Dixie Valley aero-magnetics
NED 802 & plates

An Aeromagnetic Investigation of the Dixie Valley - Carson Sink Area, Nevada

T. E. Smith June 1965

AN AEROMAGNETIC INVESTIGATION OF THE DIXIE VALLEY-CARSON SINK AREA, NEVADA

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Thomas Edward Smith

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ABSTRACT

An aeromagnetic investigation of the Dixie Valley-Carson Sink area of western Nevada was conducted in the summer of 1964. Located in the Basin-Range physiographic province, this area is typified by elongate, north-trending, fault-block mountains separated by narrow valleys. Arid climate and extreme temperature fluctuation further characterize the region.

All magnetic measurements were taken with a nuclear precession magnetometer mounted in a light aircraft. Suspension of the sensing head on a long tow cable eliminated magnetic influence of the airplane. Diurnal and regional corrections were applied to all data before analysis.

The many geologic units exposed in adjacent mountains form three principal magnetic mega-units which include: a "Triassic rock" unit consisting of Triassic slate, Triassic limestone, welded tuff, and latite; a Jurassic gabbro complex consisting of diorite, gabbro, anorthosite, dolerite, and basalt; and an unexposed homogeneous unit of magnetic equivalence to the gabbro. Effective magnetic parameters which consider both volume susceptibility and permanent magnetization were calculated for these mega-units.

Gradient analysis, inspection, and model studies of the magnetic data reveal several features of geological

significance. The magnetic basement under Dixie Valley forms an asymmetric, composite graben whose depth is 7,000 to 9,000 feet. Magnetic bedrock under Carson Sink takes the form of a double basin, separated by a subsurface ridge trending south from Lone Rock. The deep western basin is broad in areal extent, whereas the eastern basin forms a narrow, elongate trough parallel to the Stillwater Range. Model studies of magnetic anomalies suggest the gabbroic complex is a tabular body of lopolithic form, whose conduit is located in eastern Dixie Valley.

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INTRODUCTION

Location and Access

The Dixie Valley-Carson Sink area is located in west-central Nevada approximately 100 miles east of the state border. Lying entirely within the Basin-Range Province, the area is approximately bounded by latitudes 39°15' N. and 40°30' N. and by longitudes 117°30' W. and 119°00' W. (See index, Plate 1). The area is accessible throughout the year by U.S. Highway 50 which passes along the southern edge of the project area. Unsurfaced roads trending generally north-south give access to the east and west edges of both Dixie Valley and Carson Sink in most seasons, though occasional washouts occur during summer "cloudbursts." Access to the central parts of the valleys and salt marshes is best facilitated by the use of light planes equipped with oversized tires or by helicopter.

Climate and Land Use

The climate in the project area is, like other parts of the Basin-Range, extremely arid. The dominant control on climate in this region is the presence of the Sierra Nevada about 100 miles to the west. Eastward moving air masses, laden with moisture, are forced up causing heavy precipitation on the western Sierran slope in response to the orographic mechanism. As a consequence, trans-Nevadan air masses are moisture-deficient, creating a generally arid climate. Slight exceptions occur in the higher mountain ranges, where sufficient precipitation occurs to maintain sparse stands of evergreens(See fig. 1). Regional precipitation data suggest that Dixie Valley probably averages less than five inches of rainfall per year, while adjacent high peaks may receive as much as twenty inches (Cohen et al., 1963). In the valleys most precipitation

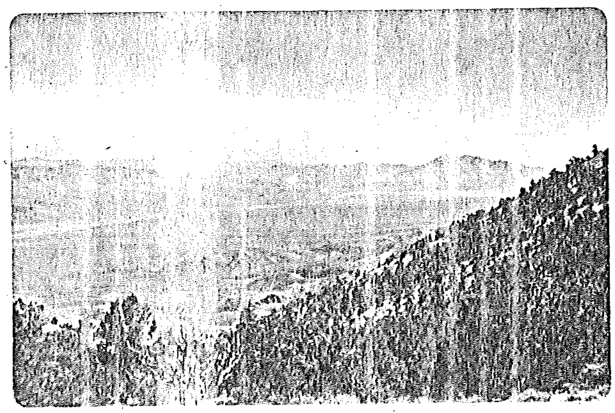

Figure 1. View of Dixie Valley and Fairview Valley from the crest of the Stillwater Range. Fairview Peak is in the background.

occurs during the summer months as rain during sporadic thunderstorms; in the mountains, winter snowfall accounts for most of the precipitation.

Extreme diurnal and seasonal temperature fluctuations further characterize the climate of the area. Moderately high elevation and extreme aridity combine to produce common diurnal variations of 50°F. Seasonal extremes vary from summer maxima of more than 100°F in July and August to slightly subzero minima in winter.

The population of the entire project area is probably less than 100. Most permanent residents of Dixie

Valley earn a living by cattle raising or by raising forage crops such as alfalfa or meadow grasses. During the growing season of 6-7 months, approximately 1000 acres are under cultivation and irrigation. Shallow wells (less than 200 ft.), some of which are artesian, provide most of the irrigation water used in Dixie Valley.

Numerous abandoned mines are present in the adjacent mountains.

Purpose and Scope of the Project

During the summer of 1964, geophysical work was started in the Dixie Valley region under the support of Air Force Contract AF 19 (628)-3867. In an attempt to resolve problems of Basin Range structure e.g., the attitude of the bounding faults in Dixie Valley, the magnitude of relative down drop of the valley block(s) etc., the Department of Geophysics at Stanford University carried out a combination seismic-aeromagnetic study of Dixie Valley and an aeromagnetic reconnaissance of Carson Sink and Buena Vista Valley. The magnetic aspects of the study are considered in the present report.

Principle objectives of the magnetic survey were to extend geologic information obtained from the adjacent mountains, e.g., lithologic contacts, to the valley basement and to supplement structural information obtained by seismic-refraction and/or gravity methods along a few restricted profiles on the valley floor. Additionally, construction and analysis of an aeromagnetic map were expected to yield both a general picture of the basement geometry under Dixie Valley and more detailed information through model studies.

Previous Work

Earlier work in the Dixie Valley-Carson Sink region and adjacent mountains has been primarily of a geologic nature, the subsurface studies being limited to hydrologic investigation from shallow well data (Cohen et al., 1963). The stratigraphy and structure of the extreme north end of the project area has been discussed by Muller and others (1951). Most useful to the present project has been the recent mapping of the Stillwater Range and parts of the West Humboldt and Clan Alpine Ranges by Page and Speed (1964, 1963, respectively).

Geophysical work in and near the project area has been limited to a reconnaissance gravity survey of Dixie Valley (Thompson, unpublished), a recent gravity survey of the Carson Sink-West Humboldt region (Wahl, 1965), and a complete geological-geophysical investigation of the Sand Springs Range-Fairview Valley-Fourmile Flat area to the south of the present project. (Nev. Bur. Mines, et al., 1962)

Acknowledgements

The writer is indebted to Sheldon Breiner of Varian Associates for the loan of a magnetometer and accessory equipment and for the recording of total intensity background during periods of aeromagnetic measurement. Dr. R.C. Speed of Jet Propulsion Laboratory has been extremely helpful in providing an additional magnetometer and in providing geologic information concerning adjacent mountain ranges. Sincere gratitude is expressed to Professor J.L. Soske and Professor G.A. Thompson for their assistance and counsel and to Professor B.M. Page for geologic information concerning the Stillwater Range, Nevada. Thanks are also due to Mr. and Mrs. Chester Knittle for permission to camp at the Crazy K Ranch and to my wife Judy R. Smith for reduction of all magnetic measurements and for her helpful criticism of this manuscript.

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GEOLOGIC SETTING

Physiography

Situated in the Great Basin, the Dixie Valley-Carson Sink area displays typical features of that physiographic province i.e., elongate north-trending mountain ranges border intervening valleys of relatively narrow width. The ranges bordering Dixie Valley i.e., the Stillwater on the west and Clan Alpine on the east, are deeply dissected, complex fault block mountains rising to as much as 4000 feet above neighboring valleys. The mountains are bounded in general by steeply-dipping north-trending normal faults along which relative displacements of thousands of feet have occurred. These displacements have resulted in the orderly topographic pattern which typifies this province.

Mountain ranges in the project area are, without exception, flanked by broad coalescing alluvial aprons. Where the valleys narrow, conjugate fans from opposite sides intertongue. It is this effect which separates Fairview Valley from Dixie Valley. More generally, however, the aprons dip gently valleyward to the valley floor proper, the lowlands of which consist of playa or salt marshes (See fig. 2). These are occasionally flooded to depths of several inches during the wet season. Marking the termination of the Carson River which provides abundant surface water throughout the year, the Carson Sink is anomalous among the Basin-Range valleys (See fig. 3).

<u>Major Rock Units</u> (adapted from Page, 1964)

Triassic Rocks--Most important of the rock units in the central map area is a large expanse of gray-black, grayish-weathering <u>slate</u> and <u>phyllite</u>. Slaty cleavage throughout this unit generally parallels bedding except near axial parts of folds where it approaches the axial plane. For the most part, only incipient recrystallization is evident; however, near granitic contacts, andalusite formation has been observed (Page, 1964).

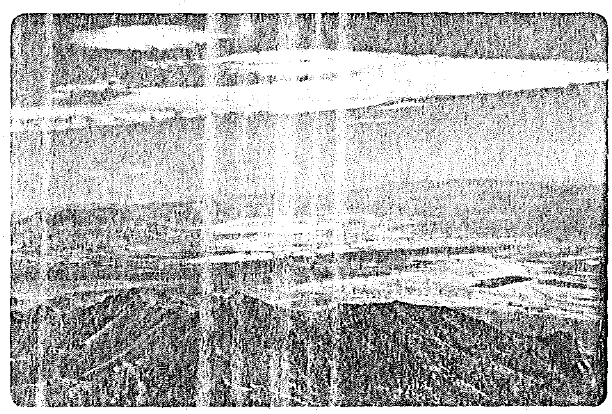

Figure 2. View of Dixie Valley looking north. Job Peak is in foreground.

Intercalated throughout the slate sequence are thin interbeds of feldspathic metaquartzite, displaying an abundant variety of primary features including flute casts, crossbedding, and apparent ripple marks.

Locally the slate sequence is interrupted by beds of gray-weathering limestone which vary in thickness from approximately 1 foot to 5 feet. Many of these are calcarenites , some containing bioclastic material.

Complex deformation of the unit prohibits direct measurement of the slate-phyllite-limestone sequence, but Page estimates its thickness at 5,000 to 10,000 feet, of which only about 10 percent is metaquartzite and limestone.

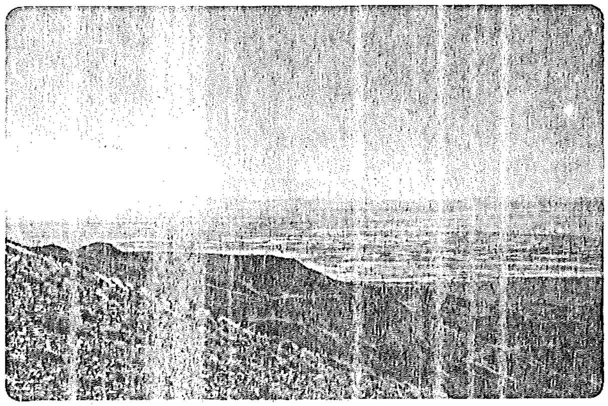

Figure 3. View of Carson Sink looking south from Job Peak.

Fossil identification has placed the age of this unit as Late Triassic. Chronologically, this sequence is probably equivalent to the Grass Valley, Dun Glenn, Winnemucca, and Raspberry formations of the Mount Tobin and Winnemucca quadrangles.

A relatively large body of allochthonous black to gray Upper Triassic limestone is present in the southern part of the project area. Fossil evidence indicates this unit is of the same age as the Upper Triassic slate upon which it rests, implying significant lateral transport of rocks formed in a different sedimentary environment.

Jurassic Rocks--Areally bordering the Triassic limestone in the southern end of the Stillwater Range is a sequence of altered and locally schistose metavolcanic rocks (Jmv, Plate 1). These consist of fine-grained slaty andesitic tuffs, schistose andesitic tuff-breccias, breccias, thin andesitic flows, graphitic slate, quartzite, calcareous sandstone, and thin conglomerate lenses. The volcanics are almost completely altered, but display certain relict textures. Probably of marine origin, this unit is in excess of 5,000 feet thick. Resting unconformably upon the allochthonous Triassic limestone, the metavolcanics are thought to have been transported in as part of the La Plata thrust sheet (Page, 1964).

A second major Jurassic unit of magnetic importance is composed of extensive basalt flows and other volcanics (Jb), which cover large areas in the Stillwater Range north of latitude 39°49' N. These occur as flows, lapilli tuffs, tuff breccias, and breccias. Alteration is common, epidote and chlorite imparting a distinct green color. The rocks appear to be petrographically identical to similar rocks found in the West Humboldt Range across Carson Sink (Page, 1964). Normally associated with the Upper Jurassic gabbroic complex, these rocks are quite possibly contemporaneous with and may represent an extrusive equivalent of the gabbro.

Of greatest importance to the present magnetic study is a large, seemingly tabular complex of gabbroic and dioritic intrusions (Jdg, Jg, See Plate 1). This complex and the Jurassic basalt dominate the northern section of the map area, occurring in the Clan Alpine and West Humboldt Ranges as well as in the Stillwater. These rocks form an igneous unit which includes hornblende gabbro, diorite, picrite, anorthosite, dolerite, keratophyre, and gabbroic pegmatite. Distinct layering is evident in the earlier parts of the suite along intrusive margins. This unit has been carefully studied by R.C. Speed who considers it to have been emplaced at very shallow depths, in places penetrating to the surface and forming the extrusive basalts discussed earlier. A potassium-argon date from the West Humboldt indicates an age of about 150 million years, placing it chronologically in Late Jurassic time. Profound alteration including albitization and dolomitization is common in this unit.

Tertiary Rocks--In the area of the Stillwater near Job Peak and to the south, lavender or blue-gray weathering latite is abundant (Tml, Plate 1). The groundmass consists primarily of microcrystalline feldspar laths, some of which are sodic in composition. With the exception of sparse, unaltered K-feldspar phenocrysts, megascopic minerals are absent. In addition, rhyolitic tuffs and latite breccias are locally present with the flows. Exposed sections of the unit show a thickness of 2,000 to 6,000 feet. Near intrusive contacts with Oligocene or Lower Miocene granite, recrystallization and darkening are common.

Much of the exposed rock south of Job Peak in the

Stillwater consists of an undifferentiated volcanic unit whose composition probably ranges from latite through silica-rich rhyolite. This sequence is mapped as devitrified welded tuff. Curiously resembling porphyries, these gray to brown weathering rocks are extremely competent, so that joint systems and topography are generally independent of original structures. Megascopically, only the presence of angular lithic fragments of Triassic slate, latite, and other volcanics attests to the pyroclastic origin of this unit. Flattened shards and microscopic banding are observable in thin section.

This entire sequence, varying in thickness from 2,000 feet to possibly 10,000 feet, unconformably rests on Upper Triassic slate and limestone and on Jurassic metavolcanics. Along the east side of the Stillwater, the devitrified tuff has been intruded by Miocene or Oligocene granitic rocks and white felsite dikes (See fig. 4).

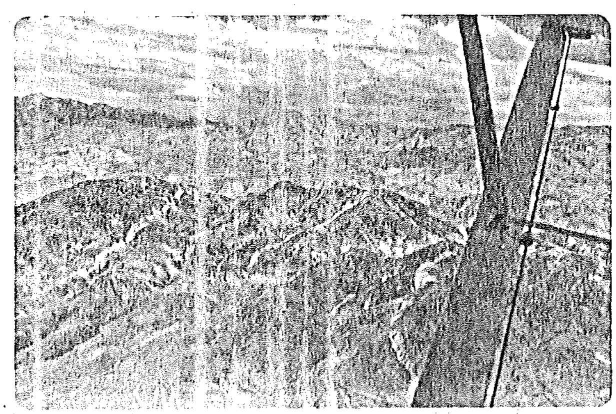

Figure 4. Felsite dikes in Louderback Mountains.

A second group of Tertiary extrusive and intrusive rocks is grouped under the heading Basalts and Andesites (Tm). The intrusive rocks of this group invade the devitrified welded tuff and older formations near the center of the project area. Extrusives of similar composition totaling about 8,000 feet in thickness are exposed south of Cox Canyon. Altered flows, breccias, and tuffs of this unit unconformably overlie Upper Triassic slate north of Alameda Canyon.

