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INVESTIGATION OF A LINEAMENT EXPRESSED IN AN OBLIQUE APOLLO 9 PHOTOGRAPH

Argus Exploration Company
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March 1974
Report of Investigation

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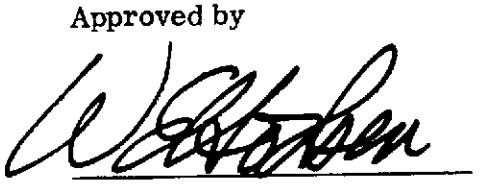

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President

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A linear topographic feature, referred to here as the New York Mountains lineament, was recognized in an oblique Apollo 9 photograph to extend from the Providence Mountains of California to near Lake Mead, Arizona. In subsequent vertical ERTS-1 imagery this feature was found to have vague and indistinct expression. A study has been conducted to determine the possible geologic origin(s) of the lineament and to explain its anomalous expression in the Apollo 9 photograph. The results of this study suggest that the apparent expression of the lineament is due to a combination of the oblique view of the Apollo photograph, low sun angle illumination of southeast facing slopes, shadowing of northwest facing slopes, and a linear snow line along the southeastern flank of the New York Mountains. No geologic or structural causes for the lineament have been found.

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ABSTRACT

A linear topographic feature, referred to here as the New York Mountains lineament, was recognized in an oblique Apollo 9 photograph to extend from the Providence Mountains of California to near Lake Mead, Arizona. In subsequent vertical ERTS-1 imagery this feature was found to have vague and indistinct expression. A study has been conducted to determine the possible geologic origin(s) of the lineament and to explain its anomalous expression in the Apollo 9 photograph. The results of this study suggest that the apparent expression of the lineament is due to a combination of the oblique view of the Apollo photograph, low sun angle illumination of southeast facing slopes, shadowing of northwest facing slopes, and a linear snow line along the southeastern flank of the New York Mountains. No geologic or structural causes for the lineament have been found.

Introduction:

A narrow topographic lineament is apparent for a distance of approximately 180 km in an oblique Apollo 9 photograph recorded over southeastern California, southern Nevada and northwestern Arizona on 12 March 1969 (Figure 1). The lineament, referred to here as the New York Mountains lineament, is expressed in the Apollo 9 photograph as a discrete northeast trending alignment of ridges, hills, and snow lines.

In vertical multi-seasonal ERTS-1 MSS imagery recorded over the area of the Apollo 9 photograph, the New York Mountains lineament has been found to have vague and indistinct expression. The following study was conducted in order to determine the possible geologic origin(s) of the lineament, and to explain its anomalous expression in the Apollo 9 photograph.

The region traversed by the New York Mountains lineament lies within the southern Basin Range Province, in an area of moderate topographic relief and arid to semi-arid climate. A northeast trending group of ranges including the New York Mountains, Mid Hills and Providence Mountains is aligned along the southwestern

trace of the lineament. The ranges traversed by the northeastern trace of the lineament are the Eldorado and Black Mountains east and west of the Colorado River. The Eldorado and Black Mountains have a northerly trend (Figure 2) controlled by normal faulting, dike-swarms, and elongate plutons of late Cenozoic age (Liggett and Childs, 1974).

The geology along portions of the New York Mountains lineament has been mapped at a variety of scales. This data has aided imagery analysis and guided field reconnaissance by members of the Argus Exploration Company research staff. Reconnaissance geologic maps used in this investigation cover Clark Co., Nevada (Longwell and others, 1965), San Bernardino Co., California (Jennings, 1972), an area bordering the Colorado River (Longwell, 1963), and Mohave Co., Arizona (Wilson and others, 1969). More detailed studies conducted along portions of the New York Mountains lineament include mapping in the vicinity of Nelson, Nevada by R. E. Anderson (1971) and Volborth (1973), the Highland Spring Range by Bingler and Bonham (1973), the Vanderbilt area in the central New York Mountains by Haskell (1959), and the Ivanpah 1^{o}x 2^{o} quadrangle by Hewett (1956).

New York Mountains Lineament:

In the Apollo 9 Ektachrome photograph AS9-20-3135 taken on 12 March 1969, the New York Mountains lineament is most clearly expressed in the northern Eldorado Mountains and on the southeastern slope of the New York Mountains (see Figure 1). In the Eldorado Mountains, near Nelson, Nevada, the lineament appears as an alignment of ridges and hills which are shadowed on the northwest slopes and illuminated on the southeastern slopes by an early morning sun elevation of approximately 41^{o}. In the New York Mountains east of Cima, California, the lineament is expressed by the anomalous northeasterly trend of the range and a nearly linear snow line which generally follows a topographic contour along the southeastern flank of the range. In the Providence Mountains, the lineament is expressed by the illumination of southeast facing ridges in the center of the range.

