have been dragged and display appreciably less offset. The upper edge of the fault is terminated by, and does not offset, the overturned zone. The lower edge was

not exposed in the cut, but probably continues into the crater at the exposed angle.

Very small step or block faults occur near the rim and are related to slumping of the lip toward the crater.

CRATER CHARACTERISTICS

In order to discuss crater characteristics (parameters and symmetry), it is necessary to define certain terms. Terminology used in this report follows that of Nordyke⁴ and is illustrated in Fig. 3. The apparent crater is the visible crater with the dimensions being measured with respect to the original ground surface. The true crater is also measured with respect to the preshot ground surface and is the sum of the apparent crater and the fallback material. The crater lip includes that material lying above the original ground surface.

CRATER SYMMETRY

Sedan crater symmetry is illustrated by the postshot topographic map (Fig. 8 — in end of report). On this figure, the preshot ground surface has been projected onto the crater walls as a dashed line. The distance from surface ground zero to the dashed line represents the apparent crater radius. This radius only varies by 10% of the average around the entire crater.

Another example of crater symmetry can be seen using this figure. The 4100-ft contour, located approximately two-thirds of the way below the rim, nearly coincides with a circle having a 340-ft radius. This circle is disrupted slightly by the slump sector in the northwest quadrant of the crater.

CRATER PARAMETERS

The following crater parameters are based on measurements made using Figs. 3 and 8.

Apparent Crater Dimensions:

Depth (D_a)	323 ft
Volume	6,550,000 yd ³
Average radius (R_a)	610 ft

True Crater Dimensions:

Depth (D_t)	805 ft
Volume	13,918,000 yd ³
Average radius (R_t)	610 ft
Sedan cavity radius (R_c)	
below Z. P.	175 ft
Apparent crater volume	
per kt	65,500 yd ³ /kt
Lip height dimensions (L_{tc})	
Maximum	99 ft
Minimum	14 ft
Average	42 ft

CONCLUSIONS

Two major structural features are evident in the Sedan crater lip: the overturned synclinal fold and the slump zone. The slump feature forms the topographic high in the northwest quadrant of the crater shell and does not exhibit fallback material along the rim or an overturned zone. The overturned synclinal fold encircles the entire crater except for the slump area.

The expanding gas bubble controlled the shape and size of the rising dome-shaped ground surface. This bubble, along with shock-induced fractures, strongly influenced the areas and direction of gas release. Most of the radioactive material was blown outside the crater as the bubble vented, leaving a minor amount in the collapse debris. After the gas pressure was released, the alluvial dome collapsed into the void with the alluvium maintaining its preshot stratigraphic order.

Density, temperature, and radioactivity logs along with core samples were helpful in studying characteristics of the collapse debris. These techniques were also useful in determining the true crater boundary.

Location of the uplifted and overturned preshot ground surface was necessary in order to decipher the crater-lip geology. In future cratering experiments, postshot geologic mapping would be facilitated by marking the ground surface in some distinct manner.

U10h SEDAN POSTSHOT HOLE "A" AREA 10
CALIPER & DENSITY LOG DATE JUNE 11, 63
TYPE DRILL FLUID: MUD (GEL) LOST CIRCULATION
BY LANE-WELLS Co.

APPENDIX 1.
LANE WELLS DENSITY LOG, HOLE "A"

30x11

APPENDIX 2.
LANE WELLS TEMPERATURE LOG, HOLE "A"

U10h SEDAN POSTSHOT HOLE "A" AREA 10
TEMPERATURE LOG DATE JUNE 11, 1963
BY LANE-WELLS Co.

APPENDIX 3.
LITHOLOGIC LOG OF CORE, HOLE "B"

<u>Core run No.</u>	<u>Interval cored</u>	<u>Core recovered</u>	<u>Description</u>
1	388.5-390.5	6 in.	Loose pebbles and cobbles of various lithologies.
2	390.5-395.5	2 ft	1-1/2 ft of loose pebbles and cobbles as above. Six inches of weakly ce- mented alluvial material.
3	395.5-403.7	4 ft	Two feet of pebbles and cobble at 388.5-390.5. Two feet of weakly con- solidated alluvial mate- rial.
4	403.7-411.1	3 ft	Pebbles and cobbles as 388.5-390.5.
5	411.1-416.1	5 ft	Loose pebbles, cobbles, and boulders of various lithologies.
6	416.1-420.6	4-1/2 ft	Upper 2 ft consists of weakly cemented sandy alluvium. Lower 2-1/2 ft is loose sand and gravel.
7	420.6-428.6	No recovery	
8	428.6-434.2	5 ft	Weakly cemented tuff- aceous alluvium.
9	434.2-439.0	4-8 ft	As 428.6-434.2 ft but with 2 ft of unconsolidated ma- terial.

