

THE NATURE AND ORIGIN OF MINERAL COATINGS ON VOLCANIC ROCKS OF THE BLACK MOUNTAIN, STONEWALL MOUNTAIN, AND KANE SPRINGS WASH VOLCANIC CENTERS IN SOUTHERN NEVADA

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**ORIGINAL CONTAINS
COLOR ILLUSTRATIONS**

January 1986
Semiannual Progress Report for Period July 1985 - January 1986

Contract Number NAS5-28765

(NASA-CR-176805) THE NATURE AND ORIGIN OF MINERAL COATINGS ON VOLCANIC ROCKS OF THE BLACK MOUNTAIN, STONEWALL MOUNTAIN AND KANE SPRINGS WASH VOLCANIC CENTERS IN SOUTHERN NEVADA Semiannual Progress Report, Jul.

N86-25912

Unclas

G3/46 43581

Prepared for
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

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INTRODUCTION

The purpose of this progress report is to describe work accomplished during the first six-month period from July, 1985 to January, 1986, under the contract "The Nature and Origin of Mineral Coatings on Volcanic Rocks of the Black Mountain, Stonewall Mountain, and Kane Springs Wash Volcanic Centers in Southern Nevada". The report includes a data analysis section which interprets the results obtained thus far. Work that has been accomplished is related to the ultimate objectives of the contract and work to be done during the next reporting interval is described. The locations of the volcanic center test sites are shown in figure 1.

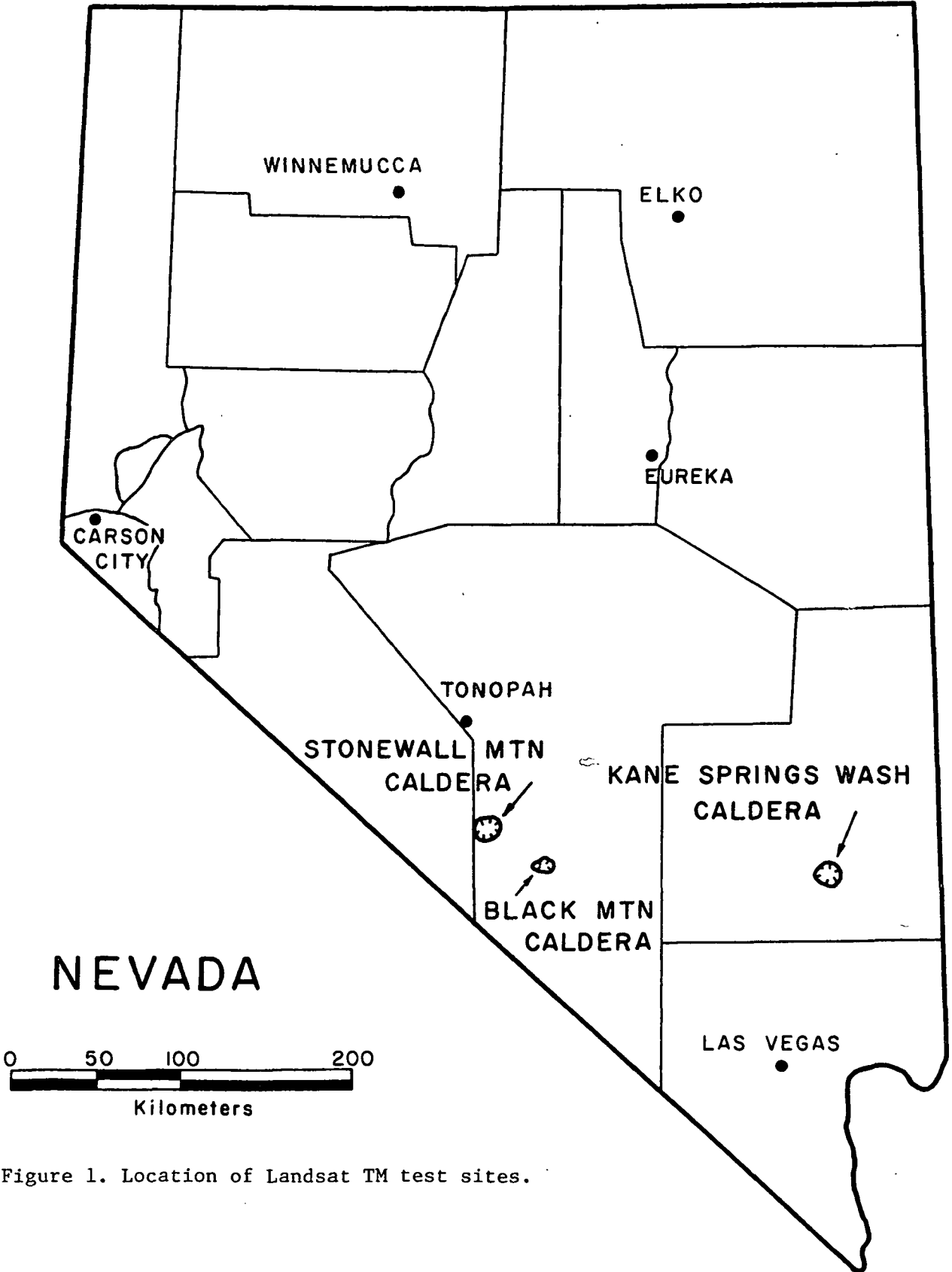


Figure 1. Location of Landsat TM test sites.

WORK ACCOMPLISHED DURING REPORTING PERIOD

During the first six-month period of the contract, approximately thirty percent of the tasks of Phase 1 (as described on page M-4 of the proposal) have been accomplished as scheduled. The tasks include remote sensing data acquisition and preliminary remote sensing data analysis of selected subscenes.

