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COMISION FEDERAL DE ELECTRICIDAD
GERENCIA DE PROYECTOS GEOTERMOELECTRICOS
SUBGERENCIA DE ESTUDIOS GEOTERMICOS
DEPARTAMENTO DE EXPLORACIÓN

RESUMEN DE LAS CONCLUSIONES DEL MODELO GEOLOGICO REGIONAL DEL CAMPO GEOTERMICO DE LOS AZUFRES, MICH.

REPORTE GG 9/87

POR: DR. VÍCTOR HUGO GARDUÑO M.

El campo geotérmico de Los Azufres representa para el estado actual de México el segundo campo de desarrollo, debido a ello se han hecho necesarios estudios más detallados para conocer el modelo conceptual de este. Se realizaron estudios en áreas bien precisadas que ayudaron a efectuar observaciones en el basamento relativo y cubierta. Ellas fueron: Tzitzio, Sierra de Santa Inés, Tlalpujahua, Cd. Hidalgo-Zitácuaro y Cuitzeo, de este último se obtuvieron datos trascendentales en la evolución estructural.

Basamento geológico

Se emplea el término de basamento relativo debido a que a pesar de constituir el basamento del campo geotérmico de Los Azufres, la posición actual de este, se debe a un proceso de aloctonía (Campa et al., 1975; Tardy M. 1981; Campa y Coney 1981; Israde y Martínez, 1986, etc.). Este basamento aflora en tres de los sectores estudiados: Tzitzio, Tlalpujahua y Zitácuaro.

Basamento relativo de Tzitzio

Se compone de una secuencia sedimentaria terrígena metamorfizada a veces afectada por metamorfismo de contacto. El protolito de esta secuencia corresponde a un paquete tipo flysch intensamente deformado, y petrográficamente corresponde a un metamorfismo a facies de esquistos verdes y clase química cuarzo feldespática, evidenciando además metamorfismo regional.

Basamento relativo de Tlalpujahua-Zitácuaro

Corresponde a una secuencia vulcano-sedimentaria metamorfizada, dentro de la cual se pueden observar productos andesíticos en forma de derrames o bien formando "Pillow-lavas", calcoesquistos, intrusivos y rocas terrígenas con influencia volcánica metamorfizadas. Este paquete corresponde a la secuencia granitizada y metamorfizada proveniente de las zonas internas.

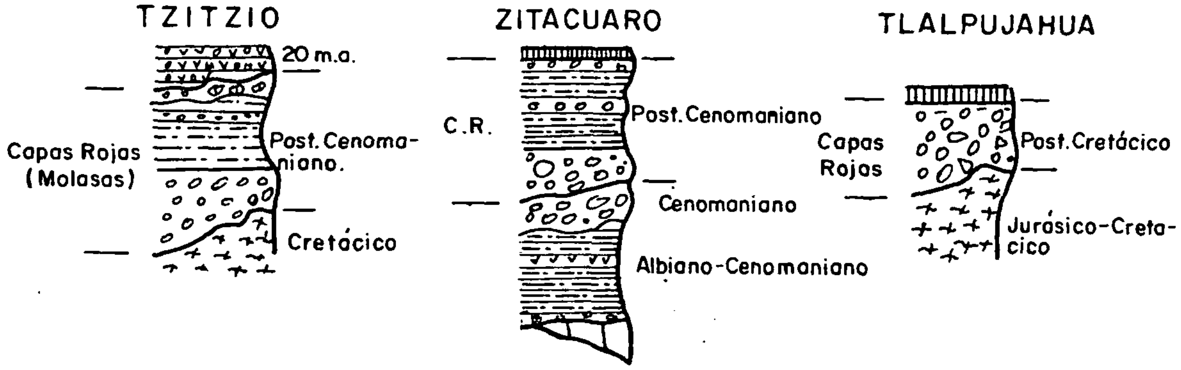
Este basamento relativo contiene una cubierta sedimentaria, mesozoica y/o terciaria. El paquete mesozoico se constituye en su base por una secuencia volcánico sedimentaria de edad neocomiense y que pasa progresivamente a una alternancia sedimentaria donde se desarrollan bancos de calizas del Albiano-Cenomaniano.

Con las edades obtenidas por Israde y Martínez (1986) y por las Amonitas reportadas por Camta et al., 1974; la secuencia del basamento relativo se le asigna una edad Jurásico Tardío-Neocomiano.

En el sector de Zitácuaro, Israde y Martínez (op. cit.) reportan un intrusivo diorítico que puede relacionarse con el magmatismo del Cretácico Medio-Inferior?

Capas Rojas (Molasas) Post-Cenomanianas

En los tres sectores donde aflora el basamento relativo se encontraron descansando sobre este, una serie de Capas Rojas, que reposan siempre en forma discordante sobre las unidades del Cretácico-Jurásico. En Tlalpujahua las molasas solo están representadas por un paquete muy "tímido" de ellas; no así, en las áreas de Zitácuaro y Tzitzio (Fig.).



En el área de Zitácuaro dentro de los clastos de las Capas Rojas, se encontraron fragmentos del intrusivo diorítico datado del Cretácico Medio. En Tzitzio, en fragmentos de caliza del conglomerado somital se encontró fauna del

Albiano-Cenomaniano. Por lo anterior se ha considerado que la edad de las Capas Rojas es del Post-Cenomaniano. El espesor de las molasas no fue nunca superior a los 500 m. Además, hacia el norte su espesor es muy reducido y tienden a ser más arcillosas.

Complejos Volcánicos Terciarios

Sobreyaciendo a las rocas mesozoicas y a las molasas Post-Cenomanianas, se encuentra un paquete andesítico cuya base se compone de conglomerados, brechas y derrames, ellos descansan en discordancia angular sobre las Capas Rojas. Este paquete andesítico se considera como la prolongación del magmatismo de la Sierra Madre Occidental hacia el oriente, la cual tiene una migración en espacio y tiempo que la hace más joven hacia el oriente.

En el sector de Tzitzio se encontró un derrame que se corrió sobre las Capas Rojas y que fue datada del Mioceno Inferior (20 m.a.). Este paquete andesítico fue dividido en dos secuencias; la inferior, constituida de brechas, derrames, tobas y conglomerados de composición andesítica y la superior, de la misma composición pero de caracter más ácido.

El espesor de ambas llega a sobrepasar los 3,000 metros y su edad se queda dentro del Mioceno, es decir, de 20 a 5 m.a.

Entre 4 y 3 m.a., se detectó un hiatus volcánico que separa el magmatismo de la Sierra Madre Occidental (S.M.O.) y del Cinturón Vulcano Mexicano (C.V.M.). Este hiatus se hace más antiguo al occidente y más joven hacia el oriente.

Vulcanismo del Cinturón Vulcano Mexicano

En el sector de estudio este fenómeno se encuentra concentrado dentro de la Caldera de Los Azufres y el colapso de Cd. Hidalgo. Ellos instalados en la intersección de dos sistemas estructurales regionales NW-SE y E-W.

Caldera de Los Azufres

La estructura de la caldera fue propuesta por vez primera por Robin y Pradal (1985), de la cual, por sus consideraciones la clasifican del tipo resurgente. Por otro lado Pasquaré (1986) también apoya la idea de esta caldera, solo que con geometría y edad diferente.

Durante el desarrollo de este trabajo se concluyó que dicha caldera es de edad pleistocénica, no resurgente y cuyo borde sur se enmascara por el sistema de fallas regionales activas E-W.

Los eventos volcánicos que podemos separar son los siguientes:

- Vulcanismo de volcanes y macizos andesíticos que van de 1 a 3 m.a.
- Vulcanismo ante-caldera: Representado por domos riolíticos de Zinapécuaro y Agua Fría, cuya edad varía entre 1.6 y 1 m.a.
- Abombamiento, explosión de ignimbritas, colapso y depósito de lacustres: Elevación de los productos lacustres del colapso de Cd. Hidalgo y salida de las ignimbritas de Santa Inés y Maravatío tipo plineano.
- Vulcanismo post-caldera: Domos dacíticos y riolíticos con edades menores a 1 m.a. y que llegan hasta 28 mil años (Domo El Guangoche). Flujos plinianos acompañan el nacimiento de estos domos.

Contemporáneos a los últimos domos riolíticos (La Yerbabuena, Carpintero, Guangoche, etc.) se produce un vulcanismo de tipo básico que da lugar a conos cineríticos y compuestos con explosiones vulcanianas. Estos aparatos son gobernados por los principales sistemas de fallamiento que afectan al basamento.

Al sur de la Caldera de Los Azufres de edad pleistocénica, se encuentra el Colapso de Cd. Hidalgo donde se instala el domo riolítico más joven de los existentes en este sector. Este colapso se relaciona con las ignimbritas que afloran en Mil Cumbres y que fueron cortadas en los pozos de Los Azufres debajo de los mil metros sobre el nivel del mar. Este paquete explosivo se considera del Plioceno y se encuentra descansando sobre el Complejo Volcánico Superior (5 m.a.) en forma discordante.

Geología Estructural

Los estudios efectuados en relación a este tema solo han tenido un enfoque local que ha evitado tener un conocimiento regional de evolución y formación de fracturas. Son tres los sistemas principales, del más antiguo al más reciente:

Sistemas de Cuencas y Sierras NNW-SSE y NW-SE

Este sistema es el que provoca el Graben de Cd. Hidalgo y los bloques escalonados de Mil Cumbres. En el Graben de Cd. Hidalgo se alinean una serie de aparatos volcánicos obedeciendo a esta dirección. Algunas de estas estructuras, en el sector de Tzitzio, se encuentran afectando al pliegue de fondo con movimiento de tipo lateral derecho.

Dentro del campo geotérmico de Los Azufres este sistema afecta a las andesitas de 1 a 3 m.a. y eventualmente a los domos riolíticos de Agua Fría. Este fenómeno se origina debido a que las estructuras antiguas son reactivadas cuando se generan las fallas NE-SW y E-W.

La edad de nacimiento de este sistema corresponde al Mioceno y Plioceno Inferior.

Sistema NE-SW

Se encuentra muy marcado en el sector del Lago de Cuitzeo provocando un escalonamiento hacia el NW. Este mismo sistema da lugar a el Corredor Tarasco donde se emplaza el vulcanismo cuaternario de Michoacán y Guanajuato. - El fracturamiento de este se encontró cuando se realizó el - análisis estructural del campo geotérmico.

En Cuitzeo las fallas conjugadas otorgaron - una componente lateral izquierda, que fue corroborada con algunas fallas que afectan a lacustres e ignimbritas.

Sistema E-W

Es el sistema de fallas más importante que gogierna las estructuras y que provoca un mínimo regional gravimétrico con esta dirección.

El borde sur de la Caldera de Los Azufres y - el borde norte del Colapso de Cd. Hidalgo, se encuentran segmentados, provocando que ambas estructuras sean enmascaradas. Dentro del campo de Los Azufres el sistema E-W es el que gobierna el termalismo, el cual tiene una dirección E-W y un - posible sentido del oeste hacia el este.

Los mecanismos focales de este sistema, el paleomagnetismo y las microestructuras traducen también un movimiento lateral izquierdo que parece ser heredado de los - primeros movimientos de las microplacas actuantes.

La fase distensiva que origina a estas estructuras no pudo quedar ajena a las estructuras antiguas, por - ello, estas rejuegan con esta tectónica y afectan al paquete cuaternario, llegando hasta dividir en dos a los aparatos andesíticos.

Al oeste y este de la caldera existen alineamientos de aparatos de afinidad basáltica que guardan la dirección de las estructuras mayores E-W.

Condiciones de Yacimiento

Los estudios realizados revelan que el yacimiento se encuentra alojado en un medio donde se combinan - las siguientes características físicas:

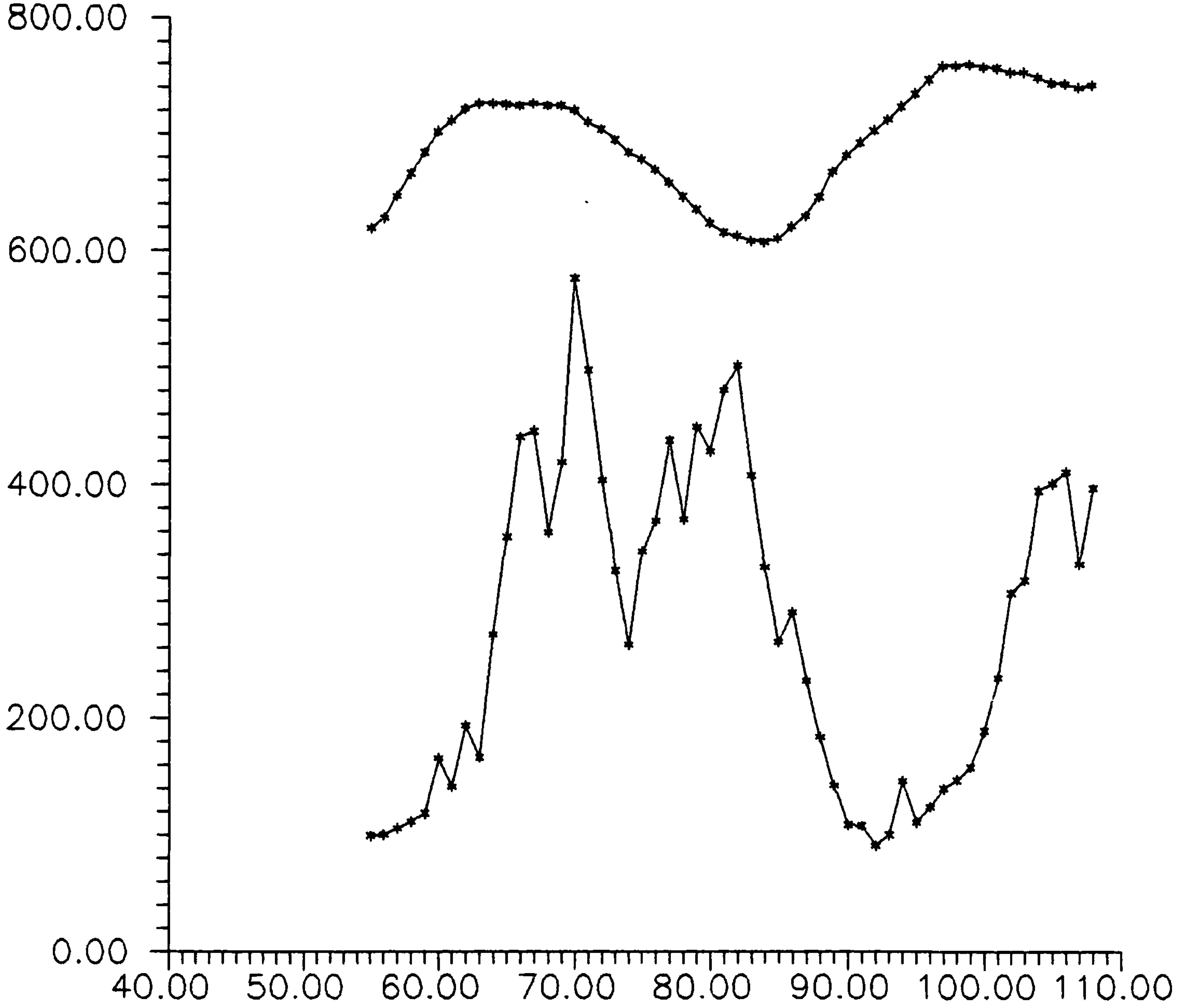
- Contactos de coladas (discordancias).
- Niveles de brechas.
- Diaclasado.
- Fracturamiento y
- Matriz

Esto provoca la presencia de un yacimiento - con permeabilidad que puede ser superior al 12%. No así, - en los casos en que la alteración intervenga.

El yacimiento se localiza en el Complejo Volcánico de Sierra Madre Occidental con una edad que puede ir desde los 20 a los 5 m.a. Con un espesor de más de 3,000 m y que en los pozos Az-20 y Az-44 estuvieron a punto de atravesar.

El sistema estructural E-W controla el comportamiento del flujo geotérmico. Los estudios de Geofísica, - Geoquímica, Minerales de alteración y vulcanológico revelan que este tiene dos posibles caminos de circulación del oeste hacia el este y del norte al sur o del sureste al noroeste, con un área de descarga en la zona norte (Az-4) y en la zona sur (Az-) ayudados por las fallas Marítaro y Agua Fría respectivamente y los sistemas antiguos NW-SE.

El yacimiento geotérmico es producto de la cámara magmática de la Caldera de Los Azufres, que aprovecha - las zonas débiles del occidente del campo; permitiendo el emplazamiento de los últimos domos riolíticos y en fin, aprovechando las fallas E-W y NW-SE, el flujo y descarga del yacimiento.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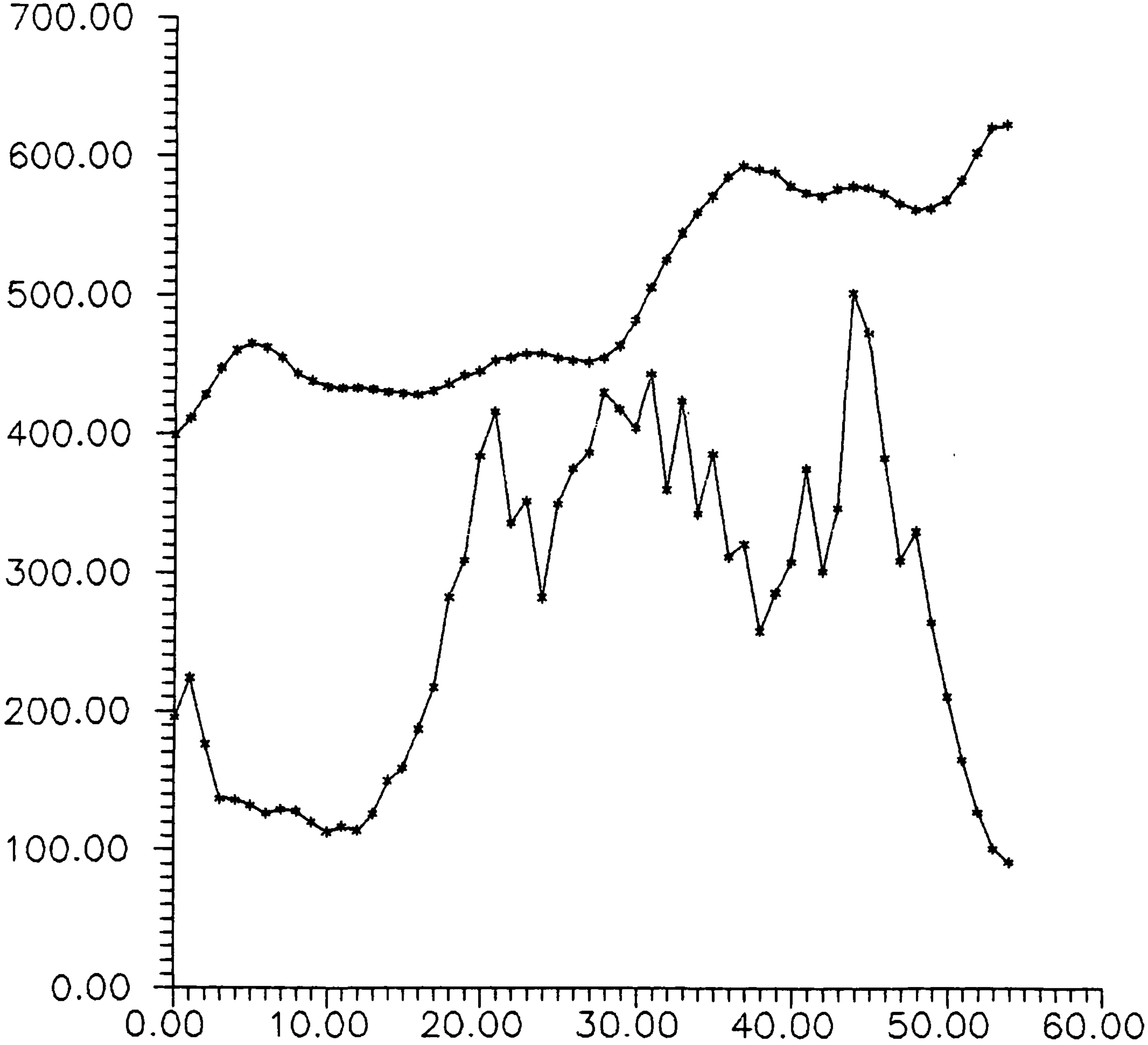
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TAREA 1 : GEOLOGIA

1.1 GEOLOGIA

- QUE SE ESPERABA PARA LA 4a. REUNION:

Haber terminado el levantamiento geológico regional.
Haber terminado el modelo conceptual del campo.
Tener dataciones de algunas unidades en el campo y sus - alrededores.
Contar con los resultados de UURI relacionados con los - análisis de elementos y tierras raras constituyentes de - las rocas del subsuelo muestreadas en pozos.
Haber iniciado parte del reporte preliminar.
Tener la carta geológica actualizada.

- QUE SE HIZO:

Se terminó el levantamiento geológico regional incluyendo el reporte correspondiente.
Se elaboró la carta geológica actualizada del campo.
Se terminó el modelo conceptual del campo.
Se obtuvo parte de la información de geoquímica de rocas (pozos AZ-28, AZ-48 y AZ-51), por UURI.
Se obtuvieron las dataciones de rocas, por UURI.
Se inició la elaboración del reporte preliminar.

- QUE SE PRETENDE PARA LA PROXIMA REUNION:

Tener la tarea completa integrada en un reporte.

1.2 INTERACCION AGUA-ROCA

QUE SE ESPERABA PARA LA PROXIMA REUNION:

Haber identificado los minerales secundarios en muestras de tres pozos.
La identificación de venas de minerales y su relación -- con las temperaturas.
Haber identificado en inclusiones fluidas las temperaturas de formación y el contenido salino en las mismas para tres pozos.

Comparar e integrar en el estudio los datos de minerales secundarios e inclusiones fluidas, obtenidos previamente por el IIE para la CFE.

- QUE SE HIZO:

Se efectuaron los estudios de inclusiones fluidas en las muestras de los tres pozos, obteniéndose las temperaturas de formación y contenido salino.
Se inició la comparación de las temperaturas de formación en inclusiones fluidas y las actuales calculadas en los pozos.
Se inició la interpretación del modelo de flujo hidrotermal en el campo, tomando en cuenta cuatro pozos (AZ-28, AZ-48, AZ-51 y AZ-3).
Se inició el informe.

- QUE SE PRETENDE PARA LA PROXIMA REUNION:

Haber terminado los estudios y tener integrado el reporte final.

TAREA 2 : GEOFISICA

2.1 INTERPRETACION DE DATOS GEOFISICOS.

(P.Wright (UURI), F.Arellano y G.García E.(CFE)
(antes O.Campos E.)

1. QUE SE ESPERABA PARA LA 4a. REUNION:

1.1 En base al modelado bidimensional, sin corrección topográfica, de dos líneas E-W y una N-S, haber procesado los datos de resistividad en UURI con programas de dicho instituto. Esta se iba a realizar en la visita programada en mayo de 1988 a Salt Lake City.

1.2 En base a los resultados, hacer una interpretación estructural y tener el reporte preliminar.

2. QUE SE HIZO:

Debido a que el personal de CFE encargado de la tarea (O. Campos) salió de la institución y por falta de tiempo, el procesado de la información de resistividad en UURI no se realizó durante la visita que llevó a cabo el personal de la CFE a UURI en el mes de agosto ppdo.

Sin embargo sí obtuvo de UURI copia del programa para el procesado en 2 dimensiones de los datos de resistividad con corrección topográfica, no fue posible obtener el de 3 dimensiones.

3. QUE SE PRETENDE PARA LA 5a.REUNION EN MARZO:

Con el Software puesto a disposición de la CFE y el procesado de interpretación preliminar bidimensional de tres líneas de resistividad en Los Azufres, se pretende que previa adaptación de los programas en la computadora de la CFE, procesar nuevamente los resultados, efectuar una interpretación estructural del campo y tener el informe a tiempo para su impresión antes de la próxima reunión en marzo de 1988.

2.2. VUELO AEROMAGNETICO.

(P.Wright UURI), G.García y F.Arellano (CFE)

- QUE SE ESPERABA PARA LA 4a. REUNION:

Haber realizado un vuelo aeromagnético bajo con helicóptero de CFE y un vuelo aeromagnético alto en avioneta.

Tener el procesado de los vuelos, haber realizado su interpretación preliminar y tener un reporte también preliminar.

- QUE SE HIZO:

Del 4 al 9 de mayo se efectuó el vuelo aeromagnético bajo, utilizando un helicóptero de CFE volando a una altura promedio de 70 m, en 47 líneas de orientación N45W y 5 líneas E-W, con las que se cubrió un área de 72 Km2.

Del 10 al 16 de mayo se efectuó el vuelo alto, a una altura promedio sobre el nivel del mar de 3,500 m, levantándose 34 líneas N-S y 3 líneas E-W, para cubrir una - superficie de 2,000 Km2.

- CON ELLOS SE OBTUVO Y ENTREGO A UURI:

Los registros magnéticos originales.
Las cintas de video para el control de las líneas aeromagnéticas.
Un fotomosaico con las líneas del vuelo bajo.
Un fotomapa con las líneas programadas para el vuelo bajo (Escala 1:10,000).
Un mapa base a escala 1:50,000 del área del vuelo alto.
Copias de los registros de campo con las variaciones -- del campo magnético monitoreado en Los Azufres entre el 19 de abril y el 26 de mayo de 1988.
Una copia del reporte del levantamiento de susceptibilidad magnética en 23 sitios de Los Azufres y de las muestras de canal de 2 pozos.
Cuatro hojas topográficas a escala 1:10,000.
Un plano topográfico a escala 1:20,000.

- CON LA INFORMACION DE LOS VUELOS AEROMAGNETICOS, DE LOS CUALES RETUVO COPIA LA CFE, SE EFECTUO:

El trazado de líneas y ubicación de estaciones de los vuelos bajo y alto, para su análisis y comparación con el trabajo realizado por UURI en Salt Lake City.

- DURANTE LA VISISTA DE PERSONAL DE LA CFE A UURI EN EL MES DE AGOSTO PPDO. SE EFECTUO:

La comparación de los planos con las líneas de vuelo y se hicieron algunas rectificaciones de trayectorias.
Se acordó que en la 4a. Reunión CFE presentaría una versión definitiva del plano con las trayectorias y estaciones del vuelo bajo. Para después de octubre se entregará la del vuelo alto.
CFE recibió varios programas para procesados de datos magnéticos, gravimétricos y magnetotelúricos. Posteriormente UURI envió más información de datos aeromagnéticos grabados en cinta.

- QUE SE ESPERA PARA LA PROXIMA REUNION:

Completar el procesado de los datos de campo, realizar los planos de anomalías magnéticas, interpretar y elaborar el reporte final.

TAREA 9 : INTERCAMBIO DE INFORMACION

9.1 LEVANTAMIENTO DE POTENCIAL NATURAL EN CERRO PRIETO

- QUE SE ESPERABA PARA LA 4a. REUNION:

  Presentar un reporte del levantamiento de SP en Cerro -- Prieto.

- QUE SE HIZO:

  Se efectuó el levantamiento de 95 Km lineales distribuidos en 7 líneas, que deberán ser las mismas del levantamiento de Corwin en 1978.

  Se elaboró un reporte preliminar con los datos de campo, señalando las diferencias con respecto al levantamiento previo.

- QUE SE PRETENDE PARA LA PROXIMA REUNION:

  Revisar los datos de campo, configurar las líneas de SP, de contar con un modelo, intentar el modelado del campo, correlacionar los datos con la información geológica y - geotérmica, interpretar y elaborar el informe final.

Dear Gerardo,

The files written on this tape are the high and low altitude magnetic files from the VHS tapes. The first six files are named HIGH#.DAT, the # refers to the tape numbers 1 thru 6. The next three files are the low survey and are named LOW#.DAT, where # are tape numbers 1 thru 3. The tape was written on a PRIME 2655 supermini computer, the tape is formated as ASCII, 1600 bpi, with no blocking. The record length is variable for each file, and the following table should be used to read each file on the tape.

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HIGH2.DAT	157
HIGH3.DAT	96
HIGH4.DAT	85
HIGH5.DAT	96
HIGH6.DAT	48
LOW1.DAT	144
LOW2.DAT	145
LOW3.DAT	144

I hope that you can read this tape, if not, I have sent along the hardcopies from each tape titled with the same names as those on the tape. Thank you for your patience, and it was a pleasure working with you and your colleagues this past week.

Sincerely,

R. Douglas Ramsey

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[MAGNET Rev. 19.4.5 Copyright (c) Prime Computer, Inc. 1985]
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 Object name = $DUMMY2 :   1192 Logical records read.
 Object name = $DUMMY1 :   1192 Physical blocks written.
 Object name = $DUMMY1 :   1192 Logical records written.
> w
MTU # = 0
File # = 9
Logical record length = 144
Blocking factor = 1
ASCII, EBCDIC, BCD or BINARY? a
Disk file: low3.dat
 Object name = $DUMMY2 :   Operation complete.
 Object name = $DUMMY2 :   1386 Logical records read.
 Object name = $DUMMY1 :   1386 Physical blocks written.
 Object name = $DUMMY1 :   1386 Logical records written.
> q
OK, un mt0
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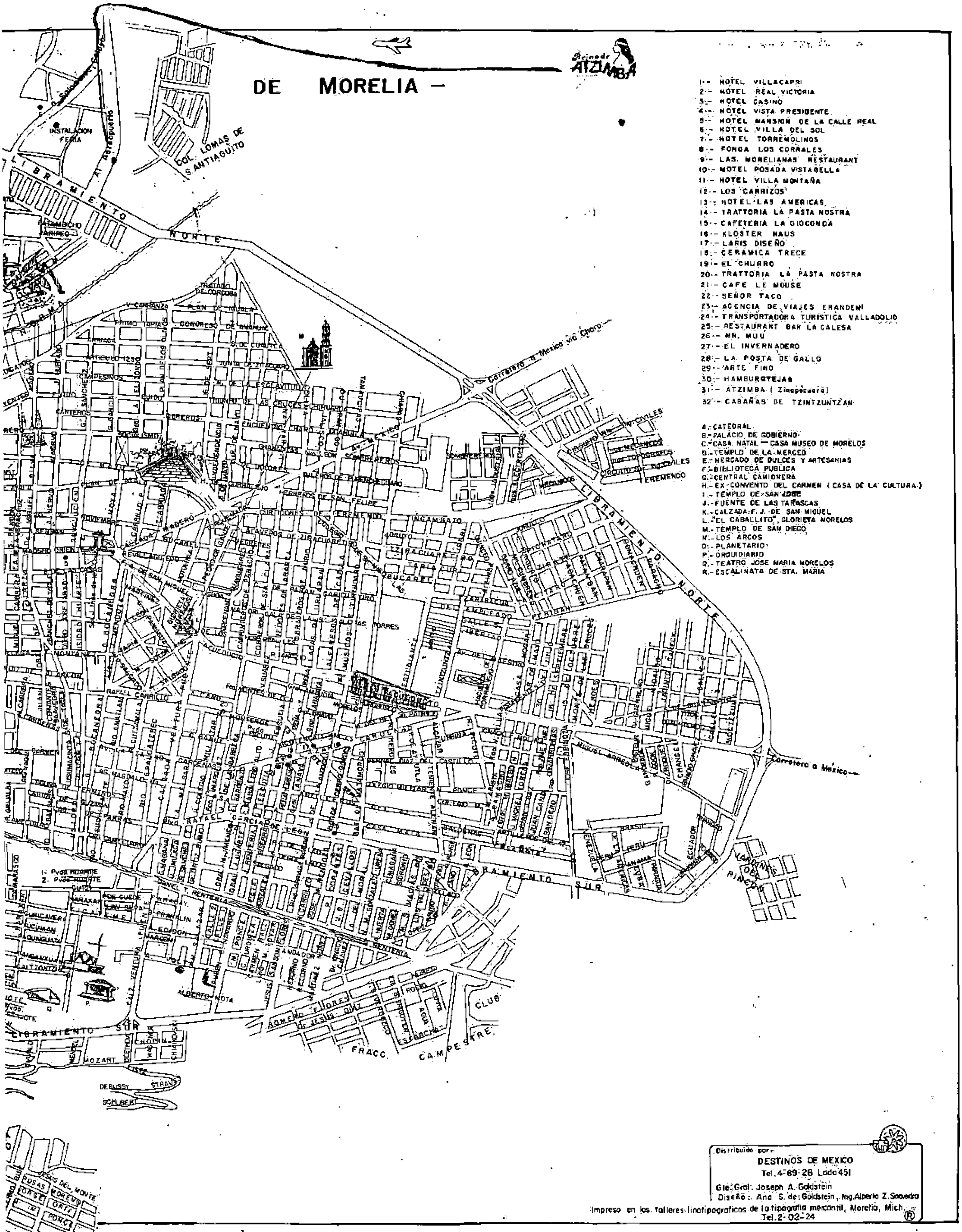

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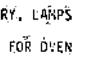

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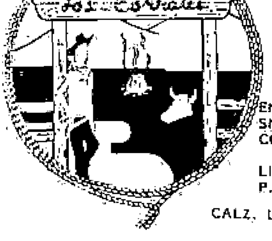

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AEROMAGNETIC STUDIES, LOS AZUFRES GEOTHERMAL AREA, MICHOACAN

by

Howard P. Ross and Phillip M. Wright
University of Utah Research Institute, Earth Science Laboratory
Salt Lake City, Utah 84108-1295

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Comisión Federal de Electricidad
Moreilia, Michoacan, Mexico

Hector Lira Herrera, Comisión Federal de Electricidad
Mexicali, B. C., Mexico

ABSTRACT

Detailed and regional aeromagnetic surveys were completed over the Los Azufres geothermal area in central Mexico. Many mapped faults are clearly expressed in the detailed magnetic data because these faults penetrate to the surface and many are reflected in the topography. East-trending faults are often cut by younger north- to -northwest trending structures which can be interpreted from the magnetic data. A large zone of mapped hydrothermal alteration is apparent in the magnetic data as an area of unusually low (0-50 nT) magnetic relief. Interpreted structures trend NW into this area and are weakly expressed within the alteration zone. The regional survey records several major volcanic - intrusive complexes as large, positive magnetic anomalies, including the Los Azufres area. The source of the Los Azufres magnetic high appears to be bounded by northwest- and north-trending regional structures.

RESUMEN

Levantamientos detallados y regionales aeromagnéticos fueron completados sobre el sistema geotérmico Los Azufres en la parte central de Mexico. Muchas fallas de las cuales se han hecho mapas estan claramente expresadas en los datos magnéticos, pues estas fallas penetran la superficie y muchas se reflejan en la topografía. Las fallas con dirección al oriente suelen ser cortadas por estructuras mas recientes con orientación norte a noroeste, las cuales se pueden interpretar atravez de datos magnéticos. Hay cerca de 18 facciónas magnéticas que están correlacionan con fallas ubicadas en mapas y otras estructuras probables. Varias fallas ubicadas en mapas pueden ser extendidas con una interpretación de los datos magneticos y ademas mas de 12 estructuras que no han sido ubicados en mapas.

Una zona amplia de alteración hidrotermal y ubicada en mapas aparece en los datos magneticos como una zona de bajo (0-50 nT) relieve magnético. Estructuras interpretadas en esta area son de dirección Noroeste y aparecen poco dentro de la zona de alteración. Los datos indican la posible relación del complejo volcánico Los Azufres con la intersection del sistema estructural Noreste-Sureste (Basin and Range?) con estructuras Este-Oeste. El levantamiento regional registra varios complejos de volcánicos-intrusivos mayores como anomalias magnéticas positivas que incluyen el area de Los Azufres. El origen del alto magnetismo de Los Azufres pareciera se limitado por estructuras regionales orientadas por el norte y el Noroeste.

INTRODUCTION

As part of a cooperative agreement between the United States Department of Energy (DOE) and the Mexico Comision Federal de Electricidad (CFE), two aeromagnetic surveys were completed over the Los Azufres geothermal area in Michoacan, central Mexico. The goals of this work were to determine the effectiveness of specialized aeromagnetic surveys for determining structural control and alteration areas in geothermal resources related to fractured volcanic systems. Other data obtained in support of the aeromagnetic surveys included the collection of magnetic susceptibility data for geologic units at Los Azufres and recording the diurnal variation of the earth's magnetic field.

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The high-altitude survey covered an area of approximately 1500 sq km in which the Los Azufres geothermal field was centrally located. Approximately 1590 line-km were flown north-south at a nearly constant altitude of 11,300 ft (3,444 m) except over parts of San Andres volcano where altitude reached 12,500 ft (3,810 m). This survey was flown in a Piper Cherokee fixed-wing airplane chartered by CFE. Dense smoke and haze resulting from numerous fires restricted flying and complicated navigation, resulting in non-uniform survey data coverage.

Both surveys were completed in May, 1988 by a four man-crew which included a pilot and navigator from CFE, and a magnetometer operator and video system/recorder operator from UURI. The variation of the earth's magnetic field was recorded with a Scintrex Base-Station Magnetometer, Model MBS-2 for the period 19 April to 26 May 1988. These variations, which have a normal distribution, have a mean value of 42,740 gammas. The goal of this magnetic field monitoring was to determine the diurnal corrections to be applied in the reduction of the aeromagnetic data. Significant diurnal variations did occur during the low-altitude survey.

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The flight-path recovery utilized VHS tapes of the flight path which were replayed many times to locate points identifiable on aerial photos, photomosaics, and topographic maps. The predominance of forest cover and incomplete photographic coverage limited the number of recovered points on both surveys.

A first-generation magnetic map of the low-altitude data was completed by removing a base level of 42,000 nanoteslas (nT) from all observed values and applying diurnal corrections to each flight line. The diurnal adjusts all recorded data to the "normal" value of 42,740 nT observed at the CFE monitor station during the survey period, (Campos E. and Herrera B., 1988). The final magnetic map includes additional corrections to entire lines or portions of lines based on tie-line intersections and altitude variations. This map of total magnetic intensity also incorporates smoothing to reduce flight-line effects and to emphasize geologic information.

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Compilation of the high-altitude data included diurnal corrections (generally less than 10 nT according to Campos E. and Herrera B., 1988) and removal of a 42,000 nT base level. Because the diurnal changes were small and well-located tie-line intersections were generally less than +/- 10 nT, no further tie-line adjustments were made. Nonconforming data for poorly located portions of several flight lines were ignored in contouring the final map.

INTERPRETATION - LOW-ALTITUDE SURVEY

An initial qualitative interpretation of the low-altitude map was completed by the correlation of geological and geophysical data, including; lithology, structure, susceptibility samples, paleomagnetic data, gravity, and ground magnetics. Linear magnetic trends and dipolar magnetic anomalies resulting from distinct sources with induced magnetization were identified from these data. In general, the detailed map (Plate I) shows well-defined regional trends with an E-W orientation which predominate in the northern sector, and NW-SE trends which predominate in the south and west portions of the area. Other trends of minor importance, with an approximate N-S orientation, occur in the eastern sector. These magnetic trends correspond to orientations associated with a system of

structures observed at the surface. The NW-SE trends may be of major importance as they coincide with trends observed in the regional gravity map. The detailed (1:10,000) geologic mapping (CFE, 1986) provides a basis for evaluation of the magnetic data. Figure 1 illustrates the form of magnetic anomalies for two characteristic models as computed for the magnetic-field parameters of the Los Azufres area.

Inspection of the low-altitude survey map, Plate I, reveals several interesting features.

1. Numerous short-wavelength highs and lows, less than 0.5 km in long dimension, occur on portions of the periphery of the surveyed area. Many of the small closed anomalies result from data acquisition or compilation problems (i.e. terrain clearance variation, flight path recovery inaccuracies). Terrain clearance variations are most severe when the magnetometer is less than 100 m above the ground surface. Many anomalies result as the irregular topography rises to, or falls away from, the smoother flight path. Anomalies of this type can be evaluated by correlation with topographic maps and review of the radar altimeter data.

2. There is a northwest-southeast elongation of contours, some of which may result from flight-line position and data leveling errors. Manual smoothing has reduced these compilation effects. Much of the remaining NW-SE elongation results from the topographic grain and magnetization contrasts due to northwest-trending faults, fractures, and geologic contacts. Discrimination between compilation errors and valid geologic contrasts is difficult, and interpreted NW-SE structures must be regarded as somewhat uncertain.

3. Magnetic field variations of 300 nT to more than 1200 nT per kilometer are common along all borders of the survey. An area of perhaps 5 km (N-S) by 1-3 km (E-W) in the center of the survey, and largely coincident with the zone of hydrothermal alteration between the north and south production zones, is characterized by only long-wavelength variations between 640 nT and 750 nT. This limited variation indicates very minor magnetization contrasts in near-surface rocks (0-1000 m depth) which may arise from different geologic models.

4. Numerous positive anomalies are associated with the San Andres dacite (Qdp) to the east, the Mil Cumbres andesites (Tma) and dacite cinders (Qvc) in the north.

5. Several negative anomalies occur over rhyolitic rocks (Qrf). The near-surface depth estimates to the source rocks along with correlation with hilltop topography and reduced terrain clearance (from the radar altimeter) suggest reversely polarized units within these Quaternary rhyolites. Several of these reversed sources are identified by (R) on the interpretation map, Plate II. Additional reversely polarized volcanic sources may be present but have not been positively identified. Flux-gate magnetometry measurements by Dobson and Mahood (1985) document reversed magnetizations in "basement rocks" and in the Agua Fria rhyolites at Los Azufres.

Interpretation of the low-level data to date has focused upon: 1) an evaluation of the utility of this detailed, low-level survey in helping to map this volcanic-hosted, fracture-dominated geothermal system; and 2) a preliminary magnetic/geometric model of the production zones and adjacent areas of the geothermal system. A more complete interpretation of the survey will result from subsequent CFE processing and numerical modeling. The results of the present interpretation are summarized on Plate II, an overlay to the magnetic data or geologic maps, and are discussed below.

Fault and Fracture Delineation

The magnetic contour map is dominated by the expression of faults and fractures. These structures are well expressed for several reasons. Many faults penetrate to the surface and are reflected in the surface topography. The faults place volcanic rocks of different magnetization in lateral contact, providing the necessary magnetization contrasts. Magnetic susceptibility contrasts within the Los Azufres area have been documented by Campos and Abad (1988) and confirm a substantial range of susceptibility variation (10 E-6 to 2047 E-6 cgs for individual measurements). The variation in remanent magnetization is probably greater. The low level of the helicopter flight provided a small distance between the magnetization contrasts and the sensor, enhancing the anomalies.

Major portions of more than 18 mapped faults and several second-order structures are expressed in the magnetic data (Plate II, Table I). The faults and fractures are expressed in various ways.

Table I
Magnetic Expression of Known Faults

Falla	Magnetic Expression	*Type of Expression	Length(Km) Expressed	Trend Direction
Falla Fio Agrio	Weak	GR + AD	1	NNW
Falla Maritaro	Strong	GR + AD	6	E
Falla Nopalito	Weak	AD	0.5	NE
Falla Espinazo del Diablo	None	---	--	E
Falla Los Coyotes	Moderate	AD	3	E
Falla La Presa (N)	Moderate	GR + AD	3	NNW
Falla Laguna Verde (N)	Moderate	GR + AD	3	NNW
Falla La Cumbre	Weak	---	1	E
Falla La Hiobba	Moderate	GR + AD	1	N;NNE
Falla La Presa (S)	Strong	GR	3	NNW
Falla Dorada	None	---	--	NE
Falla El Chino	Weak	AD	0.7	E
Falla Laguna Larga	Moderate	AD	2.5	E
Falla San Alejo	Weak	GR + AD	0.7	E
Falla Agua Fria	Moderate	GR + AD	3.5	E
Falla El Vampiro	Weak	AD	0.8	NE
Falla El Viejon	Moderate	GR + AD	2	NE
Falla Ejamaniles	Moderate	GR + AD	2	SE;E
Falla Los Azufres	Moderate	GR + AD	0.8	E
Falla Agua Ceniza	Moderate	GR + AD	1	NE
Falla El Chinapo	Strong	GR + AD	2.5	E
Falla Laguna Verde (S)	Moderate	GR + AD	1.7	NNW

* Magnetic expression type: GR = gradient; AD = alignment of discontinuities

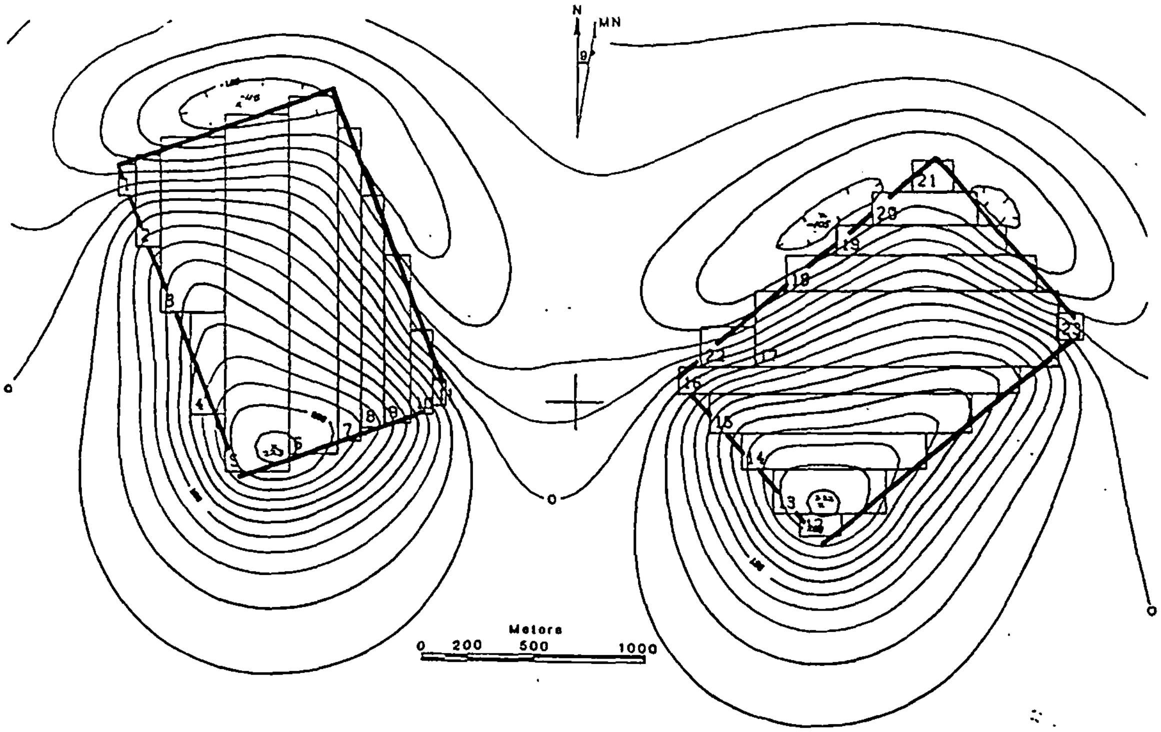

Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20W and N50E. Susceptibility contrasts 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9°E, inclination 48°, TF = 42,740 nT. Contour interval 20 nT.

