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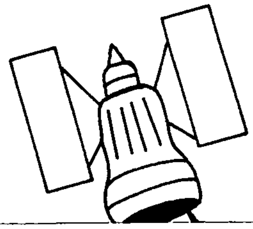

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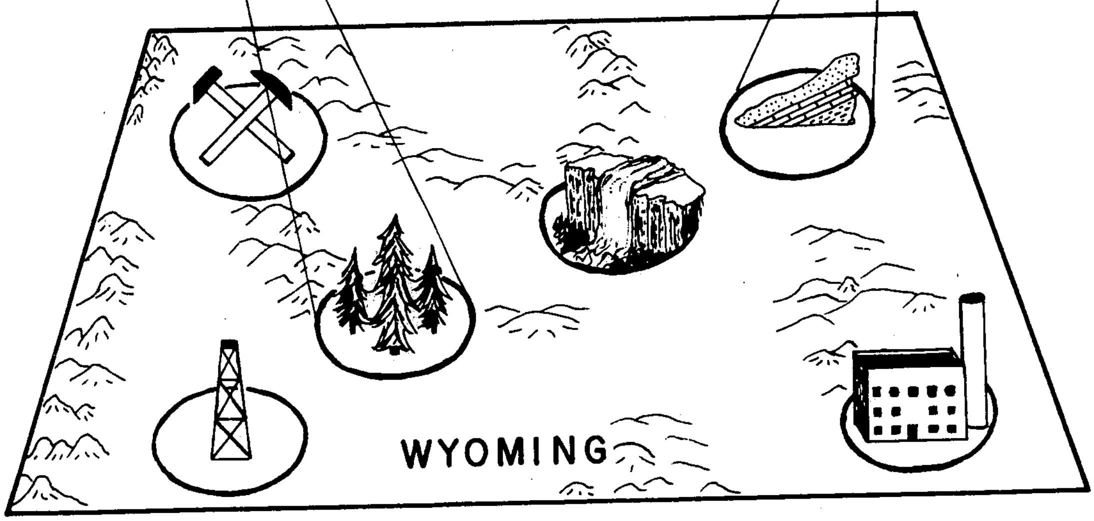

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16. Abstract

Photo linear features in the Precambrian rocks of the Laramie Mountains are delineated, and the azimuths plotted on rose diagrams. Three strike directions are dominant, two of which are in the northeast quadrant. Laramide folds in the Laramie basin to the west of the mountains appear to have the same trend, and apparently have been controlled by response of the basement along fractures such as have been measured from the imagery.

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ANALYSIS OF PHOTO LINEAR ELEMENTS, LARAMIE MOUNTAINS, WYOMING

D. L. Blackstone, Jr.
Department of Geology
University of Wyoming
Laramie, Wyoming 82070

June 1, 1973
Special Report

Prepared for

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND 20771

ANALYSIS OF PHOTO LINEAR ELEMENTS, LARAMIE MOUNTAINS, WYOMING

INTRODUCTION

The Laramie Mountains are located in southeastern Wyoming between Latitude 41° and 43° North and trend north-south along Longitude 135°30' West. The mountains represent an asymmetrical anticline, with a steep faulted eastern limb and with rocks of Precambrian age exposed in the core. At the south end Pennsylvanian rocks overlie the Precambrian basement, but at the north end Cambrian strata overlie the basement, indicating a regional unconformity at the base of the Pennsylvanian section.

PREVIOUS INVESTIGATIONS

Many investigators have contributed data and interpretations concerning the Laramie Mountains. The list of references contains papers which deal with structural aspects, particularly those concerning the Precambrian age rocks of the core, and the relationship of those rocks to the marginal Laramide age structures. Papers of particular significance are those of Darton (1909), Darton, Blackwelder and Siebenthal (1910), Newhouse and Hagner (1957), Condie (1969) and Smithson (1969).

ACKNOWLEDGEMENTS

Particular thanks are due Mr. James Sears and Mr. Hamed Bekkar, University of Wyoming graduate students who aided in assembling the data, and in preparing diagrams.

GEOLOGIC STRUCTURE

The essentially north-south trending Laramie Mountains developed during the Laramide orogeny, but have many associated northeast trending folds of considerable magnitude. The relationship of the strongly divergent structural trends is not readily apparent and is the subject of this study. The location of the area is shown on Fig. 1, an index map of Wyoming.

Using both satellite and aircraft imagery the terrane was examined for linear structural features.

Note: The term photo linear feature is used here to describe any markedly linear element observable on the imagery irregardless of cause. In this particular situation the linear features have a geomorphic expression.