Scattered plutons of Late Cretaceous or Tertiary granite, quartz monzonite, and granodiorite are exposed in the map area. The latter two (Tg) intrude latite and devitrified tuff near Job Peak (See Plate 1), where they form a composite unit consisting of several successive intrusions. A potassium-argon date on biotite from the granodiorite in IXL Canyon indicates an age of about 28 million years.

Capping much of the Stillwater Range is a sequence of post-granitic Miocene(?) volcanics including tuffs, breccias, and flows which vary in composition from latites through dacites and rhyolites (Tv). Intensive local alteration is common, although the silicic members retain fresh biotite and glass. Dissections expose only 1,800 feet; however, total thicknesses may be on the order of 3,000-4,000 feet. In other parts of the area, rocks belonging to this unit are included within the undifferentiated pre-Lahontan sediments and volcanics (Tsv, shown on Plate 1).

Pliocene sediments and tuffs (Ts) cover a relatively minor part of the map area, being prevalent only in the southern Stillwater Range. There, up to 1,500 feet of the sediments are exposed in dissected pediment slopes and low hills. Of lacustrine and fluvial origin, locally including ash beds, this unit is probably equivalent to the Truckee Formation farther to the west. In places overlying the Pliocene sediments and other earlier units along the length of the Stillwater Range are flows of olivine basalt and basaltic andesite (Qb). Individual flows vary in thickness from 20 to 100 feet, though locally aggregate thicknesses of 1,600 feet have been noted.

Late Cenozoic Lake Sediments--In the late Cenozoic valleys of the Basin-Range province, great thicknesses of essentially unconsolidated lake sediments are present (Labelled Lake Sediments on cross-sections). These range in age from Plio-Pleistocene to Recent and include alluvial fan detritus, stream channel deposits, and lacustrine sediments. The latter were deposited in lakes and consist for the most part of silt and clay, although shoreline deposits of gravel and sand exist locally. It is quite possible that the sedimentary section is punctuated with interbedded Plio-Pleistocene volcanic flows; evidence for one such flow has been found near IXL Canyon by seismic refraction techniques (Meister, personal communication, 1964).

Major Faulting of the Stillwater Range

Thrust Faults--An apparent structural base of the Triassic slate is exposed in Cox Canyon in the central part of the project area. There, a shale member of the slate discordantly rests on quartzite, a distinct zone of brecciated shale marking the contact. South of Cox Canyon, the quartzite overrides Jurassic(?) metavolcanics which in turn are thrust upon an undated limestone. Apparently, these several units form a superposed section of an imbricate thrust zone. Page suggests this zone may underlie all slates of the Stillwater Range (Page, 1959).

North of Dixie Meadows, another thrust fault structurally higher than the Cox Canyon zone is evident. This zone is well exposed in Cottonwood Canyon near Boyer Ranch where quartzite of unknown age and gabbroic rocks have overridden Upper Triassic slate. That shallow intrusion of the molten gabbroic complex has propelled the thrust sheet has been suggested by Speed and Page (1964). The gabbroic rocks of the upper plate extend across the entire north end of the region covering an area of about 500 square miles. Dating of the gabbroic rocks as Late Jurassic implies a similar age for the thrusting.

Cenozoic Faulting--Typifying late Basin-Range structure, the Stillwater Range is essentially an uplifted horst of narrow, elongate N-S blocks separated by Cenozoic normal faults. Deformation of the Plio-Pleistocene basalts attests to minor tilting as well as simple displacement. In some cases, normal faults interior to the range become the bordering fault where they extend to the range margins.

COLLECTION AND REDUCTION OF MAGNETIC DATA

Collection

All magnetic measurements were made using a Varian M-49 nuclear precession magnetometer (See fig. 5). Because the sensing head is, for the most part, insensitive to orientation and slow oscillations, this instrument lends itself well to airborne use. In addition, low cost of the sensing unit allows flexibility in low flying over undulating terrain. For this survey, 100 feet of transmission cable supported by a nylon tow cord connected the instrument package to the sensor. It was found that this distance effectively eliminated magnetic interference from the plane, regardless of flight orientation. To prevent roll and to minimize yaw of the "bottle", the towing cable was attached to a front edge of the sensor and a stabilizing tail was affixed to the rear (See fig. 5).

The Varian instrument provides facility for either manual or automatic actuation of the polarization-readout cycle. By internal adjustment, the repetition rate can be set to a minimum of about six seconds. At an airspeed of 90 mph, this cycling rate would give a station spacing of about 800 feet along the profile line. In practice, it was found that engine noise of the airplane made it impossible to hear the cycling of the instrument. As a result, occasional stations were missed by the operator, especially when flying in steep magnetic gradients. A more efficient method was adopted in which the operator polarized the sensor manually, taking a reading at ten second intervals as determined by a stop watch. These values and pertinent location information were recorded by

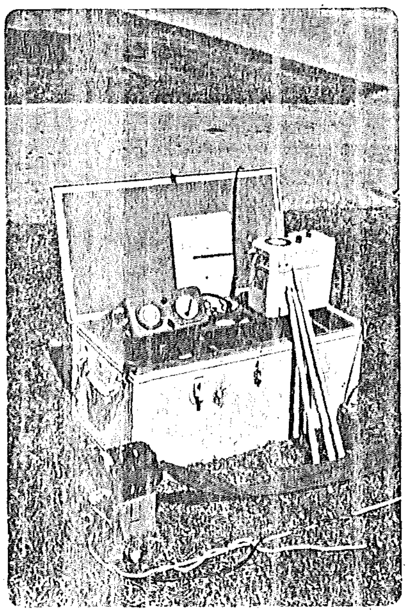

Figure 5. Varian M-49 magnetometer equipped for aeromagnetic use. Note nylon two cable and stabilizing tail on sensing head.

a third person in the airplane.

All measurements were made from either a Cessna 180 or a Piper Super Cub (See fig. 6). In general, the latter was found to perform better at the low airspeeds needed for desired station spacing. For the present project, the additional feature of large "balloon" tires greatly facilitated frequent landings in all types of terrain. Close control of flight elevation was thus possible by recalibration of the plane's barometric altimeter whenever the ground elevation was known. Using this technique, it is estimated that elevations accurate to within 50 feet have been maintained throughout the survey. Control of position was accomplished by setting up a series of ground check points over which the pilot would fly, indicating to the recorder when they were beneath the plane. Positions accurate to about 700 feet were obtainable by this method.

Figure 6. Piper Super Cub towing magnetic sensing unit.

In the subsequent plotting of data points, readings were distributed linearly between check points, thus compensating for slight variations in groundspeed, headwinds, etc.

Corrections Applied to Data

During periods of aeromagnetic measurement, a continuous monitor of total intensity was carried out by Varian Associates in Palo Alto, California ($37^{o}30'$ N., $122^{o}05'$ W.) using a rubidium-vapor station magnetometer. Plots of these recordings are shown in Appendix B. Variations from a reference level of about 51,400 gammas were applied to all survey data, (0=51,400 gammas on background graphs).

A linear gradient of about two gammas per mile in a direction N 30 E was used in determining regional corrections (From U.S.C. & G.S. map, 1955). All station values were plotted on a map together with a planar, contour representation of the regional gradient. Each value was then corrected in accordance with its position in the contoured field. After correction in this manner, crossing profiles generally agreed to within 15 gammas at points of intersection.

MAGNETIC PROPERTIES OF THE GEOLOGIC UNITS

Magnetic Megaunits

Inspection of the isoanomalic map and of profiles across the area reveals that the many rock units conveniently divide themselves into three principal magnetic megaunits. The first and southernmost of these includes Triassic slate and overlying welded tuff, latite, etc. (Labelled Triassic Rocks on the cross sections); the second includes a heterogeneous distribution of gabbro, diorite, anorthosite, dolerite, and Jurassic basalt (Labelled Gabbroic Complex on cross section); and the third an unknown geologic unit(s) of approximate magnetic equivalence to the gabbro. This third unit, bordering the gabbroic complex on the north, appears to be considerably less heterogeneous and probably forms a magnetic basement beneath the exposed Tertiary sediments and volcanics of that region.

Effective Susceptibilities

In this investigation, two methods of determination were used to ascertain the magnetic susceptibilities necessary for quantitative analysis; the first is based on inferences derived from magnetic profiles and the second on samples collected from the area. Supplementing the limited number of specimens collected by the writer in the Stillwater Range is a variety of typical samples collected by R.C. Speed while mapping in the Clan Alpine, West Humboldt and Stillwater Ranges. From cores of these samples, volume susceptibilities, permanent magnetization magnitudes, and densities were determined. A tabulated summary of these properties is included in Appendix A. Because of high average values of permanent magnetization, especially in the gabbroic complex, it was necessary to consider relative effective susceptibility contrasts across contacts of the megaunits. The general method outlined below has its basis in techniques discussed by Green, Hays and Scharon (1960, 1963, respectively), which consider the effect of remanent intensity as well as induced effects in adjoining rock units.

Given two contiguous rock bodies having volume susceptibilities k_1 and k_2 and permanent magnetizations $\overline{P}_1$ and $\overline{P}_2$, resulting magnetizations ($\overline{J}$) can be expressed by

(1)
$$\overline{J}_1 = \overline{P}_1 + k_1 \overline{T}_o$$
$$\overline{J}_2 = \overline{P}_2 + k_2 \overline{T}_o$$

where $\overline{T}_o$ is the geomagnetic field intensity. The magnetization contrast between rock 1 and rock 2 is then given by

(2)
$$\overline{J}_t = \overline{J}_1 - \overline{J}_2 = \overline{P}_1 - \overline{P}_2 - (k_1 - k_2) \overline{T}_o$$

For bodies possessing induced components of magnetization (I), susceptibility is given by

(3)
$$k = \frac{I}{T}$$

Analogously, in this case, the relative intensity contrast $\overline{J}_t$ is that which would be induced in the units if the susceptibility contrast were

(4) $$\Delta k_t = \left|\frac{J_t}{T_o}\right| \text{, where } \overline{J}_t \text{ parallels } \overline{T}_o.$$

This value is referred to as the effective susceptibility contrast.

In the absence of a paleomagnetic survey, certain assumptions regarding direction of remanent magnetization are necessary. All analyses in the present report assume that the permanent component of magnetization in the gabbroic complex parallels the present direction of the geomagnetic field. Because the Jurassic pole position was located very close to the present position and because no indication of field reversal or of excessive deformation in the gabbro is evident, this assumption is probably justified. Moreover, extreme deformation and partial recrystallization of the Triassic slate is assumed to have effectively cancelled permanent components within that unit. With these assumptions, equation (2) becomes

(5) $$\overline{J}_t = \overline{P}_1 + (k_1 - k_2)\overline{T}_o$$

where rock 1 is gabbro, rock 2 is Triassic slate. An average of properties from typical gabbro samples T-0, T-14, T-15, T-16, JD-384, JD-373, and SW-138 gives values for k_1 and $\overline{P}_1$ of

$$k_{1\ av} = 1700 \times 10^{-6} \text{ cgs}$$

$$\overline{P}_{1\ av} = 38\ \text{e.m.u./cc}$$

Over the "Triassic rock" basement to the south, the measured average intensity level is about 53,300 to 53,400 gammas (See Plates 6 and 7). Using the expression for a semi-infinite body in a total field of inclination i (See Reford et al., 1964), the following relation holds:

(6) $$\Delta\overline{T} = 2\pi k\,\overline{T}_0 \sin^2 i$$

or

(7) $$k = \frac{\Delta\overline{T}}{2\pi \overline{T}_0 \sin^2 i}$$

With a total field value of 53,000 gammas (from U.S.C. & G.S. map, 1955) and an inclination of 68°, the susceptibility of the "Triassic rock" megaunit is approximately 1000×10^{-6} cgs. Corroborating this calculated value, samples of volcanic members of this unit give values of 910 to 930 $\times 10^{-6}$ cgs. Calculation of $\overline{J}_t$ from (5) using these values of $\overline{P}_1$, k_1, and k_2 yields $\overline{J}_t = 125$ gammas. From equation (4), the effective susceptibility contrast between gabbro and Triassic rocks is then given by

$$\Delta k_t = 2350 \times 10^{-6}\ \text{cgs}$$

In an attempt to eliminate reliance on rock samples, the expression (7) derived by Gay and Hall (1963 and 1959 respectively) for two-dimensional, semi-infinite, adjacent bodies was used to calculate an effective susceptibility contrast between the units. The anomaly $\Delta\overline{T}$ was determined from several N-S profiles in Dixie Valley and along the Stillwater Range which show an increase in base level of 300 gammas when the contact between gabbroic and Triassic rocks is crossed (See Plates 2 and 6). With a base level of 53,350 gammas over the slate, a base level of 53,650 gammas over the gabbro and an inclination of 68°, Δk_t = 1000 x 10^{-6}cgs. This clearly represents a minimum value since the two rock masses are semi-infinite in dimension. Most probably this value and the one determined using measured remanent intensity magnitudes are limiting values of the k-parameter, the actual value falling somewhere between. For purposes of analysis in this paper, the effective Δk_t between gabbro and Triassic rocks is considered to be 1800 x 10^{-6} cgs.

ANALYSIS OF THE MAGNETIC DATA

Subsurface Contacts of the Gabbroic Complex

Dixie Valley--Dominating the center of the total intensity map is a broad band of sharp anomalies exhibiting numerous closures of high magnetic relief (See Plate 2). Magnetic character of this zone is even more striking on the second vertical derivative representation (Plate 3). The southernmost margin of this magnetic province is marked by a linear set of transverse contours trending N 45 W from Cow Canyon to Dixie Hot Springs. It is believed these isoanomalic lines represent an increase in magnetic base level across the transition from Triassic slate basement in the south to gabbroic basement in the central part of the valley. Supporting this interpretation, a similar change is noted across the gabbro contact on the control profile flown along the Stillwater Range where geology is known (See Plate 6). By connecting the profile inflection points, the subsurface border of the complex can be mapped across Dixie Valley (Shown on Plates 1 and 2).

Control on the position of the northern contact of the complex is less exact in both Dixie Valley and Buena Vista Valley since an analogous shift in magnetic base level is not evident. An approximate boundary can be established, however, by correlating the northernmost extent of the heterogeneous magnetic province with the exposures of gabbro in the adjacent mountains (See Plate 1). Such a boundary roughly connects the gabbro exposure at Hole-In-The-Wall with the one north of Boyer Ranch, implying the numerous closures, locally dipolar anomalies, and high total intensities observed in the center of the map are characteristic of the gabbroic complex and, furthermore, that they are primarily a consequence of the heterogeneous lithology of the units (See page 10) rather than of subsurface topography.

Carson Sink--Reconnaisance profiles flown in this area establish two points on the southern contact of the complex. The inflection point marking base level transition on profile AA-AA' (See Plate 5) correlates well with a contact projected from the West Humboldt exposure of this unit (See Plate 1). In contrast, profile BB-BB' shows no evidence of gabbro south of the exposure in the Buena Vista Hills, suggesting that either the contact between profiles is quite sinuous or that structural effects, e.g., left-lateral strike-slip faulting, have laterally offset the contact. The northern boundary of the complex is not determinable on profile CC-CC'.

Linear Anomalies and Subsurface Fault Systems In Dixie Valley

Trending north along the axis of Dixie Valley and only slightly less evident than the southern margin of the gabbro is a longitudinal, linear trend of anomalies

(See Plate 2). Farther to the west, approximately three miles from, and paralleling the east flank of the Stillwater Range is another elongate anomalic trend which is generally more subdued than the first. Additional emphasis of these trends was obtained by constructing a second vertical derivative map using a 1.3 mile grid spacing (Described by Henderson and Zietz, 1949. See Plate 3).[1] Correlation of these anomalic trends with faults located by seismic refraction methods (Meister, 1964) implies they may be edge effects associated with major subsurface fault systems (See Plates 3 and 4). By this interpretation, the basement under Dixie Valley is suggestive of a composite, asymmetric graben whose downthrown block is about three miles wide and lies under the western half of the valley. The blocks bordering the graben are downthrown with respect to the adjacent ranges, but to a lesser degree.

In addition to the longitudinal trends, several linear transverse anomalies are in evidence. These are located for the most part on the eastern upthrown block and trend obliquely (about N 25 W) to the major features. Determination of depths by gradient analysis on either side of these transverse anomalies and coincidence with projections of known faults from the adjacent mountains provide two lines of evidence that the anomalies are magnetic expressions of displaced fault blocks (See Plate 3).

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[1] A program in BALGOL to compute second vertical derivatives is included as Appendix C.