A linear gradient 0.5 to several km long (e.g. Falla La Presa, Falla Maritaro) is the most obvious expression. More common in these data are the truncation of magnetic highs and lows and changes in anomaly amplitudes along a linear alignment. Many known faults are revealed by combinations of the above.

Not all faults are well expressed in the magnetic data, and only rarely can the entire fault be interpreted from the magnetic data. Because the surface geology has been mapped in detail and many drill holes have been completed, the opportunity for identifying major new features from the magnetic data is somewhat limited. Using the criteria discussed earlier, and in conjunction with the CFE geologic map, several mapped faults may be extended with some confidence based on the magnetic data. These include Falla Laguna Verde, Falla La Hiobba, Falla El Chinapo, and other unnamed features.

More than 12 previously unmapped structures are also interpreted from the magnetic data, as shown on Plate II. Several of these interpreted structures trend N60W to N20W, at a relatively small angle to the flight lines and hence could arise from compilation problems in areas of poor flight path recovery, or a coincidental alignment of magnetic gradients of anomalies. Perhaps the most important of these trends northwest near the eastern margin of the South Production Zone. The recognition of these NW-SE structures is a useful contribution to the knowledge of Los Azufres at this stage of qualitative interpretation. These interpreted features should be verified by geological mapping or surface geophysical surveys before being accepted as faults.

Los Azufres Geothermal System

A preliminary interpretation of the Los Azufres area is shown on Plate II. This interpretation, supported by numerical modeling of the high-altitude survey, Figure 2, indicates that a large body of relatively uniform bulk magnetization extends from Falla El Chinapo on the south to Falla Los Coyotes on the north. The body is truncated by Falla Laguna Verde and Falla La Presa on the east, and extends west beyond Presa Laguna Larga. This broad, positive source appears to be the 1000 m plus thickness of andesites contrasting with San Andres dacite and La Yerbabuena rhyolite domes on the east, and La Yerbabuena rhyolite domes on the west. Superimposed on this dominantly low-relief feature are minor anomalies due to topographic effects, faulting, and locally, reversely magnetized rhyolites which may outcrop.

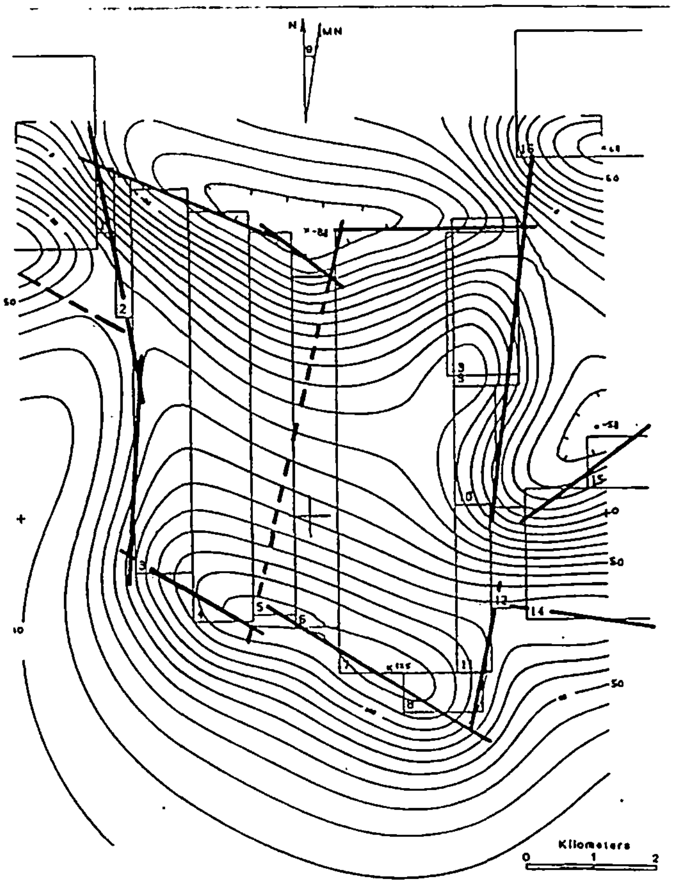

Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.

Thin, layered rhyolites overlie andesites in the central portion of the positive source body. A broad area of hydrothermal alteration is expressed by subdued magnetic variations, and appears to be oriented along the trend of two poorly defined structures interpreted from the magnetic data. We do not observe a detailed correlation between the diverse lithologic units and the magnetic contours, except that in the areas of high susceptibility (andesites and dacites) the magnetic relief is much more irregular than where the surface cover are tuffs, rhyolites and altered rocks, even though the average value of the field is approximately the same.

The structures indicated may have some significance as controls for the South

Production Zone. The significance of structures and magnetic sources near the North Production Zone is unclear at present.

INTERPRETATION - HIGH ALTITUDE SURVEY

The high altitude residual magnetic intensity map is presented as Plate III. The interpretation of this survey will be somewhat limited by flight-path recovery problems, principally in the southern third of the survey area, and by several wide gaps in flight line separation. In four areas, the spacing between flight lines exceeds three km. In these areas the frequency content of the mapped data is lower than that of the true magnetic field at this elevation, and anomaly shapes may be somewhat incorrect.

Several major west and west-northwest trending structures can be inferred from the contour map. Positive magnetic sources, 4 to 20 sq km in aerial extent, suggest major volcanic-intrusive complexes. Some of the more prominent sources occur at the eastern end of Laguna Cuitzeo, north of Presa Pucuato, near Mesa El Cantor, and at Uripitio. Geothermal fields are associated with two of these large sources: Araro, southeast of the Cuitzeo source, and Los Azufres. The volcano San Andres, less than 400 m below the flight altitude, occurs as a positive magnetic anomaly with amplitude 300 nT above background. The inferred source position includes an area of approximately 12 sq km, much of which is above 3000 m in elevation.

The low-frequency magnetic anomalies, and the magnetic sources which can be inferred from these anomalies, form a large somewhat-circular area perhaps 25 km in diameter in the southeastern portion of the survey area. Any interpretation relating this near-circular appearance to a caldera complex will require more interpretation and considerable geologic input.

The only specific interpretation of the high-altitude data reported here is first-pass modeling of a low-amplitude positive anomaly which encompasses 20 sq km and is centered over the Los Azufres geothermal area. A simplified model of this source (Figure 2) corresponds to the broad magnetic source identified from the low-altitude survey which includes the Los Azufres geothermal system. The interpreted susceptibility contrast for this body, contrasted with bordering, less magnetic blocks, is approximately 1000 E-6 cgs, assuming a finite depth extent of the order of 2300 m, for this magnetization contrast. This may relate to a thicker section of andesites downfaulted with respect to surrounding dacites, rhyolite domes and other rocks and/or intrusive rocks beneath the andesite units.

CONCLUSIONS

The high-altitude aeromagnetic survey maps an arcuate area of over 500 sq km which includes several large magnetic sources suggestive of volcanic-intrusive complexes. One of these sources includes the entire area of the Los Azufres geothermal system. This source is bordered on three sides by major mapped faults. The positive magnetic source may correspond to a thicker section of Mil Cumbres andesites, and/or intrusives at depth, and contrasts with rhyolite and dacite domes to the west and east. Several regional structures may be inferred from this survey but they have not yet been studied in detail.

On the basis of the preliminary interpretation, it appears that the low-altitude survey is only partially successful for reflecting the known geologic characteristics at Los Azufres, but contributes indications of a regional kind which shed new information and permit making hypothesis for later studies. The most important are the possible relation of the Los Azufres volcanic complex with the intersection of a NW-SE structural system (Basin and Range?) with more recent E-W structures. These data also suggest that the hydrothermal alteration observable at the surface is largely restricted to shallow units and decreases notably with depth.

The detailed, low-level magnetic survey shows numerous linear magnetic trends and discontinuities not present on the high altitude data, at least 18 of which correlate with mapped faults and other probable structures. Several mapped faults may be extended with an interpretation of the magnetic data, and more than 12 previously unmapped structures are interpreted from these data. Some of these structures may be important to a better understanding of structural controls for the South Production Zone. With more study, this structural information will lead to a better understanding of this fracture-controlled geothermal system. The cost-effectiveness of the regional survey is still being evaluated.

Magnetic surveys of similar structurally controlled volcanic geothermal systems should utilize a close flight line spacing (200-300 m) and a smoothly draped flight path somewhat higher than the minimum and mean terrain clearance of this survey. Depending on local relief and helicopter performance, a mean terrain clearance of 100 to 200 m should be considered.

Further interpretation of the detailed survey may benefit from low-pass digital filtering to reduce noisy data due to varying terrain clearance and flight-line position errors. Additional numerical modeling of the geothermal area should then be completed. Numerical modeling and structural interpretation of the high-altitude survey can be completed on a lower priority basis.

ACKNOWLEDGEMENTS

The authors thank Marshall Reed, DOE, for his interest, support and advice during this project. Mr. Dale Green, UURI, completed a major modification of the instrumentation prior to the surveys. Numerous other CFE and UURI personnel provided technical support to this project.

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ILLUSTRATIONS IN FOLDER

Plate I. Residual Magnetic Intensity, Los Azufres Geothermal Area. Detailed helicopter survey, scale 1:20,000.

Plate II. Structural Interpretation, Los Azufres Geothermal Area. Scale 1:20,000.

Plate III. Residual Magnetic Intensity, Acambaro-Ciudad Hidalgo Area. High altitude regional survey, scale 1:100,000.

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AEROMAGNETIC STUDIES, LOS AZUFRES GEOTHERMAL AREA, MICHOACAN

by

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ABSTRACT

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Major portions of more than 18 mapped faults and several second-order structures are expressed in the magnetic data (Plate II, Table I). The faults and fractures are expressed in various ways.

Table I
Magnetic Expression of Known Faults

Falla	Magnetic Expression	*Type of Expression	Length(Km) Expressed	Trend Direction
Falla Fio Agrio	Weak	GR + AD	1	NNW
Falla Maritaro	Strong	GR + AD	6	E
Falla Nopalito	Weak	AD	0.5	NE
Falla Espinazo del Diablo	None	---	--	E
Falla Los Coyotes	Moderate	AD	3	E
Falla La Presa (N)	Moderate	GR + AD	3	NNW
Falla Laguna Verde (N)	Moderate	GR + AD	3	NNW
Falla La Cumbre	Weak	---	1	E
Falla La Hiobba	Moderate	GR + AD	1	N;NNE
Falla La Presa (S)	Strong	GR	3	NNW
Falla Dorada	None	---	--	NE
Falla El Chino	Weak	AD	0.7	E
Falla Laguna Larga	Moderate	AD	2.5	E
Falla San Alejo	Weak	GR + AD	0.7	E
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Falla El Vampiro	Weak	AD	0.8	NE
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Falla Ejamaniles	Moderate	GR + AD	2	SE;E
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Falla Agua Ceniza	Moderate	GR + AD	1	NE
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* Magnetic expression type: GR = gradient; AD = alignment of discontinuities

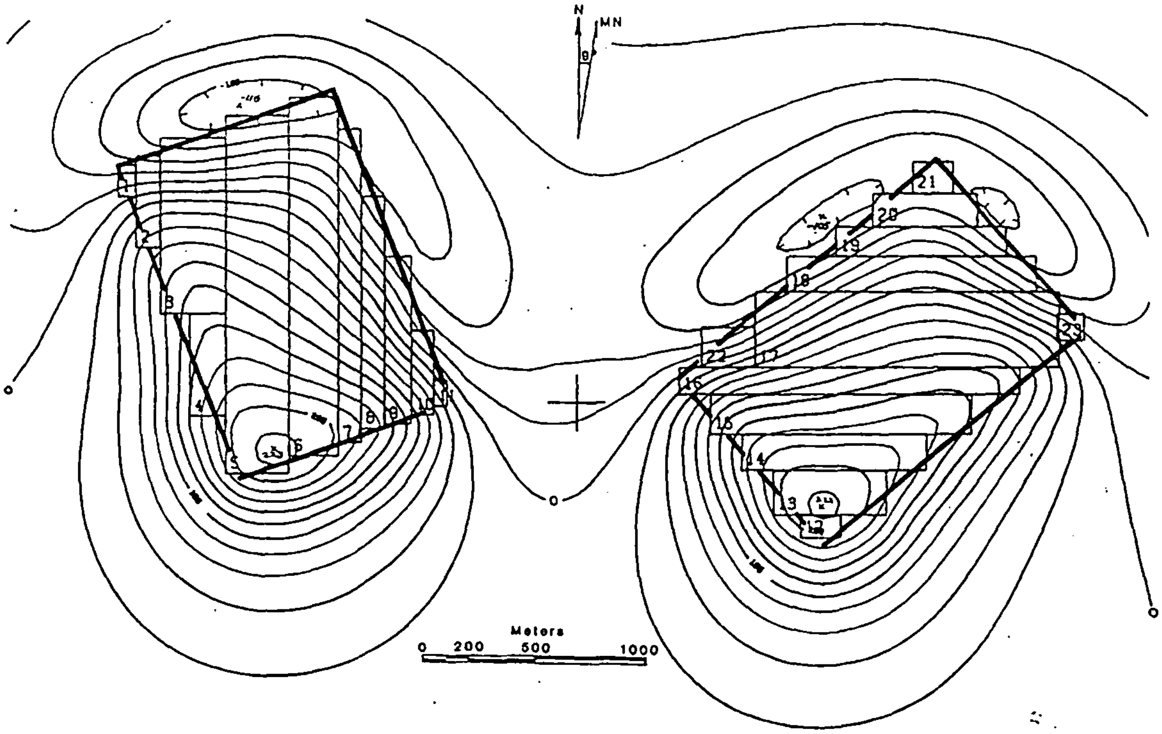

Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20W and N50E. Susceptibility contrasts 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9^{o}E, inclination 48^{o}, TF = 42,740 nT. Contour interval 20 nT.

A linear gradient 0.5 to several km long (e.g. Falla La Presa, Falla Maritaro) is the most obvious expression. More common in these data are the truncation of magnetic highs and lows and changes in anomaly amplitudes along a linear alignment. Many known faults are revealed by combinations of the above.

Not all faults are well expressed in the magnetic data, and only rarely can the entire fault be interpreted from the magnetic data. Because the surface geology has been mapped in detail and many drill holes have been completed, the opportunity for identifying major new features from the magnetic data is somewhat limited. Using the criteria discussed earlier, and in conjunction with the CFE geologic map, several mapped faults may be extended with some confidence based on the magnetic data. These include Falla Laguna Verde, Falla La Hiobba, Falla El Chinapo, and other unnamed features.

More than 12 previously unmapped structures are also interpreted from the magnetic data, as shown on Plate II. Several of these interpreted structures trend N60W to N20W, at a relatively small angle to the flight lines and hence could arise from compilation problems in areas of poor flight path recovery, or a coincidental alignment of magnetic gradients of anomalies. Perhaps the most important of these trends northwest near the eastern margin of the South Production Zone. The recognition of these NW-SE structures is a useful contribution to the knowledge of Los Azufres at this stage of qualitative interpretation. These interpreted features should be verified by geological mapping or surface geophysical surveys before being accepted as faults.

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A preliminary interpretation of the Los Azufres area is shown on Plate II. This interpretation, supported by numerical modeling of the high-altitude survey, Figure 2, indicates that a large body of relatively uniform bulk magnetization extends from Falla El Chinapo on the south to Falla Los Coyotes on the north. The body is truncated by Falla Laguna Verde and Falla La Presa on the east, and extends west beyond Presa Laguna Larga. This broad, positive source appears to be the 1000 m plus thickness of andesites contrasting with San Andres dacite and La Yerbabuena rhyolite domes on the east, and La Yerbabuena rhyolite domes on the west. Superimposed on this dominantly low-relief feature are minor anomalies due to topographic effects, faulting, and locally, reversely magnetized rhyolites which may outcrop.

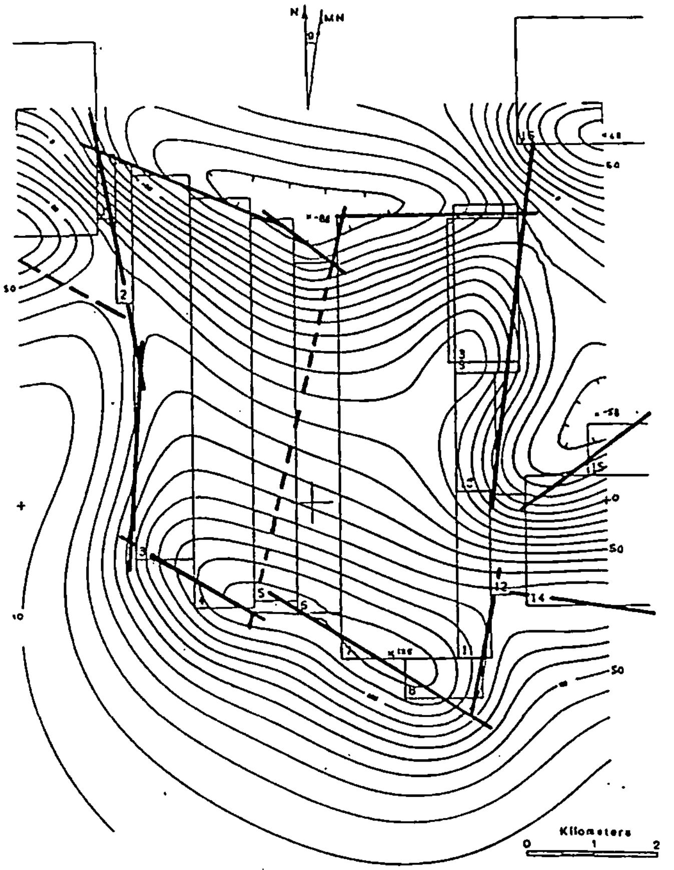

Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.

Thin, layered rhyolites overlie andesites in the central portion of the positive source body. A broad area of hydrothermal alteration is expressed by subdued magnetic variations, and appears to be oriented along the trend of two poorly defined structures interpreted from the magnetic data. We do not observe a detailed correlation between the diverse lithologic units and the magnetic contours, except that in the areas of high susceptibility (andesites and dacites) the magnetic relief is much more irregular than where the surface cover are tuffs, rhyolites and altered rocks, even though the average value of the field is approximately the same.

The structures indicated may have some significance as controls for the South

Production Zone. The significance of structures and magnetic sources near the North Production Zone is unclear at present.

INTERPRETATION - HIGH ALTITUDE SURVEY

The high altitude residual magnetic intensity map is presented as Plate III. The interpretation of this survey will be somewhat limited by flight-path recovery problems, principally in the southern third of the survey area, and by several wide gaps in flight line separation. In four areas, the spacing between flight lines exceeds three km. In these areas the frequency content of the mapped data is lower than that of the true magnetic field at this elevation, and anomaly shapes may be somewhat incorrect.

Several major west and west-northwest trending structures can be inferred from the contour map. Positive magnetic sources, 4 to 20 sq km in aerial extent, suggest major volcanic-intrusive complexes. Some of the more prominent sources occur at the eastern end of Laguna Cuitzeo, north of Presa Pucuato, near Mesa El Cantor, and at Uripitio. Geothermal fields are associated with two of these large sources: Araro, southeast of the Cuitzeo source, and Los Azufres. The volcano San Andres, less than 400 m below the flight altitude, occurs as a positive magnetic anomaly with amplitude 300 nT above background. The inferred source position includes an area of approximately 12 sq km, much of which is above 3000 m in elevation.

The low-frequency magnetic anomalies, and the magnetic sources which can be inferred from these anomalies, form a large somewhat-circular area perhaps 25 km in diameter in the southeastern portion of the survey area. Any interpretation relating this near-circular appearance to a caldera complex will require more interpretation and considerable geologic input.

The only specific interpretation of the high-altitude data reported here is first-pass modeling of a low-amplitude positive anomaly which encompasses 20 sq km and is centered over the Los Azufres geothermal area. A simplified model of this source (Figure 2) corresponds to the broad magnetic source identified from the low-altitude survey which includes the Los Azufres geothermal system. The interpreted susceptibility contrast for this body, contrasted with bordering, less magnetic blocks, is approximately 1000 E-6 cgs, assuming a finite depth extent of the order of 2300 m, for this magnetization contrast. This may relate to a thicker section of andesites downfaulted with respect to surrounding dacites, rhyolite domes and other rocks and/or intrusive rocks beneath the andesite units.

CONCLUSIONS

The high-altitude aeromagnetic survey maps an arcuate area of over 500 sq km which includes several large magnetic sources suggestive of volcanic-intrusive complexes. One of these sources includes the entire area of the Los Azufres geothermal system. This source is bordered on three sides by major mapped faults. The positive magnetic source may correspond to a thicker section of Mil Cumbres andesites, and/or intrusives at depth, and contrasts with rhyolite and dacite domes to the west and east. Several regional structures may be inferred from this survey but they have not yet been studied in detail.

On the basis of the preliminary interpretation, it appears that the low-altitude survey is only partially successful for reflecting the known geologic characteristics at Los Azufres, but contributes indications of a regional kind which shed new information and permit making hypothesis for later studies. The most important are the possible relation of the Los Azufres volcanic complex with the intersection of a NW-SE structural system (Basin and Range?) with more recent E-W structures. These data also suggest that the hydrothermal alteration observable at the surface is largely restricted to shallow units and decreases notably with depth.

The detailed, low-level magnetic survey shows numerous linear magnetic trends and discontinuities not present on the high altitude data, at least 18 of which correlate with mapped faults and other probable structures. Several mapped faults may be extended with an interpretation of the magnetic data, and more than 12 previously unmapped structures are interpreted from these data. Some of these structures may be important to a better understanding of structural controls for the South Production Zone. With more study, this structural information will lead to a better understanding of this fracture-controlled geothermal system. The cost-effectiveness of the regional survey is still being evaluated.

Magnetic surveys of similar structurally controlled volcanic geothermal systems should utilize a close flight line spacing (200-300 m) and a smoothly draped flight path somewhat higher than the minimum and mean terrain clearance of this survey. Depending on local relief and helicopter performance, a mean terrain clearance of 100 to 200 m should be considered.

Further interpretation of the detailed survey may benefit from low-pass digital filtering to reduce noisy data due to varying terrain clearance and flight-line position errors. Additional numerical modeling of the geothermal area should then be completed. Numerical modeling and structural interpretation of the high-altitude survey can be completed on a lower priority basis.

ACKNOWLEDGEMENTS

The authors thank Marshall Reed, DOE, for his interest, support and advice during this project. Mr. Dale Green, UURI, completed a major modification of the instrumentation prior to the surveys. Numerous other CFE and UURI personnel provided technical support to this project.

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ILLUSTRATIONS IN FOLDER

Plate I. Residual Magnetic Intensity, Los Azufres Geothermal Area. Detailed helicopter survey, scale 1:20,000.

Plate II. Structural Interpretation, Los Azufres Geothermal Area. Scale 1:20,000.

Plate III. Residual Magnetic Intensity, Acambaro-Ciudad Hidalgo Area. High altitude regional survey, scale 1:100,000.

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AEROMAGNETIC STUDIES, LOS AZUFRES GEOTHERMAL AREA, MICHOACAN

by

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ABSTRACT

Detailed and regional aeromagnetic surveys were completed over the Los Azufres geothermal area in central Mexico. Many mapped faults are clearly expressed in the detailed magnetic data because these faults penetrate to the surface and many are reflected in the topography. East-trending faults are often cut by younger north- to -northwest trending structures which can be interpreted from the magnetic data. A large zone of mapped hydrothermal alteration is apparent in the magnetic data as an area of unusually low (0-50 nT) magnetic relief. Interpreted structures trend NW into this area and are weakly expressed within the alteration zone. The regional survey records several major volcanic - intrusive complexes as large, positive magnetic anomalies, including the Los Azufres area. The source of the Los Azufres magnetic high appears to be bounded by northwest- and north-trending regional structures.

RESUMEN

Levantamientos detallados y regionales aeromagnéticos fueron completados sobre el sistema geotérmico Los Azufres en la parte central de Mexico. Muchas fallas de las cuales se han hecho mapas estan claramente expresadas en los datos magnéticos, pues estas fallas penetran la superficie y muchas se reflejan en la topografía. Las fallas con dirección al oriente suelen ser cortadas por estructuras mas recientes con orientación norte a noroeste, las cuales se pueden interpretar atravez de datos magnéticos. Hay cerca de 18 facciónas magnéticas que están correlacionan con fallas ubicadas en mapas y otras estructuras probables. Varias fallas ubicadas en mapas pueden ser extendidas con una interpretación de los datos magneticos y ademas mas de 12 estructuras que no han sido ubicados en mapas.

Una zona amplia de alteración hidrotermal y ubicada en mapas aparece en los datos magneticos como una zona de bajo (0-50 nT) relieve magnético. Estructuras interpretadas en esta area son de dirección Noroeste y aparecen poco dentro de la zona de alteración. Los datos indican la posible relación del complejo volcánico Los Azufres con la intersection del sistema estructural Noreste-Sureste (Basin and Range?) con estructuras Este-Oeste. El levantamiento regional registra varios complejos de volcánicos-intrusivos mayores como anomalias magnéticas positivas que incluyen el area de Los Azufres. El origen del alto magnetismo de Los Azufres pareciera se limitado por estructuras regionales orientadas por el norte y el Noroeste.

INTRODUCTION

As part of a cooperative agreement between the United States Department of Energy (DOE) and the Mexico Comision Federal de Electricidad (CFE), two aeromagnetic surveys were completed over the Los Azufres geothermal area in Michoacan, central Mexico. The goals of this work were to determine the effectiveness of specialized aeromagnetic surveys for determining structural control and alteration areas in geothermal resources related to fractured volcanic systems. Other data obtained in support of the aeromagnetic surveys included the collection of magnetic susceptibility data for geologic units at Los Azufres and recording the diurnal variation of the earth's magnetic field.

DATA ACQUISITION

The aeromagnetic surveys are classified as detailed (low-altitude survey) and

regional (high-altitude survey). The detailed survey was completed over the Los Azufres geothermal area using a Llama helicopter operated by CFE. Approximately 527 line-km were flown in an area of 96 sq km, for an average line spacing of 0.18 km. Survey lines were flown northwest-southeast at an attempted terrain clearance of 100 m. The recording equipment included a Geometrics Model G-803 Airborne (proton) Magnetometer, a Bonzar Mark 10X radar altimeter, a Panasonic color TV camera, and a Panasonic VHS Portable Video Cassette Recorder. Both analog and digital magnetic and altimeter data were recorded.

The high-altitude survey covered an area of approximately 1500 sq km in which the Los Azufres geothermal field was centrally located. Approximately 1590 line-km were flown north-south at a nearly constant altitude of 11,300 ft (3,444 m) except over parts of San Andres volcano where altitude reached 12,500 ft (3,810 m). This survey was flown in a Piper Cherokee fixed-wing airplane chartered by CFE. Dense smoke and haze resulting from numerous fires restricted flying and complicated navigation, resulting in non-uniform survey data coverage.

Both surveys were completed in May, 1988 by a four man-crew which included a pilot and navigator from CFE, and a magnetometer operator and video system/recorder operator from UURI. The variation of the earth's magnetic field was recorded with a Scintrex Base-Station Magnetometer, Model MBS-2 for the period 19 April to 26 May 1988. These variations, which have a normal distribution, have a mean value of 42,740 gammas. The goal of this magnetic field monitoring was to determine the diurnal corrections to be applied in the reduction of the aeromagnetic data. Significant diurnal variations did occur during the low-altitude survey.

DATA COMPILATION AND PROCESSING

The flight-path recovery utilized VHS tapes of the flight path which were replayed many times to locate points identifiable on aerial photos, photomosaics, and topographic maps. The predominance of forest cover and incomplete photographic coverage limited the number of recovered points on both surveys.

A first-generation magnetic map of the low-altitude data was completed by removing a base level of 42,000 nanoteslas (nT) from all observed values and applying diurnal corrections to each flight line. The diurnal adjusts all recorded data to the "normal" value of 42,740 nT observed at the CFE monitor station during the survey period, (Campos E. and Herrera B., 1988). The final magnetic map includes additional corrections to entire lines or portions of lines based on tie-line intersections and altitude variations. This map of total magnetic intensity also incorporates smoothing to reduce flight-line effects and to emphasize geologic information.

During the initial qualitative interpretation it became evident that additional computer processing would reduce the effects of terrain clearance variation, remaining flight position errors and other high-frequency noise. The aeromagnetic map was manually digitized by CFE for a square grid of 250 m interval. With digital data the following processes could later be employed: reduction to the pole; upward continuation; second vertical derivative; and downward continuation. Depending on the results obtained two-dimensional and three-dimensional modeling will be completed at a later date.

Compilation of the high-altitude data included diurnal corrections (generally less than 10 nT according to Campos E. and Herrera B., 1988) and removal of a 42,000 nT base level. Because the diurnal changes were small and well-located tie-line intersections were generally less than +/- 10 nT, no further tie-line adjustments were made. Nonconforming data for poorly located portions of several flight lines were ignored in contouring the final map.

INTERPRETATION - LOW-ALTITUDE SURVEY

An initial qualitative interpretation of the low-altitude map was completed by the correlation of geological and geophysical data, including; lithology, structure, susceptibility samples, paleomagnetic data, gravity, and ground magnetics. Linear magnetic trends and dipolar magnetic anomalies resulting from distinct sources with induced magnetization were identified from these data. In general, the detailed map (Plate I) shows well-defined regional trends with an E-W orientation which predominate in the northern sector, and NW-SE trends which predominate in the south and west portions of the area. Other trends of minor importance, with an approximate N-S orientation, occur in the eastern sector. These magnetic trends correspond to orientations associated with a system of

structures observed at the surface. The NW-SE trends may be of major importance as they coincide with trends observed in the regional gravity map. The detailed (1:10,000) geologic mapping (CFE, 1986) provides a basis for evaluation of the magnetic data. Figure 1 illustrates the form of magnetic anomalies for two characteristic models as computed for the magnetic-field parameters of the Los Azufres area.

Inspection of the low-altitude survey map, Plate I, reveals several interesting features.

1. Numerous short-wavelength highs and lows, less than 0.5 km in long dimension, occur on portions of the periphery of the surveyed area. Many of the small closed anomalies result from data acquisition or compilation problems (i.e. terrain clearance variation, flight path recovery inaccuracies). Terrain clearance variations are most severe when the magnetometer is less than 100 m above the ground surface. Many anomalies result as the irregular topography rises to, or falls away from, the smoother flight path. Anomalies of this type can be evaluated by correlation with topographic maps and review of the radar altimeter data.

2. There is a northwest-southeast elongation of contours, some of which may result from flight-line position and data leveling errors. Manual smoothing has reduced these compilation effects. Much of the remaining NW-SE elongation results from the topographic grain and magnetization contrasts due to northwest-trending faults, fractures, and geologic contacts. Discrimination between compilation errors and valid geologic contrasts is difficult, and interpreted NW-SE structures must be regarded as somewhat uncertain.

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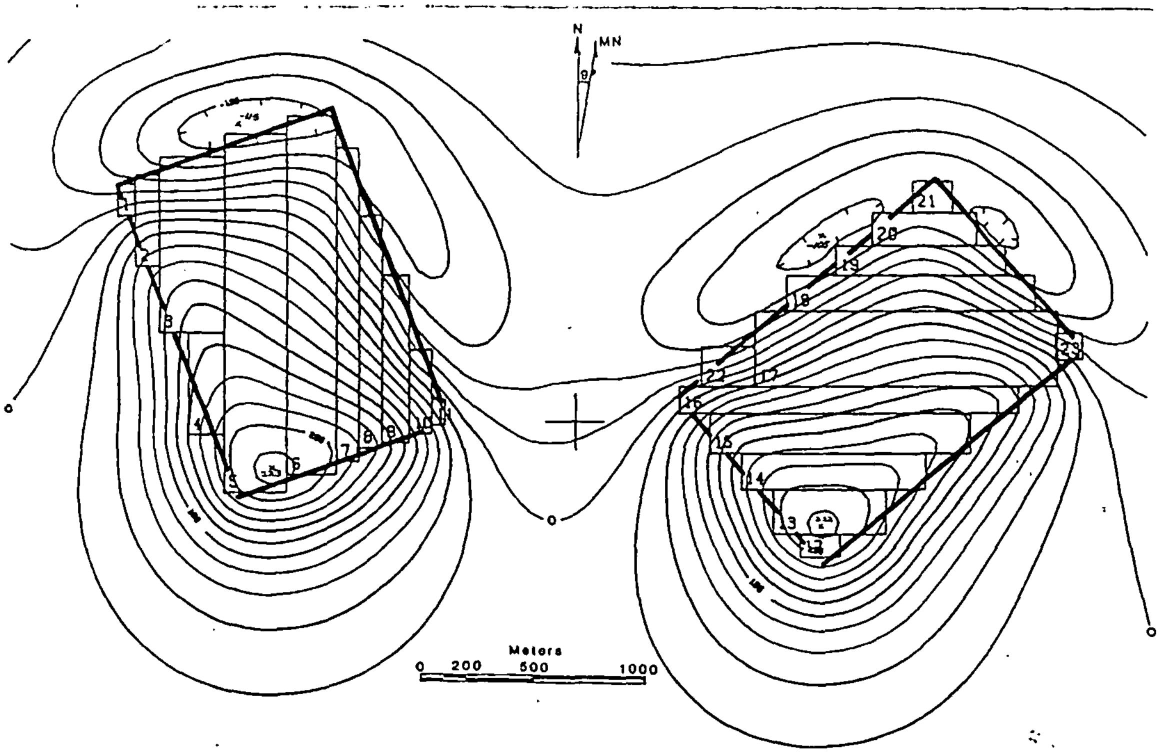

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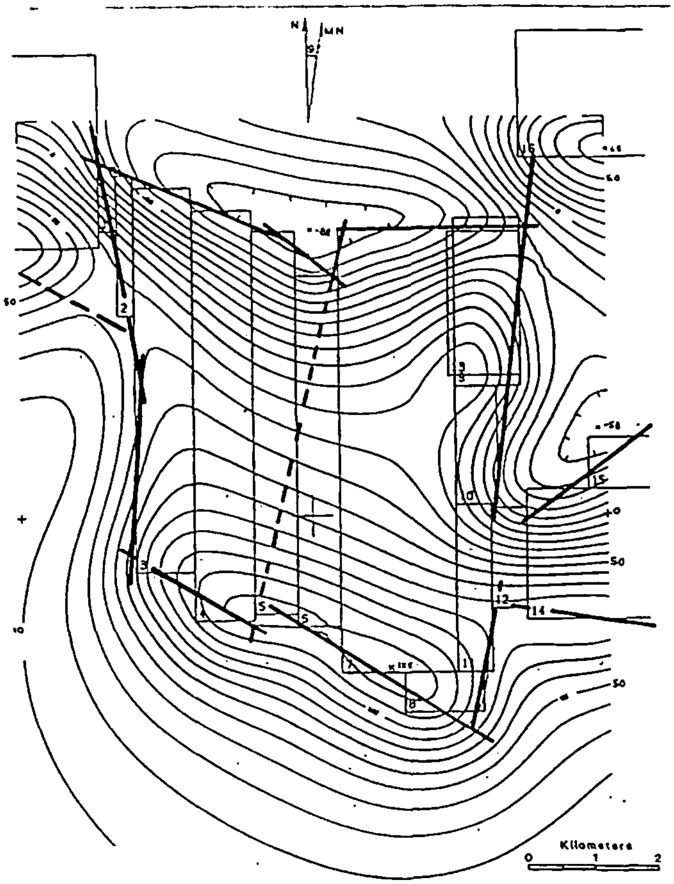

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Thin, layered rhyolites overlie andesites in the central portion of the positive source body. A broad area of hydrothermal alteration is expressed by subdued magnetic variations, and appears to be oriented along the trend of two poorly defined structures interpreted from the magnetic data. We do not observe a detailed correlation between the diverse lithologic units and the magnetic contours, except that in the areas of high susceptibility (andesites and dacites) the magnetic relief is much more irregular than where the surface cover are tuffs, rhyolites and altered rocks, even though the average value of the field is approximately the same.

The structures indicated may have some significance as controls for the South

Production Zone. The significance of structures and magnetic sources near the North Production Zone is unclear at present.

INTERPRETATION - HIGH ALTITUDE SURVEY

The high altitude residual magnetic intensity map is presented as Plate III. The interpretation of this survey will be somewhat limited by flight-path recovery problems, principally in the southern third of the survey area, and by several wide gaps in flight line separation. In four areas, the spacing between flight lines exceeds three km. In these areas the frequency content of the mapped data is lower than that of the true magnetic field at this elevation, and anomaly shapes may be somewhat incorrect.

Several major west and west-northwest trending structures can be inferred from the contour map. Positive magnetic sources, 4 to 20 sq km in aerial extent, suggest major volcanic-intrusive complexes. Some of the more prominent sources occur at the eastern end of Laguna Cuitzeo, north of Presa Pucuato, near Mesa El Cantor, and at Uripitio. Geothermal fields are associated with two of these large sources: Araro, southeast of the Cuitzeo source, and Los Azufres. The volcano San Andres, less than 400 m below the flight altitude, occurs as a positive magnetic anomaly with amplitude 300 nT above background. The inferred source position includes an area of approximately 12 sq km, much of which is above 3000 m in elevation.

The low-frequency magnetic anomalies, and the magnetic sources which can be inferred from these anomalies, form a large somewhat-circular area perhaps 25 km in diameter in the southeastern portion of the survey area. Any interpretation relating this near-circular appearance to a caldera complex will require more interpretation and considerable geologic input.

The only specific interpretation of the high-altitude data reported here is first-pass modeling of a low-amplitude positive anomaly which encompasses 20 sq km and is centered over the Los Azufres geothermal area. A simplified model of this source (Figure 2) corresponds to the broad magnetic source identified from the low-altitude survey which includes the Los Azufres geothermal system. The interpreted susceptibility contrast for this body, contrasted with bordering, less magnetic blocks, is approximately 1000 E-6 cgs, assuming a finite depth extent of the order of 2300 m, for this magnetization contrast. This may relate to a thicker section of andesites downfaulted with respect to surrounding dacites, rhyolite domes and other rocks and/or intrusive rocks beneath the andesite units.

CONCLUSIONS

The high-altitude aeromagnetic survey maps an arcuate area of over 500 sq km which includes several large magnetic sources suggestive of volcanic-intrusive complexes. One of these sources includes the entire area of the Los Azufres geothermal system. This source is bordered on three sides by major mapped faults. The positive magnetic source may correspond to a thicker section of Mil Cumbres andesites, and/or intrusives at depth, and contrasts with rhyolite and dacite domes to the west and east. Several regional structures may be inferred from this survey but they have not yet been studied in detail.

On the basis of the preliminary interpretation, it appears that the low-altitude survey is only partially successful for reflecting the known geologic characteristics at Los Azufres, but contributes indications of a regional kind which shed new information and permit making hypothesis for later studies. The most important are the possible relation of the Los Azufres volcanic complex with the intersection of a NW-SE structural system (Basin and Range?) with more recent E-W structures. These data also suggest that the hydrothermal alteration observable at the surface is largely restricted to shallow units and decreases notably with depth.

The detailed, low-level magnetic survey shows numerous linear magnetic trends and discontinuities not present on the high altitude data, at least 18 of which correlate with mapped faults and other probable structures. Several mapped faults may be extended with an interpretation of the magnetic data, and more than 12 previously unmapped structures are interpreted from these data. Some of these structures may be important to a better understanding of structural controls for the South Production Zone. With more study, this structural information will lead to a better understanding of this fracture-controlled geothermal system. The cost-effectiveness of the regional survey is still being evaluated.

Magnetic surveys of similar structurally controlled volcanic geothermal systems should utilize a close flight line spacing (200-300 m) and a smoothly draped flight path somewhat higher than the minimum and mean terrain clearance of this survey. Depending on local relief and helicopter performance, a mean terrain clearance of 100 to 200 m should be considered.

Further interpretation of the detailed survey may benefit from low-pass digital filtering to reduce noisy data due to varying terrain clearance and flight-line position errors. Additional numerical modeling of the geothermal area should then be completed. Numerical modeling and structural interpretation of the high-altitude survey can be completed on a lower priority basis.

ACKNOWLEDGEMENTS

The authors thank Marshall Reed, DOE, for his interest, support and advice during this project. Mr. Dale Green, UURI, completed a major modification of the instrumentation prior to the surveys. Numerous other CFE and UURI personnel provided technical support to this project.

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Campos, E. J. O. and Herrera B., M. C. F., 1988, Variation diurna del campo magnetico terrestre en el area del campo getérmico de Los Azufres, Mich., CFE - Gerencia de Proyectos Geotermoeléctricos Tech. Rept., 5p., Julio.

CFE, 1986, Geologica del campo geotermico, Los Azufres, Mich., Gerencia de Proyectos Geotermoeléctricos, Subgerencia de Estudios Geotérmicos, Departamento de Exploraciones Geotérmicas y Superintendencia General de Los Azufres; mapa escala 1:10,000.

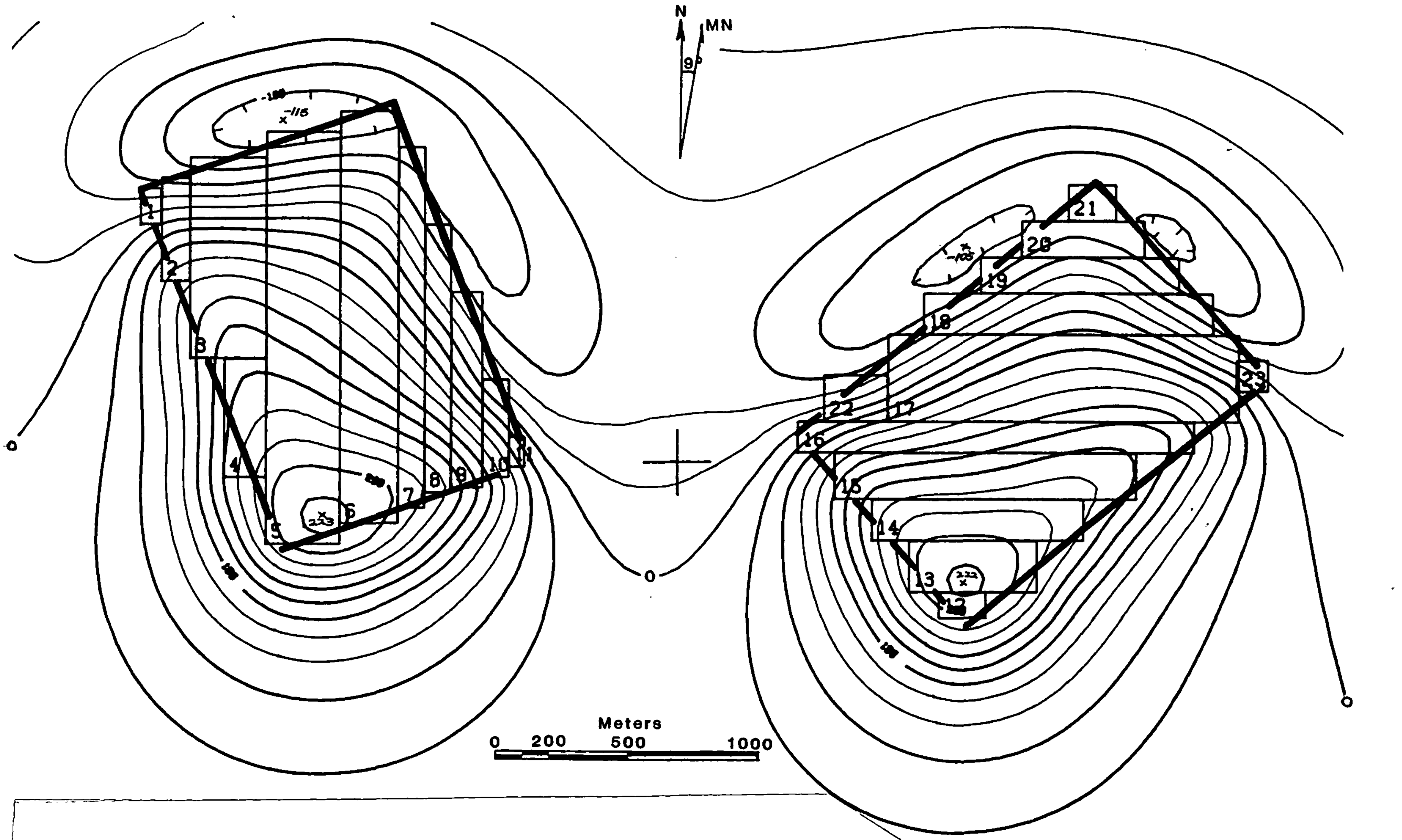
Dobson, P. F., and Mahood, G. A., 1985, Volcanic stratigraphy of the Los Azufres geothermal field: Jour. Volcanology and Geothermal Research, v. 25, p. 273-287.