The linear features are for the most part expression of rock fractures rather than layering within the rock bodies. Recognition of linears was greatly facilitated by light snow cover.

All such features were plotted on acetate overlay sheets, the strike (azimuth) determined the features counted and the results displayed in rose diagrams as frequency of occurrence. No field check has been made to date, correspondingly the results must be considered as first order reconnaissance, subject to further check.

SOUTHERN LARAMIE MOUNTAINS

The general distribution of lithologies of the Laramie Mountains is shown on Fig. 2, modified from Condie (1969), Newhouse and Hagner (1957) and Darton, Blackwelder and Siebenthal (1910). All linear features taken from ERTS images 1100-17133-7 (Fig. 3), and 1029-17184-7 (Fig. 4) are shown on Fig. 5. Comparison of Figures 2 and 5 indicates that the underlying rock type does not control the distribution nor the trend of the linear features.

The rose diagram plots of the azimuths of 720 linear features of the southern Laramie Range imagery is shown on Fig. 6a. The plot defines three

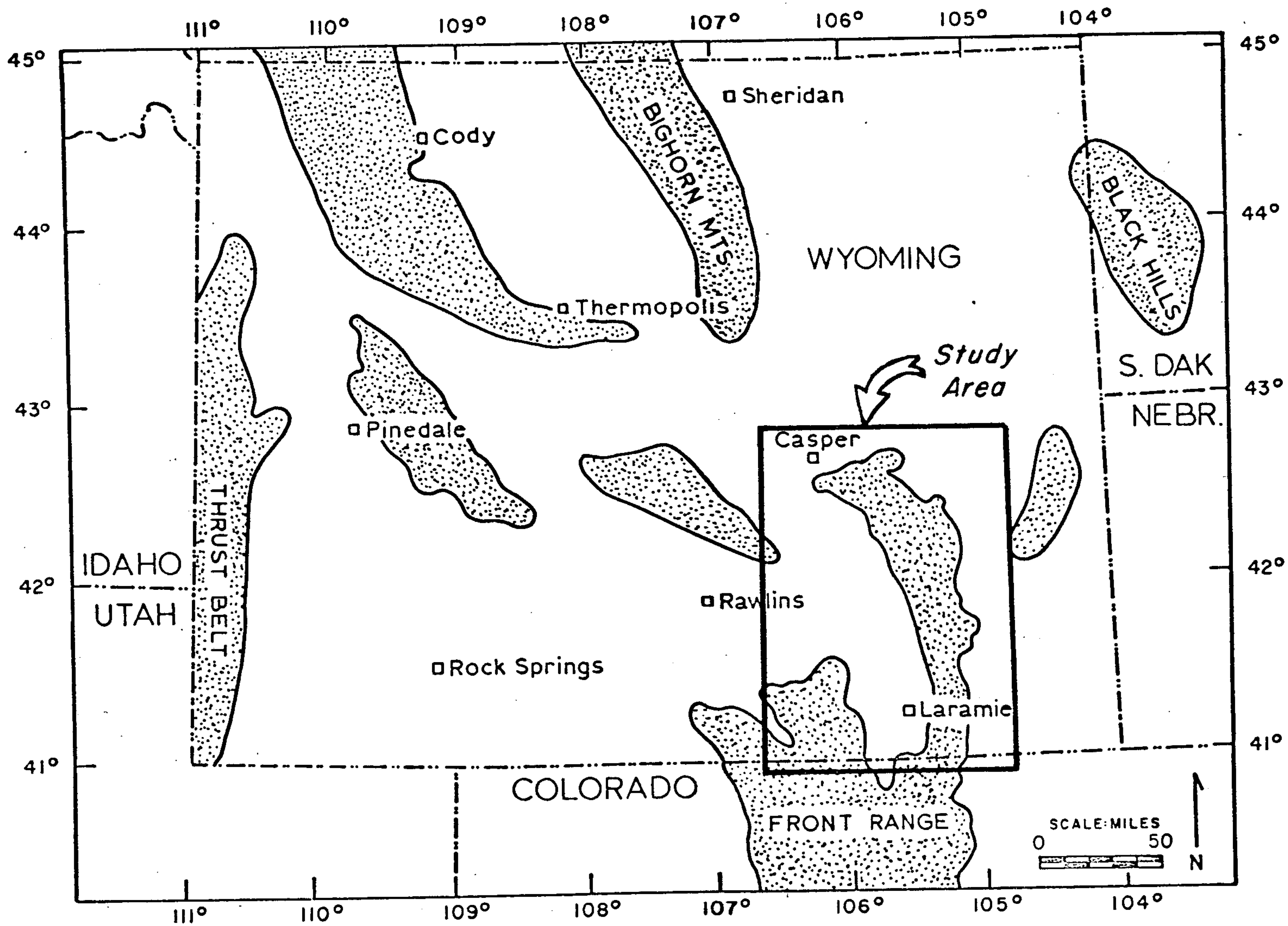

Figure 1. Index map of Wyoming and the Laramie Range study area.