<u>Core run No.</u>	<u>Interval cored</u>	<u>Core recovered</u>	<u>Description</u>
10	439.0-445.0	5 ft	Unconsolidated tuffaceous alluvium.
11	445.0-448.6	1 ft	As 439.0-445.0 ft.
12	448.6-455.2	No recovery	
13	455.2-460.2	1 ft	Assorted pebbles and cobbles.
14	460.9-467.0	6 ft	Weakly cemented and broken tuffaceous allu- vium.
15	467.0-477.0	6 ft	As 460.9-467.0 ft.
16	477.0-478.6	1-1/2 ft	Loose pebbles and cobbles.
17	478.6-483.0	4 ft	Moderately consolidated tuffaceous alluvium.

APPENDIX 4.
LRL RADIOACTIVITY LOG, HOLE "B"

UIOH SEDAN POSTSHOT HOLE "B" AREA 10
LOW INTENSITY GAMMA LOG DATE MAY 29, 63
BY LRL-N DIAGNOSTICS DEPT.

UIOh Sedan P.S. #A NTS
AREA 10
LANE WELLS CO. Low Intensity
Gamma Log
6-11-63
TYPE of Fluid in Hole: Mud (Gel) Lost
Circulation
No Radioactivity Scale

APPENDIX 5.
LANE WELLS LOW RANGE RADIOACTIVITY LOG, HOLE "A"

REFERENCES

1. R. D. Carroll; "Interpretation of Postshot Geophysical Logs, Sedan Site, Nevada Test Site"; Technical Letter Yucca-47, 1963; Unclassified.
2. E. M. Shoemaker; "Impact Mechanics at Meteor Crater, Arizona"; USGS GS-499, July 1959; Unclassified.
3. J. G. Lewis; "Operation Teapot Crater Measurements"; WT-1105, July 1958; Confidential.
4. M. D. Nordyke; "A Brief History, Analysis, and Theory of Cratering"; Lawrence Radiation Laboratory (Livermore) Rept. UCRL-6578; August 1961; Unclassified.

/mr

Fig. 1. Index map showing location of Sedan crater.

Fig. 2. Rim-to-rim photo showing various zones.

Figure -5 GEOPANORAMIC VIEW of the SEDAN CRATER

- LEGEND**
- Fallback
 - OVERTURNED ALLUVIUM
 - EXPOSED TILTED ALLUVIUM
 - SLUMP
 - TALUS
 - 2'-3' f.b. Fallback 2'-3' THICK

Figure 6 GEOLOGIC SECTION THRU THE SEDAN LIP
AS EXPOSED IN CUT LOCATED ON A
BEARING N58°W FROM G.Z.

BUBBLE DEVELOPMENT

Fig. 7. Development of the Sedan bubble.

Figure - 8 TOPOGRAPHIC MAP
of the
SEDAN CRATER
showing symmetry

0 100 200 300 400 500
SCALE

				SCALE
				DO NOT SCALE THIS MAP.
				LAWRENCE RADIATION
				LABORATORY
				UNIVERSITY OF CALIFORNIA
DATE	BY	CHKD	DATE	CRATER

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ABBREVIATIONS FOR TECHNICAL AGENCIES

STL	Space Technology Laboratories, Inc., Redondo Beach, Calif.
SC	Sandia Corporation, Sandia Base, Albuquerque, New Mexico
USC&GS	U. S. Coast and Geodetic Survey, San Francisco, California
LRL	Lawrence Radiation Laboratory, Livermore, California
LRL-N	Lawrence Radiation Laboratory, Mercury, Nevada
Boeing	The Boeing Company, Aero-Space Division, Seattle 24, Washington
USGS	Geological Survey, Denver, Colorado, Menlo Park, Calif., and Vicksburg, Mississippi
WES	USA Corps of Engineers, Waterways Experiment Station, Jackson, Mississippi
EGG	Edgerton, Germeshausen, and Grier, Inc., Las Vegas, Nevada, Santa Barbara, Calif., and Boston, Massachusetts
BYU	Brigham Young University, Provo, Utah
UCLA	UCLA School of Medicine, Dept. of Biophysics and Nuclear Medicine, Los Angeles, Calif.
NRDL	Naval Radiological Defense Laboratory, Hunters Point, Calif.
USPHS	U. S. Public Health Service, Las Vegas, Nevada
USWB	U. S. Weather Bureau, Las Vegas, Nevada
USBM	U. S. Bureau of Mines, Washington, D. C.
FAA	Federal Aviation Agency, Salt Lake City, Utah
REECO	Reynolds Electrical and Engineering Co., Las Vegas, Nevada

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