UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Saudi Arabian seismic deep-refraction profile:

Final project report

by

J. H. Healy 1/, W. D. Mooney 1/, H. R. Blank 2/, M. E. Gettings 2/,

W. M. Kohler 1/, R. J. Lamson 1/, and L. E. Leone 1/

Open-File Report 83-390

Prepared for the Ministry of Petroleum and Mineral Resources
Deputy Ministry for Mineral Resources
Jiddah, Kingdom of Saudi Arabia

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

1/ U.S. Geological Survey, Menlo Park, CA.
2/ U.S. Geological Survey Mission, Jiddah, Saudi Arabia

1983

CONTENTS

Page

Following page

ILLUSTRATIONS

Page

TABLES

APPENDICES

ABSTRACT

In February 1978 a seismic deep-refraction profile was recorded by the U.S. Geological Survey along a 1000-km line across the Arabian Shield in western Saudi Arabia. The line begins in Mesozoic cover rocks near Riyadh on the Arabian Platform, leads southwesterly across three major Precambrian tectonic provinces, traverses Cenozoic rocks of the coastal plain near Jizan (Tihamat-Asir), and terminates at the outer edge of the Farasan Bank in the southern Red Sea. More than 500 surveyed recording sites were occupied, including 19 in the Farasan Islands. Six shot points were used: five on land, with most charges placed below the water table in drill holes, and one at sea, with charges placed on the sea floor and detonated from a ship. Slightly more than 61 metric tons of explosives were used in 19 discrete firings.

Seismic energy was recorded by 100 newly-developed portable seismic stations deployed in approximately 200 km-long arrays for each firing. Each station consisted of a standard 2-Hz vertical component geophone coupled to a self-contained analog recording instrument equipped with a magnetic-tape cassette.

In this final report, we fully document the field and data-processing procedures and present the final seismogram data set as both a digital magnetic tape and as record sections for each shot point. Record sections include a normalized set of seismograms, reduced at 6 km/s, and a true-amplitude set, reduced at 8 km/s, which have been adjusted for amplifier gain, individual shot size, and distance from the shot point.

Appendices give recorder station and shot information, digital data set descriptions, computer program listings, arrival times used in the interpretation, and a bibliography of reports published as a result of this project.

We used two-dimensional ray-tracing techniques in the data analysis, and our interpretation is based primarily on horizontally layered models. The Arabian Shield is composed, to first-order, of two layers, each about 20 km thick, with average velocities of about 6.3 km/s and 7.0 km/s, respectively. At the western shield margin the crust thins to less than 20 km total thickness, beyond which the Red Sea shelf and coastal plain are interpreted to be underlain by oceanic crust.

A major crustal lateral velocity inhomogeneity northeast of Sabhah in the Shammar Tectonic Province is interpreted as the suture zone of two crustal blocks of different composition. Several high-velocity anomalies in the upper crust correlate with mapped gneissic dome structures. Two intra-crustal reflectors at 13 km depth are interpreted as the tops of mafic intrusives.

The Mohorovicic discontinuity beneath the shield varies from 43 km depth in the northeast with 8.2 km/s mantle velocity to 38 km depth in the southwest with 8.0 km/s mantle velocity. Two velocity discontinuities are identified in the upper mantle, at 59 and 70 km depth.

We suggest further work, including refined analyses of the data employing filtering and synthetic seismogram techniques, as well as consideration of attenuation properties. Extension of the seismic refraction profile to the Arabian Gulf and some short profiles perpendicular to the existing profile would be fruitful areas for future field work.

INTRODUCTION

Purpose and rationale

A large-scale seismic deep-refraction line across the Arabian Shield and coastal plain of the Kingdom of Saudi Arabia was proposed in 1974 by the geophysics group of the U.S. Geological Survey Saudi Arabian Mission/Directorate General of Mineral Resources (USGS/DGMR). The refraction profile was included as a part of the geophysics program of the DGMR Sectoral Plan, Second Five-Year Development Plan, and constitutes part of a larger program to delineate the crustal structure and tectonic framework of a 150-km-wide strip transecting the major tectonic, structural, and lithologic provinces of the Arabian Shield. This program, colloquially referred to as the "geophysical strip," was envisioned to comprise an integrated investigation of the aeromagnetic, gravitational, electrical, electromagnetic, and seismic velocity responses of the crust along the strip. For best constraint on the interpretations, an area was chosen for which there are reasonably complete sets of high-quality geologic maps at 1:100,000, 1:250,000, and 1:500,000 scales.

The refraction profile extends for about 1,000 km, approximately down the center of the strip; it is roughly parallel to the southeastern boundary of the shield and roughly perpendicular to other first-order structural boundaries (fig. 1). Starting in the northeast at the Mesozoic sedimentary platform rocks west of Riyadh, it traverses the Al Amar-Idsas fault zone, the Shammar, Najd, and Hijaz-Asir tectonic provinces (Greenwood and others, 1980), the exposed western margin of the continental plate at the foot of the Asir escarpment, and almost all of the eastern Red Sea shelf, from coastal plain to axial trough in the southern Red Sea.

We were primarily seeking information on the thickness, structure, and bulk composition of crustal layers to the depth of the Mohorovicic discontinuity (40 km or more), which could then be correlated with geologic and other geophysical data. The profile parameters were chosen to yield data that would allow us to examine fundamental questions concerning the late Proterozoic cratonization and tectonic evolution of the Arabian Shield, the origin and significance of tectonic, magmatic, and metallogenic provinces of the shield, and the nature of a continental plate margin in an active spreading zone. In addition to its intrinsic importance, a thorough understanding of the tectonic framework of Saudi Arabia is essential so that strategies for mineral exploration can be developed.

There are two basic approaches to mineral exploration. One approach involves immediate prospecting, with drilling and sampling based on surficial indications of mineral resources. The other involves the development of a sound geologic model of the region from which the processes that have acted on the region in the geologic past can be inferred. This model is then used to develop exploration strategies based on known associations of geologic processes with mineral occurrence. In a region that is rich in surficial mineral deposits the first approach is generally more efficient. But in a region that has been thoroughly prospected in the past, so that new mineral resources are less likely to be located by surficial prospecting, the second approach has many advantages. Usually, some combination of the two approaches makes up an exploration program, as it does in Saudi Arabia. Part of our goal in Saudi Arabia was to design a refraction profile line leading to a crustal model that could be compared with results from other studies, where mineral occurrence and crustal structure have been correlated.

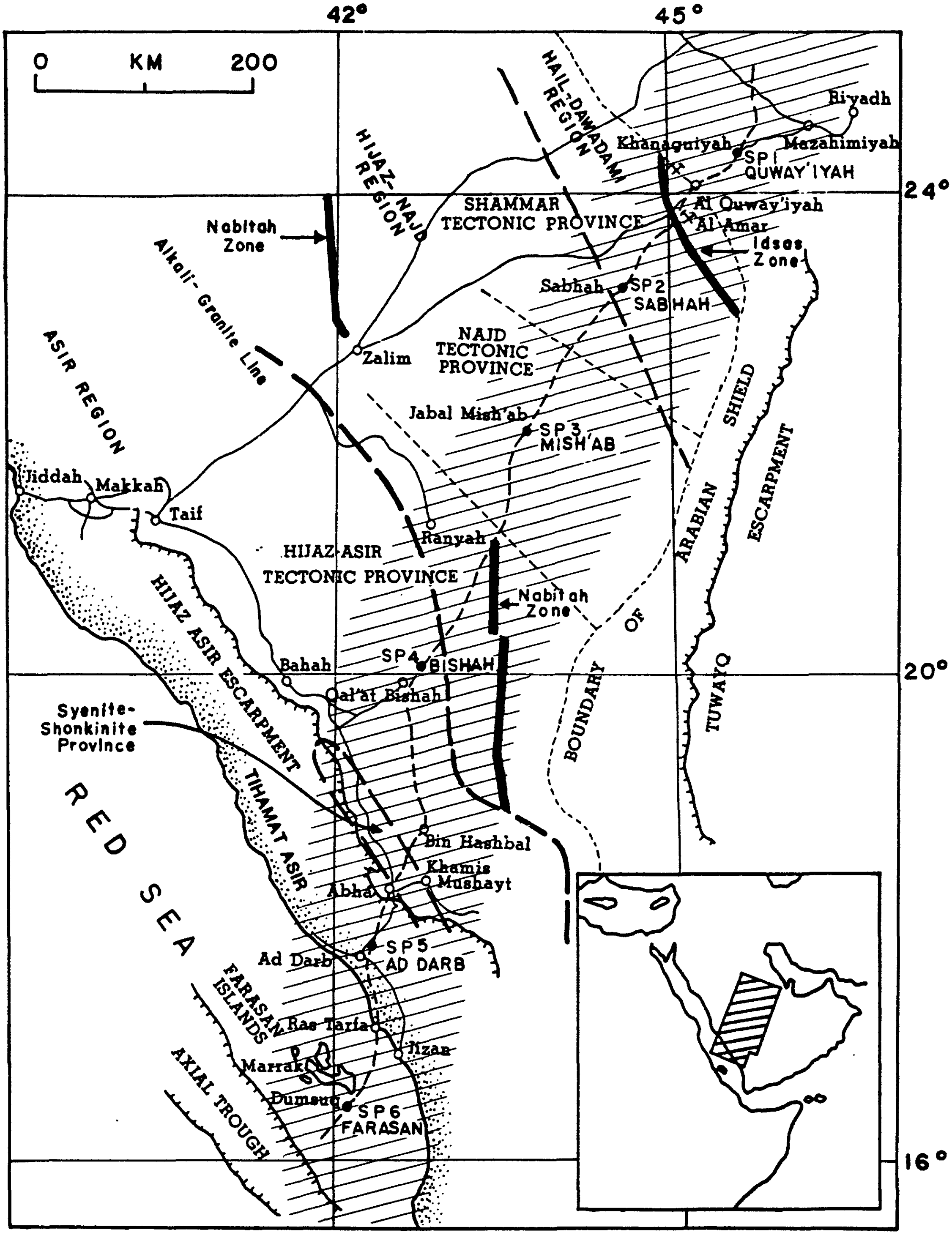


Figure 1.--Index map of western Saudi Arabia showing seismic refraction profile. Profile shown as dashed line connecting shot points (SP). Hatchured area is the coverage of the "geophysical strip". Tectonic provinces shown are from Greenwood and others (1980). Petrologic regions and boundaries from Stoeser and Elliott (1979). Nabitah and Idsas zone taken from Schmidt and others (1978). Paved access roads shown by thin solid lines.

In discussing seismic refraction methods, it is important to recognize how they differ from seismic reflection methods. The reflection method is, perhaps, the most powerful method for investigating sedimentary basins or other areas where flat-lying boundaries are present in the subsurface. It is, however, much less effective in crystalline rock terrane where boundaries tend to be irregular and do not produce clear reflections that can be identified over large distances. It is probable that new techniques for use in the exploration of crystalline rocks will evolve, combining refraction and reflection methods, and we expect that they will become powerful tools for exploration in regions such as the Saudi Arabian Shield.

Chronology of the seismic deep-refraction profile project

During January and February of 1978 the USGS recorded a seismic deep-refraction profile across western Saudi Arabia in accordance with the objective of Program 6.9 of the DGMR Sectoral Plan, Second Five-Year Development Plan, and under the terms of the Fourth Extension of a Work Agreement between the USGS and the Ministry of Petroleum and Mineral Resources. Initial plans and preparation for this large undertaking are documented by Status Reports No. 1 (Anonymous, 1976) and No. 2 (Lamson and Blank, 1978).

The refraction experiment was carried out by a team of specialists from the USGS Office of Earthquake Research and Crustal Studies, Menlo Park, California, under the direction of J. H. Healy, and with the assistance of the USGS Mission professional staff and support personnel in Jiddah. Administrative responsibility rested with the USGS Mission. Both groups also provided technical advice and logistical support for two closely-related projects concerning borehole temperature logging and microearthquake recording that were conducted by the geophysics group of DGMR.

One hundred new, advanced, portable seismographs were developed by the USGS (Menlo Park group) for use on the Saudi Arabian profile. Each of the cassette-tape recording units was equipped with an internal crystal clock and a programmable automatic-turn-on device so that they could easily be deployed successively in each of five 200-km recording spreads. A portable computer center that included a field tape playback, digitizer, and plotting system was moved along the profile to provide rapid feedback of the data quality and content and to allow for preliminary assessment of scientific results as the experiment progressed.

Five drillhole shot points were on land; the sixth shot point was at the southwest end of the profile in the Red Sea, where explosives on the ocean bottom were detonated from a ship. Temperature profiles were logged in the drill holes immediately before explosives were loaded. Shot arrivals (and seismicity) were also recorded at five Geotech Portacorder portable recorder stations on the Red Sea coastal plain (Tihamat-Asir). The temperature logging and the Tihamat-Asir project were executed by the geophysics group of the DGMR.

Lamson and Leone (1979) began processing the data at the USGS offices in Menlo Park, California; they compiled a catalog that included a partially filtered plot of the first 2.5 s of each record at each recorder site and a spectral analysis of the last half of this 2.5 s record interval. A first-arrival analysis of the data set was then made, using the partially-filtered plots. Next, computer software was developed so that the data could be conveniently edited and/or filtered. The raw data were then completely re-digitized from the original field cassette tapes and edited to increase the length of the data record, the density of samples within each record, and to include calibration information needed for true-amplitude calculations. New normalized record sections were prepared from the re-digitized data set at reduction velocities of 6 and 8 km/s.

The record sections, along with the preliminary report (Blank and others, 1979), a 1:2,000,000 scale geologic map (U.S. Geological Survey-Arabian American Oil Company, 1963), and the catalogs of Lamson and Leone (1979), were distributed to members of the Commission for Controlled Source Seismology (CCSS) of the International Association for Seismology and Physics of the Earth's Interior (IASPEI). The CCSS, which includes many of the world's leading refraction seismologists, had agreed to undertake interpretation of the Saudi Arabian seismic deep-refraction profile in order to investigate improved methods of interpreting laterally inhomogeneous earth structure.

Kohler and others (1979) completed a preliminary analysis of P-wave attenuation on the Arabian Shield using the method of spectral ratios. Lamson and others (1979) and Blank and others (unpub. data) have interpreted the southwest end of the profile from shot point 4 to shot point 6 across the boundary between the Precambrian shield and the Red Sea crust. Preliminary reports of these analyses were given at the 1979 annual winter meeting of the American Geophysical Union in San Francisco.

The interpretations of the Saudi Arabian refraction data by the members of the CCSS working group resulted in 18 written and oral papers, which were presented at a meeting in Park City, Utah, 10-16 August 1980 (see Mooney, 1980). The volume of the proceedings of this meeting (in preparation) will contribute substantially to our understanding of the structure of the Arabian Plate-Red Sea system.

Results of the Tihamat-Asir microseismicity study are reported in Merghelani and Gallanthine (1980), and the heat flow studies in Gettings (1981), Gettings and Showail (1982), and Gettings (1982).

The remainder of this report contains a summary of the geologic setting of the refraction profile transect and a discussion of its first-order gravity, magnetic, and heat flow features, as well as the results of previous seismic investigations along it. We have documented the refraction profile field operations and the data processing, and presented the final record sections (pls. 1-6) with a discussion of their uncertainties. Our traveltime analysis of the record sections, which included use of two-dimensional ray-tracing techniques, is followed by a general discussion of the seismically-defined features of the sedimentary platform, various tectonic provinces of the shield, and the Red Sea system. In the conclusions we recommend areas for further seismic refraction research and identify some of the data that is likely, with further analysis, to yield further insight into the crustal structure.

This is the concluding report of the 1978 Saudi Arabian seismic deep-refraction profile project. Our purpose has been to document the fieldwork and present the final digitized data in the form of both digital tapes and large-scale record sections suitable for continued analysis by seismologists studying a wide spectrum of problems in the Red Sea-Arabian Plate System. We hope that we have provided a framework for continued work in many fields of earth science, and that the refraction data set as a whole represents an important and fundamental contribution to our understanding of the Arabian Plate.

Acknowledgments

We wish to acknowledge the assistance of many people in the Saudi Arabian Mission of the U.S. Geological Survey, Jiddah, Saudi Arabia, the Office of Earthquake Studies, U.S. Geological Survey, Menlo Park, California, and the Office of International Geology, U.S. Geological Survey, Reston, Virginia.

The contributions of T. H. Kiilsgaard, F. S. Simons, and D. G. Hadley, all Chiefs of Mission, U.S. Geological Survey, Saudi Arabian Mission, and their administrative officer, Ron DeMatteo, were essential to the success of this project and we wish to thank them for accepting the administrative burdens that were involved in our activities. We especially wish to thank Ahmad Shams, acting USGS liaison officer, who helped us to obtain permits from the various government agencies in Saudi Arabia.

The following people from the U.S. Geological Survey and from our computer system contractor, ArgoSystems of Sunnyvale, California, carried out the field work in Saudi Arabia. The importance of their contributions to the success of this project can only be appreciated by those who were present during the experiment.

