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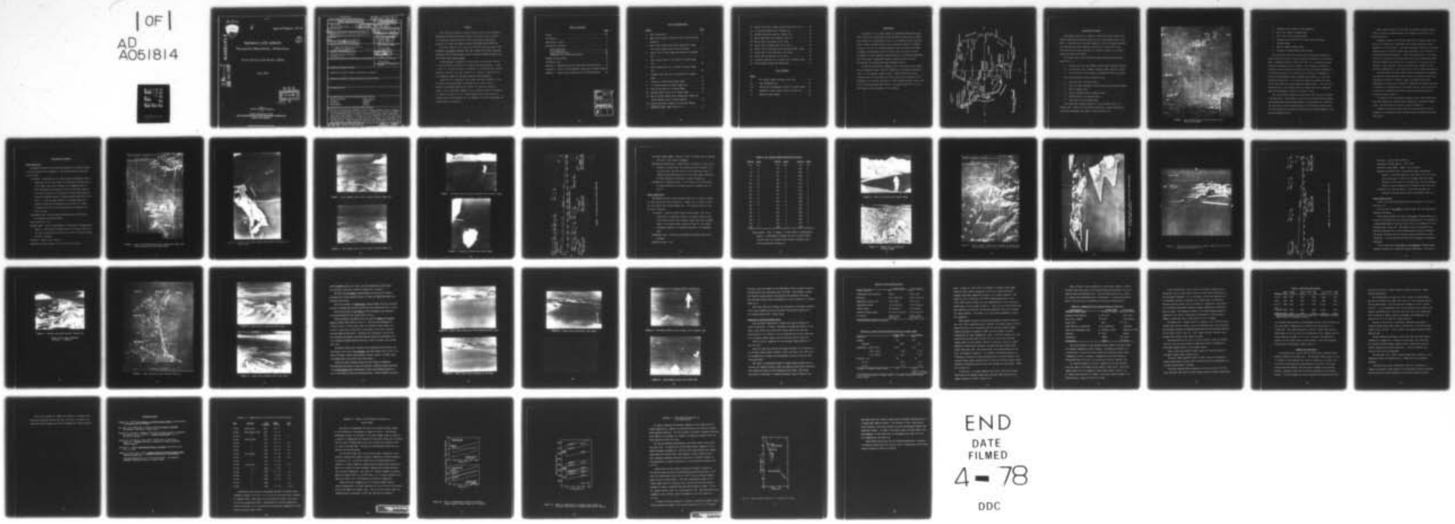

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RUNWAY SITE SURVEY

Pensacola Mountains, Antarctica

Austin Kovacs and Gunars Abele

June 1977

Prepared for
NATIONAL SCIENCE FOUNDATION
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Two blue ice areas were surveyed in the Pensacola Mountain region of Antarctica and found suitable for runway sites. A length of 2.5 to 3 km, oriented in the predominant wind direction, is available at Rosser Ridge, requiring very little snow removal. A length of 3 km, oriented at 30° to 45° with the predominant wind direction, is available at Mt. Lechner, but considerable snow removal would be required, and some obstacles are present near both ends of the runway area. Aerial inspection disclosed one and probably two more suitable sites near the Patuxent Range.

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<u>Preface</u>

This report was prepared by Austin Kovacs, Research Civil Engineer, Foundations and Materials Research Branch, and Gunars Abele, Research Civil Engineer, Applied Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory.

The work covered by this report was performed under National Science Foundation Interagency Agreement NSF CA95, Runway Site Survey, Pensacola Mountains, 1973-74 United States Antarctic Research Program Project S-37, Price Lewis, NSF Project Manager.

George Erlanger, Geophysical Survey Systems Incorporated, assisted in the field work and operated the crevasse detection equipment. Arthur B. Ford, U.S. Geological Survey, accompanied the field party and conducted geological studies of the sites visited. Dr. William D. Hibler III and Floyd Kugzruk, CRREL, did the power spectral density analysis.

Appreciation is expressed to the Holmes and Narver personnel of the Field Party Processing Center at McMurdo and the flight crews of Antarctic Development Squadron Six (VXE-6) for excellent logistics support; and to Lieutenant Commander John A. Mattson, Project Coordinator, U.S. Navy, the staff of the U.S. Naval Support Force, Antarctica, and the NSF staff at Christchurch, N.Z. and McMurdo, for their cooperation and support during this project.

Table of Contents

List of Illustrations

List of Tables

Introduction

An analysis of the overall Antarctic logistics program (Day *et al.*, 1973) showed that the National Science Foundation would realize certain cost benefits if a significant portion of its present logistic load were flown in large, wheeled aircraft via the Argentine Station on Seymour Island to a site in the Pensacola Mountains and from there distributed by smaller, ski-equipped aircraft to Pole, Siple and other stations. In addition, a major research program planned for the Pensacola Mountains area will require considerable logistics support which could most economically be achieved using heavy wheeled aircraft.

During the latter part of January 1974, a survey and aerial inspection of potential runway sites was conducted in the Pensacola Mountains (Fig. 1). The specific objective was to locate sufficiently large, suitable areas of blue glacial ice which could, with a minimum of site preparation, be used for operations of heavy wheeled aircraft, such as the C-141 (or proposed stretched version), new cargo Boeing 747, and C-5A. This report covers the results of that survey.

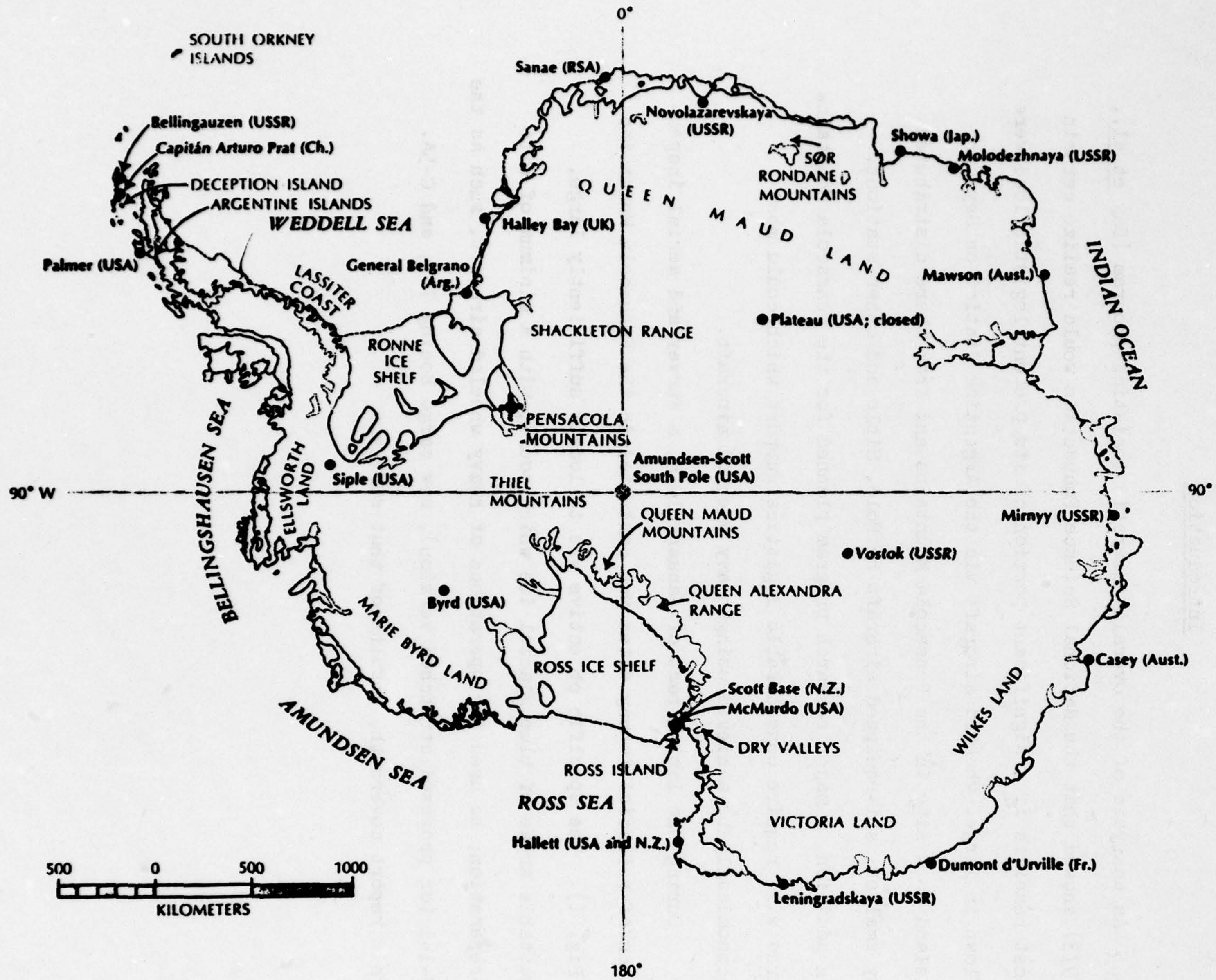

FIGURE 1. Map of Antarctica

Description of Study

Preliminary selection of a number of potential runway sites in the Pensacola Mountains region was made from aerial photographs taken in the 1960's. Three specific sites that appeared to have the highest potential were selected for ground inspection and survey; several other areas were selected for aerial inspection to determine whether or not ground inspection would be warranted.