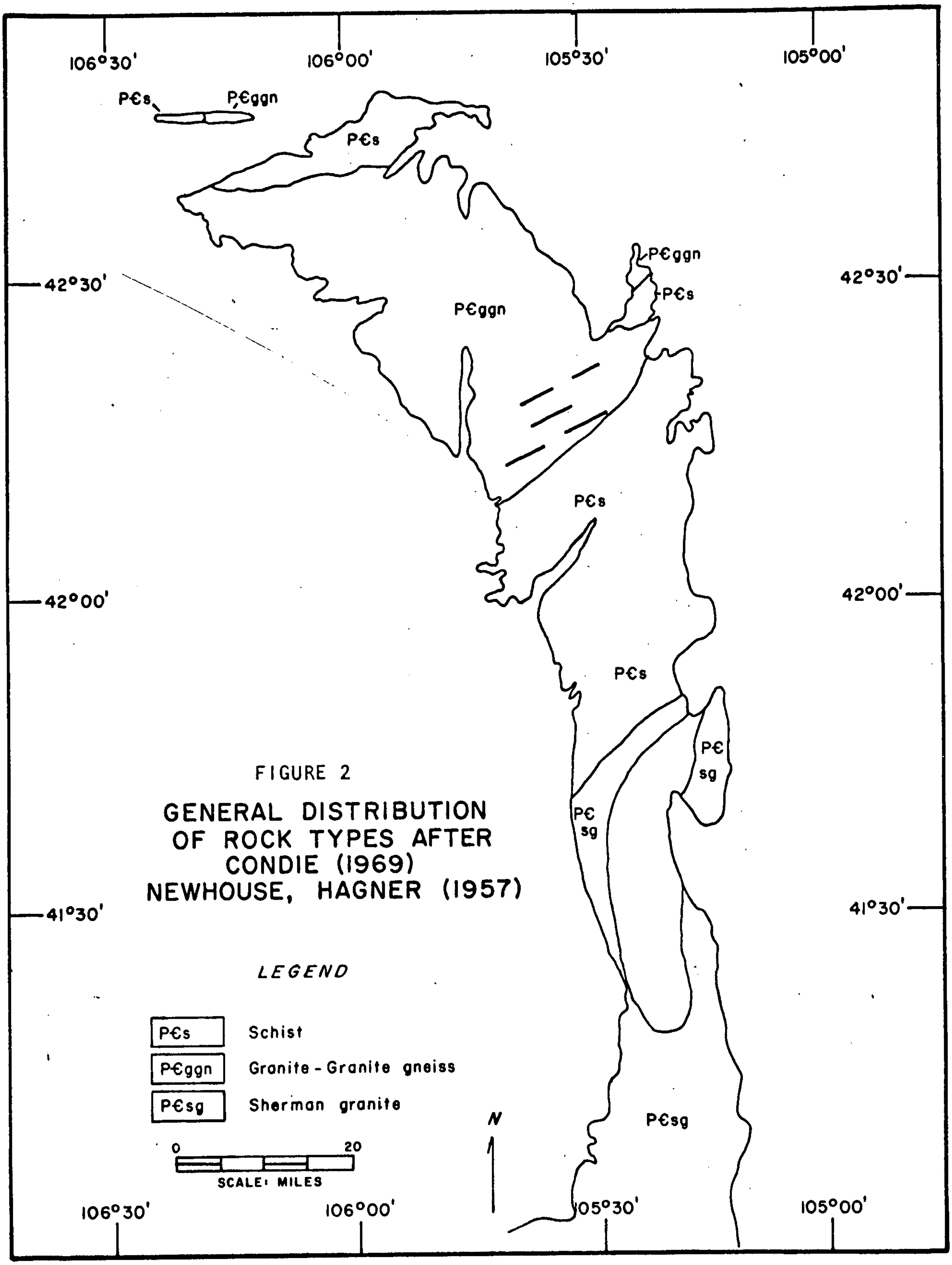

FIGURE 2

GENERAL DISTRIBUTION OF ROCK TYPES AFTER CONDIE (1969) NEWHOUSE, HAGNER (1957)