G. E. Andreasen
M. Bazzari
H. R. Blank
C. G. Bufe
E. E. Criley
J. G. Delgado
J. G. Everhart
F. G. Fischer
C. R. Frey
S. K. Gallanthine
M. E. Gettings
J. H. Healy
W. Jackson
E. G. Jensen
R. M. Kaderabek
W. M. Kohler
R. J. Lamson
R. W. McClearn
H. M. Merghelani
J. C. Roller
M. A. Spieth
D. J. Stuart
J. F. Svitek, Jr.
D. E. Taylor
A. Uthman
S. S. Wegener
S. S. Allen (Argo)
C. A. Lipkie (Argo)
T. Wright (Argo)

D. J. Faulkender, F. Fuller, Munir M. Asshatri, and Meghim S. Almutayri surveyed all the recording locations prior to the experiment and assisted in finding station locations during the refraction work. Their careful work was an important contribution.

The support staff who provided our daily living requirements while in the field made our work easier and our experience in the field camps pleasant and memorable. We wish to express our thanks to L. Finesecy and the many individuals who were involved in preparing the field camps and supporting us in the field.

We would particularly like to thank P. L. Ward, J. R. Van Schaak, J. P. Eaton, and D. P. Hill in the Office of Earthquake Studies, Menlo Park, and R. M. Hamilton, Reston, for their continued support of this work.

We also wish to thank a number of people who assisted in the completion of this report. R. Rebello and D. Kruger typed and edited the report, adding much to its clarity. L. Hoffman supervised the production of the final record section plots, J. Sharp assisted in the completion of the velocity models, and S. Cranswick drafted the figures. D. H. Warren and S. W. Stewart provided valuable criticisms of the text.

This project was carried out under the auspices of a work agreement between the Directorate General of Mineral Resources, Kingdom of Saudi Arabia, and the U.S. Geological Survey. We especially thank H. E. Ghazi Sultan, Deputy Minister of the Directorate General of Mineral Resources, and his staff for their continued support and assistance throughout this work.

GEOLOGIC SETTING

Overview

The generalized geology of the area of the refraction profile is shown on plate 7, modified from Brown (1972). The tectonic map of Brown (1972) should be consulted to supplement and clarify the geologic relations discussed here. Most of the refraction profile traverses the Arabian Shield (fig. 1), which consists predominantly of Precambrian metamorphic and plutonic rocks and forms the western one-third of the Arabian Peninsula. The shield is thought to have evolved from island arcs that formed during a series of subduction episodes and were subsequently juxtaposed by compressional orogenies (Schmidt and others, 1978). To the east, the shield is bounded by the Mesozoic sedimentary rocks of the Phanerozoic Arabian Platform, which dip gently eastward and onlap unconformably upon the shield (Powers and others, 1966). To the west the shield abuts the Tertiary rocks at the eastern edge of the Red Sea seafloor spreading system. This tectonic boundary is charcterized by complex faulting and Tertiary dike injections and volcanism.

We do not describe the geology along the refraction profile in detail, but a summary and references to the literature follow. The description follows the profile line from northeast to southwest, starting with the sedimentary platform, crossing the shield, and ending with the Red Sea seafloor spreading system.

The Phanerozoic Platform

Powers and others (1966) have summarized the sedimentary geology of the Arabian Peninsula; the 1:2,000,00 scale Arabian Peninsula Geologic Map (U.S. Geological Survey-Arabian American Oil Company, 1963) shows the geologic field relations. The geological sketch given here is drawn entirely from these two references.

The extreme northeast end of the refraction line is situated in the Jurassic Dhruma formation, which is predominantly limestone and shale. Proceeding southwest, the line crosses the exposed strata of the eastward-dipping sequence of Marrat shales and limestones (Lower Jurassic), an unconformity, the Minjur sandstone (Lower Jurassic or Triassic), the Jilh sandstones and limestones (Triassic), and the Sudair shale (Lower Triassic or Permian) at shot point 1. Continuing southwest, the refraction line crosses the Upper Permian Khuff limestone and shale, which is the base of the sedimentary sequence in this locality, lying unconformably on the metamorphic rocks of the shield (Powers and others, 1966; see fig. 1 and pl. 7).

The sedimentary rocks dip very gently and uniformly to the east-northeast, from about 1.0° at the base of the section to about 0.3° in the Upper Cretaceous and Eocene rocks, which indicates a long history of very gradual subsidence (Powers and others, 1966). This area, the interior homocline (Powers and others, 1966), has two parts: one to the north of Riyadh where the strike is to the northwest, and the other south of Riyadh where the strike is to the southwest. The separating structure, known as the central Arabian arch (Powers and others, 1966), trends approximately east-west and has a complex history of epirogenic movement in the Paleozoic and early Mesozoic. During the Middle Cretaceous, the arch became a flexure zone between a region of uplift to the south and a region of subsidence to the north (Powers and others, 1966). During the Paleocene and Eocene, subsidence continued in the north but also occurred in the south, forming the Rub al Khali basin. The zone between the southern and northern regions did not subside, and the arch, a broad, ridge-like feature, resulted (Powers and others, 1966). Fault and graben systems developed along the axis of the arch and along a northwest-trending arc to the north during the late Mesozoic and early Tertiary (Powers and others, 1966). The recorder stations at the northeast end of the refraction line were located on the northern side of the arch, to the west of the main fault and graben system, and enter the rocks of the Precambrian shield approximately at the western extension of the arch axis.

The Arabian Shield

The Arabian Shield is a stable craton of predominantly late Precambrian metamorphic and plutonic rocks. It occupies an area of about 770,000 km^2 and is composed of approximately 40 percent granitoid rocks and 60 percent volcanic and sedimentary rocks, all of which have been metamorphosed to varying degrees. The geologic history of the shield is complex, and many important details remain to be clarified. We have briefly described the major tectonic, petrologic, and structural/lithologic provinces and regions that may relate to the seismic velocity structure of the Arabian Shield. More detailed descriptions of the general geology of all or parts of the shield may be found in Brown and Jackson (1960), Brown (1972), Schmidt and others (1973), Greenwood and others (1980), Brown and Jackson (1978), Schmidt and others (1978), and Hadley and Schmidt (1979), among others. The major geochronologic relationships are given in Baubron and others (1976), Fleck and others (1976), Aldrich (1978), Brown and others (1978), Cooper and others (1979), Fleck (1980), and Stacey and others (in press).

The generalized history of the development of the shield is summarized by Schmidt and others (1978), from whom we quote here (see fig. 1 and pl. 7 for place names):

"The Arabian Shield was formed by successive accretions of newly formed crust between 1,000 and 700 m.y. ago. Successively younger island arcs formed to the east as west-dipping subduction zones shifted eastward. West of Bishah, the volcanic-plutonic crust had consolidated against Africa by about 78 m.y. ago when westward-directed subduction ceased at the Nabitah suture.

"A new marginal island arc formed subsequently east of Bishah in the southern Najd, and subduction was renewed at the Idsas suture in the eastern Najd. The volcanic arc consisted of calc-alkaline volcanic rocks (Halaban group), dominantly andesite but ranging from basalt to dacite, and comagmatic, subvolcanic plutonic rocks, dominantly diorite but ranging from gabbro to trondhjemite. About 725 m.y. ago this primitive crust was thickened by large intermediate-depth plutons of hornblende tonalite and mafic granodiorite. Compressive tectonism produced folds and faults of northerly trends and was accompanied by greenschist facies metamorphism.

"A continental collision occurred east of the Najd Province about 625 m.y. ago and initiated extensive compressional orogeny and potassic granite plutonism throughout the Shield. Large, syntectonic batholiths of calc-alkaline, leucocratic, biotite granodiorite-monzogranite formed the cores of large north-trending gneiss domes that were asymmetric toward the west. The domes consist of tonalitic and granodioritic orthogneiss that represents the low-density, plutonic part of the earlier Halaban crust. Strong compression resulted in northerly-trending structures including large west-directed thrust faults.

"Posttectonic, diapiric plutons of granite and alkalic granite intruded the eroding crust at progressively shallower levels until about 600 m.y. ago. Molasse deposits of the Murdama group transgressed westward across the eroding crust and were subsequently deformed along northerly trends. Renewed compression of the now thick continental crust resulted in large, northwest-trending Najd faults that have left-lateral displacements aggregating 300 km. The Najd faulting terminated about 560 m.y. ago. Transgressive, quartzose sandstone of early Paleozoic age subsequently covered the stabilized craton."

Greenwood and others (1980) and Schmidt and others (1978) have divided the Arabian Shield in this area into several tectonic provinces. The region from the Phanerozoic sediments to approximately midway between shot points 2 and 3 (fig. 1) is designated the Shammar tectonic province. It is composed of calc-alkaline, late-tectonic granitic rocks and extrusive equivalents, and metamorphosed sedimentary and volcanic rocks of the greenschist facies (Brown, 1972). The Idsas suture zone, which is marked by the trace of the Al Amar-Idsas thrust fault (Schmidt and others, 1978), extends north-northeast in an arc that is truncated at both ends at the boundary of the shield (fig. 1). The shield rocks to the northeast of the fault are those of a westward thrust block (pl. 7; fig. 1) that has been interpreted as the western edge of an allochthonous continental crust sutured to the rest of the shield along the Idsas zone. Evidence from lead isotope studies of mineralized zones in this area suggest that this block may be underlain by much older crust of about 2100 m.y. (million years) in age (Stacey and others, in press).

The Shammar tectonic province is bounded to the southwest by the Najd tectonic province. These provinces are separated by the northern Najd fault zone, an area of extensive left-lateral strike-slip faulting. The Najd tectonic province continues as a broad, northwest-trending belt to about midway between shot points 3 and 4 (fig. 1). The province is characterized by large amounts of syntectonic granites intruding predominantly andesitic metavolcanic and metasedimentary greenstones and greenschists (Brown, 1972; Schmidt and others, 1978). Ubiquitous faulting, tectonism, and extensive intrusion of mafic dike material also characterize this province.

The Najd province is bounded on the southwest by the southern Najd fault zone and the Hijaz-Asir tectonic province, which extends to the Hijaz-Asir escarpment. This province is not severely affected by tectonism as is the Najd province. It is composed of several subprovinces, or belts, all north-trending. Proceeding from northeast to southwest, one first encounters a zone of serpentinized ultramafic rocks, designated the Nabitah fault or suture zone (Schmidt and others, 1978), and interpreted as the expression of a Precambrian subduction zone. To the west is an area of asymmetric gneiss domes; these are thought to be the crust of the marginal basin compressed and folded into nappe structures by a subsequent seafloor-spreading episode to the east (Schmidt and others, 1978).

The gneiss dome belt terminates approximately 40 km southwest of Bishah, and a belt of metavolcanic and metasedimentary rocks is encountered. The rocks are predominantly andesitic to basaltic in composition; they increase in age and proportion of basalt toward the west. Schmidt and others (1978) believe that these rocks represent the oldest of the island arcs forming the shield and have the most primitive composition. They are, in some cases, severely deformed, show varying degrees of metamorphism, and are intruded by granitoid batholiths of pretectonic age.

Stoeser and Elliott (1979) have defined petrologic regions of the shield on the basis of the composition and proportions of granitoid rocks. A boundary (fig. 1) trending north-northwest about 30 km southwest of shot poin 2 and following the northernmost Najd faults separates the Hail-Dawadami Region, an area predominantly composed of granites, from the Hijaz-Najd Region. The Hijaz-Najd Region, a broad, northwest-trending area whose southwestern boundary crosses the profile approximately at shot point 4, is defined by the presence of alkalai granites, which do not occur west of the southwestern boundary, termed the alkalai-granite line (Stoeser and Elliott, 1979).

The remaining petrologic region, the Asir Region (Stoeser and Elliott, 1979), lies between the alkalai-granite line and the western edge of the shield. No alkalai granites have been found in it, and calc-alkaline granites are very sparse. A narrow, linear belt of syenite and shonkinite intrusives parallel to the Red Sea crosses the refraction profile approximately at Abha (fig. 1); this belt is referred to by Stoeser and Elliott (1979) as the syenite-shonkinite province.

Ramsay and others (1979) have defined a series of structural/lithologic provinces of the Arabian Shield (fig. 2) along a geotraverse that coincides with a portion of the seismic refraction line. We quote from the abstract of Ramsay and others (1979):

"A N.E.-trending field traverse across the Arabian Shield (approximately $41^{o}30$'E/$23^{o}30$'N), combined with photo-interpretation, existing maps, and geophysical data, has resulted in a strip-map covering about 600 x 100 km. This map reveals distinct structural/lithological provinces. From S.W. to N.E. these are:

"(1) Salibah Province. High-grade metasediments and metavolcanics, and low-grade metavolcanics; numerous granitoid plutons and some diorite-gabbro complexes.

"(2) Bahah Province (100-150 km wide). A western belt of metasedimentary schists, a central belt of metavolcanic schists, and an eastern belt of less metamorphosed and deformed sediments and andesites. Syn-tectonic quartz diorite-diorite-gabbro complexes exceed post-tectonic granitoid plutons. The An-Nimas batholith is the largest of these complexes.

"(3) Ranyah Province (100-150 km). A western belt of basic metavolcanics and metasediments, and an eastern belt in which granitic gneissic rocks predominate. Both belts are intruded by post-tectonic granites.

"(4) Tathlith Province (poorly represented here). Schists, amphibolites, metamorphosed granites, and slightly metamorphosed sediments.

"(5) Juqjuq Province (50 km). Slightly metamorphosed and deformed clastic sediments and volcanics, intruded by a post-tectonic granite batholith.

"(6) Dahul Province (90 km). Granitic gneiss and meta-granites intruded by post-tectonic granites.

"(7) Shumrah Province (30 km). A diorite-gabbro complex (subordinate granitic rocks), intruded into metavolcanics.

"(8) Kushaymiyah Province (50 km). Slightly metamorphosed clastic sediments intruded by circular granites, and a north-trending belt of radioactive granites.

"(9) Tays Province (50-100 km). Gneisses and amphibolites unconformably overlain by schists and meta-andesites, with ultrabasic complexes and a few post-tectonic granites.

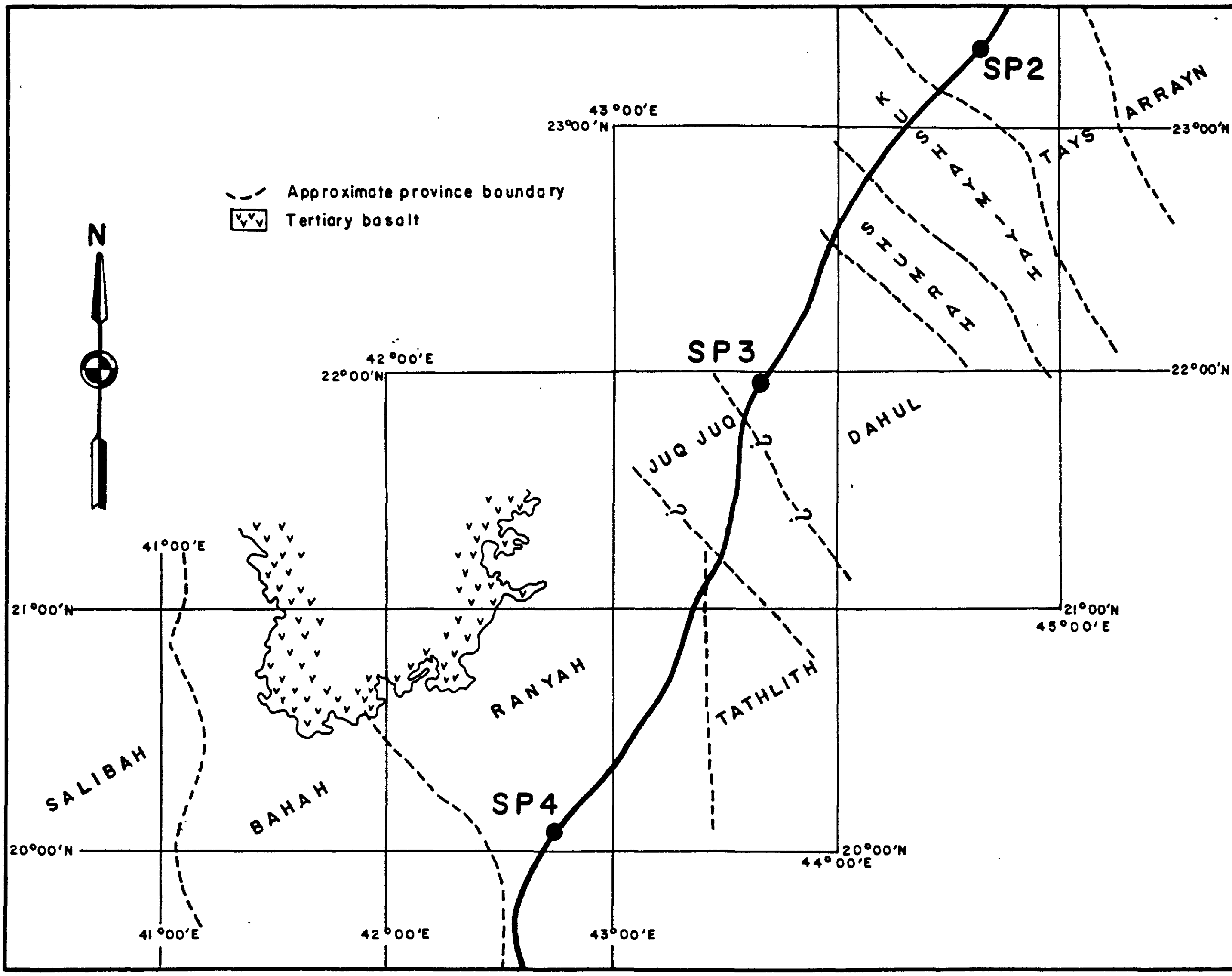


Figure 2.--Structural/lithologic provinces of Ramsay and others (1979). Track of seismic refraction profile and shot points are shown. See text for province descriptions.