The three primary sites selected for more detailed ground survey were (Fig. 2):

1. An area north of Rosser Ridge, Cordiner Peaks (82°46'S, 53°40'W)
2. An area west of Mt. Lechner, Forrestal Range (83°15'S, 51°14'W)
3. An area north of Davis Valley, Dufek Massif (82°26'S, 51°05'W)

The sites selected for arial inspection were:

1. Near Gray Hill, Forrestal Range
2. East of Torbett Escarpment, between Neptune and Forrestal Ranges
3. West of Schmidt Hills
4. West of Schneider Hills, Argentina Range
5. Several areas in the Neptune Range
6. Some areas in the Patuxent Range

The field party departed McMurdo in a ski-equipped C-130 on 18 January 1974. Enroute to the Pensacola Mountains, aerial observations, including photography, were made of the following sites:

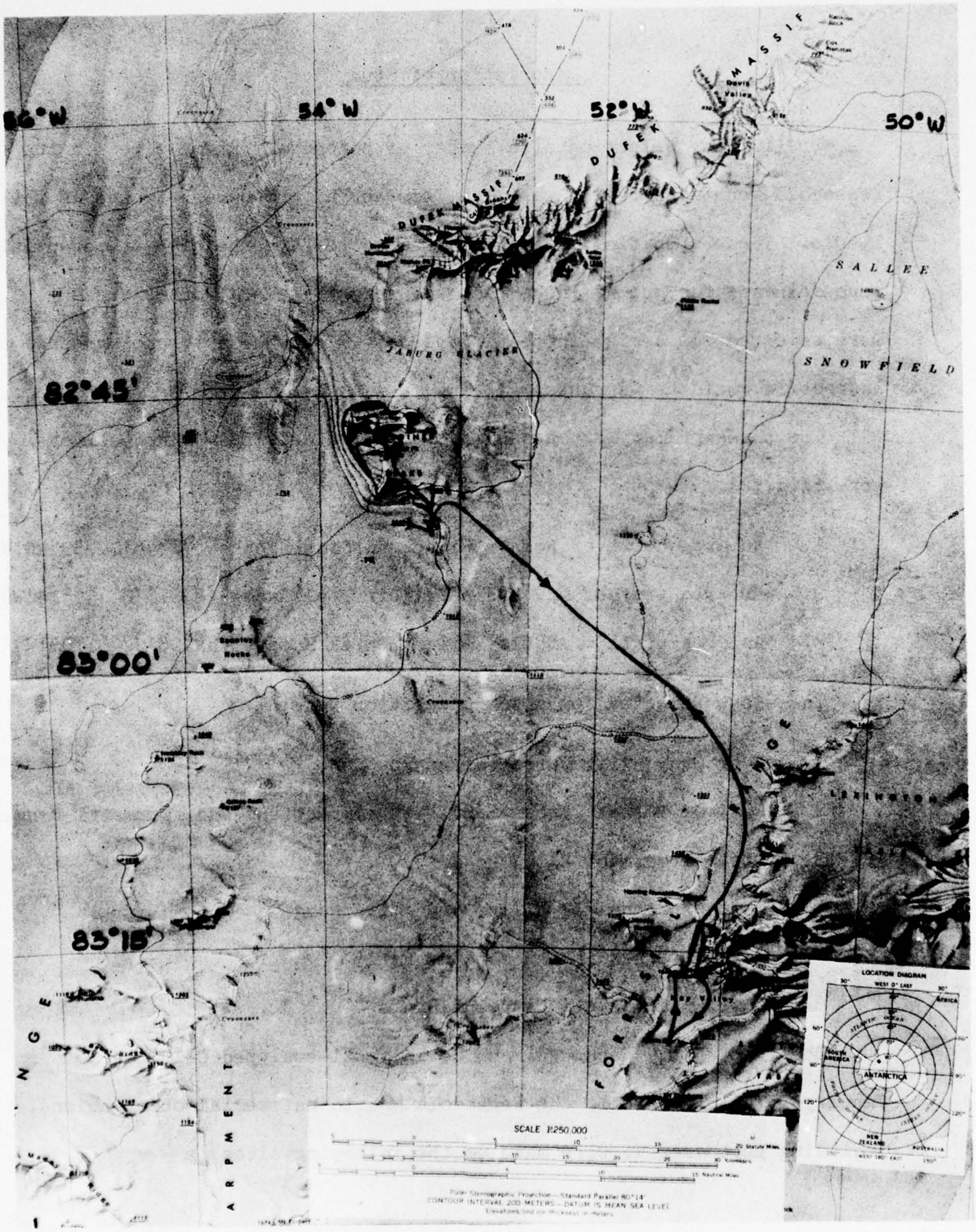

FIGURE 2. Map of field party's traverse routes in the Pensacola Mountains

1. Northeast of Mt. Walcott, Thiel Mountains

2. East of Mt. Wanous, Patuxent Range

3. East of Mt. Cross, Patuxent Range

4. Southwest and northwest of Mt. Bruns and Mt. Whillans, Patuxent Range

5. Near Mt. Hawkes, Neptune Range

6. Northwest of Hannah Ridge, Neptune Range

The put-in site (also the pick-up site), dictated by weather and terrain conditions, was in a snow-covered area southeast of the Cordiner Peaks, coordinates 82°53'S, 53°12'W (see Fig. 2). An automatic weather station was installed at this location. Air temperature, barometric pressure, and wind velocity and direction will be recorded automatically at 6-minute intervals for a 1-year period, providing a comprehensive record of meteorological data, including total snowfall, in this area during the coming year. It will also be possible to obtain some idea of the cloud cover once a day during the summer season. A snow pit was excavated next to the weather station to observe the snow accumulation pattern and temperature profile to a depth of 4.4m.

The site at Rosser Ridge was visited first, the site at Mt. Lechner a few days later. After aerial inspection of the Jaburg Glacier between the Cordiner Peaks and the Dufek Massif, it was decided not to travel to the Davis Valley site by ground because of the extensive crevasses seen in the area which would subject the field party to extreme danger on the possible approach routes.

Travel was done with a Volvo BV-202, articulated, tracked oversnow vehicle on which a crevasse detector was installed, and with two snow mobiles (Ski-Doo).

Topographic survey of the Rosser Ridge and Mt. Lechner runway sites was done to determine the longitudinal and lateral grade and surface roughness of the ice surface. The survey procedure consisted of elevation readings along the selected 1500-m long centerline at 30-m intervals for longitudinal grade determination. Every few hundred meters, a 30-m-long section was selected for more detailed surface relief measurements where elevation readings were obtained at 1-m intervals. At each end and the midpoint of the centerline, elevation readings were obtained at 30-m intervals perpendicular to the centerline for lateral grade determination.

The approximate available runway length was determined, photographs were taken and observations were made on the ice surface and snow cover conditions, presence of crevasses, signs of potential melt holes, predominant wind direction, suitability of approach and takeoff (presence of obstacles), and feasibility of the nearby area for camp construction. A record of air temperature and wind conditions was kept during the traverse and survey (App. A).

In addition to the specifically selected sites, other nearby areas were also inspected to evaluate their feasibility as potential runway sites. The field party's traverse is shown in Figure 2.

During the field activities, data were also obtained on the performance of a potentially useful crevasse detection system (Kovacs and Abele 1974).

Description of Results

Rosser Ridge Site

The general location of the surveyed runway site is shown in Figure 3, and in an aerial view in Figure 4. The characteristics of the site are as follows:

Ice Surface: microrelief up to a few cm high, no prominent cracks, relatively free of snow, extent of snow dunes or patches (up to 15 cm. high) can be seen in Figure 5 (a snowmobile trail at left, footsteps in the center), view is to the east; Figure 6 is a view to the west; at the east end of the survey area the surface is slightly rougher ("cupped" surface) and free of snow (Fig. 7). Some crevasses appear at the surface some 500 m beyond the east end of runway survey area (Fig. 8). These crevasses run in a NE to SW direction and are generally less than 1 m wide.

Predominant wind: from the east (determined from drift patterns and observations during survey).

Runway direction: E-W.

Terrain grade: (Fig. 9) approximately + 0.6% toward E (longitudinal), approx. + 1.0% toward N (lateral) for most of area, 1.7% at the east end; ice surface relief profile is shown in eight 30-m-long sections in Figure 9.

Elevation: approx. 800 m (2600 ft).

Temperature (during survey): -12° to -6°C (10° to 22°F).

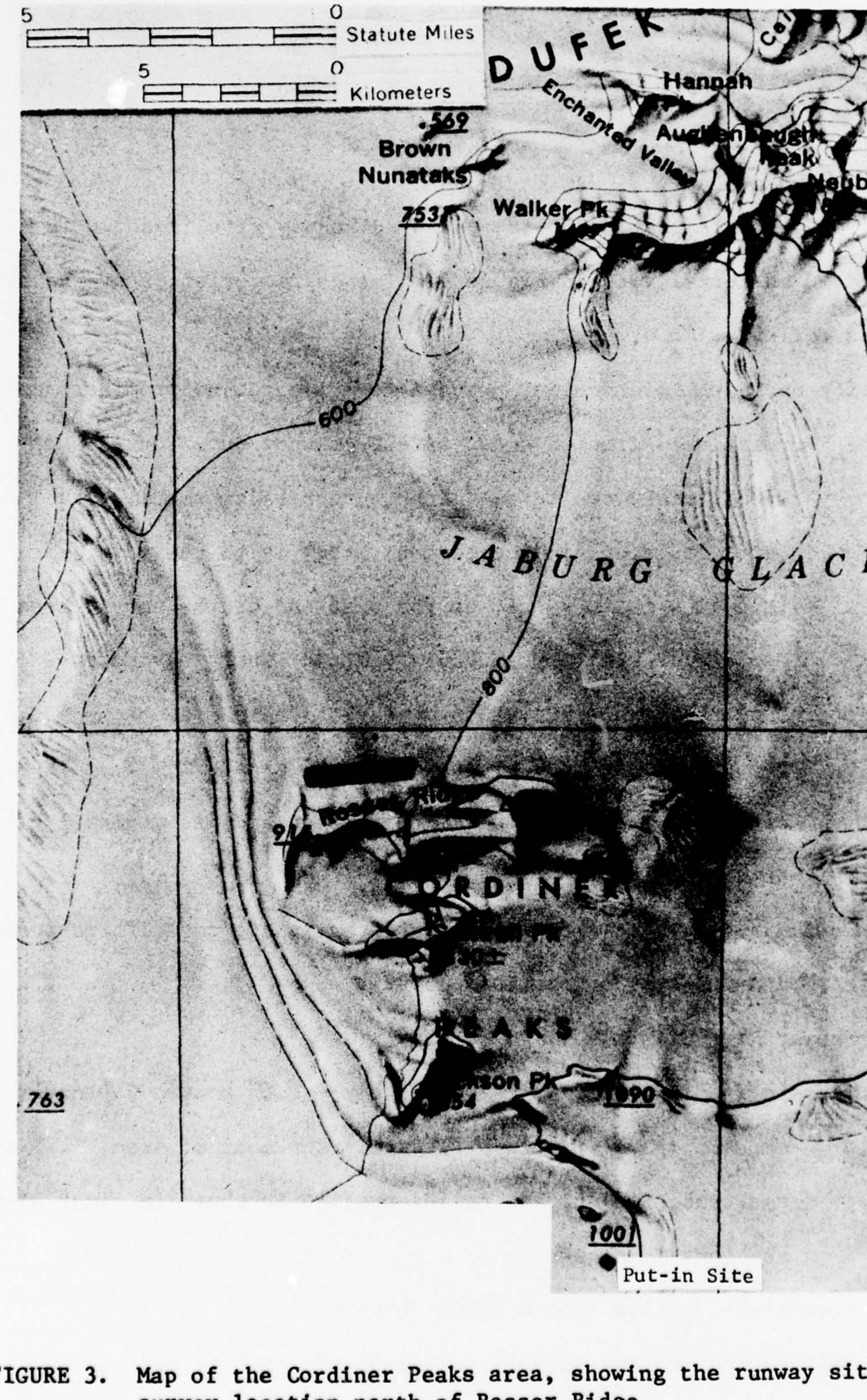

FIGURE 3. Map of the Cordiner Peaks area, showing the runway site survey location north of Rosser Ridge.

