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PRELIMINARY INTERPRETATION OF GEOPHYSICAL DATA FROM THE LOWER NOATAK RIVER BASIN, ALASKA

By

David F. Barnes and Irvin L. Tailleur

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List of Illustrations

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Introduction

In 1968 the U.S. Geological Survey contracted for about 300 miles of aeromagnetic traverse in the river valley south of Noatak Village in northwestern Alaska to further investigate the cause of two large Bouguer gravity anomalies. The gravity anomalies are a low of about -50 mgals at the southwestern corner of the valley and a high of over +70 mgals about 12 miles northeast of the low. The aeromagnetic lines were flown across the steep gradient between the two anomalies and also over the adjacent hillsides, where the bedrock is exposed. The results show that the area of the gravity high is also a magnetic high and is part of a mafic complex that crops out on the adjacent hillside, and that the gravity low probably represents a small Cenozoic basin.

Location

The locations of the geophysical surveys are shown in figure 1. The gravity data were obtained as part of more extensive regional surveys (Barnes, 1969) but the aeromagnetic data were obtained from a local survey of an area of about 500 sq. miles centered about 35 miles north of the city of Kotzebue. The area surveyed aeromagnetically is the southern half of a broad (20 miles wide), nearly flat, alluvial valley, which has been called the Mission Lowlands (Smith, 1931) and which extends for about 50 miles between the mouth of the Kelley River and the Igichuk Hills, where the Noatak River passes through a sinuous canyon before emptying into the Chukchi Sea. The valley truncates the Baird Mountains, which form the southwestern corner of the Brooks Range; and it also lies just south of the DeLong Mountains, which form the northwest corner of the Range. The valley resembles many other swampy, lake-covered, interior lowlands of northern and central Alaska, some of which may be actively subsiding. The abundant lakes and rivers provide good fishing and support the village of Noatak, which is near the center of the valley on the northwest edge of the aeromagnetic survey.

Gravity survey

The swampy alluvial cover conceals geologic evidence for one of the largest and steepest gravity gradients in North America: 120 mgals in a distance of 12 miles. The U.S. Geological Survey first found evidence for large gravity contrasts in the Noatak River Basin when five reconnaissance landings were made there enroute to a detailed investigation at Cape Thompson in 1960. These early measurements were released without comment in a report of that detailed survey (Barnes and Allen, 1961), and preliminary attempts to contour the measurements (Ostenso, 1962) suggested unusual curvature of the contours marking the end of the Brooks Range gravity low, which is believed to represent primarily a crustal thickening caused by isostatic adjustment. In 1961 the Geological Survey continued its investigation of the anomalies with a gravity traverse along the river and with a few float-plane landings on nearby lakes. The latter measurements were interrupted by a loose connection in the gravimeter's heater-thermostat circuit, which was also tentatively assumed to be the cause of one exceptionally high reading an hour before the circuit failure was detected. Attempts to contour and interpret the data were handicapped by lack of coverage away from the river traverse and especially by lack of stations on rock outcrops in the surrounding hills. During 1962, 1964, 1965 and 1966 Cessna aircraft of the Navy's Arctic Research Laboratory at Point Barrow flew several USGS gravity observers on many attempts to obtain additional data by float or ski-plane landings, but landing conditions were seldom good enough to obtain more than a few stations. Even use of a helicopter in 1965 provided few new data because of very strong winds during the three days it was in the area. However, reexamination of poorly-located (and therefore unpublished) 1958 aeromagnetic profiles across the valley made Barnes later suspect that the anomalously high reading of 1961 might not have been an instrumental error. In 1967, after a long period of heavy rains, two days' use of a Piper Super Cub on floats provided enough landings for the first contourable data and thus delineated the steep gravity gradient. The necessity of aeromagnetic data for interpretation of the gravity anomaly was immediately recognized.

Figure 3 locates the gravity stations obtained between 1958 and 1967 and shows the simple Bouguer anomaly contours which can be drawn from the still-limited data. Observed gravities are based on the gravity base station network of Barnes (1968, pp. 29-K and 30-L), of which the stations at Kotzebue (KTZH and KTZT) and Noatak Village (NOAS and NOAM) were most frequently occupied. Elevations have been obtained from river gradient, sea level, altimetry, unchecked spot elevations on the 1:250,000 Noatak topographic map compiled in 1960, and spot elevations on some 1:50,000 manuscript maps. Simple Bouguer anomalies have been computed using a reduction density of 2.67 gm/cm^3. The variety of elevation control and the large differences in weather conditions when altimetry was