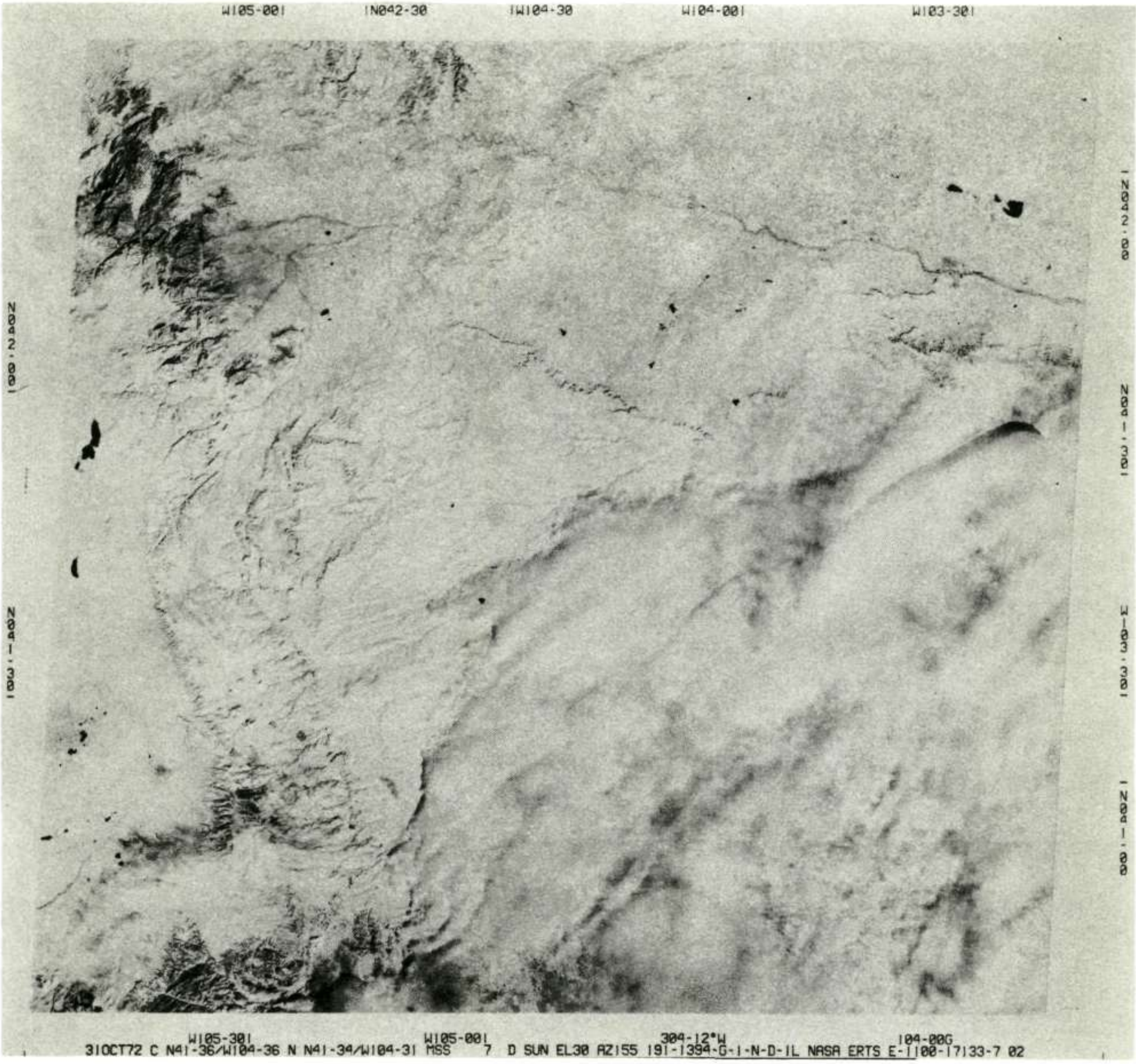

Figure 3. ERTS-1 image 1100-17133-7, showing the southern Laramie Range under snow cover.