Remote Sensing Data Acquisition

Four Landsat TM scenes in southern Nevada were requested at two different acquisition times in order to assess the effect of vegetation on the signature of the volcanic units. Computer compatible tapes (CCT's), prints, and negative transparencies for seven bands were requested for the following scenes:

Path 39	Row 34	Quadrants 1,3,4
Path 40	Row 34	Quadrants 1,2,3,4
Path 40	Row 33	Quadrants 3,4
Path 41	Row 34	Quadrants 1,2,4

Figure 2 shows the location of the Landsat scenes required for the project area. Table 1 lists remote sensing data that has been received by Mackay School of Mines as of January 15, 1986. Data acquisition is nearly complete, with the primary exception of an August or September scene for Path 41, Row 33, Quadrants 3 and 4.

Data quality of the May and June scenes is good. Cloud cover is less than 10%. Later scenes have not yet been examined.

Remote Sensing Data Analysis

Thematic Mapper data in computer compatible tape form is being analyzed using a VAX 11/780 based ESL IDIMS system at Mackay School of Mines.

Subscene selection

Scenes acquired in May and June were read onto disk and subscenes of key areas of interest were chosen for each volcanic center. The subscenes are 1024 by 1024 pixels in size (29 km by 29 km) and will constitute the initial data upon which further investigations will take place. Figures 3 and 4 show the locations of the Stonewall Mountain, Black Mountain, and Kane Springs Wash subscenes.

Geology of the subscenes

The Black Mountain volcanic center (figures 3 and 5) was mapped by R.L. Christiansen and D.C. Noble in the early 1960's (Noble and Christiansen, 1974), and the stratigraphy of the ash-flow sheetes related to the center, which comprise the

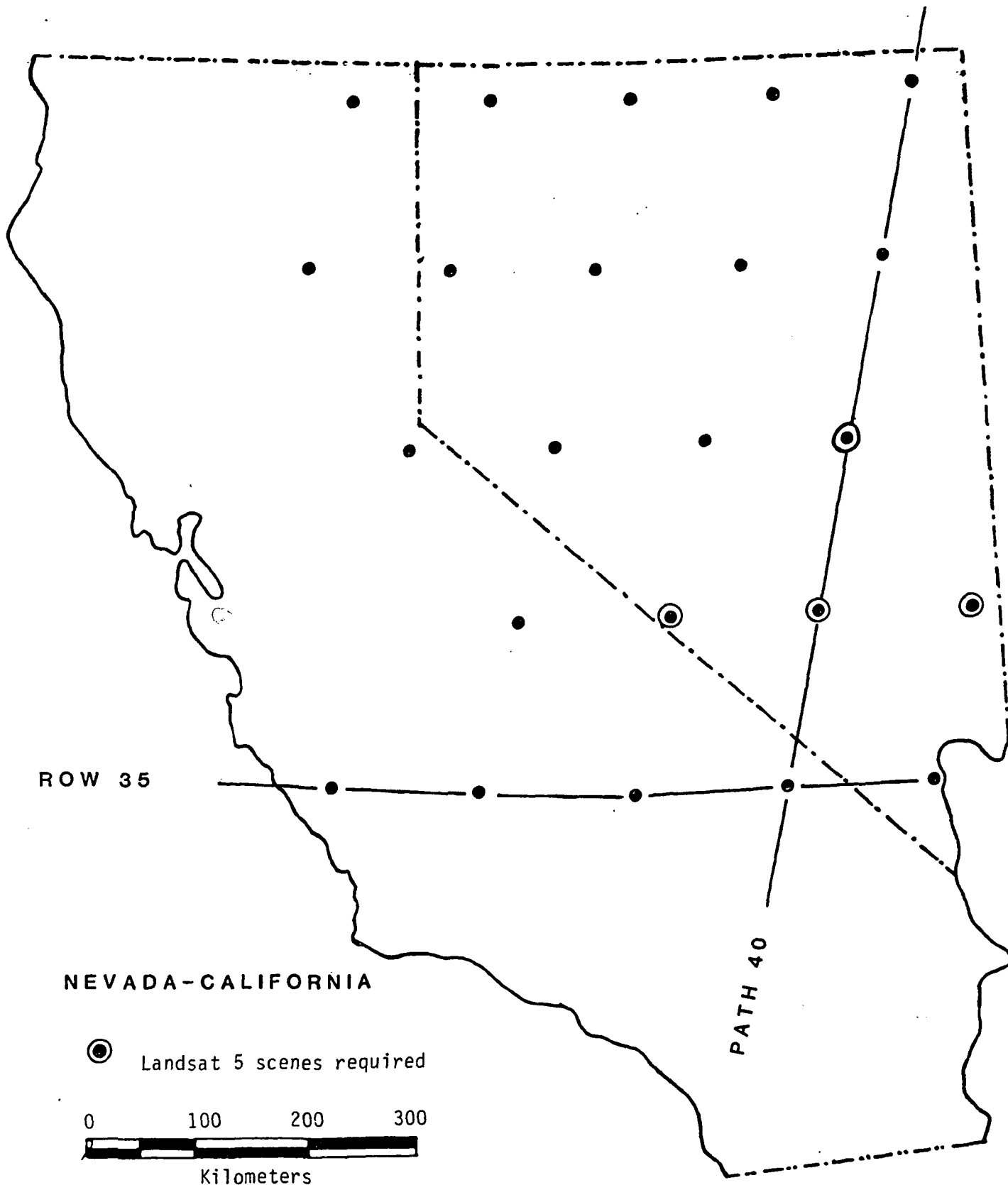
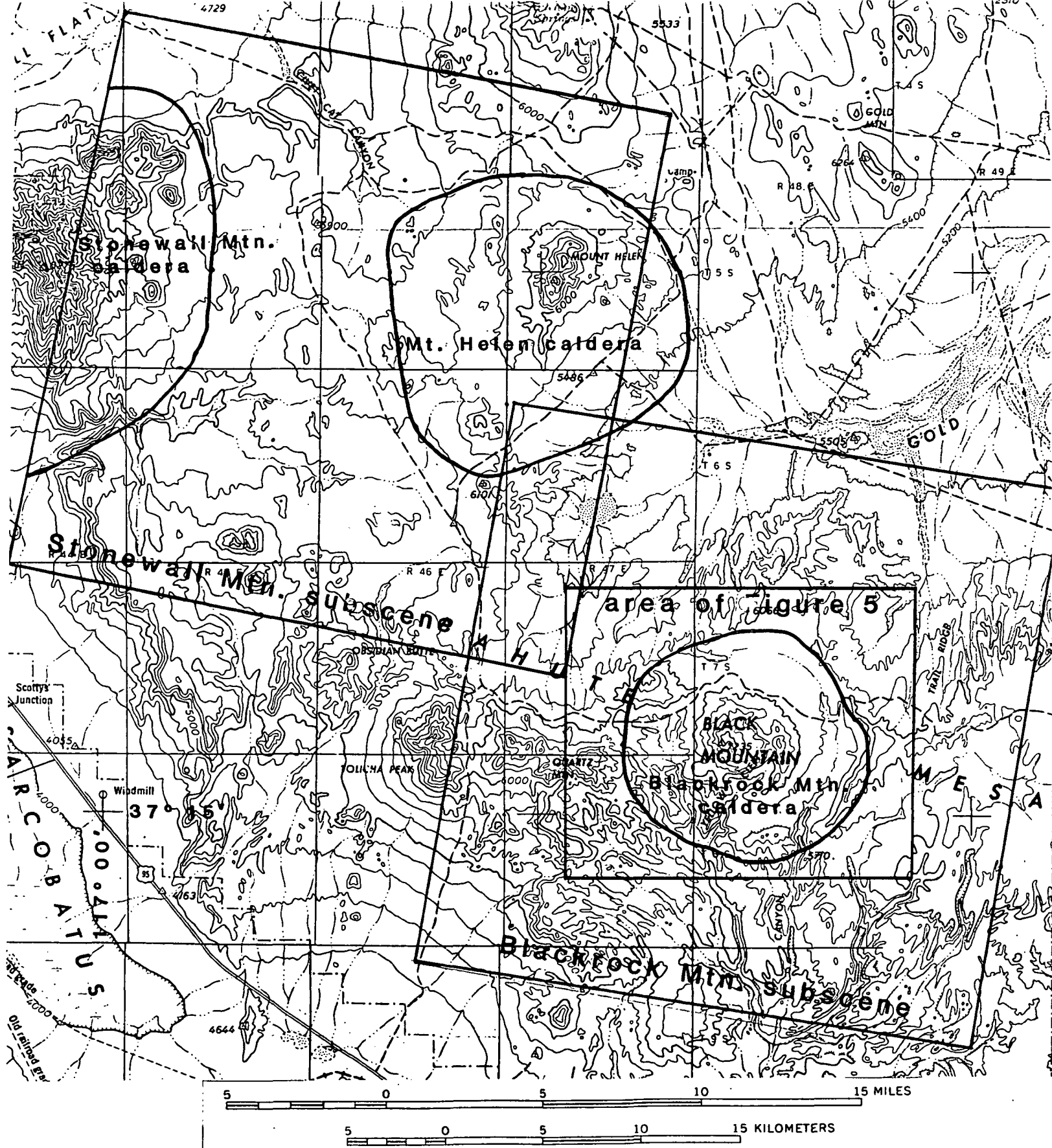


