Although the Kokernot is the only one of the Davis Mountain Quaternary formations recognized as having equivalents in the area here described, the authors believe that further field investigation may disclose the presence of older Quaternary formations in the Finlay Mountain area.

Stability of Boulders on Slopes in the Finlay Mountains, Texas*

Ben R. Howard, Jr.

In a recent note[1] the writer and his associates showed that Indian petroglyphs might be used as criteria to indicate the stability of boulders resting on relatively steep slopes. Space did not permit a full account of the data which led to this suggestion. Accordingly, it is the purpose of this paper to amplify these data with a more complete description.

Location and Description of Site

A large Indian campsite is located at the Wilkie ranch house in the Finlay Mountains of West Texas. The approximate latitude, as determined on the Fort Hancock topographic sheet, is 31° 24′ N, and the longitude, 105° 38′ W. The site is upon the steeper slope of a cuesta facing the east (Figs. 1 and 2). It is located at the northwestern end of the mountains, about 400 yards west of Campagrande Draw.

A resistant cliff-forming sandstone caps this cuesta, and a similar stratum crops out about one-third the way down the slope. Joint blocks of sandstone that have broken away from the lower cliff litter the slope below. The campsite

*The writer is greatly indebted to Dr. C. C. Albritton, Jr., for his assistance and criticisms; to Professor T. N. Campbell, of the Department of Anthropology, The University of Texas, for guidance in treating the archaeology of the site; and to Dr. H. P. Mera of the Laboratory of Anthropology, Santa Fe, New Mexico, for identifying the pottery. Gratitude is also due to David Trexler, Dodd Osburn, Robert Trace, and William Ham for their help in the field work.

[1]Campbell, T. N., Howard, B. R., Albritton, C. C., Jr., and Osburn, D. N., "Petroglyphs as Criteria for Slope Stability,", *Science*, n. s., Vol. 93 (1941) p. 400.

extends for some 850 feet along the cuesta front, occupying the face of the cuesta from its base 450 feet upward to the lower sandstone cliff (Figs. 1 and 3). Joint blocks on the cuesta front are of all sizes, many exceeding 20 feet in length and 10 feet in width and height (Fig. 3). Approximately four-fifths of the surface of the cuesta front is covered by such blocks (Fig. 2). They lie at all angles and positions, forming natural shelters under their protecting margins. These served as protection for the dwellers at this campsite.

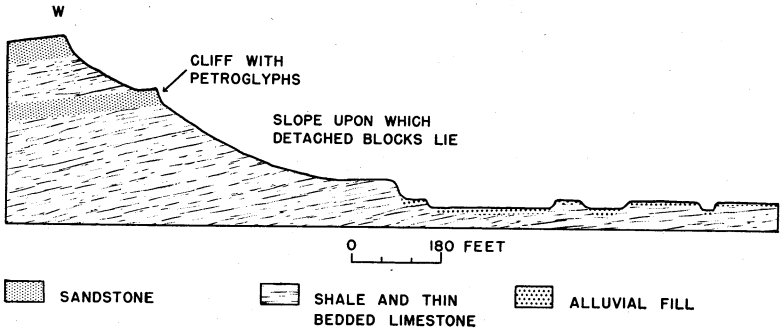

Fig. 1. Profile of cuesta at Wilkie ranch house.

There is evidence that this area was an Indian camp for a considerable length of time. This is shown by numerous middens built up around the shelters, and by the fragments of pottery and stone implements scattered over the slope. Mortar holes, petroglyphs, and pictographs occur on many of the boulders.

Local Geology

The resistant stratum of sandstone forming the lower cliff is about 30 feet thick. The face of the cliff is brown, due to the presence of brown desert varnish. Joint blocks detached from this cliff have in most places preserved their varnish. Beneath the brown rinds is crumbly or only moderately well cemented ferruginous sandstone of lighter color. Petroglyphs were formed by pecking through the rind so as to expose the lighter color beneath (Fig. 4).