In general, magnetic indication of large strike-slip displacements along the longitudinal faults is not manifest, even along the marginal faults of the ranges. An exception does exist, however, along the central longitudinal fault system. There, nearly all anomalies with a transverse strike are deflected one to three miles in a right-lateral direction (See Plate 2). A tendency for smaller deflections of the same sense continues north to the tip of the Tobin Range, intimating this same fault may become the marginal fault bordering the range.

<u>Topography of the Magnetic Basement</u>

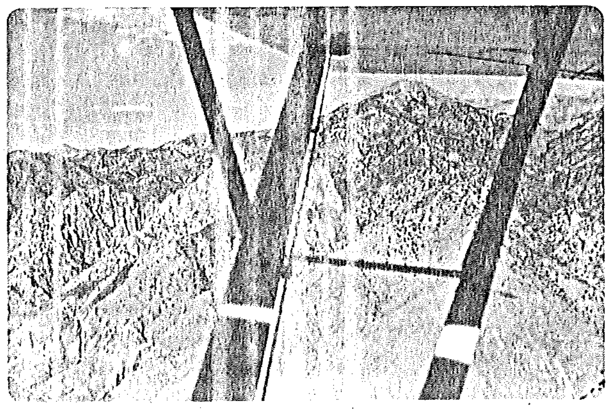
Depth Estimation Methods--In studies of sedimentary basins, techniques of depth determination are generally employed in order to delineate the configuration of the magnetic basement. Most such methods are derived from potential expressions and operate on magnetic gradients. By some graphical means, the horizontal extent of a gradient is obtained, after which this "depth index" is then converted to actual depths below the point of measurement. Gradient methods of this type are usually independent of assumptions regarding specific rock parameters such as volume susceptibility and permanent magnetization. Because of this independence, the methods constitute extremely powerful techniques for aeromagnetic work where such parameters are indeterminable. The only constraint on rock properties is that they must remain relatively constant within the assumed geometric models. One additional limitation on these methods does exist, however, in that certain geometrical requirements of the disturbing body influence the choice of a constant by which the depth index is multiplied to give actual depth. In this sense, the methods are to a degree empirical, requiring either assumptions regarding the shape of the disturbing body or adequate geologic control in surrounding areas which can be extrapolated to the area of interest. In the present survey, detailed mapping of adjacent mountains indicates that dike models of intermediate thickness are probable shapes for anomalous subsurface bodies (See figures 4, 7, and 8).

Figure 7. Dike-like body of Triassic sediments in gabbroic complex.

Peters and Sokolov have discussed the theory and application of similar methods which assume this model (1949 and 1956 respectively).

Peters' method of depth estimation is particularly applicable in higher magnetic latitudes where the horizontal magnetization is small with respect to the vertical component. If the disturbing body is a two-dimensional dike with vertical contacts and with a lower end extending to more than twice the depth of burial, the resulting anomaly appears effectively "unipolar." In such a case, the depth index I_d is found by noting the points where

Figure 8. Diabase dike near Job Peak.



a line of half the maximum gradient is tangent to the anomaly curve. Actual depths (Z) are then determined from the expression

$$(8) \qquad Z = \frac{Id}{C}$$

where C is a constant determined from widths of the model. For a two-dimensional sheet, C equals 1.2, while for a semi-infinite block, C equals 2.0. For this survey, the constant was adjusted to agree with a control profile flown over the Stillwater Range. A value of 1.35 for C was found to give accurate depths along the entire profile (See Plate 6) and to give depths elsewhere which agree closely with other geophysical methods (Meister, personal communication, 1965). Using this empirically determined value, depth estimates in this report have been calculated from the equation

$$(9) \qquad Z = \frac{I_d}{1.35}$$

Dixie Valley--Applying this expression to depth indices from all Dixie Valley profiles parallel to usable gradients, it was possible to construct a topographic map of the magnetic basement (See Plate 4). Valley fill between the reference plane (elev = 3500') and this magnetic surface is thought to consist mainly of Pliocene sediments, Pleistocene-Recent lake sediments, and possible volcanic flows as described earlier. Most dominant of the features revealed by this map is a longitudinal trough whose axis parallels the Stillwater Range about four or five miles out from the flanks of the range. Close spacing of depth contours along the edges of the trough lends confirmation to the fault-bounded graben alluded to in an earlier section. Both the anomalic trends and fault locations determined by seismic refraction fall on these closely spaced contours (See Plates 2,3, and 4). Seismic depths on the valley blocks adjacent to the graben also agree quite well; however, depths in the bottom of the trough appear to be shallower by about 2,000 feet than those determined by the seismic methods. In part, this shallowing effect is to be expected since the original model assumption of a flat basement is violated along the axis of the graben. More important than this particular depth problem, however, is the fact that the bordering faults of the graben can be quite accurately extended between points of seismic control.

A second feature shown in the northeastern part of the depth map is an apparent transverse fault which trends approximately N 40 W. The block to the north shows about 2,000 to 3,000 feet of uplift with respect to the southern block. A seismic refraction profile across the southwest corner of the uplifted block indicates a fault which coincides closely in both location and magnitude of throw (Meister, 1965). Additional evidence for the existence of this feature is the remarkable coincidence with projections of transverse faults in the Clan Alpine Range (Shown in heavy black lines, Plate 4).

A similar deflection of depth contours is present approximately 10 miles to the southwest, suggesting a transverse fault with displacement in the same sense, but of about 1,000 feet. Subsurface connection of this feature with the oblique-trending fault exposed near Dyer Canyon is possible.

Finally, the depth map clearly delineates an equidimensional topographic high in the southeast part of Dixie Valley. Probably representing a "buried mountain" of gabbro, this high coincides exactly with a closed magnetic high of approximately 500 gammas (See Plate 2).

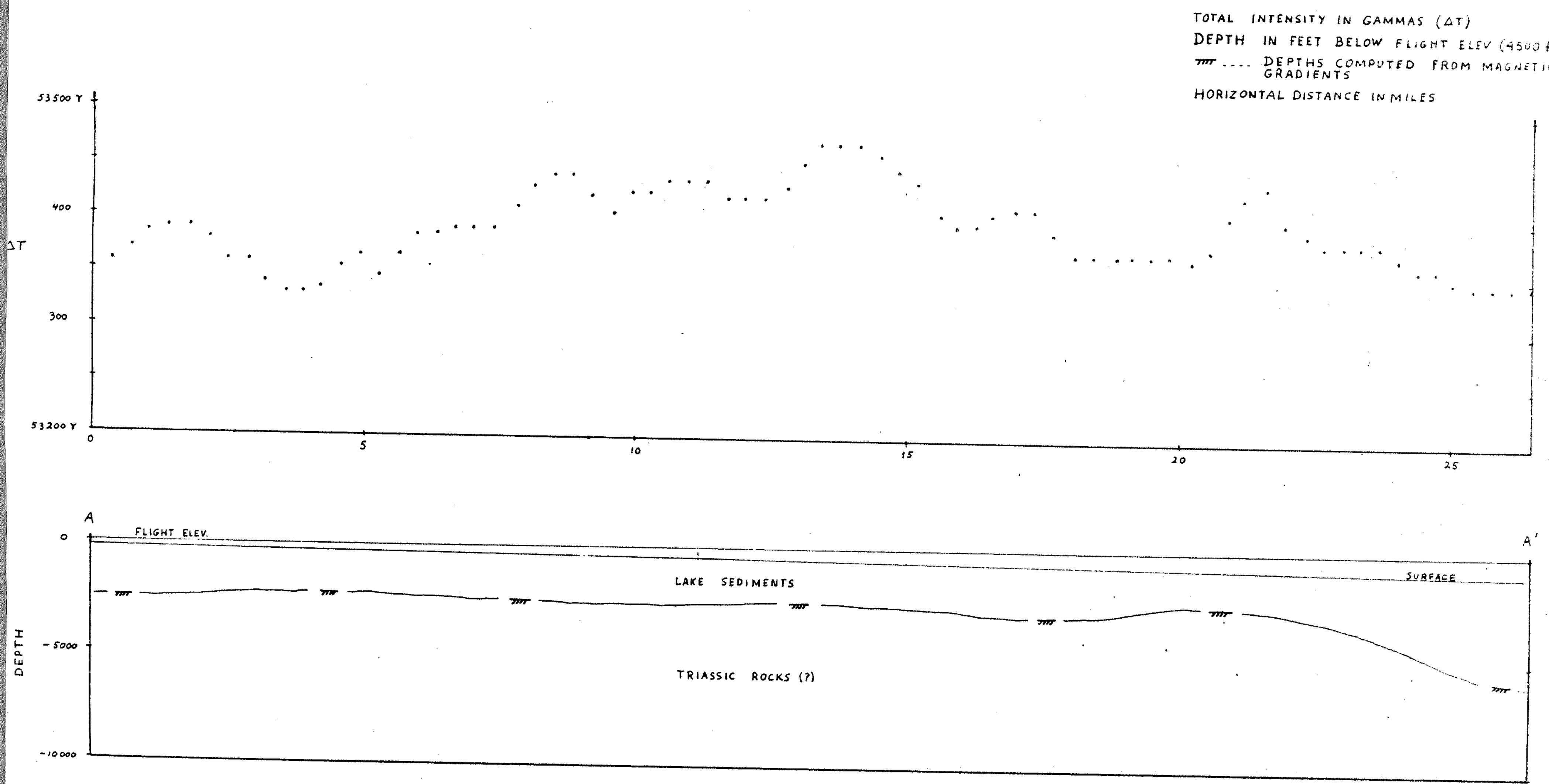
Application of the depth expression to the extremely steep gradients across the magnetic high places the top of the mountain between 400 and 1,000 feet below the valley surface. Total topographic relief above the mean level of the east valley block is probably about 2,000 to 3,000 feet.

Dixie-Fairview Profile--The same method of depth determination was used on the reconnaissance profiles flown in Carson Sink and in south Dixie Valley. Because the observed gradients are apparent, i.e., they may angularly traverse a gradient trend, all depths computed along the isolated profiles probably represent maximum values.

A cross-section from Highway 50 north to Dixie Valley (See Plate 7), computed from apparent gradients, suggests that a fairly constant depth of 2,500 feet exists between Fairview Valley and Dixie Valley. That such constancy of depth might be present is not obvious on the surface where a definite constriction of the valley is evident. Appreciable depth is attained only at the north end of the profile where it passes onto the south end of the longitudinal trough.

Carson Sink Profiles--Two longitudinal profiles extending from near Fallon, Nevada, northeast to the Buena Vista Hills give evidence of a broad, deep basin under the center of Carson Sink (See Plate 5). The magnetic gradients indicate the apparent depth of this basin is

PROFILE A-A' – DIXIE VALLEY + FAIRVIEW VALLEY



approximately 8,000 feet, a depth which agrees well with a recent gravity study of the area (Wahl, 1965). An examination of the same gravity data further reveals that Profile BB-BB' runs nearly along the axis of a subsurface ridge trending N 35 E, the surface expression of which is Lone Rock in the northern part of the Sink. Because this profile apparently crosses major structures and their associated anomalies at a very low angle, the anomalies are deceivingly long in horizontal extent. The writer believes this effect is responsible for the length of the "edge" anomaly observed on Profile BB-BB'.

At the north end and just south of the center of Profile AA-AA', the magnetic base level rises to a value characteristic of the gabbroic complex. At the extreme north end, however, the magnetic field value first decreases sharply to the north, then rises beyond the range of the instrument. This effect is characteristic of dipolar bodies and is interpreted in this case as the magnetic expression of shallow magnetite bodies, a few of which are currently being mined. Similar anomalies exist at the south end of the Buena Vista Profile CC-CC', and at the north end of Profile BB-BB', implying the N-S width of the magnetite-rich gabbro zone is nearly two miles.

In addition to the longitudinal profiles, a transverse line was flown from Shanghai Canyon to the Humboldt Range (See Profile DD-DD', Plate 5). Only three depth determinations were obtainable along this profile, the center one of which establishes the position of the sub-surface ridge mentioned previously.

Model Studies of the Magnetic Units

Basalt Flows--Few of the observed magnetic anomalies over the area exhibit the dipolar form, steep gradients, and limited horizontal extend expected of magnetic edge effects over shallow volcanic flows. If, however, as discussed in the previous section, the apparent anomaly near the south end of Carson Sink Profile AA-AA' is projected onto a section trending N 60 W, a classic edge effect is the result. Because the projected section is nearly perpendicular to the magnetic meridian, the vertical intensity anomaly ΔV is of the same form as the total field anomaly ΔT, the latter requiring only an adjustment of magnitude in order to use analytical methods developed for vertical intensity profiles. The conversion to vertical intensity is readily accomplished using the following expression:

$$(10) \qquad \Delta \overline{V} = \Delta \overline{T} \sin i$$

where i is the field inclination. Moreover, since anomalies observed in the entire area are no greater than 1,000 gammas, an addition of the disturbing vector with the average field $\overline{T}_o$ of 53,000 gammas produces no significant change in direction e.g., if the disturbing vector is orthogonal to $\overline{T}_o$, the deflection of i (Δi) is maximum and

$$\tan \Delta i \leq \frac{1,000}{53,000} \simeq 0.0189$$

or

$$i \leq 1^{\circ}5'$$

As a consequence, in this case no appreciable error is introduced in converting to vertical intensity by use of equation (10). The resulting profile is shown as a solid line in figure 11.

In order to approximate the disturbing body causing the anomaly, the model indicated in figure 11 was postulated. If the properties of rock sample Sw-65 (See Appendix A) are assumed to represent those of a typical basalt flow with remanent magnetization paralleling $\overline{T}_0$, and the enclosing lake sediments are assumed to have a negligible susceptibility and no permanent magnetization, equation (4) gives an effective susceptibility contrast of

$$\Delta k_t = 1630 \times 10^{-5} \text{ cgs}$$

An analysis using Nettleton's expression for a horizontal edge (1942) indicates that an idealized model 1,400 feet in thickness, whose top is approximately 1,300 feet below the surface, could produce a similar anomaly. Lack of better control on rock parameters and anomaly distribution precludes a more nearly unique interpretation. The presence of such an edge is probable, however, since extensive basalt flows are exposed in the adjacent mountains (See fig. 12), and very recent faulting has displaced the

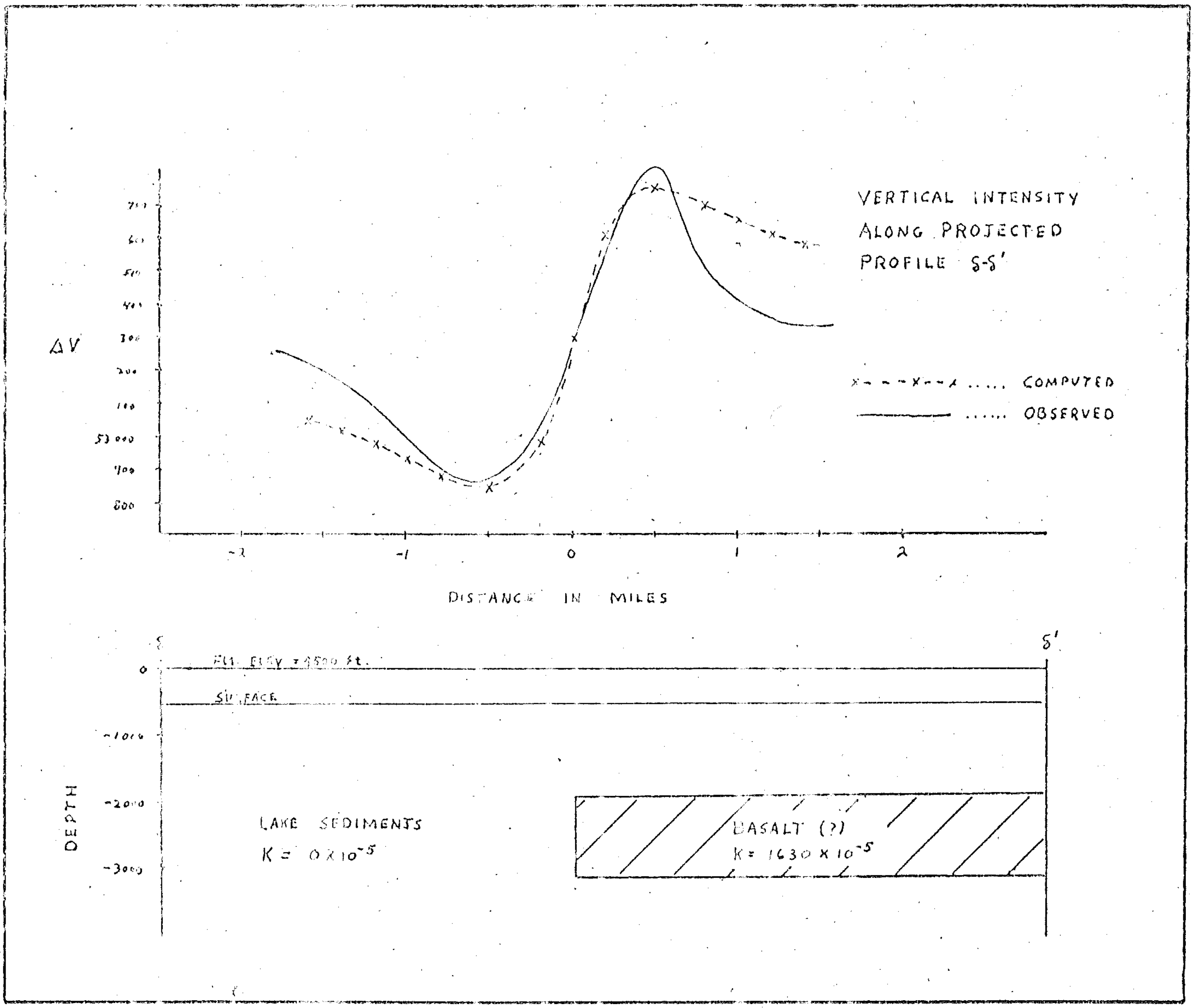


Figure 11. Projected vertical intensity profiles over postulated model of basalt flow in south Carson Sink.

valley surface nearby (Slemmons, 1957).