Figure 2. Landsat 5 coverage required for project area.

PATH	ROW	QUADRANT	SCENE ID	DATE OF ACQUISITION	PRODUCT
39	34	1,3,4	50139-17440	July 18,1984	P,T(no band4),N(band 4), B/W print,1:250,000
			50475-17451	June 19,1985	P,N,B/W print,1:1,000,000
			50491-17450	July 5,1985	P
			50539-17444	Aug. 22,1985	P,N
40	33	3,4	50066-17481	May 6,1984	P,N,B/W print,1:250,000
			50466-17512	June 10,1985	P,N
			50482-17510	June 26,1985	N
			50530-17503	Aug. 13,1985	P,N
40	34	1,2,3,4	50466-17515	June 10,1985	P,N
			50482-17512	June 26,1985	P,N
			50530-17510	Aug. 13,1985	P,N
			50546-17505	Aug. 29,1985	P
			50578-17502	Sept. 30,1985	P
			50594-17501	Oct. 16,1985	P
			50562-17503	Sept. 14,1985	P
41	33	3,4	50121-17553	June 30,1984	P,T(bands 3,6),N(bands 1, 2,4,5,7),B/W print,1:250000
41	34	1,2,4	50409-17575	April 14,1985	B/W print,1:1,000,000
			50457-17573	June 1,1985	P
			50473-17573	June 17,1985	P
			50489-17573	July 3,1985	P
			50569-17564	Sept. 21,1985	P,N

Table 1. Landsat 5 TM Data Acquisitions as of January 15, 1986



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Figure 3. Topographic map of part of Nye County, Nevada, showing locations of Stonevall Mountain subscene, Blackrock Mountain subscene, and figure 5 (from Cornwall, 1972).