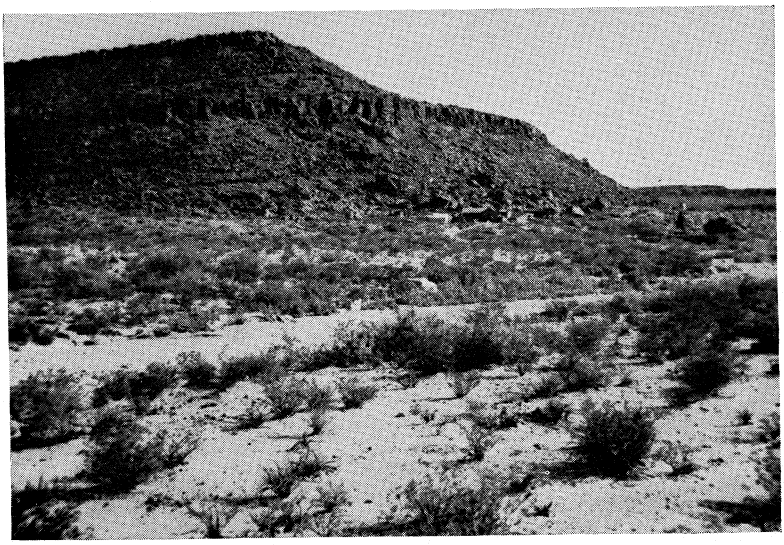

Fig. 2. Eastern face of cuesta. Petroglyphs occur on face of lower cliff and on large boulders.

Below the cliff-forming sandstone, the cuesta front is underlain by thin-bedded, fossilferous, gray limestone and drab red shale.

All bedrock on the slope belongs to the Cox formation of Lower Cretaceous age. The average angle of slope of the cuesta face is about 20°. Wasting of this slope has been accompanied by the detachment of sandstone joint blocks from the cliffs. These blocks have slid or rolled down the slope, accumulating at the base of the cuesta front. It would seem that this recession of the sandstone cliffs must be proceeding rapidly at the present time. However, this is not the case.

Evidence for Stability of Slope and Cliff

Petroglyphs and pictographs have been pecked or painted upon approximately 60 of the joint blocks that cover the cuesta front, and upon the sandstone cliff at the rim of the cuesta. Recently these pictures have been described by Osburn.[2] Location of individual pictures figured on Osburn's plate is made in the following table:

Block Number[3] (Fig. 3)	*Petroglyph Numbers* (Osburn)
1	2-4-10-21-22-29-37-39-40-41-42-54-57-58-60. 61-62-63-77-79-94-109-120-131-146-153.
2	8-9-36-65-71-80-99.
3	1.
4	3-31-56-67-72-98-101-154.
5	45.
9	141.
10	33-34-51-73-89-107.
11	25-121.
18	47-69-135.
19	55-108.
20	46-53-59-148.
22	48.
23	85.
27	136.
29	93.
30	137-138.
31	140.
32	129.
33	26-45.
35	122.
36	68-88-97-116-119-125-134.
37	28.
38	82.
39	144.
40	6-110.
41	35-43-66-100-113-117.
43	78.
44	7-104-130-142.
47	50.
48	111.
54	123-139.

[2]Osburn, D. N., "Petroglyph and Pictograph Site in the Finlay Mountains," *Field and Laboratory*, Vol. 9 (1941) pp. 30-35.

[3]Blocks which are not listed had petroglyphs which either were so badly weathered as to be unintelligible, or else were repetitions of petroglyphs on other blocks.

56	96-128.
58	24-102.
59	147.
61	149.
62	13.
63	5.
65	12-91-95-133.
66	11-14-15-16-17-18-19-20-27-30-32-38-44-64-70 81-86-87-90-92-106-112-114-115-124-126-127 143-145-150-151-152.
67	74.
70	84-118.
71	76.
72	132.
73	75-105.
75	103.
78	23.

Many of the pictures on the joint blocks upon the slope are of man-like figures and animals (Fig. 4). These are in up-right positions today, showing that since the petroglyphs were made none of the blocks upon which they occur has toppled or rotated.

Middens are found in and around the natural shelters on the downslope sides of many blocks bearing petroglyphs or mortar holes. As none of these blocks was found resting on the top of one of these middens, it is safe to assume that the boulders have not crept down-slope by any noticeable amount since the formation of the middens.

As shown in Fig. 3, petroglyphs occur upon the cuesta rim in a continuous series for a distance of approximately 300 feet. Thus, no joint blocks have broken away from this section of the cliff since the carvings were made.

Pottery collected from the middens adjacent to the blocks bearing petroglyphs and mortar holes has been identified by Dr. H. P. Mera of the Laboratory of Anthropology, Santa Fe, New Mexico. Dr. Mera's analysis is quoted below.