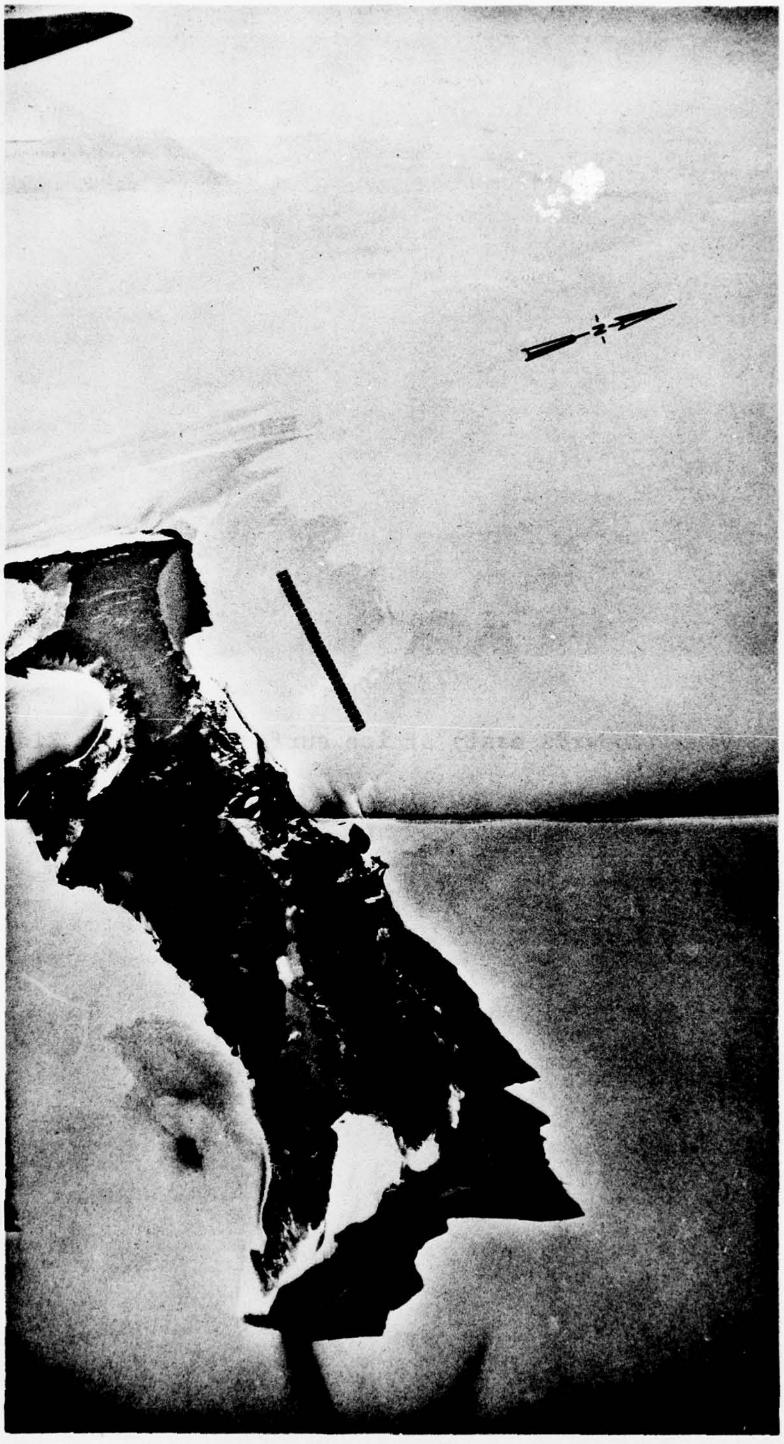

Figure 4. Aerial view of Rosser Ridge and location of surveyed site (dashed line).

FIGURE 5. View (towards east) of ice surface at Rosser Ridge site

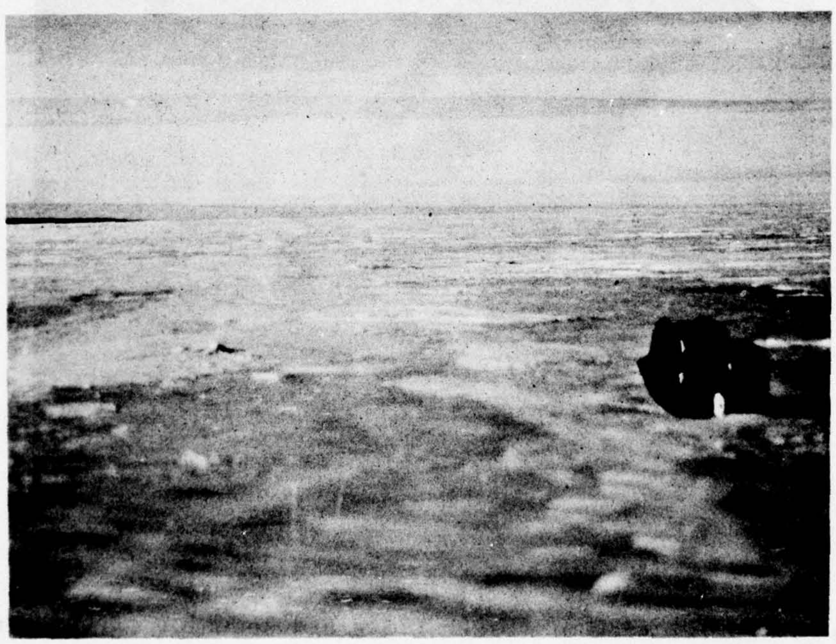

FIGURE 6. View (towards west) of ice surface at Rosser Ridge site

FIGURE 7. Crevasses near east end of surveyed site at Rosser Ridge

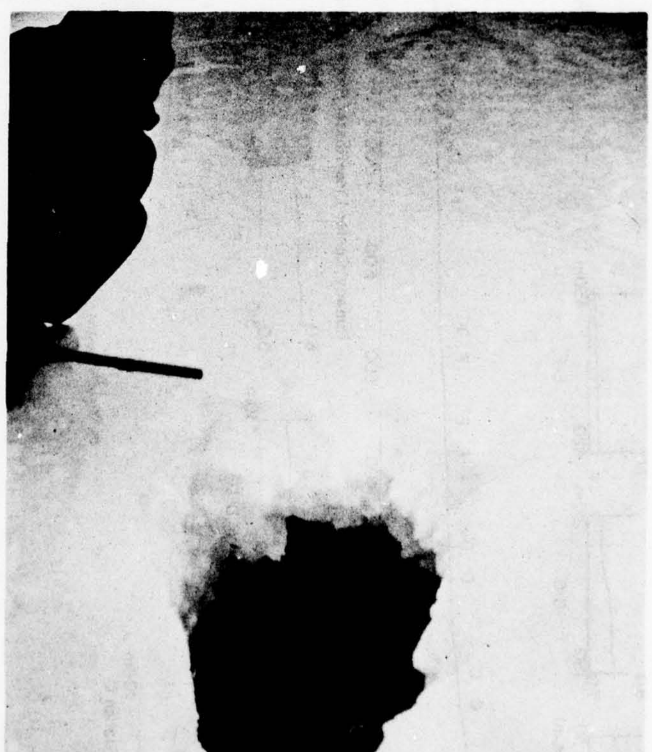

FIGURE 8. Closeup of crevasse near Rosser Ridge

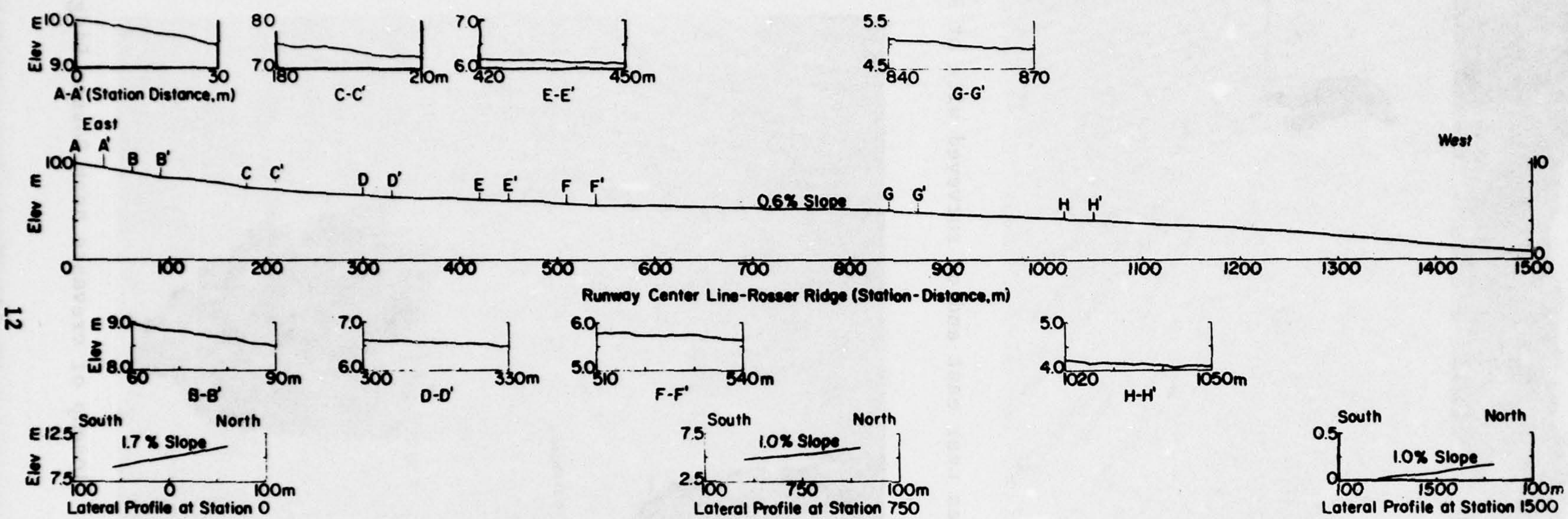

FIGURE 9. Ice surface profile at Rosser Ridge site

Available runway length: approx. 2.4 km (1.5 miles); may be extended with aid of snow removal equipment.