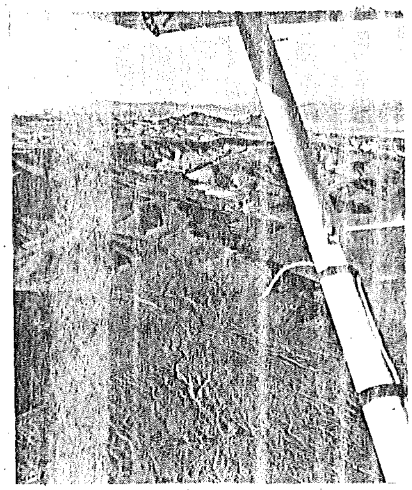


Figure 12. Quaternary basalt flows in southern Stillwater Range.

Geometry of the Gabbroic Complex--A more tentative objective of the magnetic survey was to test a hypothesis advanced by R.C. Speed. Based on geologic evidence in the three mountain ranges, Speed suggests that the gabbroic complex forms a tabular, yet elongate, northwest-trending body which was presumably fed through a conduit of undetermined location and diameter (Personal communication, 1964). Toward this goal, an analysis of a N-S profile over the southern edge of the complex was performed (See Plate 2 and fig. 9). Inspection of the observed anomaly along this profile reveals that few aspects of a classical edge effect are present i.e., a significant negative does not appear south of the contact, nor is a conjugate "high" present to the north. Rather, a simple shift of magnetic base level is observed, a characteristic generally attributed to the contact of two semi-infinite basement blocks. To investigate intermediate models, whose lower extreme is deep enough

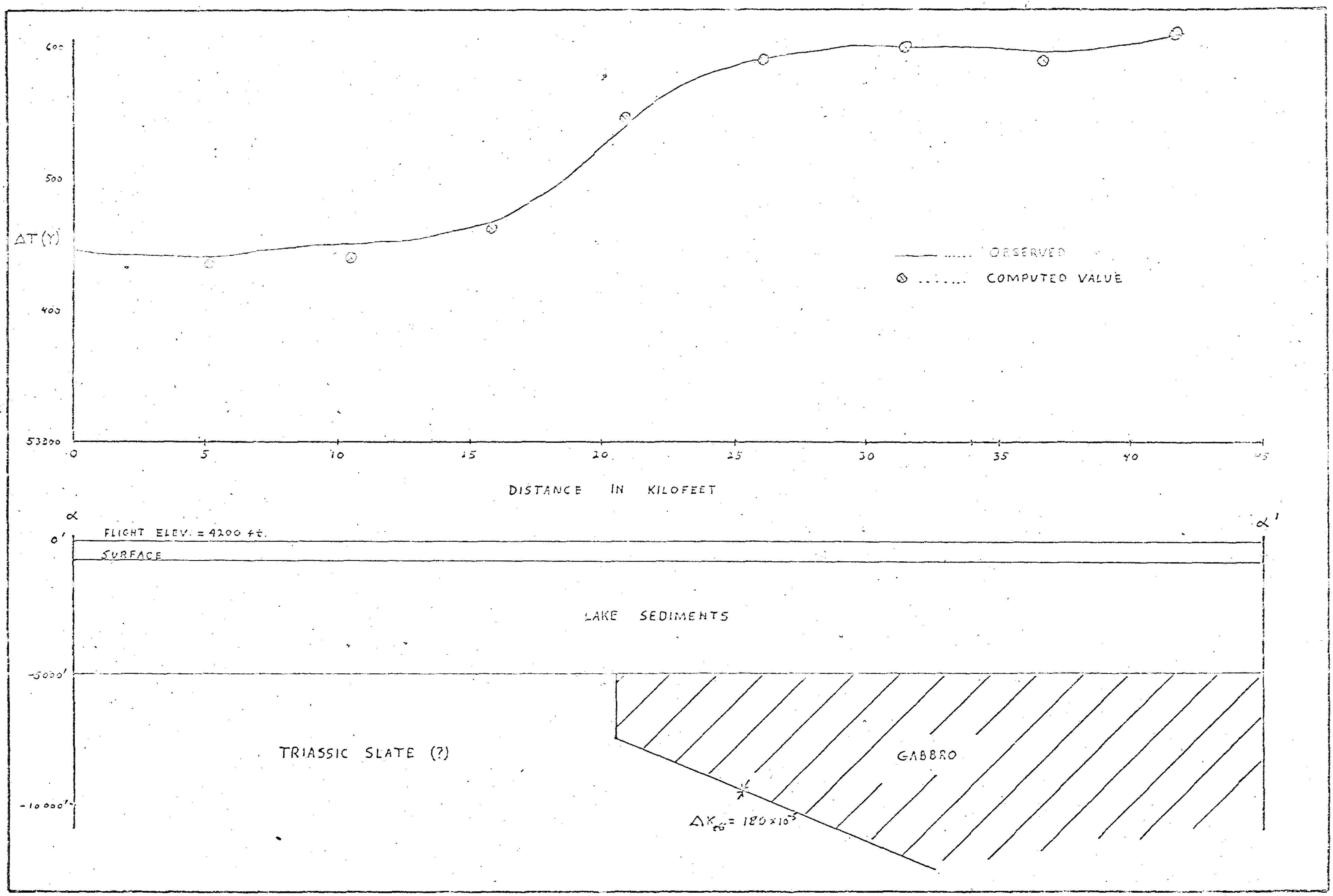


Figure 9. Observed and calculated total intensities over south edge of gabbroic complex.

to eliminate the pre-edge negative and whose post-edge shape prohibits return of the positive to base level, a modified Pirson Polar Chart was employed (Pirson, 1940). Using the previously calculated susceptibility contrast for this contact, a series of successive model-assumption and curve-match operations yielded the tapered model and computed anomaly shown in figure 9. The associated intensity curve over this model displays close agreement with the observed anomaly, even to the slight negative north of the contact.

Existence of such a tabular body is, in addition, indirectly supported by geological and geophysical evidence which indicate a significant offset of the gabbro contact along the Clan Alpine Range. The present magnetic study places the subsurface contact near Cow Canyon, whereas the nearest surface exposure is over ten miles to the northeast at Shoshone Point. Strike-slip faulting could produce a left-lateral displacement of this magnititude, although it is probably better explained by uplift and subsequent erosional stripping of a tapered body similar to the assumed model. Northward extrapolation of the lower gabbro contact shown in figures 9 and 10 would place its depth near Shoshone Point at about 10,000 to 20,000 feet; this depth implies a Clan Alpine uplift of comparable magnitude in order to produce the apparent offset.

In addition to the graticule analysis, a second investigative approach was used to study the dominant magnetic "high" in eastern Dixie Valley. For purposes of analysis, a north-trending profile across the feature was smoothed and reduced to vertical intensity by equation 10 (See Plate 2 and fig. 10). The resulting curve is very similar to the actual vertical intensity curve except for a slight southward displacement of the maximum and a small negative on the north. Because of high magnetic latitude, the displacement is only on the order of hundreds of feet (Smellie, 1956), a negligible distance when compared to the anomaly width of 40,000 feet. As a consequence, reduction to vertical intensity, while introducing no appreciable error in solution, greatly facilitates use of solid angle charts developed by Nettleton (1942) for determining magnetic effects of buried vertical cylinders.

Attempts to correlate the observed anomaly with the effect of a buried mountain, approximated by a stack of vertical cylinders, reveal that the anomaly is largely due to a much deeper source, suggesting that a vertical extension of the gabbro might exist beneath the tabular complex. Also, absence of a significant negative anomaly around the "high" is indicative of a cylindrical conduit or pipe extending to great depths. Using this type of model and the aforementioned susceptibility contrasts, the solution depicted in figure 10 is obtained. This model of the buried mountain and conduit would generate a curve closely resembling the observed anomaly if it may be assumed the k-contrast at depth is reasonably accurate. Realizing the limitation of this assumption, however, the writer believes this model

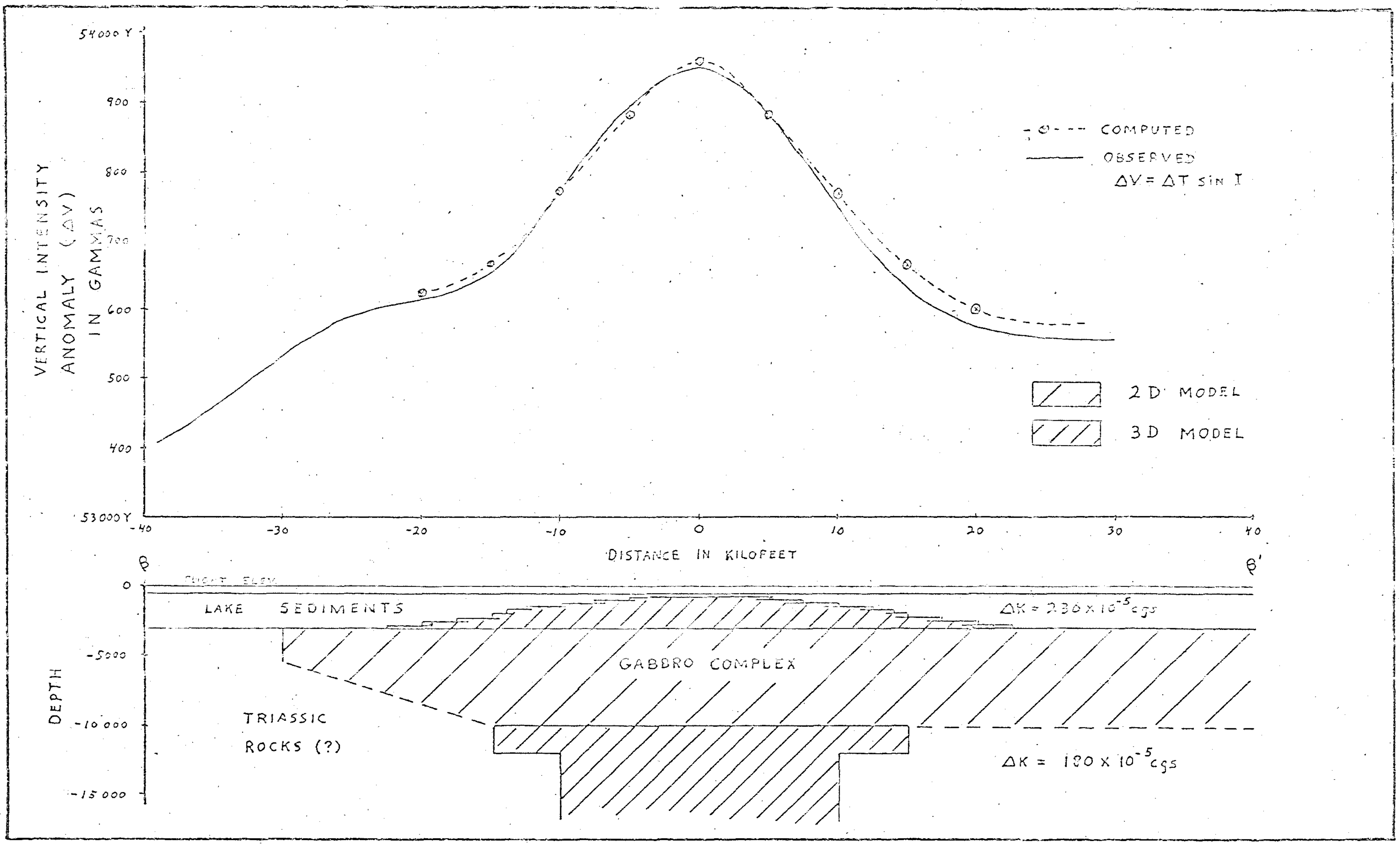


Figure 10. Observed and calculated vertical intensity profiles over 3-D model of gabbro pipe and buried mountain.

probably represents a good approximation to the actual case and provides rather remarkable validation of Speed's hypothesis.

SUMMARY OF GEOLOGICAL IMPLICATIONS

Carson Sink Area

Magnetic investigation of the Dixie Valley-Carson Sink area has yielded several implications of geological importance, ranging from delineation of Cenozoic basins to the more speculative geometry of intra-basement bodies. Difference of magnetic character between the Triassic rock unit and the gabbroic complex renders possible mapping of the subsurface contact. In the north part of Carson Sink, two points on the southern contact of the gabbro can be located from the N-S reconnaissance profiles. A significant offset between the profiles may indicate either sinuous form or strike-slip displacement of the contact. The northern boundary of the complex cannot be ascertained from the single profile over Buena Vista Valley.

Gradient analyses of the Carson Sink profiles give indication of a broad, deep basin whose western margin is a subsurface ridge running approximately S 40 W from Lone Rock . To the west of this ridge, the analyses suggest the presence of a narrow trough which parallels the Stillwater Range.

To the north, in Buena Vista Valley, the depth determination method shows a smooth basement surface descending to about 6,000 feet under the center of the valley.

Dixie-Fairview Area

A similar analysis performed on the Dixie-Fairview profile in the southeast part of the project area gives a surprising constancy of depth along the basement connection of the valleys, a feature not expected from surface evidence. Displaying little subsurface relief, the magnetic basement attains appreciable depths only in central Dixie Valley.

Dixie Valley

Across central Dixie Valley, the subsurface boundary of the gabbroic complex is accurately mappable, trending southeastward from Dixie Hot Springs to Cow Canyon. The northern contact of the complex, though less precisely determined, extends across the valley connecting the surface exposure at Hole-In-The-Wall with the one north of Boyer Ranch.

Gradient analyses of many profiles in Dixie Valley define a longitudinal trough, probably fault bounded, under the western side of the valley, whose depth is estimated at 7,000 to 9,000 feet. Depth to valley blocks bordering the trough varies between 1,000 and 4,000 feet. Subordinate transverse structure is evident on the eastern valley block, where at least three sub-parallel, normal faults trend obliquely to the main graben. Displacement on these faults is of a normal sense, the north side being upthrown in all cases.

Magnetic evidence for large scale strike-slip faulting in Dixie Valley is generally lacking. An exception exists across the east edge of the elongate trough, however, where right-lateral displacement of up to three miles may have occurred. Observed left-lateral offset of the gabbro contact along the flank of the Clan Alpine is better explained by uplift and erosional stripping than by strike-slip activity.

Model studies of Dixie Valley anomalies tend to verify Speed's hypothesis that the gabbroic complex forms a tabular body with tapering edges. Moreover, both gradient analysis and model studies give evidence of a cylindrical conduit beneath the gabbro complex and of a coinciding subsurface mountain whose crest is 400 to 1,000 feet below the surface.