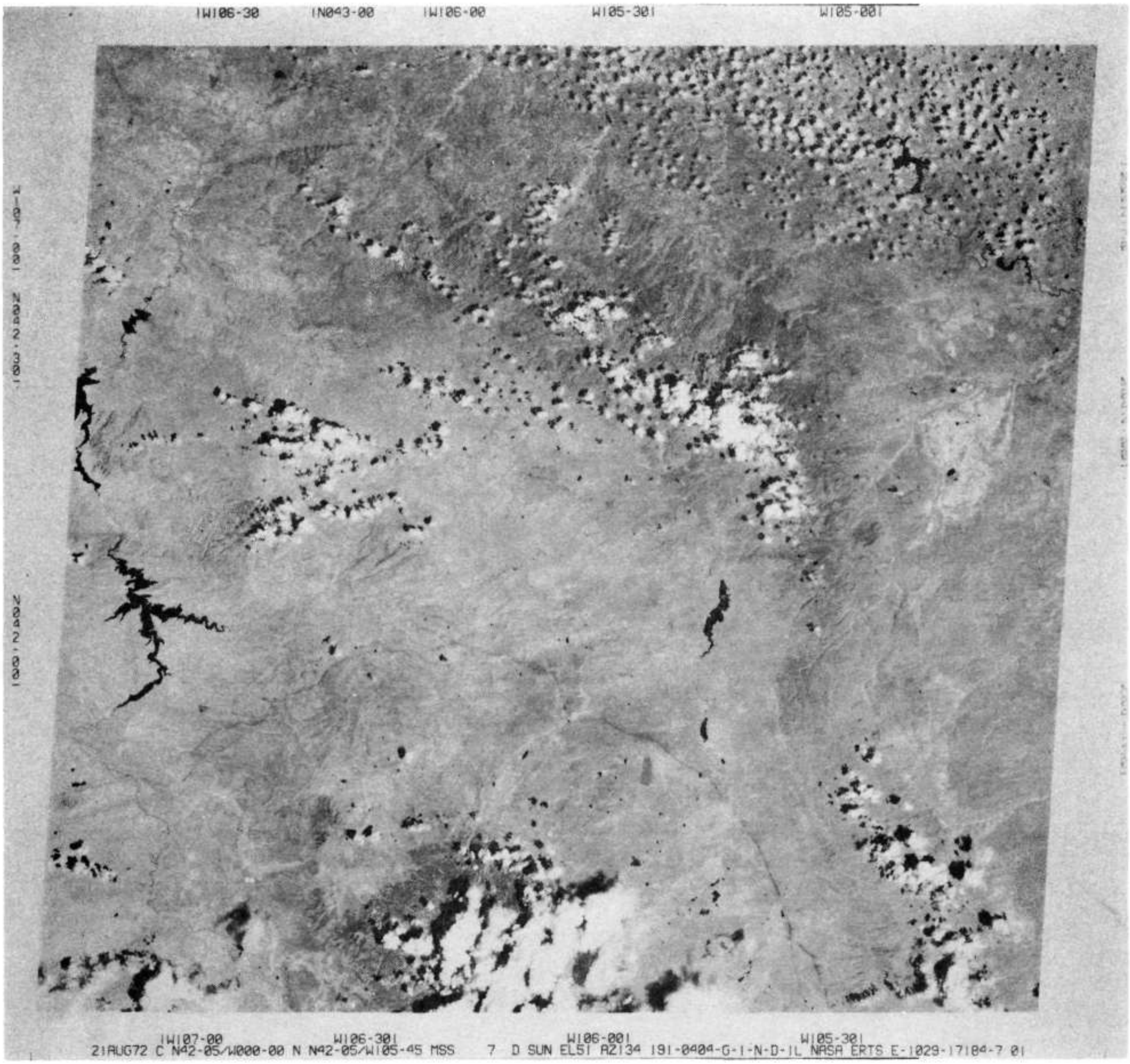

Figure 4. ERTS-1 image 1029-17184-7 of the northern Laramie Range. Considerable cloud cover in the area of interest undoubtedly obscures many significant photo linear features.