"(10) Ar-Rayn Province (exposed for 40 km). Foliated granites with minor gneiss, gabbro and metavolcanics.

"We conclude that these provinces are fundamentally characteristic of the Arabian Shield, and could have important implications in the interpretation of gross stratigraphy, structure, and evolutionary models."

The Red Sea and continental margin

The Red Sea is one of the world's youngest ocean basins. It is accepted that the narrow, central axial trough is a seafloor spreading center associated with the separation of Arabia from Africa (Vine, 1966; McKenzie and others, 1970; Lowell and Genik, 1972; Girdler and Styles, 1974; Le Pichon and Francheteau, 1978). Axial magnetic anomalies indicate that new oceanic crust has been forming for approximately the last 4-5 m.y. at about 1 cm/yr (Vine, 1966; Phillips, 1970; Roeser, 1975; Noy, 1978; Hall, 1979).

Most of the Red Sea "depression" is occupied by the "main trough" (Drake and Girdler, 1964). The axial trough—main trough boundary is not everywhere sharply distinguished (particularly in the northern Red Sea), and the terminology of different authors to designate the various structural and physiographic elements easily leads to confusion. However, between latitudes 16°N and 17°N (the latitude of the refraction profile line), the eastern margin of the axial trough is a steep submarine escarpment, and all of the main trough to the east is above the 100-m bathymetric contour (see Laughton, 1970). The seaward portion of the main trough in this region will be referred to as the "shelf" and the landward portion as the "Tihamat-Asir," which is the formal geographic name for the coastal plain of southwestern Saudi Arabia. We deliberately avoid use of the term "Red Sea rift" except where we wish to indicate that portion of the Red Sea structural depression floored mainly by sialic crust and formed prior to continental separation by seafloor spreading.

The nature of the crust beneath the main trough is not yet established unequivocably. Consequently, the total amount of separation between Arabia and Africa remains a matter of debate. The remarkably close fit of opposing shorelines strongly suggests that nearly the entire width of the Red Sea is due to crustal separation (e.g., Wegener, 1915). This venerable concept is now reinforced by palinspastic reconstructions of Precambrian structures across the Red Sea (Abdel-Gawad, 1970; Greenwood and Anderson, 1977), by stratigraphic and physiographic evidence for 105 km of post-Cretaceous sinistral shear on the Dead Sea rift (Quennell, 1958; Freund and others, 1968, 1970), and by compelling geophysical evidence from magnetic anomalies (Girdler and Styles, 1974).

Various plate tectonic models (Laughton, 1966; Le Pichon and Heirtzler, 1968; Roberts, 1969; Freund and others, 1970; McKenzie and others, 1970; Girdler and Darracott, 1972; Lowell and Genik, 1972; Girdler and Styles, 1976; Le Pichon and Francheteau, 1978; Hall, 1979) have been proposed to account for the opening of the Red Sea-Gulf of Aden, most involving relative movement of five rigid plates: Arabia, Nubia, Somalia, Sinai, and Danakil. The pole of rotation for Arabia with respect to Nubia is generally calculated to be in northern Africa or the central Mediterranean. "Total opening" models require that most of the Afar depression at the southern end of the Red Sea is floored by oceanic crust to account for the overlap when Arabia is fitted back onto Africa, and also require that the Danakil continental block in Afar is small and rotated about 30 degrees counterclockwise during the spreading process. Paleomagnetic investigations support the rotation of Danakil (Burek, 1970, 1972).

Despite the intensive program of geophysical surveys and geologic mapping carried out in Afar, considerable disagreement exists as to whether its crust is predominantly oceanic or attenuated continental material (Mohr, 1970; Baker and others, 1972). Spreading processes are evidently active in Afar and new oceanic-type crust has been forming there for at least the past 1-2 m.y. (Tazieff and Varet, 1969; Barberi and Varet, 1977). The gravity and seismic data in this area indicate a transition between oceanic and continental properties. Locally within the Afar depression the thickness of the crust ranges from 0 to 8 km, whereas beneath the adjacent Ethiopian plateau it is about 40 km thick (Ruegg, 1975).

Delineating the nature of the crust of the Red Sea shelves and coastal plains is even more difficult than it is in Afar because most of the shelves and coastal plains are almost completely covered by clastics and evaporites. Fortunately, in southwest Saudi Arabia the shield margin is reasonably well exposed, and one can examine geologic relations in the structural transition zone in detail.

Both Precambrian (Late Proterozoic) rocks and the younger, covering rocks of the shield margin at the eastern edge of the Tihamat-Asir have been invaded by closely-spaced diabase dikes, then cut into narrow northwest-trending tectonic slices that were then rotated counterclockwise. The number of dikes and the dike/host volume ratio both increase from east to west across the shield margin; westernmost exposures consist entirely of sheeted dikes, pillow lavas, and volcanoclastics. Masses of gabbro and granophyre or related rocks intrude the dike complex. The entire assemblage has close petrochemical affinities with oceanic tholeiite. Ghent and others (1980) and Blank (1977) consider the exposed western edge of the shield to mark the oceanic-continental crustal boundary, principally on the basis of gravity data presented by Gettings (1977). These authors interpret lateral offsets of the dike swarm as Tertiary transform faults. The region to the west of the shield margin in southwest Saudi Arabia should thus be floored by mafic crust of Tertiary age, and the total opening of the Red Sea at this latitude probably exceeds 350 km (Arabian Shield margin to western shore at the northern tip of Danakil). Linear magnetic anomalies, which Gettings (1977), Hall and others (1977), Hall (1979), and Blank and others (1981) infer to have resulted from sea-floor spreading processes, substantiate the Tertiary age and 350-km-wide opening at this latitude.

The chronology of the development of the Red Sea rift is still being deciphered. Marine incursions in the Red Sea-Gulf of Suez region may date back to Carboniferous time (Heybroek, 1965), and certainly occurred during the Mesozoic and early Tertiary. Linear magnetic anomalies over the shelves of the southern Red Sea have been interpreted as evidence of seafloor spreading in Eocene-Oligocene time (Girdler and Styles, 1974) or Oligocene-Miocene time (Blank, 1977; Hall and others, 1977; Hall, 1979). Alternatively, the crust may have attenuated in the embryonic rift system. Analysis of marine magnetic anomalies in the Gulf of Aden led Girdler and others (1980) to conclude that emplacement of new oceanic crust in the Gulf of Aden probably occurred in at least three stages: 43-35.5 m.y. ago, 23.5-16 m.y. ago, and 4.5-0 m.y. ago. However, Cochran (1981) interprets the Gulf of Aden data as indicating that "organized" spreading (systematic plate divergence from a spreading axis) did not begin until about 15 m.y. ago, although crustal extension in both the Gulf of Aden and Red Sea areas began much earlier through the mechanism of diffuse dike injections, as earlier suggested by Laughton (1966).

Widespread flood-basalt volcanism on the margins of the Red Sea apparently began about 29-30 m.y. ago (Late Oligocene). In southwestern Saudi Arabia, the As Sarat plateau basalts at the edge of the Hijaz-Asir escarpment have been dated at 24-29 m.y. (Brown, 1970). The layered gabbro and granophyre of the Jabal at Tirf complex on the Tihamat-Asir is 22 $\pm$ 2 m.y. old, i.e., early Miocene (Coleman and others, 1972). Whether the emplacement of this gabbro was more or less synchronous with spreading is not conclusively demonstrated. Recent studies of offsets of 18-22 m.y.-old diabasic dikes on the Levant shear system (Bartov and others, 1980) indicate that most of the sinistral movement of the Sinai Plate relative to the Arabian Plate is accounted for by those offsets. This strongly supports a post-As Sarat, post-Jabal at Tirf age for most of the Red Sea crustal extension.

OTHER GEOPHYSICAL DATA

Aeromagnetic (Andreasen and others, 1980) and regional gravity data (Gettings, 1981) exist for the entire seismic profile except for the northern end, where the line extends onto the sedimentary rocks of the Arabian Platform. Gettings (1982) and Gettings and Showail (1982) report the heat flow observations made at shot points 1 through 5 of the seismic refraction line. Plate 8 shows profiles of these three sets of data. The aeromagnetic and gravity data are along straight-line segments between the shot points.

General features of the gravity profile

The simple Bouguer gravity anomaly profile (pl. 8) shows several distinctive features at both regional (several hundred km) and local (50 km or less) scales. The most striking feature is the abrupt transition from values near zero (+30 to -15 mgals) southwest of shot point 5 to values near -100 mgals shortly beyond the exposed boundary between the Tertiary age rocks and the Precambrian rocks southwest of shot point 5. The lithologic boundary occurs approximately at the halfway point on the gravity anomaly gradient, and the anomaly is approximately symmetric; therefore, we infer that the boundary dips steeply. Proceeding northeast, the regional gravity anomaly pattern is broad and concave for about 400 km, with a minimum value of about -120 mgal. Northeast of the Nabitah suture zone, which coincides with the southwestern Najd fault zone at this point, the regional gravity anomaly begins to increase. If the increase were linear, the gradient would be approximately 0.13 mgal km^{-1} between the Nabitah suture zone and the edge of the shield.

Gravity modeling of this profile (Gettings, 1977; Gettings, unpublished) indicates that the density of the crust southwest of the Precambrian shield boundary is characteristic of oceanic crust. The broad, concave regional pattern of the gravity anomaly profile from shot point 5 to the Nabitah zone, and the linearly increasing pattern to the northeast, indicate that the entire crust southwest of the Nabitah zone must be of somewhat higher average density than that to the northeast. This is consistent with Schmidt and others (1978), who interpret the crust southwest of the Nabitah to be more mafic in composition.

Superimposed on this pattern are several positive and negative local gravity anomalies of ± 30 mgal amplitude. The local negative anomaly at the southwest end of the profile is almost certainly due to salt diapirism beneath the emergent Farasan Islands. The local positive anomaly at the top of the steep gravity gradient southwest of shot point 5 is associated with Tertiary layered gabbro. The local negative anomaly correlating with the highest elevation of the escarpment is probably caused for the most part by terrain effects rather than geologic variations.

For the most part, the positive anomalies correlate with areas of greenstone or greenschist outcrop, and the negative anomalies correlate with areas of granitoid intrusives (geologic map, pl. 7, and pl. 8). Both the southwestern Najd fault zone (which, on this profile, coincides with the Nabitah ultramafic suture zone) and the northeastern Najd fault zone have positive gravity anomaly signatures. These zones also show strong magnetic anomalies and have numerous mafic dikes along them (see 1:500,000 geologic map of Jackson and others, 1963). We infer that the anomalous magnetic and gravity responses are caused by the mafic intrusives in the Najd fault zones.

The broad local positive gravity anomaly near the northeast end of the profile correlates with the high-grade metamorphic rocks that outcrop northeast of the Al Amar-Idsas thrust fault. The sedimentary wedge of the Arabian platform correlates well with the negative departure from the regional gradient at the northeast end of the profile.

General features of the aeromagnetic profile

Because of high variability in magnetic properties due to near-surface sources, the features of the magnetic field are best observed on a contour map (Andreasen and others, 1980). However, some relevant features can be ascertained from the profile along the seismic refraction line (pl. 8). The profile was flown at 150 m mean terrain clearance except the southwest end, starting midway between shot point 4 and 5, which was completed at 300 m clearance due to the rugged terrain.

At the northeast end of the profile, the block to the east of the Al Amar-Idsas thrust fault is characterized by large-amplitude, short-wavelength anomalies (10 km or less) that correlate well with the high-grade metamorphic rocks and intrusives that outcrop there. Across the thrust fault, the magnetic field changes radically, becoming very flat and of low intensity; this pattern extends nearly to the northeast Najd fault zone, although some expression of the Uyaijah ring complex (Dodge and Helaby, 1979) is seen just northeast of the Najd fault zone. This large magnetic quiet zone is similar to those found over stable granitic blocks of crust in both the Canadian and Australian Shields.

The Najd tectonic province (fig. 1, pl. 9) is characterized by numerous, short-wavelength ($\sim$5 km) magnetic anomalies, many of which may be due to east-west and northwest-southeast trending mafic dikes. These anomalies are, in general, not as intense in amplitude as those of the crustal block east of the Al Amar-Idsas thrust fault. In addition, longer-wavelength ($\sim$10 km), variable-amplitude anomalies are superimposed on the pattern. The short-wavelength anomalies continue across the southern boundary of the Najd province, although not in such profusion. Whether this pattern persists to the southwest beyond about midway between shot points 4 and 5 is uncertain because of the change to 300 m mean terrain clearance in the data.

The southward increase in overall magnetic intensity observed is at least in part a relic of the data removed arbitrarily from the flight path profiles by the contractor when compiling the maps (Andreasen and others, 1980) and probably does not reflect an actual overall southward increase in magnetization.

The magnetic signatures of the block east of the Al Amar-Idsas zone are distinctive, especially in map view (Andreasen and others, 1980), and suggest that this block may well represent a crustal type different from the rest of the shield, as suggested by Schmidt and others (1978) and Stacey and others (1981).

General features of the heat flow profile

The heat flow measurements taken during the seismic refraction field work in 1978 were the first to be made on the Arabian Shield. They were completed at shot points 1 through 5 by temperature-logging of the drillholes before the explosives were loaded. We determined thermal conductivities by modal analyses of thin sections of core samples taken at the shot points. At shot points 2, 3, and 4, drillholes were in granitic rocks, and heat production was measured. The plot of heat production versus heat flow is strongly non-linear; however, as there were only three measurement points, more data are needed to confirm the non-linear relationship.

We have included heat flow values from the deep petroleum exploration drillhole Mansiyah I (Girdler, 1970), and from the Red Sea shelf and axial trough (Girdler and Evans, 1977) in the heat flow profile shown in Plate 8. We refer the reader to Gettings (1982) and Gettings and Showail (1982) for a detailed analysis of the 1978 heat flow data.

The profile (pl. 8) shows an increase in heat flow toward the Red Sea margin; assuming an exponential heat source distribution (Lachenbruch, 1970), extrapolation of geotherms yields a temperature estimate for shot point 4 that, even considering uncertainties, is higher at the base of the crust than that at shot points 2 or 3.

The high heat flow at shot point 5 can be explained by heating from the abutting oceanic crust and/or an enhanced mantle component of heat flow through the thin continental crust, provided the higher temperature regime has persisted for 10 m.y. or so (Gettings, 1982). In order to maintain the high heat flow values observed on the Red Sea shelves and coastal plains (Girdler and Evans, 1977), a model with a mass flux of hot material at the base of the lithosphere seems necessary if the age of this crust exceeds about 5 m.y. (Gettings, 1982). Finally, in the actively spreading axial trough, classical seafloor spreading models that allow for hydrothermal convective activity are adequate to explain the observed heat flow (Gettings, 1982).

Previous seismic work

Girdler (1969) reviewed early seismic work in the Red Sea. The pioneering surveys made in 1958, using the two ships RV VEMA and RV ATLANTIS, included 15 refraction profiles in the northern, central, and southern sectors (Drake and Girdler, 1964). Profiles 170 through 176 of this set, in the southern sector, show a sedimentary cover 0.5-4.5 km thick (velocity 3.49-4.48 km/s) that consists largely of the Miocene evaporite-clastic deposits. A profile near the center of the axial trough southwest of the Farasan Islands showed basement velocities of 7.16-7.31 km/s, whereas two profiles on the southern shelves west of the axial trough (at 16.5°N and east of the axial trough at 15°N) showed basement velocities of 5.5-5.9 km/s. Similar results were obtained elsewhere in the Red Sea on the same survey; velocities over the axial trough were mostly in the range 6.8-7.3 km/s, and velocities over the main trough were mostly in the range 5.8-6.1 km/s. However, velocities on the shelves (at 23-23.5°N) were as high as 6.97 km/s. Girdler (1969) interpreted the high-velocity basement in the axial trough as oceanic crust and the lower-velocity basement on the shelves as continental material. For oceanic basins, the arithmetic mean seismic P-wave velocity of layer two, the upper layer of oceanic crust, is only about 5.1 km/s (Hill, 1957, and Raitt, 1963, cited in Le Pichon and others, 1973), with a standard deviation of 0.6 km/s; if velocities for oceanic crust of Tertiary age are not greatly different from the arithmetic mean figures, then the lower-velocity basement reported by Girdler (1969) could be oceanic or continental.