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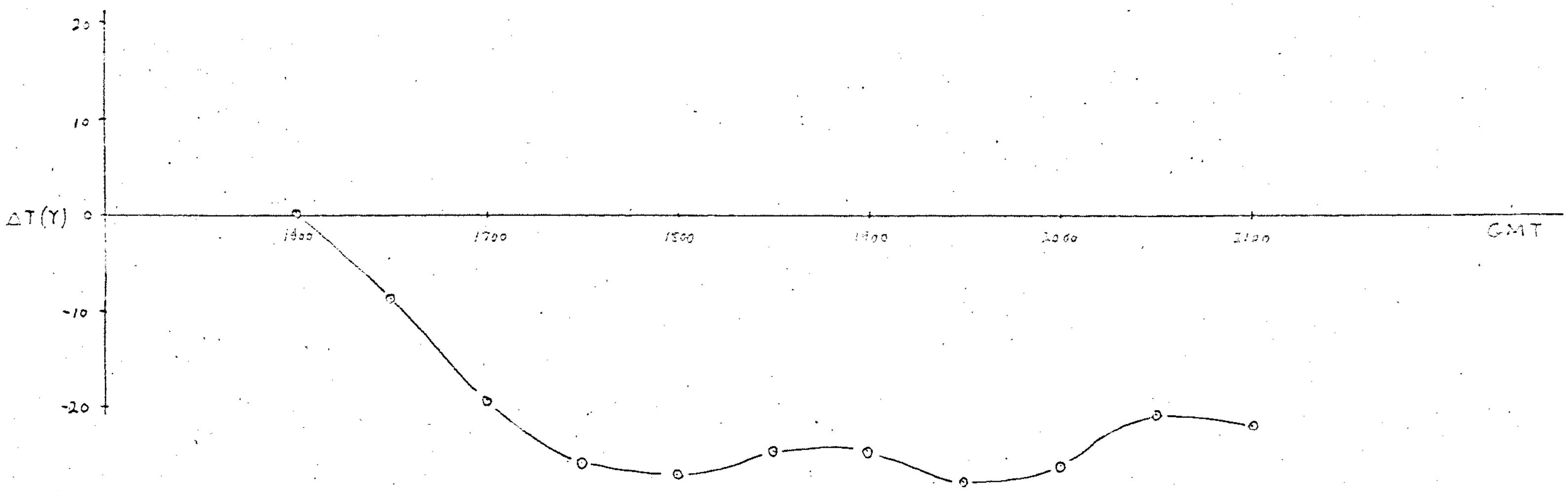
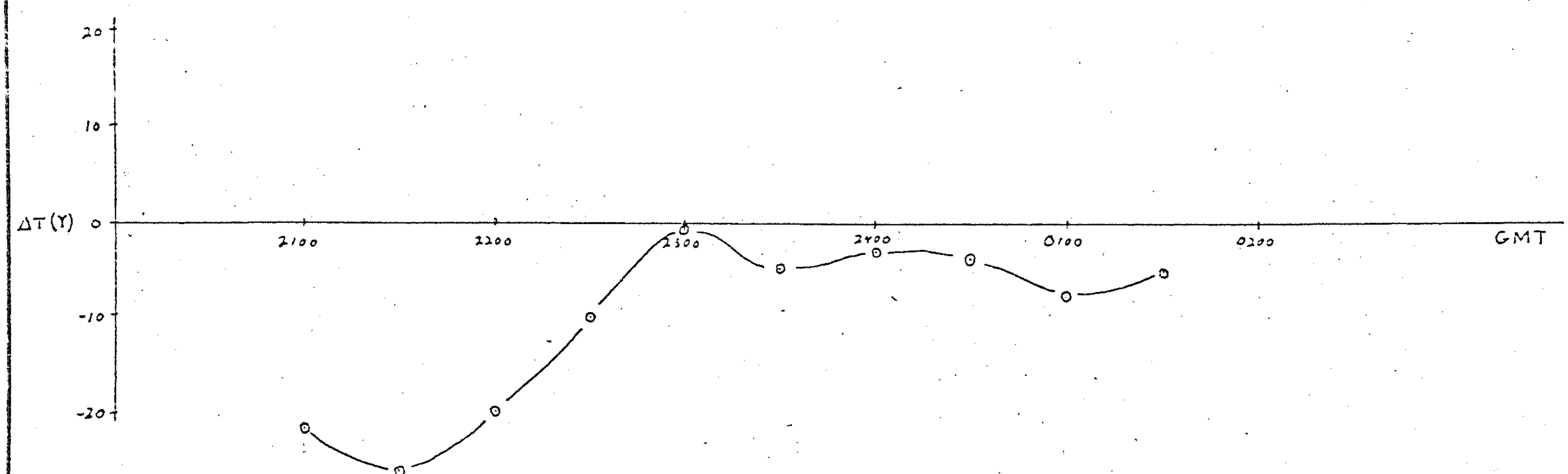
APPENDIX B

Magnetic background during periods of aeromagnetic measurement. Recorded at Palo Alto, California by Varian Associates Inc. Reference level equals 51,400 gammas.


20
10
ΔT(Y) 0
-10
-20
GMT

JULY 19, 1964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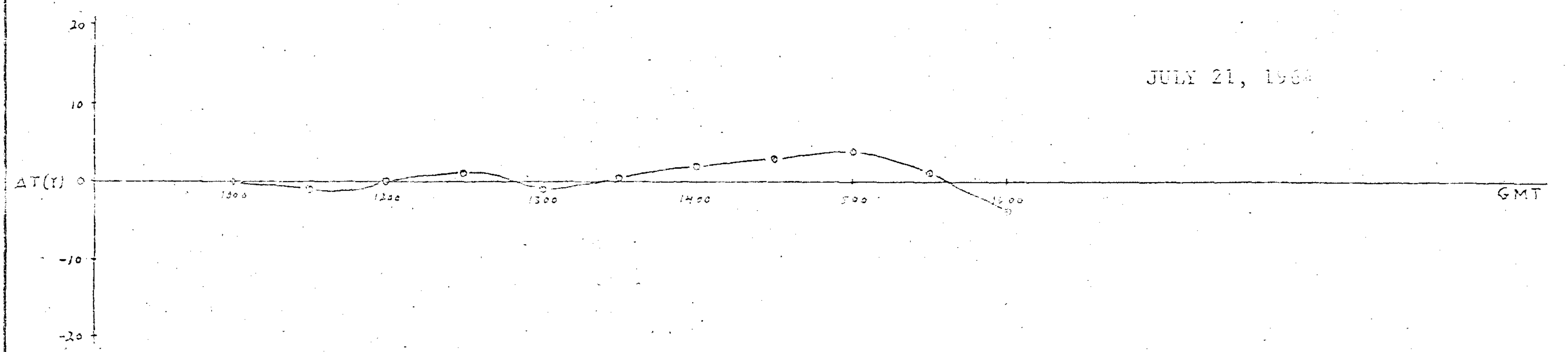
-10
-20
2100
2200
2300
2400
0100
0200
GMT


JULY 21, 1964
ΔT(Y)
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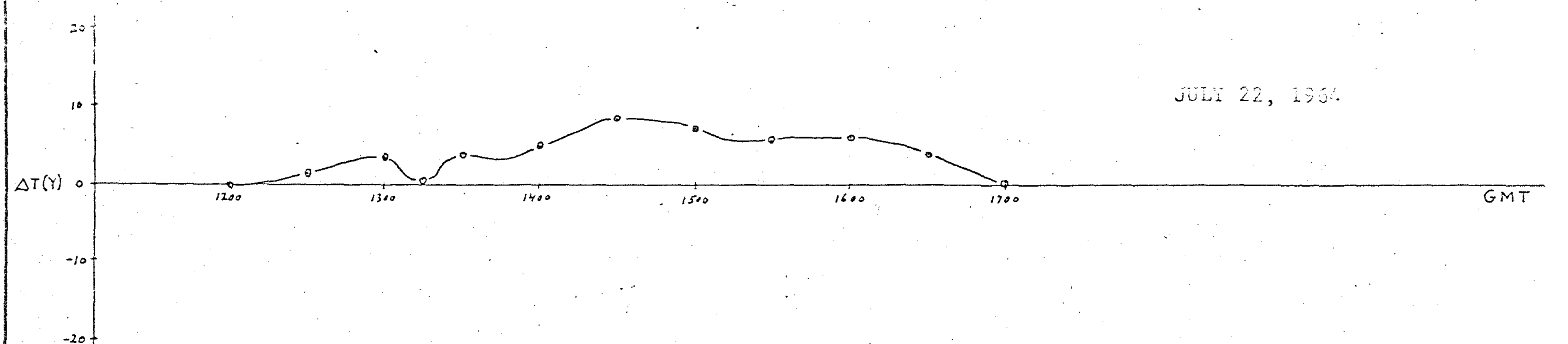
0
-10
-20
1300
1200
1300
1400
500
GMT


JULY 22, 1964
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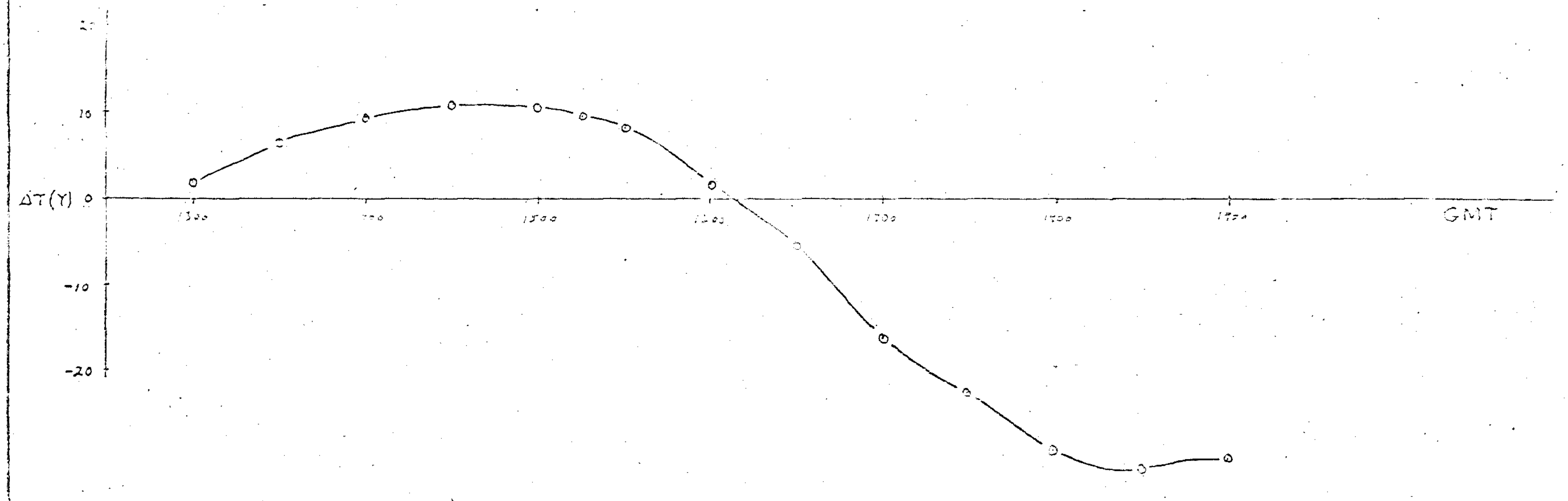
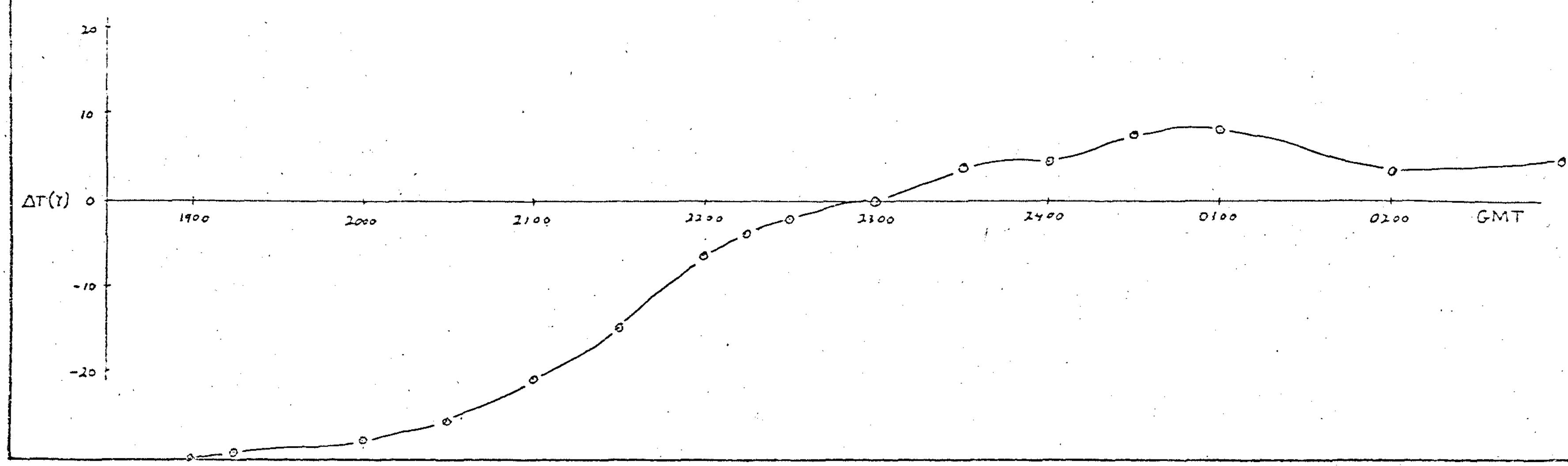
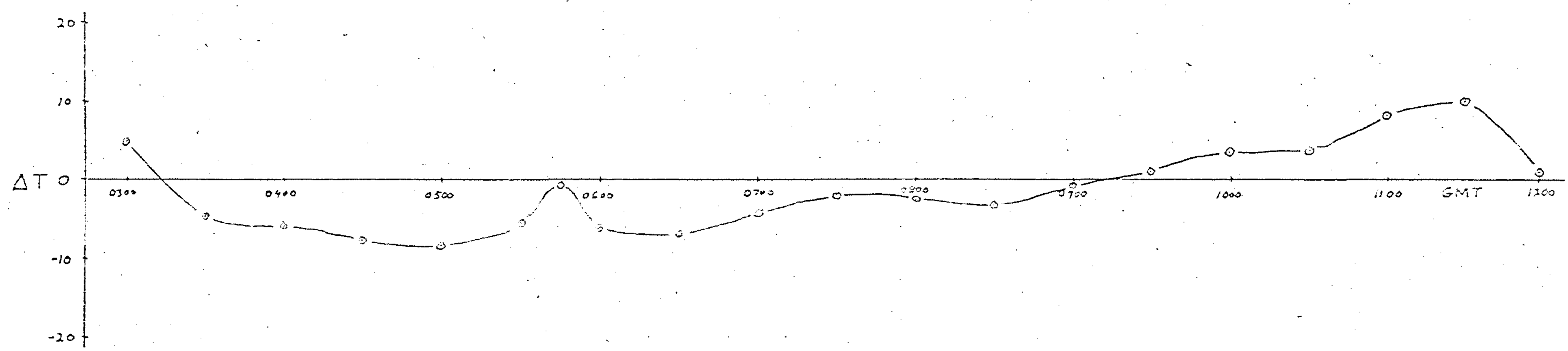
1600
1700
GMT



AUGUST 6, 1964





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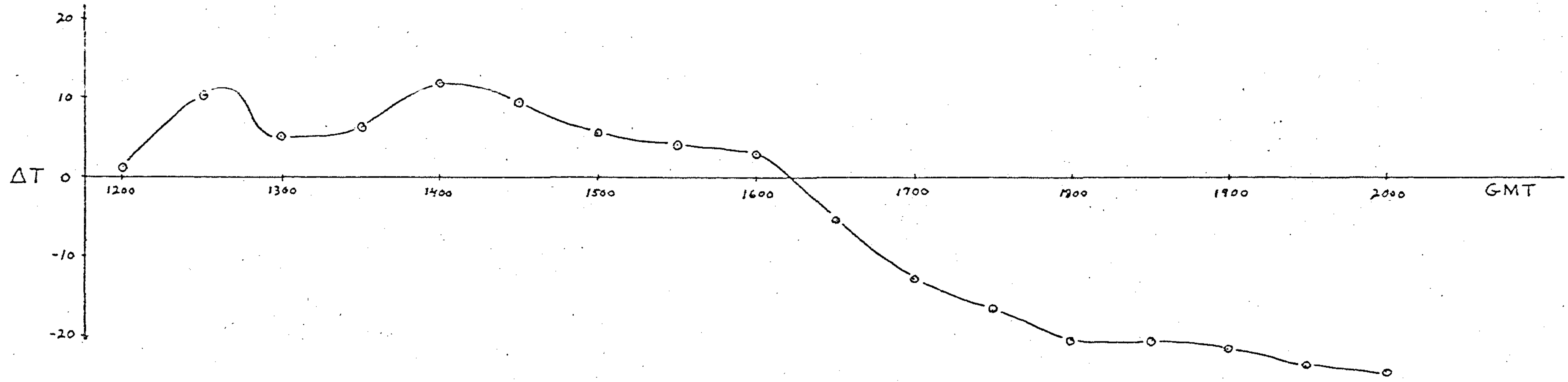

