A GRAVITY STUDY OF THE KILBOURNE HOLE AREA, NEW MEXICO

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Introduction

This investigation is one of a number of geophysical studies in progress of an area running east from the Guadalupe Mountains of West Texas to the Potrillo Mountains of Southern New Mexico. It is hoped that these studies will reveal the structure of the mountain ranges and also the intervening bolsons in this area thus providing important clues to cause of mountain building.

In the Kilbourne Hole area there has been no previous geophysical investigation, except by geophysical exploration crews of oil companies, and their work is generally not available for study. Kilbourne Hole was chosen for study, since an interesting controversy has raged for years as to the cause of the structure. Many ideas have been put forth, but most of these are reducible to two principal hypotheses.

One hypothesis maintains that a basaltic intrusion of high temperature was formed under the crater-like structure, Kilbourne Hole, vaporizing the subterranean water there and raising it to a high pressure. The pressure supposedly became so great that a vast explosion occured creating the Hole.

The other hypothesis maintains that the hole is merely a weathered collapse hole into which the basalt from the north has flowed.

Geologic Setting

Physiography

Kilbourne Hole is a crater-like structure generally elliptical in shape. The major axis is about two miles, and the minor axis is about 1.25 miles. From the edge of the Hole to the lowest point is a change of elevation of 280 feet. A rim of slightly varying height rises 170 feet above the surrounding desert terrain.

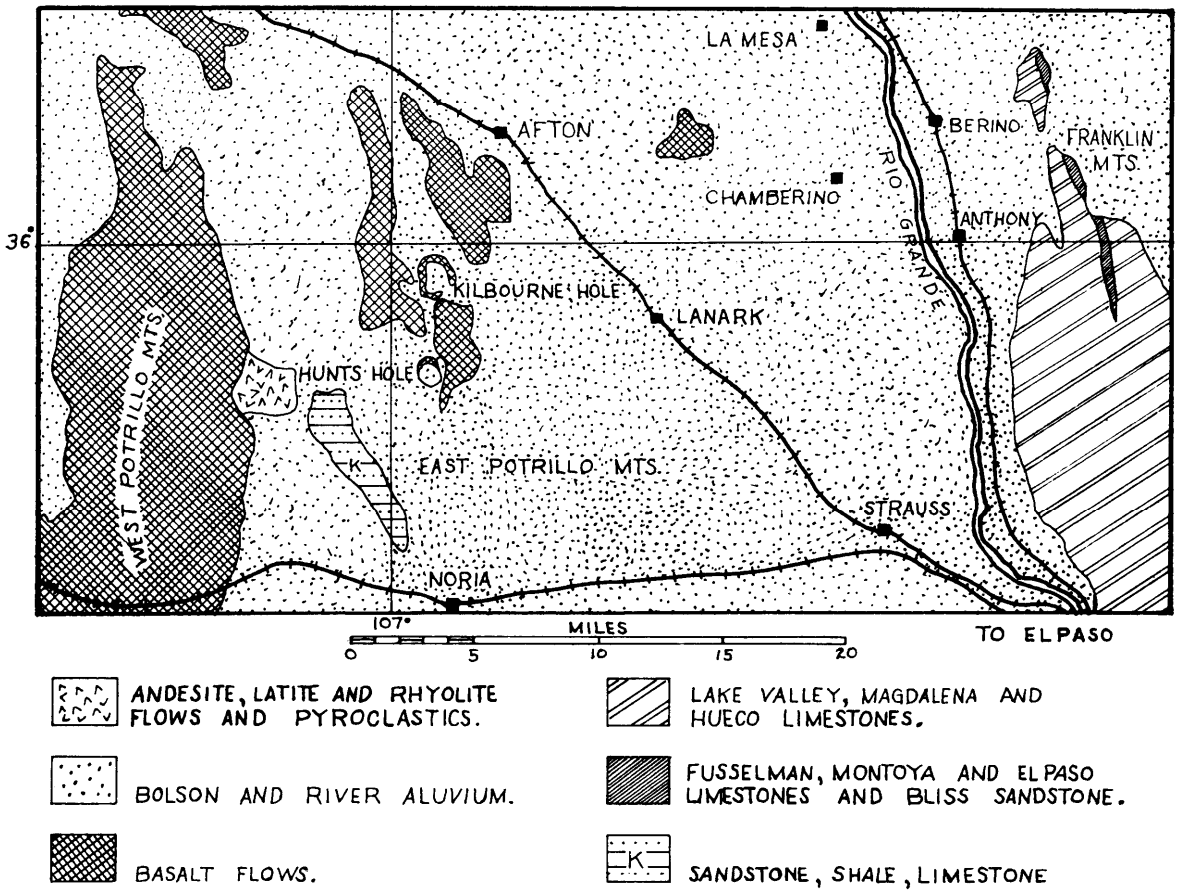


Figure 1 Geologic Map of Kilbourne Hole Area

Directly to the south is Hunts Hole, a similar feature except smaller, having a depth of 100 feet and major and minor axes of 1.25 miles and 0.75 miles, respectively. To the west of these features are the Potrillo Mountains rising to heights exceeding 5,000 feet.