Other early seismic work in the Red Sea includes continuous ("sparker") reflection profiles, by the RV CHAIN, over the main and axial troughs in 1964 (Knott and others, 1966) and 1966 (Phillips and Ross, 1970), and refraction profiles, using sono-buoys from the RRS DISCOVERY, on the shelf of the northern sector in 1967, and by the M/V ASSAB, in the central sector in 1967-1968 (Tramontini and Davies, 1969). The M/V ASSAB survey, which covered a limited area in detail, mainly over the axial trough between 22°N and 23°N, found an average basement velocity of 6.6 km/s and an average basement depth of 4.6 km for the portion of the main trough adjacent to the axial trough. DISCOVERY's refraction results were similar to those of the 1958 VEMA-ATLANTIS survey.

The Saudi Arabian-Sudanese Joint Commission for Exploitation of Red Sea Mineral Resources has carried out an important series of geophysical investigations in the Red Sea during the past several years. This work included seismic refraction as well as magnetic, gravimetric, and bathymetric surveys; the results have apparently not yet been published. Also, cooperative refraction programs, including those of the University of Hamburg with Cairo University, and the University of Hamburg with King Abdulaziz University in Jiddah, are being undertaken in the northern Red Sea and adjacent land areas.

In summary, seismic refraction data available from previous surveys on the Red Sea clearly indicate that material with oceanic crustal velocities is present in the axial trough and that the basement of the main trough is composed, at least in part, of oceanic crust. Whether continental crust also underlies the thick sediments on the shelves is controversial. Very little information has been obtained on velocities or crustal thicknesses beneath the landward portion of the shelves, due chiefly to the difficulty of navigation in the shallow reef zones.

The seaward portion of the coastal plain in southwest Saudi Arabia was studied by seismic reflection methods by the French petroleum company AUXIRAP during 1963 (Gillmann, 1968). The surface of the Jurassic and basement dips toward the Red Sea at an average angle of about 10 degrees; its depth increases from about 2 km some 20 km inland to nearly 5 km in the vicinity of the Mansiyah No. 1 drillhole and Jizan salt dome (the coastline). Unfortunately, the Mansiyah drillhole had to be discontinued just short of where it would have intersected the seismic basement as extrapolated from the AUXIRAP work. The profiles did not extend onto the Precambrian shield, and the nature of its basement remains speculative.

No seismic deep-refraction data have previously been obtained for southwestern Saudi Arabia. Studies of shear waves on the path Addis Ababa-Shiraz (which passes through the Afar depression) have shown that the average crustal thickness for this region is about 35 km (Niazi, 1968; Knopoff and Fouda, 1975). Shear-wave velocity models from these studies show a pronounced low-velocity zone with the top of the zone at 100-140 km depth (Knopoff and Fouda, 1975). Phase velocities of the Arabian Shield are lower than those of the

Canadian Shield; however, they are higher than those of the United States Gulf Coastal Plain (Knopoff and Fouda, 1975).

FIELD PROGRAM

The documentation of the field program given here is, for the most part, from Blank and others (1979), supplemented by more recent information (unpublished), and by geologic information from Gettings and Showail (1982); the additional information has been included for completeness and convenience in further analysis of the refraction data.

The profile

The seismic refraction profile (fig. 1) was chosen to meet our goal of crossing the principal tectonic boundaries of the Arabian Shield as nearly as possible at right angles within the constraints of the existing road system. Fortunately, a combination of road and track exists that is almost ideally suited to this requirement. The seismic profile begins about 100 km west-northwest of Riyadh and 35-40 km north of the Jiddah-Riyadh highway, and proceeds along a track that intersects the Zalim-Mazahimiyah highway between Mazahimiyah and Al Quway'iyah, at the first shot point. From there it follows pavement to Al Quway'iyah and thence a system of tracks southward to Bishah, Bin Hashbal, and Abha. The western of the two roads leading south from Bin Hashbal joins the Abha-Khamis Mushayt paved highway near Abha. From Abha an arterial road descends sharply in a series of switchbacks down the face of the escarpment; the first 40 km of this road were still under construction when the seismic line was recorded. The profile, however, takes a more direct route down the crest of the ridge system, so that helicopters were needed to deploy the recording instruments. Pavement resumes near shot point 5 and continues to Ad Darb and Jizan; however, the refraction line leaves the highway near shot point 5 and passes through sandy terrain on unimproved tracks to Ras Tarfa. This segment and the Farasan segment of the line also required helicopter deployment. The southwest end of the profile is off the coral island of Dumsuq at the outer edge of the Farasan bank about 90 km west of Jizan.

In a few places the route is deeply rutted or very sandy, particularly where it traverses dune fields south of the Jiddah-Riyadh highway and in the Wadi Bishah distributaries east of Ranyah. The line passes directly through several villages (Al Quway'iyah, Sabhah, Bin Hashbal) but bypasses the large communities (Bishah, Khamis Mushayt, Abha). Elevation along the line gradually increases from a minimum of just over 600 m in the northeast to a maximum of nearly 2300 m near the edge of the Hijaz-Asir escarpment.

Access to the shot points also depends on a combination of roads and tracks. From our headquarters at Jiddah to shot point 1, surface access via Mazahimiyah was entirely on paved road. We traveled directly to shot point 2 from shot point 1; half this distance was on pavement. Access to to shot points 3 and 4 was by paved road to Ranyah and from there on sandy track. One can also reach shot point 4 by pavement from the escarpment road from Taif and Bahah. Abha and points on the Tihamat-Asir were reached via the paved road from Taif and Bahah.

Surveying

Surveying to establish absolute coordinates for each shot point and recorder site began in February 1977 after an initial aerial reconnaissance in January, during which shot points 1 through 4 were selected (shot point 5 was established in May). Except for a few stations, the surveying, done by D. J. Faulkender and F. J. Fuller of the USGS Mission, was completed by the end of the year. The surveyors used a Wild T-2 theodolite and a microwave distance-measuring instrument, Electrotape Model DM20 (Cubic Corporation). Wherever feasible, the line was tied to control points of the Kingdom Geodetic Net. The nominal spacing of recorder stations was 2 km, but departures from this optimum spacing were often necessary. Location latitudes and longitudes are accurate to about $\pm 3''$ (seconds of arc); elevations are accurate to ± 5 m (D. J. Faulkender, oral commun., 1979).

Faulkender and Fuller used a combination of radial line and transit traverse survey methods. The radial line method is applicable if a recording site can be seen from a station for which geodetic coordinates have been established. Both horizontal and vertical angles are measured, and the distance between the established station and the recording site is obtained by microwave measurement. For the transit traverse method, one station with established geodetic coordinates must be visible from at least one of a sequence of recording sites that have interstation visibility.

The surveyors numbered each recording site and identified it with red or orange paint, either on outcrops or on rock cairns that were piled up to 1 m high. The numbering system is not strictly sequential along the profile because, with radial line and transit traverse methods, the surveying is not strictly sequential.

The master shot list (app. 5) shows the coordinates of each shot point. The number of recorder stations on either side of the shot point in each 100-station spread is indicated in figure 3. This illustration also serves as an index for the 1:100,000-scale photomosaics that were used for station plots.

The complete list of recorder station coordinates, elevations, and data collected (app. 5) was entered in the field data-processing computer memory.

Shot points

The criteria considered for selection of the land shot points were:

(1) Locations at roughly 100-km intervals.

(2) Geologic environment favorable for efficient energy transfer to the surrounding medium, i.e., for maximum wave energy propagation per unit weight of explosive. Shallow water table was essential.

(3) Accessibility for heavy drilling equipment.

(4) Relative isolation from human habitation and livestock or other cultural features.

A program of test drilling confirmed that the tentative choices met the geologic criteria.

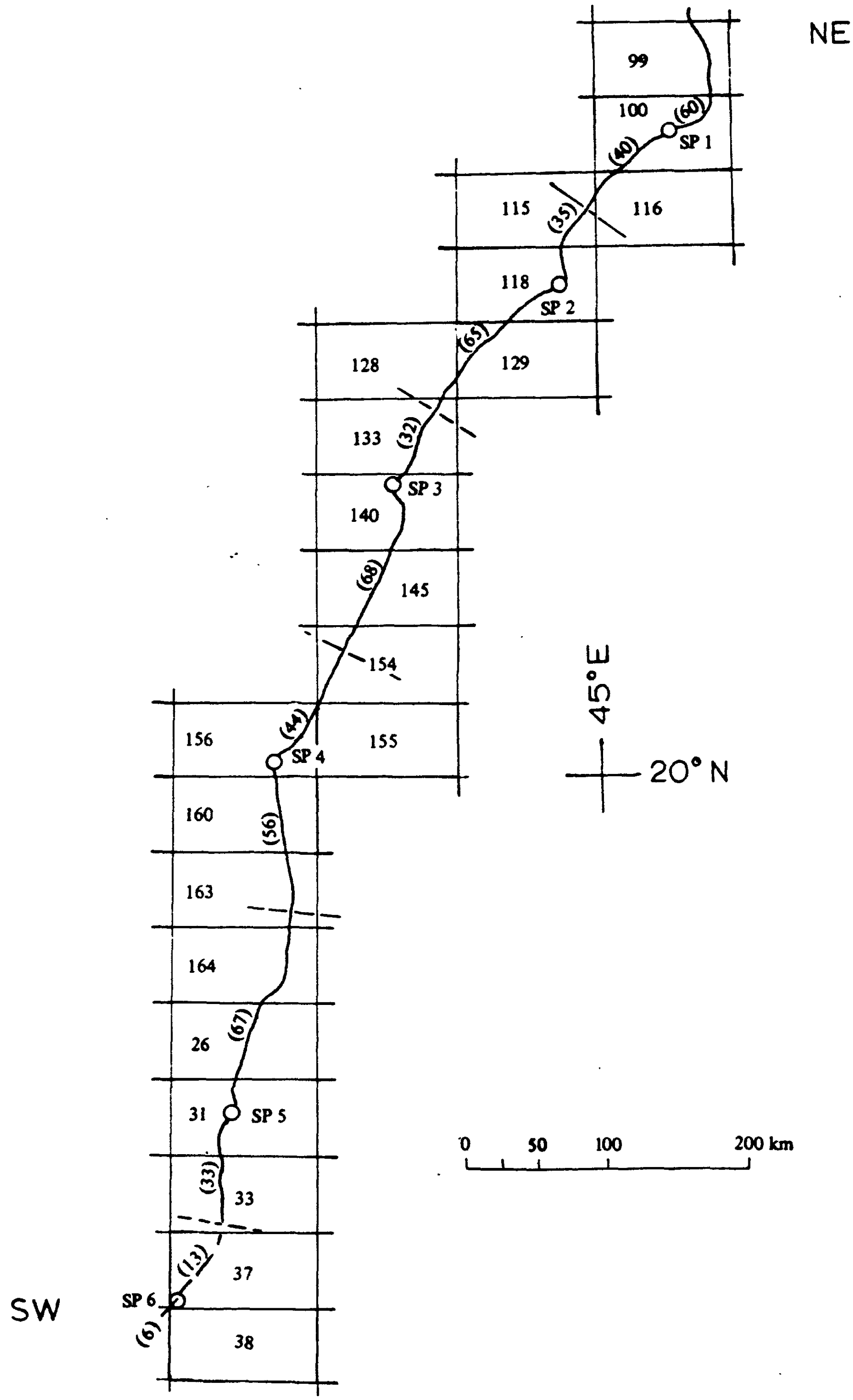


Figure 3.--Seismic refraction line and index of 1:100,000-scale photomosaics showing recorder spreads. Number of surveyed recorder sites between shot points and end of spreads are indicated in parentheses.

During 21-23 April 1978, G. M. Fairer and M. E. Gettings, using a DGMR fixed-wing aircraft for transportation made a short field trip to shot point 2, 3, 4, and 5 to map the detailed geologic relations and estimate topograph relief. The shot point areas were surveyed with a tripod-mounted Brunton compass for vertical angles and azimuths. The map base line (accurately pin-pricked on the photographs) and distances between the drillholes at each shot point were measured with a 30 m tape. Approximately one-half day was spent at each of the four shot points (2-5) for a total of four man days for the field work. M. E. Gettings, using photogeologic methods, compiled geologic maps to supplement the field work, with enlargements of existing 1:60,000 scale aerial photographs used as a base.

Modal analyses of mineral compositions were carried out on samples taken by Fairer and Gettings, using point counts on thin sections, stained slabs, and acid-etched slabs. Table 1 shows modal mineral compositions for this suite of rocks.

The hole designations on the geologic maps in this report may not conform to the numbering given in other reports.

Shot point 1

Shot point 1 (26°16'12"N, 45°35'57"E) is 43 km northeast of the village of Al Quway'iyah on the east side of the Nafud As Sirr river at an elevation of 692 m. The site is approximately 1 km north of the paved road and about 150 m from the edge of the sand dunes. The immediate area is entirely unconsolidated material and desert pavement, although some outcrops of shales are present about 1 km to the northeast. Inspection of the chips from drilling showed that bedrock is predominantly green shale with some red shales and some sandy and pebbly lenses or interbeds. The rocks belong to the Sudair Shale formation (Powers and others, 1966).

Eighteen holes of average depth about 65 m were drilled in the pattern shown in figure 4; twelve of them were logged for temperature and two were electrically logged for self-potential and single-point resistivity. The logger operation and calibration were checked beforehand.

M. E. Gettings measured the electric logs on 1 February 1978, using a Neltronic Instrument Corporation model 1 K type D Logger. Figure 5 shows the resulting log of hole SP1-3. Hole SP1-12 (see fig. 4 for location) was also logged; the results were identical to those of SP1-3 within experimental error, so only the log for SP1-3 is illustrated. Both holes were logged

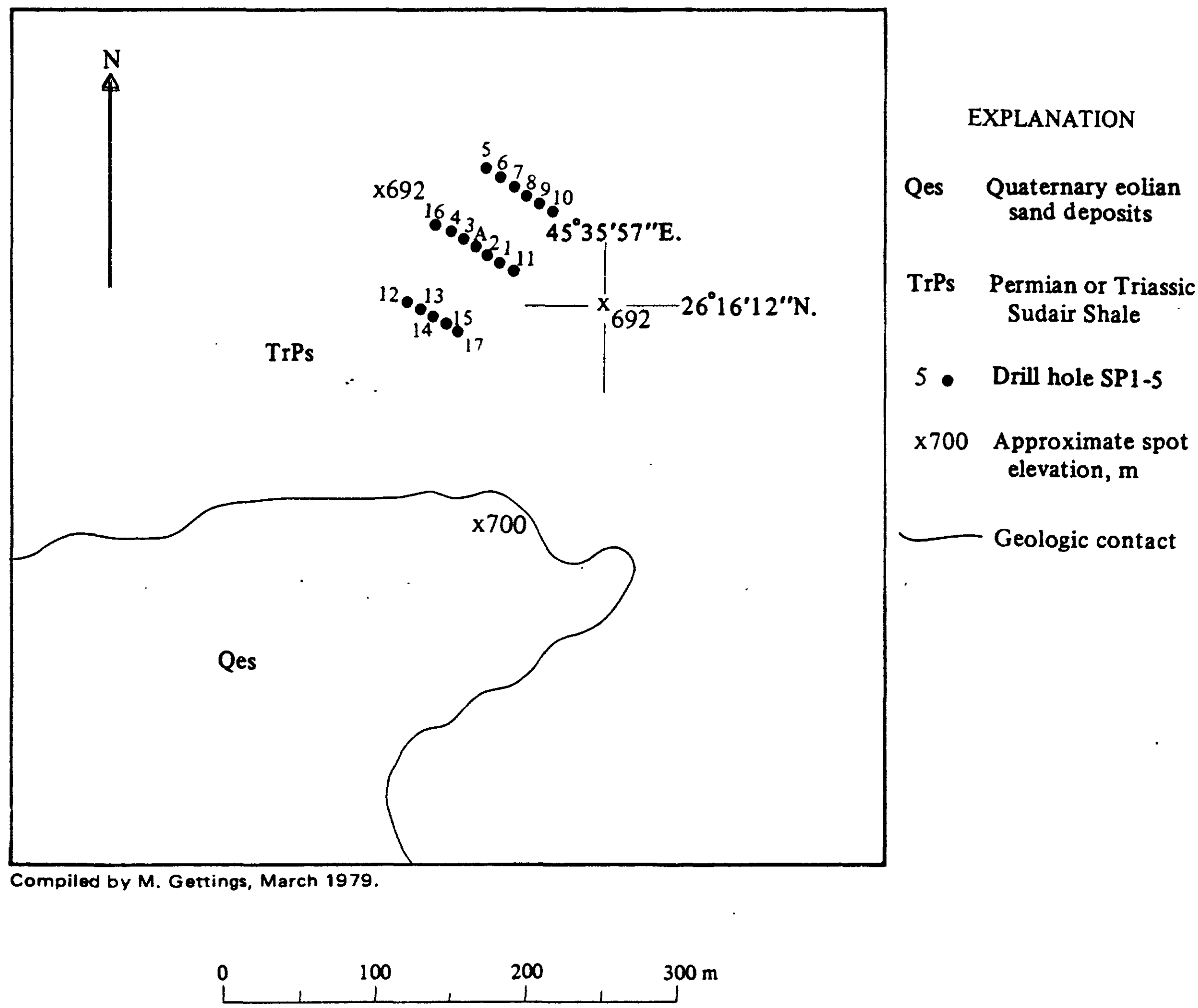


Figure 4.--Geologic sketch map of the shot point 1 area.