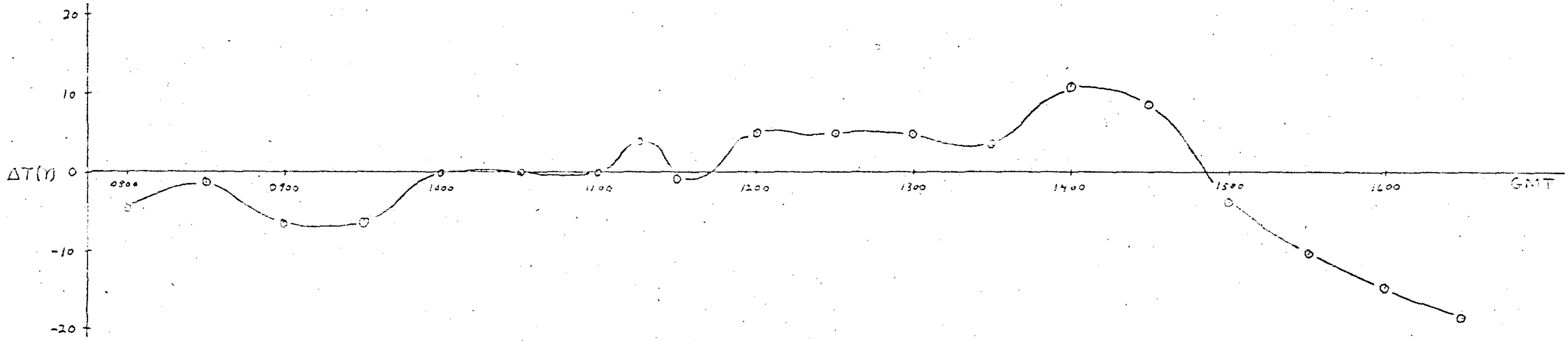

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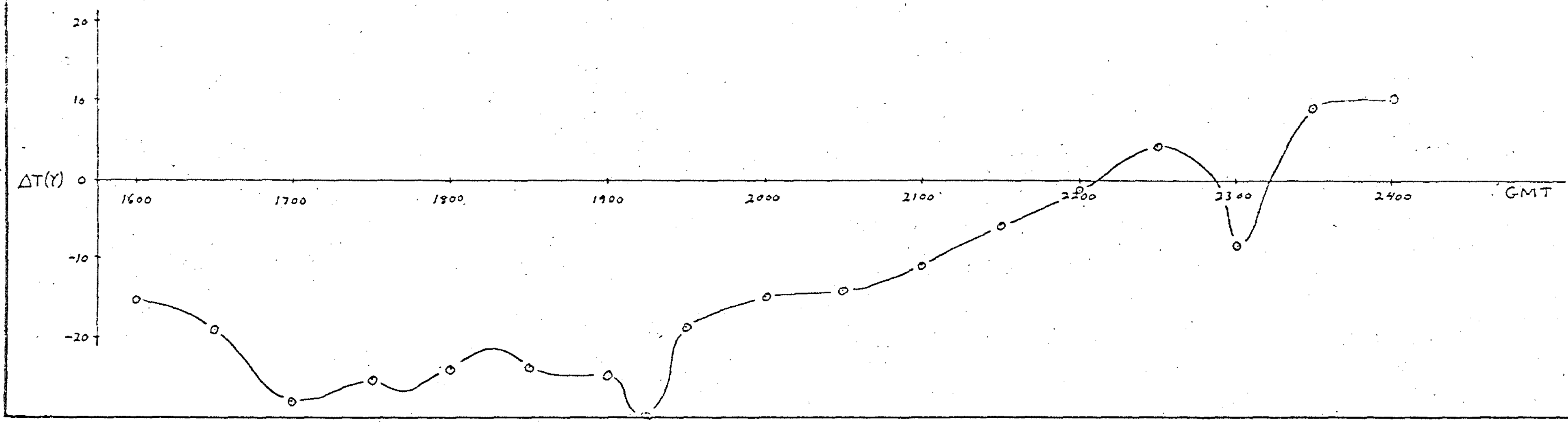

APPENDIX C

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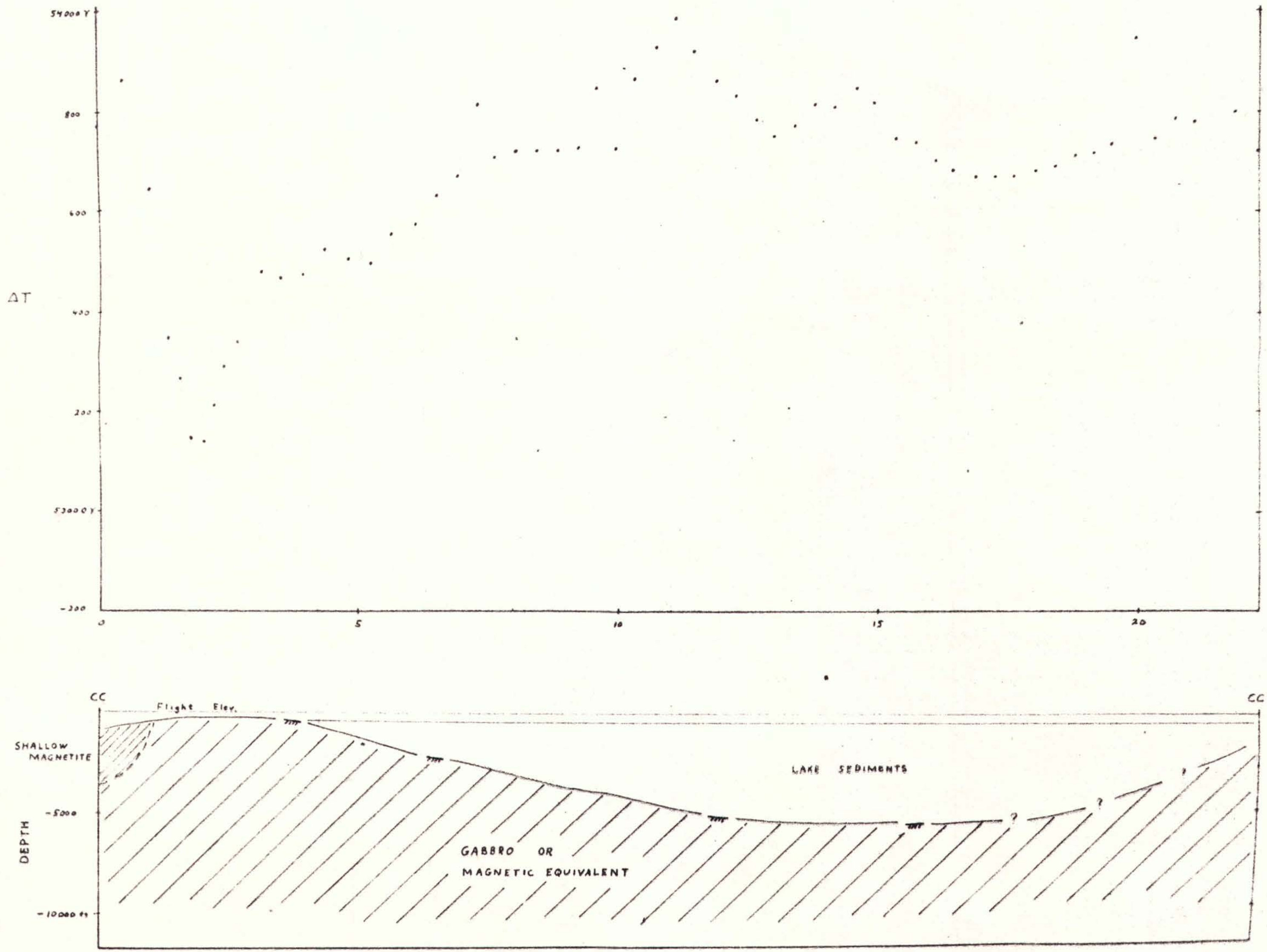
1 MIN 600          TE SMITH       BALGOL

   BURROUGHS ALGEBRAIC COMPILER-STANFORD VERSION   10/20/62

COMMENT   PGM TO CALCULATE SECOND DERIVATIVES AND RESIDUALS OF MAG.
          AND GRAV DATA.  ORIG ANOMALY, RESIDUAL, AND SEC DERIV ARE
          PLOTTED AT CHOSEN SCALE.  THOMAS E SMITH, GEOPHYSICS DEPT,
          STANFORD UNIVERSITY $
INTEGER   I, J, M, N, W, D, R, U $
ARRAY     T (20,20), TZRO(20,20), AV(20,20), RESID(20,20),SECDRV(20,20)$
INPUT     DATA(M,N,W,D,R,U, FOR J=(1,1,M)$ FOR I=(1,1,N)$ T(I,J))$
READ      ($$DATA)$
          FOR I=(2,1,N-1)$
          FOR J=(2,1,M-1)$
          BEGIN
              TZRO (I,J)=T(I,J)$
              AV(I,J)=(TZRO(I,J) +T(I,J-1) +T(I,J+1) -T(I-1,J)+
              T(I+1 ,J) +T(I+1,J-1) +T(I+1,J+1) +T(I-1,J+1) +
              T(I-1,J-1))/9.0  $
              RESID(I,J) =TZRO(I,J)-AV(I,J)  $
              SECDRV(I,J)=(3.0).(RESID(I,J))  $
          END $
OUTPUT    OUT1( FOR J=(1,1,M)$ FOR I=(1,1,N) $ T(I,J)) $
OUTPUT    OUT2( FOR J=(1,1,M)$ FOR I=(1,1,N) $ RESID(I,J)) $
OUTPUT    OUT3( FOR J=(1,1,M)$ FOR I=(1,1,N) $ SECDRV (I,J)) $
FORMAT    HED1(*  ORIGINAL ANOMALY VALUES  *,W3 )$
FORMAT    HED2(*  SECOND DERIVATIVE VALUES *,W3)$
```