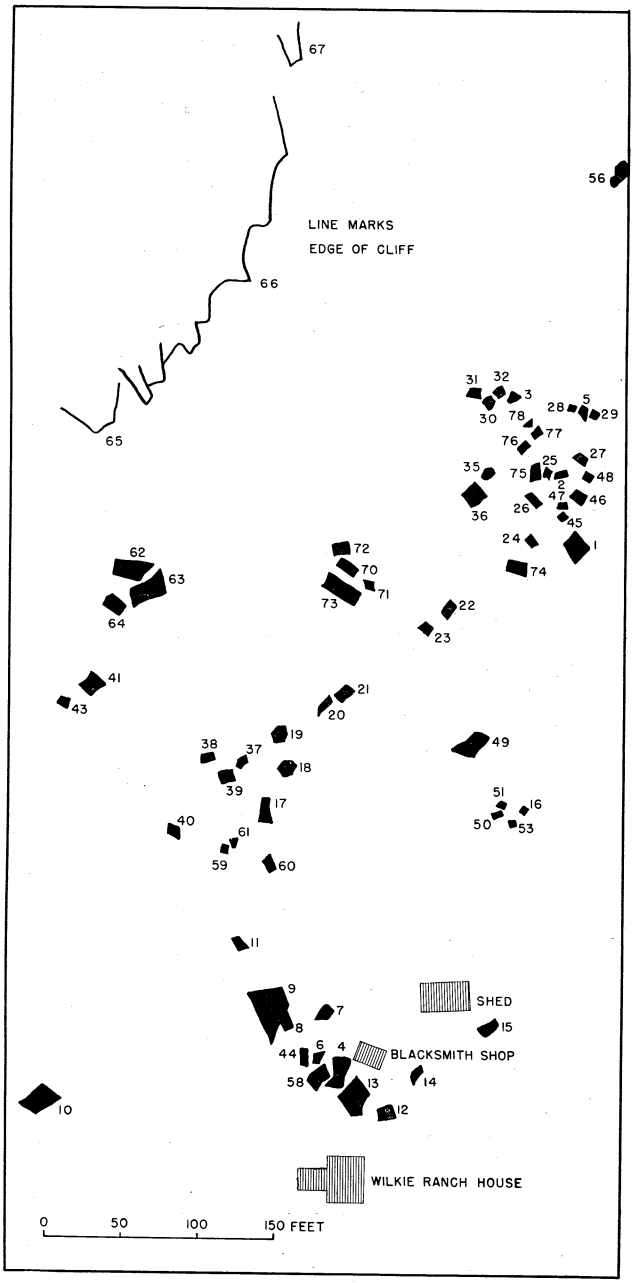

Fig. 3. Map of Indian campsite at Wilkie ranch house. Blocks with petroglyphs in solid black.

Fig. 4. Petroglyphs on sandstone joint block.

"The following types are present in varying numbers: El Paso Polychrome, Chupadero Black-on-white, Three Rivers Red-on-terracotta as well as El Paso and some variation of that type. These are a scored and a rubbed corrugated sort, the latter merely showing an influence derived from the north. There are also two examples of a rubbed corrugated ware having a paste of Three Rivers character. The ceramic complex is typical for sites in the area. . . . . .

"As actual tree-ring dates cannot be obtained for ruins in the more southern areas because of the lack of dateable wood, reliance will have to be placed on dates obtained in northern ruins in which southern types appear as intrusives —the result of trading relations.

"Of the three principal types represented, El Paso Polychrome and Chupadero Black-on-white offer the least hope for any thing like the best dating because it has been

found that both styles existed over an unusually long period. The Three Rivers Red-on-terracotta presents the best chance.

"We know that this latter type underwent a transformation into the Lincoln Black-on-red type sometime after the middle of the 14th century. This was due to attempts to copy a well dated northern black-on-red ware. For a lower limit, it can be cited that red-on-terracotta is found in Mimbres Black-on-white sites that appear to date in the first part of the 13th century. Hence, basing an estimate on this and a few other minor factors, it would seem safe to believe that the Finlay Mountains site was occupied sometime during the interval between the first parts of the 13th and 14th centuries."

The following quantitative data are also the result of Dr. Mera's work.

Quantitative Data on Pottery from Petroglyph Site

El Paso Type and Variations	Number of Sherds	
El Paso Polychrome	26	
El Paso (undecorated)	55	
Scored (variation of El Paso type)	12	
Rubbed corrugated (variation of El Paso, showing influence from the north)	8	
	101	101
Chupadero Black-on-white	4	4
Three Rivers Red-on-terracotta		
Decorated (includes 5 sherds that fitted together to make one rim sherd)	8	
Undecorated	18	
	26	26
Total		131

If, as seems likely, the pottery, petroglyphs, and middens are contemporaneous, the cliff rim and the petroglyph-bearing boulders that cover the cuesta face have been in essentially their present positions for the past 600 or 700 years. Furthermore, no blocks have broken away from the cuesta rim since the carvings were made, or since 1200 or 1300 A. D.

MICHIGAN STATE COLLEGE
EAST LANSING, MICHIGAN