ILLUSTRATIONS IN FOLDER

Plate I. Residual Magnetic Intensity, Los Azufres Geothermal Area. Detailed helicopter survey, scale 1:20,000.

Plate II. Structural Interpretation, Los Azufres Geothermal Area. Scale 1:20,000.

Plate III. Residual Magnetic Intensity, Acambaro-Ciudad Hidalgo Area. High altitude regional survey, scale 1:100,000.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MN
9°
-100
-115
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223
100
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23
-105
222
200
100
0
Meters
0 200 500 1000

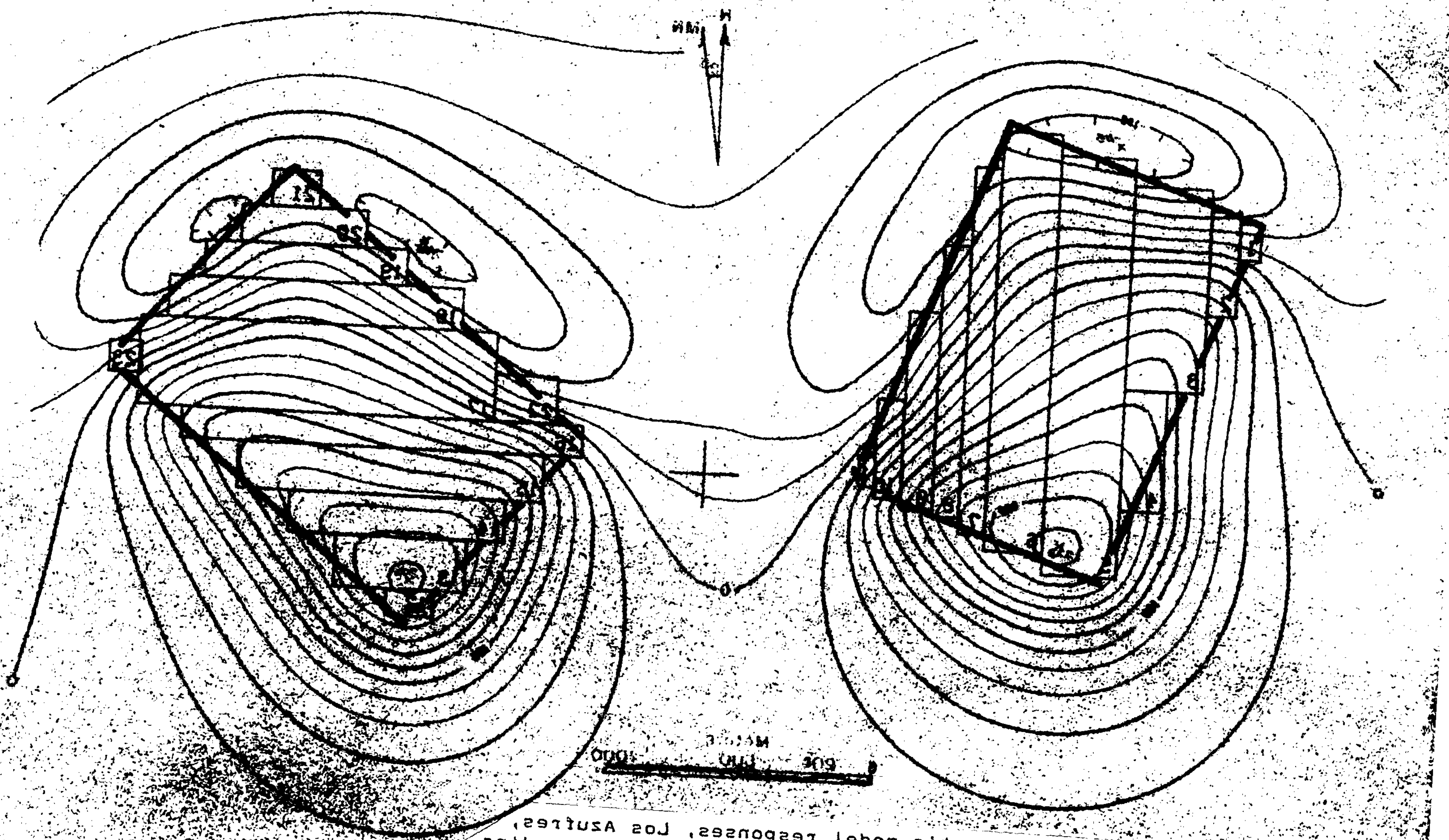
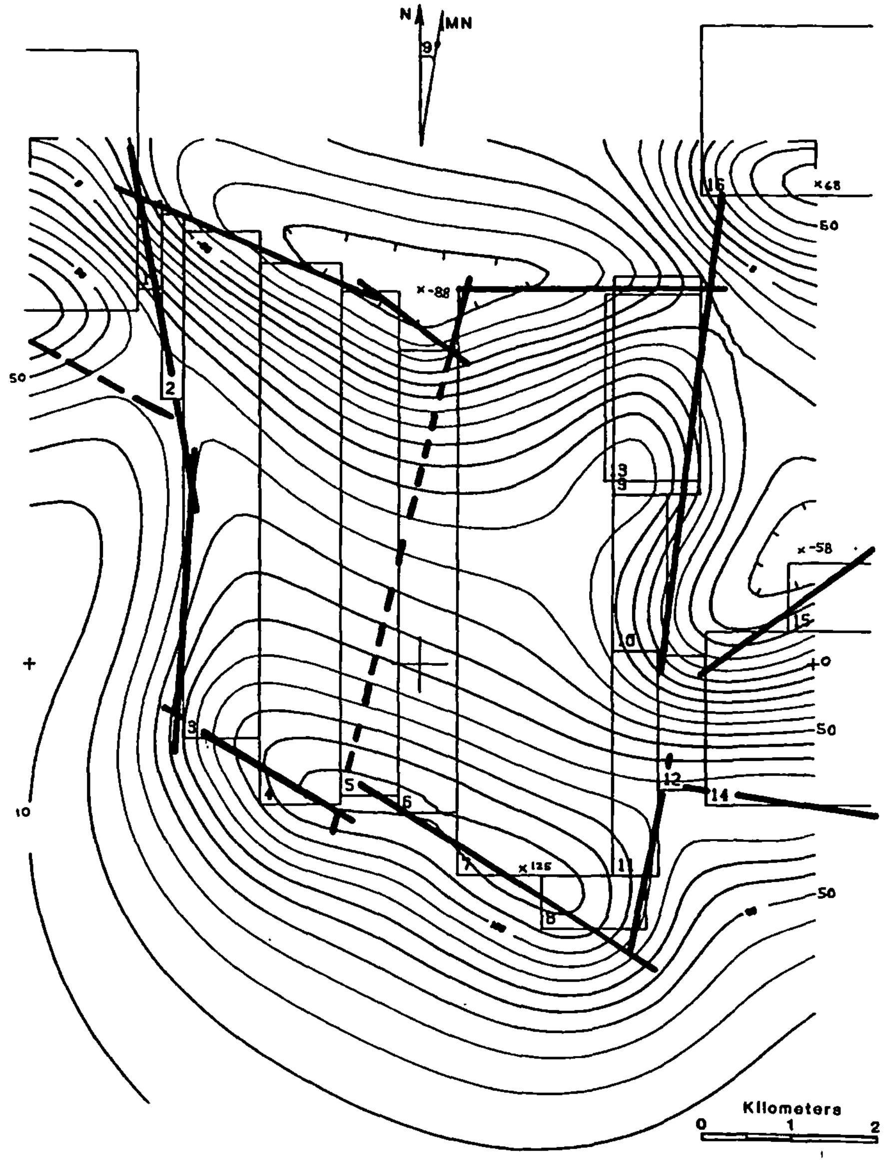


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20° W and N50° E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9° E, inclination 48°, TF = 42,740 nT. Scale 1:20,000. Contour interval 20 nT.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×68
16
50
×-88
2
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13
9
×-58
15
10
+0
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3
4
5
6
12
14
10
7
×125
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Kilometers
0
1
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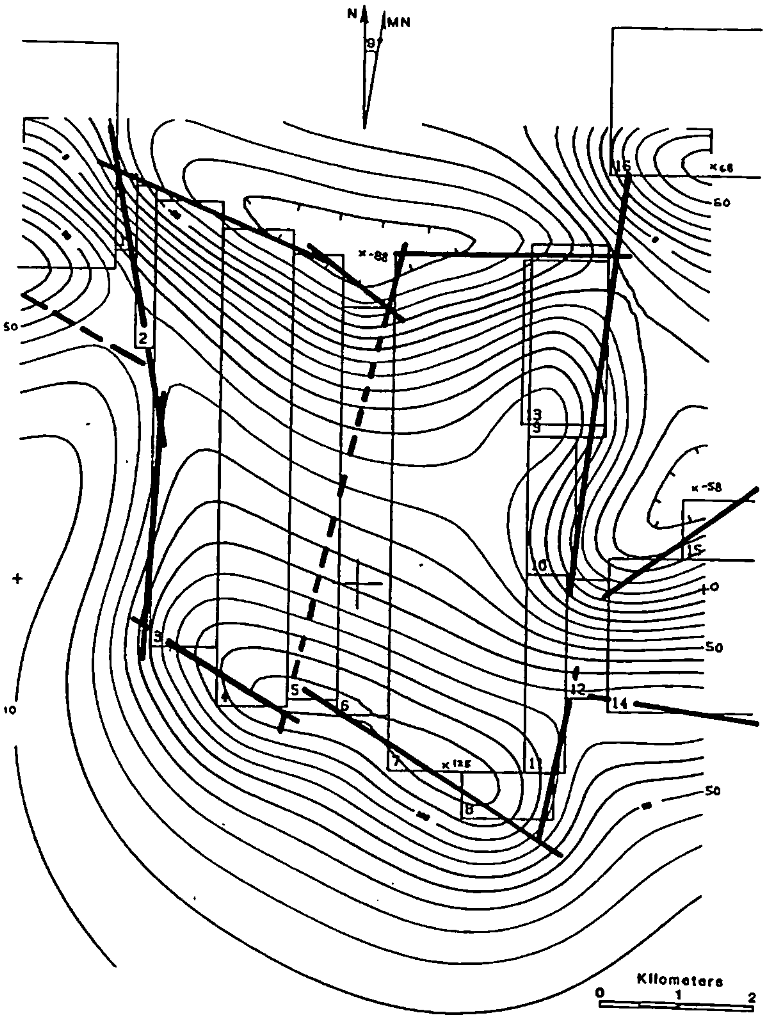
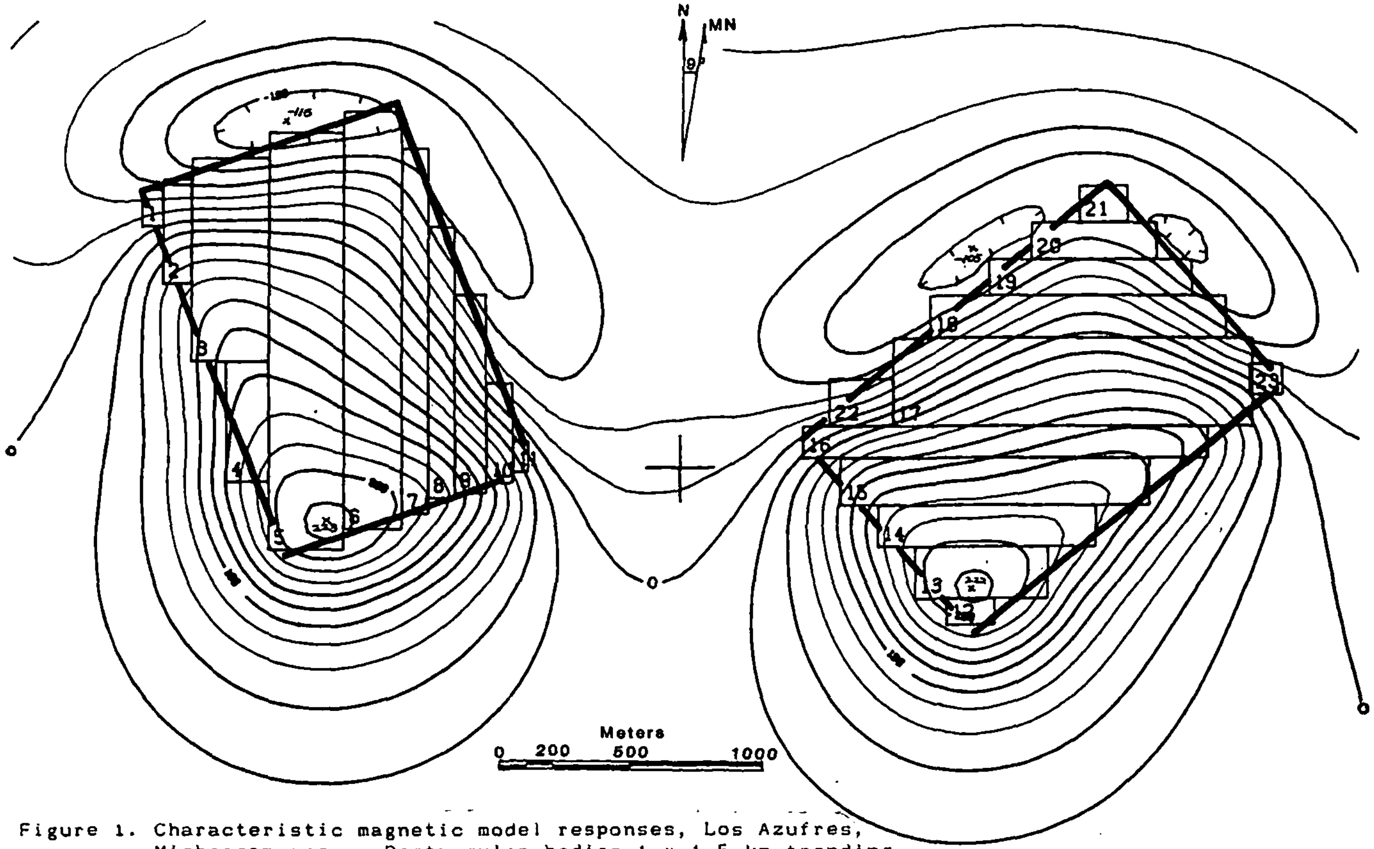
Complete
caption
for
Fig. 1.

$\frac{17.8\text{ mm}}{25.4} = 0.7007$



x.7



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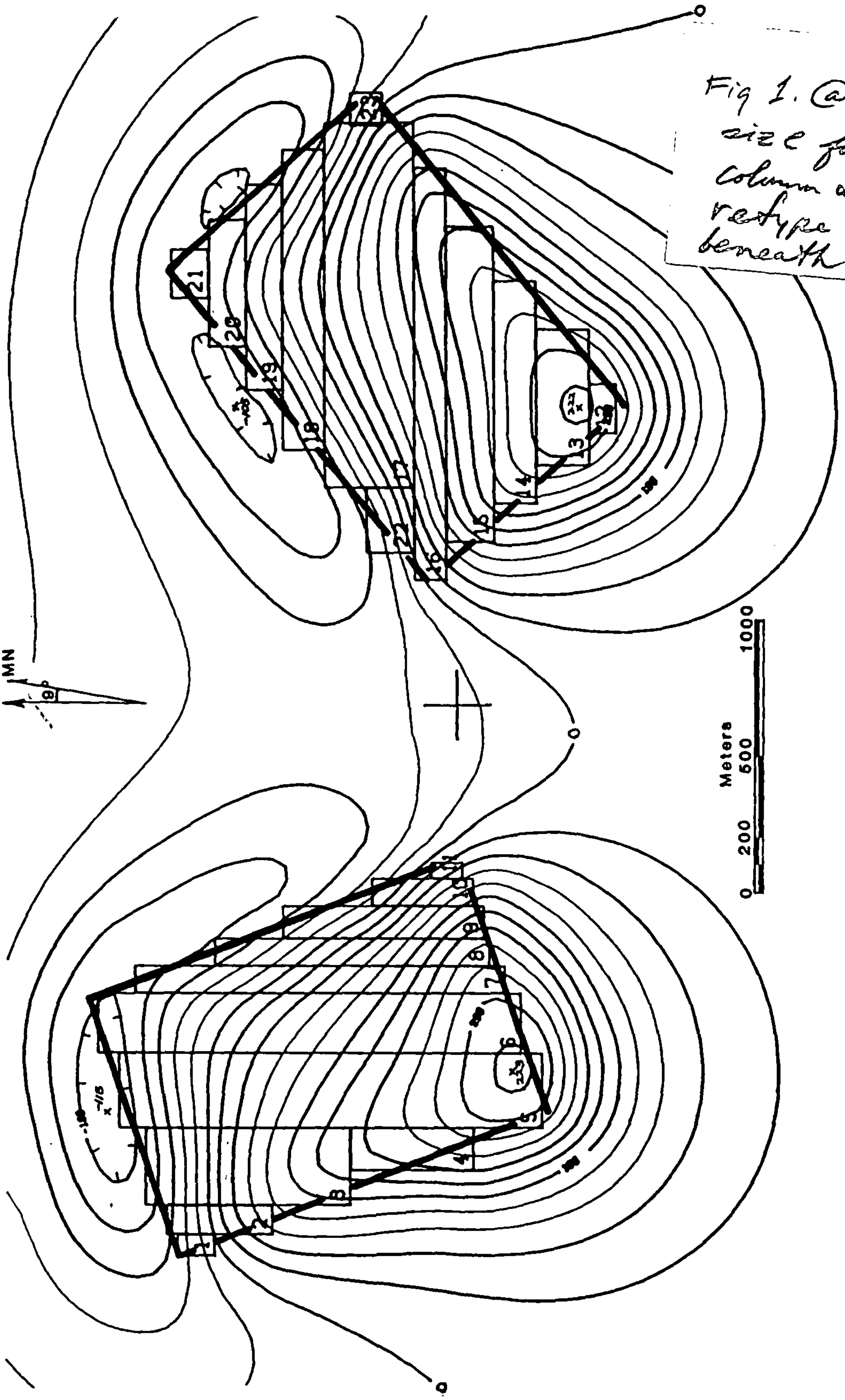


Fig 1. @ correct size for 2 column width - retype label beneath fig.

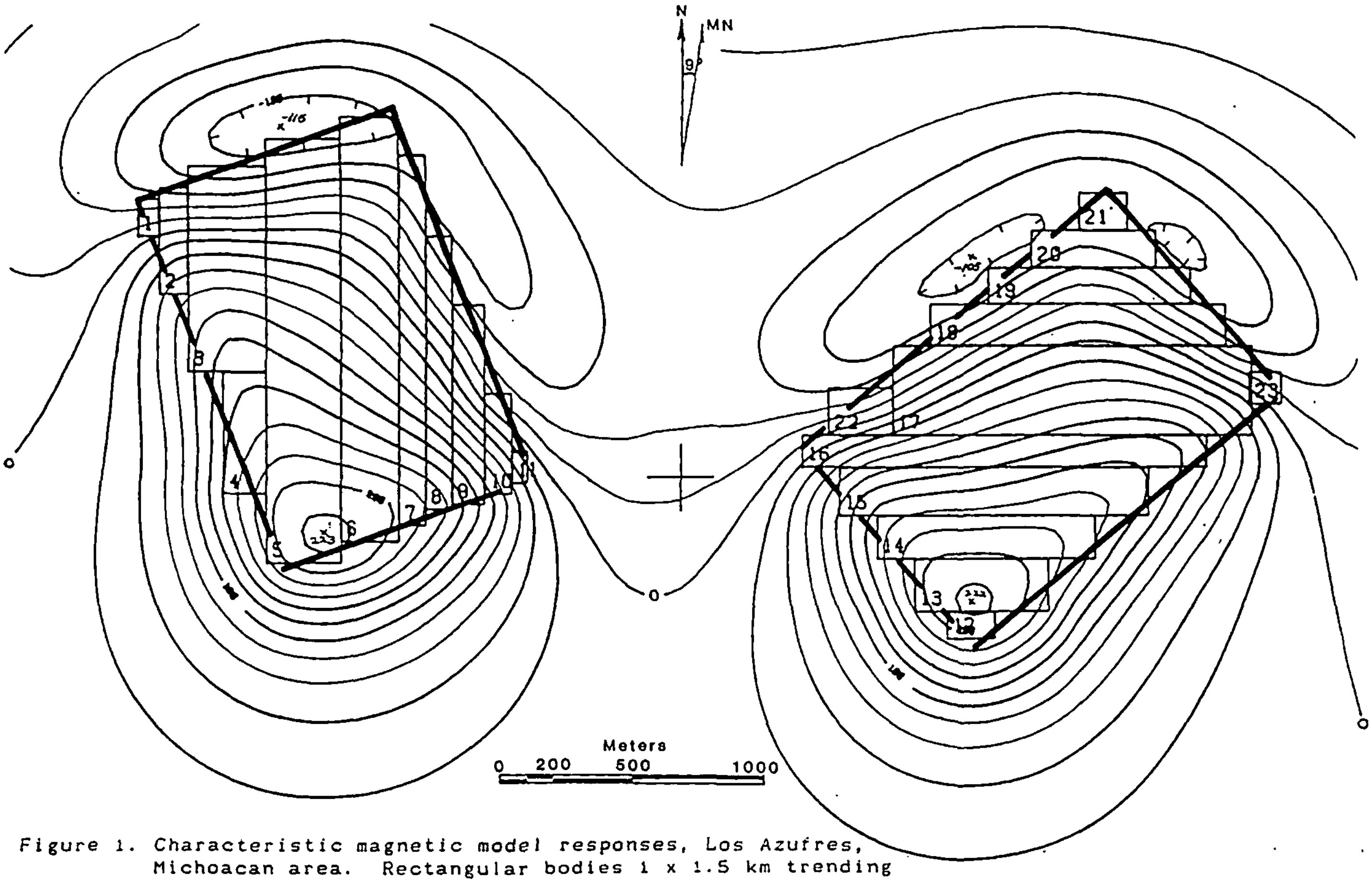
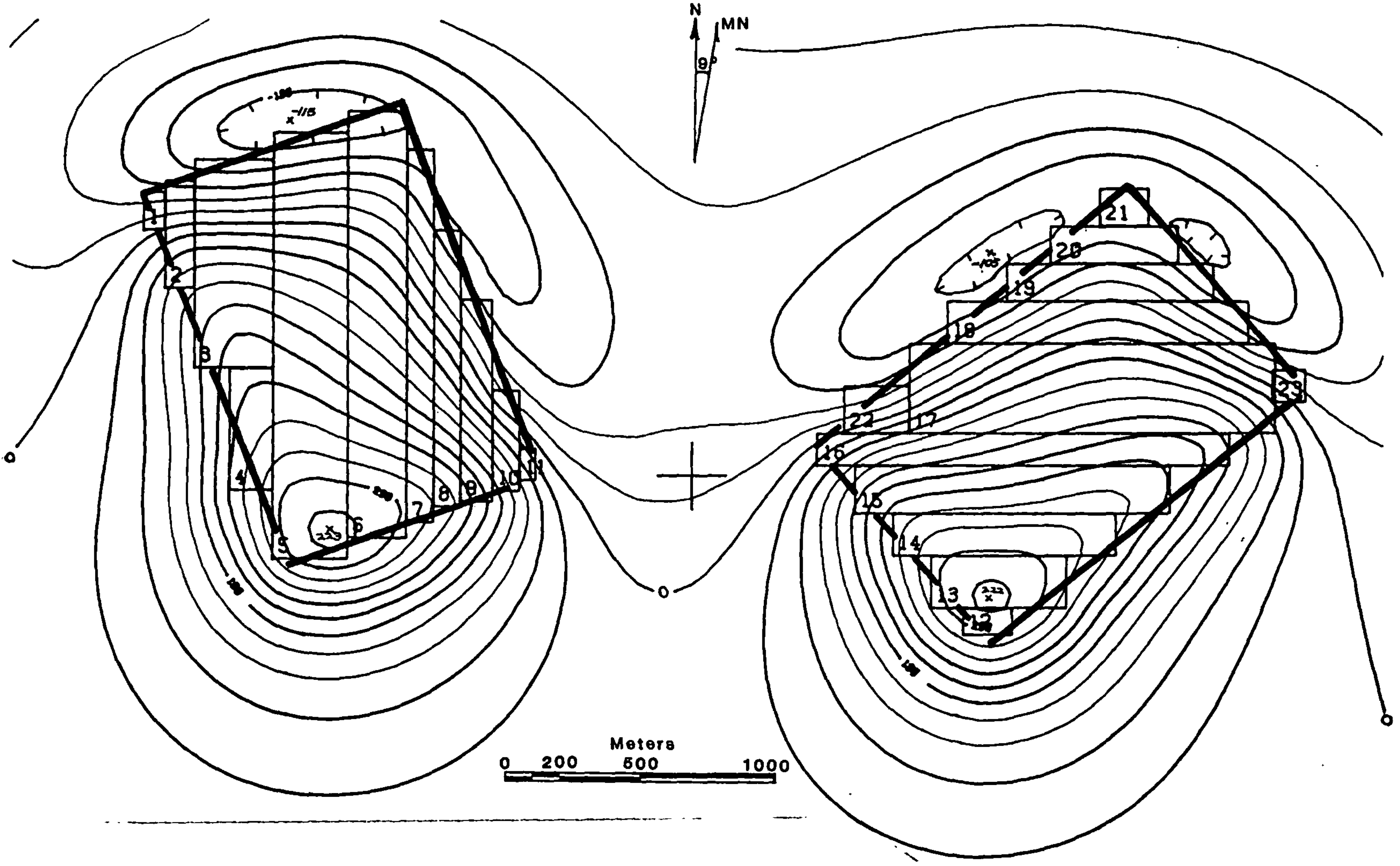


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20W and N50E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9°E, inclination 48°. TF=42,740 nT. Contour interval 20 nT.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Paper
Size

X.7

.85x1

8.9"

4.25

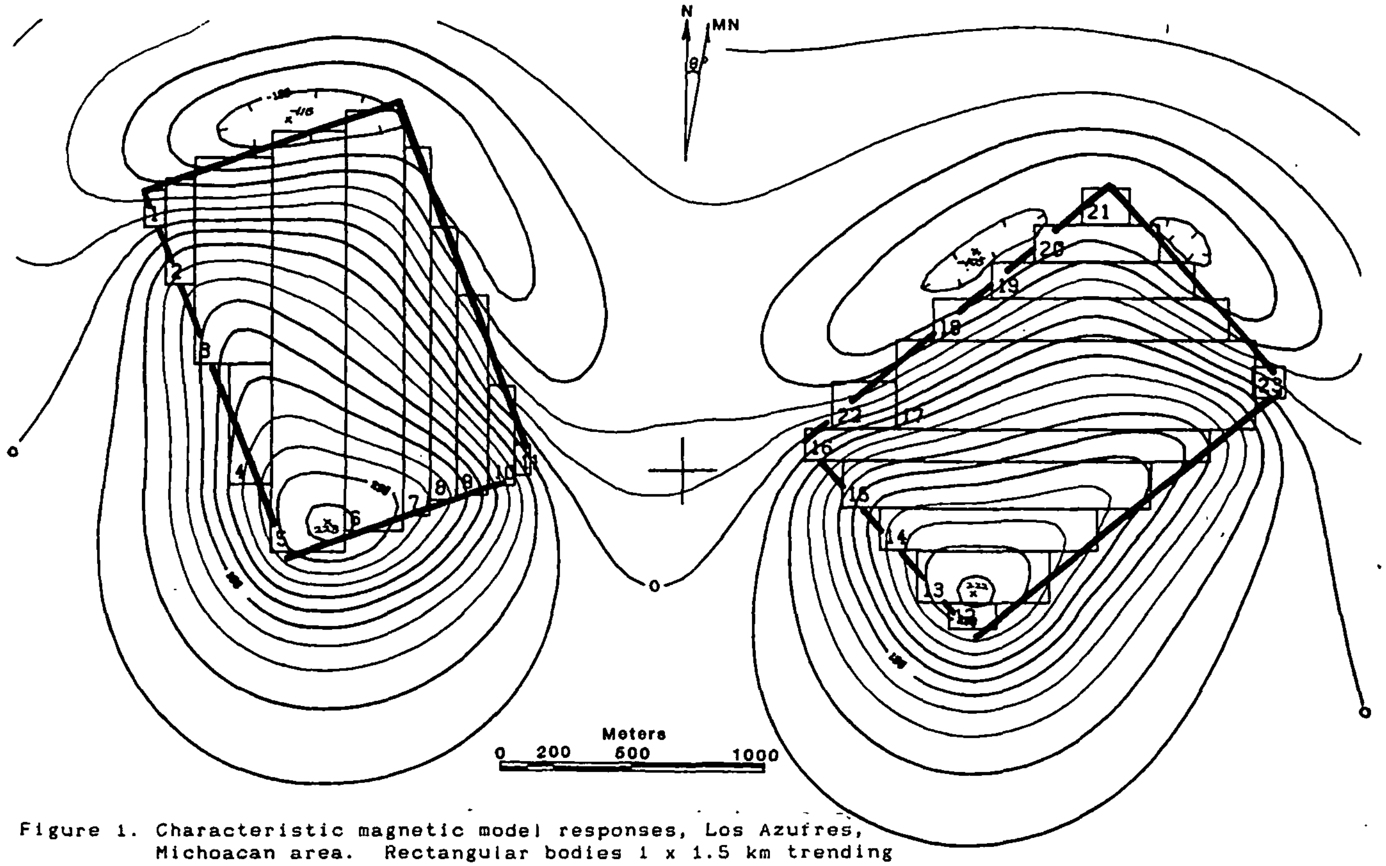


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20W and N50E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9°E, inclination 48°, TF=42,740 nT. Contour interval 20 nT.

Fig 2 @ correct size for 1 column - retype label beneath illust.

$\frac{133mm}{215} = .6186 = .70 \times .88$

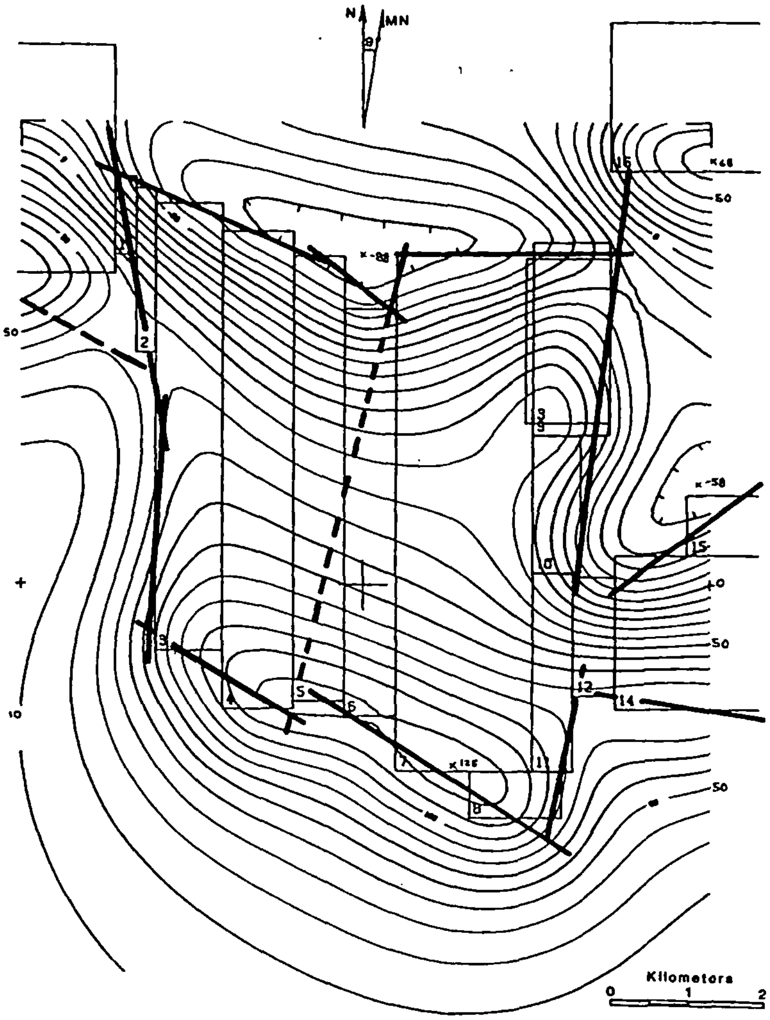


Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.

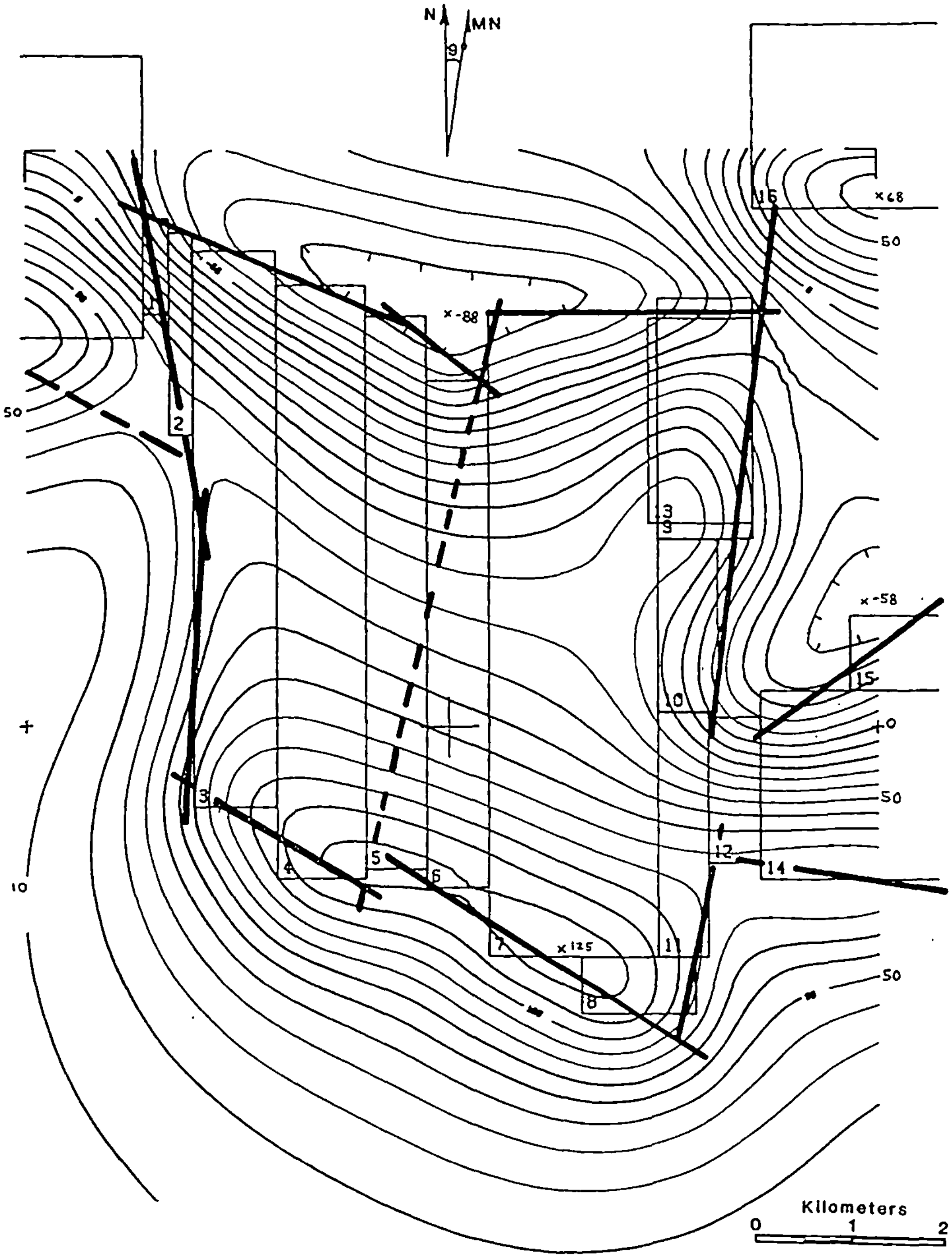


Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.

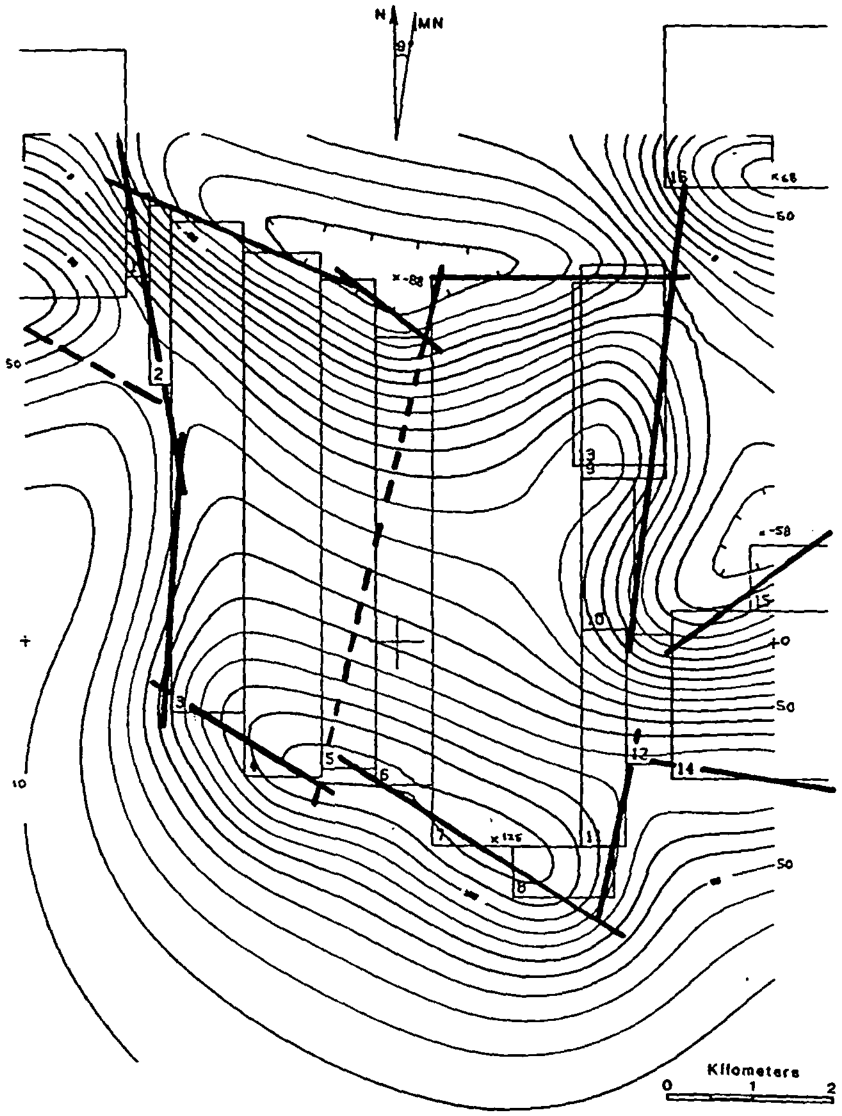
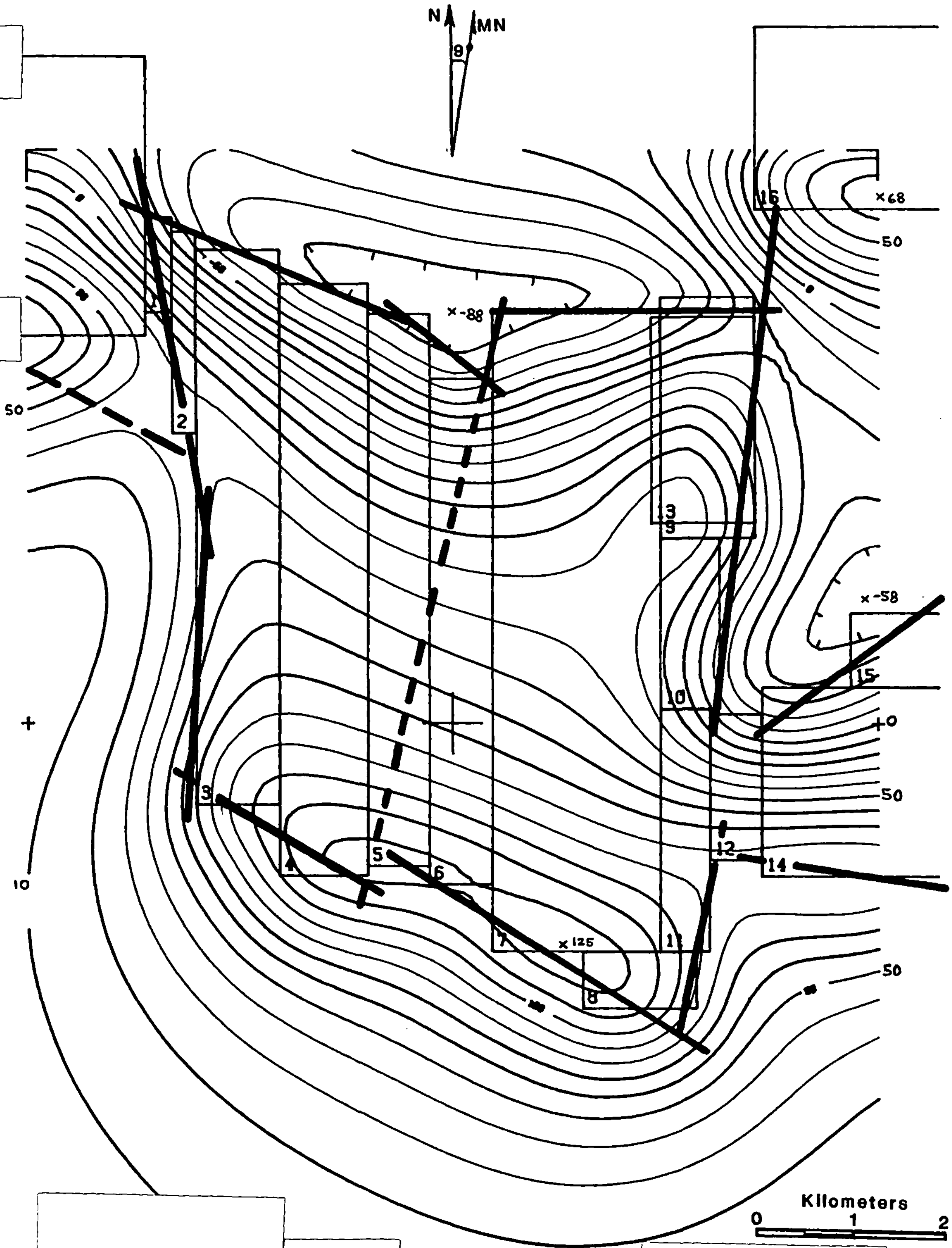


Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.