Approach and takeoff area: Rosser Ridge (7 km long) is south of and parallel to runway (Fig. 4); centerline can be oriented to be no closer than 1 km from the toe of the mountains, crest of ridge and high peaks being 2 km or more from runway centerline; no other obstacles on approach or takeoff flightline.

Suitability for camp facilities: at the north toe of the mountain are some relatively level areas; gravel is abundant (Fig. 10 and 11).

Mount Lechner Site

The general location of the surveyed runway site is shown in Figure 12, and in an aerial view in Figure 13. Figure 14 is an aerial view of the north end of the surveyed runway site. The characteristics of the site are as follows:

Ice surface: smoother terrain than at Rosser Ridge, very little microrelief, no prominent cracks, ice skating possible, snow cover more extensive than at Rosser Ridge, mean snow thickness approx. 4 cm. along runway centerline (Table I), snow depth increasing towards W, no crevasses observed in the immediate area.

Predominant wind: from east and northeast (determined from drift patterns).

Runway direction: N-S.

TABLE I. Mt. Lechner runway centerline snow cover

Station (m)	Depth (cm)	Station (m)	Depth (cm)	Station (m)	Depth (cm)
0	0	510	9	1020	2
30	7	540	0	1050	6
60	16	570	18	1080	0
90	15	600	1	1110	0
120	15	630	17	1140	0
150	20	660	11	1170	1
180	15	690	0	1200	6
210	15	720	6	1230	0
240	11	750	4	1260	0
270	13	780	12	1290	0
300	15	810	0	1320	0
330	0	840	8	1350	1
360	0	870	4	1380	3
390	2	900	0	1410	0
420	5	930	4	1440	7
450	0	960	0	1470	0
480	4	990	9	1500	0

Terrain grade: (Fig. 15) approx. + 0.75% toward S, (longitudinal), approx. + 1.0% toward W (lateral) for most of area, 2.3% at the north end; ice surface relief profile is shown in four 30-m long sections in Figure 15.

FIGURE 10. View of the north toe of Rosser Ridge

Figure 11. Moraine till at north toe of Rosser Ridge.

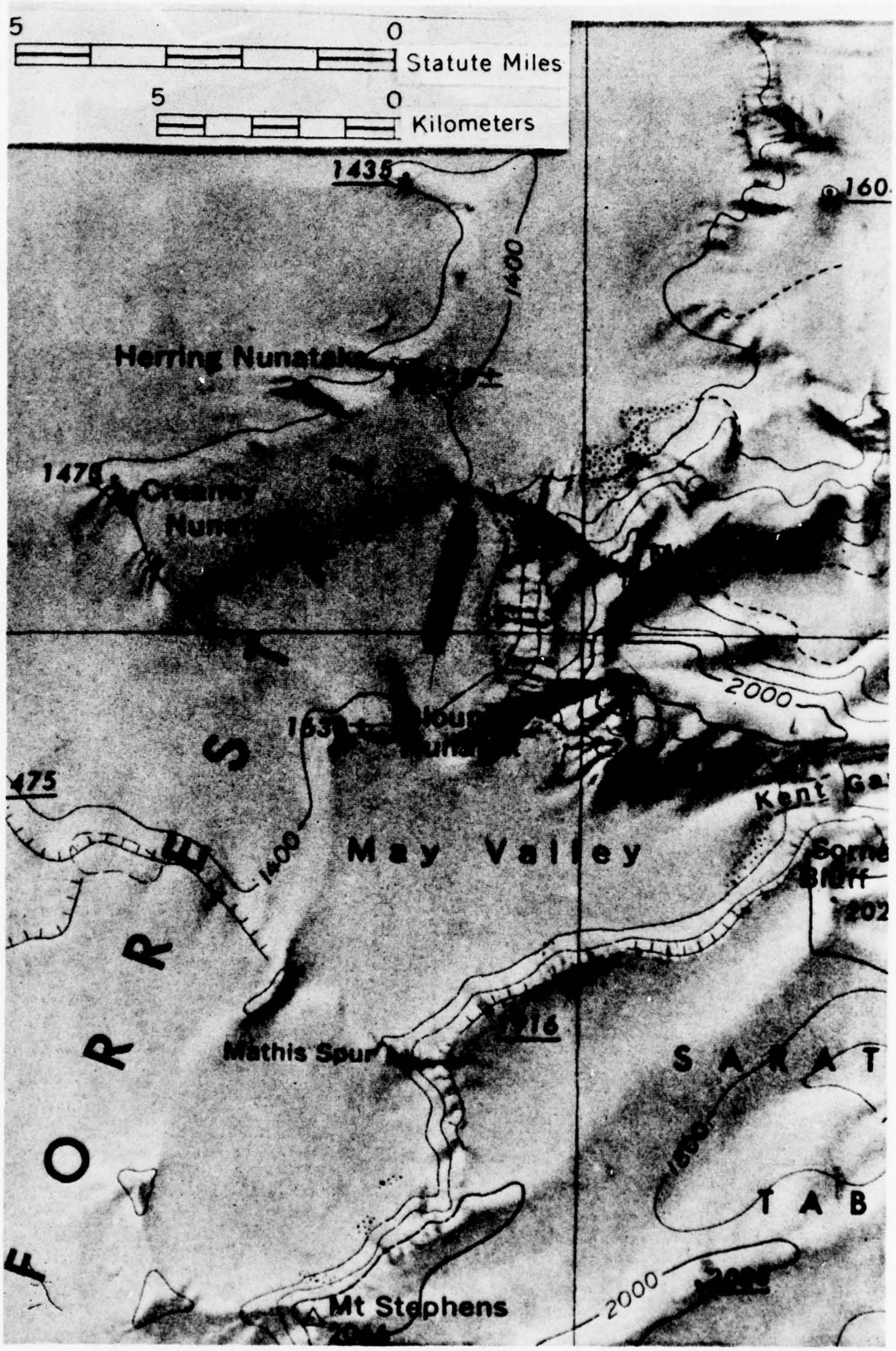

Figure 12. Map of the Mt. Lechner area, showing the runway site survey location (solid line) north of Blount Nunatak.

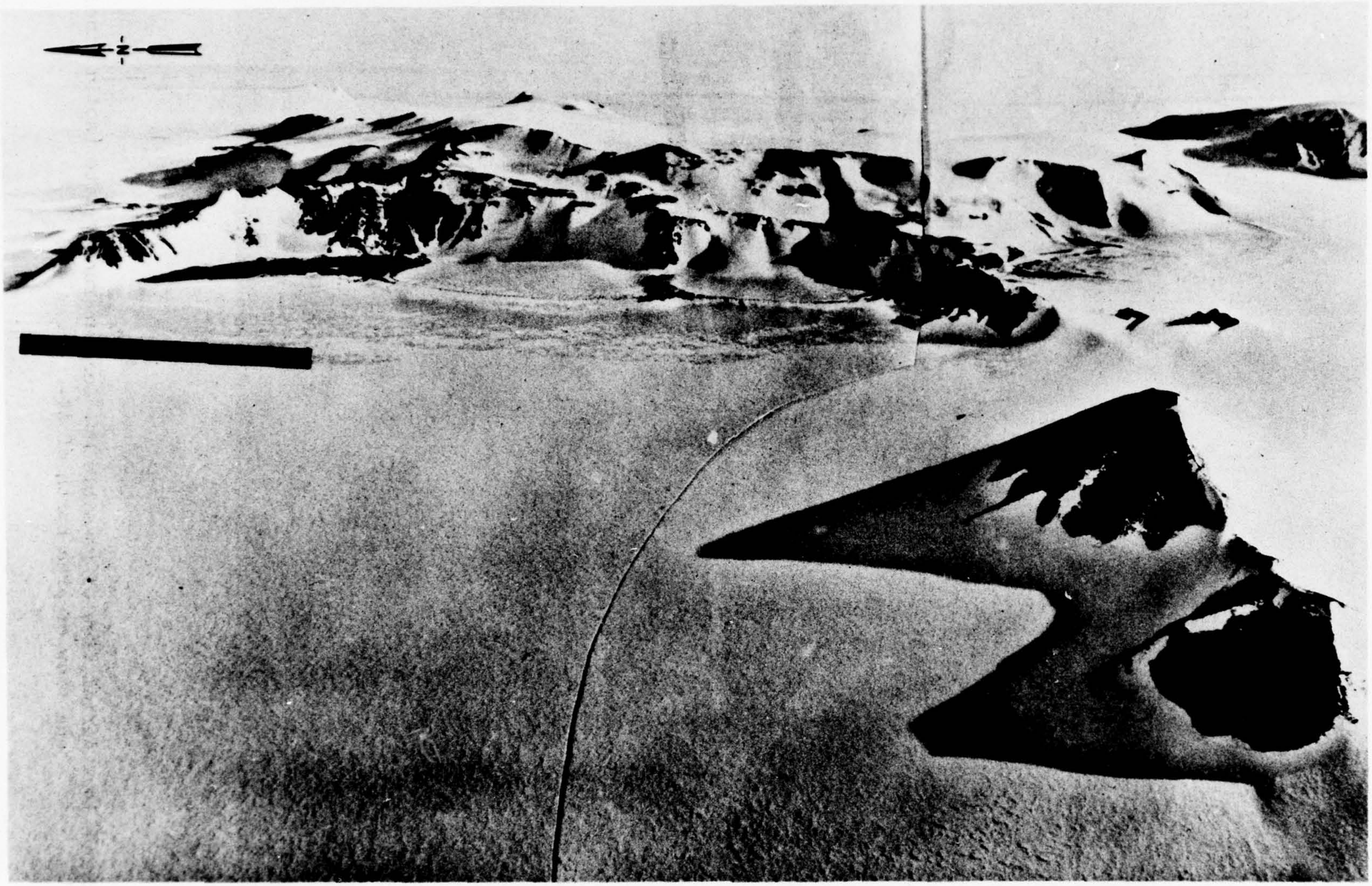

FIGURE 13. Aerial view of Mt. Lechner site and area (Blount Nunatak at lower right) south of it