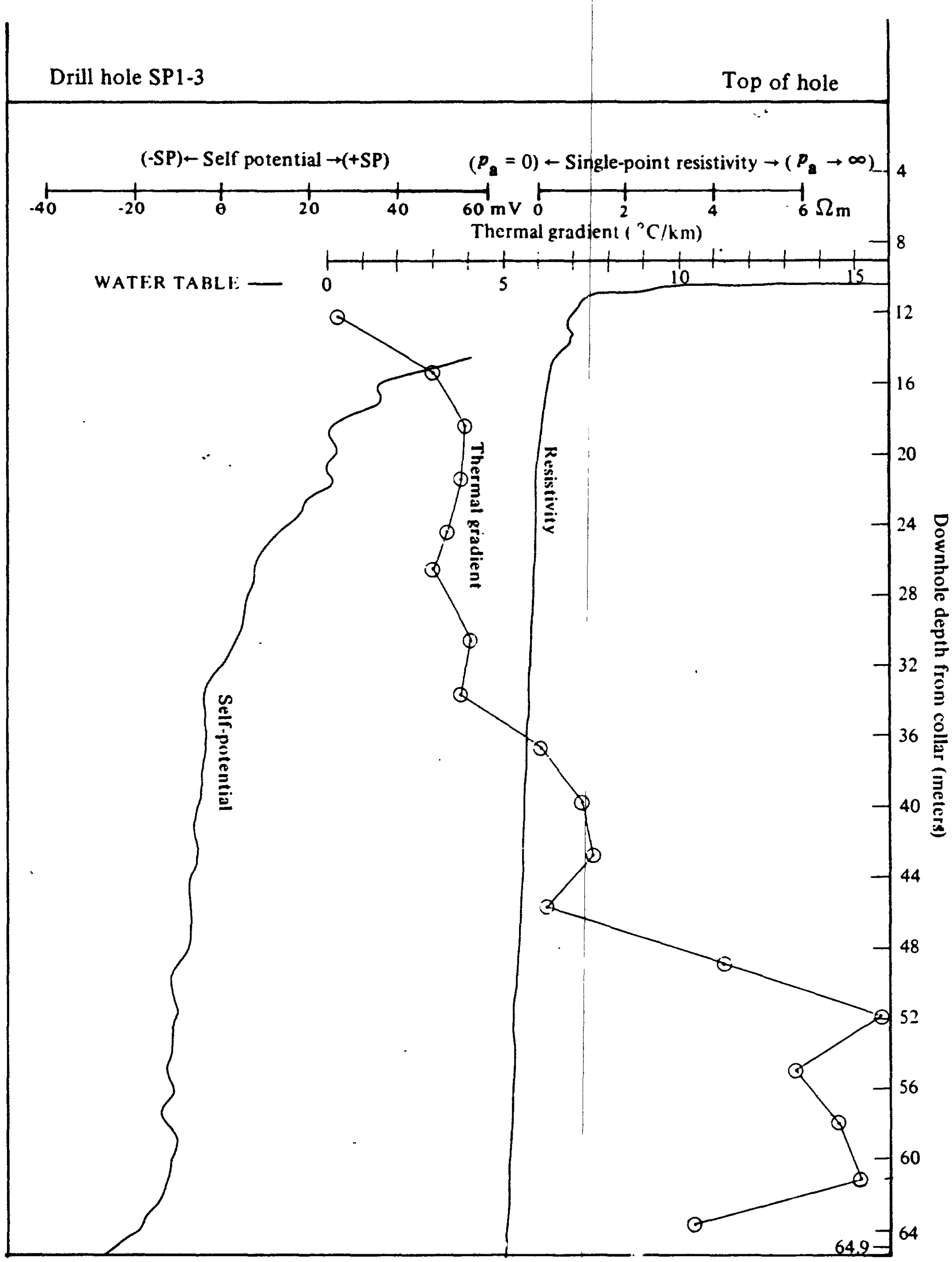


Figure 5.--Single-point resistivity, self-potential, and thermal gradient logs of drillhole SP1-3.

Table 1. Percentage of modal mineral compositions of selected specimens from shot points 2, 3, 4, and 5. Modes for all specimens except SP5-8 and SP5-14 were determined by counting 300 points in thin section. Alkalai feldspar was determined by 200-700 point counts on stained slabs. F. Elsass and M. Naqvi used quantitative x-ray diffraction methods to determine quartz contents, accurate to about ±5%. Plagioclase compositions were determined by x-ray diffraction and Carlsbad-Albite twin extinction angles in thin sections. Modes (except quartz) for specimens SP5-8 and SP5-14 were estimated visually because the rock is a very fine grained schist making point counts difficult. Rows "Q/(Q+A+P)" and "P/(A+P)" are the variables which determine the igneous rock classification under the IUGS system (Streckeisen, 1973). In general, thin section point counts utilized 300-400 total counts, and are probably accurate to ±20%; stained slab point counts utilized about 500 points, and are probably accurate to ±15%.

Mineral	SP2-1E	SP2-1E	SP2-3	SP2-5	SP3-4567	SP3-12	SP3-12A	SP3-13	SP4-4	SP4-6B	SP4-8A	SP4-8B	SP5-8	SP5-14
Quartz	22	13	35	27	-	35	27	39	-	36	36	30	34	37
Alkalai Feldspar	-	20	-	8.5	-	49.5	45	39.8	-	42	42	41	-	-
Plagioclase	39.3 (Ab)	38.7 (Ab)	15.3 (Ab)	7.2 (Ab)	35.3 (An)	5.8 (An)	12.3 (Ab)	15.5 (An)	46 (An)	7 (An)	18.3 (An)	21 (An)	Minor	Minor
Calcite	14	13.7	3.7	-	-	..	-	-	-	-	-	-	-	-
Muscovite	5.7	8.6	3	3	-	-	tr	-	-	-	-	-	16	13
Biotite	14	-	11.3	-	-	4	-	3.7	-	14	2.3	6.7	-	-
Hornblende	-	-	-	-	56 (Titanian)	3	11.3	0.7	52.6	-	-	-	-	-
Chlorite	4	6	8.7	35.3	-	-	2.7	-	-	-	-	-	47	47
Epidote	-	-	10	11.7	-	-	-	-	-	-	-	-	-	-
Sphene	-	-	-	-	-	1.7	1	-	-	-	-	-	-	-
Opaques	1	-	13	7.3	8.7	1	0.7	1.3	1.4	1	1.4	1.3	3	3
Q/(Q+A+P)	-	-	0.70	0.63	-	0.39	0.32	0.41	0.0	0.42	0.37	0.33	-	-
P/(A+P)	-	-	1.00	0.46	-	0.10	0.21	0.28	1.0	0.14	0.30	0.34	-	-

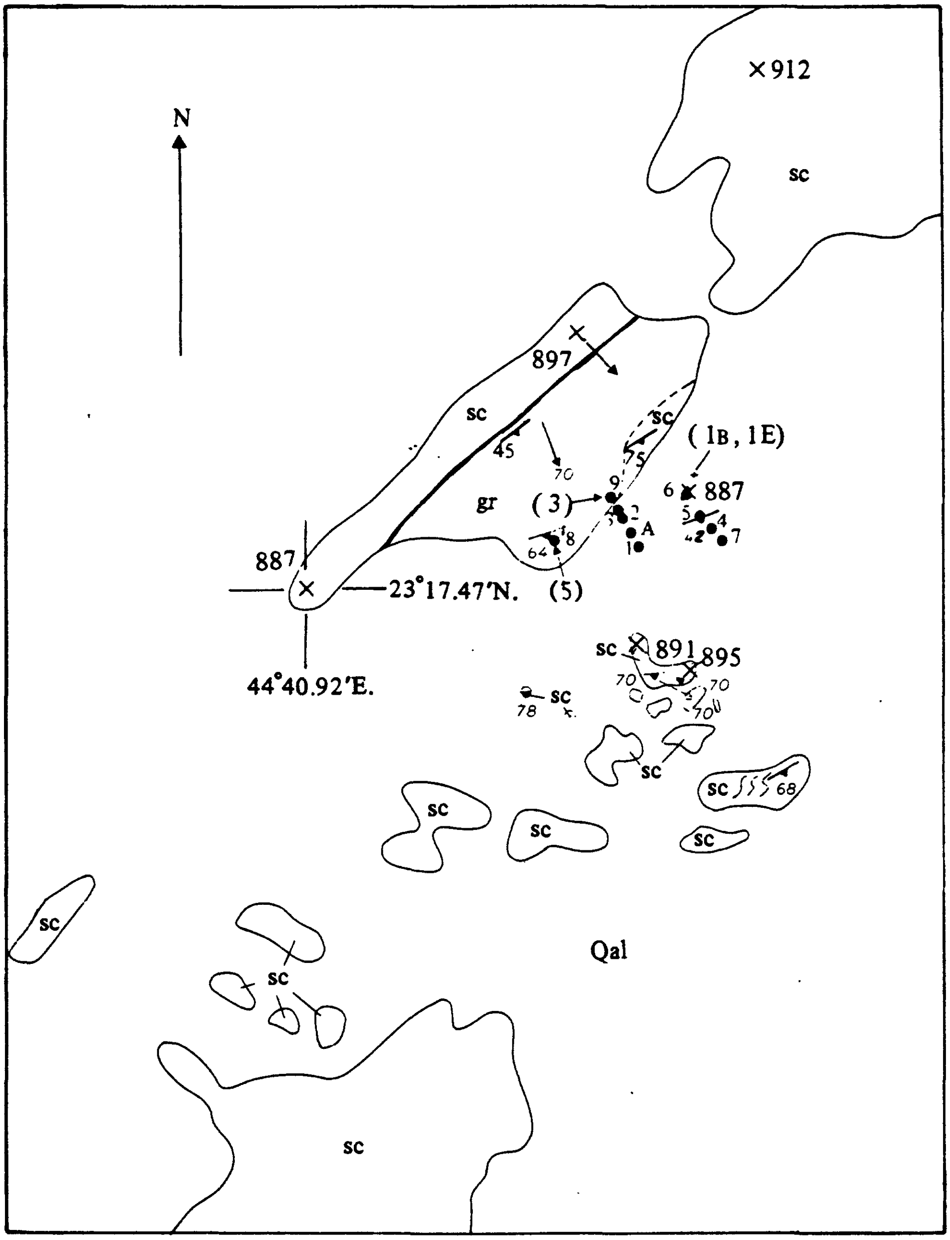
twice, with identical results. The log is quite monotonous, with only the self-potential log showing any variation, and that small. No large-scale lithologic changes are implied by the log. The variations suggest units of beds of shale 1-5 m thick with slightly different self-potential properties. The approximately linear increase in the self-potential response from 33-14 m depth is a commonly observed phenomenon in such logs, and probably represents a zone of changing oxidation state as the water table is approached. For comparison, figure 5 shows the thermal gradient for SP1-3 (Gettings and Showail, 1982). Note that the sharp decrease in thermal gradient at about 48 m depth corresponds with a change in character of the self-potential log from variable below to essentially constant above 48 m.

Shot point 2

Shot point 2 (23°17'28"N, 44°40'55"E) is at an elevation of 887 m, about 5 km northeast of the village of Sabhah in a terrane predominantly composed of highly deformed quartz sericite schist. The nearest outcrops of the post-tectonic Jabal Sabhah granite are 1.7 km to the southwest, although parts of the intrusion may be much nearer and concealed beneath the alluvial cover.

Ten holes of average depth 62 m were drilled at this site (fig. 6). Maximum topographic relief within 250 m of the drill holes does not exceed 10 m.

The lithologies at shot point 2 are principally a calcareous quartz-sericite schist (table 1) and a small area of foliated and folded quartz-rich granitoid (IUGG Subcommission plutonic rock classification is used here; see Streckeisen, 1973). The schists are severely deformed; pervasive chevron



EXPLANATION

Qal Quaternary alluvium deposits

Precambrian

sc Quartz-sericite schist, calcareous

gr Metagranitoid

Contact, exposed

Contact, inferred

Fault

Strike and dip of foliation

Strike and plunge of fold axis

(5) Sample locality and number (SP2-5)

•4 Drill hole SP2-4

×912 Spot elevation, m

Fieldwork by G. Fairer and M. Gettings, April 1978.
Compiled by M. Gettings, March 1979.

0 100 200 300 m

Figure 6.--Geologic map of the shot point 2 area.

folding and quartz "rods" in the noses of larger ($\sim$10 m half-wavelength) folds are commonly observed. The foliation generally strikes northeast and dips 40-70° to the southeast. Fold axes of both chevron and larger folds plunge steeply ($\sim$70°) to the southeast. The modal compositions of the schist indicate a pelitic assemblage, and this unit is probably part of the Abt schist (Fitch, 1978), which was mapped short distances to the northeast and to the south (Vincent, 1968). The granitoid appears to be a holocrystalline rock in hand specimen; however, in thin section it is apparent that it has had a complex history of deformation and metamorphism. Plagioclase recrystallization is obvious, and retrograde metamorphism is suggested by the conversion of biotite to chlorite. About all that can be said is that the original rock was probably a tonalite in composition. Where exposed, the contact between the granitoid and the schist appears to be a fault because the folding in the granitoid is truncated at the contact.

Shot point 3

Shot point 3 (21°56'44"N, 43°34'16"E) is on a large plain at an elevation of 946 m, about 550 m northeast of a small granite peak in a large granite intrusive body. The terrain is extremely flat here, with less than 5 m relief within 500 m of the site.

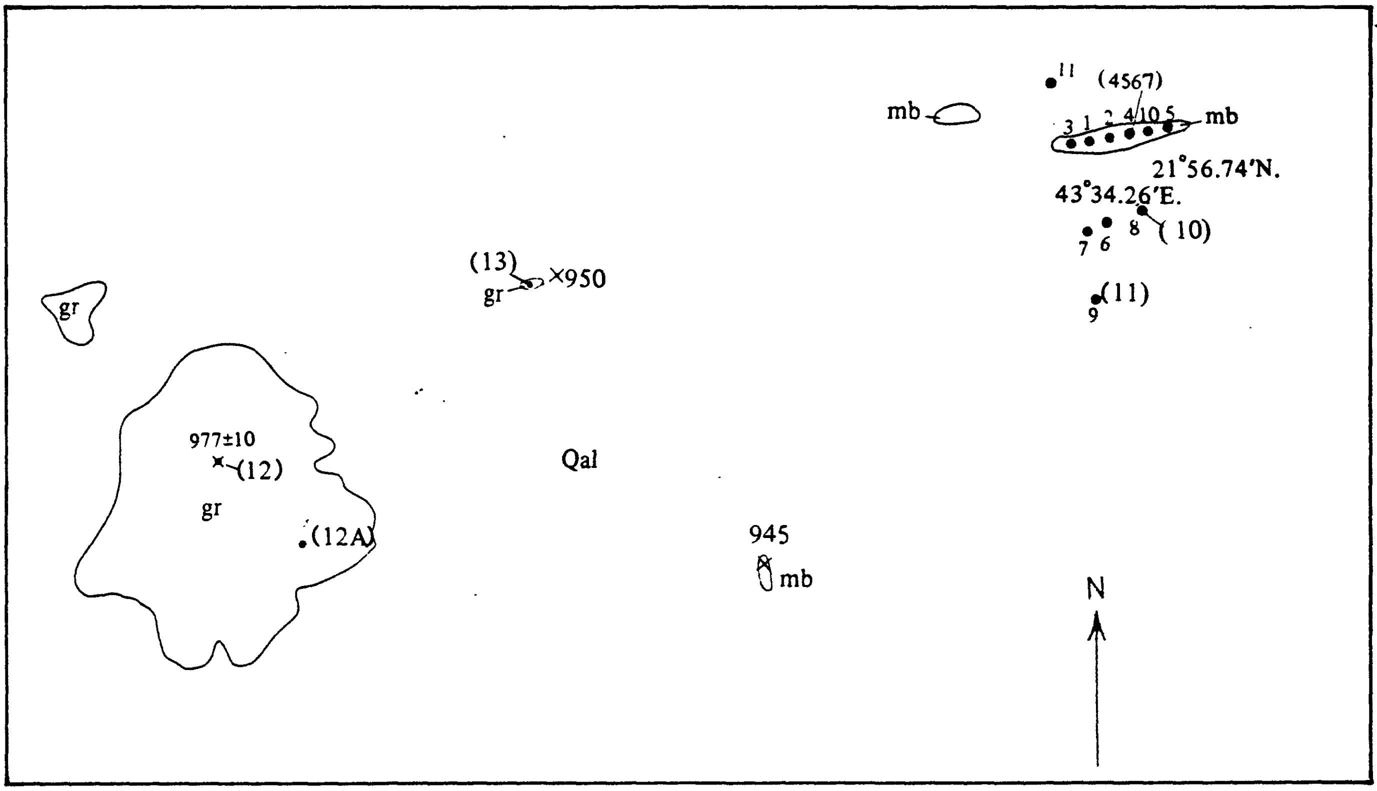
Eleven holes of average depth 60 m were drilled in the pattern shown in figure 7. Holes 1, 2, 3, 4, 5, and 10, which includes the hole of the test drilling program (Blank and others, 1979), were drilled in a xenolith of greenstone (probably Halaban andesite); the remainder penetrated the Precambrian granite. The granite does not show any foliation or evidence of having been deformed or tectonized. The only notable feature of the greenstone is that its dominant mineral (56%) is titanian hornblende (Kaersatite).