Paper Size too big



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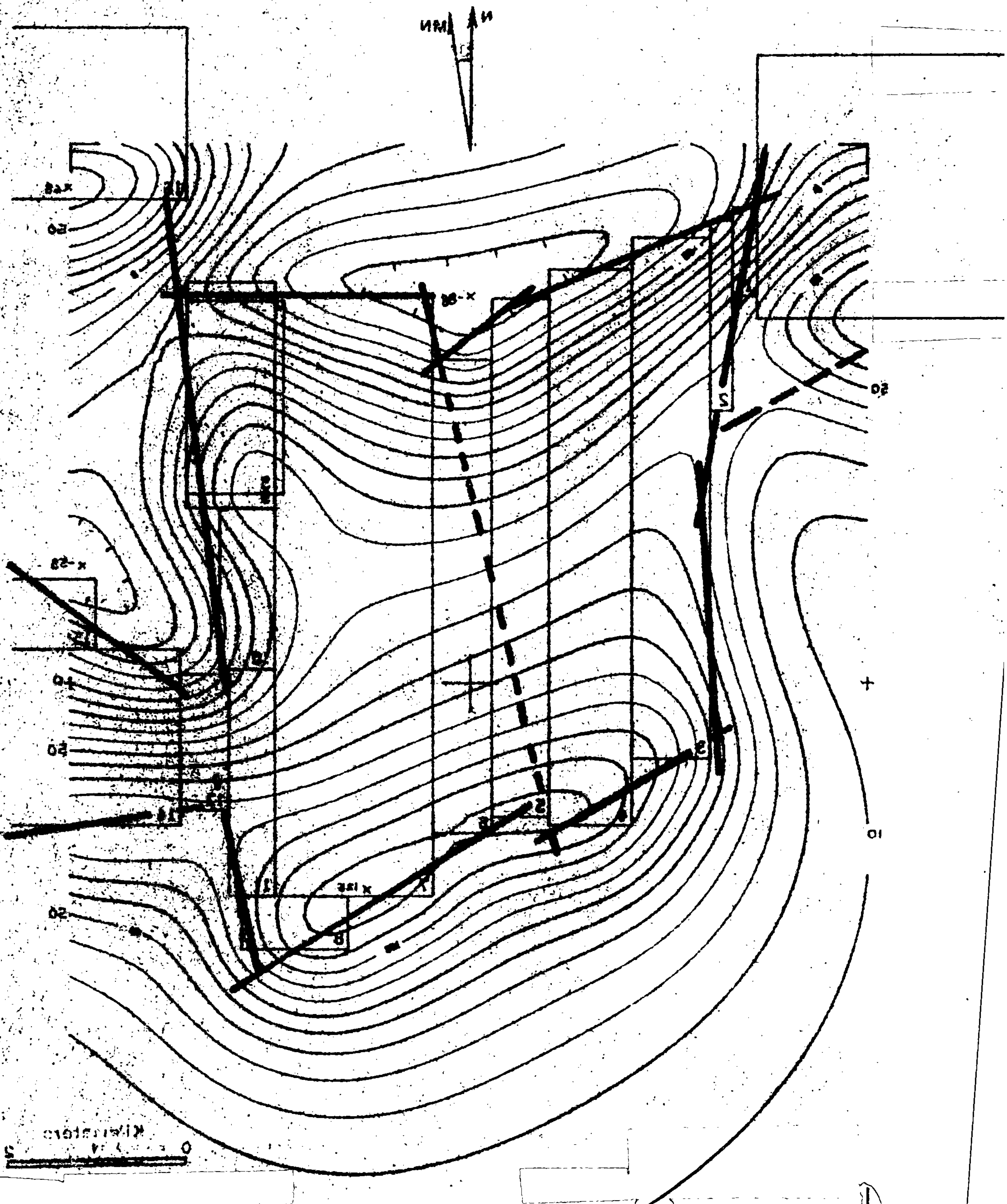
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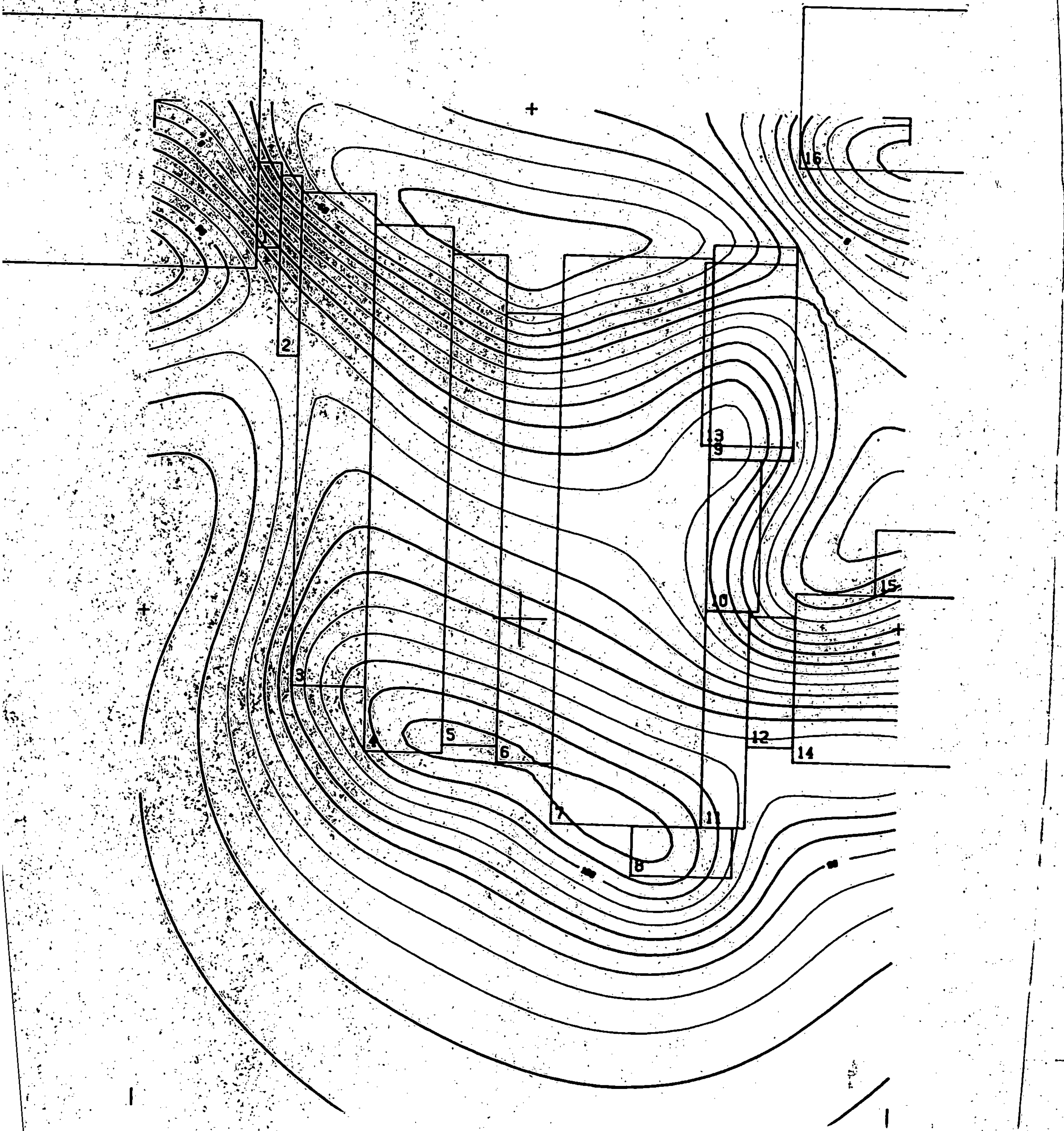
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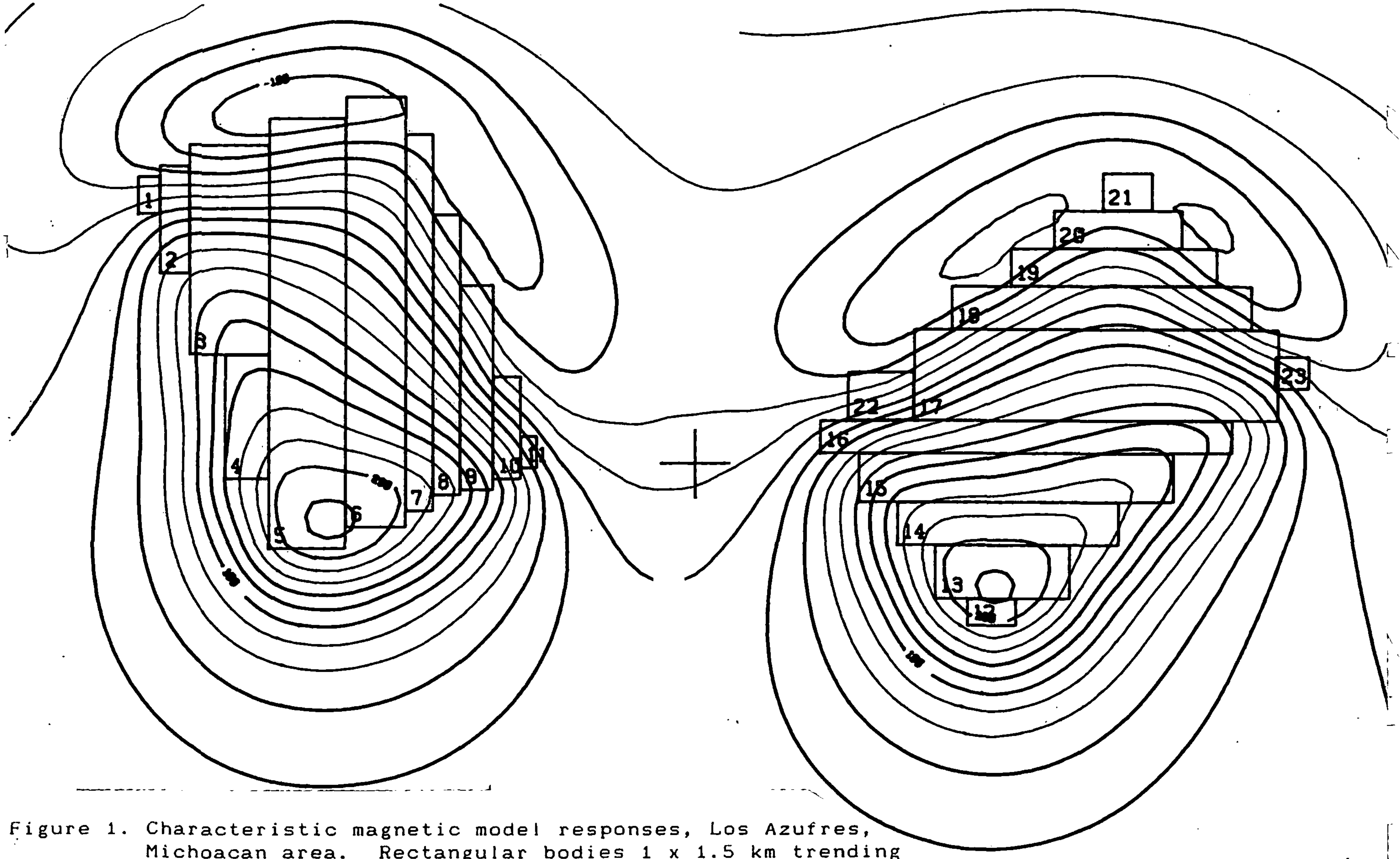
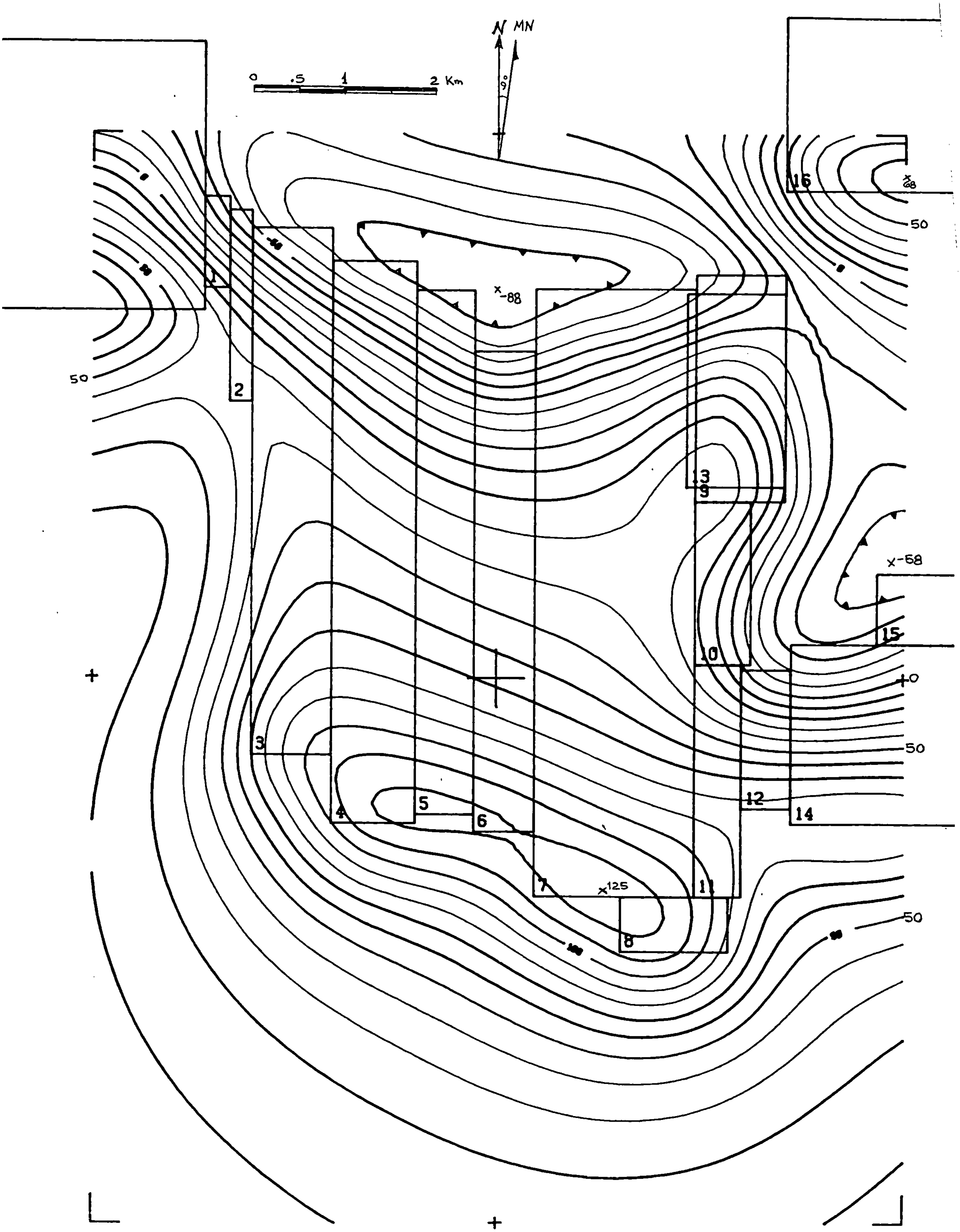


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20 W and N50 E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9 E, inclination 48 , TF = 42,740 nT. Scale 1:20,000. Contour interval 20 nT.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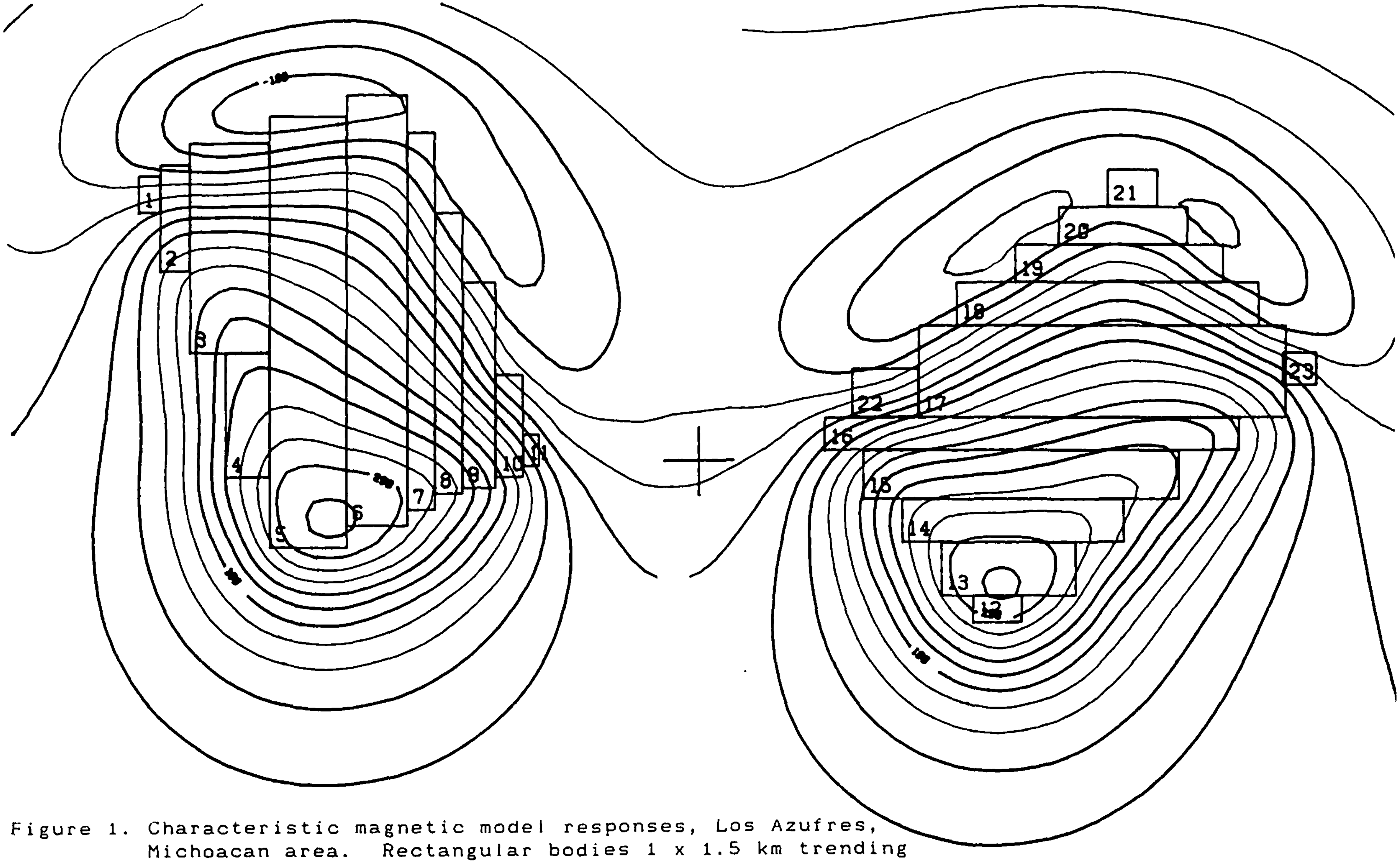
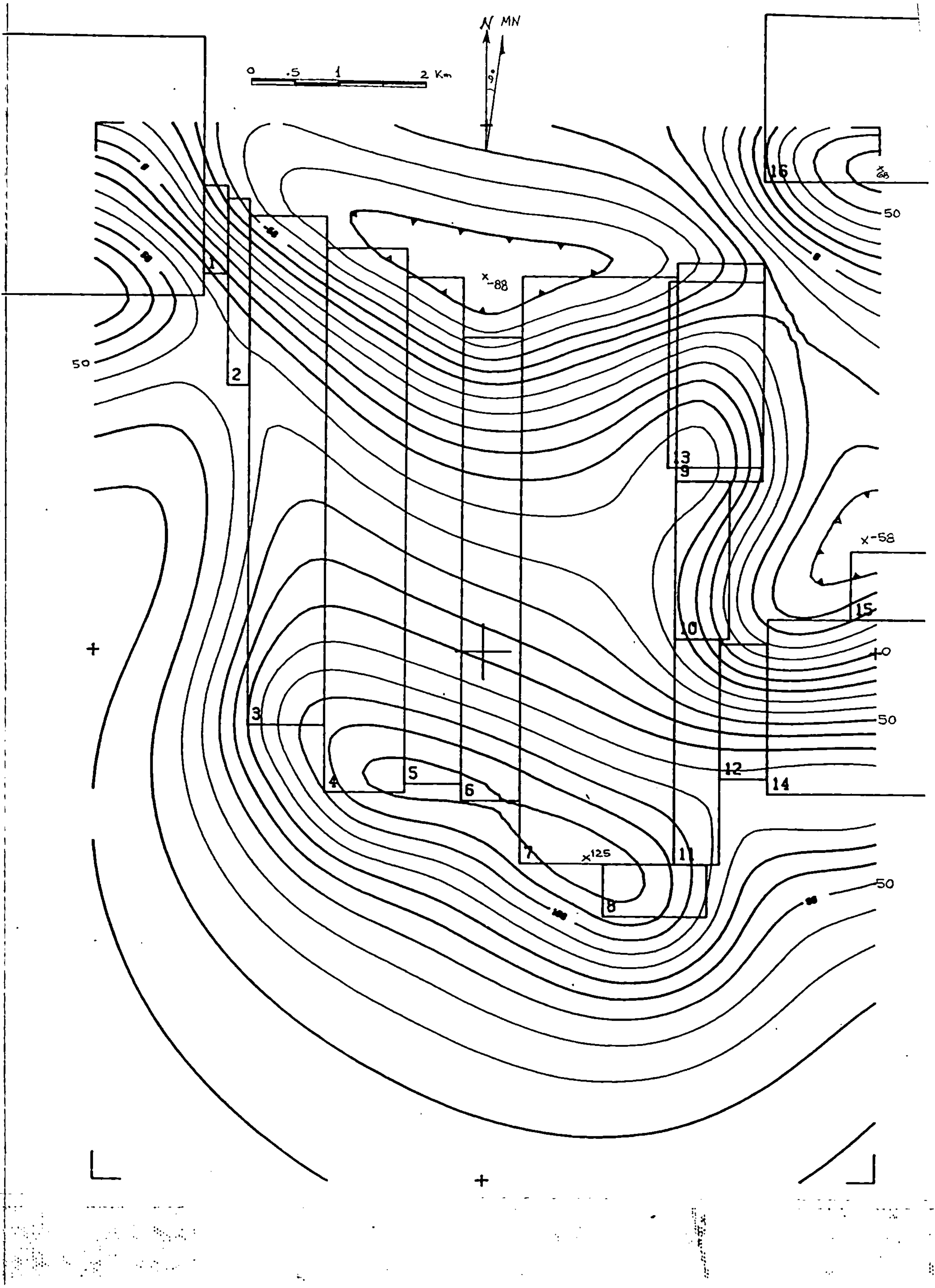


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20 W and N50 E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9 E, inclination 48 , TF = 42,740 nT. Scale 1:20,000. Contour interval 20 nT.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50
4
5
6
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7
x125
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50

SPANISH VOCABULARY

Articles, etc.

de - of, from, by
el - the, that, that one
o - either, or
y - and
del = de + el = of the.
para = for, toward, to,
para- = near, beside
segun - according to
así - so; thus
aun - still; further

Lineas - lines
estacion - station
dipolo - dipole
numero - number
posicion - location, position
Blanca - white
marca - mark, brand, point out
Sofrem.
direcciones - directions
además - furthermore, besides
aumento - increase

Geologic terms & technical usage

siglados - labeled, identified (?)
sondeos - drill hole, boring, well.

gradientes - gradients
facies - species (?)

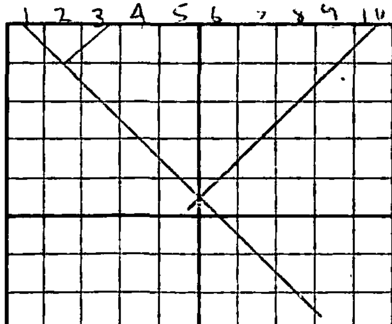
tales - tables, listings (?)
almacenes - reservoir (?) lit=warehouse storage
mezclas - mixing.
agua-roca - water rock
de gran escala - regional scale
aprovechado - making progress
manantial - spring
caudal - volume
alcanzar - to reach, to be sufficient
afloramientos - outcrops of rock
ligado - bound
muestradas - samples
marcador - plotting
mediante - interceding
cuenca - basin, valley
calizo - limestone
yacimientos - deposits
cadena - chain
fosa - pit, rift
superficie - surface
salada - saline
afloramientos - surface outcroppings
septentrional - northern
desarolla - develop, expand
algo - something, somewhat
quizás - maybe, perhaps
cercanía - proximity
rasgos = feature

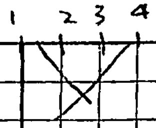
English
Tx - Rc = n
3 - 1 = 2
10 - 1 = 9
15 - 1 = 14
20 - 1 = 19
26 - 1 = 25

US
1

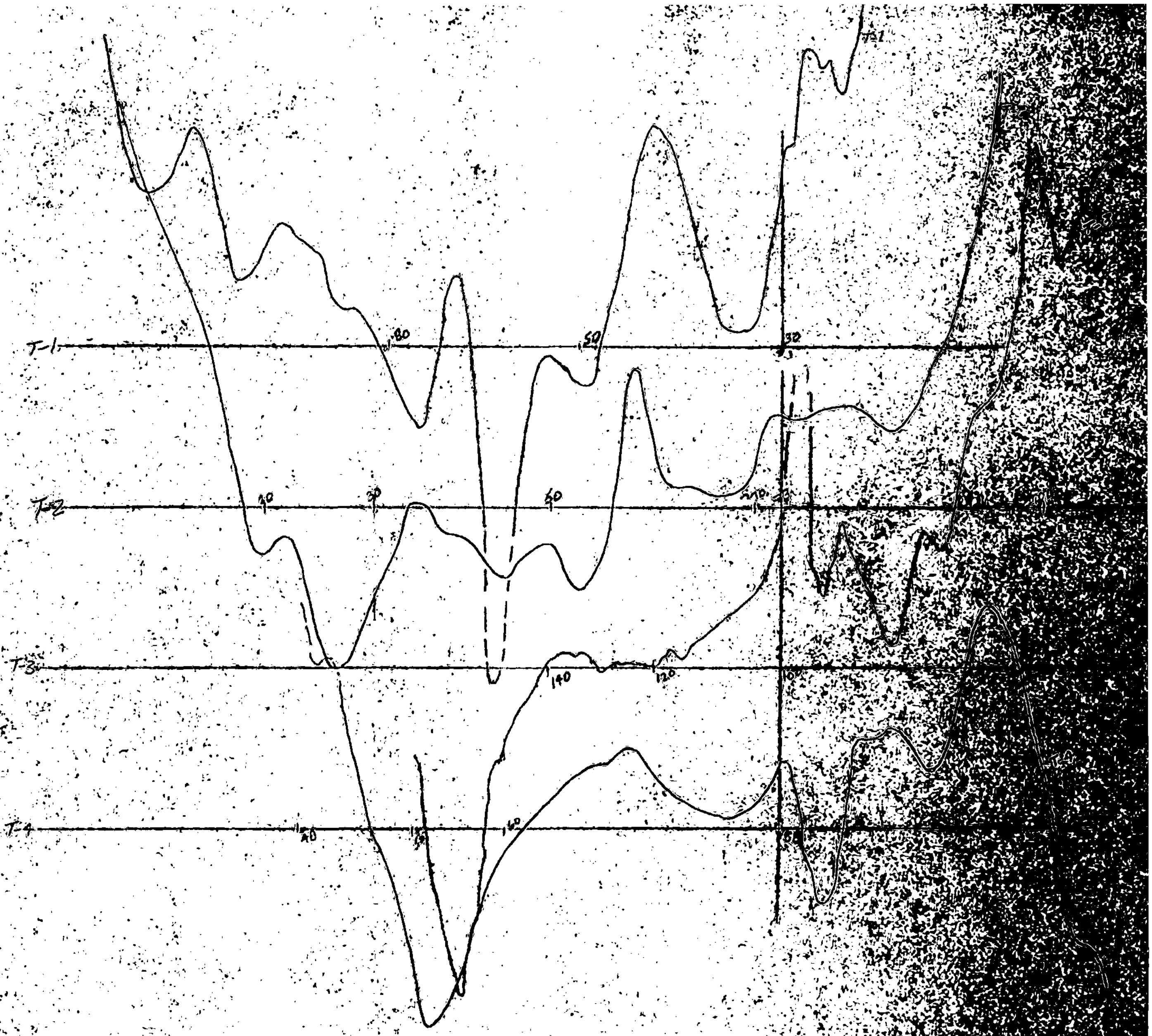
LANL

Tx - Rc =
4 - 2 = 2





25-26 1-2 =29



Tie-Lines Across Quiet Area
1" = 100 nT

Tie Line Profile Plots, Los Azufres Low Altitude

Digital Data, Tape No.3

	Fids					Full Line			Priority Area			Priority Zone	
Profile	Central Ar.	2 diff/dist.	digital Samples/in.	Large Area	5 digital Samples/in Horiz Scale	6 Range nT	Range alt. ft.	8 Plot Scales	9 Range nT	10 Range alt. ft.	11 Plot Scales	12 Digital Fid. Nos.	13
1						0 - 220							
T1-SW 2	50 - 30	20/4.7"	8.51	60-10 11.5"	8.70	399 ~~336~~ →963 ~1000	91-1078	100 nT/in	399 -760 ~360	91-500	50 nT/in	0-110	
3													
T2-NE 4	60-78	19/5.85"	6.15	40-80 13.1"	6.11	335-841 (~500)	84-1078		352-773 ~400	177-1078		110- 200	
5													
T3-SW 6	130 -110	20/5.35"	7.48	140-100 10.73"	7.46	332 -924 (~600)	70-1078		470- 820 ~350	88-1016		120 -298	
7													
T-4-NE 8	70 - 90	20/6.1"	6.56	60-110 15.5"	6.45	437- 914 (~500)	90 -1078		610 - 862 ~250	131 - 1080		100-260	
9													
T-5-SW 10	140-110	30/7.12"	8.43	140-90 12.63	7.92	477 -859 (~300)	83-1078		477 -873 400	91-1077		120-320	
11													
12													
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31													

- value of 500 or ** for missing values
- no gaps in fid no's - to preserve horiz. scale

Tie Line Profile plots, Los Azufros Low Altitude Survey.

Central area

Line T1 ⇄ NE SW — samples/inch $\underset{\text{mean}}{\overset{60-10}{\frac{50\times2}{11.5''}}} = 8.7/\text{in}$; $\underset{\text{corr}}{\frac{50\times2}{12.0''}} = 8.33$; $\overset{50-30}{\frac{20\times2}{9.4''}} = 8.51$

T2 ← NE — " / " $\overset{40-80}{\frac{40\times2}{13.4''}} = \overset{6.11}{\cancel{5.97}}/\text{in}$; $\frac{50\times2}{16.6} = 6.02$ $\frac{36r^2}{12}$; $\overset{60-78}{\frac{18\times2}{5.85''}} = 6.15$

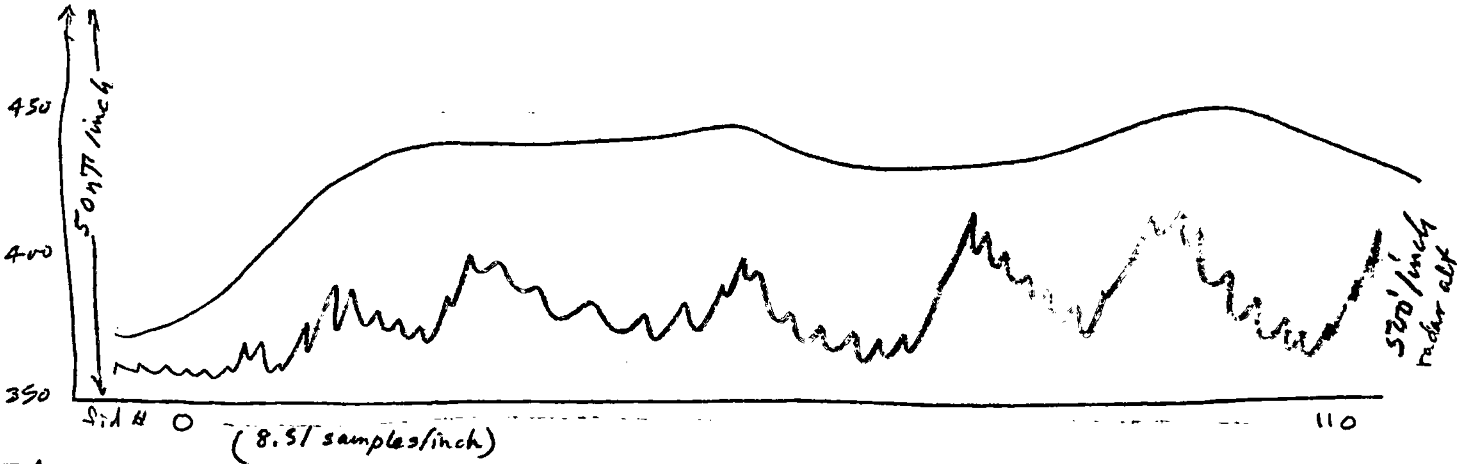
T3 ← SW — " / " $\overset{140-100}{\frac{40\times2}{10.73''}} = 7.46$; $\frac{60\times2}{15.5} = 7.74$; $\overset{130-110}{\frac{20\times2}{5.35''}} = 7.48$

T4 ⇄ SW NE — " / " $\overset{66-110}{\frac{50\times2}{15.5}} = 6.45$ $\frac{30\times2}{9.2} = 6.52$ $\overset{70-90}{\frac{20\times2}{6.14}} = 6.56$

T5 ⇄ NE SW — " / " $\overset{\leftarrow 140-90}{\frac{50\times2}{12.63}} = 7.92$; $\overset{140-110}{\frac{30\times2}{7.124}} = 8.43$

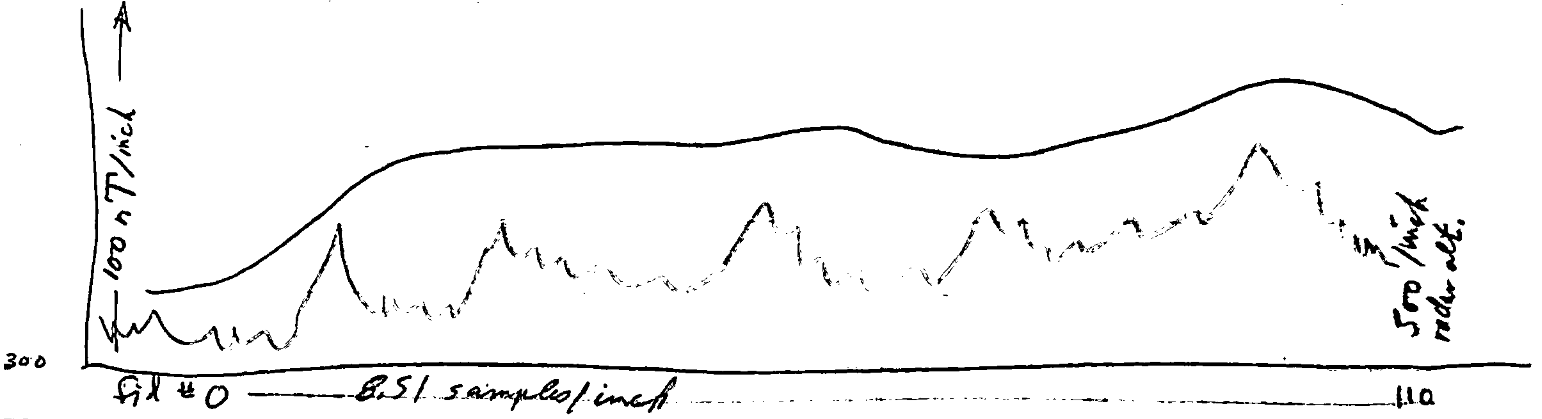
T-1 - Alt. 91 - 10~~78~~ ft

Priority Plots



-1

Full line Plots



LOS AZUFRES AEROMAGNETIC
LOW ALTITUDE DATA - CORRECTIONS

		Phase 1	Phase 2					Phase 1	Phase 2
TRAV.	1 Tape	Diurnal	Tie Li. Adj.	4	5	6 TRAV.	7 Tape	Diurnal	Tie Li. Adj.
12	3	+11	+20			40	1	+64	-10
13		11	-20			41		+70	+16
14		11	-13			42		55	-14
15		11	-14			43		52	0
16		11	-20			44		52	+10
17		11	+6			45		45	+20
18	3	11	+20			46		41	+16
19	2	11	+20			47		41	+17
20		11	+20			48		42	+10
21		11	+20			49		46	+20
22		11	0			50		50	+06
23		11	0			51		51	+08
24		11	0			52		51	+08
25		11	+05			53		53	+06
26		11	+10			54		54	+15
27		11	-08			55	1	53	+20
28		11	+13			56	2	53	-12
29		11	+10			57	2	53	+10
30		11	+15			58	2	+52	+10
31	2	+11	0						
32	2	+45	+10			T-1	3	-05	0
33	2	+42	0			T-2		-05	0
34	2	+40	+04			T-3		-04	0
35	2	+39	0			T-4		-02	0
36	3	+05	-11			T-5	3	-03	0
37	3	+06	-07						
38	3	+05	-20						
39	3	+03	-13						

L.A.1

Low Altitude Survey - Flight No. 1 Digital/Analog Fid Check

Adjustment of Digital Data to Analog/Flight Path Fid #.

A=	when D =
$D/2$	2a-0
$\frac{D+1}{2}$	2a-1
$\frac{D+2}{2}$	2a-2
$\frac{D+3}{2}$	2a-3
$\frac{D+4}{2}$	2a-4

Line 34 NW

Feature	Ana. #	Dig. #	2
Min: 04	15	26	2a-4
min: 70	48	96	2a
max 42	84½	166; 167	2a-2
700	100	200	2a
600	129	256	2a-2
max	138½	275	2a-2
500	163½	324	2a-3
800	182	363½	2a

LINE 42

min - 23	03	06	0
min - 14	31½	62	-1
min - 77	41½	80	-3
max - 51	67	NOISE	

LINE 43SE

max 40	05	06	-4
min 45	10½	18	-3
max 57	69½	138	-1
min 34	119½	238	-1

Line 47SE

min 34	03½	05	-2
max 57	07½	12	-3
max 83	35	67	-3
max 79	86	169	-3
min 87	127½	252	-3
max 39	115½	227	-4

Line 35 SE

Feature	Anal. #	Dig.	
500	30	58	
600	73	157	
min 655	103	20	
600	165	329	
min	203	403	

LINE 40 NW

min 66	08	12	
max 48	4$\overset{9}{3}$½	85	-3 -2
max 78	72	140	-4
min 81	97	180	-4 -2
500	128½	254	-3
max 25	157	310	-4
max 27	172	340	-4

LINE 44 NW

max 29	07½	11	-4
min 37	21½	38	-5
max 17	27	52 -2	reset fid @ 52
max 61	~~14~~ 16	28	⊖4
max 16	~~40~~ 41	78	-4 -2
min 54	78	152	-4
min 35	117	229	-5

Line 48 NW

max 15	4	6	-2
min 85	38	73	-3
max 70	43½	84	-3
max 00	66	129	-3
min 13	98	193	-3
min 36	137½	272	-3

		#	10
			2a-3
			2a-2
			-2
		8	-2
		5	0.
			-3 ~~-2~~
min 44	48	94	-4 -2
max 48	75½	148	-3
max 89	129½	252	-3
min 07	150½	297	-4 -5

LINE 45SE

max 37	11½	20	-3
min 77	48	92	-4
max 08	79	155	-3
min 63	115½	228	-3
max 70	12$\overset{9}{8}$½	256	-3 ~~-1~~

LINE 49SE

max 100	00½	?	-
min 38	05½	8	-3
min 67	37½	72	-3
max 02	80	157	-3
min 19	111½	220	-3
min 76	103	203	-3

Line 39

Feature	Anal. #	Dig. #.
min 28	31½	59 -4
max 36	113	223 -3
max 77	136½	272 -1
min 51	75½	150 -1
min 04	156	308 -4

LINE 42 NW

min 14	8½	14 -3
max 22	38	75 -
min 57	89	177 -
min 51	167	332 -

LINE 46 NW

min 00	07½	05
min 05	1$\overset{8}{7}$½	33 -
max 46	59½	116 -3
max 102	105	208 -2
max 97	138½	274 -3

LINE 50 NW

max 06	0½	—
min 16	05	06 -4
max 55	35½	67 -4
— 00	19½	36 -3
max 32	28	53 -3
max 96	60½	118 -3
min 50	95½	190 -0

(2a-3
2a-4)

LA.2

Low Altitude Survey - Flights No. 2,3 Digital/Analog Fid Check

LINE 51 SE

Feature	Anal #	Dig #	2
max 83	0 1	3	?
min 66	14 2	25	-3
min 66	31½ 3	60	-3
min 12	49 4	95	-3
max 63	78 5	152	-4
	6		

LINE 52 NW

Feature	4 Anal #	5 Dig #	6
max 27	-0½	1	0
min 57	18½	36	-1
min 80	33½	66	-1
Max 86	60½	120	-1
min 13	72½	144	-1

LINE 53 SE

7 Feature	8 Anal #	9 Dig #	10
min 40	2½3	3	-3 -2
max 24	25	46	-4
max 14	61	118	-4
max 23	84	165	-3

LINE 54 NW

Feature	Anal #	Dig #	
min 99	3½	4	-3
max 15	24 25	47	-3 -1
max 21	47	91	-3
min 21	70	136	-4

LINE 55SE

Feature	Anal #	Dig #	
min 66	02 8	02	-2
min 48	19 9	37	-2
max 33	27½ 26½ 10	52	-3 -1
max 363	47½ 11	92	-3
max 641	74 73½ 12	146	-2
	13		

LINE 56SE

Feature	Anal #	Dig #	
max 654	01½	-02	-5
min 362	24	47	-2
min 287	32	62	-2
600	57 56½	110	-4 -3 -2
800	61	122	0

LINE 57 NW

Feature	Anal #	Dig #	
max 888	06	09	-3
min 685	18	34	-2
max 537	51	99	-3
max 52	69½	136	-3

LINE 58 SE

Feature	Anal #	Dig #	
Max 497	06	12	6
max 69	25½	50	-1
max 770	55½	108	-3
max 881	75	147	-
min 302	41	81	-1

LINE 35 SE

Feature	Anal #	Dig #	
max 627	08 15	14	-2
max 665	44 16	87	-1
max 47	84½ 17	167	-2
max 86	128 18	253	-3
max 75	141 19	280	-2
min 499	152½ 20	302	-3
min 566	139 21	277	-1
max	120½ 22	238	-3
	23		

LINE 34 NW

Feature	Anal #	Dig #	
	16		
max 27	8½	13	-4
min 06	35	66	-4
min 96	63	121	-5
min 602	113½		-3
max 669	95	186	-4
min 657	80	157 156	-4
max 706	84	164	-4
max 71	120	238	-2

LINE 33 SE

Feature	Anal #	Dig #	
min 68	06½	08	-3
max 67	14	25	-3
max 48	53	103	-3
max 70	74½	146	-3
min 13	85½	168	-3
min 82	115½	229	+1
max 66	120	239	-1 -1

LINE 32 NW

Feature	Anal #	Dig #	
max 769	36½	72	-1
min 74	63½	126	-
min 75	72½	144	-1
min 50	101½	205	+2
max 47	153	303	-3
max 61	110½	222	-1

31SE 24

Feature	Anal #	Dig #	
flat 606	6½ 25	10	-3
max 761	17 26	31	-3
max 769	39½ 27	77	-2
max 32	66 28	130	-2
min 14	72 29	143	-1
max 900	125½ 30	251	0
min 380	143 31	286?	0

30NW

Feature	Anal #	Dig #	
max 69	11½	78	-4
max 97	43½	83	-4
min 19	76½	149	-4
max 38	125	246	-4
min 43	156½	309	-4

29SE

Feature	Anal #	Dig #	
Max 775	03½	03	-4
Max 740	23½	44	-3
Max 888	56½	109	-4
min 590	102	200	-4
max 77	138	272	-4
min 75	163	322	-4

28NW

Feature	Anal #	Dig #	
Max 06	00½		
600	11½	20	-3
min 414	29½	56	-3
max 882	67½	133	-2
min 607	100½	198	-3
min 687	127	251	-3
max 751	183½	364	-3

TDFS FORM 3422

L.A. 3

– Low Altitude Survey – Flights # 4

Tape No. 2, 3

Line 27 SE				LINE 26 NW				LINE 25 SE				LINE 24 NW			
Feature	Anal #	Dig #	2	3 Feature	Anal #	Dig #	6	Feature	Anal #	9 Dig #	10	1 Feature	1 Anal #	Dig #	
min 634	11 1	20	-2	min 422	12	21	-3	max 50	92½	01	-4	max 541	07	10	-4
max 878	17 2	32	-2	max 800	41½	80	-3	max 68	25½	49	-4	min 455	21	38	-
max 812	42 3	85	(+1)	min 755	62½	123	-2	max 55	91½	80	-3	min 783	50½	97	-
max 796	65½ 4	129	-2	max 728	86	170	-2	5. max 49	58½	112	-5	max 760	66½	130	-3
max 734	89½ 5	177	-2	max 816	113	225	-1	max 93	73	146	-4	max 801	77	151	-3
max 740	117 6	232	-2	max 796	134½	270	+$ 0	max 63	99	184	-4	max 811	120	241	+1
400	153 7	305	-1	min 606	154½	313	(+4) ?	max 33	122½	240	-5	max 736	140	280	0
	8			max 888	162	327	(+3)	5 max 531	137½	273	-2				
Line	23SE 9				22 NW				21SE				20 NW		
max 68	0 10	–		100	03	03	-3	Min 23	00	-02	-2	min 026	02	01	-3
min 435	07 11	11	-3	min 18	20	36	-4	max 46	05	08	-2	max 88	15	26	-
max 800	35½ 12	69	-2	Max 71	42	82	-2	Min 83	11	19	-3	min 546	25	46	-4
max 69	55½ 13	110	-1	max 58	56	110	-2	max 94	25½	48	-3				
max 825	77 14	154	0	max 95	103½	205	-2	min 57	62	123	-1	max 853	62	120	-4
min 673	95½ 15	191	0	max 06	131½	261	-2	min 90	92	181	-3				
max 766	104 16	209	(+1)					max 07	102	201	-3				
Line	19SE 17				18 NW				17 SE				16 NW		
max 17	01 18	00	-2	min 624	2½	01	-4	min 985	2½	01	-4	max 621	05	08	-2
max 65	12½ 19	22	-3	max 715	19	36	-2	max 72	29½	55	-4	max 53	26½	53	0
max 15	33½ 20	64	-3	max 737	32½	61	-4	Max 690	50	96	-4	max 49	53	105	-
max 87	64 21	126	-2	max 10	49½	95	-4	min 522	76	149	-3	min 89	82½	164	-
max 98	96 22	190	-2	min 629	77	151	-3								
min 76	105 23	209	-1												
	24														
15SE	25				14 NW				13 SE				12 NW		
Min 560	02½ 26	02	-3	Max 01	05	06	-4	Min 635	06½	09	-4	max 590	08	12	-4
max 044	25 27	47	-3	min 25	27½	50	-5	Max 724	13	23	-3	min 400	25	48	-2
max 74	43 28	83	-3	min 14	47	91	-3	min 34	27	51	-3	min 388	47½	93	-2
min 30	58½ 29	115	-2	max 697	57	110	-4	max 701	54½	107	-2	max 52	61	119	-3
max 22	71 30	139	-5	max 72	75½	147	-4					min 52	80	157	-3
	31												A = T-1		

	A = T-2		A = T-2	

TOPS FORM 3522
LITH. IN U.S.A.