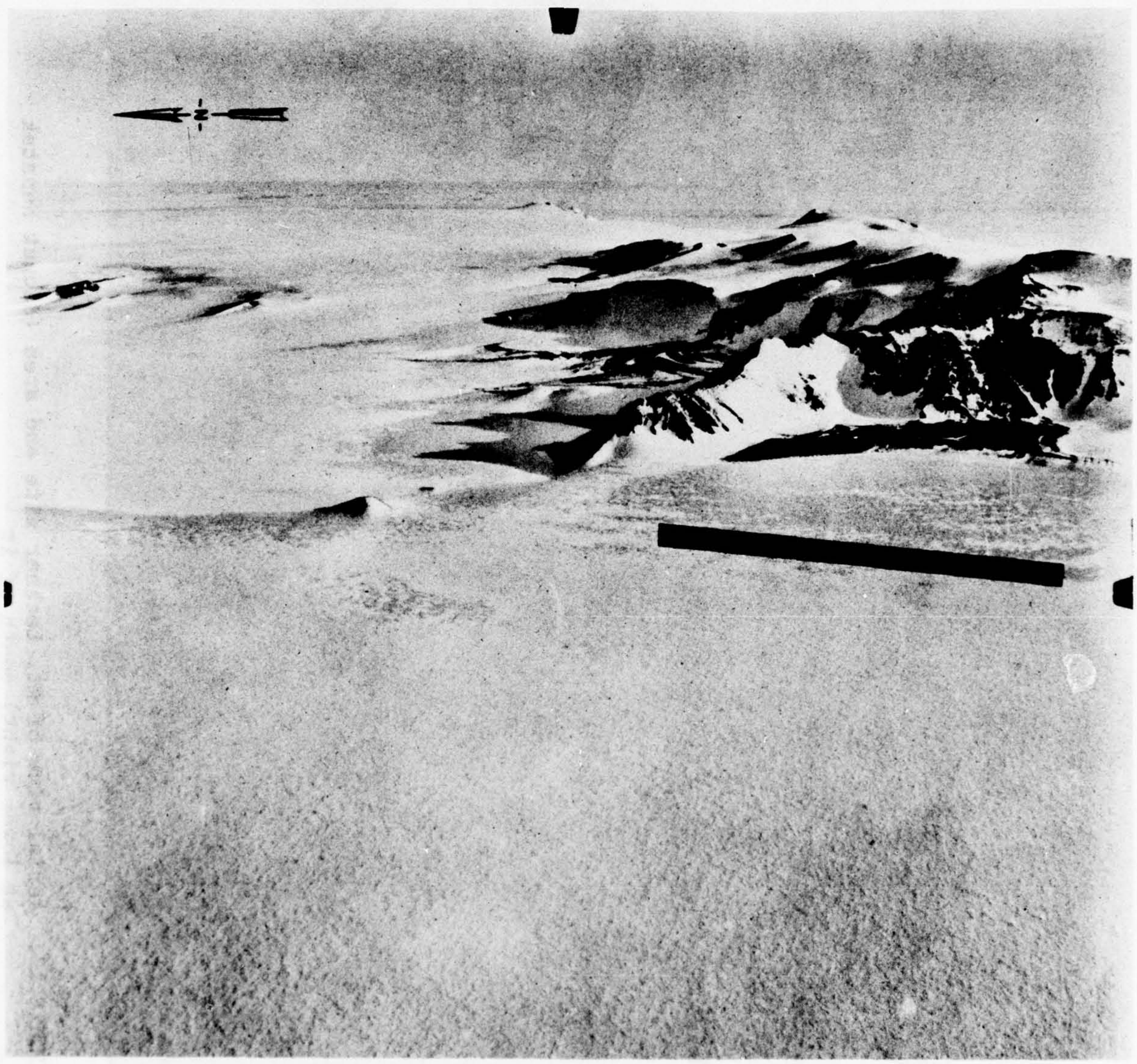

Figure 14. Aerial view of possible Mt. Lechner runway site (solid line) and view of area north of it.

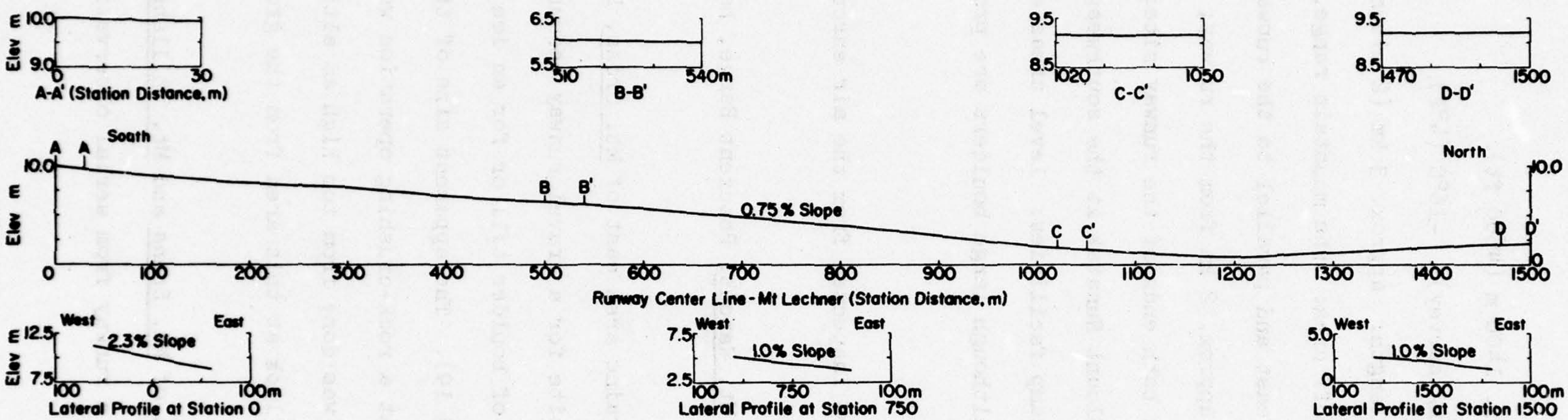

FIGURE 15. Ice surface profile at Mt. Lechner site

Elevation: approx. 1400 m (4600 ft).

Temperature (during survey): -16°C (4°F).

Available runway length: approx. 3 km (2 miles).

Approach and takeoff area: the mountain range, including Mt. Lechner, is east and parallel to the runway, the crest of the ridge being approx. 2 km from the runway; there are nearby obstacles at both ends of the runway site; the most prominent feature is Blount Nunatak at the southwest corner (Fig. 14).

Suitability for camp facilities: level areas and gravel are available, although large boulders are prominent (Fig. 16).

Other Potential Sites

Several sites were inspected from the air enroute to the put-in area (Fig. 17).

The site east of Mt. Wanous, Patuxent Range, had very unfavorable approach limitations.

The extensive moraine area east of Mt. Cross, Patuxent Range, was viewed as a possible site for a gravel runway because of the presence of a considerable amount of boulder till or for an ice runway next to the moraines (Figs. 18 and 19). The apparent size of the boulder till material indicates that a rock-crushing operation would be necessary. The aerial inspection was done from too high an altitude for proper evaluation. A closer look at this area from the ground is considered warranted.

The ice area west of Mt. Bruns and Mt. Whillans, Patuxent Range, appeared suitable for a runway from aerial observation. The blue ice

FIGURE 16. Boulders and gravel near Mt. Lechner site

(Large rock in right foreground is approx. 1 m square.)