In the multi-seasonal ERTS-1 MSS imagery, the lineament observed on the Apollo 9 photography is poorly expressed. In the Eldorado Mountains a general alignment of hills and ridges shows illumination effects similar to those observed on the Apollo 9 photograph. Analysis of ERTS-1 MSS imagery recorded during several seasons has shown this alignment of topographic features to be most distinct in winter when the solar elevation is at a minimum of approximately 26^{o} above the horizon.

The ERTS-1 MSS imagery and topographic maps of the Providence Mountains show this range to have a more northerly trend than is apparent in the Apollo 9 photograph. This geometric distortion is believed to be the result of the oblique look angle of the Apollo 9 photograph, which has a bearing of N 6^{o}W, and is estimated to be approximately 55^{o} from vertical.

No consistent geologic or structural features which might account for the New York Mountains lineament have been recognized along its trace in either the mapped geology, or field reconnaissance by members of the Argus Exploration Company staff. Detailed analysis of the terrain along the lineament has been conducted using a variety of high altitude imagery including USGS-USAF black and white U-2 photographs, and NASA Pre-ERTS Investigator Support (PEIS) U-2 multispectral, and infrared Aerographic and Aerochrome photography. This supporting data is listed in the imagery reference portion of this report.

In the vicinity of Nelson, Nevada, and east of the Colorado River along the western flank of the Black Mountains in Arizona, late Tertiary and Quaternary dikes and normal faults occur along the northeast trending trace of the New York Mountains lineament. However, most of these features have northerly strikes and it is considered improbable that the few geologic features aligned parallel with the lineament in this region have controlled its apparent topographic expression.

The structure of the New York and Providence Mountains is essentially that of a tilted block raised on the northwestern range front by a system of northeast striking normal faults. Within these ranges Precambrian granitic rocks are overlain by Tertiary volcanic rocks which have been tilted with the range and dip toward the southeast beneath the basin alluvium of Lanfair Valley. Several felsic dikes of probable Cretaceous or younger age (Hewett, 1956) strike parallel to the frontal fault of the New York Mountains but do not align with the trace of the New York Mountains lineament.

Conclusions:

The New York Mountains lineament appears as a prominent linear alignment of ridges, hills, and other geomorphic features in the Apollo 9 oblique photograph, but does not appear as a distinct feature in the multi-seasonal ERTS-1 imagery.

No geologic or structural causes for the New York Mountains lineament in the Apollo 9 photograph have been recognized. The vertical ERTS-1 MSS imagery has shown that the apparent alignment of the New York Mountains, Mid Hills, and Providence Mountains, in the Apollo photograph is incorrect. The apparent alignment of these ranges in the Apollo 9 photograph is due in large part to the oblique look angle of the photograph which has produced a foreshortening of the field of view. The oblique northerly view in the Apollo 9 photograph, in combination with the low sun elevation in the southeast, produced a strong expression of southeasterly facing slopes. This effect is enhanced by the presence of a linear snow line on the southeastern flank of the New York Mountains.

This study emphasizes the value of vertical, repetitive and multi-seasonal ERTS-1 imagery for analysis and evaluation of topographic features, especially in applications to structural geology and geomorphology.