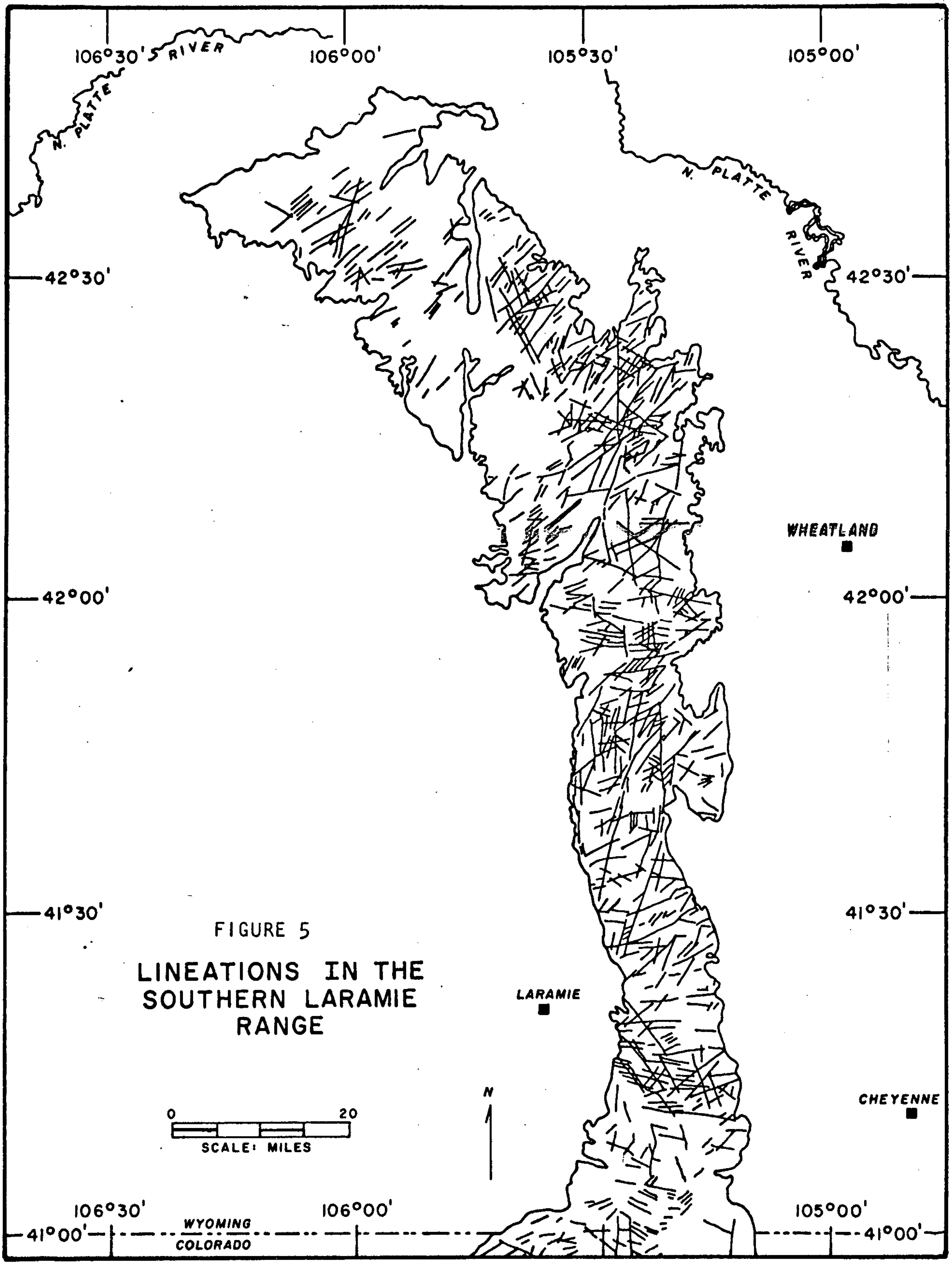

FIGURE 5

LINEATIONS IN THE SOUTHERN LARAMIE RANGE

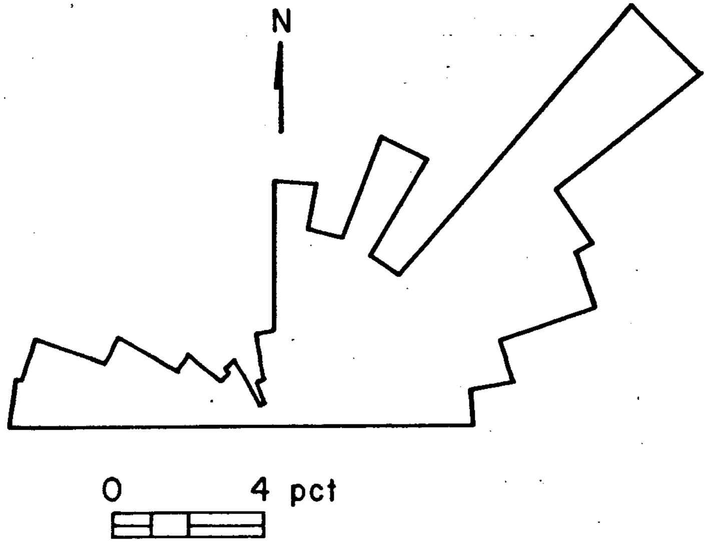

Figure 6a. Rose diagram showing dominant orientations of photo linear elements of the southern Laramie Range.