L.A. 4.

d= 2a-3

Low Altitude Survey - Flight #5, Tape #3

Line. 36 SE analog mag = T-1, L36-39

Feature	Anal #	1 Dig #	2
max 473	08½	14	-3
min 543	33	65	-1
max 584	52½	104	-1
max 740	115	227	-3
max 785	166½	330	-3
max 24	197	390	-3
mag OK T-1 SW			
max 470	039	05	-1
min 613	42½	84	-1
min 668	93	GAP 183 GAP	-3
min 13	108	211	-5
max 89	73	145	-1
T-5 SW			
min 680	33½	63 ✓	-3
max 732	56?	103 ✓	+1 (?)
min 699	57?	116 ✓	+2 (?)
min 632	129	257 ✓	-1

Line 37 NW

Feature	4 Anal #	Dig #	6
max 898	0	—	
min 831	7½	12	-3
min 580	24	46	-2
max 683	54	108	0
max 578	122½	244	-1
max 645	155½	310	-1
	T-2 NE		
max 767	18	35	-1
min 758	48	95	-1
max 697	82		
max 678	111	218	-4
max 846	131½	262	-1
max 687	152	303	-1

Line 38 SE

7 Feature	8 Anal #	9 Dig #	10
max 56	10	16	-4
max 678	53	102	-4
max 707	79	195	-3
max 693	119	237	-1
min 666	169½	337	-2
min 404	208	414	-2
	T-3 SW		
max 851	08 2	14	-2
max 857	23½ 1	45	-2
min 336	39	77	-1
min 655	88½	177	0
max 743	126?	251	-1
max 597	175?	353	+3

Line 39 NW

Feature	Anal #	Dig #	
min 527	11	29	-1
max 858	34½	66	-3
max 745	73½	144	-3
max 714	109½	216	-
max 689	143½	284	-
	T-4 NE		
max	64		
min 439	22½	44	-
max 609	28½	55	-
max 854	52½	102	-3
max 734	81½	160	-3
max 687	136	273	+1
max 543	148	297	-1

TLPS FORM 2022
[illegible]

LOS AZUFRES AEROMAGNETIC
LOW ALTITUDE DATA - CORRECTIONS

			Phase1	Phase2		
TRAV.		1 Tape	2 Diurnal	3 Tie Li. Adj.	4	5
12	1	3	+11	+20		
13	2		11	-20		
14	3		11	-13		
15	4		11	-14		
16	5		11	-20		
17	6		11	+6		
18	7	3	11	+20		
19	8	2	11	+20		
20	9		11	+20		
21	10		11	+20		
22	11		11	0		
23	12		11	0		
24	13		11	0		
25	14		11	+05		
26	15		11	+10		
27	16		11	-08		
28	17		11	+13		
29	18		11	+10		
30	19		11	+15		
31	20	2	+11	0		
32	21	2	+45	+10		
33	22	2	+42	0		
34	23	2	+40	+04		
35	24	2	+39	0		
36	25	3	+05	-11		
37	26	3	+06	-07		
38	27	3	+05	-20		
39	28	3	+03	-13		
	29					
	30					
	31					

		Phase 1	Phase 2	
6 TRAV.	7 Tape	8 Diurnal	9 Tie Li. Adj	net
40	1	+64	-10	+54
41		+70	+16	+86
42		55	-14	+41
43		52	0	
44		52	+10	
45		45	+20	
46		41	+16	
47		41	+17	
48		42	+10	
49		46	+20	
50		50	+06	
51		51	+08	
52		51	+08	
53		53	+06	
54		54	+15	
55	1	53	+20	
56	2	53	-12	
57	2	53	+10	
58	2	+52	+10	
T-1	3	-05	0	
T-2		-05	0	
T-3		-04	0	
T-4		-02	0	
T-5	3	-03	0	

LA-MT.

Pg 2

Tie Line Evaluation - Low Altitude
Mistie Summary

								Ties Improve							
TRAV.		1 T-2	2 T-1	3 T-3	4 T-4	5 T-5	6 Corr. to Tieline	7 X/4	X/5	8	9 Diur	10 Diurt Ph' 2.	11	12	13
32 NW	1	+09 o	-71 p	+10 o	+03 a	+27 o	+10	3	4	✓	+45 May				
33	2	+23 o	-10 o p	-07 o	-01 o a	+29 o	00	3	3	✓	+42				
34	3	+27 o	+61 p	+04 o	-27 p,a	00 o	+04	3	3	✓	+40				
35	4	+03 o	+34 o	-01 o	-33 p,a	-103 [illegible]	00			✓	+39				
36	5	-11 a	-39 o	-08 o	-10 o	+224? p	-11	4	4	✓	+05 May 9	+06			
37	6	+02 a	-4 o	-13 o	+29 a	-41 ?	-07	2	3	✓	+06	-01			
38	7	-32 - a	+62 a	+167 p	+19 p,a	-22 Na	-20	1	3	✓ ?	+05	+15			
39	8	-17 o	-09 o a	+31 p	+44 o	+52 Na	-13	2	3	✓ ?	+03	-10			
40	9	-22 o a	-101 p	+30 o	-07 o a	+04 o Na	-10	3	3	✓ ?	May 6 +64	+54			
→ 41	10	+08 a	+06 o	+49 o	+29 o a	-61 a	+16	4	4	✓	+70	+86			
42 NW	11	-09 a	-29 p,a	-38 o	-08 o	-42 a	-14	4	5	✓ ?	+55	+41			
→ 43	12	+47 a	+120 p	00 o	-48 a	+20 o a,p	+20? 00	-	-	✓ ?	+52	+52			
44	13	+08 o a	+83 a,p	-21 o	+12 o	-64 p	+10	3	3	✓	+52	+62			
45	14	+65		+12 o	+60	-160 p	+20	3/3	3/4	✓	+45	+65			
46	15	+16 o a		-35 o	+24 o a	+30 o	+16	2/3	3/4	✓	41	+57			
→ 47	16	-70		+17 o	+69 p	-27 o a	+17	2/3	2/4	✓ ?	41	+58			
48	17	+05 o		-74 p	+32 p	+53 a	+10	2/3	3/4	✓	42	+52			
49	18	-123 p?		+20	+51 a	+255	+20	2/3	3/4	✓	46	+66			
→ 50	19	+06 o p?		-40 a	-48 p	+209 p	+06	1/3	2/4	✓ ?	50	+56			
51	20	+87		+08 o	-90 p	+250 p	+08	2/3	3/4	✓	51	+59			
52	21	+08 o		+06 o	-117 p	+94 p	+08	2/3	3/4	✓	51	+59			
53	22	+76 p		+03 o	+28 o	+95 p	+06	3/3	4/4	✓	53	+59			
54	23	-39 o p		+15 o	+43 p	+252 p	+15	2/3	3/4	✓	54	+65			
55	24	+21 o		-27 o p	+138	-32 o a,p	+20	2/3	2/4	✓	53	+73			
→ 56	25	+54 a,p		-11 o p	-24 o p	—	-12	2/3	2/3	✓ ?	53	+41			
57	26	-01 o a,p		-188 p	+12 o p	-45 p	+10	1/3	1/4	✓	53	+63			
58	27	+24 o		-89 p	+5 o p	+58 a,p	+10	2/3	3/4	✓	52	+62			
	28														
	29														
	30														
	31														

LA-MT
Pg 1

Mistie Summary - Low Altitude

		alt 100-500 ft (Trav. lines too)	alt. 100-500 ft. (Trav. lines too)	alt 100-500 ft. (some Trav. high)	alt 150-700 Trav. avg. same	T-5 gen. too high! Poor ties	disregard T-5	Ties Improve							
TRAV		1 T-2	2 T-1	3 T-3	4 T-4	5 T-5	6 Corr to Trav Line	7 ×/4	×/5	8	9 Diurn	Diur+Ph.2	11	12	13
12	1	+19 ǀ p	+06	-27 ǀ a	+20 ∘ a	+93 ǀǀǀ p	+20	3	4		+11 may →	+31			
13	2	-20 ǀ p	-39 ǁ p	-34 ǁ p, a	-11 a	+168 ǀǀǀ a	-20	3	4			-19			
14	3	+57 ǁ p	-16 p	-10 • ✓	00 • ✓	+119 ǀǀǀ a	-13	2	2			-02			
15	4	+10 p, a	+20 ǀ p	-37 ǁ p, a	-14 • ✓	+170 ǀǀǀ a	-14	2	2			-09			
16	5	-13 · a	+44 ǁ p	+66 ǁ ✓	-31 ǀ• a	+71 ǀǀǀ ✓	-20	2	2			-17			
17	6	+07 ✓	+06 • ✓	-04 a	-179 ǀǀǀ∘ ✓	+86 ǁ a	+6	2	2			+17			
18	7	+27 ǀ ✓	+11 • a	+61 ǁ• ✓	+32 ǀ∘ ✓	+92 ǀǀǀ a	+20	4	5			+34			
19	8	+58 ǁ ✓	+11 • ✓	+31 ǀ a	-123 ǀǀǀ a	+89 ǀǀǀ ✓	+20	3	4			+32			
20	9	+07 • ✓	+16 • p	+61 ǁ∘ ✓	+29 ǀ∘ ✓	+64 ǁ ✓	+20	3	4			+31			
21	10	+14 • ✓	+14 ∘ p	+46 ǁ• ✓	-62 ǁ• ✓	+17 p, a	+20	3	4			+31			
22	11	-19 ǀ• ✓	+16 ∘ a, p	00 a	-20 ǀ• ✓	+19 ǀ p, a	-0	—	—			+11			
23	12	-10 • a	+16 a	00 a	+08 • a	+62 ǁ a	-0	—	—			+11			
24	13	+21 ǀ a	-74 ǀǀǀ a	-06 • a	-22 ǀ• ✓	+101 ǀǀǀ a	-0	—	—			+11			
25	14	+10 a	+30 ǀ a	+05 • a	-01 • ✓	-18 ✓	+05	3	3			+16			
26	15	+26 ǀ• a	+148 ǀǀǀ• a	+03 ∘ a	+08 ∘ ✓	-15 a	+10	4	4			+21			
27	16	-46 ǁ a	+120 ǁ• ✓	-65 a	-08 • a	+24 ǀ a	-08	3	3			+03			
28	17	+31 ǁ a	-128 ǁ a	+14 • ✓	+13 • a	-33 ǀ a	+13	3	3			+24			
29	18	+40 ǁ• a	-49 ǁ• ✓	+27 ǀ• ✓	-11 a	-21 ǀ a	+10	2	2			+21			
30	19	-27 ǀ• a	+34 ǀ• ✓	+08 • ✓	+18 ǁ a	-76 ǁ a	+15	3	3			+26			
31	20	-55 ǁ p, a	+14 ∘ a	00 • ✓	-06 a	-03 a	+00	—	—		+11??	+011			
	21														
	22	15 ok	12 ok	15 ok	17 ok	7 ok		45/64	51/80						
	23	13	10	9	9	16		= 70.3%	64%						
mistie avg.	24	$\frac{+57}{20}$ = +2.85	$\frac{+168}{20}$ = +8.4	$\frac{+199}{20}$ ±9.95	$\frac{-369}{20}$ = -18.										
	25														
	26														
	27														
	28														
	29														
	30														
	31														

TOPE FORM 3522

T-2 ②

Tie-Line 2

Trav Line-Tie

Trav.	Fid.	Line Alt	Line Mag	T-2 Mag	T-2 Alt	T-2 (fid)	Tie Line - Trav	5 Corr	6 Comm ALT	7 ents POS	8 DIUR	9	10	11	12	13
·43SE	58 1	387	579	626	692	88 ✓	+ 47		- 305 -	~~ex~~	52					
44NW	64½ 2	256	561	569	648	90½	+ 08 ○		- 392 ●	ok	52					
45SE	55 3	717	462	527	558	92	+ 65		+ 165 ●	ok	45					
46NW	91 4	172	375	391	519	96	+ 16 ○		- 339 ●	ok	41					
·47SE	49½ 5	282	433	363	363	97½	- 70		- 81 ●	ok	41					
48NW	100½ 6	264	378	363	418	97½	+ 05 ○		- 154 ●	ok	42					
49SE	44 7	370	533	410	500	102½	- 123		- 130 ●	ok	46					
·50NW	68 8	278	519	525	282	105	+ 06 ●		- 04 ●	ok	56					
51SE	37 9	125	575	662	170	108½	+ 87		- 45 ●	ok	51					
52NW	51½ 10	101	664	672	151	110	+ 08 ●		- 50 ●	?	51					
53SE	31 11	297	503	579	229	113	+ 76		+ 68 ●	?	53					
54NW	51½ 12	207	501	462	147	117	- 39		+ 60 ●	?	54					
55SE	31½ 13	327	559	580	270	120½	+ 21 ●		+ 57 ●	??	53					
·56NW	42 14	970	601	655	389	124	+ 54		+ 540 ●	?	53					
57SE	23 15	165	820	819	570	129½	- 01		- 405 ●	??	53					
58NW	57½ 16	691	810	834	684	131	+ 24 ○		+ 07 ●	ex ✓	52					
	17															
	18															
	19															
	20															
	21															
	22															
	23															
	24															
	25															
	26															
	27															
	28															
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	30															
	31															

TOFS FORM [illegible]

Tie-line Evaluation - Low Altitude

Tie Lie 1 SE

w. diurnal

Trav. line - Tie

Δ Trav - Tie

Trav	/ Fid	Alt	Line Mag	Tie 2 Mag	Alt	3 Tie1-fid	4 T1-Line(+)	5 Corr	6 Comments ALT.	7 POS.	8 DIUR.	9 Incr alt (γ)	10	11	12	13
12NW	65 1	222	617	623	161	108½	+06		+60 ✓	?	+16 ✓	-06				
13	07 2	122	648	609	156	106	-39 ▮		-34 ✓	??	+16 NO BASE READING	-39				
14	70 3	138	656	640	141	103	-16		-03 ✓	??	+16	—	+7			
15	12? 4	151	674	696	106	100	+22 |		+45 ✓	??	?	-22	-11			
16	○ 78 5	296	650	694	117	97½	+44 ▮		+179 ✓	??		-44	even 3			
17	● 16? 6	136	658	664	136	93	+06 ●		00 ✓	ok		—				
18	● 69 7	438	663	674	118	90½	+11 ●		+320 ▮	ok		-11				
19	● 46 8	133	663	674	110	90	+11 ●		+23 ✓	ok.		-11				
20	○ 88 9	161	697	713	113	83½	+16 ○		+48 ✓	?		-16				
21	○ 26 10	177	703	717	177	80½	+14 ○		-60 ✓	?		+14				
22	● 111½ 11	136	754	770	339	75	+16 ●		-203 |	?	??	+16				
23	● 34 12	121	758	774	645	72	+16 ○		-524 ▮	ok		+16				
24	● 129 13	121	784	710	539	69½	-74 ● ▮		-418 ▮	ok		-74				
25	● 35 14	214	667	697	600	67½	+30 ● ▮		-386 ‖	ok		+30				
26	● 120½ 15	196	736	884	394	64	+148 ○ ▮		-200 |	ok		+148				
27	● 52 16	135	840	960	~247	61½	+120 ○ ▮		-112 ✓	ok		+120				
28	● 148½ 17	107	908	779	450	57½	-128 ● ▮		-343 ▮	ok		-128				
29	○ 54 18	281	808	759	407	56½	-49 ● ▮		-126 ✓	ok		-49				
30 NW	○ 130½ 19	225	724	758	140	49	+34 ○ ▮		+85 ✓	ok		-34				
31 SE	● 43½ 20	164	734	748	395	52½	+14 ●		-231 |	ok	+16 ???	+14			
32	● 123 21	557	684	613	502	41½	-71 p		+55 ✓	?						
33	● 61 22	484	646	636	450	.40	-10 ○		+34 ✓	?						
34	○ 116½ 23	434	666	727	446	.34	+61 p		-12 ✓	ok						
35	○ 42 24	395	693	727	167	.32	+34 ○		+228 ▮							
36	● 65 25	78	668	629	101	.28½	-39 ●		-23 ✓							
37	○ 113 26	183	625	621	101	.27	-4 ●		+82							
38	○ 82 27	696	527	589	286	.20	+62 ▮		+414 ▮							
39	○ 119 28	985	581	572	386	.18	-09		+600 ▮	ok						
40	— 129½ 29	320	557	458	282	.12½	-101 ▮		+38	?						
41	● 53 30	234	425	431	217	.9	+06 ●		+17 ●	ok						
42	○ 135 31	571	461	432	126	.7	-29		+445 ▮	?						
● 43	41	252	371	465	132	03	+120 ▮		+130 ○	?	52					
44	81	843	482	399	195	01	+83 ▮		+648	?	52					

Tie Line Evaluation — Low Alt.
Tie Line T-3

Trav / Fid		1 Line Alt - Mag	2 T-3 Mag - Alt	3 Tie-3-Fid	4 T3-Line X	5 Corr	6 Comments Trav.-Tie ALT.	7 POS.	8 Trav-Tie → DIUR.	9 Inv Alt (?)	10	11	12	13
12 NW	• 40 1	754 627	nd 600 200	170	-27 |		+580 ▮	ok	+15 ✓	+27				
13	• -26 2	1020 - 655	621 223	167	-34 ▮		+800 ▮	?	+15 ✓	+34				
14	• -46½ 3	285 - 640	630 278	166½	-10		+07 ✓	?	+15	-10				
15	• -36 4	1052 - 697	680 200	165	-37 ▮		+850 ▮	?	NO BASE READING ?	+37	7+			
16	• 48½ 5	881 663	729 197	161	+66 ▮		+684 ▮	ok		-66	9-			
17	• 38 6	486 735	731 130	159	-04		+350 ▮	ok		+04	4 even			
18	• 44½ 7	374 789	850 276	154	+61 ▮		+100 ✓	ok		-60				
19	• 69½ 8	448 747	778 113	156	+31 ▮		+335 ▮	ok		-31				
20	• 61 9	214 842	903 160	149	+61 ▮		+54 ✓	ok		-54				
21	• 55 10	126 776	820 129	146	+46 ▮		-03 ✓	ok		—				
22	• 82½ 11	139 790	790 500	142½	00		-350 ▮	ok		00				
23	• 61 12	205 764	+/- est. 764 700	141	00		-500 ▮	ok		00				
24	• 100 13	403 758	752 611	138	-06		-210 |	ok	??	-06				
25	• 69 14	359 727	732 673	135	+05		-320 ▮	ok		-05				
26	• 92½ 15	602 723	726 951	131½	+03		-350 ▮	ok		+03				
27	• 80½ 16	281 731	726 1016	132½	-05		-735 ▮	ok		-03				
28	• 119½ 17	197 724	738 - 317	125½	+14		-120 ✓	ok		+14				
29	• 80 18	161 711	738 -317	125½	+27 |		-160 ✓	ok		+27				
30 NW	• -102 19	154 727	735 -92	119	+08 o		+62 ✓	ok		-08				
31 SE	• 69½ 20	191 - 733	733 -140	120	+00 o		-49 ✓	ok	+15 ???	00				
32	- 98 21	263 718	728 - 151	-113	+10 o		+112		??					
33	• 86½ 22	152 731	724 158	-112	-07 o		-06		?					
34	• 89 23	358 708	712 133	-108	+04 o		+225 ▮		?					
35	• 74½ 24	360 704	703 151	•106	-01 o		+209							
36	• 105½ 25	300 705	697 185	•104	-08 o		+115 o	ok						
37	• 88 26	721 659	646 531	•98½	-13 o		+190 o	ok						
38	• 122½ 27	337 560	667 261	-94	+107 p		+76 o	?						
39	• 90 28	180 621	652 178	-90	+31 o p		+02 o	?						
40	• 93 29	220 648	678 103	•87½	+30 o		+117 o	ok						
41	• 87½ 30	224 649	698 136	•85½	+49 o		+88 o	ok						
42	• 99½ 31	175 723	685 196	•80½	-38 o		-21 o	ok						

TOPS FORM 3622

Low Altitude
Tie Line -3

Trav / Fid			Line 1 Alt - Mag		T-3 2 Mag Alt		3 T-3 Fid	4 T-3 - Line	5 Corr	Trav - Tie 6 Comments		8	9	10	11	12	13
										ACT	POS.	DIUR.					
• 43.	72	1	240	674 ✓	674	202	80	00 ✓		+38	ex	52					
44	46	2	328	691	670	241	76	-21		-87	ex	52					
45	68½	3	306	618	630 est	350	73	+12		~ 44	ex	45					
46	74	4	273	617	582	168	68½	-35		+105	ex	41					
• 47	66	5	287	563	580	170	68 ✓	+17 ✓✓		+117	ex ✓✓	41					
48	84½	6	190	573	499	209	63	-74		-109	ok	42					
49	59	7	204	461	481 est	394	60	+20		-190	ex	46					
• 50	53½ ✓	8	157	543	503 est	834	57 ✓	-40		-680	ex	50					
51	51	9	140	471	479	643	54	+08		-503	ex	51					
52	38	10	125	452	458	693	52	+06		-568	ex	51					
53	43½	11	599	441	444	711	49	+03		-111	ex	53					
54	38½	12	168	418	433	351	45½	+15		-183	ex	54					
55	42	13	102	401	374	99	41½	-27		+03	?	53					
• 56	30½ ?	14	99	352	341	84	38½	-11		+15	?	53					
57	31	15	126	652	464	70	33½	-188		+56	??	53					
58	49	16	116	619	530	86	31½	-89		+30	??	52					
		17															
		18															
		19															
		20															
		21															
		22															
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		29															
		30															
		31															

TOPS FORM 36 22
[illegible]

Low Altitude
Tie Line 4

Trav. / Fid	Line Alt	Line Mag	2 T-4 Mag	T-4 Alt	3 T-4 fid	4 T4 - Line	5 Corr.	6 Comments (Trav.-Tie) ALT.	POS.	8 (Trav.-Tie) DIUR.	9 Incr. (δ) Alt	10	11	12	13
12 NW •25 1	204	417	437 -	461	23	+20		-260	ok	+13 ✓	+20				
13 ∘37½ 2	968	598	587	287	27	-11		+700	OK	+13 ✓	+11				
14 ∘32½ 3	314	600	660	167	30½	00		+167 ✓	OK	+13	—				
15 ∘50 4	313	601	587	155	31½	-14		+160 ✓	OK	— No BASE READING — ?	+14	high alt. high mag ⑫			
16 ∘31 5	276	597	566	162	34	-31		+214	OK		+31				
17 ∘51 6	169	743	564	171	38	-179		-02 ✓	OK		—				
18 ∘27½ 7	185	610	642	130	40½	+32		+55 ✓	—		-32	low alt high mag ⑤			
19 ∘84 8	875	763	640	129	42	-123		+750	—		+123				
20 ∘45½ 9	126	724	753	199	47	+29		-73 ✓	OK		+29	same mag ③			
21 ∘69½ 10	181	845	783	144	49	-62 ∘		+37 ✓	OK		+62				
22 ∘65½ 11	147	868	848	293	52½	-20 ∘		-150 ✓	OK		-20				
23 •74½ 12	338	799	807	520	55½	+08		-180	OK		-08				
24 83 13	739	775	753	626	58½	-22		+113 ✓	OK	??	+22				
25 ∘84 14	636	752	751	683	59	-01		-50	OK		—				
26 ∘78½ 15	895	700	708	957	65½	+08		-60	OK		+08				
27 93 16	801	731	723	507	63	-08		+300	OK		+08				
28 ∘106 17	425	681	694	645	70	+13		-220	OK		+13				
29 ∘91½ 18	356	707	696	786	70½	-11		-430	OK		-11				
30 ∘87 19	221	697	715	1073	75	+18		-850	—		+18				
31 ∘81 20	128	724	718	1059	75½	-06		-930	—	+13???	-06				
32 ∘86 21	408	727	730	988	∘80	+03 ∘a		-580	?						
33 ∘99½ 22	158	733	732	1025	∘81	-01 ∘a		-878	ok						
34 ∘84½ 23	149	747	720	1035	-85	-27 ∘a		-886	?						
35 —85½ 24	151	747	714	1076	-85½	-38 ∘a		-825	?						
36 ∘120 25	172	789	779	443	-90½	-10 ∘		-271	?						
37 —76 26	321	724	753	805	-93	+29 a		-484	?						
38 ∘135½ 27	372	664	683	838	-97½	+19 a		-466	?						
39 ∘80 28	489	647	691	860	∘100	+44 ∘		-370	ok						
40 •83½ 29	284	713	706	761	∘101½	-07 ∘ a		-476	ok	+64					
41 •97½ 30	224	649	678	996	∘104	+29 ∘ a		-772	ok	+70					
42 •88 31	288	619	611	1069	∘107	-08 ∘		-323	ok	+55					

TOPS FORM 3622
LITHO IN U.S.A.

Low Altitude
Tie Line 4

Trav-Tie

Trav.	Fid		Line		T-4		3 T-4 fid	4 T4 -Line	5 Corr	6 Comments		8	9	10	11	12	13
			1 Alt	Mag	2 Mag	Alt				ALT	POS	DIUR.					
43	84½	1	264	658	610	1021	107½	-48		-960	ok	52					
44	31	2	799	659	671	916	111½	+12		-117	ok	52					
45	80½	3	490	749	809	585	118½	+60		-95	ok	45					
46	59½	4	225	789	813	480	119	+24		-255	ok	41					
47	79	5	652	744	813	480	119	+69		+172	?	41					
48	68½	6	104	701	733	299	123	+32		-195	?	42					
49	76	7	133	692	743	491	126	+51		-358	[illegible]	46					
50	36½	8	226	704	656	289	129	-48		-67	??	50					
51	72½	9	145	696	606	242	131	-90		-97	??	51					
52	22	10	122	667	550	144	133	-117		-22	??	51					
53	65	11	162	600	628	141	135½	+28		+21	?	53					
54	17	12	135	633	676	137	137	+43		-02	??	54					
55	61½	13	92	486	624	107	143	+138		-15	?	53					
56	6½	14	753	560	536	90	145	-24		+163	??	53					
57	54	15	118	519	531	119	148	+12		-01	??	53					
58	28	16	87	505	520	155	150½	+15		-78	??	52					
		17															
		18															
		19															
		20															
		21															
		22															
		23															
		24															
		25															
		26															
		27															
		28															
		29															
		30															
		31															

Low Altitude
Tie Line 5

		Line		T-S					Trav-Tie		Trav-Tie					
Trav.	Fid	1 Alt	Mag	2 Mag	Alt	3 T-S fid	4 T-S-Line	5 Corr	6 Comments			9 Incr. alt.	10	11	12	13
									ALT	POS.	DIUR.					
12 NW	14 1	212	515	608	230	174½	+93 ✓		−18 ✓	??	+14 ✓	+93				
13	45 2	823	565	733	185	169½	+168		+640	?	NO BASE READING +14 ✓	−168				
14	23 3	302	601	720	209	164	+119		−400	—	14	+119				
15	59½ 4	468	550	720	709	164	+170		−250	OK	?	+170	high alt ↓ high mag ⑩			
16	17½ 5	483	657	728	473	165½	+71 ✓		+10 ✓	—		—				
17	60 6	648	663	749	926	162	+86		−290	OK		+86	low alt high mag ⑨			
18	17 7	325	693	785	1045	160	+92		−720	OK		+92				
19	94½ 8	785	694	783	960	158	+89 ✓		−180	OK		+89				
20	35 9	854	701	765	932	155	+64 ✓		−80 ✓	OK		+64				
21	81 10	897	743	~780?	~300	153	+37 ?		+400	?		−37				
22	56 11	786	771	~790?	~400	149	+19 ?		+386	?	??	−19				
23	84½ 12	748	760	822	442	147	+62		+306	?		−62				
24	70½ 13	1075	767	868	443	145	+101		+632	OK		−101				
25	94½ 14	510	855	837	566	143½	−18 ✓		−56 ✓	OK		−18				
26	65 15	734	790	775	1066	140½	−15		−332	OK		−15				
27	104 16	537	732	756	973	139½	+24		−440	OK		+24				
28	92 17	864	731	698	544	134½	−33		−322	OK		+33				
29	104½ 18	713	649	628	352	132½	−21		−360	OK		+21				
30	73 19	159	609	533	502	129	−76		−340	OK		−76				
31	94½ 20	247	580	577	491	125½	−03		−240	OK	+14 ???	−03				
32	71½ 21	383	628	655	188	120½	+27		+195	ok						
33	113½ 22	267	659	688	169	119	+29		+98	ok						
34	63½ 23	213	644	644	499	114	00		+99	ok						
35	101½ 24	359	633	530	350	112	−103		+09	ok						
36	103½ 25	310	207	431?	128	106	+224 ?		+180	?						
37	63½ 26	115	484	525?	91	103½	+41 ?		+24	ok						
38	151 27	117	612	590 est	700	99½	−22 ~		−583	ok						
39	65 28	159	563	615 est	700	98	+52 ~		−541	ok						
40	63½ 29	167	626	630 est	700	96	+04 ~		−533	ok						
41	111 30	206	712	651	799	93½	−61		−593	ok						
42	−70 31	227	692	650	1078	90	−42		−851	??						

TOPS FORM 3522
IN U.S.A.

Low Altitude
Tie Line 5

			Trav		T-S					Trav.- Tie							
Trav.	Fid		Alt	Mag	Mag	Alt	3 T-S fid	4 T-S-Line	5 Corr	6 comments		8	9	10	11	12	13
										ALT	Pos	DIUR					
43	98½	1	314	555	575	615	87½	+20		-301	?	52					
44	15	2	135	547	483	224	82	-64		-90	?	52					
45 SE	93	3	244	647	487	178	81	-160		+66	?	45					
46	47½	4	209	647	677	396	73	+30		-187	ef	41					
47	90	5	146	707	680	505	72 ✓	-27		-360	ef	41					
48	58	6	153	629	682	380	68	+53		-227	ok	42					
49	? 87?	7	273	459	714	175	63.	+255		+98	ok	46					
50	25?	8	136	476	685	121	60.	+209		+15	?	50					
51	85	9	94	450	708	103	56½	+250		-09	??	51					
52	12	10	165	635	729	110	53	+94		+55	??	51					
53	74	11	121	616	711	151	48	+95		-30	?	53					
54	5	12	118	456	708	185	47½	+252		-67	??	54					
55	72	13	338	667	635	722	41	-32		-390	?	53					
56	—	14	—		—		—	—	—	—	—	53					
57	65	15	853	622	577	1061	36	-45		-208	??	53					
58	18	16	359	720	778	772	18	+58		-413	?	52					
		17															
		18															
		19															
		20															
		21															
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		23															
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TOPS FORM 3622

T-2-①
11/01/88

Low Alt.

Tie Line Evaluation – Line T-2

Trav / Fid		Line Alt	Mag	T-2 Mag	Alt	3 Tie-2 fid	4 T-Line (?)	5 Corr.	6 COMMENTS (Trav Line - Tie) ALT.	POS.	8 ——→ (Trav Δ - Tie) DIUR.	9 Incr. alt	10	11	12	13
12NW	53½ ^{1}	246	627	646	124	13	+19 |		+120 ✓	??	+16 ✓	−19				
13SE	15 ^{2}	245	720	700	124	15	−20 |		+120 ✓	???	+16 ✓	+20				
14NW	59 ^{3}	167	697	754	184	17	+57 ‖		−17 ✓	???	+16	+57	+9			
15SE	24 ^{4}	671	752	762	111	18	+10		+560	???	NO BASE READING ?	−10	−10			
16NW	63 ^{5}	293	766	753	92	20½	−13		−460	?		+13	even 1			
17SE	29 ^{6}	246	784	791	81	22½	+07		+.165 ✓	?		−07				
18NW	55 ^{7} ✓	135	795	822	102	26½	+27 ‖		+33 ✓	?		−27				
19SE	59½ ^{8} ✓	141	768	826	102	25	+58 ‖		+39 ✓	?		−58				
20NW	• 71 ^{9} ✓	134	751	758	135	31	+07 •		+01 ✓	?		—				
21SE	• 45 ^{10}	111	716	730	176	33½	+14 •		−65 ✓	—		+14				
22NW	• 94 ^{11} ✓	153	765	746	230	37½	−19 • |		−27 ✓	ok ex.		−19				
23SE	• 51½ ^{12} ✓	190	759	749	271	40 38½	−10 •		−81 •	ok ex		−10				
24NW	• 111½ ^{13}	102	735	756	408	41	+21 • |		−366	ok ex		+21				
25SE	• 55 ^{14} ✓	174	763	773	536	44½	+10 •		−370	ok ex	??	+10				
26NW	• 105 ^{15} ✓	248	737	758	517	46½	+26 |		−270	ok		+26				
27SE	° 68 ^{16}	282	800	754	575	47½	−46 ‖		−300	ok		−46				
28NW	• 133½ ^{17} ✓	298	743	774	747	52½	+31 • ‖		−449	ok ex		+31				
29SE	• 69 ^{18} ✓	429	740	780	692	51	+40		−265	ok ex		+40				
30NW	° 117 ^{19} ✓	175	701	674	370	58	−27 • |	+27	−200	ok ex		−27				
31SE	• 56 ^{20}	180	709	654	446	57	−55 ‖		−260	?	+16 ???	−55				
32NW	° 110 ^{21} ✓	1068	715	724	1073	• 63½ •	+09 •		−05	ok	+50					
33SE	° 72½ ^{22}	430	701	724	619	• 66 •	+23 •		−190 ✓	ok	+47					
34NW	• 103½ ^{23} ✓	458	697	724	416	• 67½ °	+27 •		+42	ok	+45					
35SE	° 57 ^{24}	229	680	683	214	• 70 •	+03 •		+15	ok	+44					
36SE	• 85 ✓ ^{25}	129	695	684	873	• 73	−11 a		−750	ok	+10					
37NW	° 102 ^{26}	443	675	677	1061	• 75	+2 a		−618	ok	+11					
38SE	° 100½ ^{27}	531	710	678	1016	° 79	−32 −		−485 −	ok	+10					
39NW	° 106 ^{28} ✓	767	695	678	1016	• 79	−17 •		−249 ✓	ok	+08					
40NW	• 113 ^{29} ✓	370	705	683	999	° 83	−22		−629	ok	+69					
41SE	° 70 ^{30}	169	675	683	999	• 83	+08		−830	ok	+75					
42NW	° 117 ^{31}	273	652	643	885	• 86½	−09		−633	ok	+60					

TOPS FORM 3622

Los Azufres

Preliminary Diurnal Correction- Low Altitude Survey

Reconcile to mean 42,740γ base station value

H. P. Ross
Aug. 25, 88

Line No.	May	1 Time	Diur. Corr	3	4	5
34SE	5	9:41	(-07)			
35SE		9:56	(-06)			
38		10:08	(-04)			
39		10:20	(-02)			
42		10:30	(0)			
40 NW	6	8:10	+64			
41 SE		822	+70			
42 NW		833	55			
43 SE		843	52			
44 NW		852	52			
45 SE		9:01	45			
46 NW		9:09	41			
47 SE		917	41			
48 NW		925	42			
49 SE		931	46			
50 NW		937	50			
51 SE		943	51			
52 NW		949	51			
53 SE		954	53			
54 NW		959	54			
55 SE		1003	53			
56 NW		1007	53			
57SE		1011	53			
58 NW		10:15	+ 52			
35 SE	6	11:33	+ 39			
34NW		11:45	40			
33SE		11:57	42			
32NW		12:10	+ 45			

Line No.	7 May	8 Time	Diur. Corr	10	11	12	13
31SE	7	0809	+ 11				
30NW		0815	+ 11				
29SE		0821	+ 11				
28		0827	11				
27		0834	11				
26		0840	11				
25		0846	11				
24		0852	11				
23		0857	11				
22		0902	11				
21		0907	11				
20		0912	11				
19		0916	11				
18		0920	11				
17		0923	11				
16		0927	11				
15		0930	11				
14		0933	11				
13 SE		0936	11				
12 NW		0940	+11				
36SE	9	0836	+05				
37NW		0841	+06				
38 SE		0846	+05				
39 NW		0851	+03				
					Instrument trouble		
T-1SW		1020	-05				
T-2NE		1027	-05				
T-3SW		1033	-04				
T-4NE		1040	-02				
T-5SW		1047	-03				

Magnetic Data Compilation

RECORDED DATA				PHASE I Preliminary Base Level			PHASE II Corrections			PHASE III			
Line - Fid #	Sample No. (sec)	Ttl. Mag. Int. (γ)	3 Altimeter (feet)	4 Diurnal Corr (γ)	5 Adjustment γ	6 T. M. I. γ	Tie & Base	2nd Diurn.	9 T. M. I.	10 Final Corr	11	12 T. M. I.	13
1													
32 - 121 2	242	42,723	∼	70	- 42,000	653							
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
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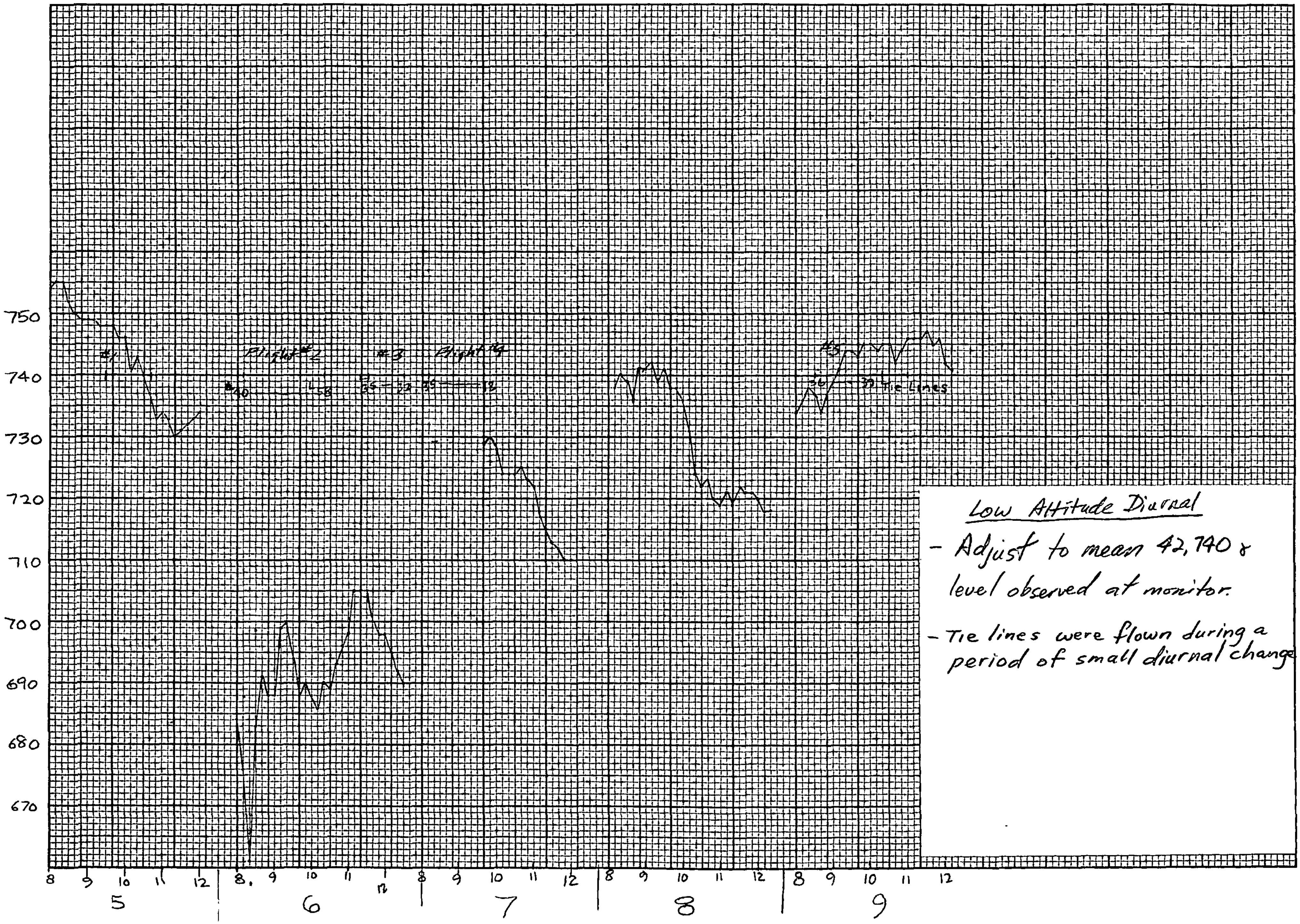
28													
29													
30													
31													

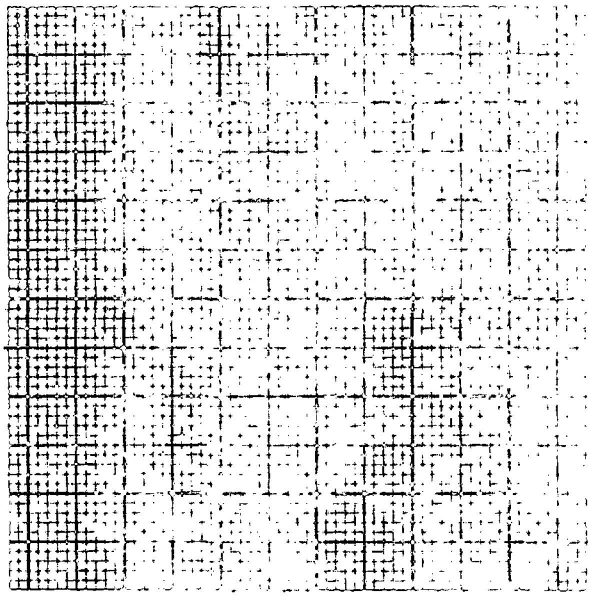
Detailed Diurnal Variation – Low Altitude