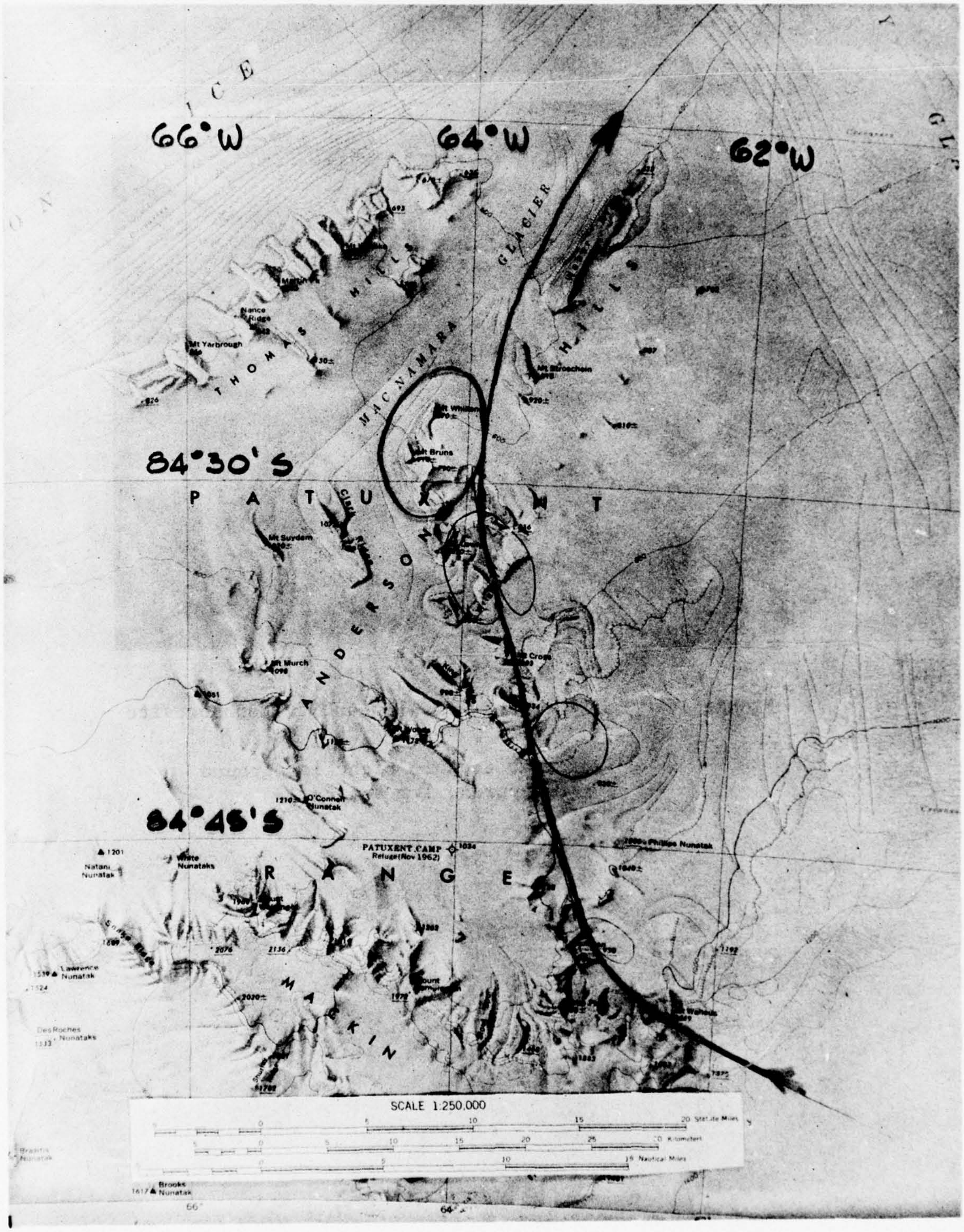

FIGURE 17. Map of potential sites inspected from air.

FIGURE 18. Aerial view of area east of Mt. Cross

FIGURE 19. Aerial view of moraine east of Mt. Cross

terrain appeared level, and long, low level approaches could be made into the area. The site is shown in Figures 20, 21 and 22.

The site near Mt. Hawkes, Neptune Range, was found to be totally unsuitable for runway purposes because of steep and undulating grade and approach restrictions.

The site northwest of Hannah Ridge, Neptune Range, was also unsuitable because of approach and landing constraints and insufficient blue ice area.

The site northeast of Mt. Walcott, Thiel Mountains, was considered unsuitable because of the rolling glacial relief.

Ground inspection was made of the area west of Sumrall and Jackson Peaks, Cordiner Peaks (refer to Fig. 3). The site was considered not suitable because of steep grade, lack of sufficient runway length, and takeoff (towards east) constraints (steep grade at east end of runway, mountain peaks on each side). Crevasses were observed at the west end, and potential melt ponds (cryoconite patches caused by the absorption of solar energy by mineral material present on the ice surface) were evident (Fig. 23).

Crevassed terrain west of Mathis Spur prevented the field party from inspecting a site west of Mt. Stephens, Forrestal Range (refer to Fig. 12). Figure 24 shows a typical snow-bridged crevasse, approx. 7 m wide, found near Mathis Spur at the south end of May Valley.

Because of heavy overcast during both the flight to Pensacola Mountains and the return, it was not possible to make an aerial inspection of the Davis Valley area, Dufek Massif, which was initially selected as one of the primary sites for the ground survey. Adverse weather conditions

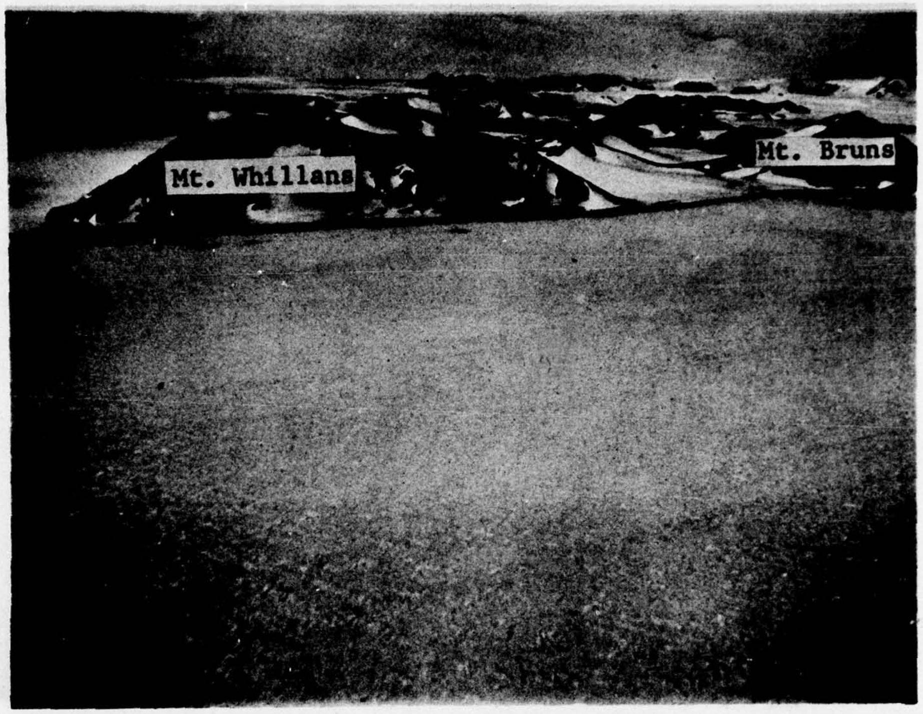

FIGURE 20. Aerial view of area west of Mt. Whillans and Mt. Bruns

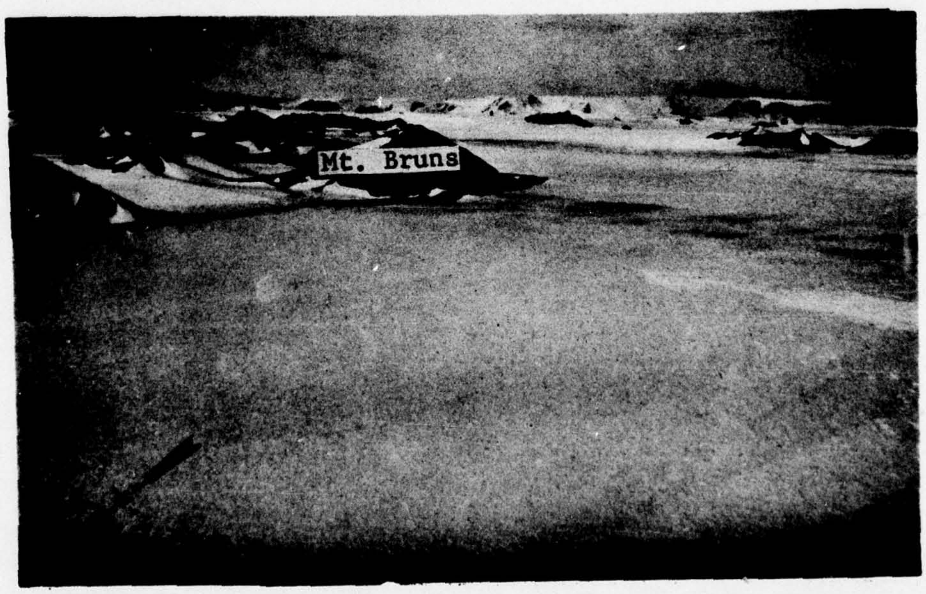

FIGURE 21. Aerial view of area northwest of Mt. Bruns

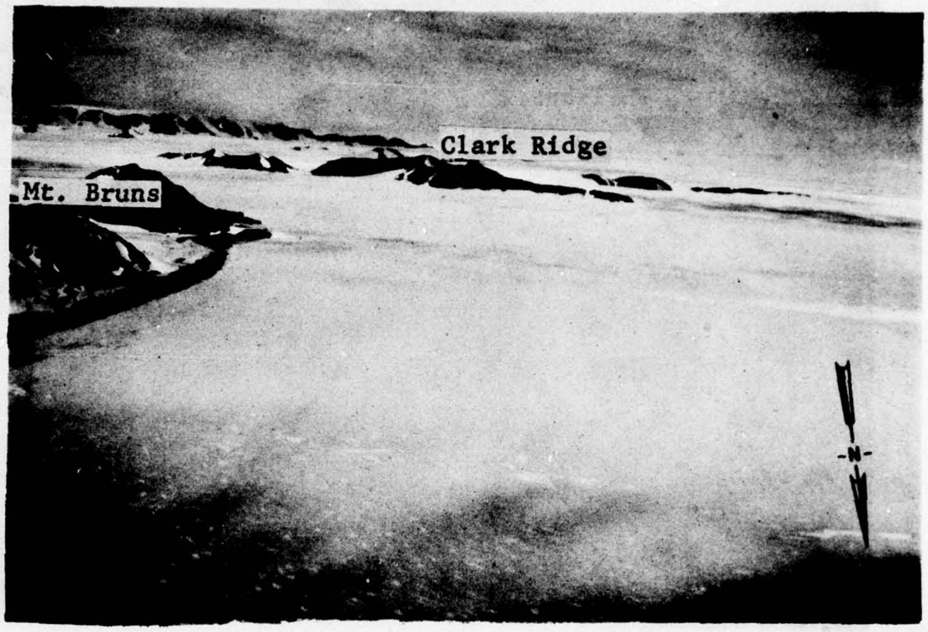

FIGURE 22. Aerial view of area west of Mt. Bruns

FIGURE 23. Cryoconite patches on ice surface west of Sumrall Peak

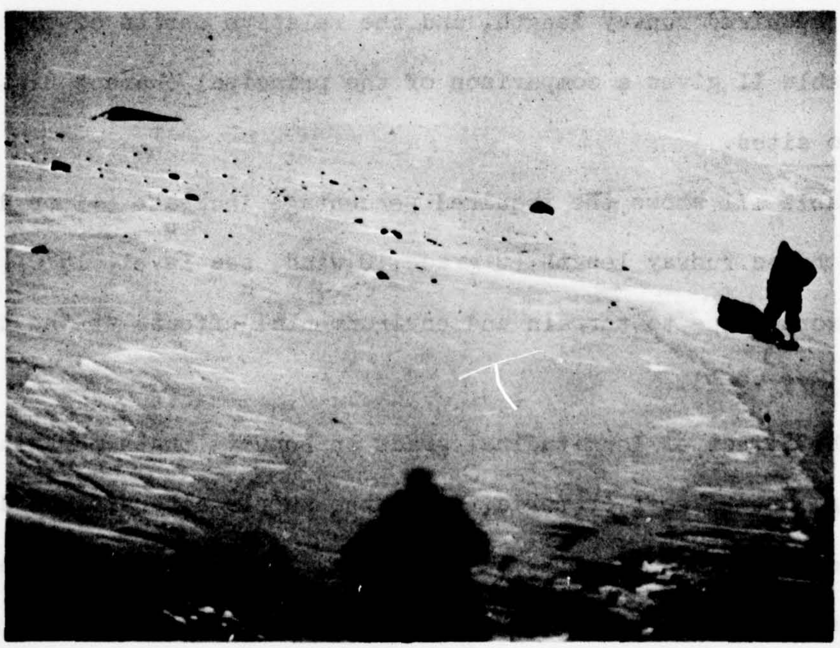

FIGURE 24. Snow-bridged crevasse near Mathis Spur

(overcast, fog) were common in the Dufek Massif area, at least during the two-week period the field party was in the area. This finding, coupled with similar weather reports from earlier field parties to the area, precludes any serious further consideration of this location as a suitable runway site.