used, may cause elevation errors of ±10 m (±33 ft) and possible anomaly errors as large as ±2 mgal. However, such errors are believed to be rate and are much smaller than the 10-mgal contour interval. Principal facts of the gravity observations will be released at a later date. No terrain corrections have been made, but the generally low topographic relief should not cause terrain errors greater than the possible elevation errors. The authors gratefully acknowledge the assistance of R. C. Jachens, R. V. Allen, S. L. Robbins, R. C. Olson and many aircraft pilots for their part in obtaining the field data. The logistic support of M. C. Brewer of the Naval Arctic Research Laboratory at Point Barrow and of M. E. Britton through the U.S. Office of Naval Research project NR307-265 have also been very valuable.

Aeromagnetic survey

The aeromagnetic survey was planned primarily to aid the interpretation of the steep gravity gradient and to compare the geophysical anomalies in the alluvial covered area with those where rocks of known lithology are exposed on surrounding hillsides. Interpretation of structures in areas where the rocks are exposed was not a planned objective of the survey although the results suggest that such information could have been another useful objective. The survey was part of several flown by Lockwood, Kessler and Bartlett in 1968 under contract to the U.S. Geological Survey.

The survey consisted of one northwest control line plus 13 northeast-southwest flight lines, which were 23 miles long and were separated by intervals of 2 miles. The flight elevation was 2,000 ft above sea level, and position control was obtained from manuscript copies of 1:50,000 maps which were also used for the initial compilation. A flux-gate magnetometer recorded total magnetic intensity; and the data were contoured with a 20-gamma interval and on an arbitrary datum, which was estimated to be about 55,500 gammas. The original 1:50,000 map was reduced to 1:250,000 for figure 2. A regional gradient of about 4.5 gammas/mile increasing towards the northeast (U.S. Coast & Geodetic Survey, 1965) was not removed from the contoured data, but has been removed from a profile along which quantitative interpretations were attempted.

Geologic data

The large geophysical anomalies revealed by the gravity and aeromagnetic surveys are concentrated in an alluvial basin, where only Quaternary sediments are exposed. However, a complicated sequence of Paleozoic and Mesozoic sedimentary rocks plus mafic igneous rocks crop out on the surrounding hills. Early summaries of the geology of the area were included in Smith (1913), and Smith and Mertie (1930). More recent summaries by Tailleur and Snelson (1966), Tailleur and others

(1967), Snelson and Tailleur (1968), and Tailleur (1969) have emphasized the complex geology and thrusting relationships which may be recognized by separating the Paleozoic and Mesozoic rocks into distinct depositional and tectonic sequences. Preliminary interpretation of the geophysical anomalies does not require an understanding of these sequences, but a brief description of the sedimentary and igneous lithologies and of the regional geologic structure is desirable.

Devonian rocks are the oldest rocks identified in the area and also comprise the largest outcrop area on the geologic map in figure 4. They crop out along most of the southern and western rim of the valley and are also present east of the hills on the eastern side of the valley. Thus they almost surround completely the surveyed area. They may be conveniently divided into two units: the predominantly carbonate Baird Group of probable Devonian and older age, and the predominantly clastic Endicott Group of Late Devonian and Early Mississippian age. The clastic group varies in composition from shale to conglomerate and includes minor amounts of carbonate. The Baird Group has in many places been thrust over the Endicott Group, and many of its outcrops have been considered allochthonous (Tailleur and others, 1967). As the predominant rock unit in the mapped area, these rocks are probably the country rock that surrounds the causes of the geophysical anomalies.

Mississippian carbonate rocks of the Lisburne Group crop out in parts of the mapped area. The beds probably are not more than half a mile thick but they are present on both sides of the valley. Their areal extent is small and their physical properties probably do not differ significantly from those of the Devonian sediments.

The mapped area also includes on its east side a narrow outcrop of post-Mississippian sedimentary rocks. The oldest are some cherts, shales and limestones, which appear to belong to the Triassic Sublik Formation and possibly to the Permian Siksikpuk Formation. Overlying these sediments is a narrow, discontinuous strip of Cretaceous graywackes and mudstones which may belong to the Okpikruak Formation. The limited exposures, and the probable small contrast in physical properties suggest that these Mesozoic sedimentary rocks have little geophysical importance in the mapped area.