May 5-9, 1988

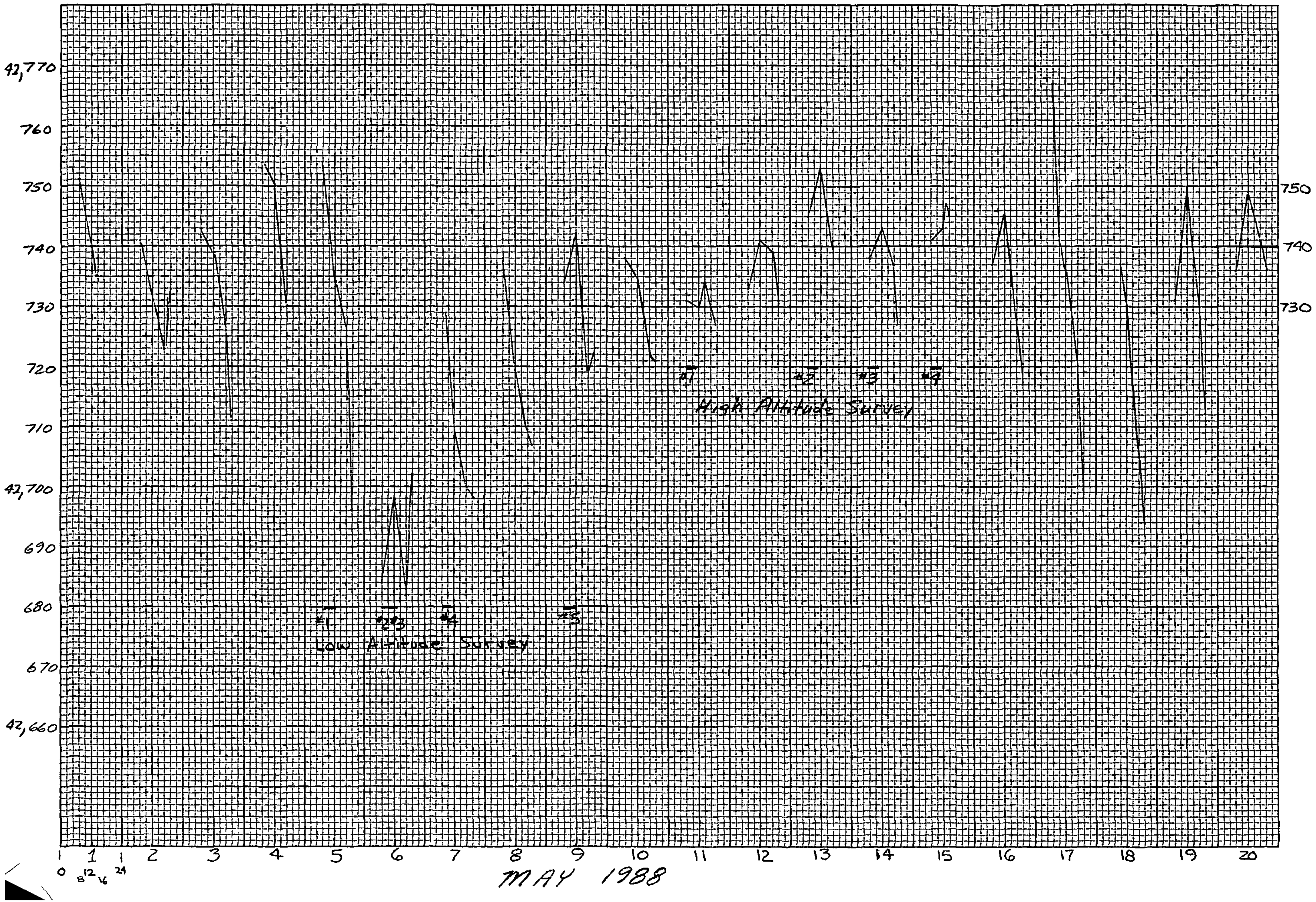


Low Altitude Diurnal

- Adjust to mean 42,740 γ level observed at monitor.
- Tie lines were flown during a period of small diurnal change



Los Azufres Magnetic Survey- Diurnal Field Variation



Los Azufres - Low Altitude

Pg. 1
HAR
8/24/88

Tape No.		Flight Line No.	Line No on Audio	Compile	Analog Fiducial No. 4 Begin	Digital Sample No. 5 End	COMMENTS
Flight #1	1	5 May 1988 9:41 am → 10:30 am					
Tape 1	2	34 SE	34 SE	No	06	90	No video on monitor - abort - donot compile
	3	34 SE	34 SE rept.	No	01	417 180	Strayed across 35 - abort - " " "
	4	35 SE	35 SE	No	30	458 210	Strayed across lines - " " "
	5	38	38	NO	05	446 180	Strayed across lines - " " "
	6	39	39	NO	01	358 160	Strayed across lines - " " "
	7	42	42	NO	05	173	Strayed across lines. - " " "
	8						
FLIGHT #2		6 May 1988: 8:10 am → 10:15 am.					altimer check @ 7200 ft.
Tape #1	10	40 NW	40 NW	Yes	10	397 185	ok; delete altimeter plot; use 0-1000 f
	11	41 SE	41 SE	"	04	337 170	ok
	12	42 NW	42 NW	"	03	401 180+	ok
	13	43 SE	43 SE	"	02	281 138	ok
	14	44 NW	✓	"	02 14-24	52 118 275	reset fid counter after 24;
	15	45 SE	✓	"	05	291 133+	ok
	16	46 NW	✓	"	02	307 142	ok
	17	47 SE	✓	"	03	289 130	ok
	18	48 NW	✓	"	02	329 156	ok
	19	49 SE	✓	"	02	272 122	ok
	20	50 NW	✓	"	03	241 102	ok
	21	51 SE	✓	"	04	[illegible] 92	ok
	22	52 NW	✓	"	02	176 77	ok
	23	53 SE	✓	"	04	208 86	ok
	24	54 NW	✓	"	02	188 82	ok
	25	55 SE	✓	"	04	171 84	ok
Tape #2	26	56 NW	✓	"	10	138 65	OK
	27	57 SE	✓	"	05	80	ok
	28	58 NW	✓	"	05	78	OK - Back to refuel est. 10:30 a.m.
	29						
	30						
	31						

P. 2.
HPR
8/24/88

Los Azufres - Low Altitude

Tape No	Flight Line No.	Line No. on Audio	Compile	Analog Fiducial No. Begin	End	COMMENTS
Flight #3	6 May	1988	11:30 -	12:30 est.	✓	
Tape #2	35 SE	35 SE	Yes	01-20; 01	166^{377}	Reset fids after start; ok
	34 NW	✓	✓	04	172^{395}	ok
	33 SE	✓	✓	04	170^{370}	ok
	32 NW	✓	✓	02	180^{367}	ok
Flight #4	7 May 8:06 am	1988 -9:40 am				
	31 SE	✓	✓	03	162^{356}	OK 8:06 am →
	30 NW	✓	✓	05	160^{352}	ok
	29 SE	✓	✓	06	170^{369}	OK 8:18 am →
	28 NW	✓	✓	05	200^{406}	ok
	27 SE	✓	✓	03	158^{381}	OK 8:31 am →
	26 NW	✓	✓	02	162^{362}	OK 8:38 am →
Tape #2	25 SE	✓	✓	05	146^{330}	OK 8:44 am @ f#19
	24 NW	✓	✓	04	159^{359}	ok
	23 SE	✓	✓	03	116^{273}	ok 8:55 am →
	22 NW	✓	✓	03	140^{321}	ok
	21 SE	✓	✓	03	110^{258}	ok 9:05 am @ f#20
	20 NW	✓	✓	04	109^{249}	ok
	19 SE	✓	✓	04	110^{228}	ok
Tape #3	18 NW	✓	✓	03	80	OK 9:18 am →
	17 SE	✓	✓	06	78	ok
	16 NW	✓	✓	06	86	ok
	15 SE	✓	✓	05	77	OK 9:28 →
	14 NW	✓	✓	05	80	ok
	13 SE	✓	✓	02	57	ok
	12 NW	✓	✓	06	80	ok E.O.L @ 9:40 am

P.3
HPR
8/24/88

Los Azufres - Low Altitude

Tape No.	Flight Line No.	Line No. on Audio	Compile	Analog Fiducial No Begin	End	COMMENTS
Flight #3	9 May	1988 8:30am –	10:53 am			
Tape #3	36 SE	repeat	✓	01	197	ok; 8:30am →
	37 NW	✓	✓	04	159	ok;
	38 SE	✓	✓	02	217	OK; 8:45am @ fid# 65
	39 NW	✓	✓	04	170	ok
	Turning: Inverter Problem: Blew fuse in mag: Set Down					
	T-1 SW	T-1 SW	No	03-40;	02-22	Turning; Blew fuse in mag.
	Test Mag on Ground					
	T-1 SW	T-1 SW	✓	01	140	ok 10:19 am → 10:22 am
	T-2 NE	✓	✓	07	150.	ok
	T-3 SW	✓	✓	04	200.	ok
	T-4 NE	✓	✓	03	180	ok
	T-5 SW	✓	✓	06	191	ok poor analoge: 10:50 am. low power
	Turning - power/inverter problems - turbalance - quit.					

HPR
9/14/88

Los Azufres
Low Altitude Survey Digital Data

Tape #1

Lines 34NW, 35 SE, 38, 39, 42: Retain File:
We will not compile these data
in Phase I.

Lines 40NW - 55SE : good data!

Tape #2.	data end at	
Line 56SE:	138	
57NW	160	
58SE	148	
35 SE	Data missing from 99-332	
34 NW		Mag values are incorrect after #148: any ideas?? should go to # 350.
33 SE		Mag values are incorrect after #147; should go to ~#340
32 NW		Mag values are Incorrect after #147;
31 SE	Data missing from #158-320	
Lines 30-19		Good Data!

Tape #3.		
Lines 18-13		Good Data
Line 12 NW		Bad Fid No.'s from 189 →; delete
37, 38, 39		Good Data
T-1SW		Data gap #120-#124
T-2NE		O.K.,
T-3SW		Data gap #111-117; Bad #'s, 143-145
T-4NE, T-5SW		Good data

HR

LOS AZUFRES - LOW ALTITUDE MAGNETIC SURVEY
LAMA HELICOPTER MAY 1988

DATE	FLIGHT	LINE No	TAPE No	COMMENTS
5 May 88-Th	1	34	TU-1	Strayed off line
		35	"	" " "
	MD-1	38	"	" " "
		39	"	" " "
6 May 88-F	2	40 NW		Good data - much stepping
		41 SE		" " " "
		42 NW		
		43 SE		
	MD-2	44 NW		
		45 SE		
		46 NW		
		47 SE		
		48 NW		
		49 SE		
		50 NW		
		51 SE		
		52 NW		
		53 SE		
		54 NW		
		55 SE		
		56 NW		
		57 SE		
		58 NW		
6 May 88-F	3	35 SE	TU-2	Good data
	MD-3	34 NW		" "
		33 SE		
		32 NW		
7 May 88-S	4	31 SE		Good data
		30 NW		" "
		29 SE	TU-2	
	MD-4	28 NW		
		27 SE		
		26 NW		

	DATE	FLIGHT No	LINE No.	TAPE No.	COMMENTS
	7 MAY 88	4	25 SE	TU-3	Good data
			24 NW	2	" "
			23 SE		
			22 NW		
			21 SE		
			20 NW		
			19 SE		
			18 NW	Tape 3	
			17 SE		
			16 NW		
			15 SE		
			14 NW		
			13 SE		
			12 NW		
	9 MAY 88	5	36 SE		Repeat line
			37 NW		" "
	MD-5		38 SE		" "
			39 NW		" "
			T-1		Turbulance; low power
			T-2		Records only fair quality
			T-3		Inverter Problem - noisy da
			T-4		" " "
			T-5		" " "
As Planned	16 MAY 88	6	11	TU-4	As Planned
			10		
			9		
	MD-6		8		
			7		Not Flown Helicopter Down
			6		
			T-1		
			T-3		
			T-5		
V			59		
			65		

DATA STATUS AS OF 16 MAY 88

Item	Location of Original	Location of Copies	Status
TV-1	UURI	CFE	completed
TV-2	"	"	"
TV-3	"	"	"
TV-4	none	none	"
TV-5	UURI	CFE	"
TV-6	"	"	"
TV-7	"	"	"
TV-8	"	"	"
TV-9	"	"	"
TV-10	CFE	—	Being copied
TV-11	none	none	
MD-1	CFE		Being copied
MD-2	"		"
MD-3	"		"
MD-4	"		"
MD-5	"		"
MD-6	"		"
MD-7	"		"
MD-8	"		"
MD-9	"		"
MD-10	"		"
MAP-1	—	—	Being made by CFE
MAP-2	UURI	CFE	—
MAP-3	CFE	—	Should be sent to UURI
MAP-4	CFE	—	" " " " "
MAP-5	CFE	—	" " " " "
REC-1	CFE	—	" " " " "

H. Ross

LOS AZUFRES - HIGH ALTITUDE MAGNETIC SURVEY

CHEROKEE 206 MAY 1988

DATE	FLIGHT	LINE No.	TAPE No.	COMMENTS	
11 MAY 88-W	1	17S 25N	TV-5	Lines trend NNE-SSW	
		24AS		"	Tape
	MD-7	23N		"	1
		22S		"	
		21AS		"	Tape
		20N		"	2
		19S		"	
		18N		"	
13 MAY 88-F	2	25S		Good data	
		26N		"	
		27S		"	
	MD-8	28N		"	Tape 3
		29S		"	
		30N		"	
		31N		"	
		T-1 W		"	
		T-2 E		lost pwr @ end of line	
14 MAY 88-S	3	16S		Noise level ±2γ, but o.k.	
		15N		Good data	
	MD-9	14S		"	Tape 4
		13N	TV-8	"	
		12S		"	
		11N		"	
		9S		"	
		8N	TV-9	"	Tape 5
		7S		20% of line - lost power	

DATE	FLIGHT#	LINE No.	TAPE No.	COMMENTS	
15 MAY	4	T-3E	TV-9	Good data	
		25B S		"	Tape
	MD-10	7AN		"	5
		6S		"	
		5N		"	
		4S	TV-10	"	
		3N		"	Tape
		2S		"	6
		1N		"	

MEMORANDUM

TO: Ing. Antonio Razo M.
Jefe, Del Depto. De Exploracion
Gernecia De Proyectos Geotermoelectricos, CFE

FROM: Howard P. Ross
Earth Science Lab/UURI

SUBJECT: Aeromagnetic Survey Data Items

Transmitted herewith are the digital aeromagnetic data from the Los Azufres high altitude and low altitude aeromagnetic surveys. We have delayed in shipping these items until now so that I could identify the line numbers for the data that Douglas Ramsey has blocked out, and so that I could perform a comparison of analog records and the digital data.

Due to occassional noise encountered during the survey there are some gaps in the time record (seconds) and corresponding digital magnetic data values. These have been identified in the data printout. The data can be recovered from the analog records in most cases.

Identification of magnetic maxima and minima values along a flight line, and comparison of the analog fiducial numbers (1 fiducial/2 seconds) indicates a shift effect of a few seconds for the digital values with respect to the analog record. The relationship between the magnetic data samples should be:

Digital sample no. = 2 x analog no. (seconds),

or, $D = 2 \times A$.

Instead of this the relationship varies from

$D = 2 \times A + 0$, to $D = 2 \times A - 4$.

Approximately 75 % of the time the comparison is

$D = 2 \times A - 3$,

which seems to apply for the entire line unless there are gaps in the digital data.

Since the flight path recovery is based on the analog fiducial number the digital data must be adjusted to correspond to this position. Most commonly the adjustment of the digital sample number to the analog position number is

$$A = (D + 3)/2.$$

We have completed our low altitude flight path recovery, gaining many more points with the better quality 1:10,000 scale photo mosaic. We must rely on CFE for the positions of bordering areas where we only have topographic coverage. A copy of our present Low Altitude Flight Path map is enclosed.

We have revised our flight path recovery for the high altitude survey using the preliminary (unnumbered) flight paths which CFE personnel had completed using photographs. With this assistance we have recovered many more specific points have have identified the line numbers. A copy of this map is also enclosed.

UURI is looking forward to the meeting in Mexicali where we can discuss the flight path and aeromagnetic maps in detail. We are beginning to post the low altitude magnetic data. We will then contour the map in a preliminary manner and determine additional leveling corrections.

10/24/88
H.P. Ross

AEROMAG. COMPILATION

Map Types

I. Low Altitude
  A. Base Map Grid (Pencil Mylar)
    1. Flight Line Map (Sepia Mylar)
      a. Interpolated mag stations (Sepia Mylar)
        i. Mag data values - contoured I (Black Line)
        ii. Mag data values - contoured II (Black Line

9/28/88

Tie Line Evaluation - Low Altitude

Tie Line 1·SE

	(w. diurnal)					Comments							
Trav /Fid	1 Alt. Mag	2 Mag Alt	3 Tie 1-Fid	4 Line-T1 (γ)	5 Corr	6	7	8	9	10	11	12	13
15 SE - 21½ 1	377 - 716	647 - 539	101½	+ 69 ΔA									
16 NW - 60½ 2	173 - 760	674 - 151	97½	- 86 ✓									
17 SE - 24 3	153 - 716	676 - 150	95	+ 40 ✓									
18 NW - 70½ 4	232 - 664	674 - 110	90	- 10 ✓									
19 SE - 45 5	113 - 657	670 - 116	91	- 13 ✓									
20 NW - 88 6	920 - 702	713 - 115	83½	- 11 ΔA									
21 SE - 25½ 7	118 - 705	717 - 177	80½	- 12 ✓									
22 NW - 111½ 8	136 - 754	770 - 339	75	-16 ΔA									
23 SE - 33½ 9	156 - 741	774 - 645	72	-33 ΔA									
24 NW - 128½ 10	123 - 790	710 - 539	69½	-80 ΔA									
25 SE - 35½ 11	253 - 641	695 - 521	68	-54 ΔA									
26 NW - 120½ 12	196 - 736	884 - 384	64	-148 ΔA									
27 SE - 52 13	135 - 840	~900 - ~300	62	~ -60 ΔA									
28 NW - 148½ 14	107 - 908	766 - 480	57	+142 ΔA									
29 SE - 54½ 15	360 - 831	791 - 365	58	+40 ✓									
30 NW - 130½ 16	209 - 733	746 - 124	48½	-13 ✓									
31 SE - 43½ 17	164 - 734	748 - 395	52½	-14 ΔA									
32 NW - 122½ 18	557 - 684	608 - 330	42½	+76 ΔA									
33 SE - 60½ 19	297 - 651	636 - 450	40	+ 15 ✓									
34 NW - 116½ 20	434 - 666	727 - 446	34	-61 ✓									
35 SE 41½ 21	400 - 686	712 - 142	31	-26 ΔA									
36 SE 67 22	90 - 655	621 - 101	27	+34 ✓									
37 NW - 111 23	142 - 654	583 - 165	26	+71 ✓									
38 SE - 83 24	780 - 557	545 - 424	017	+12 ΔA									
39 NW - 118 25	950 - 605	594 - 321	019	+ 11 ΔA									
40 NW - 127½ 26	408 - 591	455 - 350	013	+136 ✓									
41 SE - 59½ 27	395 - 462	442 - 309	010	+20 ✓									
42 NW - 131 28	321 - 453	432 - 126	007 ?	+21 ΔA									
43 SE - 44 29	182 - 432	465 - 132	003 ?	-33 ✓									
44 NW - 78 30	823 - 408	399 - 195	001 ?	+07 ΔA									
45 SE - 40½ 31	320 - 385	389? - 203	(-003) ?	-04 ✓									

TOPS FORM 3622

Holidays Sept. 30 ?

2 May

LOS AZUFRES

May 1988

CFE, Morelia

Helicopter is in Guadalahara Mon.

Will try to begin flying Wed if equipment is here

Detailed

~~10~~ 12 Km NS × 14 EW @ 5/km

separation @ 200 m.

10 Km NS × 12 E @ 5/Km

600 line km. @ 60 Km/hr = 10 hrs.

+turns = 5 hrs.

60 Km/hr. ≃ 40 miles/hr.

40 hrs of VHS cassetts

30 min
2 hr.
30 min

3 hr

+ 30 min
+ 1 hr.
+ 30 min

2 hr

5 hr

L A – Morelia 30 – 90 min;

3 hrs/fuel up; 2 trips, 2hrs on line

* 30+ diurnal; station recording @ Los Azufres.

5 days detailed survey

1st line @ 200 m

Wednesday ½ setup; ½ prod

Thursday 1 prod.

Friday 1 prod.

2 ½ prod

Sat 1

<u>Regional Survey</u>: 3200 line-km:

90 × 40 = 1600 × 2 lines/km ≃ 3200 line-km

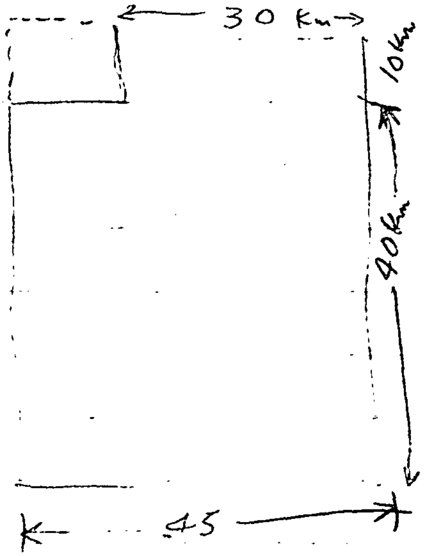
@ 150 km/hr = 22 hrs.

4 hrs/day @ 150 km/hr = 600 line km

× 6 days ⇒ 3600 line km

Revised Survey

40 × 45 km = 1800 sq km × 2 lines/km = 3600



50 × 45 km = 2250

2 line/km

4500 line-k

@ 500 m smoothly draped.
above terrain

Mon. 2 Mayo:

AEROMAG COMMUNICATIONS

NAVIG. TO OPERATOR

Norte
Sur
Este
Oeste

Approaching Survey Area - 5 min	Acercar Area	Cinco Min
Approaching Survey Area - 1 min	Acercar Area	Uno Min
Comming on line; Line _ _ SE	Venir A LINEA	
ON LINE: LINE __ SE (Fid=1)	A LINEA LINEA __	
A		
Approaching End of Line	Acercar Final de LINEA	
END OF LINE	FINAL DE LINEA	
(Turn & Line Up)		
Comming On Line; Line - -	VENIR A LINEA	
or		
Problem:	Problema!	
OFF LINE	No en linea!	
RECORDING OFF	NO REGISTRO!	
TURNING TO ~~R~~ RETURN TO LINE:	TURNO A	
READY	Preparado :	
RESUME RECORDING: LINE	Recomenzar REGISTRO!	
LAST LINE BEFORE FUEL UP:	linea ultima ante combusti	
RETURN FOR FUEL		
EMERGENCY - DROP BIRD		
REPEAT: EMERGENCY - DROP BIRD		
PULL IN BIRD		

110

Reconnaissance of Thermals, National, almost completed.

Statellite imagery, photogeology, age dating; 1,500 springs, fumerolas, wells, hot soils
Down to ~540± separate systems thermal zones;

Prioritization; Evaluation by states, establish priority

have visited most areas; tried geol. & geochemical evaluations

Have decided on 42 areas for prefeasibility studies.

Of 42, have received geol, geophy, geochem for 21

8 Detailed Cerro Prieto, Los Azufres, Los Humeras (to E)
Las Primavera (to W), San Marcos, Araro, Las Dorumbas
Tres (6) Virgins; (almost all in Neovolcanic belt.)

Los Azufres: 30 mw . San Maros only to 180°C, low permeability; (older system) epidote.

Cerro Prieto: 620 mW: Araro (1 blow out, 1 @ San Marcos 5 Km away)

Valley of Mexacali 40-50 wells @ 300-500 m; 1 @ 1000 m, T ≃ 1000 m.

Many areas have potential for binary: @ Tres Virgins, began drilling last yr, - big area. Chemical geothermometers indicate T ≥ 280°C; drilling showed 175°C in basement. Will search 5 Km to N, but permeability is unknown. Try to drill fractures, depths to 2000 m.

Llama:
500 Kg w/o Pilot ≐ 2.2 1100#

2000-2200#

TV	25
Magnetometer	60
Bird & Cable	40
Batteries @ 30	60
Radar Altimeter	15
VCR	10
static Invertor	15
Filter	5 -
Cables, misc	20
	250# ≃ 100 Kg.

Ross	195
Wright	160
Lira	120
Equip	250
	725#

Generally hard to find production at shallow depths, ie less than 1500 m. So wells are programed below 2000 2500 m. More convenient to drill deeper ie.

What is the principal structural system connecting heat source to surface.

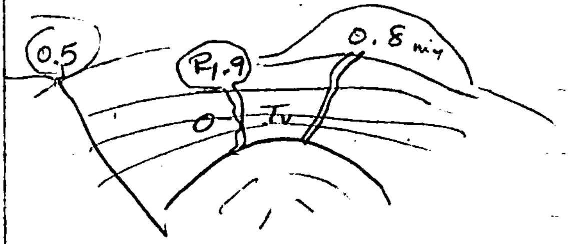
Los Azufres may have begun 300,000 - 800,000 yrs ago.

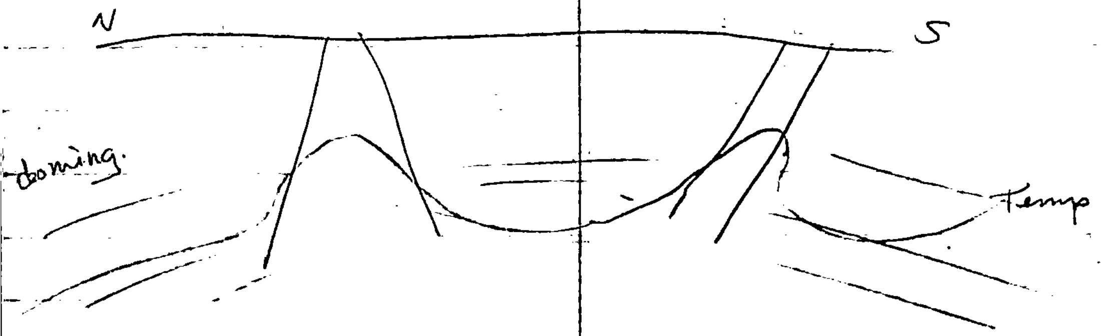
Rhyolites are 1.9 my old,

Rhyolite dome alteration 1.1 my

Andesite not alt @ 0.8 my

Age - 1.1 - 0.8 my





EXTRA SUPPLIES - IN FLIGHT

Carry on bag: 2 rolls paper
1 extra paper roll
drafting tape for roll
2 extra VHS cassetts
2 felt tip pens
electrical tape

notebook pad
pencil case
sunglasses
soda (?)
gloves
yellow highlight for E.O.L.

SUPPLIES

VHS = 2 hrs. cont. recording

Chart Paper = 10 in × 82 ft = 984"

@ 2"/min = 492 min = 8.2 hrs.
= 3-4 flights.

13 rolls × 3.5 = 45.5 flights.

Estoy listo - I'm ready

No tenemos tiempo - We don't have time

MAG TUNING

① Batteries → ON ② Mode → STANDBY
③ ON-OFF → ON
④ Tuning, Coarse → 43,000
⑤ Meterswitch → POL
⑤ Mode switch → NORM
⑦ Depress GATE-START lamp → in green
⑧ Observe peak position, meter needle
⑨ Meter switch → SIG
⑩ Wait 2 polarize cycles; note posit.
⑪ Adjust TUNING, FINE to max meter rd.
⑫ Slowly adjust POL-PHASE "
(allow 2 polarize cycles each change)
⑬ Resett PHASE LOCK light.

Sys. Power on.

Approach area: Printer on. (warm up)

Time — Magnetometer on.

Power all/switches on
Check Altimeter/Mag switch
Update line No. CG
VCR ON - check video
RECORD - MONITOR

Enter line no [Audio
video - Insert

Reset FID A y FID B = 1

Write Line No on chart

Fid count Audio & Chart
" " (@ 10-20)
" "
" "

Check (delete) title (CG)
Fid count
" "
" "

Insert Title (CG)
Fid count
" "

check Title (CG)
Fid Count
" "

Insert Title
END OF LINE# [AUDIO

Time: Record Fid, CHART
Felt Tip pen line CHART

MAG OFF (?)

New line No. in CG.

Enter line No. [Audio
CG

MAG OFF
RESET FID A Y FID B

Write line ON CHART
Fid Count Audio & CHART

etc.

~~Power Consum~~ption

LE

Power Requirements

	volts		amps		
Magnetometer	22-32v	@	10A max	= 10	
Altimeter T-R unit	11-35v	@	1.0A - 0.5A ≅	1	16 watts pk
Thermal Printer				~1 ?	
Hitachi TV	120v	@	~1.0 →	1*	@120 19 watts
VCR	12v		~1.0	1.	10 watts
Camera Drive Unit	120v	@		1	14 watts
Inverter loss					

17-20 amph/hr.

CFE Staff:

Antonio Razo - Dir Geol, Geophys
Oscar Campos - Geophys
Hector Lira (M) - Geol., Remote Sensing, Nav.
— Huitrón - Chief Geol, Los Azufres
Francisco Araellno - Geophys.
Jamie Ortiz (Stanford) - Chief Resor. Engr
Ramón Reyes - Staff Coordinator
Rafael Molinar - Res. Engr (Stan)
- Hector Alonzo - Chefe, Geothermal, CFE
~ Garcia - Chief Assist. to ↑
Euardo Hernandes Vasquez Pilot
Horencia = General Office

High Altitude Survey

1600 line km + fill in lines.
400
2000. 180 km/hr

~ 3 days.

110 m/hr
5280 ft/mi.

Recovery 58 lake on SE end

ft/sec × sec/hr = ft/hr.
5280'/mi × 100 mi/hr ×

[illegible] farm

180 km/hr

8 lines

8 lines @ 50 km

✓ L20N — L20N
✓ L19S D19S
✓ L18~~S~~/N — L18N
EOF

NS @ 1km; 500m for Sw
EW @ 1km across Reservoir area

3 hr. + 3 hr. = 6 hr/day

Flight 1 Thurs 5 May ~10 am - 12 noon

Flight 2 Fri 6 May 9am - 10:5

Flight 3 Fri 6 May 12:00 - 12:3

Flight 4 Sat 7 May 8:18 - 9:40

H.A. Flt. 1 Wed May 11 8:00 - 12
8:00am
Line Sequence: 18S → 12S /
500' Could ~~not clip~~
L10N → L10 ?

✓ L17S → L24N Goo

[illegible]
~~L25N →~~

✓ L24AS → L24A S

✓ 23 ~~L33N →~~ 23 ~~L33N →~~

✓ L22S → L22S

10:26 L _ N → Strayed off line

✓ L21A,S → 21AS

— L-N -3-10l- Aborted -

Expenses

5/1/88: Res/Wright/Airport (R/T)
Sun SLC / Mex. DF
Restr. @ Airport 0.-
$60 @ 2260/$ = peso =
Hotel Baggage tip

5/2 Mon Breakfast @ 10,000.-
Dinner @ 20,000
Hotel

5/3 Tues Breakfast @ 5,000
Dinner @ 20,000
Baggage tip 10,000 (HR + PM)
Shippers tip 4,500
Hotel

5/4 Wed Baggage tip 5000
Dinner 12,000
Hotel

5/5 Thurs. Food shopping 10,000
Luggage tip 2000
Dinner 10,000
Hotel

5/6 Fri. Dinner 16,000
Hotel

5/7 Sat. Candies $6,000
Dinner 22,000
Hotel

5/8 Sun.

/9 Mon

/10 Tues

/11 Wed

/12 Thurs

/13 Fri

/14 Sat

/15 Sun

/16 M

/17 Tu

Expenses

Sat - 14 May
Beer lunch - $0,00 Lyra
Groceries - 3,000

Sun - 15 May
Lunch w. Campos $0.00
Sopa & drinks $10,000

~~Mon - 16 May - no data~~
Lunch @ Morelia pmw
Israel - Mor → Mex $20.- pmw
Car ~~Taxi~~ → Publ Arait: pmw
Tip - baggage ~~→ inside~~ $4000.-
Tip - baggage out 2000.-
Taxi - taken —— $10,000.-
Dinner — 40,000 -
Hotel drinks 8,000 -

HOTEL • POSADA • D •
LA • SOLEDAD •

Tues 17 May Limo tip 5000.
Baggage Inn - 2,000
Baggage Apt. 2,000
Apt. Dept. Fee. - $10.00 ; Cambio - 2.00

12,000 ✓

20,000 ✓

20,000 ✓

0,000

256000
$103.54

25,000 Th ✓
3,000 Fri pmw dinner ✓
3,000 Sat ✓
14,000 Sun
40,000 Mx City Mon
0 — Tues

16 days @ $10/day
160.

Hotel Posada d La Soledad

Hostal de los Camelinas 34,08
Hotel Morelia Mision 109,00
Hotel (old town) 55,9

LOS AZUFRES
SURVEY PRODUCTION RECORD

Date	Comments
5/4 - Wed	Install in Llama; Test flight: no CDU off; rain over Los Azufres
5/5 - Thurs.	FLIGHT #1 : L34, 35, 38, 39 w. altim. Flying @ S45°E mag all lines strayed off (Low Batteries)
5/6 - Fri,	FLIGHT #2 : L40 NW - L58 NW much stepping good data
5/6 - Fri,	FLIGHT #3 : L35 SE - L32 NW good data
5/7 - Sat.	FLIGHT #4 : L31 SE - 12 NW 1000γ scale reads 46γ too high. (8:06am) (9:40am) Good data pilot quit early - wind by 10:30??? fuel? See Lines 31, 30 to Compare 1000γ and 100γ scale differen
5/9 - Mon	FLIGHT #5 : L-36R SE - 39R NW (Repeats (8:30 am) [Blew 2 fuses - Inverter Trouble] Noisy Data on L-T-1 to T-5 Noisy data (Inverter) + Turbulance Bad Paper Records (Usable, but not great)
5/10 Tues.	Helicopter down: Install in Cherokee 206; Test Flight
5/11 Wed.	Visibility USR 4 miles, less than 5 min High Alt, Flight #1 : L17S; L24AS; L23N; L22S; L21AS; L20N; L19S; L18N. 8 lines @ 50 = 40 1.L
5/12 Thurs.	Ready for takeoff @ 7:15am : Visibility @ 2mi & dropping thru 1 pm - It windoby 9:30 am - quit then. Breakfast.
5/13 Friday	Off @ 7:45 - L25S; L26N; L27S; L28N; L29S; L30 L31N; LT-1 W; LT-2E out of batteries.
14 Sat	Off @ 8:15

L-

14 May Sat Flight #3 High Alt.

Recorder L-7 out of batteries @ 20% of line
L-8N
L-9S
L-11N
L-12S'
L-13N
L-14S
L-15N

L-16S noise level ±2 r but o.k.

TV-1,2,3,
Low Alt

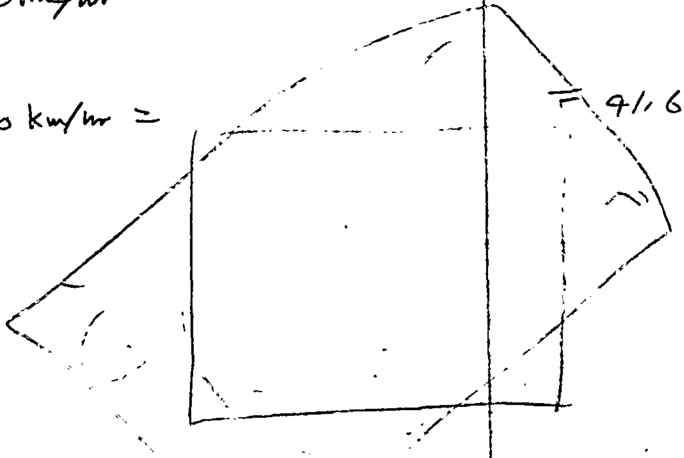
TV-10 L 4,3,2,1 High Alt
TV-9 8, T-3, 25B, 7,6,5,

1 Km = 1000 m

100 Km/hr = 1000 m/Km × 100 Km × $\frac{1}{3600\ \text{sec/hr}}$ = 27.78 m/sec = 91.13 ft/sec

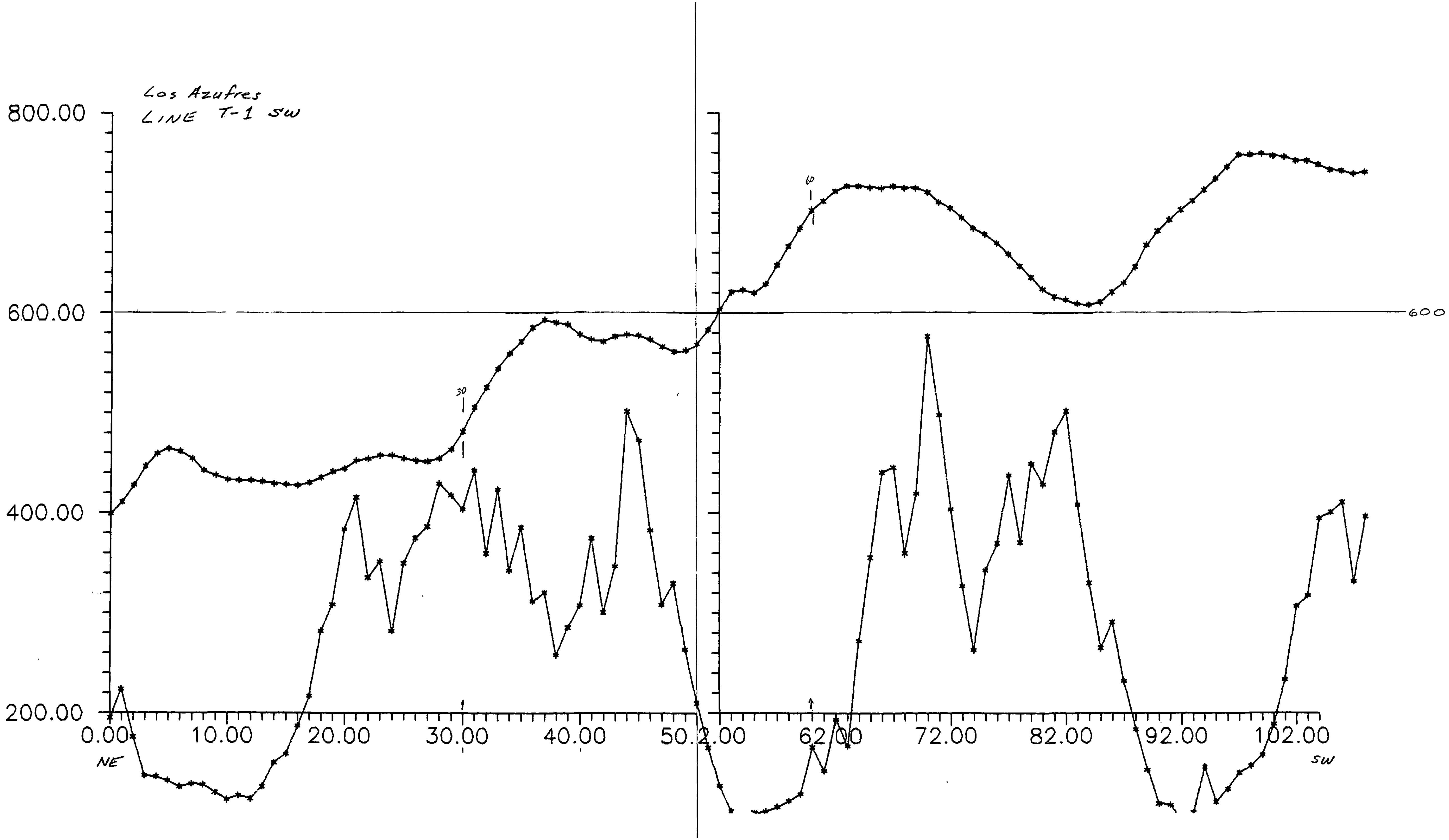
120 Km/hr = = 33.33 m/sec = 109.36 ft/sec

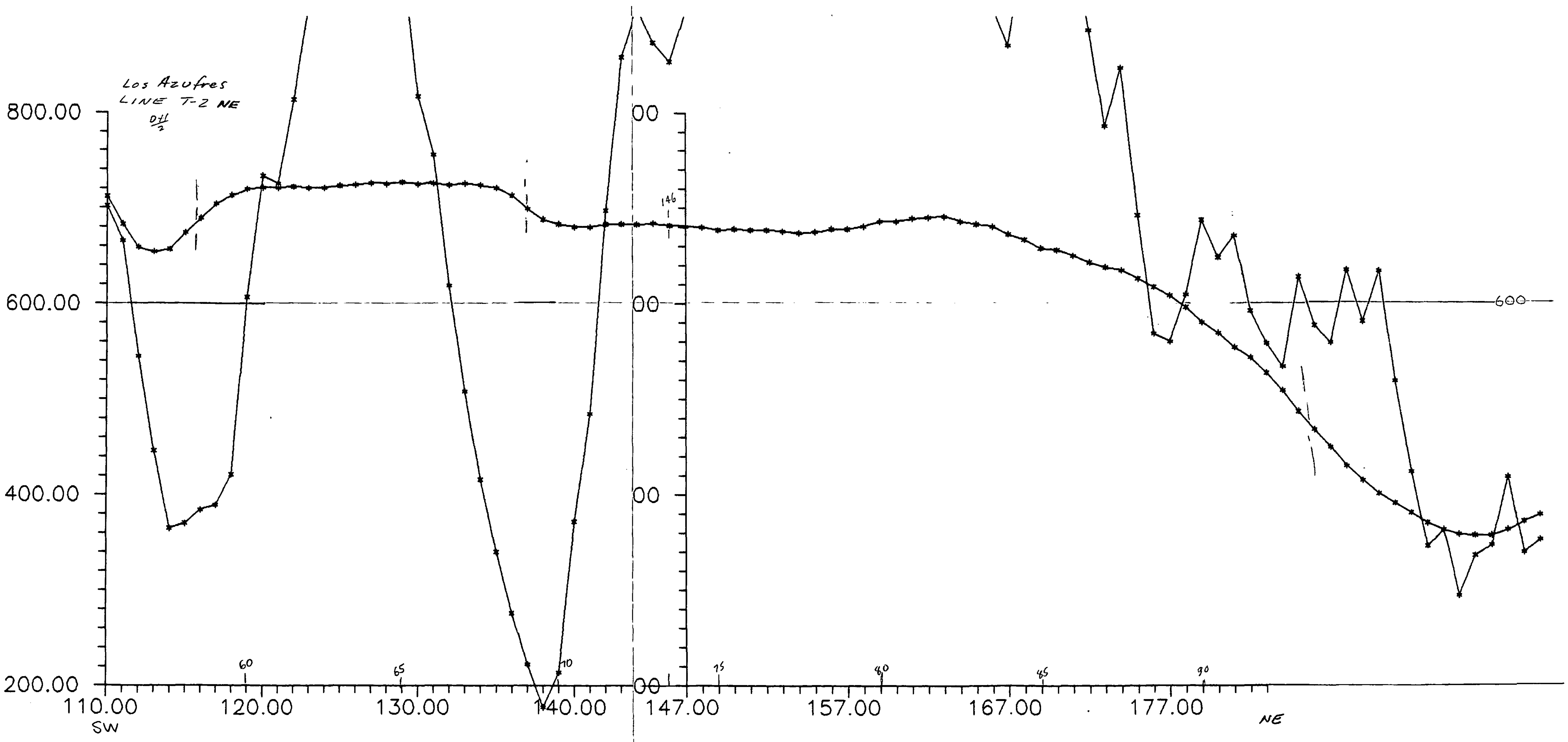
150 km/hr = = 41.67 m/sec 136.70 ft/sec



200 Km/hr = 124.28 mph = 113 knots 55.56 m/ = 182.27

Los Azufres
LINE T-1 SW




Los Azufres
LINE T-2 NE
0tl/2
800.00
600.00
400.00
200.00
00
00
00
00
600
146
60
65
70
75
80
85
90
110.00
120.00
130.00
140.00
147.00
157.00
167.00
177.00
SW
NE

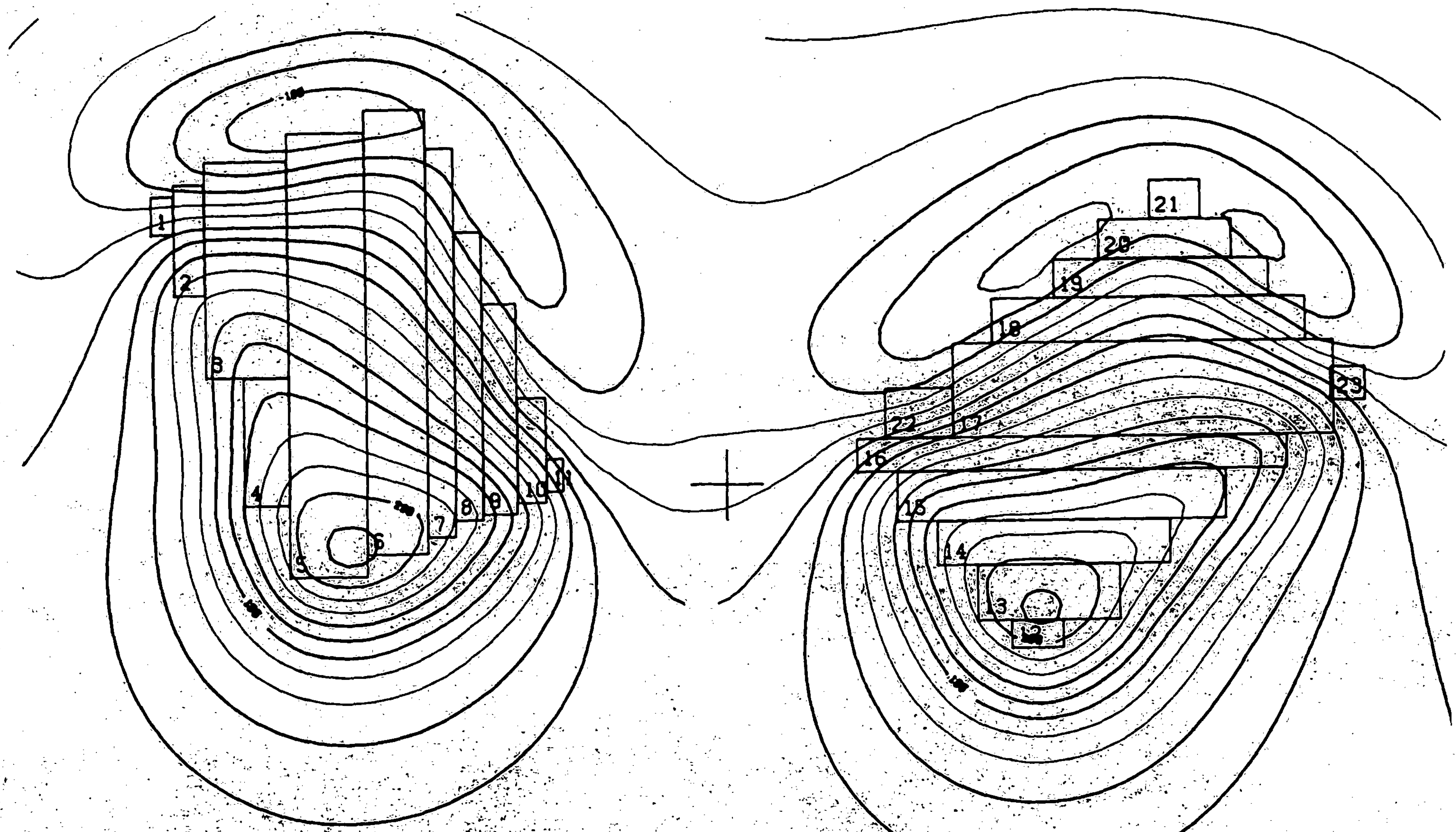
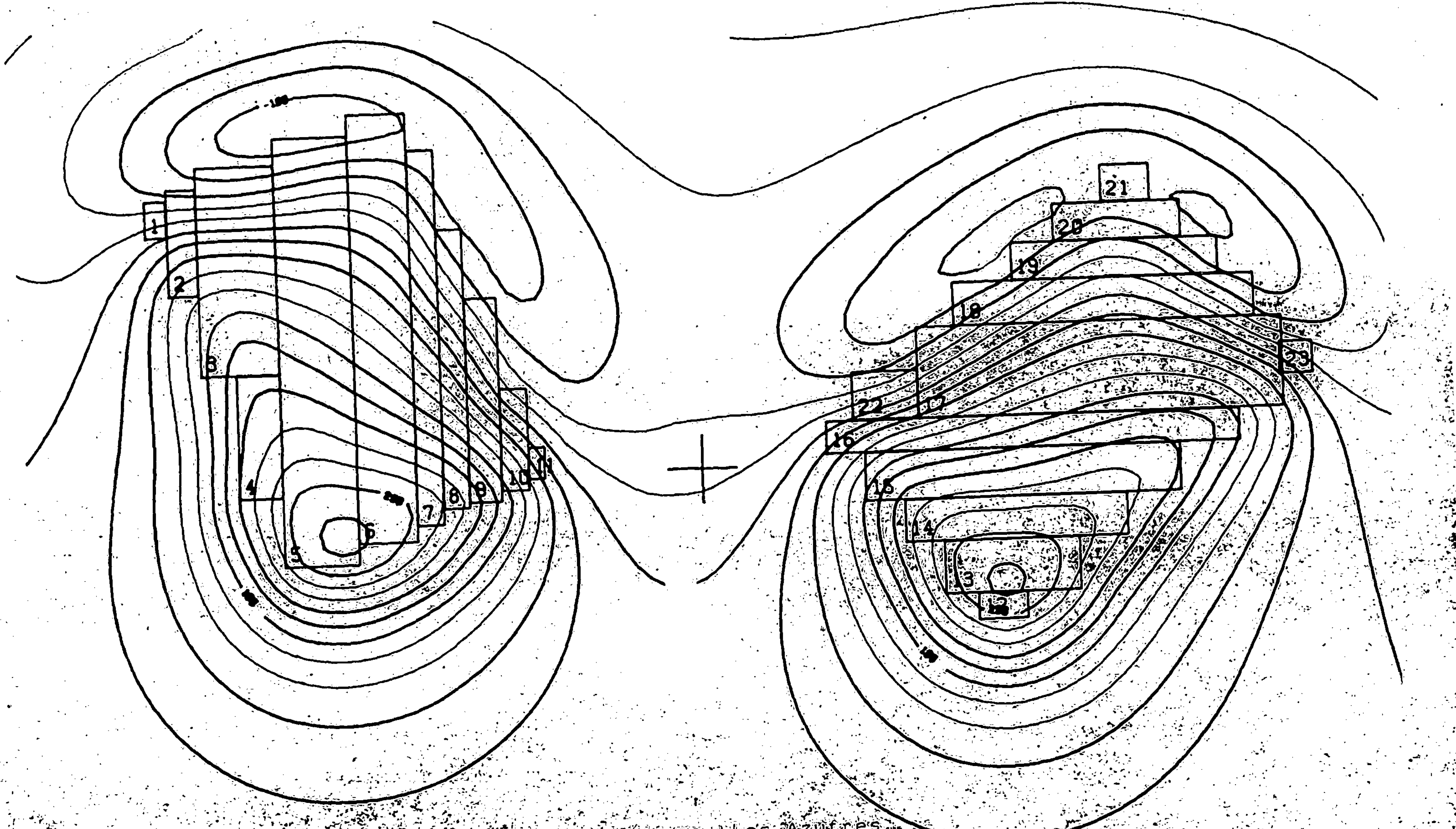


Figure 1. Characteristic magnetic-model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20 W and N50 E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9 E, inclination 48 , TF = 42,740 nT. Scale 1:20,000. Contour interval 20 nT.