Shot point 4

Shot point 4 (20°05'13"N, 42°39'04"E) is at an elevation of 1144 m on a flat, approximately 400 m in diameter, surrounded by low rolling hills. The locality is approximately 11 km northeast of Qa'lat Bishah and 4 km east of Wadi Bishah. The rocks are mainly a Precambrian gneissic granite containing several large metadiorite xenoliths. Topographic relief is low, with a maximum of 10 m within 300 m of the drillholes.

Nine holes of average depth 51 m were drilled (fig. 8). Examination of drilling chips and fragments blown out by the shots indicates that the holes predominantly or wholly penetrated the gneissic granite.

The granite is similar to that of shot point 3, but has well-developed gneissic layering that strikes northeast and dips 15-30° to the northwest. In the easternmost outcrops of figure 8, the granite is in 1-5 m thick leucocratic and melanocratic layers. It weathers both pink and gray and varies in grain size from fine to coarse. Several outcrops of metamorphosed diorite in the immediate vicinity (fig. 8) are xenoliths in the granite. Where the contact is visible, structures and small mafic dikes in the diorite are truncated at the granite contact; further, veinlets from the granite fill fractures in the diorite at the contact. Several later, northeast-trending, mafic dikes are observed in the area. The diorite, although altered, is coarse-grained, holocrystalline, and shows evidence of rhythmic layering.



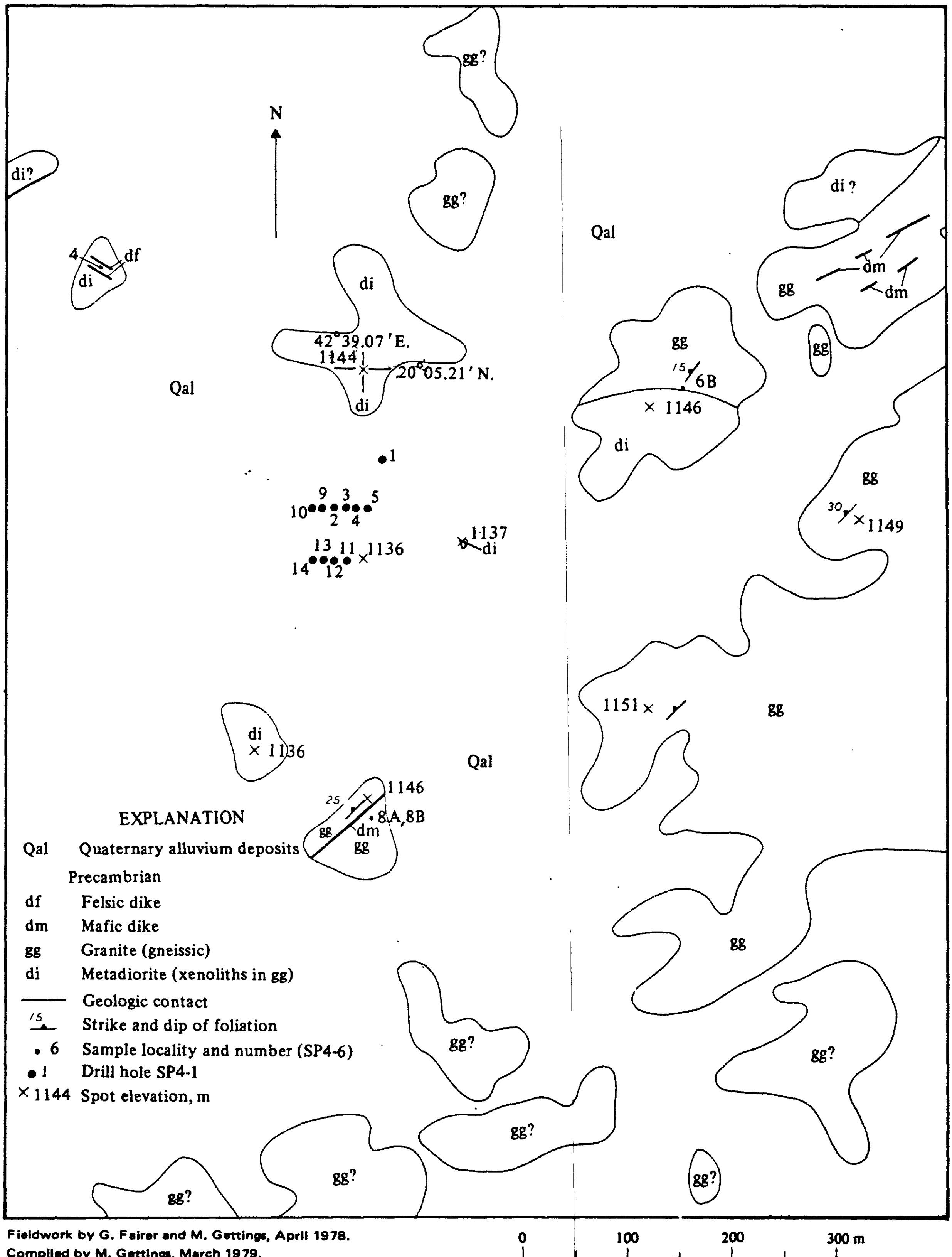
Fieldwork by G. Fairer and M. Gettings, April 1978.
Compiled by M. Gettings, March 1979.

0 100 200 300 m

EXPLANATION

Qal	Quaternary alluvium deposits	——	Geologic contact
	Precambrian	•(12A)	Sample locality and number (SP3-12A)
gr	Granite	•1	Drill hole SP4-1
mb	Metabasalt (greenstone)	× 912	Spot elevation, m

Figure 7.--Geologic map of the shot point 3 area.



Fieldwork by G. Fairer and M. Gettings, April 1978.
Compiled by M. Gettings, March 1979.

Figure 8.--Geologic map of the shot point 4 area.

Shot point 5

Shot point 5 (17°46'36"N, 42°20'47"E) is at an elevation of 179 m. The area is an extensive gravel-covered plain whose bedrock is Precambrian phyllitic schist and the shot point is on the west side of a meander of the Wadi Itwad river, 11 km northeast of the village of Ad Darb. The river channel is about 15 m deep, the only significant topographic relief in the area.

Seven holes were drilled in the pattern shown in figure 9, to an average depth of 60 m. Chips from the holes all indicate that they penetrated a uniform quartz-mica phyllite. The rock is fine grained, blue-gray, and has well-developed slaty cleavage with the foliation striking north-northwest and dipping about 35° to the northeast. Veins and pods of quartz, usually striking parallel to the phyllite, are common.

Examination of the aerial photographs of the region shows that a large regional fault or fault zone trends through the shot point at about 80° as shown in figure 9; it is probably responsible for the formation of the meander in the Wadi Itwad. The fault was not detected in the reconnaissance of the west wall of the Wadi Itwad channel, probably because large areas of the wall are covered with talus debris and vegetation.

Shot point 6

An oceanographic research vessel, the R/V Comandante Giobbe of Italian registry, was engaged on a contract basis for execution of the sea shots. The ship carried a JMR-1 satellite receiver used to precisely determine coordinates. Shots were fired near the island of Dumsuq, in the Farasan Island group.

Drilling

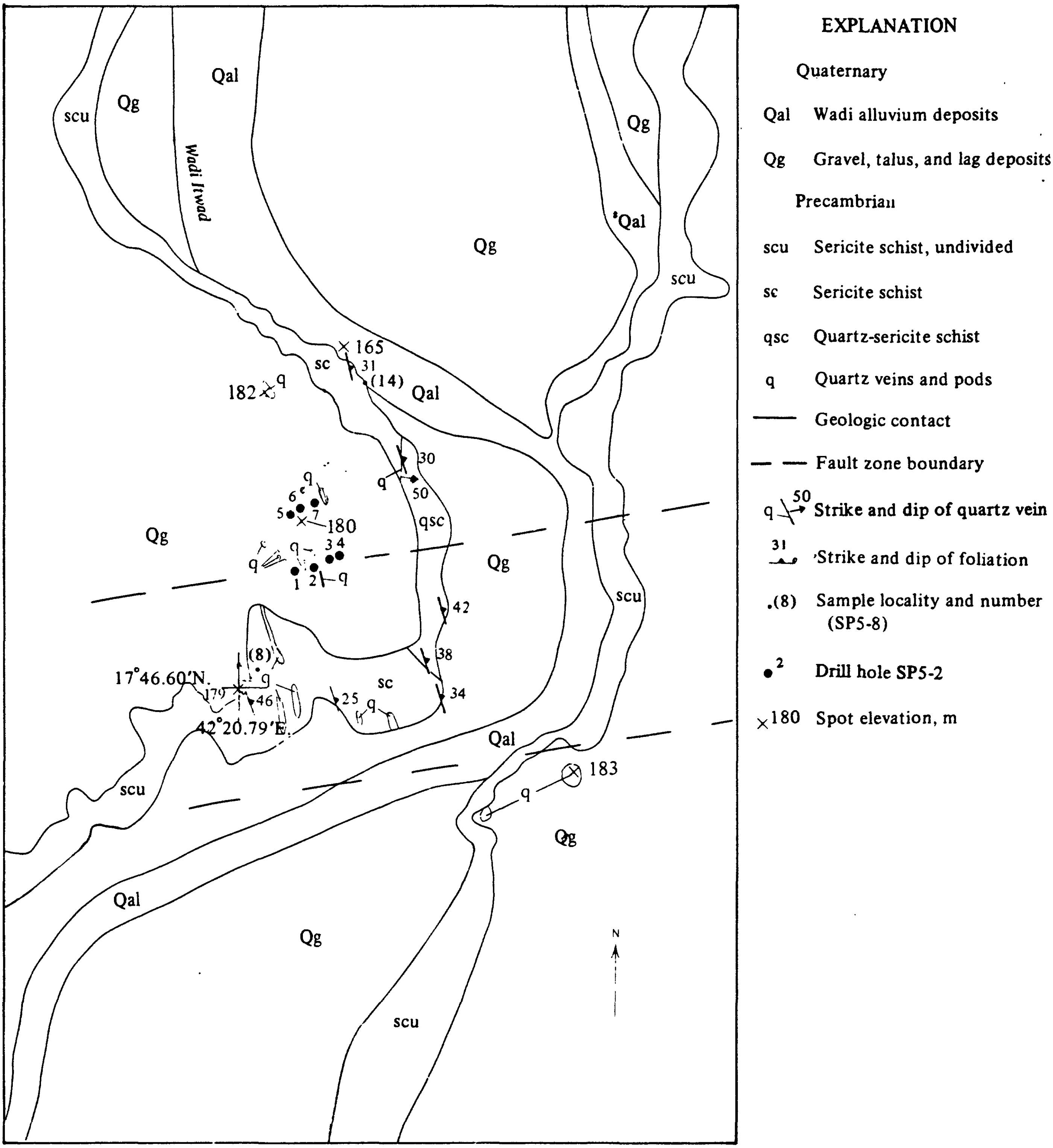
The Arabian Drilling Company (ADC) carried out the shot hole drilling under the direction of USGS representative J. C. Roller. A crew of the Bureau de Recherches Geologique et Minieres (BRGM) drilled additional holes at shot points 1 and 2 during the shooting program, using ADC equipment.

The ADC, using a Gardner 1500 rig, began drilling a series of test holes at the first four tentatively-selected shot points in February 1977. They used both rotary tri-cone bits and down-hole hammers, the former only in soft shale or highly weathered material, drilling one or two 5-inch- to 7-inch-diameter holes to a depth of 60 m at each site. The results helped to establish rock type, depth of water table, and time schedules for drilling in the patterns designated for each site ("pattern drilling") (see table 2). All test holes descended below the water table.

Rock cuttings from shot point 1 indicate strata of shale with thin interbeds of sandstone. The water table was intersected 13 m beneath the ground surface, and drilling continued through 47 m of saturated shale, which is an optimum medium for transferring explosive energy into seismic waves. The hole was completed in one day.

Rock cuttings from shot point 2 have an aphanitic texture and are presumably andesite of the Halaban group. The weathered zone is approximately 6 m thick, and below this depth the drilling rate decreased from 6 to 3 m/h. The water table was intersected at 36 m, and 24 m of saturated rock were penetrated. The hole was completed in two days.

The weathered zone of shot point 3 is 6 m thick. Rock cuttings from this site are andesite to a depth of 60 m. The water table was intersected at 27 m,



Fieldwork by G. Fairer and M. Gettings, April 1978.
Compiled by M. Gettings, March 1979.

0 100 200 300 m

Figure 9.--Geologic map of the shot point 5 area.

Table 2.--Test Drilling Results

(No test drilling was done at shot point 5, where holes are in schistose metasedimentary rocks of the Ablah group.)

Shot point	Hole diameter (cm)	Depth (m)	Formation and rock type	Depth to water table (m)	Method of drilling	Drilling rate
1	17.78	0- 0-6 0-60	Weathered zone Sand Shale and sand-stone stringers Sudeir shale	13	3-cone rock bit	10 m/h
2	17.78	0-6 0-60	Weathered zone Halaban andesite	36	down-hole hammer	3 m/h
3	17.78	0-6 0-10 10-60	Weathered zone Greenish-red clay Grey Halaban andesite	27	down-hole hammer	4 m/h
4	13.97	0-18 0-3 3-18 18-26 26-60	Weathered zone Sand and clay Clay-limestone-gravel Gravel-andesite Halaban(?) andesite	18	down-hole hammer	3 m/h

and 33 m of saturated rock were penetrated. The hole was completed in two days at an average drilling rate of 4 m/h.

The weathered zone of shot point 4 is 18 m thick. Rock cuttings below 18 m are thought to be slaty schist containing zones of amphibolite. The water table was intersected at 18 m, and 42 m of saturated rock were penetrated. The hole was completed in two days at an average drilling rate of 3 m/h.

Because of the time and expense required to move heavy equipment down the escarpment, no test drilling was done at shot point 5.

The test drilling program ended in early March 1977, and was immediately followed by the pattern drilling, which was completed by midsummer. The upper few meters of each hole were cased with steel pipe, and the holes were capped for protection. Before the refraction program began, the ADC drill rig returned to the shot points to clean out the drillholes.

Field equipment and procedures for firing explosives, recording, and data processing

Introduction

Until recently, the high cost of seismic experiments both in money and time has limited their use for study of the fine structure of the Earth's crust and mantle. Although the cost of an experiment is dominated by the cost of the explosives required to produce seismic signals of adequate amplitude, the experiments have also been time-consuming and expensive because of the instruments available for recording. The instrumentation has basically been of two types: truck-mounted multi-channel seismographs, with six to 50 seismometers (geophones) connected by cable into a spread of up to 5 km in length, and single-point seismographs and geophones that recorded the data at one position. The multi-channel systems work well for recording many data points along a short profile, but for long profiles with long distances between recording positions, the task of laying out and picking up the cable imposes severe practical limitations, particularly in rough terrain where road access is limited. Single-point recorders avoid the problems associated with long cables, but place severe limitations on the number of data points that can be observed at any one time because most instruments require an operator for each recording position; large-scale seismic experiments, therefore, required 50-100 operators.

A system employing a large number of single-point recorders that do not require an operator for each station is obviously desirable, allowing flexibility in the design of an experiment and maximizing the use of each explosive source. Advances in electronics in recent years have made such a system possible. The cost, size, weight, and power-consumption requirements of seismic systems have been reduced, and it is now possible to build highly automated single-point recorders at a reasonable cost. The USGS employed 100 of these new, advanced seismic stations for this experiment. They can be left unattended for periods of up to 10 days with 10 variable-length recording periods, limited by the recording time available on the cassette tape. A number of groups now use such a recorder, but to our knowledge, this project was the first full-scale test of this new type of portable seismic recording system.

Another significant expense in a seismic experiment is the cost of retrieving the recorded data and preparing it for interpretation. Digitizing and plotting the data by computer are usually done in the office, which frequently results in problems and delays due to misunderstandings of data content, unclear field notes, incorrect recorder settings, and problems with computer system hardware and software, such as revisions in the computer operating system that make it necessary to rewrite the processing programs. Consequently, production of record sections can take months after the field data reaches the office.

For this project a small field-deployable computer system was developed so that the computer could be brought to the data rather than the reverse. We found that we could produce record sections containing approximately 65 seismograms within 36 hours of a shot. We were able to avoid many of the problems inherent in post-experiment processing, and we knew almost immediately if the portable seismic stations were not operating correctly. The computer system was designed specifically to be used with the new recording system; its design was guided by the following principles:

- the system should be small and rugged enough to be easily transported to the field;

- it should be simple and convenient to use, so that one or two people could be responsible for all computer operations, including set-up;

- it should be functionally equivalent to a larger office-based seismic processing system;

- the computer should be able to function as a general-purpose unit when not used for digitizing and plotting;

- the operating software supplied for the computer system by the manufacturer should be advanced and encompassing enough to minimize the effort of creating and maintaining specialized programs and to allow easy data-file management;

- the system software should be simple enough that operators familiar with seismic data processing could easily be trained to run the programs.