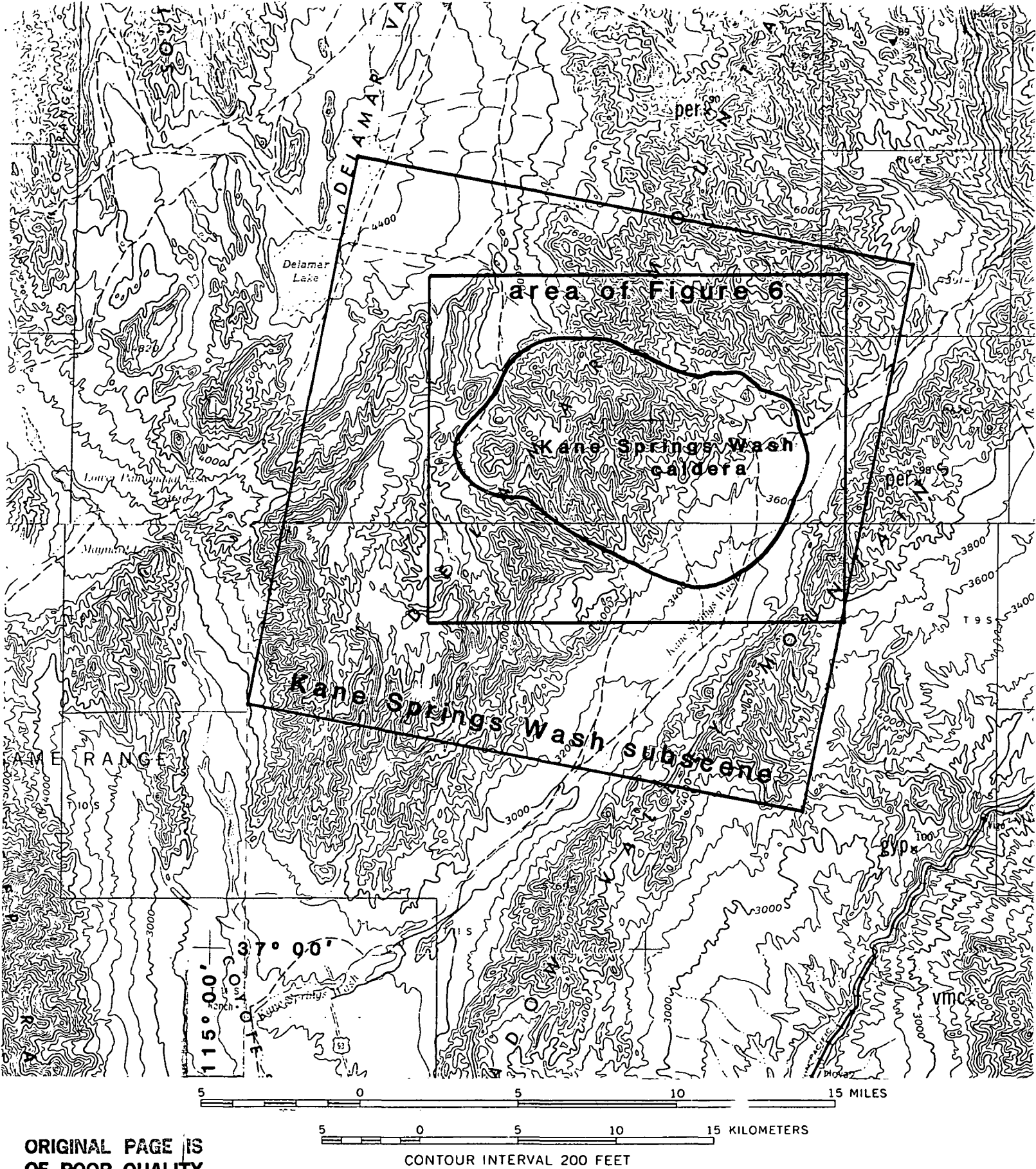
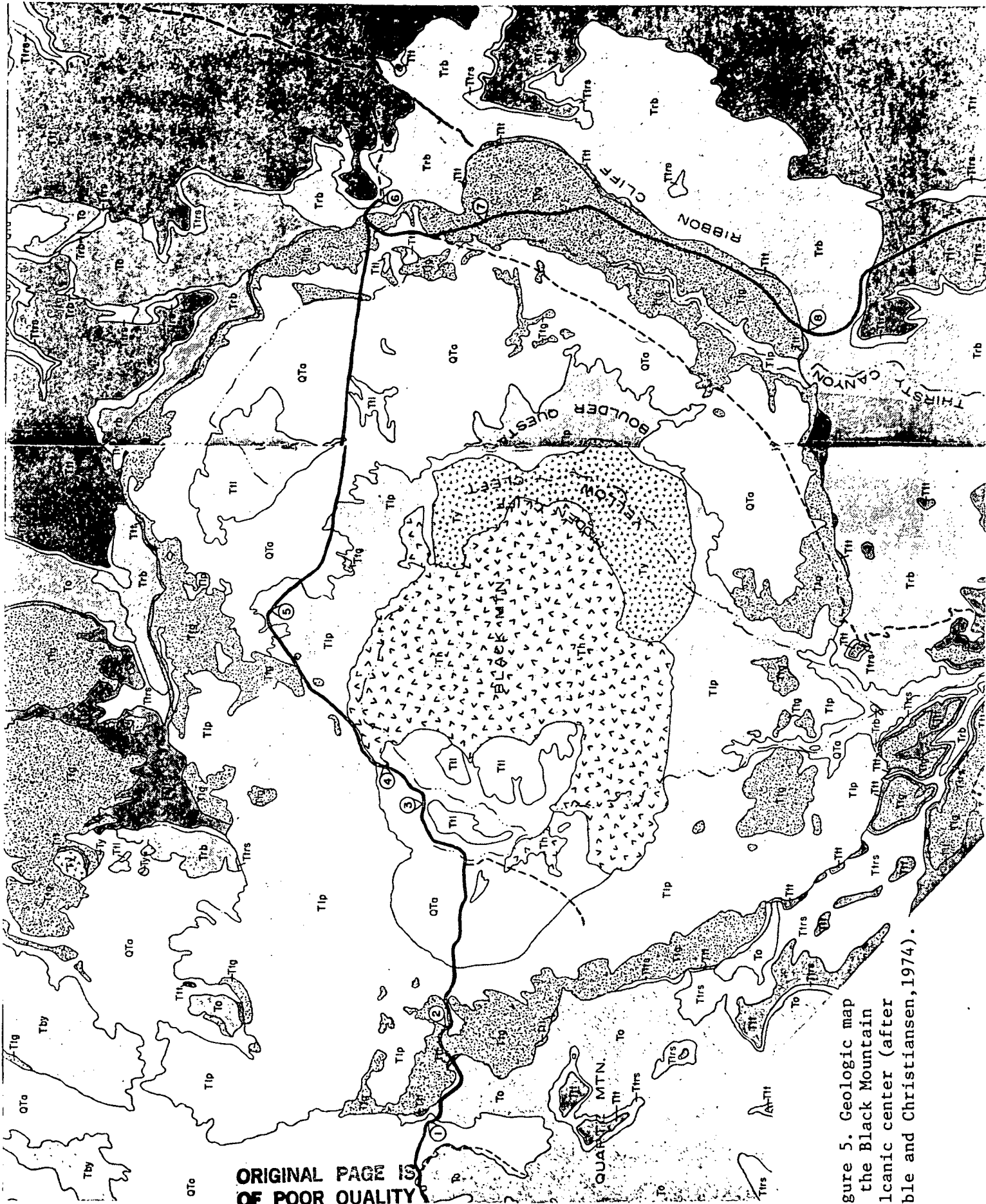