The youngest sedimentary unit mapped near Noatak Village are sediments of Quaternary age, which cover most of the area where geophysical data are available. No sediments with ages intermediate between Cretaceous and Quaternary have yet been observed in the reconnaissance geologic mapping in the area. However, the geophysical data strongly suggest that older Cenozoic sediments may locally underlie the alluvial cover. Such rocks were mapped in the Selawik lowlands, about 100 miles

to the southeast (Patton and Miller, 1968), and they may have been observed at other localities about 100 miles northwest and southwest of the Noatak Valley (Campbell, 1966, and Hopkins, 1959). The exposed Quaternary sediments are largely alluvial with limited amounts of talus and glacial debris. The area was covered by glaciers in the mid-Wisconsin (Coulter and others, 1965). Thaw lakes and pingos now indicate the presence of much perenially frozen ground, and ice wedges may comprise a significant proportion of the upper thousand feet of the Quaternary section (Lachenbruch, 1966).

Mafic volcanics and intrusives form the final rock unit of the geologic map, and may also be the most geophysically significant unit. These rocks form most of the hills on the east side of the valley. South of the Eli River intrusive rocks varying in composition from diabase and gabbro to serpentinite predominate, but fine-grained volcanics are also present. Traces of metallic minerals have been found in some specimens, and one local inhabitant told Barnes that he had heard of a chromite occurrence near Asik Mountain. However, the location was not known, and the report is unconfirmed.

North of the Eli River the proportion of fine-grained and chemically altered intrusive rocks is larger than south of the river, but gabbroic intrusions are also present. Vesicularity is also greater north of this river, and pillow basalts and cherts are part of the igneous complex.

The distribution of the various lithologies in the mafic assemblages of northwest Alaska suggests that many of these assemblages could be layered sequences. In the rocks east of the Noatak Valley serpentinites are most abundant along the southwest edge of the outcrop, and extrusive rocks and cherts predominate on the east and north sides of the outcrop. In some places the contacts of the mafic rocks appear to be nearly conformable with some adjacent sedimentary rocks.

A potassium-argon date of a hornblende-bearing intrusive found near Asik Mountain suggested that the igneous rocks have an age of about 315 ± 110 million years, with the relatively high uncertainty caused by a low potassium content. However, igneous rocks which Tailleur considers the same as those in the mapped area crop out extensively along the south edge of the DeLong Mountains. Hornblende-bearing phases from two widely separated localities there have been dated 148 ± 30 and 160 ± 40 million years (J. B. Von Essen, personal communication, 1968).

Most of these mafic rock assemblages in the northwestern Brooks Range appear to be included in sequences or tectonic units that are allochthonous. The contacts of the igneous rocks in the mapped area have not been observed, but geologic mapping suggests that these igneous rocks are included along with the Baird and Lisburne groups, in one or two tectonic units that have been thrust over the adjoining Endicott Group and other rocks (Figure 4).

Large thrust sheets are the dominant structural feature of northern Alaska, and Tailleur (1969) has estimated that the total displacements may have exceeded 100 miles (100-175 km). Deformation and differential erosion of these thrust sheets make the mapped geology difficult to interpret without detailed geologic mapping. In the vicinity of these geophysical surveys, the structural grain trends southwest. Northwestward (beyond the map), the outcrop patterns seem to bend toward the west and northwest and suggest a small orocline or syntaxis between the southwest trends at this end of the DeLong Mountains and the north-trending Lisburne Hills on the westernmost coast. Similarly, the arcuate outcrop of Devonian rocks around the Noatak Valley and the presence of younger rocks on the inside edge of this arcuate outcrop could suggest a northward plunging synclinorium with the river near its center. Examination of the poorly-located 1958 aeromagnetic profiles across the valley suggested to Tailleur that the mafic rocks extend beneath the river valley, where they also seemed to have an arcuate boundary that could be considered subparallel to the bordering Devonian rocks. This evidence supported his belief that the mafic assemblage and the adjoining sedimentary rocks of the Baird Group could all be part of an allochthonous unit which had been deformed into a synclinorium that now underlies the river basin.

Physical properties of the rock units

Measurements of physical properties such as density, magnetic susceptibility and remanent magnetism can be a valuable aid in quantitative geophysical interpretation. However, geophysicists working near the Noatak Valley have not yet been able to obtain a good sample collection. A few specimens from along the river and from geologic mapping provide some information although the collection primarily represents the variety of rock types instead of average physical properties.