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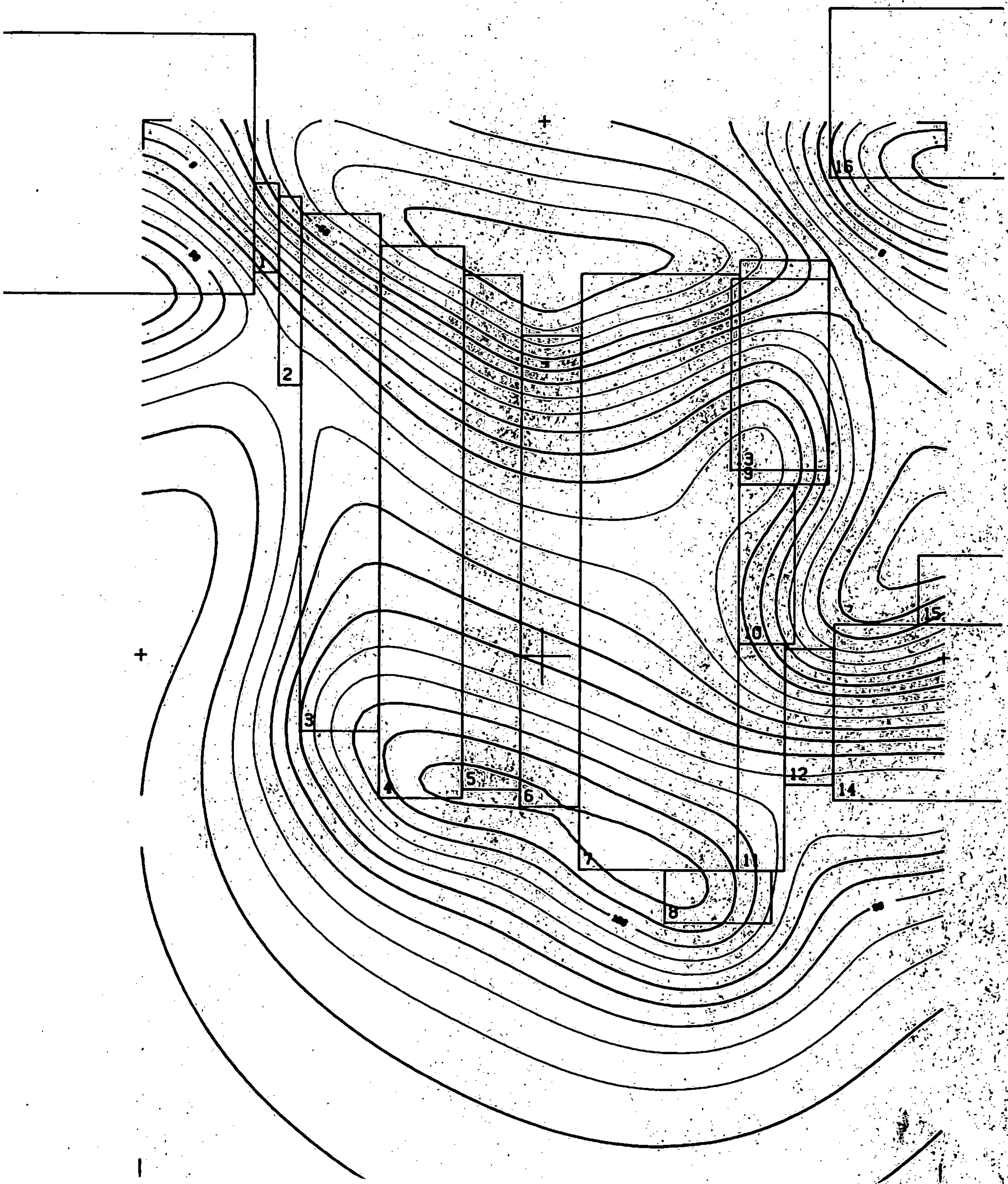
1
2
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6
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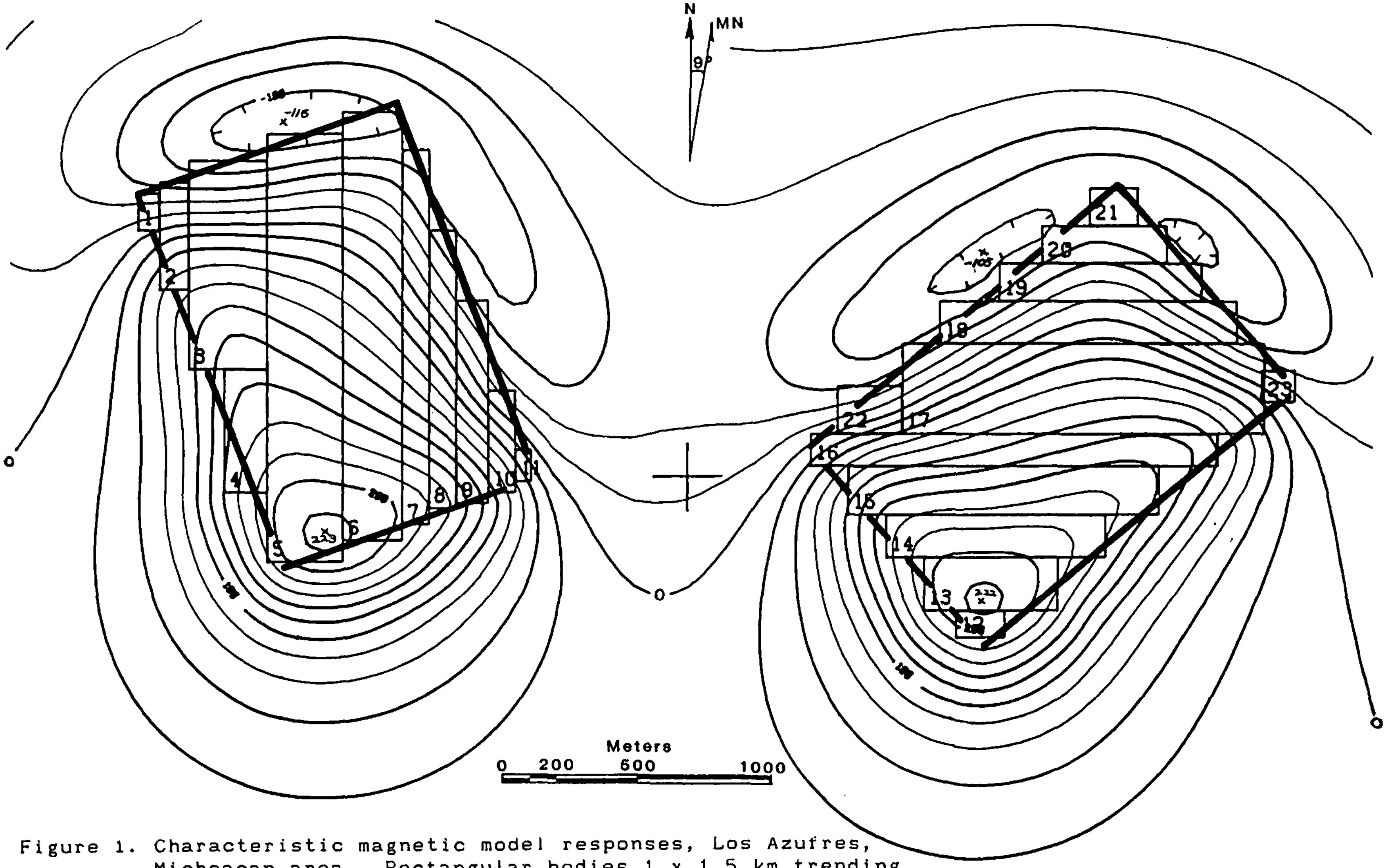
14
15
16



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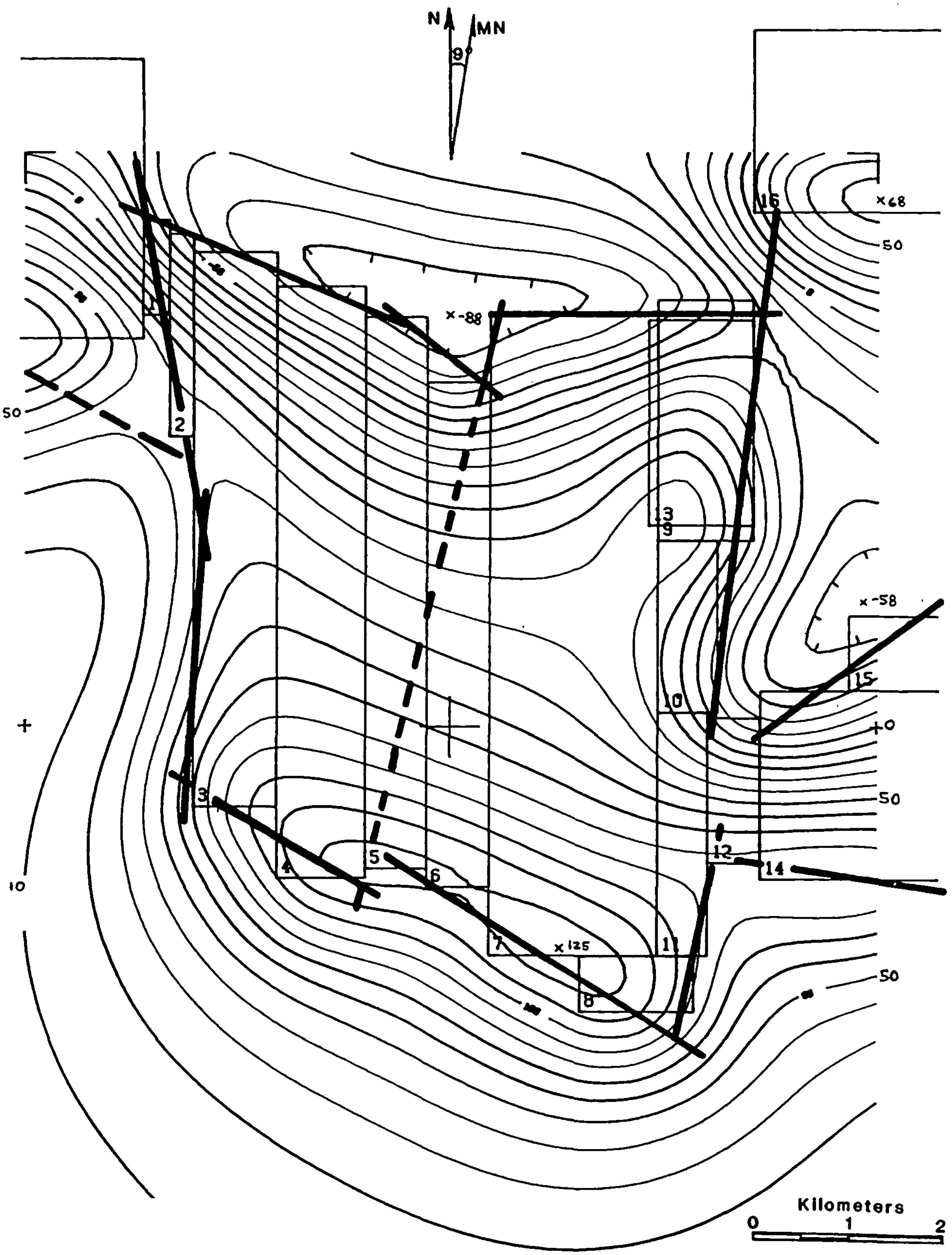
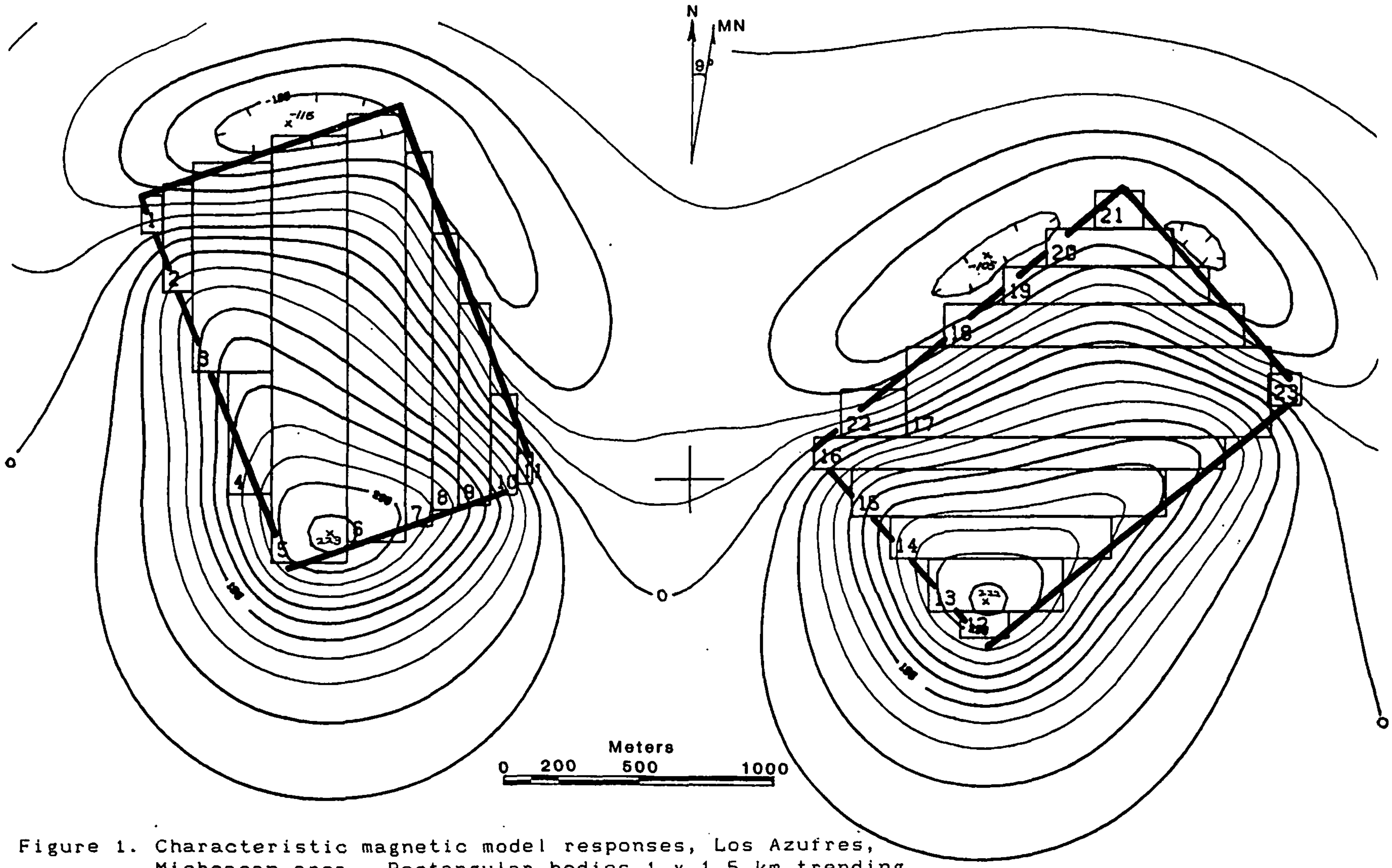


Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Contour interval 10 nT.



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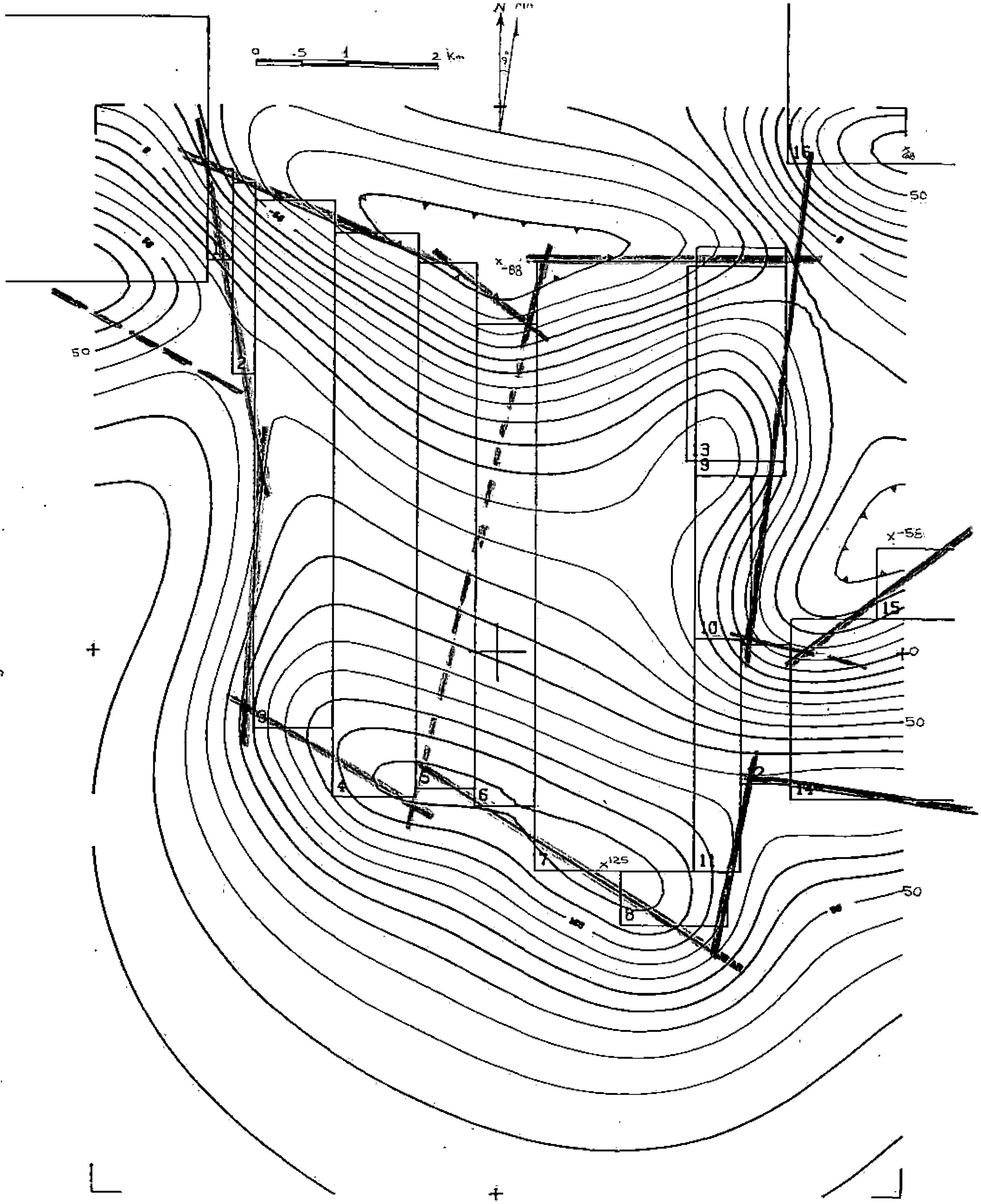
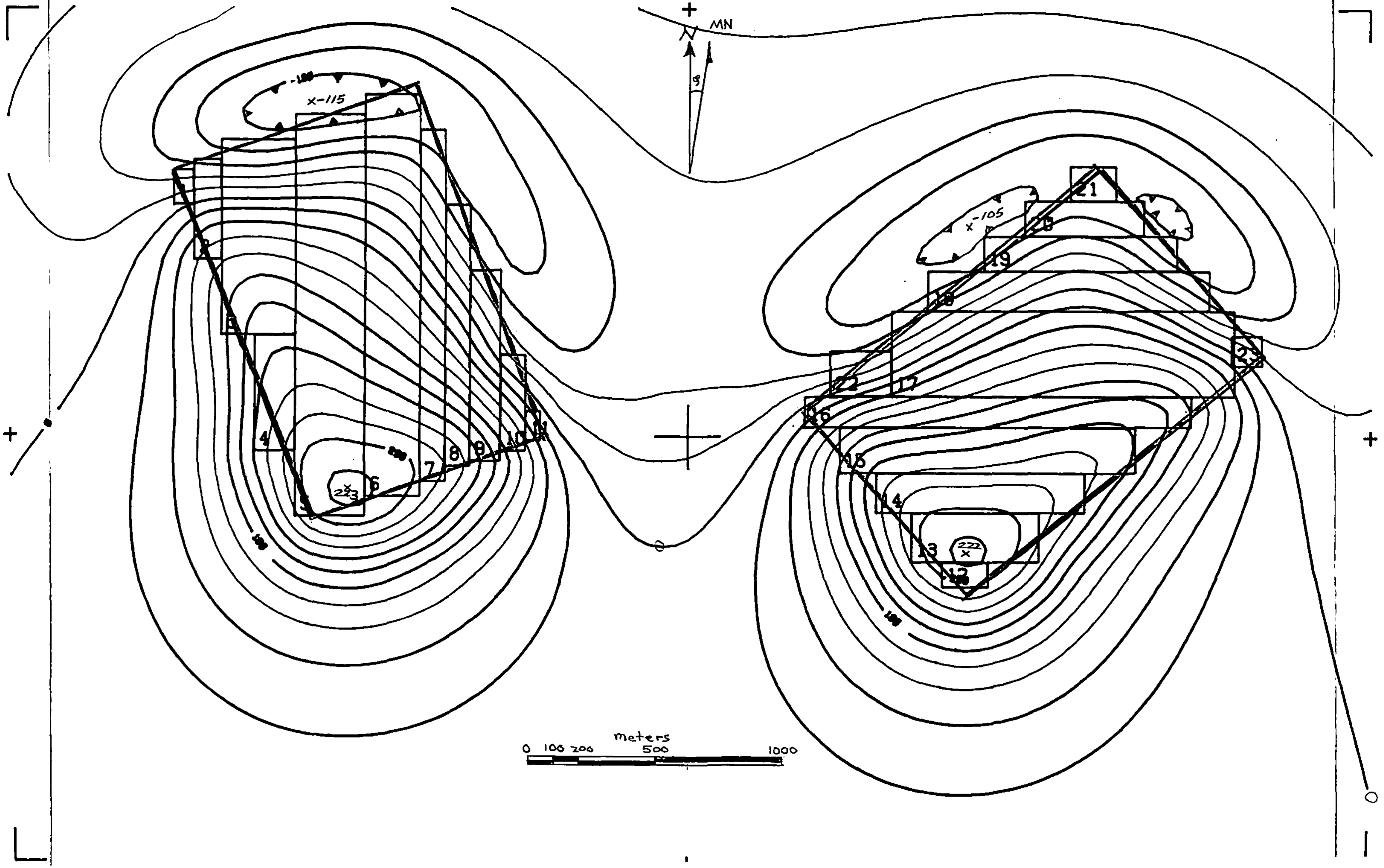

N
9°
0 .5 1 2 Km
x-68
x-58
x125
50
50
-50
50
0
1
2
3
4
5
6
7
8
9
9
10
11
12
13
14
15
16


MN
9
x-115
-100
x-105
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
200
100
223
222
0
meters
0 100 200 500 1000

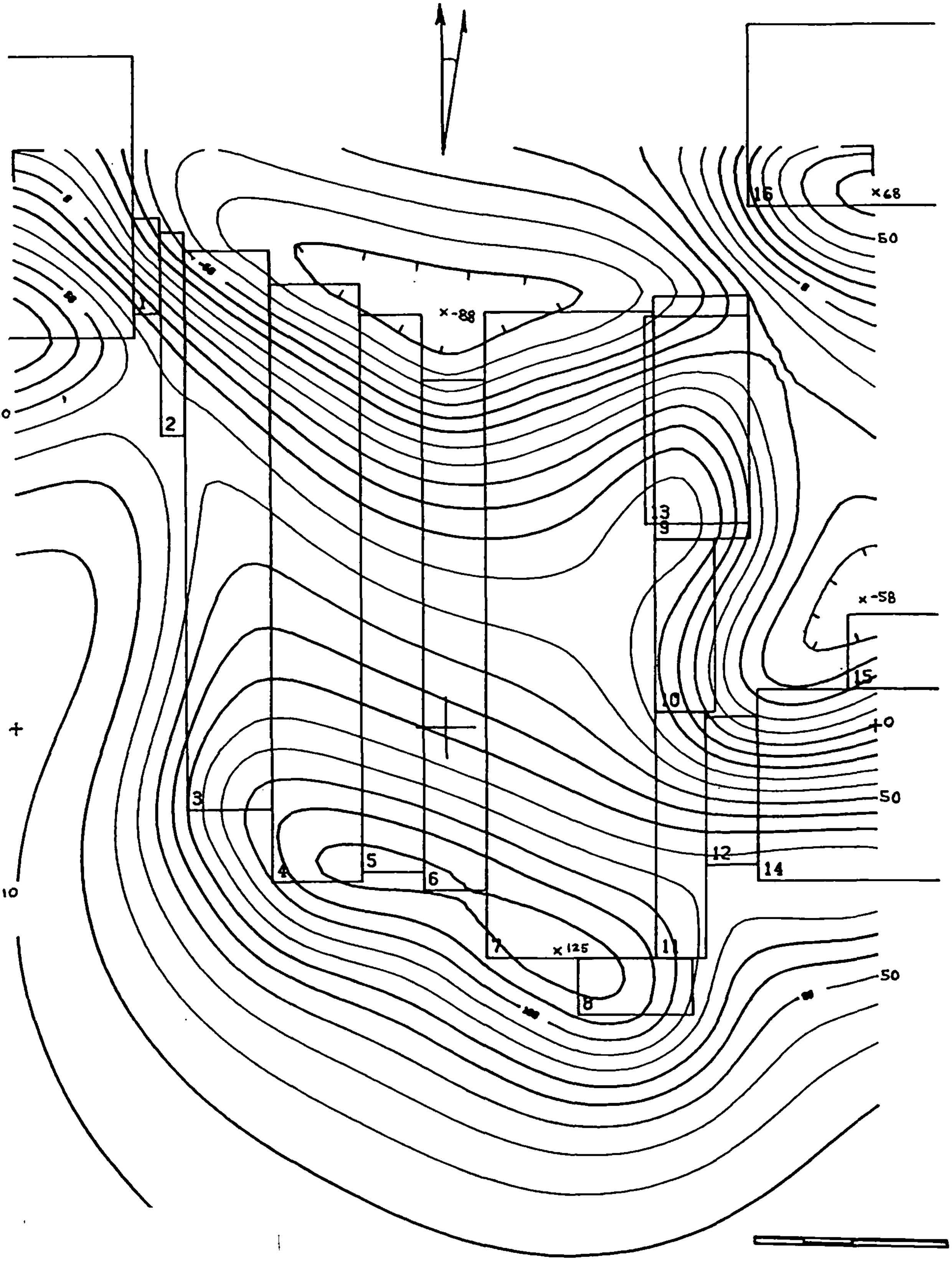


Figure 2. Preliminary magnetic model for Los Azufres geothermal area, from high altitude data. Major source body with susceptibility contrast 0.001 cgs, outcropping, with thickness of 2300 m. Body borders are probably defined by regional structures. Scale 1:60,000. Contour interval 10 nT.

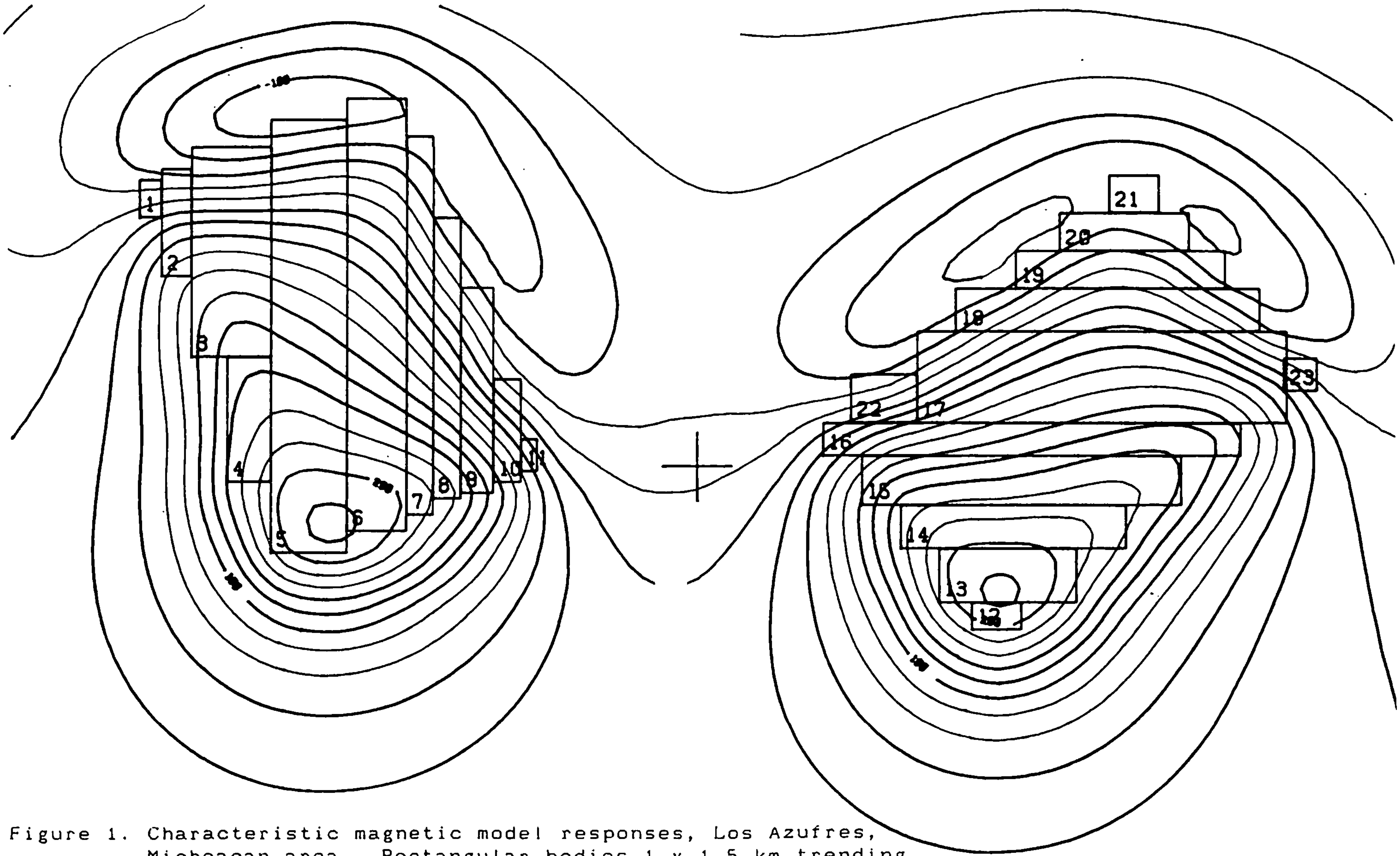
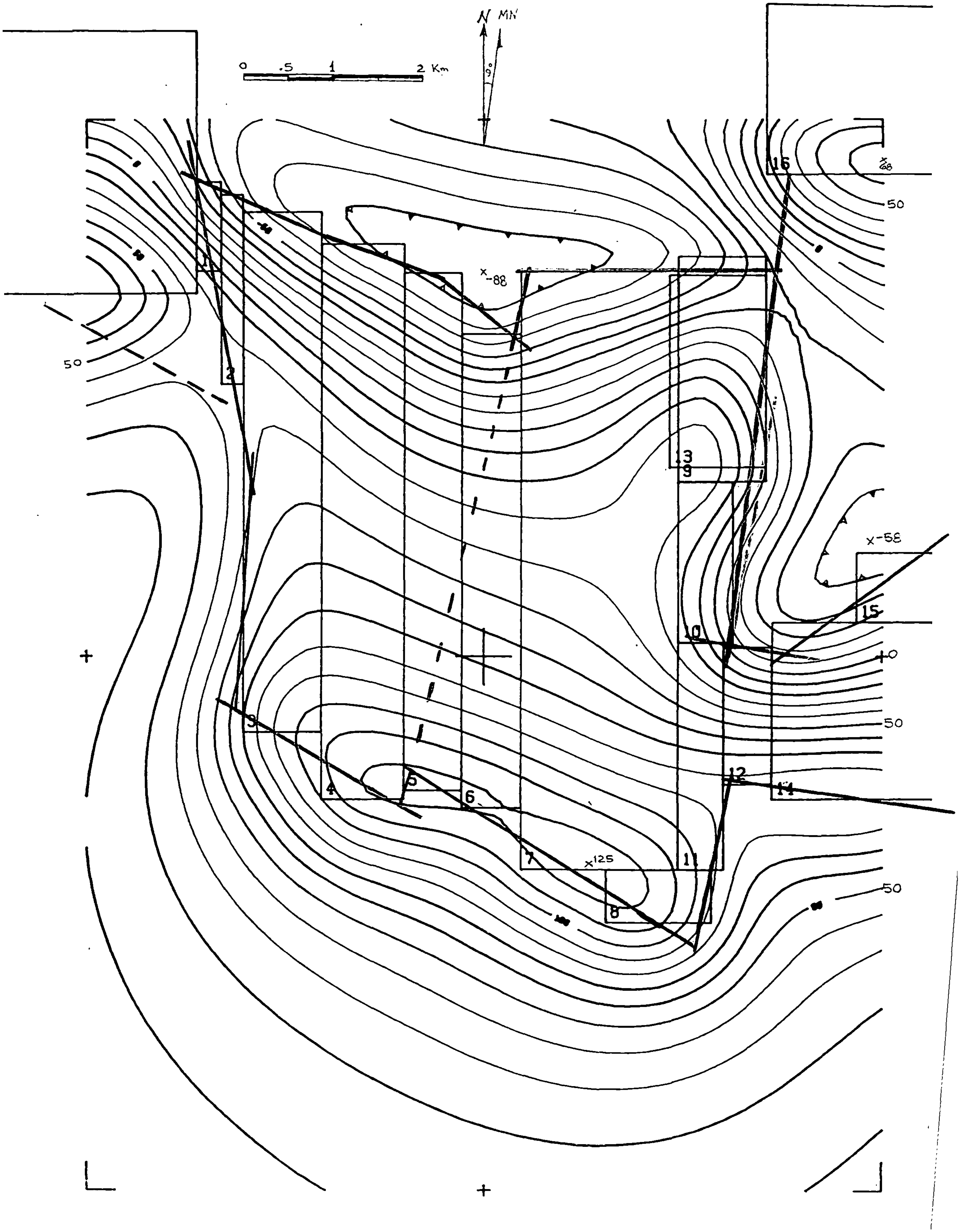


Figure 1. Characteristic magnetic model responses, Los Azufres, Michoacan area. Rectangular bodies 1 x 1.5 km trending N20 W and N50 E. Susceptibility contrast 0.002 cgs, depth to top 200 m, thickness 600 m. Declination 9 E, inclination 48 , TF = 42,740 nT. Scale 1:20,000. Contour interval 20 nT.


N
MN
9°
0 .5 1 2 Km
x-88
x68
50
x-58
50
0
50
50
x125
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

D.N.C. = Do Not Compile

Los Azufres - Tape No. 1

Aug. 1988
HR

Tight Line.