Figure 4. Topographic map of part of Lincoln County, Nevada, showing locations of Kane Springs Wash subscene and figure 6 (from Tschanz and Pampeyan, 1972).



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Figure 5. Geologic map of the Black Mountain volcanic center (after Noble and Christiansen, 1974).

EXPLANATION

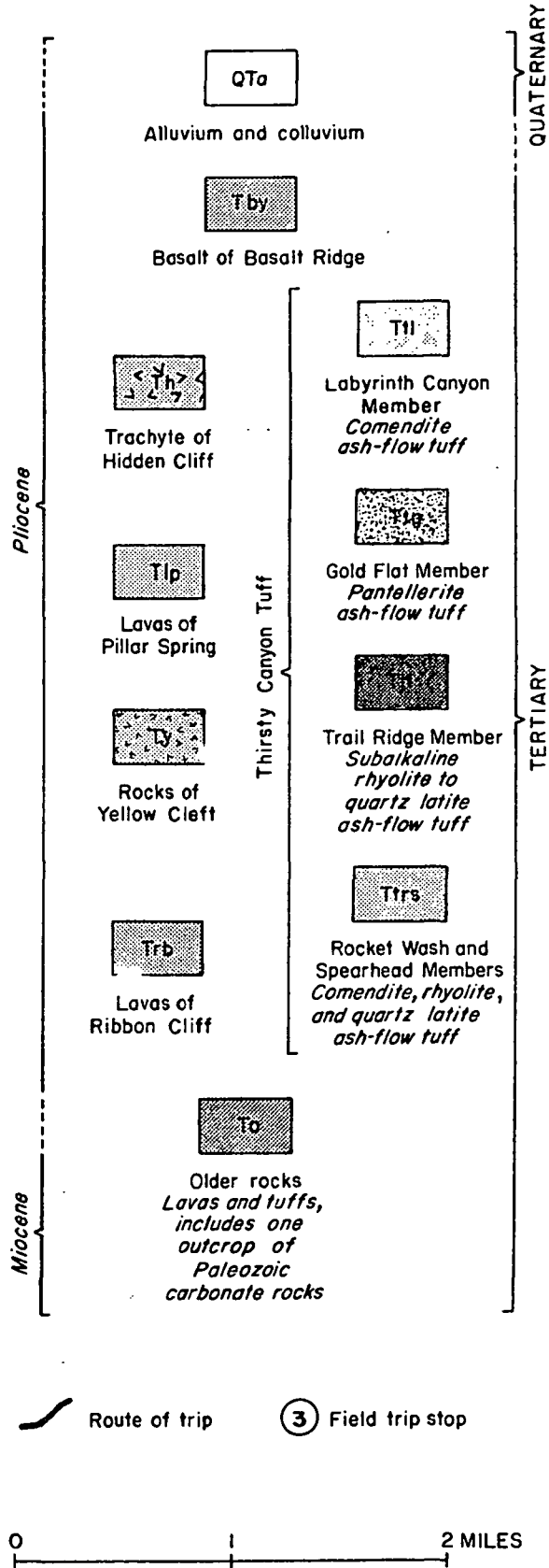


Figure 5. (continued) Geologic map of the Black Mountain volcanic center (after Noble and Christiansen, 1974), explanation.