Densities of about 100 specimens were measured by comparing the weights in air and water. Adequate samples were not available for some rock units, and estimates of their densities must be based on data from other areas. The results of the measurements made on samples from the area covered by the Noatak map are listed in the following table:

DENSITIES OF ROCK SPECIMENS FROM THE VICINITY

OF THE LOWER NOATAK VALLEY

Geologic Age	Rock Unit	Predominant rock type	Number of specimens	Measured densities, g/cm^3 Minimum	Maximum	Average
Jurassic?	Mafic rocks South of Eli R.	Gabbro, etc.	30	2.46	3.32	2.93
"	Mafic rocks North of Eli R.	Volcanics, etc.	42	1.95	3.05	2.64
Triassic	Shublik Fm, etc.	Shale	6	2.43	2.77	2.61
Devonian	Baird Gp.	Carbonates	35	2.47	2.90	2.67
Devonian	Endicott Gp.	Clastics	6	2.60	2.88	2.70

Missing from the table are data on the Cenozoic sediments, the Cretaceous rocks, and the Mississippian Lisburne Group. Density measurements of the latter two were summarized in a previous report which described the gravity field near Cape Thompson approximately 100 miles northwest of the present survey (Barnes, 1965). There, 11 Cretaceous specimens had an average density of 2.70 gm/cm^3, and 42 Mississippian specimens had an average density of 2.69 gm/cm^3. These densities are very close to the sedimentary-rock densities in the previous table. The average density for the Triassic rocks in the table is considered to be anomalous and the result of a small, unrepresentative sampling; higher densities were measured for similar Triassic rocks from the vicinity of Cape Thompson. The 2.67 gm/cm^3 density used for computation of the simple Bouguer anomalies thus appears to be within ±0.03 gm/cm^3 of the average densities for all the Paleozoic and Mesozoic sedimentary rock units within the Noatak Valley.

The igneous rocks south of the Eli River where gabbroic intrusive rocks predominate have the highest average density of 2.93 gm/cm^3. Furthermore, the sampling included seven altered or vesicular specimens, and if these are omitted, the average density is 3.04. If only the plutonic gabbros are considered, the density is still higher. An average of 3.10 g/cc based on an initial sampling of 14 specimens was used in the interpretation. The increased proportion of vesicular extrusive rocks and other nonplutonic rocks north of the Eli River accounts for the lower average density of the specimens from this part of the mafic complex. However, the density range is very large because it primarily represents the large variety of rock types, and most of the samples came from a traverse across the lower third of the unit. Elsewhere intrusive rocks predominate in the upper part of the unit. If the samples are weighted in proportion to their abundance in outcrop, the average density would probably be between 2.80 and 2.90 gm/cm^3, which is greater than that of the sedimentary rock units but not as high as that of the chiefly plutonic rocks south of the river.

The density of the Cenozoic sediments which cover the valley floor is perhaps the most difficult to estimate. Ice wedges may be abundant in the upper 1,000 feet, and densities as low as 1.40 gm/cm^3 were estimated for the frozen portions of the Gubik Formation in the Naval Petroleum Reserve (Woolson, 1952). Water-saturated recent sediments may range between 1.3 to 2.5 gm/cm^3 depending on their composition and degree of compaction. If great thicknesses are involved, densities of 2.1 to 2.3 gm/cm^3 are probable, especially if the section includes Tertiary deposits.

The specimens were too small and too limited in number for a sampling of magnetic properties, so a susceptibility of 0.0045 cgs for the mafic rocks was assumed for the interpretations. Preliminary tests using other values did not provide such easy fits to the observed aeromagnetic data, and the value is within the broad range of magnetic susceptibilities which have been measured for similar mafic rocks. The assumption is, however, basically arbitrary and reasonable changes could influence the shape of the postulated model.

Interpretation of the geophysical anomalies

The gravity maximum and minimum are the most prominent features of the Bouguer anomaly map in figure 3. Comparison with figure 2 suggests that there is a common cause for the magnetic and gravity maxima, and comparison between figure 2 and the geologic map in figure 4 suggests that mafic rocks are the cause of these anomalies. The interpretation of the gravity low is more tentative and requires more discussion as does a detailed analysis of the anomalies caused by the mafic rocks. However, before beginning a detailed analysis, a few less obvious but more regional features of the gravity and magnetic maps should be mentioned.

The gravity map shows a regional decrease towards the northeast, and except for the distortion caused by the gravity high and low, the regional contours would probably trend northwest across the map and might thus be almost normal to the regional geologic trends. The probable explanation is that this gravity decrease represents the crustal thickening towards the higher parts of the Brooks Range. The regional gradient is about 1 mgal/km ($1\frac{1}{2}$ mgal/mile) across the northeast diagonal of the map and probably represents an increase in depth to the Mohorovicic discontinuity of a little less than 3 km.