	D.N.C.	D.N.C.		D.N.C.					D.N.C. ?
Test	18S	10N	17S	[illegible]	25N	24AS	23N	22S	
256 42736	16 42707	1 43595	0 42795	0 42585	1 42636	0 42787	0 42690	8 42816	0 42663
257 42734	17 42707	2 42568	1 42795	1 42585	2 42638	1 42785	1 42701	9 42816	1 42659
258 42733	18 42709	3 42569	2 42794	2 42585	3 42639	2 42785	2 42712	10 42815	2 42658
259 42731	19 42710	4 42570	3 42791	3 42583	4 42640	3 42784	1 42722	11 42815	3 42655
260 42731	20 42712	5 42572	4 42789	4 42583	5 42642	4 42783	2 42733	12 42813	4 42654
261 42730	21 42714	6 42573	5 42789	5 42583	6 42644	5 42783	3 42742	13 42812	5 42654
262 42728	22 42715	7 42577	6 42788	6 42582	7 42645	6 42782	4 42753	14 42810	6 42653
263 42729	23 42716	8 42577	7 42786	7 42582	8 42647	7 42782	5 42761	15 42811	7 42653
264 42727	24 42718	9 42580	8 42785	8 42580	9 42649	8 42781	6 42767	16 42810	8 42650
265 42727	25 42720	10 42582	9 42784	9 42581	10 42650	9 42780	7 42777	17 42808	9 42651
266 42725	26 42719	11 42585	10 42782	10 42579	11 42653	10 42779	8 42783	18 42807	10 42651
267 42724	27 42720	12 42586	11 42782	11 42579	12 42654	11 42779	9 42789	19 42807	11 42651
268 42725	28 42722	13 42589	12 42780	12 42577	13 42657	12 42779	10 42796	20 42807	12 42653
269 42724	29 42723	14 42591	13 42780	13 42576	14 42661	13 42778	12 42801	21 42806	13 42652
270 42724	30 42723	15 42593	14 42777	14 42576	15 42662	14 42777	13 42806	22 42806	14 42657
271 42722	31 42724	16 42596	15 42777	15 42575	16 42667	15 42776	14 42811	23 42803	15 42654
272 42721	32 42725	17 42598	16 42776	16 42571	17 42672	16 42775	15 42816	24 42803	16 42655
273 42721	33 42725	18 42600	17 42775	17 42571	18 42674	17 42775	16 42821	25 42803	17 42655
274 42721	34 42724	19 42603	18 42774	18 42570	19 42677	18 42775	17 42826	26 42802	18 42660
275 42720	35 42727	20 42605	19 42774	19 42569	20 42681	19 42775	18 42830	27 42801	19 42661
276 42720	36 42726	21 42609	20 42772	20 42568	21 42687	20 42776	19 42832	28 42801	20 42663
277 42718	37 42727	22 42611	21 42770	21 42566	22 42691	21 42775	20 42836	29 42800	21 42666
278 42717	38 42727	23 42613	22 42770	22 42566	23 42695	22 42775	21 42839	30 42800	22 42667
279 42719	39 42727	24 42616	23 42770	23 42564	24 42700	23 42774	22 42839	31 42800	23 42672
280 42719	40 42727	25 42617	24 42768	24 42563	25 42705	24 42774	23 42842	32 42798	24 42674
281 42719	41 42730	26 42619	25 42767	25 42562	26 42711	25 42775	24 42843	33 42799	25 42674
282 42719	42 42730	27 42624	26 42766	26 42561	27 42716	26 42774	25 42845	34 42797	26 42678
283 42718	43 42732	28 42627	27 42766	27 42561	28 42722	27 42774	26 42846	35 42797	27 42691
284 42718	44 42732	29 42628	28 42765	28 42559	29 42727	28 42773	27 42847	36 42796	28 42683
285 42718	45 42734	30 42631	29 42764	29 42559	30 42730	29 42772	28 42846	37 42796	29 42687
286 42718	46 42735	31 42633	30 42764	30 42558	31 42737	30 42772	29 42845	38 42794	30 42689
287 42717	47 42737	32 42635	31 42764	31 42557	32 42741	31 42770	30 42847	39 42794	31 42692
288 42716	48 42740	33 42638	32 42763	32 42556	33 42747	32 42770	31 42844	40 42794	32 42694
289 42716	49 42742	34 42640	33 42762	33 42558	34 42750	33 42768	32 42842	41 42793	33 42697
290 42716	50 42744	35 42641	34 42762	34 42556	35 42754	34 42768	33 42840	42 42793	34 42699
291 42715	51 42745	36 42643	35 42762	35 42556	36 42758	35 42769	34 42837	43 42792	35 42702
292 42715	52 42747	37 42646	36 42761	36 42555	37 42760	36 42767	35 42836	44 42792	36 42703
293 42714	53 42749	38 42648	37 42761	37 42556	38 42762	37 42767	36 42832	45 42791	37 42703
294 42713	54 42751	39 42650	38 42761	38 42555	39 42764	38 42765	37 42830	46 42791	38 42704
295 42713	55 42752	40 42650	39 42760	39 42554	40 42767	39 42765	38 42826	47 42791	39 42704
296 42710	56 42754	41 42654	40 42760	40 42555	41 42767	40 42764	39 42822	48 42790	40 42705
297 42708	57 42754	42 42655	41 42760	41 42555	42 42769	41 42762	40 42818	49 42788	41 42704
	58 42753	43 42655	42 42759	42 42555	43 42768	42 42761	41 42812	50 42788	42 42701
	59 42753	44 42656	43 42759	43 42556	44 42769	43 42761	42 42809	51 42788	43 42700
	60 42750	45 42659	44 42758	44 42557	45 42769	44 42759	43 42804	52 42787	44 42699
	61 42749	46 42661	45 42757	45 42556	46 42770	45 42758	44 42798	53 42786	
	62 42745	47 42663	46 42758	46 42557	47 42768	46 42758	45 42795	54 42785	
	63 42745	48 42664	47 42757	47 42559	48 42768	47 42757	46 42790	55 42785	
	64 42742	49 42665	48 42756	48 42560	49 42766	48 42756	47 42786	56 42786	
	65 42738	50 42666	49 42756	49 42562	50 42765	49 42756	48 42782	57 42784	
	66 42734	51 42669	50 42755	50 42563	51 42764	50 42753	49 42777	58 42784	

HIGH ALTITUDE SURVEY - TAPE No. 2

HR

???	21AS	Turning ???	OFF LINE ???	20N	Turning	19S	Turning	18N	25S	Turning	26N	
93 42667	3 42782	0 42647	1 42696	0 2673	1 42834	2 42815	0 42580	1 42582	15 42864	0 42660	0 42550	0 42799
94 42669	4 42782	1 42645	3 42701	9 42631	2 42835	3 42812	1 42581	1 42561	15 42863	1 42662	1 42550	1 42900
95 42670	5 42781	2 42652	4 42701	10 42630	3 42836	4 42813	2 42579	2 42582	17 42863	2 42663	2 42550	2 42800
96 42671	6 42781	5 42647	5 42703	11 42629	4 42838	5 42812	3 42579	3 42585	18 42862	3 42663	3 42550	3 42802
97 42673	7 42780	6 42648	6 42706	12 42631	5 42838	6 42810	4 42583	4 42582	19 42861	4 42663	4 42550	4 42803
98 42673	8 42780	7 42551	7 42707	13 42631	6 42839	7 42808	5 42579	5 42586	20 42860	5 42664	5 42546	5 42803
99 42673	9 42780	8 42652	8 42710	14 42631	7 42840	8 42806	6 42581	6 42584	21 42860	6 42665	6 42547	6 42805
100 42675	10 42780	9 42651	9 42712	15 42632	8 42842	9 42805	7 42582	7 42588	22 42859	7 42666	7 42548	7 42805
101 42676	11 42780	10 42649	10 42713	16 42633	9 42843	10 42804	8 42580	6 42586	23 42857	8 42667	6 42548	8 42808
102 42676	12 42780	11 42656	11 42715	17 42633	10 42844	11 42802	9 42581	9 42591	24 42857	9 42666	9 42544	9 42809
103 42676	13 42780	12 42661	12 42716	18 42632	11 42844	12 42800	10 42582	10 42590	25 42855	10 42665	10 42545	10 42809
104 42676	14 42778	13 42659	13 42716	19 42633	12 42845	13 42798		11 42595	26 42855	11 42667	11 42543	11 42811
105 42678	15 42779	14 42658	14 42718	20 42635	13 42847	14 42797		12 42594	27 42854	12 42668	12 42543	12 42812
106 42676	16 42778	15 42654	15 42721	21 42633	14 42847	15 42795		13 42598	28 42854	13 42666	13 42543	13 42813
107 42678	17 42778	16 42662	16 42721	22 42636	15 42849	16 42794		14 42596	29 42853	14 42667	14 42541	14 42814
108 42678	18 42776	17 42667	17 42720	23 42635	16 42850	17 42793		16 42601	30 42851	15 42669	15 42540	15 42817
109 42680	19 42776	18 42668	18 42721	24 42635	17 42849	18 42792		17 42599	31 42851	16 42668	16 42541	16 42818
110 42678	20 42775	19 42669	19 42719	25 42636	18 42850	19 42790		18 42605	32 42849	17 42667	17 42539	17 42819
111 42679	21 42775	20 42670	20 42720	26 42638	19 42852	20 42788		19 42606	33 42848	18 42668	18 42539	18 42820
112 42680	22 42773	21 42672	21 42718	27 42637	20 42852	21 42786		20 42607	34 42848	19 42667	19 42537	19 42822
113 42681	23 42774	22 42677	22 42718	28 42642	21 42853	22 42784		21 42610	35 42847	20 42667	20 42536	20 42825
114 42684	24 42772	23 42676	23 42716	29 42641	22 42853	23 42783		22 42611	36 42847	21 42667	21 42538	21 42825
115 42683	25 42773	24 42678	24 42714	30 42641	23 42852	24 42781		23 42611	37 42846	22 42667	22 42537	22 42827
116 42686	26 42771	25 42679	25 42712	31 42642	24 42852	25 42782		24 42616	38 42846	23 42667	23 42539	23 42829
117 42687	27 42771	26 42679	26 42711	32 42645	25 42853	26 42780		25 42619	39 42845	24 42665	24 42540	24 42829
118 42691	28 42770	27 42680	27 42703	33 42645	26 42851	27 42779		26 42620	40 42844	25 42666	25 42539	25 42831
119 42693	29 42769	28 42681	28 42704	34 42649	27 42852	28 42777		27 42623	41 42843	26 42665	26 42541	26 42832
120 42696	30 42769	29 42685	29 42700	35 42650	28 42852	29 42776		28 42623	42 42842	27 42663	27 42542	27 42833
121 42698	31 42768	30 42682	30 42699	36 42652	29 42851	30 42773		29 42625	43 42841	28 42663	28 42544	28 42834
122 42700	32 42768	31 42683	31 42694	37 42654	30 42849	31 42772		30 42628	44 42841	29 42665	29 42547	29 42836
123 42703	33 42766	32 42684	32 42692	38 42655	31 42849	32 42772		31 42631	45 42840	30 42664	30 42548	30 42837
124 42708	34 42765	33 42682	33 42689	39 42658	32 42848	33 42770		32 42632	46 42839	31 42662	31 42547	31 42837
125 42711	35 42765	34 42684	34 42685	40 42657	33 42847	34 42769		33 42637	47 42839	32 42662	32 42551	32 42839
126 42714	36 42765	35 42685	36 42680	41 42662	34 42845	35 42768		34 42638	48 42837	33 42662	33 42557	33 42840
127 42716	37 42764	36 42684	37 42674	42 42664	35 42843	36 42767		35 42644	49 42837	34 42660	34 42560	34 42841
128 42718	38 42765	37 42683	38 42671	43 42666	36 42842	37 42766		36 42644	50 42836	35 42663	35 42562	35 42842
129 42721	39 42765	38 42687	39 42671	44 42669	37 42842	38 42765		37 42649	51 42836	36 42662	36 42565	36 42842
130 42724	40 42764	39 42686	40 42667	45 42671	38 42839	39 42765		38 42653	52 42835	37 42662	37 42571	37 42844
1 42725	41 42762	40 42689	41 42663	46 42673	39 42838	40 42761		39 42655	53 42835	38 42662	38 42575	38 42845
2 42726	42 42760	41 42690	42 42663	47 42679	40 42837	41 42762		40 42659	54 42834	39 42664	39 42578	39 42845
3 42726	43 42761	42 42690	43 42662	48 42683	41 42837	42 42761		41 42661	55 42833	40 42664	40 42583	40 42846
4 42727	44 42759	43 42693	44 42659	49 42684	42 42835	43 42761		42 42665	56 42833	41 42666	41 42588	41 42848
5 42727	45 42759	44 42695	45 42659	50 42689	43 42833	44 42760		43 42670	57 42834	42 42667	42 42592	42 42848
6 42729	46 42758		46 42660	51 42693	44 42832	45 42760		44 42673	58 42832	43 42669	43 42596	43 42849
7 42727	47 42757		47 42657	52 42695	45 42830	46 42759		45 42674	59 42831	44 42669	44 42600	44 42849
8 42726	48 42755		48 42659	53 42700	46 42828	47 42759		46 42678	60 42832	45 42671	45 42607	45 42850
9 42726	49 42754		49 42656	54 42702	47 42828	48 42757		47 42682	61 42830	46 42675	46 42611	46 42851
10 42722	50 42753		50 42655	55 42704	48 42825	49 42757		48 42685	62 42830	47 42678	47 42614	47 42850
11 42721	51 42752		51 42656	56 42709	49 42825	50 42756		49 42686	63 42829	48 42681	48 42618	48 42852
12 42720	52 42751		52 42652	57 42713	50 42824	51 42756		50 42689	64 42829	49 42684	49 42626	49 42852
13 42717	53 42749		53 42652	58 42716	51 42823	52 42755		51 42691	65 42829	50 42688	50 42629	50 42853
Max Fid# 340½	500	22	122½	369½	180	500	05	362½	500	123	500	40½

HIGH ALTITUDE SURVEY- TAPE No. 3

27S		TURNING		28N		29S		30N		31S		T-1W		T-2E	
23	42844	0	42669	0	42541	20	42873	11	42663	10	42895	13	42685	14	42684
24	42844	1	42670	1	42545	21	42872	12	42653	11	42895	14	42685	15	42687
25	42844	2	42670	2	42546	22	42872	13	42651	12	42894	15	42683	16	42687
26	42844	3	42671	3	42548	23	42871	14	42649	13	42892	16	42682	17	42688
27	42844	4	42671	4	42551	24	42871	15	42644	14	42893	17	42684	18	42687
28	42644	5	42672	5	42553	25	42870	16	42643	15	42892	18	42679	19	42688
29	42845	6	42673	6	42556	26	42870	17	42640	16	42893	19	42680	20	42688
30	42845	7	42673	7	42558	27	42870	18	42641	17	42892	20	42679	21	42690
31	42845	8	42674	8	42561	28	42868	19	42639	18	42892	21	42680	22	42687
32	42846	9	42674	9	42564	29	42868	20	42640	19	42893	22	42681	23	42688
33	42845	10	42675	10	42566	30	42867	21	42639	20	42892	23	42679	24	42688
34	42845	11	42675	11	42569	31	42866	22	42640	21	42892	24	42679	25	42688
35	42846	12	42675	12	42572	32	42866	23	42641	22	42892	25	42676	26	42689
36	42846	13	42675	13	42574	33	42866	24	42640	23	42892	26	42675	27	42685
37	42847	14	42676	14	42578	34	42864	25	42641	24	42891	27	42673	28	42686
38	42847	15	42676	15	42580	35	42863	26	42643	25	42892	28	42674	29	42684
39	42847	16	42675	16	42582	36	42864	27	42644	26	42892	29	42671	30	42685
40	42847	17	42676	17	42584	37	42862	28	42645	27	42892	30	42671	31	42687
41	42847	18	42675	18	42567	38	42863	29	42645	28	42893	31	42669	32	42686
42	42846	19	42675	19	42590	39	42861	30	42647	29	42894	32	42667	33	42687
43	42847	20	42675	20	42591	40	42862	31	42649	30	42893	33	42668	34	42686
44	42846	21	42675	21	42596	41	42860	32	42651	31	42894	34	42663	35	42684
45	42848	22	42674	22	42597	42	42860	33	42650	32	42895	35	42664	36	42683
46	42847	23	42673	23	42600	43	42859	34	42655	33	42895	36	42662	37	42686
47	42847	24	42673	24	42600	44	42859	35	42656	34	42896	37	42661	38	42685
48	42847	25	42672	25	42601	45	42858	36	42655	35	42896	38	42662	39	42686
101	42821			78	42714	98	42856	89	42688	88	42892	92	42593	92	42685
102	42820			79	42716	99	42857	90	42687	89	42893	93	42593	93	42686
103	42819			80	42719	100	42857	91	42687	90	42895	94	42594	94	42686
104	42818			81	42720	101	42858	92	42687	91	42895	95	42594	95	42685
105	42818	9		82	42723	102	42858	93	42685	92	42894	96	42594	96	42689
106	42818	97	42527	83	42725	103	42858	94	42686	93	42895	97	42594	97	42689
107	42817	98	42529	84	42728	104	42858	95	42683	94	42897	98	42594	98	42690
108	42816	99	42531	85	42732	105	42859	96	42683	95	42897	99	42596	99	42691
109	42815	100	42534	86	42732	106	42858	97	42680	96	42897	100	42597	100	42693
110	42813	101	42536	87	42737	107	42858	98	42677	97	42898	101	42596	101	42694
111	42814	102	42537	88	42737	108	42858	99	42676	98	42899	102	42598	102	42695
112	42813	103	42539	89	42741	109	42858	100	42674	99	42899	103	42600 ✓	103	42698
113	42812			90	42740	110	42858	101	42673	100	42900	104	42600	104	42699
114	42810			91	42742	111	42858	102	42671	101	42898	105	42601	105	42701
115	42810			92	42744	112	42857	103	42670	102	42900	106	42601	106	42701
116	42809			93	42745	113	42857	104	42668	103	42900	107	42604	107	42704
117	42809			94	42747	114	42856	105	42665	104	42900	108	42606	108	42706
118	42806			95	42748	115	42856	106	42663	105	42899	109	42607	109	42705
119	42807			96	42748	116	42856	107	42662	106	42900	110	42607	110	42707
120	42806			97	42748	117	42855	108	42661	107	42899	111	42608	111	42710
121	42806			98	42749	118	42854	109	42657	108	42899	112	42609	112	42711
122	42806			99	42749	119	42853	110	42655	109	42899	113	42612	113	42711
123	42805			100	42749	120	42854	111	42654	110	42899	114	42613	114	42713
124	42803			101	42750	121	42852	112	42650	111	42898	115	42614	115	42717
125	42803			102	42750	125	42850	113	42647	112	42897	116	42616	116	42717

Max Fid#	27S	TURNING	28N	29S	30N	31S	T-1W	T-2E
	500	38½	416	458	381	480	382	280

High Altitude Survey - Tape No. 4 HR

Los Azufres

16S		16N		14S		13N		12S		11N		9S	
17	42811	2	42633	2	42760	2	42639	1	42751	1	42564	2	42871
18	42816	3	42630	3	42758	3	42640	2	42749	2	42565	3	42871
19	42810	4	42629	4	42759	4	42639	3	42747	3	42568	4	42870
20	42812	5	42627	5	42756	5	42639	4	42746	4	42570	5	42870
21	42807	6	42627	6	42756	6	42639	5	42745	5	42569	6	42870
22	42810	7	42625	7	42755	7	42638	6	42743	6	42569	1	42869
23	42804	8	42623	8	42754	8	42636	7	42741	7	42570	2	42868
24	42806	9	42623	9	42752	9	42637	8	42740	8	42572	3	42867
25	42801	10	42620	10	42751	10	42637	9	42740	9	42572	4	42868
26	42800	11	42618	11	42749	11	42633	10	42737	10	42575	5	42867
27	42798	12	42616	12	42749	12	42633	11	42737	11	42576	6	42865
28	42799	13	42615	13	42747	13	42631	12	42736	12	42577	7	42865
29	42796	14	42613	14	42746	14	42628	13	42734	13	42577	8	42863
30	42794	15	42611	15	42744	15	42627	14	42733	14	42578	9	42862
31	42792	16	42609	16	42744	16	42626	15	42732	15	42582	10	42863
32	42785	17	42606	17	42743	17	42623	16	42730	16	42581	11	42861
33	42788	18	42606	18	42741	18	42621	17	42730	17	42581	12	42859
34	42780	19	42604	19	42741	19	42619	18	42728	18	42583	13	42858
35	42783	20	42602	20	42739	20	42619	19	42727	19	42584	14	42856
36	42780	21	42601	21	42738	21	42617	20	42727	20	42583	15	42854
37	42773	22	42600	22	42737	22	42615	21	42727	21	42585	16	42854
38	42775	23	42597	23	42736	23	42613	22	42727	22	42587	17	42852
39	42767	24	42597	24	42735	24	42612	23	42725	23	42588	18	42850
40	42772	25	42594	25	42733	25	42609	24	42725	24	42589	19	42850
41	42763	26	42592	26	42732	26	42607	25	42724	25	42589	20	42847
42	42765	27	42592	27	42732	27	42607	26	42724	26	42590	21	42844
43	42758	28	42590	28	42730	28	42606	27	42724	27	42590	22	42844
44	42757	29	42588	29	42731	29	42604	28	42723	28	42591	23	42843
45	42757	30	42588	30	42729	30	42603	29	42725	29	42592	24	42842
46	42751	31	42586	31	42730	31	42604	30	42723	30	42594	25	42840
47	42752	32	42585	32	42728	32	42603	31	42724	31	42594	26	42838
48	42747	33	42584	33	42727	33	42602	32	42723	32	42595	27	42836
49	42747	34	42583	34	42727	34	42603	33	42724	33	42595	28	42836
50	42741	35	42582	35	42726	35	42604	34	42726	34	42598	29	42834
51	42746	36	42581	36	42726	36	42603	35	42725	35	42595	30	42833
52	42739	37	42580	37	42727	37	42602	36	42725	36	42598	31	42832
53	42743	38	42578	38	42726	38	42602	37	42726	37	42599	32	42829
54	42738	39	42577	39	42725	39	42603	38	42727	38	42601	33	42827
55	42740	40	42577	40	42725	40	42603	39	42727	39	42601	34	42826
56	42735	41	42576	41	42725	41	42604	40	42726	40	42603	35	42824
57	42739	42	42576	42	42723	42	42604	41	42727	41	42603	36	42822
58	42734	43	42576	43	42724	43	42606	42	42727	42	42604	37	42821
59	42736	44	42575	44	42722	44	42607	43	42728	43	42605	38	42819
60	42733	45	42575	45	42723	45	42607	44	42729	44	42607	39	42818
61	42734	46	42575	46	42724	46	42608	45	42729	45	42607	40	42816
62	42730	47	42575	47	42723	47	42609	46	42729	46	42608	41	42814
63	42733	48	42575	48	42723	48	42610	47	42730	47	42609	42	42812
64	42729	49	42576	49	42723	49	42611	48	42731	48	42609	43	42810
65	42732	50	42575	50	42723	50	42612	49	42731	49	42609	44	42809
66	42727	51	42575	51	42723	51	42613	50	42732	50	42609	45	42805
67	42731	52	42577	52	42723	52	42615	51	42734	51	42610	46	42804
68	42726	53	42577	53	42723	53	42614	52	42734	52	42612	47	42802

Max Fid No.	465	455	430	477	400	444	447

Tape #4
finis.

67	42730	52	42670	51	42754	51	42564	52	42763	51	42754	50	42775	59	42784
68	42726	53	42670	52	42754	52	42567	53	42761	52	42753	51	42770	60	42782
69	42725	54	42672	53	42754	53	42566	54	42758	53	42752	52	42766	61	42782
70	42723	55	42673	54	42752	54	42567	55	42757	54	42752	53	42761	62	42782
71	42721	56	42674	55	42752	55	42569	56	42755	55	42750	54	42757	63	42781
72	42718	57	42675	56	42751	56	42572	57	42751	56	42751	55	42754	64	42780
73	42719	58	42675	57	42751	57	42573	58	42746	57	42749	56	42749	65	42780
74	42718	59	42676	58	42750	58	42575	59	42745	58	42749	57	42744	66	42779
75	42719	60	42677	59	42749	59	42577	60	42742	59	42748	58	42740	67	42778
76	42720	61	42677	60	42747	60	42579	61	42738	60	42749	59	42738	68	42778
77	42722	62	42679	61	42748	61	42580	62	42734	61	42748	60	42735	69	42777
78	42723	63	42679	62	42747	62	42581	63	42731	62	42747	61	42730	70	42776
79	42725	64	42680	63	42745	63	42584	64	42727	63	42746	62	42727	71	42775
80	42728	65	42679	64	42746	64	42585	65	42724	64	42746	63	42723	72	42774
81	42732	66	42679	65	42745	65	42587	66	42720	65	42746	64	42720	73	42774
82	42735	67	42679	66	42744	66	42592	67	42716	66	42745	65	42717	74	42774
83	42740	68	42679	67	42743	67	42592	68	42714	67	42744	66	42715	75	42773
84	42744	69	42679	68	42743	68	42590	69	42709	68	42744	67	42712	76	42772
85	42747	70	42678	69	42741	69	42594	70	42706	69	42744	68	42708	77	42771
86	42750	71	42677	70	42742	70	42597	71	42703	70	42743	69	42706	78	42771
87	42753	72	42678	71	42741	71	42600	72	42699	71	42742	70	42703	79	42770
88	42755	73	42676	72	42740	72	42597	73	42695	72	42740	71	42699	80	42770
89	42758	74	42675	73	42738	73	42596	74	42693	73	42740	72	42696	81	42768
90	42762	75	42675	74	42739	74	42600	75	42690	74	42738	73	42694	82	42769
91	42764	76	42673	75	42737	75	42605	76	42687	75	42736	74	42691	83	42768
92	42765	77	42672	76	42737	76	42601	77	42686	76	42736	75	42687	84	42767
93	42766	78	42671	77	42736	77	42604	78	42680	77	42733	76	42685	85	42767
94	42768	79	42669	78	42736	78	42606	79	42680	78	42732	77	42682	86	42766
95	42771	80	42669	79	42735	79	42606	80	42679	79	42729	78	42680	87	42766
96	42772	81	42667	80	42734	80	42614	81	42674	80	42728	79	42677	88	42764
97	42775	82	42664	81	42734	81	42613	82	42674	81	42727	80	42674	89	42765
98	42778	83	42665	82	42732	82	42606	83	42671	82	42724	81	42674	90	42763
99	42780	84	42663	83	42733	83	42607	84	42670	83	42722	82	42671	91	42762
100	42782	85	42660	84	42732	84	42618	85	42667	84	42719	83	42671	92	42762
101	42787	86	42659	85	42731	85	42618	86	42666	85	42718	84	42670	93	42760
102	42789	87	42656	86	42731	86	42617	87	42664	86	42716	85	42669	94	42760
103	42795	88	42655	87	42730	87	42619	88	42663	87	42714	86	42667	95	42759
104	42801	89	42653	88	42729	88	42623	89	42661	88	42712	87	42665	96	42759
105	42805	90	42651	89	42727	89	42622	90	42660	89	42709	88	42666	97	42759
106	42810	91	42651	90	42728	90	42627	91	42660	90	42707	89	42664	98	42756
107	42816	92	42649	91	42727	91	42630	92	42657	91	42705	90	42665	99	42757
108	42822	93	42645	92	42727	92	42631	93	42657	92	42703	91	42666	100	42756
109	42827	94	42644	93	42726	42	62634	94	42657	93	42702	92	42666	101	42755
110	42833	95	42643	94	42726			95	42657	94	42701	93	42665	102	42754
111	42837	96	42639	95	42725			96	42656	95	42699	94	42664	103	42754
112	42844	97	42640	96	42725			97	42653	96	42698	95	42665	104	42752
113	42849	98	42638	97	42724			98	42654	97	42698	96	42665	105	42751
114	42856	99	42636	98	42722			99	42653	98	42695	97	42666	106	42750
115	42860	100	42636	99	42723			100	42652	99	42696	98	42668	107	42749
116	42865	101	42634	100	42722			101	42650	100	42696	99	42667	108	42749
117	42869	102	42632	101	42722			102	42650	101	42696	100	42666	109	42748
118	42873	103	42632	102	42722			103	42650	102	42695	101	42670	110	42748

148½ 397 475 499½ 476 436 499½ 397½ 499½ 22

7/GH 5

HIGH ALTITUDE SURVEY - TAPE No. 5

	8N	(incomplete) 7S	T-3E	25BS	(incomplete) 7N	7AN	6S	5N
	83 42603	2 42912	~~2 7427~~	~~4 44311~~	~~12 42594~~	2 44299	2 42769	2 42551
	84 42602	3 42908	~~28 42710~~	~~5 42830~~	~~13 42594~~	3 42562	3 42768	3 42553
	85 42604	4 42906	~~29 42710~~	~~6 42832~~	~~14 42597~~	4 42560	4 42768	4 42549
	86 42605	5 42902	~~30 42711~~	~~1 42830~~	~~15 42595~~	5 42560	5 42766	5 42551
	87 42605	6 42900	~~31 42712~~	~~2 42830~~	~~16 42597~~	6 42561	6 42762	6 42551
	88 42606	7 42896	~~32 42713~~	~~3 42827~~	~~17 42597~~	7 42560	7 42764	7 42550
	89 42606	8 42893	~~44 42713~~	~~? 5 40000 ?~~	~~18 42596~~	8 42561	8 42763	8 42553
	90 42608	9 42890	5 42711	~~6 42827~~	~~19 42598~~	9 42559	9 42761	9 42551
	91 42608	10 42886	6 42712	~~7 42826~~	~~20 42598~~	10 42559	10 42762	10 42550
	92 42610	11 42886	7 42716	~~8 42825~~	~~21 42597~~	11 42560	11 42763	11 42549
	93 42609	12 42883	8 42714	~~9 42824~~	~~22 42598~~	12 42558	12 42762	12 42550
	94 42610	13 42879	9 42717	~~0 42823~~	~~23 42599~~	13 42559	13 42762	13 42549
	95 42612	14 42878	10 42717	1 42823	~~24 42599~~	14 42559	14 42762	14 42551
	96 42613	15 42876	11 42718	2 42823	~~25 42599~~	15 42559	15 42764	15 42549
	97 42614	16 42871	12 42718	3 42821	~~26 42601~~	16 42559	16 42763	16 42550
	98 42613	17 42869	13 42718	4 42821	~~27 42601~~	17 42559	17 42765	17 42551
	99 42616	18 42867	14 42720	5 42821	~~28 42605~~	18 42558	18 42765	18 42549
	100 42616	19 42863	15 42720	6 42817	29 42603	19 42558	19 42767	19 42554
	101 42619	20 42861	16 42722	7 42820	30 42606	20 42558	20 42769	20 42552
	102 42620	21 42857	17 42721	8 42818	31 42605	21 42558	21 42769	21 42549
	103 42621	22 42854	18 42721	9 42818	32 42607	22 42558	22 42771	22 42552
	104 42621	23 42851	19 42724	10 42818	33 42609	23 42558	23 42771	23 42551
	105 42623	24 42848	20 42722	11 42816	34 42609	24 42558	24 42773	24 42552
	106 42624	25 42846	21 42723	12 42817	35 42610	25 42559	25 42774	25 42551
	107 42624	26 42842	22 42723	13 42816	36 42610	26 42557	26 42777	26 42551
	108 42627	27 42838	23 42723	14 42817	37 42613	27 42558	27 42776	27 42553
	109 42629	28 42836	74 42723	15 42815	38 42613	28 42552	28 42772	28 42555
	162 42656	82 42771	77 42739	68 42782	91 42643	81 42580	A 81 42909	81 42563
	163 42655	83 42772	78 42739	69 42781	92 42643	82 42579	A 82 42909	82 42564
	164 42654	84 42771	79 42741	70 42780	93 42645	83 42580	83 42908	83 42564
	165 42654	85 42771	80 42741	71 42780	94 42645	84 42581	84 42908	84 42563
	166 42653	86 42771	81 42744	72 42779	95 42647	85 42583	85 42908	85 42563
	167 42655	87 42770	82 42746	73 42779	96 42648	86 42584	86 42908	86 42561
	168 42656	88 42771	83 42744	74 42778	97 42650	87 42584	88 42908	87 42562
	169 42653	89 42771	84 42747	75 42777	98 42651	88 42584	89 42907	88 42564
	170 42653	90 42769	85 42748	76 42777	99 42651	89 42586	90 42908	89 42564
	171 42656	91 42770	86 42749	77 42776	100 42655	90 42586	91 42907	90 42564
B –	172 42657	92 42771	87 42752	78 42775	101 42657	91 42588	92 42907	91 42568
	173 42656	93 42769	88 42751	79 42775	102 42658	92 42591	93 42903	92 42566
	174 42658	94 42769	89 42753	80 42773	103 42659	93 42590	94 42904	93 42565
	175 42661	95 42769	90 42752	81 42773	104 42661	94 42592	95 42902	94 42568
A 88 –	176 42661	96 42770	91 42755	82 42772	105 42663	95 42592	96 42903	95 42564
	177 42660	97 42770	92 42755	83 42771	106 42666	96 42594	97 42904	96 42569
	178 42663	98 42770	93 42756	84 42774	107 42667	97 42595	98 42902	97 42567
	179 42663	99 42770	94 42757	85 42770	108 42670	98 42596	99 42902	98 42568
	180 42665	100 42772	95 42758	86 42768	109 42671	99 42597	100 42901	99 42566
	181 42666	101 42772	96 42760	87 42767	110 42674	100 42598	101 42900	100 42570
	182 42667	102 42773	97 42761	88 42766	111 42675	101 42599	102 42900	101 42570
	183 42666	103 42774	98 42761	89 42765	112 42678	102 42600	103 42900	102 42572
	184 42668	104 42776	99 42764	90 42764	113 42679	103 42602	104 42899	103 42569
	185 42667	105 42777	100 42764	91 42763	114 42682	104 42601	105 42899	104 42570
	186 42668	106 42779	101 42766	92 42762	115 42684	105 42605	106 42898	105 42569
Max Fid #	404	170	344	438	87	471	379	494

Analoge Fid Counter Stopped @ #67–83

TAPE 6 HIGH ALTITUDE

8/25/88

4S		3N		2S		1N	
2	42895	2	42547	1	43596	1	42569
3	42892	3	42550	2	42959	2	42551
4	42892	4	42550	3	42959	3	42550
5	42893	5	42551	4	42957	4	42551
6	42890	6	42548	5	42956	5	42554
7	42886	7	42549	6	42953	6	42554
8	42887	8	42548	7	42950	7	42555
9	42884	9	42548	8	42947	8	42553
10	42883	10	42549	9	42943	9	42553
11	42881	11	42549	10	42938	10	42552
12	42878	12	42550	11	42933	11	42553
13	42877	13	42550	12	42929	12	42553
14	42875	14	42550	13	42922	13	42554
15	42872	15	42549	14	42917	14	42555
16	42870	16	42550	15	42912	15	42556
17	42869	17	42552	16	42907	16	42553
18	42865	18	42550	17	42902	17	42555
19	42864	19	42548	18	42897	18	42555
20	42860	20	42551	19	42891	19	42553
21	42858	21	42549	20	42885	20	42556
22	42857	22	42548	21	42880	21	42556
23	42854	23	42552	22	42876	22	42555
24	42850	24	42550	23	42870	23	42558
25	42848	25	42551	24	42866	24	42556
26	42844	26	42550	25	42864	25	42557
27	42841	27	42550	26	42859	27	42555
28	42836	28	42552	27	42855	28	42558
29	42834	29	42550	28	42850	29	42557
30	42831	30	42551	29	42847	30	42558
31	42827	31	42551	30	42841	31	42557
32	42823	32	42550	31	42836	32	42558
33	42820	33	42552	32	42833	33	42560
34	42815	34	42552	33	42830	34	42560
35	42812	35	42551	34	42826	35	42559
36	42808	36	42553	35	42823	36	42558
37	42804	37	42553	36	42817	37	42560
38	42801	38	42552	37	42814	38	42560
39	42795	39	42551	38	42813	39	42564
40	42794	40	42551	39	42810	40	42562
41	42789	41	42554	40	42807	41	42563
42	42785	42	42553	41	42804	42	42562
43	42782	43	42554	42	42799	43	42567
44	42778	44	42554	43	42795	44	42566
45	42776	45	42556	44	42793	45	42566
46	42773	46	42554	45	42790	46	42565
47	42770	47	42555	46	42787	47	42567
48	42768	48	42554	47	42784	48	42567
49	42765	49	42556	48	42780	49	42569
50	42762	50	42553	49	42778	50	42569
51	42760	51	42555	50	42774	51	42573
52	42760	52	42554	51	42772	52	42570
53	42758	53	42556	52	42770	53	42574
				1			
	409½		444½		373½		429

May Fid. No.

HIGH ALTITUDE SURVEY - TAPE No. 5

Doug R.,'GHs-

8N		7S (incomplete)		T-3E		25BS		7N (incomplete)		7AN		6S		5N	
83	42603	2	42912	2	7427	4	44311	12	42594	2	44299	2	42769	2	42551
84	42602	3	42908	28	42710	5	42830	13	42594	3	42562	3	42768	3	42553
85	42604	4	42906	29	42710	6	42832	14	42597	4	42560	4	42768	4	42549
86	42605	5	42902	30	42711	1	42830	15	42595	5	42560	5	42766	5	42551
87	42605	6	42900	31	42712	2	42830	16	42597	6	42561	6	42762	6	42551
88	42606	7	42896	32	42713	3	42827	17	42599	7	42560	7	42764	7	42550
89	42606	8	42893	44	42713	? 5	40000 ?	18	42596	8	42561	8	42763	8	42553
90	42608	9	42890	5	42711	6	42827	19	42598	9	42559	9	42761	9	42551
91	42606	10	42888	6	42712	7	42826	20	42598	10	42559	10	42762	10	42550
92	42610	11	42886	7	42716	8	42825	21	42597	11	42560	11	42763	11	42549
93	42609	12	42883	8	42714	9	42824	22	42598	12	42558	12	42762	12	42550
94	42610	13	42879	9	42717	0	42823	23	42599	13	42559	13	42762	13	42549
95	42612	14	42878	10	42717	1	42823	24	42599	14	42559	14	42762	14	42551
96	42613	15	42876	11	42719	2	42823	25	42599	15	42559	15	42764	15	42549
97	42614	16	42871	12	42718	3	42821	26	42601	16	42559	16	42763	16	42550
98	42613	17	42869	13	42718	4	42821	27	42601	17	42559	17	42765	17	42551
99	42616	18	42867	14	42720	5	42821	28	42605	18	42558	18	42765	18	42549
100	42616	19	42863	15	42720	6	42819	29	42603	19	42558	19	42767	19	42551
101	42619	20	42861	16	42722	7	42820	30	42606	20	42558	20	42769	20	42552
102	42620	21	42857	17	42721	8	42818	31	42605	21	42558	21	42769	21	42549
103	42621	22	42854	18	42721	9	42818	32	42607	22	42558	22	42771	22	42552
104	42621	23	42851	19	42724	10	42818	33	42609	23	42558	23	42771	23	42551
105	42623	24	42848	20	42722	11	42816	34	42609	24	42558	24	42773	24	42552
106	42624	25	42846	21	42723	12	42817	35	42610	25	42559	25	42774	25	42551
107	42626	26	42842	22	42723	13	42816	36	42610	26	42557	26	42777	26	42551
108	42627	27	42838	23	42723	14	42817	37	42613	27	42558	27	42776	27	42553
109	42629	28	42836	24	42723 ✓	15	42815	38	42613	28	42557	28	42779	28	42555
162	42656	✓ 82	42771 ✓	77	42739	68	42782	91	42643	81	42580	A 81	42909	81	42563
163	42655	83	42772	78	42739	69	42781	92	42643	82	42579	A 82	42909	82	42564
164	42654	84	42771	79	42741	70	42780	93	42645	83	42580	83	42908	83	42564
165	42654	85	42771	80	42741	71	42780	94	42645	84	42581	84	42908	84	42563
166	42653	86	42771	81	42744	72	42779	95	42647	85	42583	85	42908	85	42563
167	42655	87	42770	82	42746	73	42779	96	42648	86	42584	86	42908	86	42561
168	42656	88	42771	83	42744	74	42778	97	42650	87	42584	88	42908	87	42562
169	42653	89	42771	84	42747	75	42777	98	42651	88	42584	89	42907	88	42564
170	42653	90	42769	85	42748	76	42777	99	42651	89	42586	90	42908	89	42564
171	42656	91	42770	86	42749	77	42776	100	42655	90	42586	91	42907	90	42564
D- 172	42657	92	42771	87	42752	78	42775	101	42657	91	42588	92	42907	91	42568
173	42656	93	42769	88	42751	79	42775	102	42658	92	42591	93	42903	92	42566
174	42658	94	42769	89	42753	80	42773	103	42659	93	42590	94	42904	93	42565
175	42661	95	42769	90	42752	81	42773	104	42661	94	42592	95	42902	94	42568
488- 176	42661	96	42770	91	42755	82	42772	105	42663	95	42592	96	42903	95	42564
177	42660	97	42770	92	42755	83	42771	106	42666	96	42594	97	42904	96	42569
178	42663	98	42770	93	42756	84	42771	107	42667	97	42595	98	42902	97	42567
179	42663	99	42770	94	42757	85	42770	108	42670	98	42596	99	42902	98	42568
180	42665	100	42772	95	42758	86	42768	109	42671	99	42597	100	42901	99	42566
181	42666	101	42772	96	42760	87	42767	110	42674	100	42598	101	42900	100	42570
182	42667	102	42773	97	42761	88	42766	111	42675	101	42599	102	42900	101	42570
183	42666	103	42774	98	42761	89	42765	112	42678	102	42600	103	42900	102	42572
184	42668	104	42776	99	42764	90	42764	113	42679	103	42602	104	42899	103	42569
185	42667	105	42777	100	42764	91	42763	114	42682	104	42601	105	42899	104	42570
186	42668	106	42779	101	42766	92	42762	115	42684	105	42605	106	42898	105	42569

Analoge Fid Counter Stopped @ #67-#83

2

Max Fid #	8N	7S	T-3E	25BS	7N	7AN	6S	5N
	404	170	344	438	87	471	379	494

HPRoss
Aug. 25, 88

Preliminary Diurnal Correction - High Altitude Survey - Los Azufres
Reconcile to mean 42,740 γ base station value

Line No.	May	Time	Diur. Corr.
17S	11	0836	+ 11
25N		0854	13
24AS		0912	13
23N		0930	12
22S		0950	11
21AS		1020	9
20N		10:46	7
19S		11:04	6
18N		11 22	+ 8
25S	13	0838	− 8
26N		0856	− 8
27S		0914	−10
28N		0932	− 11
29S		0950	− 11
30N		1008	− 11
31S		1026	− 9
T-1W		1051	−10
T-2E		1106	− 10
16S	14	0842	+ 6
15N		0901	+ 4
14S		0919	+ 4
13N		0940	+ 3
12S		0959	+ 3
11N		1017	+ 2
9S		1036	0
8N		1057	− 2
7S		1108	− 3

Line No	May	Time	Diur. Corr.
~~T-3E~~	15	—	—
T-3E		0850	−1
25BS		0907	0
7N		0925	+1
7AN		0936	+1
6S		0953	+2
5N		1015	+2
4S		1032	+2
3N		1049	+ 1
2S		1105	0
1N		1119	−1

TOPS FORM 3672

VUELO ALTO

FECHA	Nº LINEA	RUMBO	Nº VIDEOC.	OBSERVACIONES
11-MAYO-88	17	S	1	No esta marcada en el plano
	24 A	S	1	Solo se verifico 24 sin A
	23	N	1	Normal
	22	S	1	Normal
	21 A	S	1	No se verifico
	20	N	1	Normal
	19	S	1	Normal
	18	N	2	No fue posible determinar el nº de linea debido a interferencias.
13-MAYO-88	25	S	2	
	26	N	2	
	27	S	3	Normal
	28	N	3	Normal
	29	S	3	Normal
	30	N	3	Normal
	31	N (S)	3	Normal, solo que es hacia el Sur.
	T-1	W	3	Normal
	T-2	E	3	Normal
14-MAYO-88	16	S	4	Normal
	15	N	4	Normal
	14	S	4	Normal
	13	N	4	Normal
	12	S	4	Normal
	11	N	4	Normal
	9	S	4	Normal
	8	N	5	Normal
	7	S	5	Sin verificar linea?
15-MAYO-88	T-3	E	5	Sin verificar linea?
	25 B	S	5	Normal
	7 A	N	5	Sin verificar linea 7 ó 7A
	6	S	5	Normal
	5	N	5	Normal
16-MAYO-88	4	S	6	Normal
	3	N	6	Normal
	2	S	6	Normal
	1	N	6	Normal

En algunas líneas solo se logro interpretar la parte inicial ó la parte final.

"VUELO BAJO"

FECHA	Nº LINEA	RUMBO	Nº VIDEOC.	OBSERVACIONES
5-MAYO-88	34	?	1	¿Puede ser SE?
	35	NW	1	Normal con algunas interferencias
	38	SE	1	Normal con interferencias
	39	NW	1	Normal con interferencias
	40	NW	1	Normal
	41	SE	1	Normal
	42	NW	1	Normal
	43	SE	1	Normal
	44	NW	1	Normal
	45	SE	1	Normal
	46	NW	1	Normal
	47	SE	1	Normal
	48	NW	1	Normal
	49	SE	1	Normal
	50	NW	1	Normal
	51	SE	1	Normal
	52	NW	1	Normal
	53	SE	1	Normal
	54	NW	1	Normal
	55	SE	1	Normal
	56	NW	2	Normal
	57	SE	2	Normal
	58	NW	2	Normal
	35	SE	2	Normal
	34	NW	2	Normal
	33	SE	2	Normal
	32	NW	2	Normal
7-MAYO-88	31	SE	2	Normal
	30	NW	2	Normal
	29	SE	2	Normal
	28	NW	2	Normal
	27	SE	2	Normal
	26	NW	2	Normal
	25	SE	2	Normal
	24	NW	2	Normal
	23	SE	2	Normal
	22	NW	2	Normal
	21	SE	2	Normal
	20	NW	2	Normal
	19	SE	2	Normal

"VUELO BAJO"

FECHA	Nº LINEA	RUMBO	Nº VIDEOC.	OBSERVACIONES
7-MAYO-88'	18	NW	3	
	17	SE	3	
	16	NW	3	
	15	SE	3	
	14	NW	3	
	13	SE	3	
	12	NW	3	
	36	SE	3	
	37	NW	3	
	38	SE	3	
	39	NW	3	
	T-1	SW	3	Problemas con interferencias
	T-2	N.E	3	Con interferencia
	T-3	SW	3	
	T-4	NE	3	
	T-5	SW	3	

MAIL DOE4418 'M. REED' AR

SUBJECT: Biographical Sketch for Drs. P.M. Wright & H.P. Ross

Dr. Phillip M.Wright

Dr. Phillip M. Wright is Director of the Earth Science Laboratory and Technical Vice President of the University of Utah Research Institute. In this capacity Dr. Wright provides technical and programmatic guidance to scientists working on the U.S. Department of Energy's Geothermal Programs as well as other governmental and private projects. Dr. Wright is a recognized authority on the application of geophysical techniques to geothermal exploration and in the numerical modelling of geophysical data.

Dr. Wright will serve as coordinator of joint U.S. - Mexican scientific teams studying the geophysical characteristics of the Los Azufres and Cerro Preito geothermal fields established under the recently signed U.S. - Mexico cooperative geothermal program.

The purpose of the trip is two fold. 1) Dr. Wright will prepare detailed plans with Mexican scientists for an aeromagnetic survey of the Los Azufres geothermal field. The purpose of this survey is to test the applicability of using aeromagnetic data as an exploration technique and as a method of developing a better understanding of the fault distributions in mountainous volcanic terrains. 2) Wright will also review existing geophysical data from Los Azufres and Cerro Prieto, and formulate specific plans for numerical modelling of the data. He will obtain copies of the data for distribution to other members of the working groups and for the initial modelling efforts.

The results of the joint research will be published in the U.S. literature where it will be available to the U.S. geothermal industry. The results of these studies will be of particular importance to the U.S. geothermal industry currently involved in exploration of volcanic systems which occur in the northwestern U.S.

Dr. Howard P. Ross

Dr. Howard P. Ross is Section Head, Applied Geophysics of the University of Utah Research Institute. In this capacity Dr. Ross manages and directly participates in geophysical studies which are part of the U.S. Department of Energy's Geothermal Programs as well as other governmental and private projects. Dr. Ross is a recognized authority on the application of geophysical techniques to geothermal exploration and in the numerical modelling and interpretation of geophysical data.

Dr. Ross will assist Dr. Wright in the design, preparation for, and in-flight completion of an aeromagnetic survey of the Los Azufres geothermal field. The purpose of the trip is to assist in the installation and testing of the aeromagnetic survey equipment, and in the in-flight data recording during the aeromagnetic survey. Dr. Ross will supervise the data recovery and compilation operations. The purpose of this survey is to test the applicability of using aeromagnetic data as an exploration technique and as a method of developing a better understanding of the fault distributions in mountainous volcanic terrains. Dr. Ross will also review existing geophysical data from Los Azufres and Cerro Prieto, and formulate specific plans for numerical modelling of the data. He will assist team members

in data interpretation efforts.

The results of the joint research will be published in the U.S. literature where it will be available to the U.S. geothermal industry. The results of these studies will be of particular importance to the U.S. geothermal industry currently involved in exploration of volcanic systems which occur in the northwestern U.S.

Timing: Intended travel dates - 1 March to 11 march, 1988

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