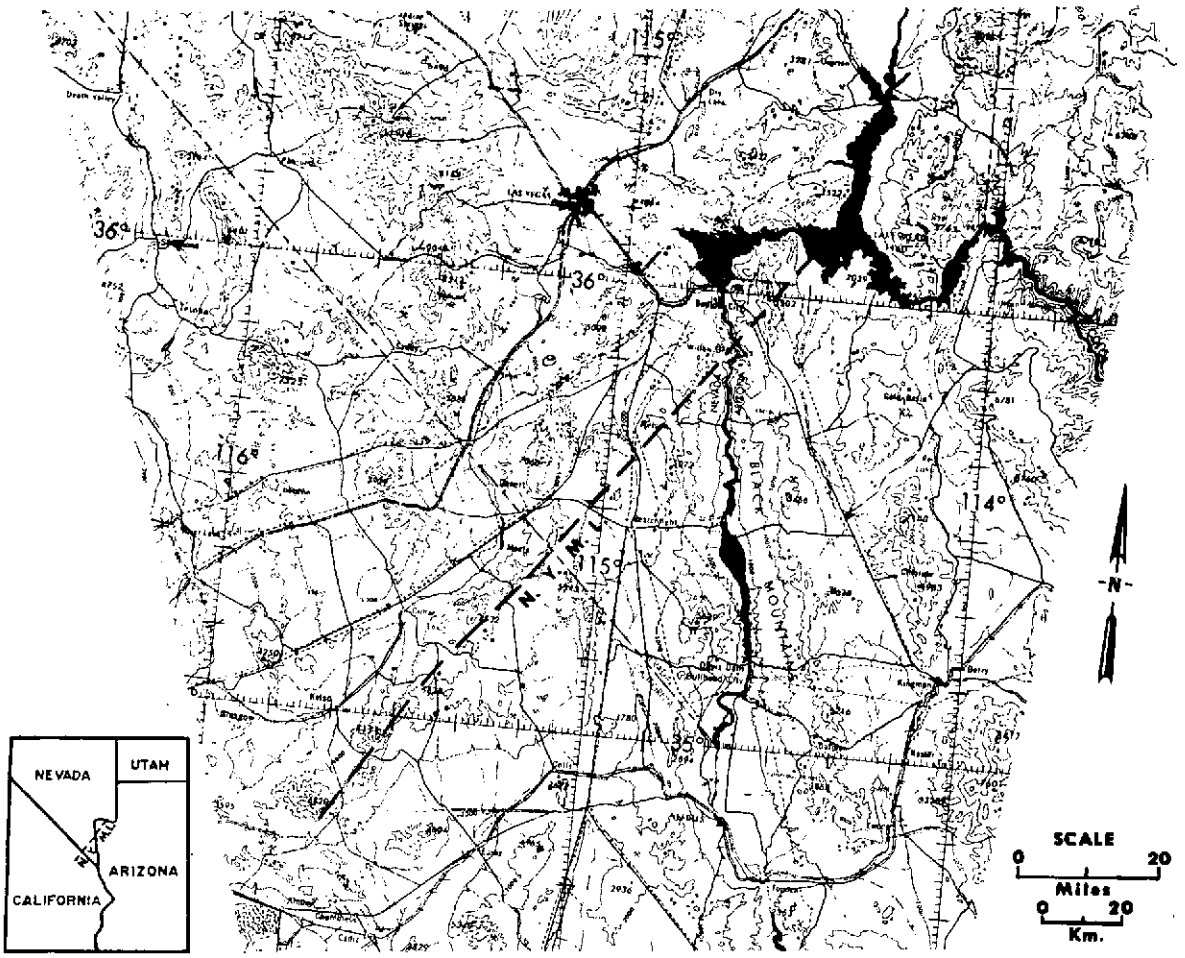

Figure 2 Index map showing the trace of the New York Mountains lineament as expressed on the Apollo 9 oblique photograph. The lineament is notated as N. Y. M. L. The area covered in the index map is the same as shown in the lower two-thirds of the Apollo 9 photograph.

Figure 1 Apollo 9 oblique photograph number AS9-20-3135 over southeastern California, southern Nevada, and northwestern Arizona. The trace of the New York Mountains lineament is shown on the index map, Figure 2.

Imagery References:

ERTS-1 multispectral scanner imagery

Date	Frame
13 September 1972	1052-17490
6 November 1972	1106-17495
30 March 1973	1250-17501
17 April 1973	1268-17501
23 May 1973	1304-17495
10 June 1973	1322-17494
28 June 1973	1340-17493

Apollo 9 space photographs

12 March 1969	AS9-20-3135
12 March 1969	AS9-20-3136

NASA Pre-ERTS Investigator Support (PEIS) imagery

Flight No.	Accession No.
72-059	00285
72-077	00345
72-077	00346 Frames 049-049
	0058-0061
	0065-0067
	0072-0073

USGS-USAF high altitude black and white U-2 photography

Flight No.	Frames	Date
018V	207-209	10 July 1968
059V	171-173	17 July 1969
059L	169-171	17 July 1968
059R	173-178	17 July 1968
374V	208-209	6 September 1968
374L	206-209	6 September 1968
374R	207-209	6 September 1968
774R	079b-079e	29 November 1967

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