Thick snow cover and crevasses were prominent in the areas traversed, and no other suitable sites were observed during ground inspection in the Cordiner Peaks and Mt. Lechner areas.

Comparison of the Two Surveyed Sites

Both the Rosser Ridge and Mt. Lechner sites may be suitable for runway installation. To make a comprehensive comparison between the two sites, three tables were constructed listing side by side the site characteristics, the effects of the environmental and terrain conditions on the required runway length, and the relative merits of each site.

Table II gives a comparison of the principal characteristics of the two sites.

Table III shows the required percentage increase (+) or decrease (-) of the basic runway length [0 grade, 0 wind, sea level, 15°C (59°F)] for jet aircraft due to terrain and environmental effects at the two sites (Horonjeff 1962).

The effect of longitudinal grade on runway length pertains more to landing, not takeoff criteria, since the supply aircraft would ordinarily land loaded, and take off with relatively light cargo. The design temperature is difficult to establish because of lack of data in this

Table II. Site characteristics

	Rosser Ridge	Mt. Lechner
Runway direction	E-W	N-S
Predominant wind direction	From E	From E, NE
Elevation	800 m (2600 ft)	1400 m (4600 ft)
Temperature (late Jan.)*	-9°C (16°F)	-16°C (3°F)
Longitudinal grade	+0.6% towards E	+0.75 towards S
Lateral grade	+1% towards N	+1% towards W
Available runway length	2.5 km (~1.5 miles)	3 km (~2 miles)
Ice surface	Cupped, some snow dunes	Smooth, mean snow cover 4 cm

* Observed mean during site survey

Table III. Terrain and environmental effects on runway length

	Rosser Ridge	Mt. Lechner
Elevation	+18%	+31%
Landing	0%	+ 8%
(Takeoff)	(+6%)	(0%)
Temperature, -12°C (10°F)	-12%	-12%
-23°C (-10°F)	(-17%)	(-17%)
- 1°C (+30°F)	(-7%)	(-7%)
Headwind, 0 kt	0%	0%
(10 kt)	(-7%)	(-7%)
(20 kt)	(-15%)	(-15%)
Increase in required runway length	+ 6%	+27% (+19% if landing uphill at no wind)

(+ = required increase in runway length, - = allowed decrease in required runway length) area. A figure of -12°C (10°F) is probably a reasonable mean summer figure for both sides, although the site at Mt. Lechner may have a slightly lower mean temperature because of its higher elevation. The effect of -23°C (-10°F) and -1°C (30°F) design temperatures if the -12°C (10°F) value is found to be not representative or not a realistic design value, is also shown in Table II. Since close to 0-wind conditions were observed, the presence of persistent headwind could not be assumed for design purposes. The effect of 10- and 20-knot headwinds is shown for comparison.

Using design criteria of elevations and grade as shown in Table II, the -12°C (10°F) temperature and no headwind, the runway length at Rosser Ridge would have to be increased by 6% over the basic design length, primarily because of elevation (+18%), but the increase is offset substantially by lower temperature (-12%). At the Mt. Lechner site, the required net increase would be 19%, since at the no-wind condition, landing could be in the uphill (towards S) direction, and in a 10-knot headwind (if from the N) condition, the grade and wind effects would cancel each other (+8%, -7%, respectively), the landing being into the wind, but downhill (towards N). If, however, the landing direction is N (because of terrain or other considerations) at 0-wind condition, the required runway length increase would be 27% over the basic design length. Ordinarily crosswinds (from E or NE) will probably be encountered. (Refer also to App. B.).

In any case, it is quite apparent that at Mt. Lechner the runway would have to be somewhat longer than at Rosser Ridge because of the higher elevation of the Mt. Lechner site.

Table IV gives a direct comparison of the various aspects or characteristics that would have to be considered when deciding which of the two would be the more preferable site. The site characteristics are listed in a more-or-less decreasing order of importance. A check mark indicates which of the two sites is preferable for each site characteristic.

Table IV. Comparison of the relative merits of each site

Characteristic	Rosser Ridge	Mt. Lechner
Available runway length	2.5 km (1.5 mile)	✔ 3 km (2 mile)
Obstacles near approach	✔ one side	Both sides
Snow cover, removal	✔ Little	Considerable
Cloud cover	More	✔ Less
Wind relative to centerline	✔ On centerline	Crosswind
Grade into predominant wind	✔ Positive (0.6%)	Negative (0.75%)
Elevation	✔ Lower	Higher
Temperature	Warmer	✔ Colder
Ice surface	Cupped	✔ Smooth

With the exception of the available runway length, the Rosser Ridge site appears preferable in most respects. Relocating the runway site at Rosser more to the north would increase the available runway length (comparable to that at Lechner), although more snow cover would be encountered there (but still not as much as at the Mt. Lechner site).

Two serious drawbacks of the Mt. Lechner site are the obstacles near both ends of the runway and the extent of snow cover. Snow cover removal would not be a problem at Rosser Ridge (refer to Fig 5); at Mt Lechner snow removal for a 3000-m x 100-m area (mean thickness 4 cm) would involve a volume of 12,000 m^3 of snow.

It was observed also at other sites (from aerial inspection and photographs) that, as the runway location is moved away from obstacles, the snow depth increases; i.e., as the merit of one site characteristic is increased, the merit of another site characteristic is decreased. The same situation exists with the elevation - temperature relationship, a low elevation (desirable) implying a higher temperature (undesirable) and vice versa. The required increase in the runway length because of elevation is not really a significant consideration if the available length is sufficient, and if snow removal is not a problem.

The runway at Mt. Lechner could be oriented in a SW to NE direction, further away from Mt. Lechner, into the predominant wind, thus decreasing the crosswind problem, the approach being from SW with the Blount Nunatak on the right (refer to Fig. 12). This runway location, however, would present very extensive snow removal problems.

The microrelief of the ice is of little concern, since the surface (top cm or so) will very likely be planed and scored to increase the frictional characteristics of the runway surface.

Table V shows the required runway length for various aircraft at the Rosser Ridge and Mt. Lechner sites.

The basic length distances shown in Table V may not correspond to runway design length criteria used in Antarctica and some adjustments in the above figures may be required.

The power spectral density analysis of the ice surface at the two sites indicates that there are weak spectral peaks of limited significance

Table V. Required runway length

Aircraft	Basic length* (ft)	(m)	Rosser Ridge (+6%) (ft)	(m)	Mt. Lechner (+19%) (ft)	(m)
C-130	5830	1780	6200	1890	6950	2120
C-141	5370	1640	5700	1740	6400	1950
KC-135	8620	2630	9150	2790	10,300	3130
C-5A (takeoff)	9400	2870	9950	3040	11,200	3420
(landing)	6700	2040	7100	2160	7970	2430

* Basic length denotes takeoff run to clear 50 ft. (Reference: Pertinent Characteristics of Military Aircraft)

in the Rosser Ridge profile at approximately 100-m and 65-m intervals and that the surface roughness may be classified as that similar to a "rough road." The spectral analysis of the Mt. Lechner data showed a strong peak at 75 m, but here too the amplitude of the roughness was not large, being on the order of 1 to 2 cm. In short, the existing ice surfaces are not unlike those of field runways. (For a more detailed discussion on this analysis, refer to App. C.)

Summary and Conclusions

The surveyed blue ice area north of Rosser Ridge, Cordiner Peaks, appears suitable for a runway site. The available runway length, ~2.5 km (1.5 miles) at the surveyed site, could be increased to at least 3 km (2 miles) by relocating the runway further to the north. This would involve some snow removal, but this does not appear to be a serious problem. The grade, wind, and ice surface conditions are very satisfactory. The site presents no serious approach and takeoff constraints.

The area at the base of Rosser Ridge is suitable for camp or support station installation.

The surveyed blue ice area west of Mt. Lechner, Forrestal Range, may also be feasible as a runway site, but it is less suitable than the site at Rosser Ridge. The two principal drawbacks at the Mt. Lechner site are: 1) the considerable snow removal required and 2) approach and takeoff constraints due to obstacles near both ends of the runway area. The ice surface is smooth, grade is acceptable, and predominant wind would be at 30° to 45° with the runway direction.

Because of the effects of elevation, temperature and grade, a runway at Rosser Ridge would require a 6% increase in the basic runway length for jet aircraft. At Mt. Lechner, the minimum required increase would be 19%.

Aerial inspection disclosed at least one other area which may be suitable as a runway site. The blue ice area west of Mt. Bruns and Mt. Whillans, Patuxent Range, appeared level, sufficiently long and without approach and takeoff constraints. A ground inspection and survey of this area is recommended.

The area east of Mt. Cross, Patuxent Range, also requires a closer inspection before its suitability as a runway site can be properly assessed.

The Davis Valley area, Dufek Massif, may not be suitable as a runway site because of what appears to be persistent overcast conditions. Neither aerial nor ground inspection was possible during this study.