```
FORMAT    HED3(* RESIDUAL VALUES          *,W3)$
FORMAT    FMT(15X6.1,W4)  $
FORMAT    PLOT(15X8.1,5W)   $
WRITE     ($$HED1)$
WRITE     ($$OUT1,FMT)$
WRITE     ($$HED3)$
WRITE     ($$OUT2,FMT)$
WRITE     ($$HED2)$
WRITE     ($$OUT3,FMT)$
WRITE     ($$HED1)$
WRITE     ($$OUT1,PLOT)$
WRITE     ($$HED3)$
WRITE     ($$OUT2,PLOT)$
WRITE     ($$HED2)$
WRITE     ($$OUT3,PLOT)$
FINISH         $
```

PLATE 5



54000 γ
800
600
400
200
53000 γ
-200
ΔT
0
5
10
15
20
CC
CC'
Flight Elev.
SHALLOW MAGNETITE
LAKE SEDIMENTS
-5000
DEPTH
-10000 ft
GABBRO OR MAGNETIC EQUIVALENT

PLATE 5

CORRECTED FOR REGIONAL AND DIURNAL VARIATIONS

ALL DEPTHS MEASURED FROM FLIGHT ELEVATION (4500 ft)

ALL INTENSITIES (ΔT) IN GAMMAS (γ)

— DEPTH COMPUTED FROM APPARENT MAGNETIC GRADIENT

[illegible] DISTANCES IN MILES FROM START OF PROFILE

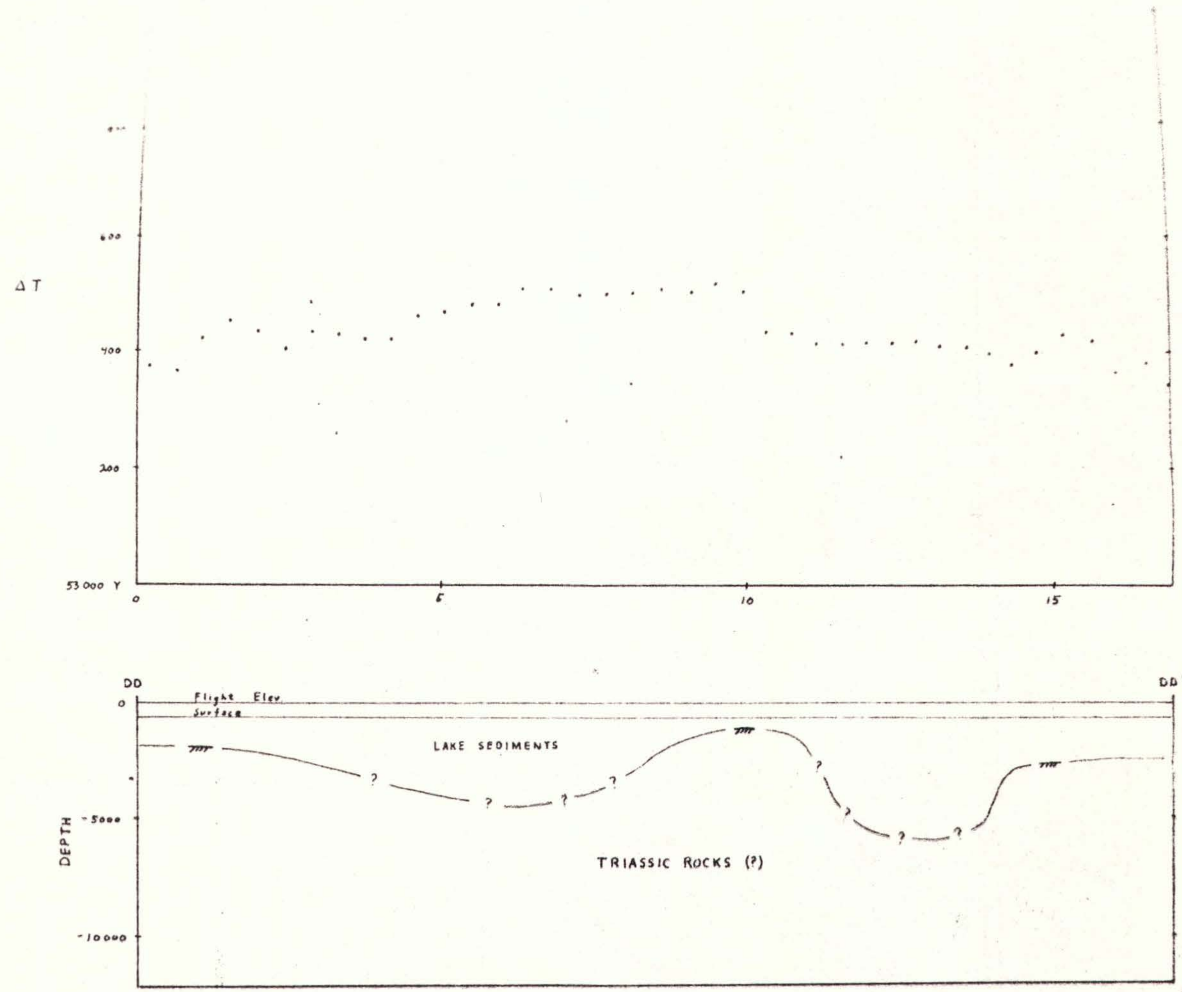
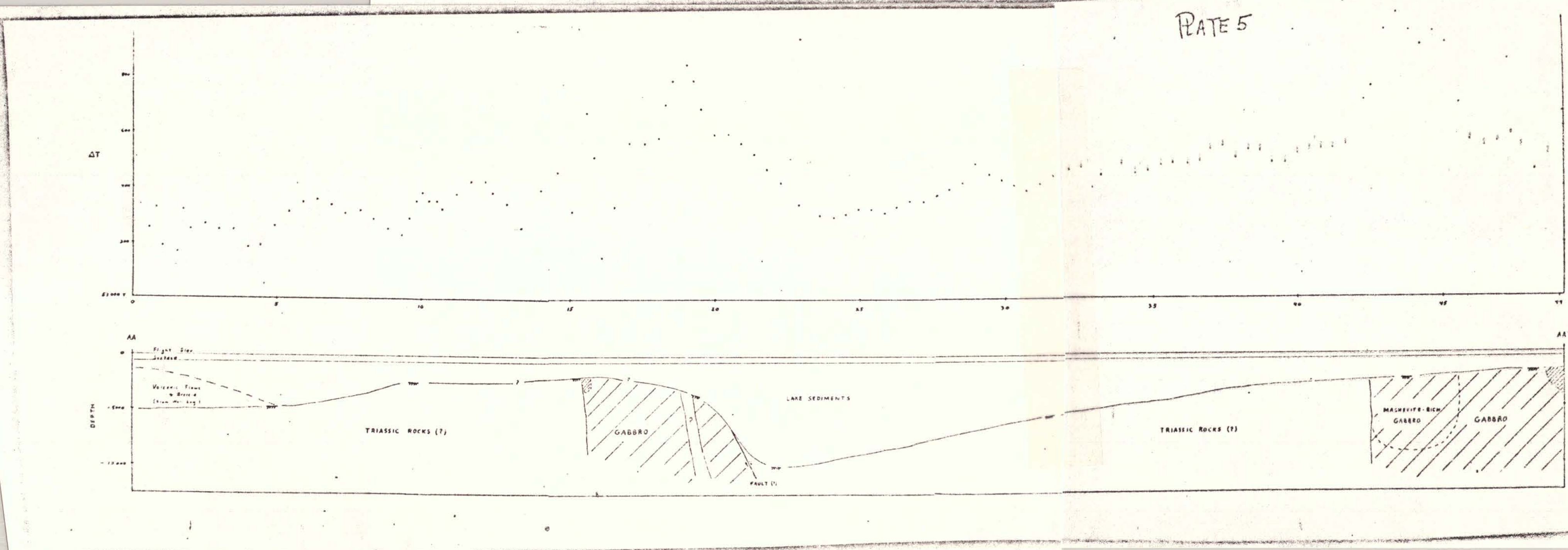


PLATE 5



ΔT
DEPTH
AA
AA'
Flight Elev.
Surface
Volcanic Flows & Breccia (from Mel. Log.)
TRIASSIC ROCKS (?)
GABBRO
LAKE SEDIMENTS
FAULT (?)
TRIASSIC ROCKS (?)
MAGNETITE-RICH GABBRO
GABBRO
0
5
10
15
20
25
30
35
40
45

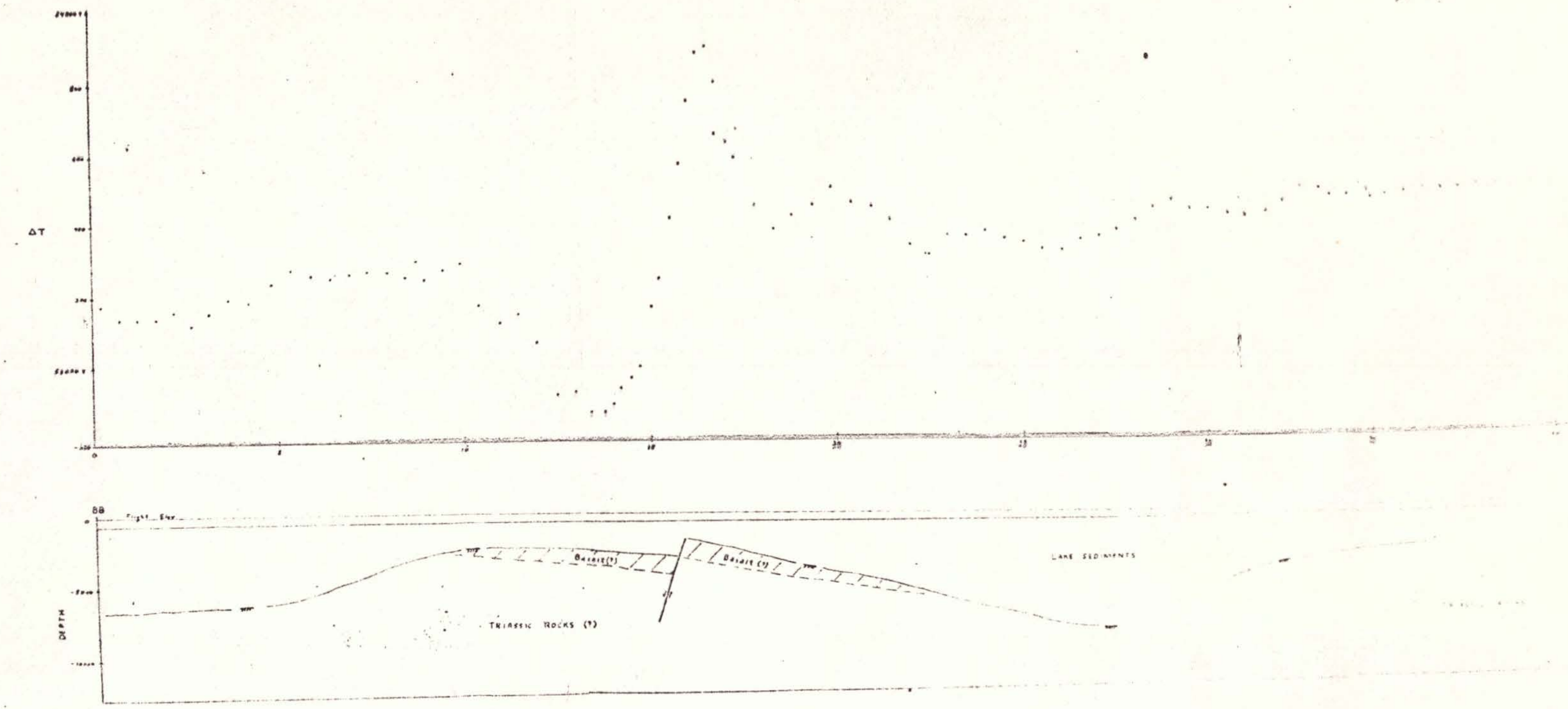

ΔT
BB
Flight Elev.
DEPTH
Basalt (?)
Basalt (?)
LAKE SEDIMENTS
TRIASSIC ROCKS (?)

PLATE 5

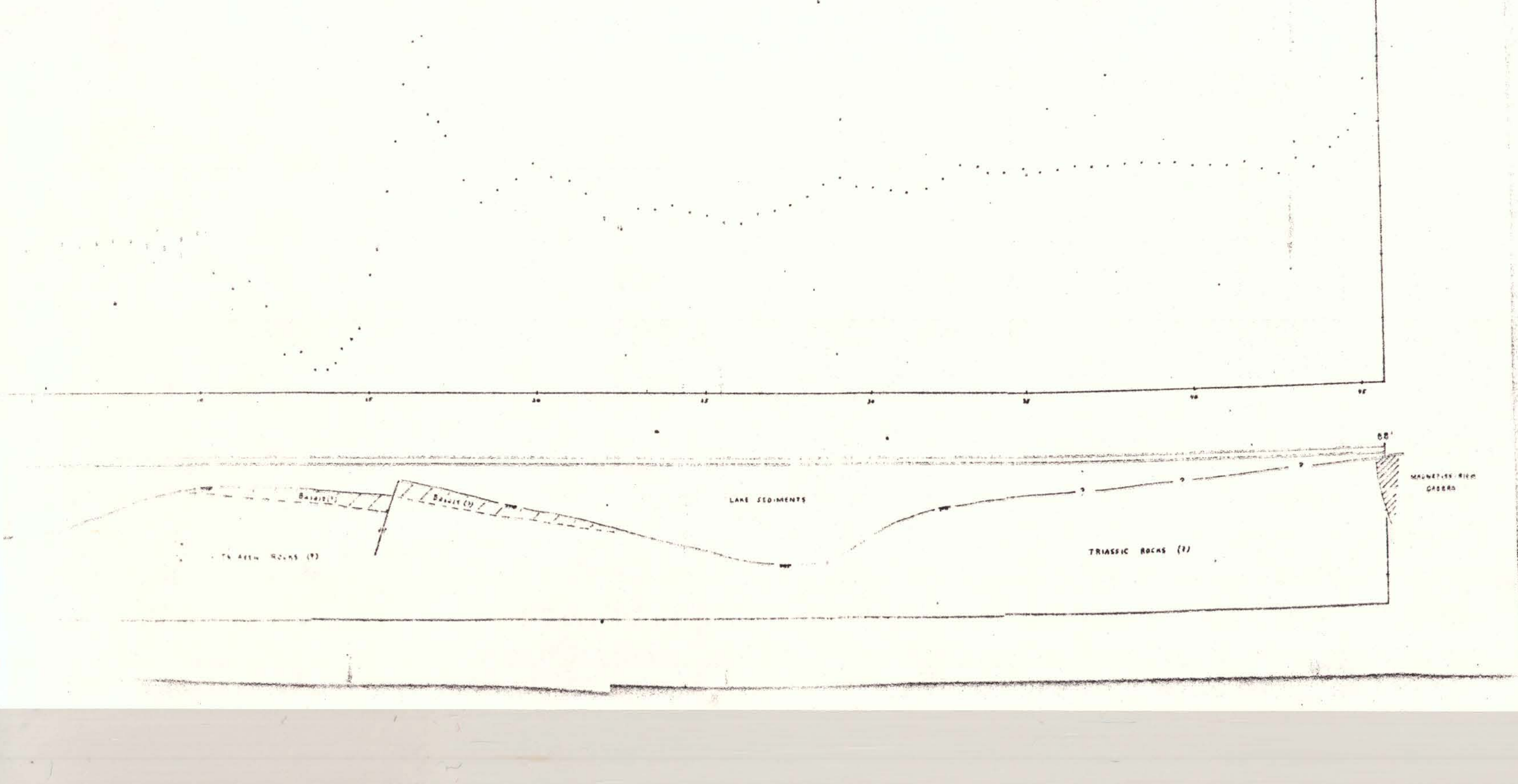
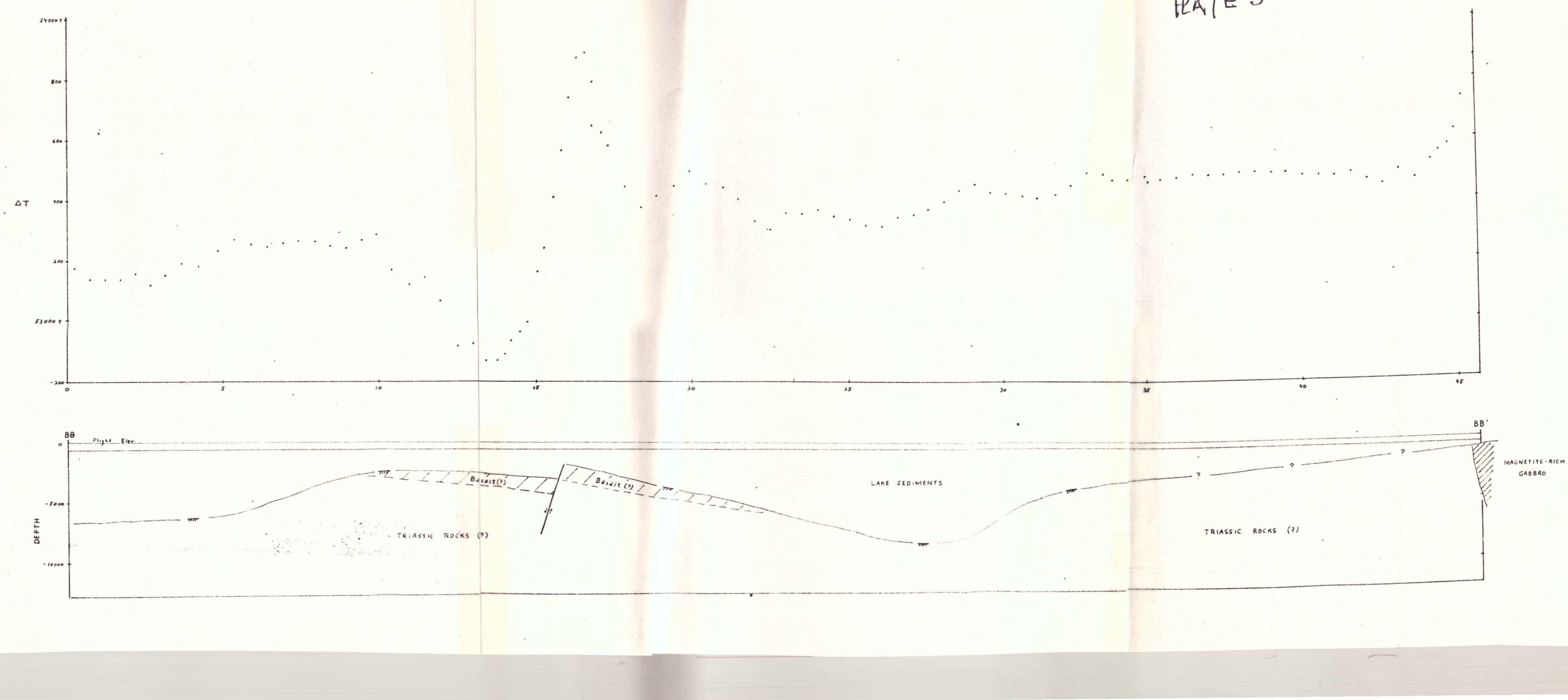

68'
Basalt (?)