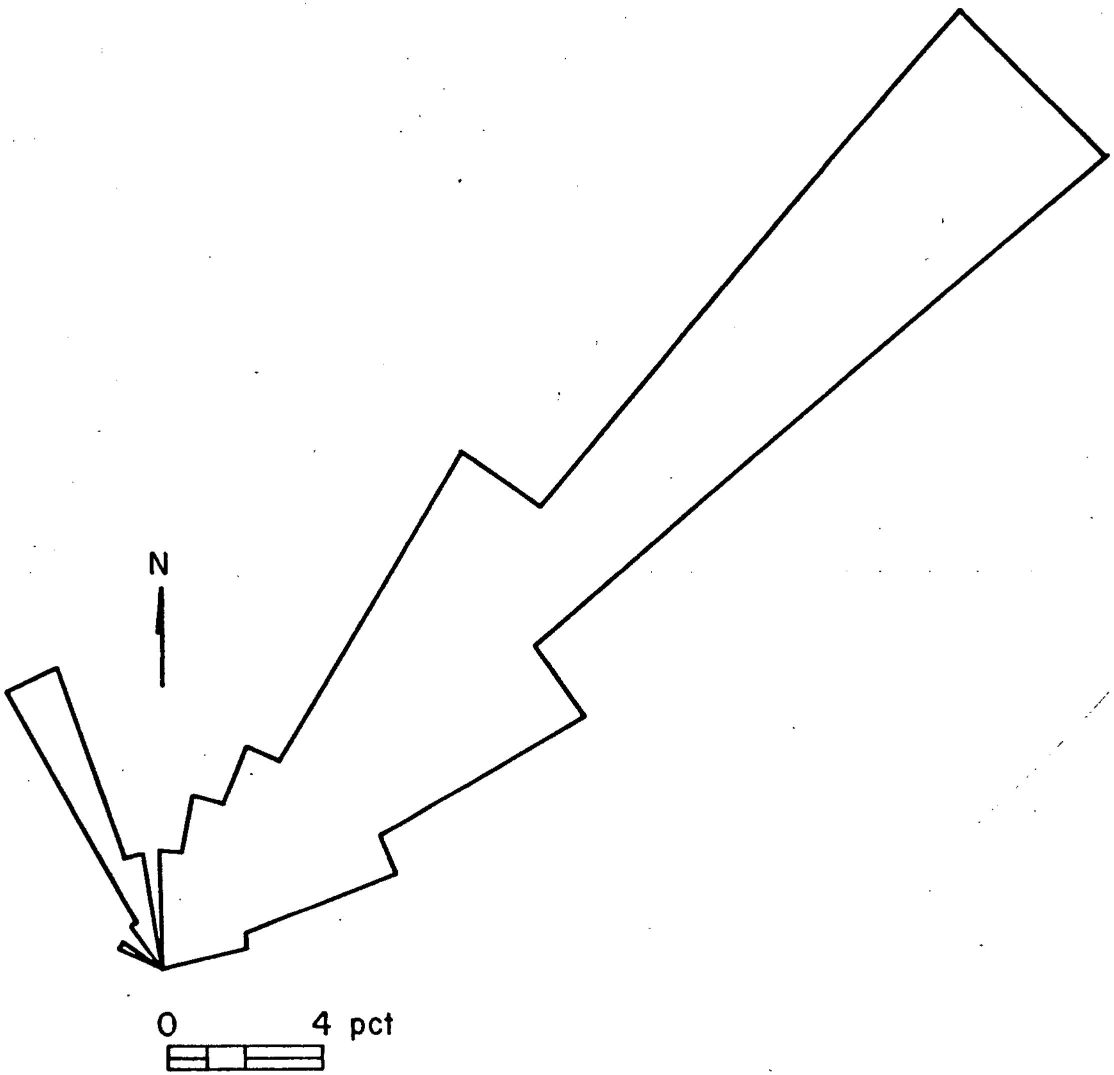

Figure 6b. Rose diagram showing dominant orientations of photo linear elements of the northern Laramie Range.

principal trend directions of the linear features which are believed to be fractures. The three dominant directions are:

Quadrant	Concentration	Azimuth
N. 20 E.	8.2%	20°
N. 40 to 50 E.	14.5%	40° to 50°
N. 70 to 80 W.	13.7%	280° to 290°

Granite and granite gneiss terrances totally dominate the northern Laramie Range, consequently there was no opportunity to establish any relationship between rock type and variation in orientation of linear features.