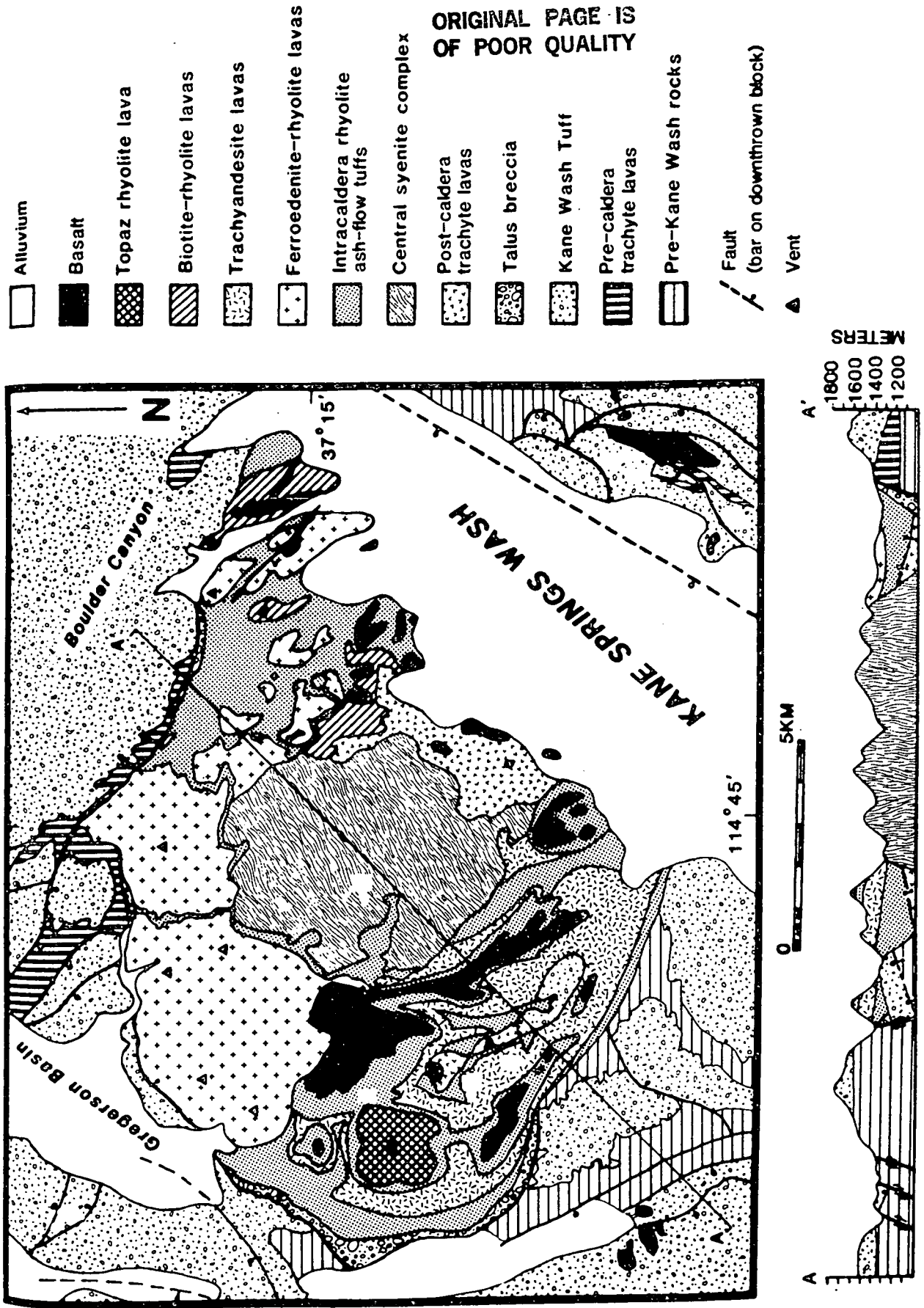


Figure 6. Geologic map and cross section of the Kane Springs Wash volcanic center (after Novak, 1984).

Thirsty Canyon Tuff, has been studied by Noble and other workers (Noble et al., 1964, 1968, 1984). Recent work by Noble, T.A. Vogel, S.I. Weiss, and L.W. Younker (Vogel et al., 1983; Noble et al., 1984; Weiss et al., in ms.) have refreshed our knowledge and added to our understanding of the geology and geochemistry of the center.

Although the Black Mountain center is perhaps the smallest center of collapse-caldera type in the southern Nevada volcanic field, it has a relatively complex documented history and its rocks show an unusually wide range in chemical composition. The four ash-flow sheets range from high-silica rhyolite to iron-rich peralkaline rhyolite (pantellerite - Gold Flat Member of the Thirsty Canyon Tuff, Noble, 1965), the latter containing over six percent total iron. Associated lavas, which have an unusually wide areal extent for a center of this type, range in composition from rhyolite to basalt. Both peralkaline and subalkaline magma types are present, and two of the ash-flow sheets show evidence of strong auto-oxidation during cooling. Available radiometric ages show that the Black Mountain center was active between about 8.5 to 6.5 m.y. ago.

The Stonewall Mountain volcanic center (figure 3) was originally recognized during the early 1960's (Ekren et al., 1971), but its true age and geological relations were only recognized recently. Foley (1978) mapped the intracaldera portion of the center in detail, and presented radiometric ages showing that the center was appreciably younger (about 6 to 8 m.y.) than heretofore believed. More recently, Noble and his coworkers demonstrated that the Stonewall Mountain center was the source of ash-flow units that were previously related to the Black Mountain center, and by precise radiometric dating demonstrated that the center is the youngest (6.3 to about 6.0 m.y.) center of the southern Nevada field (Noble et al., 1984; Weiss, 1984).

The Stonewall Flat center possesses two major ash-flow sheets. The first, the Spearhead Member of the Stonewall Flat Tuff, is composed of remarkably homogeneous, highly differentiated, slightly peralkaline, high-silica rhyolite. The unit should be ideal to evaluate the variations in spectral response resulting from variations in density and degree of welding and in devitrification and vapor-phase crystallization characteristics. In contrast, the upper unit, the Civet Cat Canyon Member of the Stonewall Flat Tuff, shows major variations in chemical composition. Although the bulk of the unit consists of slightly peralkaline high-silica rhyolite, near the Stonewall Mountain center the unit incorporates subunits of trachytic composition within its upper part (Weiss, 1984; Weiss and Noble, 1984).

The Kane Springs Wash volcanic center (figures 4 and 6), located east of the Black Mountain and Stonewall Mountain centers in southeastern Nevada, has been studied by Cook (1966), Noble

(1968), and Novak (1984). Based on the work of Cook and Noble, at least eight distinct ash-flow sheets can be related to the center. These range in composition from iron-poor, subalkaline rhyolite to peralkaline rhyolite containing almost four percent total iron as FeO. In addition to the numerous compositionally distinct ash-flow sheets, a variety of post-caldera units of lava and tuff, ranging in composition from topaz rhyolite to trachyte to basalt are exposed.