All these features are located on an extensive tableland, eastern boundary of which forms the western edge of the Rio Grande Valley rising about 400 feet above the valley floor. The Franklin Mountains are to the east of this edge of the mesa and rise to a height of 6477 feet.

Rocks of the Area

Kilbourne Hole is filled with bolson andalluvium material intermixed with basalt flow material. Along the sides of the Hole are huge blocks of basalt. Basalt flows can be traced back from the edge of the Hole thus giving the appearance of basalt flows into the Hole. There are numerous and very extensive basalt flows surrounding Kilbourne Hole. Many volcano cones are located to the north, east, and west of Kilbourne Hole.

In this area there are mesa like structures about 100 feet in height built up of basaltic flow material. The West Potrillo Mountains are mainly composed of basalt. Mount Riley on the eastern edge of this range is composed of andesite, latite, and rhyolite flows and pyroclastics. The East Potrillo Mountains are made up of sandstone, shale, and limestone layers and are classified as Cretaceus according to the type of fossils they contain.

The Franklins to the east are composed of limestone and sandstone with andesite and granite intrusions. It is interesting to note that in the Franklins, layers classified as Ordovician are resting conformably on layers classified as Cretaceus without the slightest physical evidence of thrust movement. The surface distribution of the rocks may be seen in Figure 1. (These conformable layers are discussed in the paper immediately following: "Supposed Overthrust in Franklin Mountains."--Editors)

Gravity Survey

Gravity Field Methods

Gravity stations were established in the vicinity of Kilbourne Hole and Hunts Hole. A La-Coste-Romberg gravity meter was used. These observations were made during the years of 1962 and 1963 while some have been made very recently during February and March, 1966. Latitude positions of the stations were determined to an accuracy of ½ foot in elevation and 50 feet in latitude position.

Gravity reductions

Gravity values were reduced to the Bouguer anomaly. A density of 2.2 $gmcm^{-3}$ was found to be most suitable for most of the area. Terrain corrections were omitted since they are fairly uniform throughout the area, and those of a local character are insignificant for most stations. The results are shown on the Bouguer anomally map in Figure 2. The gravity values are given in Table I.

Gravity interpretation

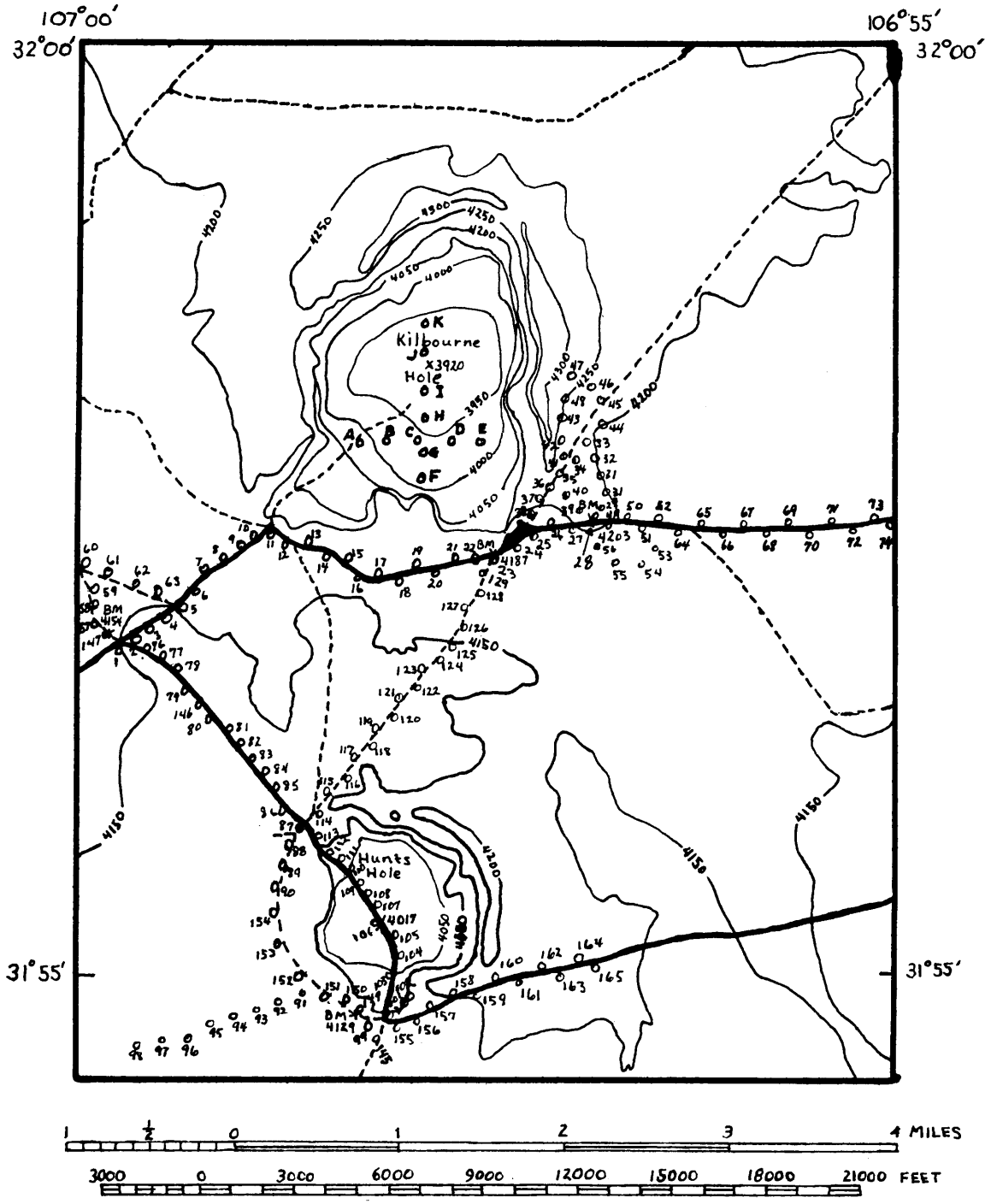
Study of the gravity values available would indicate that Kilbourne Hole is a collapse structure into which basalt lava has flowed. The gravity highs do not exist over the Holes thus indicating that anomalous igneous plugs do not exist under the Holes.