Basalt (?)
LAKE SEDIMENTS
TRIASSIC ROCKS (?)
MAGNETITE RICH GABBRO

PLATE 5



54000 γ
800
600
400
ΔT
200
53000 γ
-200
0
5
10
15
20
25
30
35
40
45
BB
BB'
Flight Elev.
0
-5000
-10000
DEPTH
Basalt (?)
Basalt (?)
LAKE SEDIMENTS
TRIASSIC ROCKS (?)
TRIASSIC ROCKS (?)
MAGNETITE-RICH GABBRO

PLATE 6

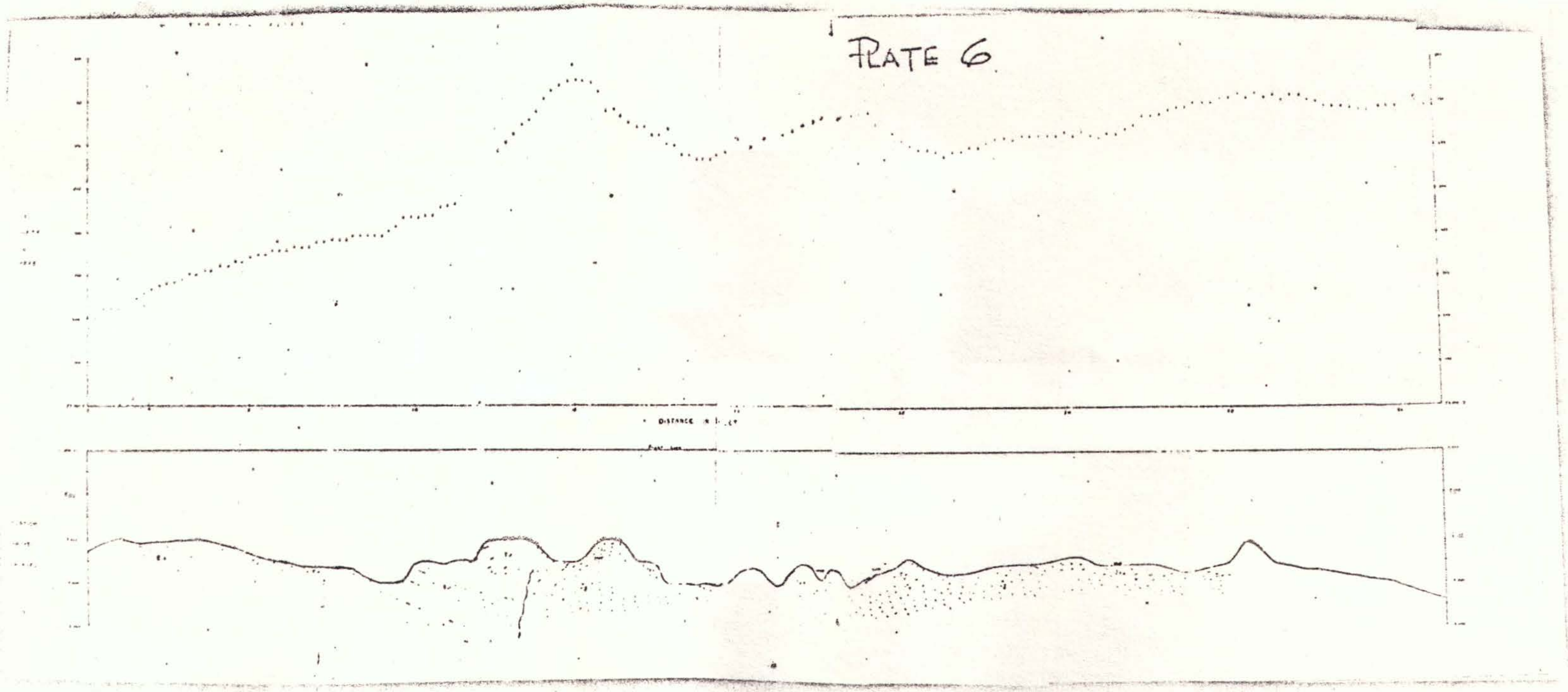
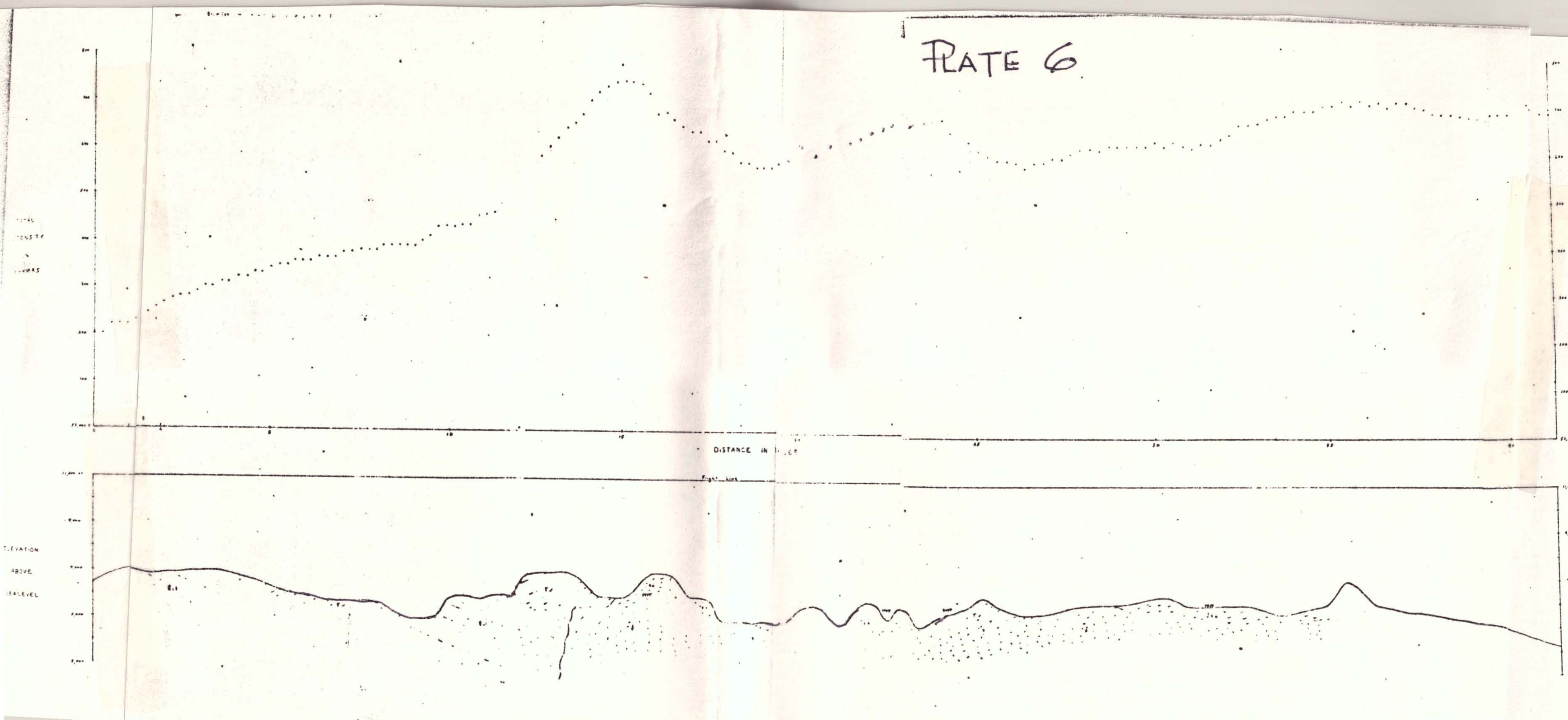


PLATE 6



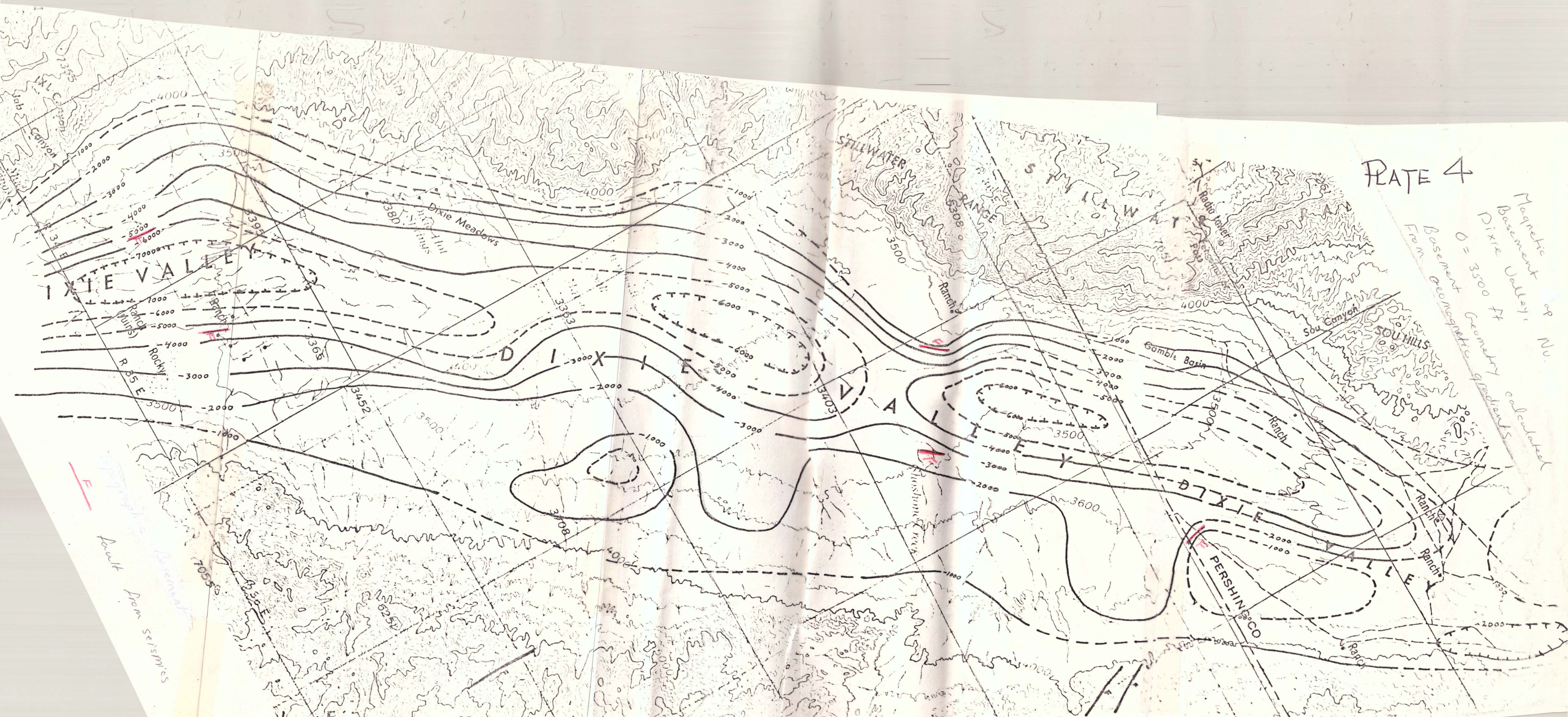


PLATE 4
Magnetic Basement Map
Dixie Valley, Nv.
0 = 3500 ft
Basement Geometry calculated
From geomagnetic gradients
F fault from seismics
Topographic Basement
STILLWATER RANGE
DIXIE VALLEY
Dixie Meadows
Gamble Basin
Shoshone Creek
SOU HILLS
Sou Canyon
Radio Tower
PERSHING CO
Ranch
Rocky
R 34 E
R 35 E
Job Canyon

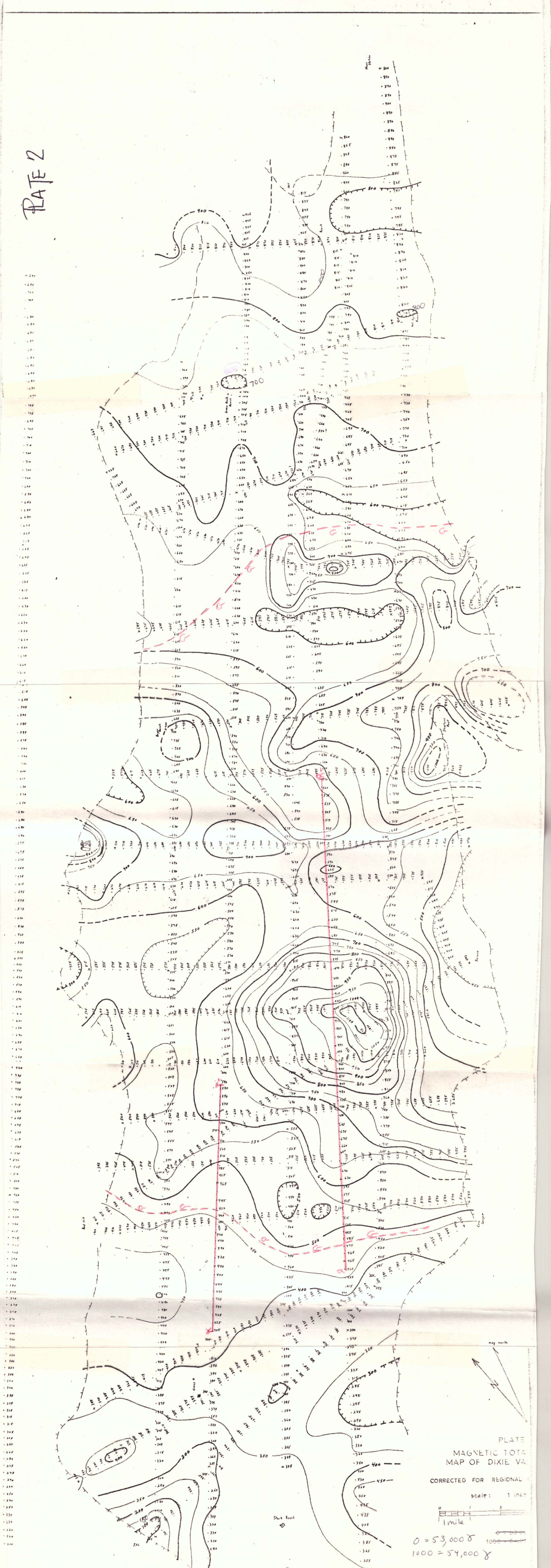
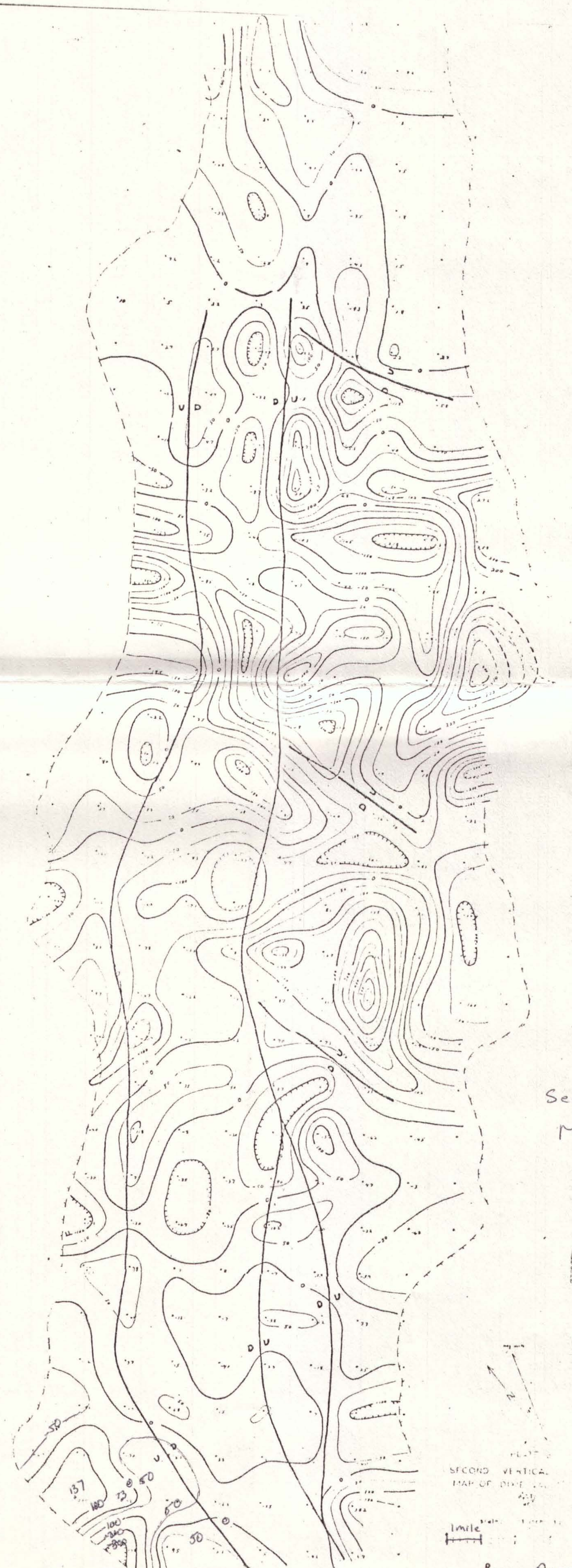


Plate 2 Magnetic Total Intensity Map of Dixie Valley, Nv.
corrected for regional and diurnal variations

Plate 3

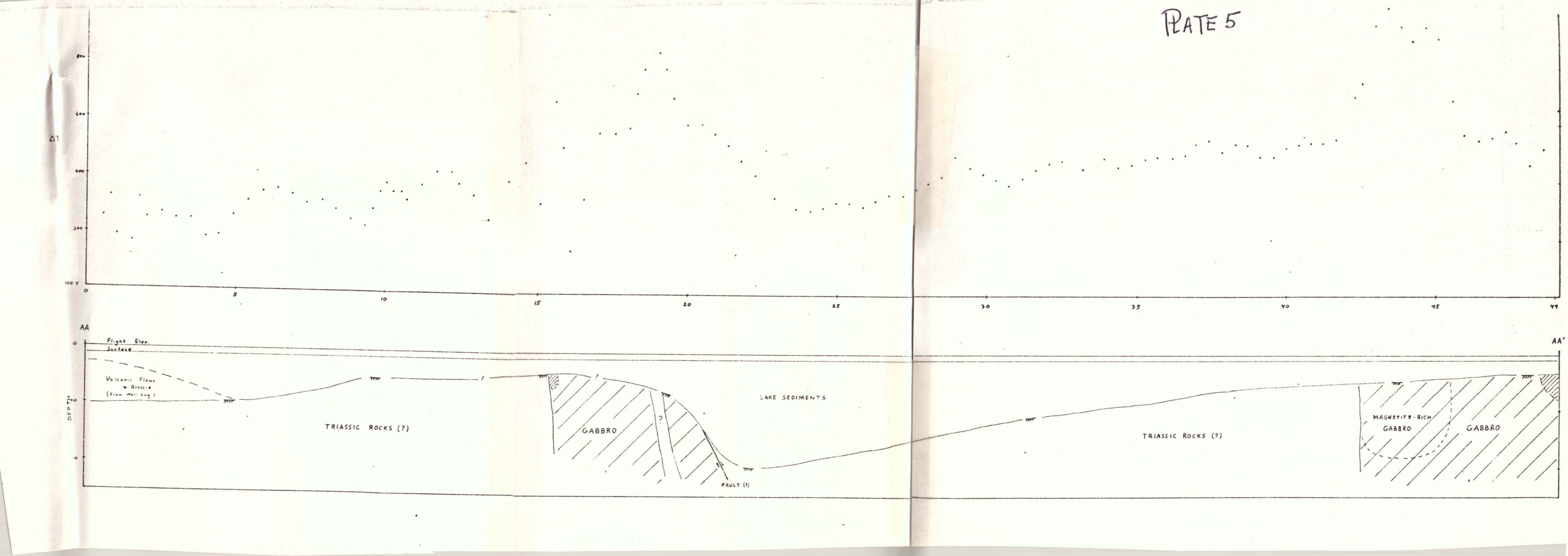


Second Verticle Derivative Map of Dixie Valley, NV

$$\frac{\partial^2(\Delta T)}{\partial r^2}$$

Possible Fault

PLATE 5



ΔT
800
600
400
300
100 Y
0
5
10
15
20
25
30
35
40
45
49
AA
AA'
DEPTH
Flight Elev.
Surface
Volcanic Flows + Breccia (from Well Log)
TRIASSIC ROCKS (?)
GABBRO
LAKE SEDIMENTS
FAULT (?)
TRIASSIC ROCKS (?)
MAGNETITE-RICH GABBRO
GABBRO