Preprocessing

The scenes examined so far are of good quality. Cloud cover is less than ten percent. Striping due to detector calibration is minimal. The added brightness in TM bands 1, 2, and 3 due to Rayleigh scattering is not pronounced and will be corrected only when necessary for certain image transformation techniques such as ratioing. Effects of water vapor absorption on TM bands 4, 5, and 7 appears to be negligible for the purpose of this study.

Image enhancement

To improve the ability to discriminate cover differences, the images were contrast enhanced. For each subscene, histograms for each band were examined prior to enhancement. Linear contrast stretches were applied to each band to expand the original gray level range to fill the dynamic range of the display. Care was taken to keep saturation at both extremes of the output range to less than one percent.

Image transformation

To maximize the display of spectral differences between bands, ratios were performed using several different band combinations. The ratios included bands 3/1, 4/1, 3/2, 5/1, 4/2, 7/5, and 5/7. Linear contrast stretches were applied to enhance the band ratios.

Image interpretation

Visual comparisons were made of images enhanced by contrast stretches and transformed by band ratios. Simple linear contrast stretches of individual bands appear to be superior for discriminating image features. Band ratios 3/1, 5/1, and 7/5 may also be useful in discriminating certain features. Band 3 (stretched) images of the Stonewall Mountain, Black Mountain, and Kane Springs Wash subscenes are shown in figure 7. Band ratios 3/1 and 5/1 (stretched) of the Kane Springs Wash subscene are shown in figure 8.

Comparison of the images in figures 7 and 8 with the detailed geologic maps in figures 5 and 6 reveal that many volcanic rock units are distinguishable using relatively simple image processing techniques. In particular, different tuff members of the Thirsty Canyon Tuff (Black Mountain subscene), and the Kane Wash Tuff (Kane Springs Wash subscene) appear to be separable on the images. Also, post-caldera basalts and rhyolites

Figure 7. Landsat 5 TM subscenes of Stonewall Mountain,
Blackrock Mountain, and Kane Springs Wash
(band 3, stretched).