Sites at Mt. Wanous, Mt. Hawkes, Mt. Walcott, and Hannah Ridge, which were inspected from the air, and a site west of Sumrall Peak, inspected from the ground, were found unsuitable for runway purposes.

Literature Cited

Bekker, M.G. (1969) Introduction to terrain-vehicle systems, the University of Michigan Press, p. 316-319.

Day, C.F., W.T. Towles and R. Sweeney (1973) Zero Base II analysis. RMC Research Corporation, Report UR-213.

Hibler, W.D. III and L. LeShack (1972) Power spectrum analysis of undersea and surface sea ice profiles. Journal of Glaciology, vol. II, no. 63, p. 345-356.

Hibler, W.D. III and S.J. Mock (1972) Interim sea ice statistics, Report #1. USACRREL SEV Report, prepared for Advanced Research Projects Agency.

Horonjeff, R. (1962) Planning and design of airports, McGraw-Hill Book Co., p. 85-95.

Kovacs, A. and G. Abele (1974) Crevasse detection using an impulse radar system, a field trial. USACRREL Technical Note (unpublished).

Pertinent Characteristics of Military Aircraft. USA Engineer Waterways Experiment Station, Internal Report.

Appendix A: Temperature and Wind Conditions During Traverse

Date	Location	Time (McMurdo)	Temp. (°F)(°C)	Wind (kt)
19 Jan	Put-in site	1800	+20 - 7	
20 Jan	Near Sumrall Peak	0900	+ 2 -17	
21 Jan	"	1200	+18 - 8	5
21 Jan	Rosser Ridge	1530	+22 - 6	
22 Jan	"	1015	+22 - 6	1-2
22 Jan	"	1500	+10 -12	1-2
23 Jan	"	1100	+18 - 8	1-2
24 Jan	Mt. Lechner	0030	+ 5 -15	1-2
24 Jan	"	1400	+ 4 -16	1-2
25 Jan	"	1500	+ 6 -14	
26 Jan	Put-in site	1500	- 3 -19	1-2
27 Jan	"	1600	0 -18	0
28 Jan	"	1500	+ 1 -17	1-2
28 Jan	"	1845	- 2 -19	1-2
29 Jan	"	0600	+ 3 -16	2-3
29 Jan	"	0900		10
30 Jan	"	1600	+ 5 -15	10-15

Observations from snow pit stratigraphy indicate an average yearly snowfall of approx. 5 to 9 cm (2 to 3.5 in) at the put-in site, southeast of Cordiner Peaks. High winds at this elevated site may be the reason for the low accumulation noted. Extrapolation of the snow temperature profile (from data to 4.4 m) indicates the mean annual temperature in this area to be around -30°C (-22°F).

Appendix B: Effects of Environmental Conditions on Runway Length

The effect of temperature and wind on the required runway length at two elevations is illustrated in Figures B1 and B2. The required percentage increase (or decrease) in the basic runway length is shown as a function of temperature and headwind for the Rosser Ridge site, elevation 2600 ft, grade 0.6% (Fig. B1a) and the Mt. Lechner site, elevation 4600 ft, grade 0.75% (Fig. B1b). The data are from Horonjeff (1962) and are shown in the British system.

At the Rosser Ridge site, the prevailing wind is downslope; consequently, landing would always be upslope, regardless of whether headwind is present or not. At the Mt. Lechner site, the prevailing wind is upslope; at no-wind condition, landing could be made upslope (heading S), while at a 10-knot (or more) headwind, landing could be made downslope into the wind (heading N). The effect of a 10-knot headwind is approximately the same as that of a +0.75% slope, i.e., a 10-knot headwind would cancel the effect of a 0.75% downslope, as shown in Figure B1b.

Figure B2 shows a comparison of the required runway length at various temperatures, at 0-wind condition, for the C-5A and C-141 aircraft at both the Rosser and Lechner sites. (For the C-5A at gross load, the landing distance requirement is 29% less than that for takeoff.)

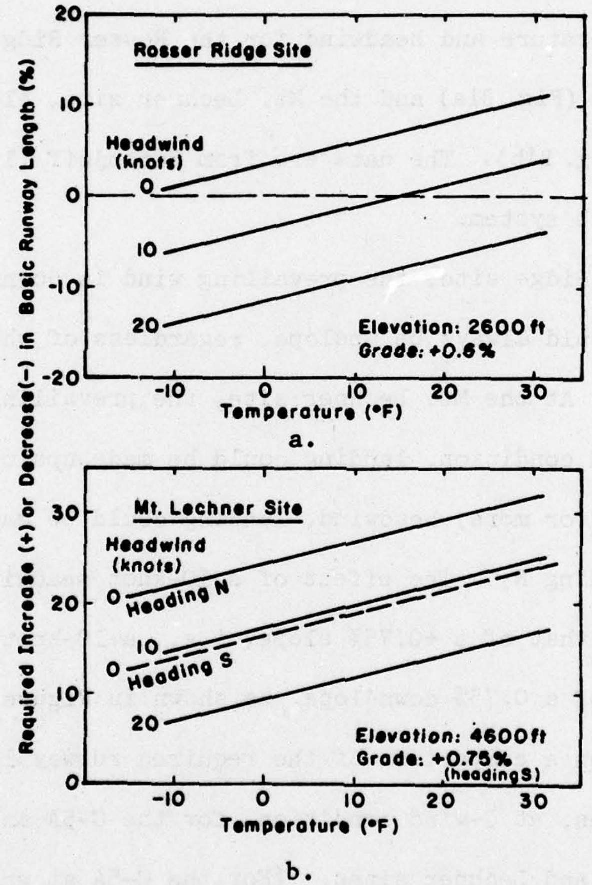

Figure B1. Effect of temperature and wind on required runway length at Rosser Ridge and Mt. Lechner.

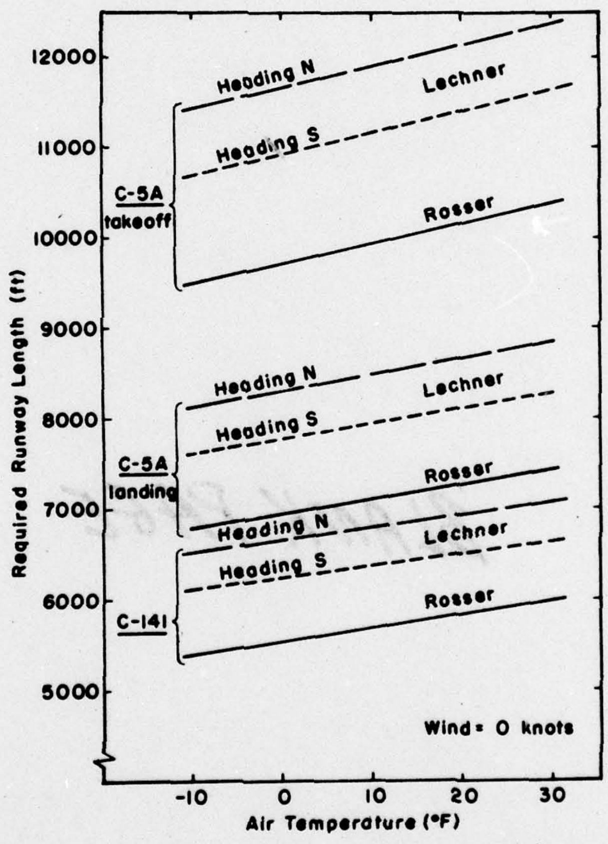

Figure B2. Effect of temperature on required runway length for C-5A and C-141 aircraft at Rosser Ridge and Mt. Lechner.

Appendix C: Power Spectral Densities of Ice Surface Relief

In order to quantify the surface roughness of the runway relief at Rosser Ridge and Mt. Lechner, the measured profiles were used to estimate power spectral densities. For this prupose, a battery of programs developed by W. Hibler, as discussed, for example, in Hibler and LeShack (1972) and Hibler and Mock (1972) were used.

For the low-frequency macrospectra, the profile data at 30-m intervals were used. To quantify the Rosser Ridge surface roughness for the higher-frequency mesospectra, a series of 30-m long profiles with samples every meter were joined after trend removal to form a larger profile. This technique introduced some error but gives a tolerable estimate of the mesospectra at spatial frequencies $\underline{f}$ (cycles per meter) greater than $\sim 0.1\ m^{-1}$.

Log-log plots of the spectral densities are shown in Figure C1. The spectral densities may be approximately characterized by $\underline{S}(\underline{f}) = \Omega f^{-n}$ where the coefficients $n \simeq 1.8$ and $\Omega \cong 2x10^{-5}$ with the spectral density $\underline{S}(\underline{f})$ in units of cubic meters. There are weak spectral peaks in the Rosser Ridge profile at $\sim$100m and $\sim$65m, but they are not particularly dominant in terms of deviation from the overall spectral shape. In the Mt. Lechner profile, there is a strong peak at $\sim$75m. The amplitude of the roughness is not, however, great and appears to be of the order of 1 to 2 cm.

In terms of typical roughness of runways as reported by Bekker (1969), these surfaces are rougher, with spectral densities $\sim 10^2$ to 10^3 greater

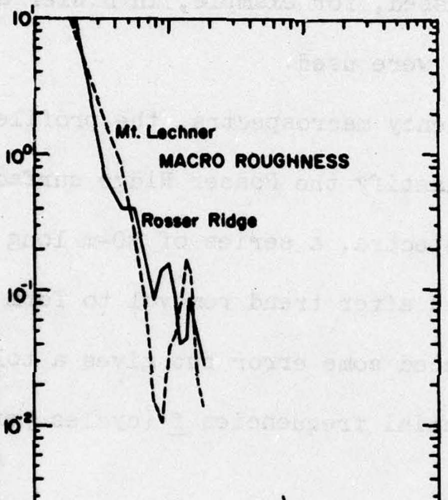

Fig. C1. Power spectral density of ice surfaces surveyed.

than those given for a smooth runway, and are somewhat representative of a "rough road" spectral density. This however, is not a particularly valid criterion, since field runways are often considerably rougher than commercial runways. In terms of the Rosser Ridge root-mean-square (rms) mesoroughness, it was found that, at wavelengths less than ~10 m, the rms roughness was less than 1 cm.

These spectra may be used by the airframe manufacturer to generate a stochastic profile which can then be used for landing gear and airframe response studies on these ice surfaces.