Similarly, the predominant trend of the magnetic contours is northwest and represents in small part the regional gradient of the earth's magnetic field which is about 4.5 gammas/mile. However, the more important factor causing this trend is the form of the mafic intrusive. The contours representing the southwest margin of this intrusive are the predominating pattern in the area covered by the aeromagnetic survey. Near Noatak Village these contours have a southward trend, but south of the village they curve to the southeast and trend almost linearly across the map before swinging to the northeast at the southeast edge of the survey. The linear portion of these contours have a trend that is normal to most of the mapped geologic trends, but the larger arcuate pattern approximately parallels the outcrop of the Devonian sedimentary rocks. The gross outline of the anomaly could thus support the hypothesis that the mafic rocks are part of a northward-plunging synclinorium. However, a geophysical interpretation of what the magnetic contours reveal about the attitude of this mafic contact does not support this interpretation and will be discussed later. The eastern edge of the mafic mass is complex and is not adequately covered by the limited area of the aeromagnetic survey. One of the

1958 magnetic profiles suggests that the mafic rocks extend northward and underlie much of the northern part of the river valley. This magnetic profile shows irregular anomalies with smaller amplitude than the magnetic high covered by the detailed survey. The anomalies suggest a group of discontinuous magnetic bodies with significant variations of magnetic properties.

The magnitudes of both the gravity and magnetic anomalies show that the mafic rocks must represent a significant crustal thickness. A density of 3.10 gm/cm^3 is believed to be representative of the unaltered portion of the gabbroic intrusive and even an infinite horizontal slab of this material would have to be more than $4\frac{1}{2}$ km (3 miles) thick to cause the observed, positive gravity anomaly, which is about 85 mgals above the regional level. Figure 5 shows a semi-infinite, two-dimensional model based on the available gravity and magnetic data using computer programs similar to those of Talwani (1959). This model suggests that the thickness must be at least 6 km (4 miles), and use of a more realistic three-dimensional model would probably indicate a thickness of more than 5 miles. This large thickness suggests that the anomaly is caused by an intrusive rather than an allochthonous mass. However, a thick, steeply-dipping, tabular body could give an anomaly of equivalent magnitude if the dimensions were adequate. The outcrop east of the Noatak Valley is about 8 km (5 miles) wide and if it dips at an angle of about 45° to the west, it could cause an anomaly that is close to the measured amplitude. Certainly a slightly-thicker, steeply-dipping sheet suoh as might be formed by the stacking of adjacent mafic thrust sheets could explain the anomaly.

Both the gravity and magnetic data show that the southwest edge of the mafic mass probably dips about 20° to 40° SW, which is hard to reconcile with a stratiform body in a synclinorium that plunges to the northwest. The contact might represent an erosional surface, but this raises several problems about the erosional processes and the type of sediments which now overlie the large erosional surface. The gravity data also restrict the erosional possibilities. The magnetic data are too limited to determine the attitude of the opposite or northern and eastern sides of the mafic mass. The magnetic profile dips very steeply on the east, and the contours indicate an arcuate minimum. However, this minimum is partly inside the outcrop of the mafic rocks and probably represents variations within the mafic complex. If the observed magnetic minimum is a true minimum and not merely a low in the middle of a complex anomaly, the magnetic data would suggest that the northeast edge of the intrusive dips steeply to the northeast. However, the extent of the outcrop supports the southwest dip indicated in figure 5, which is not inconsistent with the limited magnetic observations. The gravity data northwest of the maximum are even more limited than the magnetic data, but the low value measured on the Agashashok River at the edge of the mafic outcrop is also consistent with a steep or inverted eastern edge of the intrusive. A fairly definite conclusion of both the gravity and magnetic data is that the largest proportion of the studied mafic mass is west of the outcrop and beneath the swampy floor of the valley. However, more data north of the surveyed area could define the extent of other mafic bodies which may be either within the area of mafic outcrop or similarly located primarily beneath the valley fill.

The shape of the magnetic contours also suggests that the top of the mafic mass may plunge to the northwest and be several miles deep beneath Noatak Village. Another arm of the magnetic anomaly extends northward and probably follows the outcrop of the mafic rocks. No gravity anomalies of comparable positive magnitude have been measured in the northern part of the mapped area (Barnes, 1967) which suggests the absence of similar thick, mafic masses north of the main intrusive. However, another explanation for this absence is the density decrease and vesicularity increase of the mafic rocks, which is suggested by the limited sampling in the northern part of the mapped area. Furthermore, the density of gravity stations is so low that other anomalies of similar magnitude and areal extent could have been missed by the available survey data. Indeed, considerably north of the mapped area one gravity measurement gave a Bouguer anomaly of -17 mgal on a lake at the head of Sisiak Creek (spot marked "High" in Figure 1) where surrounding measurements north and south of the station vary between -40 and -50 mgals. Mafic rocks are believed to crop out on each side of the station. More geophysical data might locate another large anomaly. In spite of these possibilities, Barnes believes that the positive anomaly in the southern part of the Noatak Valley represents a very thick autochthonous gabbroic intrusion, but that most of the other exposed mafic rocks are thinner and that many could be allochthonous.