In the following sections, we discuss the explosives used, and field equipment and procedures in detail. The equipment includes the timing system (clocks), the shooting system, the portable seismic stations and an interface unit called the hand-held tester, and the field computing system, which includes equipment for reorganizing the records (tape-dubbing) for efficient processing, and equipment for digitizing and plotting the data. We end with a discussion of procedures followed by the field crew before, during, and after any given shot.

Explosives

The Saudi Chemical Company, LTD. (SCC), a domestically-controlled affiliate of NitroNobel of Sweden, provided all explosives for the seismic refraction profile. The Saudi Arabian Ministry of the Interior authorized the purchase and use of the explosives. The Director of Police for the Kingdom of Saudi Arabia issued specific permits for release of explosives from SCC's stores in Riyadh (for shot points 1 and 2) and Jiddah (for shot points 3-6), and for trans-shipment to the shot points, including to the R/V *Comandante Giobbe* in the port of Jizan.

A technical committee appointed by Kingdom authorities inspected the trucks used to transport the explosives and accessories, the field storage containers, and the field storage areas, as well as the shot points themselves. The SCC procured approved trucks and storage containers under a contractual agreement with the USGS and also furnished licensed blasting engineers to supervise shot hole loading and firing.

Hercules Gelatin Extra and Nobel Dynamex-B were employed as explosives for the land shots, and Hercules Vibro-Gel for the shots at sea. All three products have 75-80 percent absolute strength (a measure of pure nitroglycerine equivalence), a detonation velocity of 6,000-7,000 m/s (the velocity at which the explosion travels away from the point of detonation), and a specific gravity of 1.4-1.5. However, Vibro-Gel is superior for sea shots because of its packaging and greater resistance to deterioration in water. It can be fired at depths up to 200 m. Gelatin Extra or Dynamex-B, used in the drillholes, may undergo a significant decrease in reliability if holes are loaded more than a few days before firing, particularly if groundwater movement is appreciable (nitroglycerin is dissolved and extracted). Technical specifications for explosives and blasting accessories (caps, boosters, and primacord) are given in table 3.

The shot holes were drilled approximately eight months before the shooting took place. The number, size, and depth of the holes at each shot point were calculated on the assumption that the explosives would be a slurry type (DuPont Flogel, Hercules Tovex, or equivalent), which completely fills the drillhole. Unfortunately, this type of explosive proved to be unavailable in Saudi Arabia and as a result, several new holes had to be drilled and previously-fired holes had to be cleaned and reused. The BRGM graciously supplied a drill a second time to recover holes at shot points 1 and 2, and the ADC drilled additional holes at shot point 4.

Because the explosives provided were not familiar to the USGS or even to the SCC explosives engineers, several of the shots at the start of the project were not loaded to the desired amount. After some experimentation, however, loading proceeded in a routine and orderly manner.

Table 3.—Technical specifications of explosives and accessories

Hercules Gelatin Extra and Nobel Dynamex-B (for land shots)

- 75 percent absolute strength
- 3-packed 3-inch x 24-inch (65 x 400 mm) cartridges, at 1.3 kg each
- Cartridges are plastic bags (Dynamex-B) or paper (Gelatin Extra)
- Detonating velocity 23,000 ft/s
- Specific gravity 1.4

Hercules Vibro-Gel (sea shots)

- 80 percent absolute strength
- 3-packed 3-inch x 24-inch (65 x 400 mm) cartridges (hard plastic tubes)
- 6 to 8 1/3-pound 3-pack tubes are packed in 50-pound (net) paper boxes
- Detonating velocity 19,700 ft/s
- Specific gravity 1.5

Primacord

- High velocity, cap-sensitive explosive cord
- Detonating velocity 23,000 ft/s

Blasting caps (detonators)

- Resistance 3.9 ohms
- Firing current 3.5 amps
- Up to 2 ms delay

Titan-500 Boosters

- High-velocity, non-nitroglycerin, cap-sensitive explosive
- 2¼-inch diameter x 4½-inch height, each
- 1 pound each, 60 per case

Firing Procedures

Obtaining, loading, and detonating explosives in Saudi Arabia, where permission is very carefully controlled by the Internal Security Office, presented the USGS with requirements not normally encountered in the United States. All explosives, from the time they are purchased from the licensed distributor (SCC) until they are actually detonated, are carefully counted and signed for by the user (USGS), the licensed blasting engineer (SCC), and a representative of the Internal Security Office of the Kingdom.

The procedure for shooting is outlined in the following steps.

(1) Approved trucks delivered explosives to the field storage containers under police guard. The amounts and types of explosives were carefully checked and signed for. The field storage containers were double-locked; the police held one key and the licensed blasting engineer the other.

(2) The desired amount of explosives, exclusive of blasting caps (detonators), was removed from the magazine and taken to the drillholes. Both the USGS representative and the police counted the amount and type.

(3) The drillholes were charged; any excess explosives, usually primacord, were returned to the storage container and signed back in.

(4) Police guards were stationed at the blast site; they remained until the explosives were detonated.

(5) A few hours (usually two) before the blast, the police and USGS representative removed the blasting caps from a separate storage container.

(6) The licensed blasting engineer armed the charge with blasting caps.

(7) After testing the firing circuit, the blasting engineer connected the firing line to the special USGS blaster.

(8) The police carefully checked the blasting site for safety.

(9) The special blasting circuit automatically detonated the charge at a preselected time. The time, to the nearest millisecond, was recorded on a paper record.

(10) The police and the USGS representative checked the site to determine if all charges did indeed explode and the area was safe to leave.

(11) Any surface disturbance that was potentially dangerous to people or livestock was restored to a safe condition before the area was finally evacuated.

Timing system

The master clocks, which are part of the shot timing and measurement system, and the portable seismic station (PSS) clocks contain the same basic circuitry. Both provide an IRIG-E serial time-code output and a LED display of hours, minutes, seconds, and the Julian date. In addition, the master clocks have an oven-stabilized crystal oscillator, an output pulse on a preselected minute, an internal battery charger, and a 1-MHz frequency standard output that is used as a standard frequency for a precision counter. The counter, in turn, is used to adjust the PSS clock drift rate and to set the tape deck capstan speeds.

The oven-stabilized crystal has an aging rate of five parts in 10^{10}, which is two-and-a-half orders of magnitude more stable than the crystals used in the PSS clocks. Because of this stability, we could construct five identical master clocks that needed comparison less than once a week to maintain timing differences of less than 1 millisecond.

The clocks can be powered by either 120 v AC, an external 25 v DC battery, or their internal rechargeable batteries. These internal batteries supply enough power to operate the clocks for 3½ days, so they could be transported between camps or to the actual shot points without loss of the time base.

The same methods are used to set both the master clocks and the PSS clocks. First, the main power or internal battery is turned on. After a 1-hour warm-up period, six controls are used to set the time in the following manner:

- Place the HOLD/RUN switch into hold
- Depress RESET
- Turn the DIGIT SELECT switch to TS (tens of seconds)
- Depress SET once to advance the tens-of-seconds digit by 1 (push twice for 2, etc.)
- Set the rest of the display digits in order from right to left (UM = units of minutes, UH = units of hours, UD = units of days)
- When the present display time coincides with true time, move the HOLD/RUN to run, then release it to the center position. (Alternately, the clock may be set by a 0 to +10 v DC level change applied to the RUN.)
- To advance or retard the clock to agree with a known standard, hold the ADV/RET switch in the correct position while holding the RATE switch in the 1 msec/sec or 100 msec/sec position for the necessary amount of time.

We used the time signals broadcast by the British Broadcasting Company (BBC) as the source of Greenwich mean time (GMT). We assumed that these signals were perfectly stable and accurate. No correction was made for radio propagation delays because any delays were assumed constant over the entire length of the profile. However, propagation delay variations from day to day were minimized by using the same broadcast frequency each day at the same time. For the first part of the experiment, the BBC signals were received at 9:00 a.m. local time (0600 GMT) at 15.4 MHz. In order to ease recording problems on the ship, the frequency received was changed to 9.4 MHz at 6:00 p.m. local time (1500 GMT) for the second half of the experiment.

Only two master clocks were set against the BBC standard, one on the ship (shot point 6) and the other at shot point 1. The clock at shot point 1 was used to set the three other master clocks located at the other shot points a few days before each shot series. Due to the master clock crystal stability, this tranfer procedure resulted in a relative error between master clocks of less than 1 millisecond.

The relative error between the BBC time and the master clock time was determined by recording both signals on magnetic tape; the blaster interface has a gated oscillator that converts the clock's IRIG code DC level shift into a 2 KHz tone burst that can be recorded. Both signals are then played back onto the Kiowa strip-chart recorder for comparison. The magnetic tape is used as an intermediate step because the noise of the strip-chart recorder would interfere with the radio signal. The following procedure was used:

- Set up equipment as in figure 10
- Tune in correct BBC station 1 minute before desired hour
- Start tape recorder 45 sec before hour
- Set chart speed on the strip-chart recorder to 20 cm/sec
- Record the timing signals on the chart recorder

- Measure relative error on paper record (±0.1 mm yields ±0.5 msec resolution; see sample record, figure 11)
- Advance or retard master clock to eliminate error greater than 1 msec
- Record the amount of error and date and time of correction in master clock log book.

Shooting system

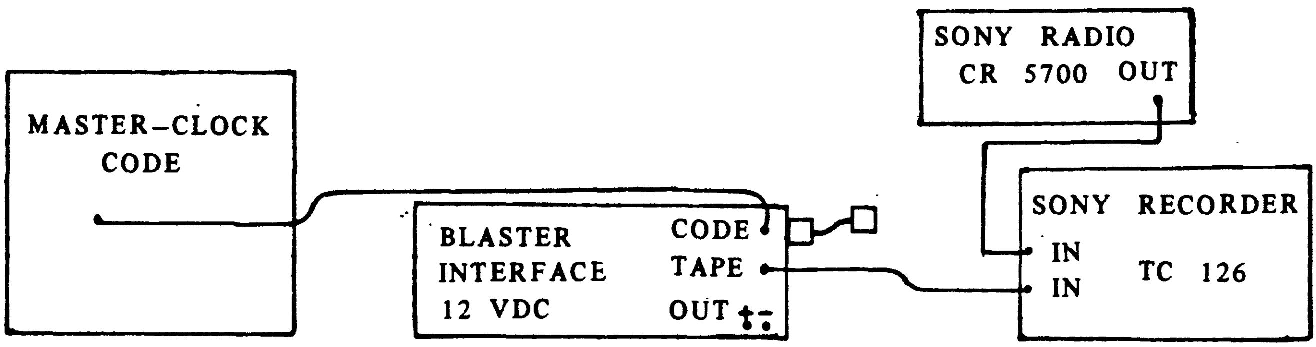
The timing and firing system automatically fires explosives on a preselected minute and records the time on a strip-chart recorder. The system is contained in four separate units: a master clock, a blaster interface, a blaster, and a strip-chart recorder. It is powered by internal rechargeable batteries in the master clock (24 v 7.5 AH) and in the blaster interface (12 v 6 AH gel cells). As discussed above, the clocks can also be powered by an external 25 v DC battery or by a 120 v AC connection.

Figure 12 shows how the system is set up. The procedures for system tests and shot-firing steps are:

Firing system set-up

- Connect CODE line from master clock to chart recorder (BNC to pins)
- Connect START line from master clock to blaster interface (BNC-BNC)
- Connect cap BREAK LINE from master clock to chart recorder
- Connect blaster interface cable from blaster (four pin end) to interface (five pin end)
- Connect 12 VDC from blaster interface to chart recorder
- Turn recorder OFF
- Switch blaster to AUTOMATIC

SCHEMATIC FOR RECORDING TIME SIGNALS



SCHEMATIC FOR PLAYBACK TIME SIGNALS

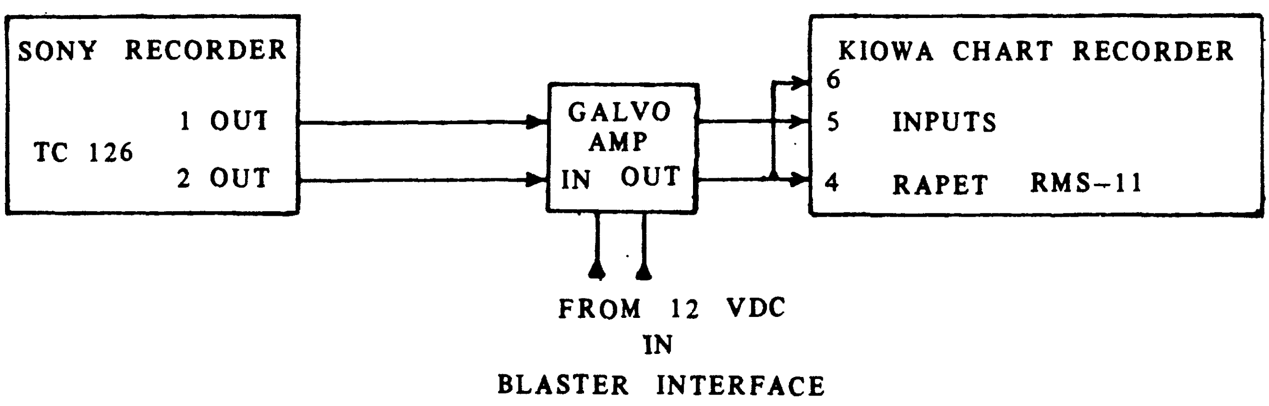


Figure 10.--Timing system equipment interconnections.

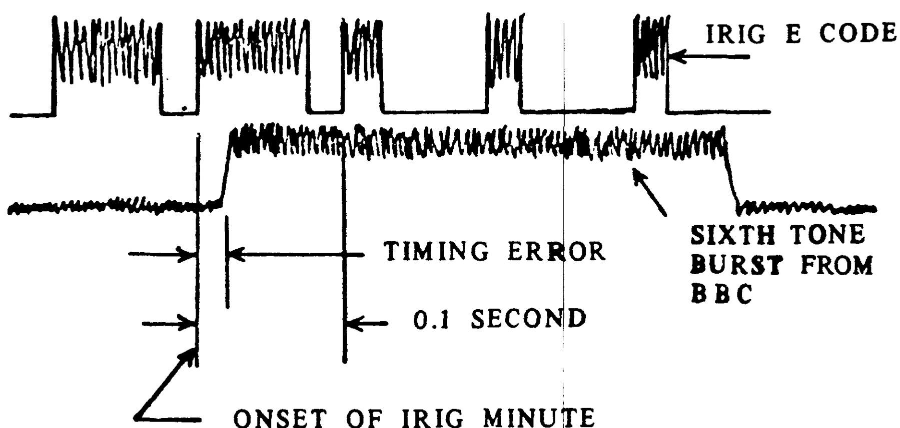


Figure 11.--Sample time error measurement record.

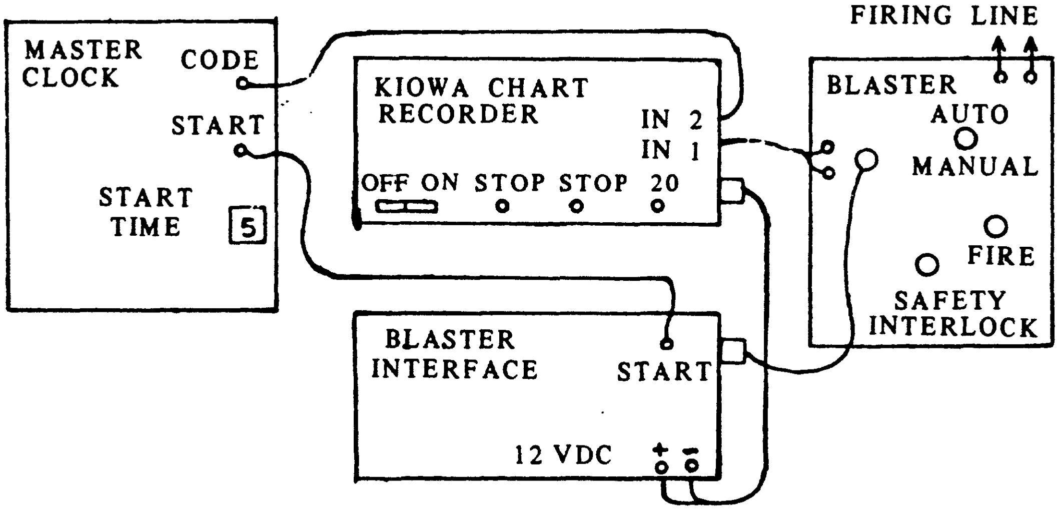


Figure 12.--Shot timing and firing system interconnections.