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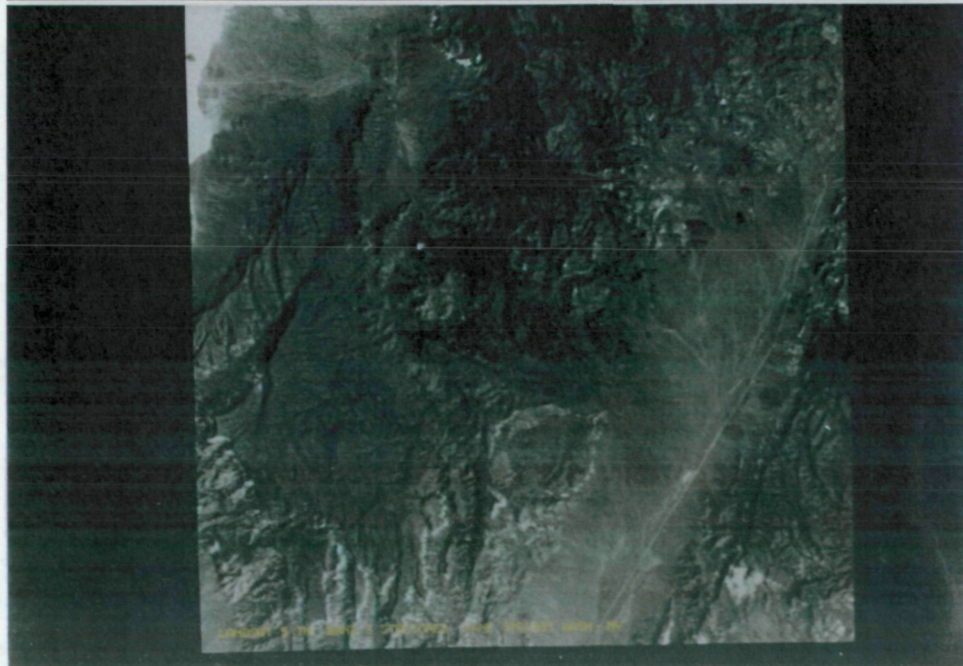
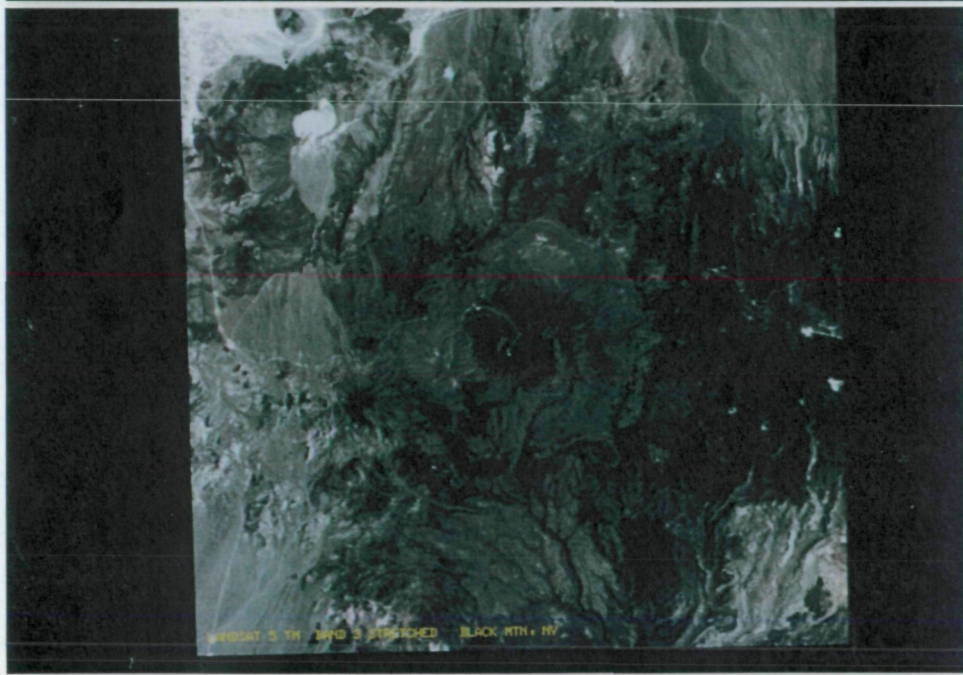
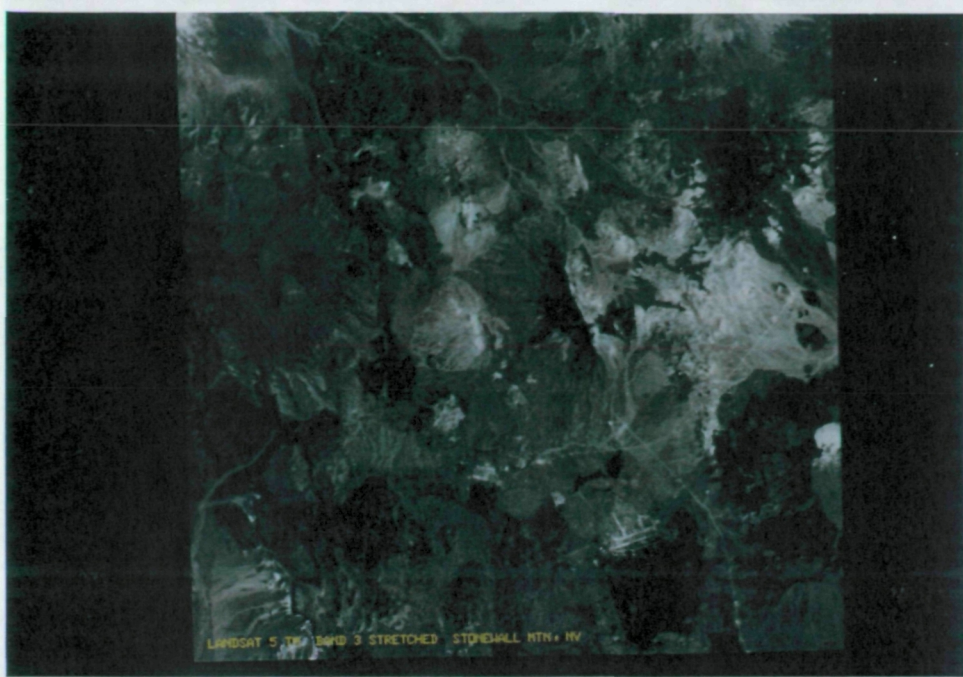
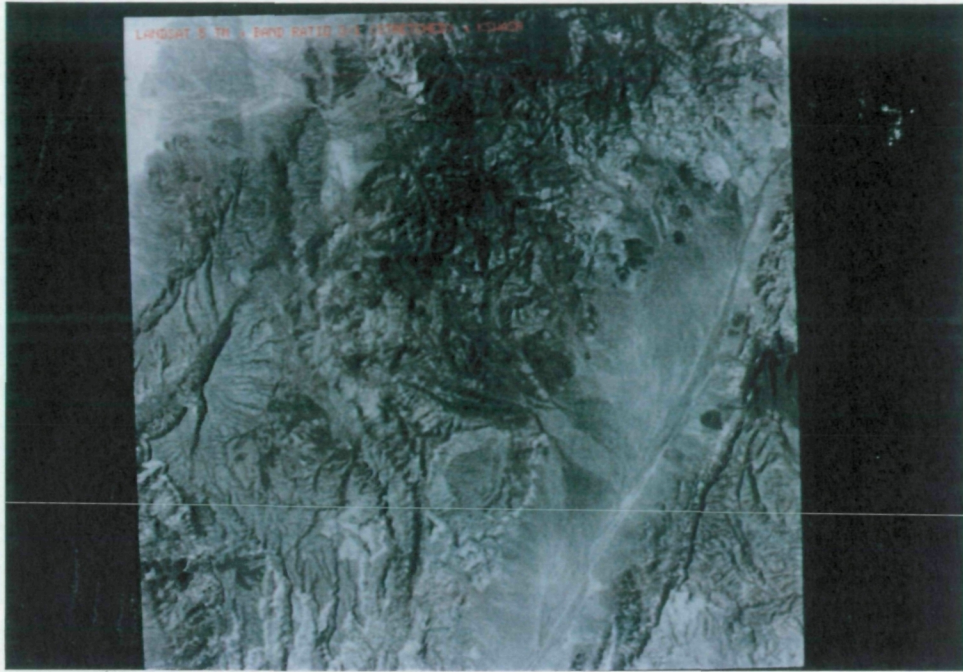


Figure 8. Landsat 5 TM subscene of Kane Springs Wash
(band ratios 3/1 and 5/1, stretched).

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within the Kane Springs Wash caldera are easily distinguished from each other and the surrounding rocks.

We are currently investigating other image processing methods to allow better delineation of areas with distinct spectral characteristics, such as principal component transformation and classification techniques.

Conclusions

The remote sensing data acquisition and analysis portions of Phase 1 of the project are nearly completed. The Landsat TM data is of good quality, and image analysis techniques are so far successful in delineating areas with distinct spectral characteristics. The correlation of these spectrally distinct areas with variations in surface coatings and lithologies of the volcanic rocks is the purpose of this research project.

PROGRAM FOR THE NEXT REPORTING INTERVAL

During the next six months (January - July, 1986), we plan to complete the remote sensing data analysis and begin field work and laboratory analysis of samples. Field work will concentrate on the nature of surficial coatings and weathering rinds and the relation of the coatings to different volcanic rock units. Samples of both the surface coatings and whole-rocks will be collected for analysis. The Phase 1 field work will be done within the area of the subscenes we have selected.

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