The gravity low is almost as pronounced as the gravity high, but the magnetic profiles across it are almost featureless except for a gentle slope and curvature caused by the regional gradient and the nearby intrusive. This lack of magnetic relief shows that the underlying rocks are nonmagnetic and thus eliminates several possible causes of gravity lows, such as: silicic intrusives, most altered mafic rocks, very vesicular extrusive rocks, and thick deposits of volcanic ash. The most probable remaining cause for the gravity low is a small basin filled with recent sediments. The total negative anomaly has a magnitude of about 50 mgals which could be explained by about 3 km (2 miles) of sediments with a density of 2.27 gm/cm^3 or 2 km (less than 1½ miles) of sediments with a density of 2.07 gm/cm^3. The former density was used to calculate the two-dimensional cross section in figure 5. A large proportion of ice wedges in an upper layer might lower its density to 1.4 gm/cm^3, but the earth's geothermal gradient would probably restrict the thickness of such a layer to about 300 m, which would

cause only a gravity anomaly of about 15 mgals. Quaternary sediments could be thick enough to cause the whole anomaly, but an underlying layer of late Tertiary sediments seems probable.

The gravity data are not sufficiently abundant to adequately define the attitude of the basin's boundaries. Figure 5 suggests that the basin partly overlies the intrusive and that there may be an intermediate layer of Paleozoic or Mesozoic sediments. One consequence of this close proximity of the intrusive is that the attitude of its southwest boundary must also influence any gravitational calculations concerning the attitude of the adjacent boundary of the sedimentary basin. A real effort was made to obtain a profile of closely spaced gravity stations along Sevisok Slough, where local variations in gradient might have revealed a faulted boundary of either the sediments or the intrusive rocks. However, the limited number of stations which were obtained suggest that the gradient between the high and the low is remarkably constant and that both the intrusion and sedimentary basin have gently dipping boundaries. Even fewer stations are available for interpreting the attitude of the basin's southwest side, but the proximity of low gravity measurements to outcrops of dense Paleozoic sediments suggests that this contact must be significantly steeper, and may represent a fault. The magnetic data suggest that the intrusive extends northwestward as far as Noatak Village, so the presence of this underlying mass probably explains the contours on the north side of the gravity low. The recent sediments may extend northward across the underlying mafic rocks and into the upper Noatak Valley. Detailed data from the west side of the valley would provide much additional information concerning the form and extent of the postulated sedimentary basin.

Tectonic conclusions

The gravity anomalies in the Noatak Valley and the steep gradient that separates them represent a pair of geologic structures that must be very thick in comparison with similar features that have been observed by gravity surveys in Northern Alaska. The proximity of the two anomalies emphasizes the gradient between them, but may be largely a geophysical coincidence. Various types of processes which might cause a genetic relationship between the causes of the two anomalies have been considered, but there are good arguments against most processes which might cause such a relationship. The mafic intrusion must have occurred a few hundred million years before the subsidence which caused the sedimentary basin, but it might have later localized the crustal stresses which caused the subsidence. However, both anomalies occur a the western end of the Brooks Range, where complicated discontinuities and flexures of geologic and geophysical trends suggest a complex history of geologic stress. Perhaps it is easier to tentatively assume that much broader stress patterns localized two very different types of tectonic activity at two totally different periods in the earth's history. Further study of other geophysical anomalies in a broader area around the lower Noatak Valley might thus provide a better insight into the processes that caused the two unusual geophysical anomalies. For example, scattered gravity measurements in the area outside the mapped area have already revealed gradients as steep as those in the lower Noatak Valley. However, the magnitude of the anomalies that the gradients represent cannot be determined without the use of vehicles which can be used to obtain gravity data away from the water bodies.