However, the stations are so arranged that it is difficult to obtain a Bouguer contour gravity map. It may be that material has flowed out from under the Hole thus causing a collapse.

This paper represents a preliminary study and certainly is not complete. Establishment of more gravity stations to fill in the gaps for the area is anticipated. A more complete picture and report on this study is planned for the future.

Acknowledgments

My students provided much valuable assistance. J. VanVelkinburgh helped considerably with the data reduction of the gravity readings to the Bouguer gravity values. J. B. Gillespie, Jr.; Isaac Segura; and James Johnson did much field work in obtaining the data. J. Powell did the drawings.



THE SMALL CIRCLES INDICATE THE LOCATION OF THE GRAVITY STATIONS. TABLE 1 GIVES THE GRAVITY VALUE IN MILLIGALS FOR EACH STATION RELATIVE TO STATION 28.

Figure 2 Bouguer Gravity Map

TABLE I

Station	Gravity Value in Milligals	Station	Gravity Value in Milligals	Station	Gravity Value in Milligals	Station	Gravity Value in Milligals
A	285.50	34	279.60	78	291.13	122	284.26
B	284.53	35	279.61	79	290.31	123	283.60
C	284.28	36	279.52	80	290.09	124	282.23
D	282.89	37	279.23	81	289.76	125	282.66
E	282.61	38	279.69	82	289.38	126	282.81
F	284.68	39	279.39	83	288.87	127	281.62
G	285.78	40	279.34	84	288.94	128	281.22
H	283.90	41	279.82	85	288.55	129	281.07
I	283.88	42	279.85	86	288.13	145	
J	283.25	43	279.97	87		146	
K	283.73	44	280.24	88	288.68	147	
1	293.44	45	279.93	89		148	281.73
2	293.04	46	280.55	90		149	288.14
3	292.26	47	280.48	91	288.53	150	288.37
4	291.87	48	280.32	92	289.13	151	288.64
5	291.15	49	278.95	93	289.74	152	289.19
6	290.41	50	278.86	94	290.22	153	289.56
7	289.67	51	278.79	95	290.86	154	289.61
8	289.07	52	278.72	96	291.31	155	289.71
9	288.32	53	278.76	97	292.24	156	285.08
10		54	278.93	98	293.37	157	
11	286.94	55	278.85	99	287.70	158	
12	286.38	56	279.05	100	287.28	159	284.96
13	285.68	57	293.46	101	28745	160	284.30
14	284.97	58	292.93	102	287.46	161	284.30
15	284.67	59	292.56	103	287.31	162	28400
16	284.35	60	292.05	104	287.24	163	283.74
17	283.65	61	291.51	105	287.23	164	282.44
18	283.03	62	290.65	106	287.58	165	282.17
19	282.52	63	290.01	107	287.81	166	281.01
20	281.94	64	278.73	108	287.67	167	281.34
21	281.67	65	278.76	109	287.60	168	
22	281.11	66	278.83	110	287.71	169	
23	280.62	67	278.88	111	288.99	170	282.70
24	280.18	68		112	288.04	171	282.72
25	279.91	69	279.12	113	287.44	172	282.82
26	279.65	70	279.29	114	287.76	173	282.83
27	279.54	71	279.48	115	287.40	174	282.82
28	279.28	72	279.72	116	286.84	175	282.93
29		73	280.07	117	286.36	176	
30		74	280.37	118	285.96	177	
31		75	280.66	119	285.56		
32		76		120	284.98		
33	279.54	77	292.24	121	284.50		