The rose diagram plot of 160 linear features of the northern Laramie Range is shown on Figure 6b for ERTS image 1029-17184 (Fig. 4), 21 Aug. 1972 reveals a pronounced northeast orientation. The principal orientation is:

Quadrant	Concentration	Azimuth
N. 40-50 E.	31.8%	40° to 50°

With a limited number of linear features having an orientation of:

Quadrant	Concentration	Azimuth
N. 20 W.	6.3%	340°

OBSERVATIONS IN RESTRICTED DOMAINS

In addition to the measurements described above, and made from ERTS satellite imagery at an approximate scale of 1:000,000, a similar set of measurements was made from underflight photography (color) at a scale of approximately 1:16,000.

Data from the three small domains follows.

Domain A - T. 17 N,, Rs. 71 and 72 W.
167 Readings

Domain B - T. 26 N., R. 72 W.
169 Readings
Area of granite and granitic gneiss

Domain C - T. 30 N., R. 75 W.
280 Readings
Area of granite and granitic gneiss

No small area entirely within an area of schistose rocks was studied.

In Domain A the observed data is summarized below.

Quadrant	Concentration	Azimuth of Trends
N. 45 E.	7.2%	45°
N. 80 E.	10.1%	80°
N. 60 W.	11.4%	300°

Data from Domain B is summarized below.

Quadrant	Concentration	Azimuth of Trends
N. 5 E.	2.9%	5°
N. 50 E.	26.6%	50°
N. 85 E.	4.1%	85°
N. 65 W.	5.3%	295°

Data from Domain C are summarized below.

Quadrant	Concentration	Azimuth of Trends
N. 15 E.	7.1%	15°
N. 50 E.	17.5%	50°
N. 85 W.	5.0%	275°
N. 60 W.	11.1%	300°

Figure 7 is a composite rose diagram of 616 readings in the restricted domains.

A comparison of the data from the two sets of imagery (satellite and underflight) shows very little variation. The number of observations from the restricted domains is greater, indicating that smaller scale features can be seen from the underflight that are not detectable from the satellite imagery. It is also apparent that the minor fractures agree well in orientation with the major ones.

Hamed Bekkar (1973) compared the orientation of the imagery features with the orientation of folds and faults for the entire Laramie Basin, and demonstrated the close agreement of the two sets of observations.

SUMMARY AND CONCLUSIONS

The ERTS imagery has yielded data which is very satisfactory for analysis of regional tectonic features.

The imagery derived from ERTS underflights has yielded data which provides more observations per unit area, but which do not change the significant values i.e. - dominant orientation of the photo linear features.

The northeast trending linear elements appear to control the orientation of numerous Laramide folds in the areas marginal to the Laramie Mountain uplift. Examples of such folds are Como Bluff anticline, McGill anticline, and Flat Top anticline.

The type of rock within the Precambrian terrane does not appear to influence the orientation of the fractures, assuming that the photo linear features are the expression of bedrock fracturing.

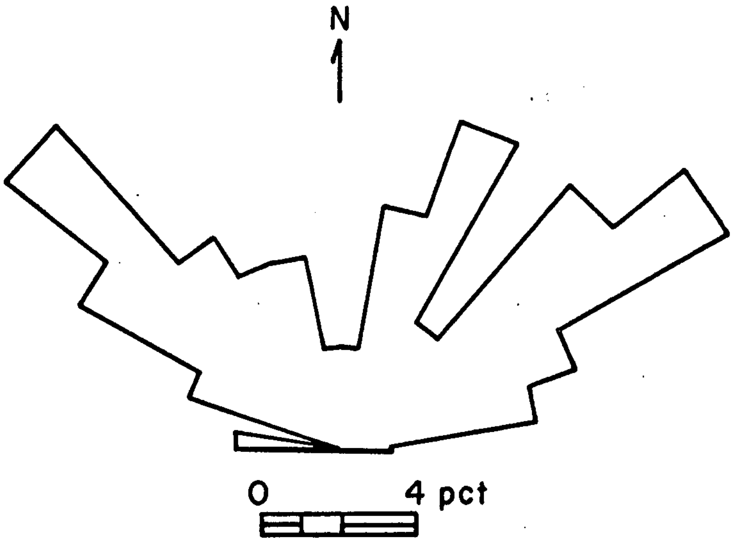

Figure 7. Composite rose diagram of photo linear elements located on aircraft imagery.

Detailed ground studies should be conducted to determine the nature of the linear elements. It is unlikely that shear zones, joints and multiple fracture systems will be found to be the basis for the geomorphic expression.

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