The thickness of the crustal section represented by the gravity anomalies and especially the probable 5-mile thickness of the mafic intrusion raises other questions concerning their presence in an area where geologic mapping (Tailleur, 1969) suggests that most mafic complexes are thin and allochthonous. A wide belt of mafic outcrops in the southern DeLong Mountains appears to be lithologically similar to those which crop out on the east side of the Noatak Valley, although a single radioactive age measurement suggests that the Noatak gabbro may be older. Gravity measurements over the northern outcrops have not revealed any highs comparable to that in the Noatak Valley, although most stations are not directly on their outcrops. However, the limited data suggest that these northern mafics are either thinner or less dense. Density measurements in the northern part of the mapped area suggest that both conclusions are possible. Although the available geophysical data strongly suggest that the intrusive in the Noatak Valley is autochthonous, the limited data elsewhere in the DeLong Mountains do not restrict or limit in any way an allochthonous structure for mafic outcrops there.

Sedimentary basins and large mafic intrusions have considerable economic importance in some parts of the world and little economic significance elsewhere. No exposures of economically important rocks have been observed around the Noatak Valley, but the geophysical data do suggest that the largest parts of both the sedimentary basin and the intrusive are covered by alluvium. Additional, more definitive surveys, might provide further evidence concerning any possible economic importance of the geophysical anomalies.

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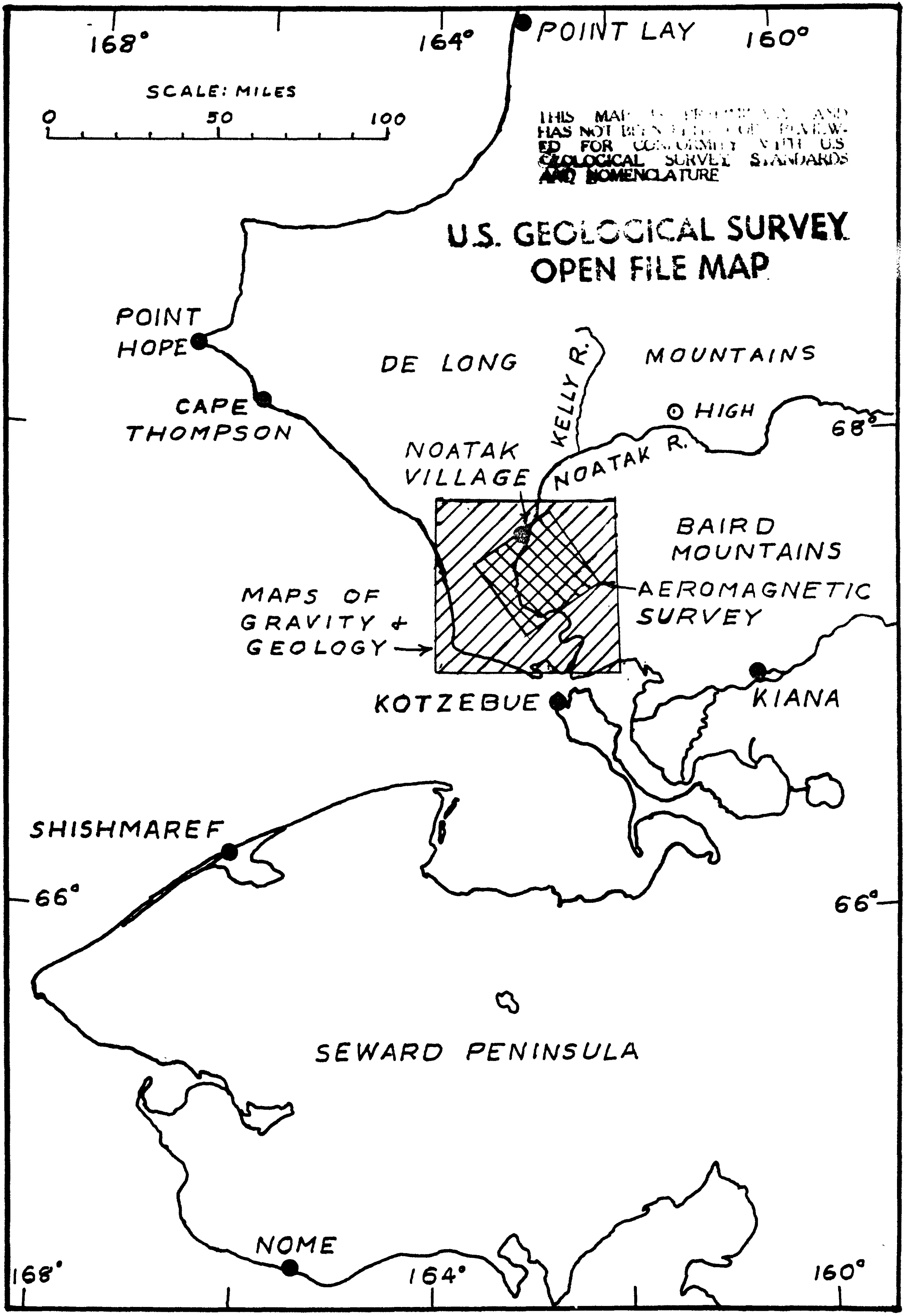

FIGURE 1 - LOCATION OF SURVEYS NEAR NOATAK, ALASKA

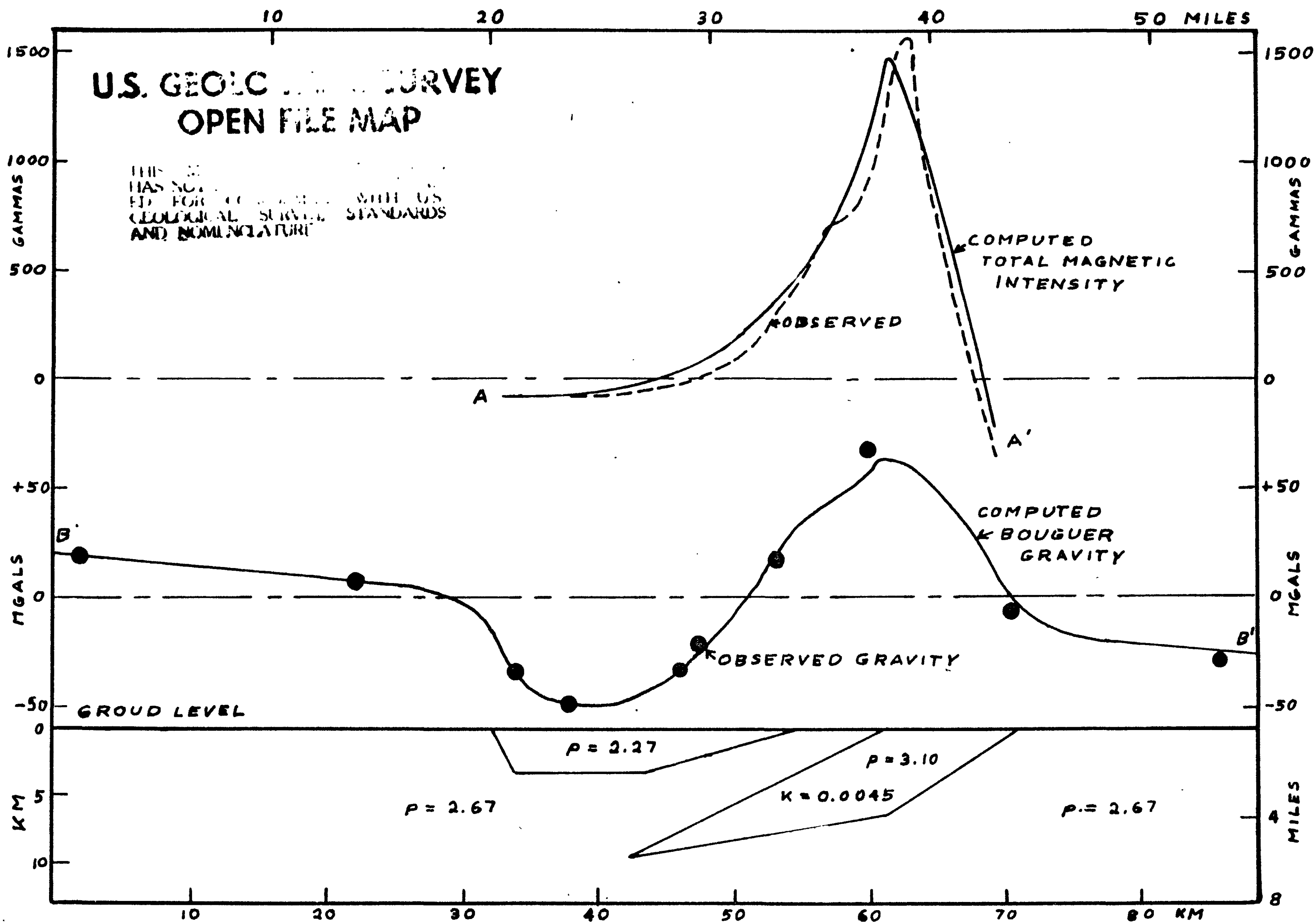

FIGURE 5 - COMPARISON OF OBSERVED AND COMPUTED PROFILES