Firing system test (firing line must be disconnected)

- Connect a 10-Ohm resistor across firing line posts
- Set START thumbwheel to 2 minutes beyond current minute
- Hold down SAFETY INTERLOCK and crank up firing voltage to 50 volts
- Turn recorder ON (20 cm/sec)
- 5 sec before start time, start chart recorder
- 4 sec before start time, pull up and hold the FIRE knob
- After beep, stop recorder and develop record

Firing sequence

- Switch blaster to AUTOMATIC
- Set thumbwheel on master clock for desired shot minute
- Connect firing line 1 minute before shot time
- Turn clock display on to 50 volts
- Crank up firing voltage to 50 volts
- Depress SAFETY INTERLOCK; hold down until after shot
- 5 sec before shot time, start recorder
- 4 sec before shot time, hold up FIRE knob
- After shot, release FIRE knob and turn recorder off
- (If shot did not fire, switch blaster to MANUAL and momentarily pull up the FIRE knob)
- Turn clock display off
- On paper record, print date, shot location, and length of primacord between cap and explosives
- Disconnect all cables

Determining the actual shot time includes calculating the delays caused by relay closure times and the propagation time of the detonating fuse between the blasting cap and the explosives. The following steps are taken to determine the shot time (refer to fig. 11).

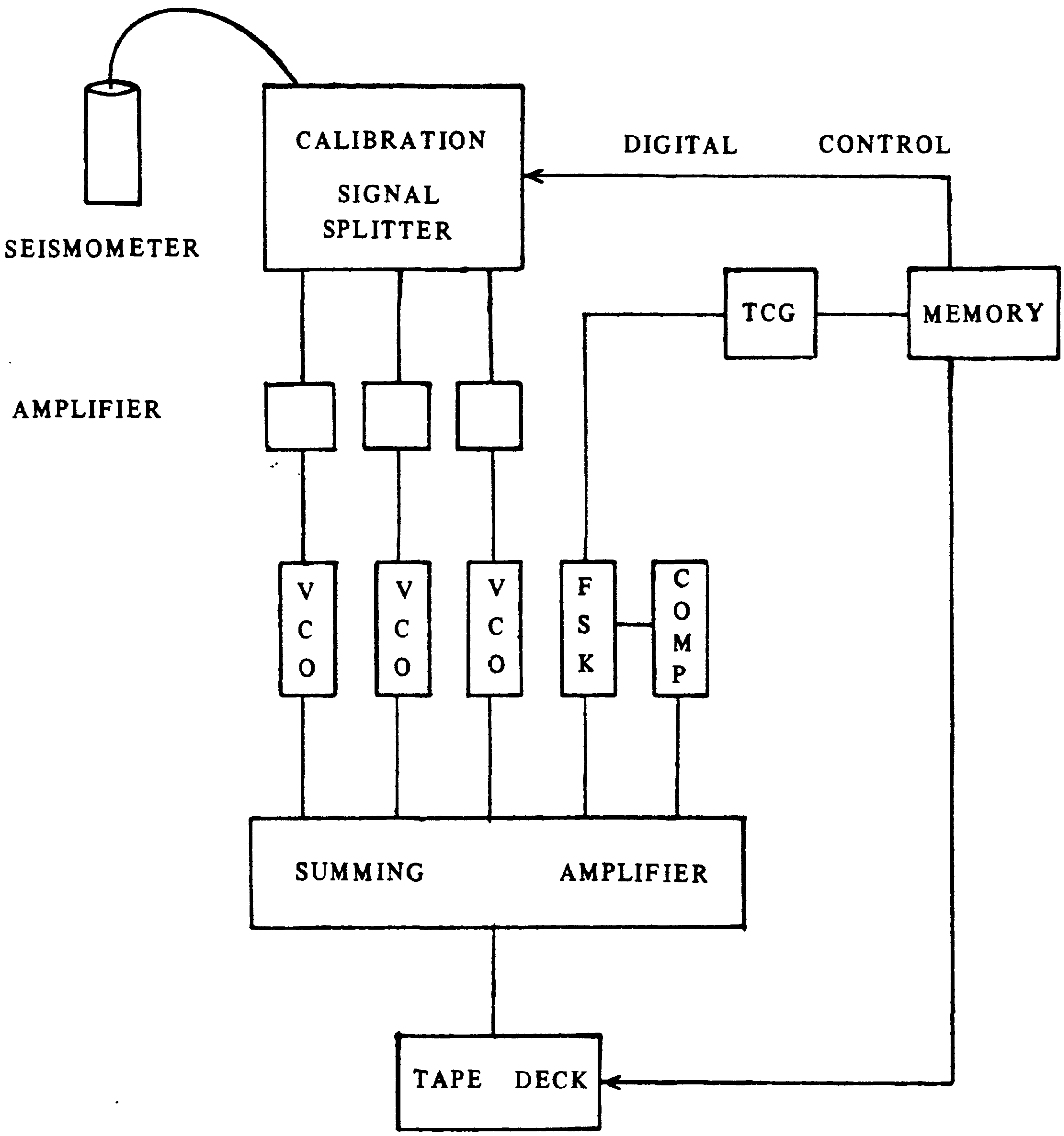
- Locate preselected start time on paper record (IRIG code)
- Measure length of a 0.1-sec interval (TSL)
- Measure length between START time and the blasting cap break (CBL), displayed as an impulse
- Calculate cap detonation time (CT) in seconds: CT = (0.1) CBL/TSL
- Calculate time from initiation of the primacord explosion until the time it detonates the main charge at its burning rate of 28 ft/msec: N (ft of primacord) x 0.001/28 = primacord time
- Calculate shot time: shot time = start time + CT + primacord time.

The date, time, charge, and depth load spread of all shots fired for the deep-refraction profile are listed in the master shot list in (app. 5).

Portable seismic recording system

The portable seismic system records the calibration, seismic, and timing data on magnetic tapes in analog form. Each instrument typically was calibrated, programmed to time specified time intervals, and then deployed the day before shooting. After each shooting sequence, the instruments were retrieved, the clock drift was checked, and the data tape was removed.

Internally, the instruments function in the following way (see fig. 13). A memory board in each instrument's USGS time-code generator provides control over the start and recording times of each recording period. During the ten



COMP = COMPENSATION
FSK = FREQUENCY SHIFT KEYING
TCG = TIME CODE GENERATOR
VCO = VOLTAGE-CONTROLLED OSCILLATOR

Figure 13.--Schematic diagram of a recording unit.

minutes before the expected shot-energy arrival, the instrument warms up and stabilizes, then records a calibration train that includes a seismometer pulse, amplifier step, and 10-Hz sine wave calibration signals at 1, 10, 100, and 1000 microvolt. The calibration train is followed by a recording window during which the shot energy is sensed, amplified, and recorded. The output of the seismometer is split without attenuation and amplified at selected gains by three independent amplifiers, which allows the seismograph to record a large dynamic range. The output of these amplifiers is then frequency-modulated, as is the serial IRIG-E time code pulse train. These four signals are then summed with a tape speed compensation reference signal before they are recorded. This sequence is repeated for each of the subsequent programmed "turn on" times.

The hand-held tester

The portable seismic station requires environmental protection, so a unit that allows remote access to all critical functions is necessary. The hand-held tester (HHT) is the interface between the field technician and the portable seismic station (fig. 14). Much of the operation of the portable seismic station can be controlled by switches on the HHT face plate; the electrical connection is through a multi-conductor cable link. The HHT is easily portable and can be used at both the seismic station sites and in the field camp for instrument maintenance.

The primary functions of the HHT include setting the seismic station's chronometer, monitoring the seismic signals and tape-handling functions, setting the VCO and tape recorder power controls, and setting recorder start and stop times. A J. Ellis chronometer with essentially no modifications performs the timing functions; the controls of the HHT clock are on the front panel of the HHT and are the same as those on the portable seismic station chronometer. The HHT's E. G. Jensen Error Detect circuit generates a timing reference signal that is displayed, along with the master clock time, on the front panel of the HHT. Any error in the portable seismic station's chronometer can be corrected remotely.

Field data processing system

Tape dubbing system. The first step in the field data-processing sequence is to reorganize the recordings of the shots. The original data tapes contain records of several shots from a single recorder, but for rapid processing all the records of a given shot should be together on one tape. Therefore, a special system of tape recorders, called a "tape-dubbing system," has been designed to accomplish the transfer of shot data from one tape to another (see block diagram, fig. 15).

The system consists of four Phi-Deck tape recorders, onto which blank tapes are loaded, connected to a TEAC tape recorder that is used to play back the original data tapes. A specific shot is assigned to each tape on the recorders, so four shots can be transferred, or "dubbed," before the original data tape must be changed. Basically, the operator mounts a field tape from one end of the recording profile line onto the playback unit and transfers up to four shot records to the appropriate tapes. He then loads the tape from the next position on the profile line and transfers its records of the same shots.

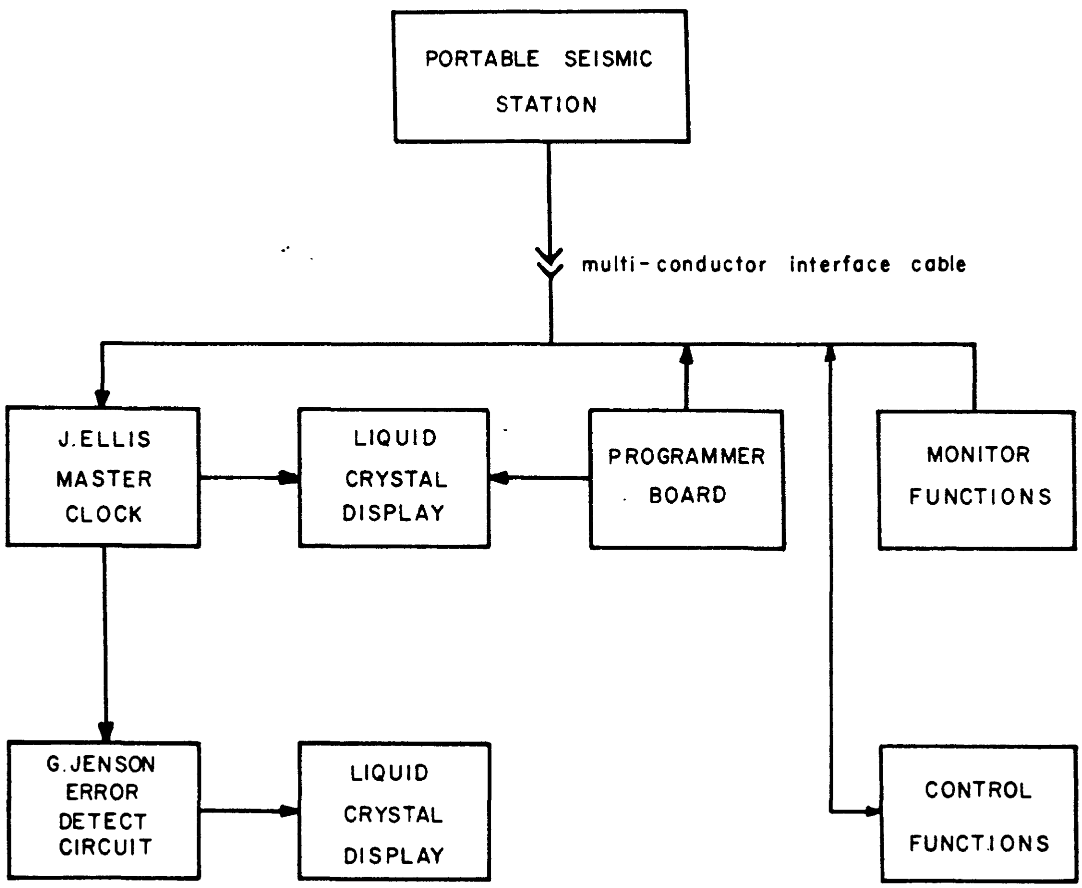


Figure 14.--Hand-held tester block diagram.

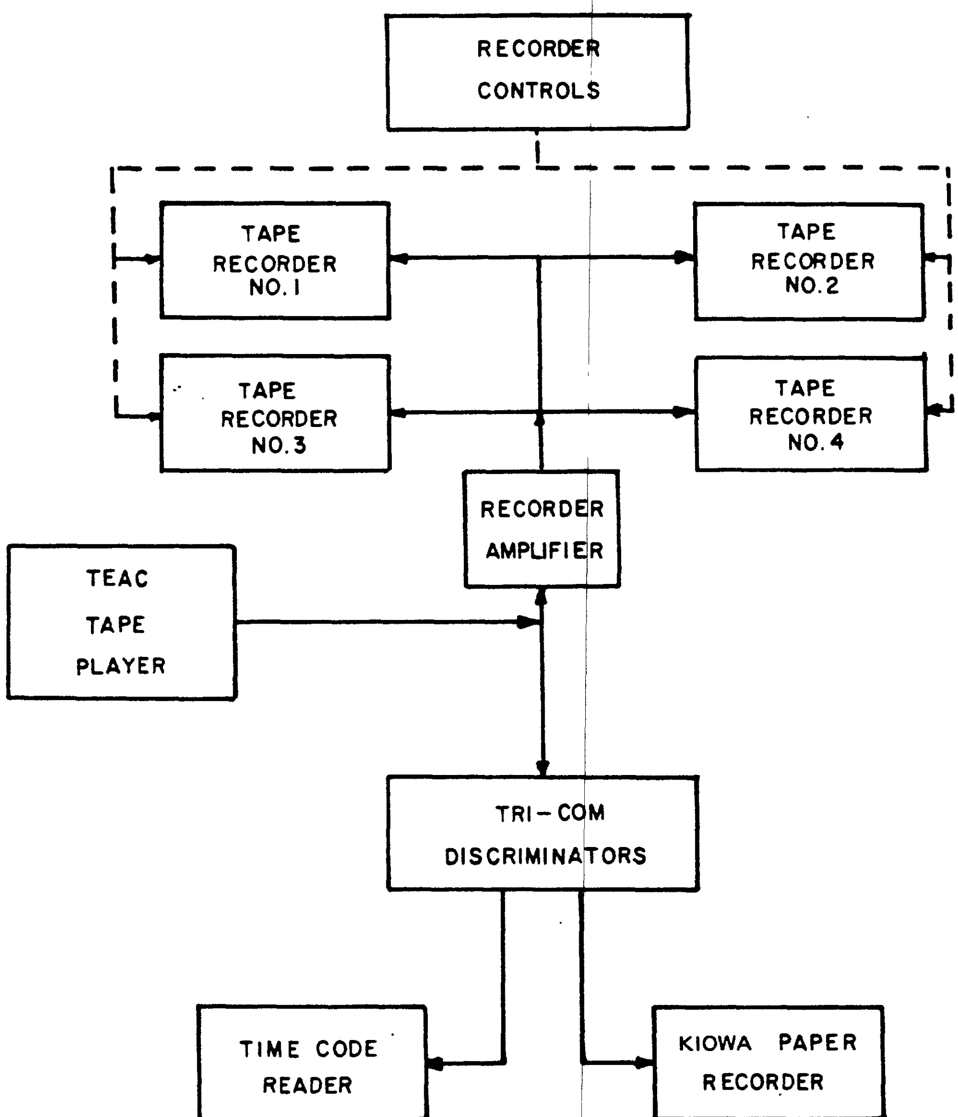


Figure 15.--Tape-dubbing system block diagram.

Two sets of four switches control the recorders. The first set, toggle switches labeled one through four corresponding to the four recorders, may be switched to either MANUAL or AUTO. The second set are pushbutton switches labeled STOP, PLAY, FAST FORWARD, and FAST REVERSE. When a given recorder's toggle switch is in MANUAL, the recorder is controlled by the four pushbuttons; when it is in AUTO the recorder cannot be controlled by the pushbuttons. The recorders can be controlled individually or in any combination.

The playback unit is also connected to a bank of discriminators, which, in turn, is connected to a Kiowa photosensitive paper recorder. A paper copy record can be made at any time during the playback process by starting the Kiowa recorder. The discriminators are also connected to a time code reader that reads the IRIG-E code on the tape, allowing the operator to determine what part of the record is being played back and on what unit the record was made. The reader displays a time that is 6 seconds behind the time actually on the tape; it requires about 10-20 seconds from the time it begins receiving the time codes before it is able to display the proper time.

This is the operating procedure for the tape-dubbing process:

- Load a data tape on the playback machine
- Set the counter on the playback machine at zero
- Scan the tape, using the fast-forward feature. A time-code reader will identify the starting and ending points of each shot segment
- Rewind the data tape
- Load blank tapes on the four recorders
- Determine which tape is to record which shot

- Set the toggle switch of the recorder that is to record the first shot to MANUAL
- Set all other toggle switches to AUTO
- If necessary, use fast-forward to advance the data tape to the beginning of the first data segment
- Depress PLAY; both the playback unit and the appropriate recorder will begin operating, transferring the data
- When the time-code reader indicates the end of the segment, depress STOP
- Move the first toggle switch to AUTO
- Set the second toggle switch to MANUAL
- If necessary, use fast-forward to advance to the next data segment
- Depress PLAY; both the playback unit and the appropriate recorder will begin operating, transferring the data
- Unload data tape after all four shot segments have been transferred
- Load the next data tape.

Digitizing and plotting. The data are recorded at the seismograph in analog form; before they can be plotted, the analog signals must be converted to computer-readable digital signals. Figure 16 is a block diagram of the analog-to-digital (A/D) and plotting system.

The seismograph system has nine data-recording channels available; for this experiment there were three data channels corresponding to three different attenuation settings in the geophone amplifier, four unused channels, a time-code channel, and a compensation frequency channel. The seismograph's output to the data tape is recorded in FM format, with each of the nine channels frequency-multiplexed. Before the signal can be digitized

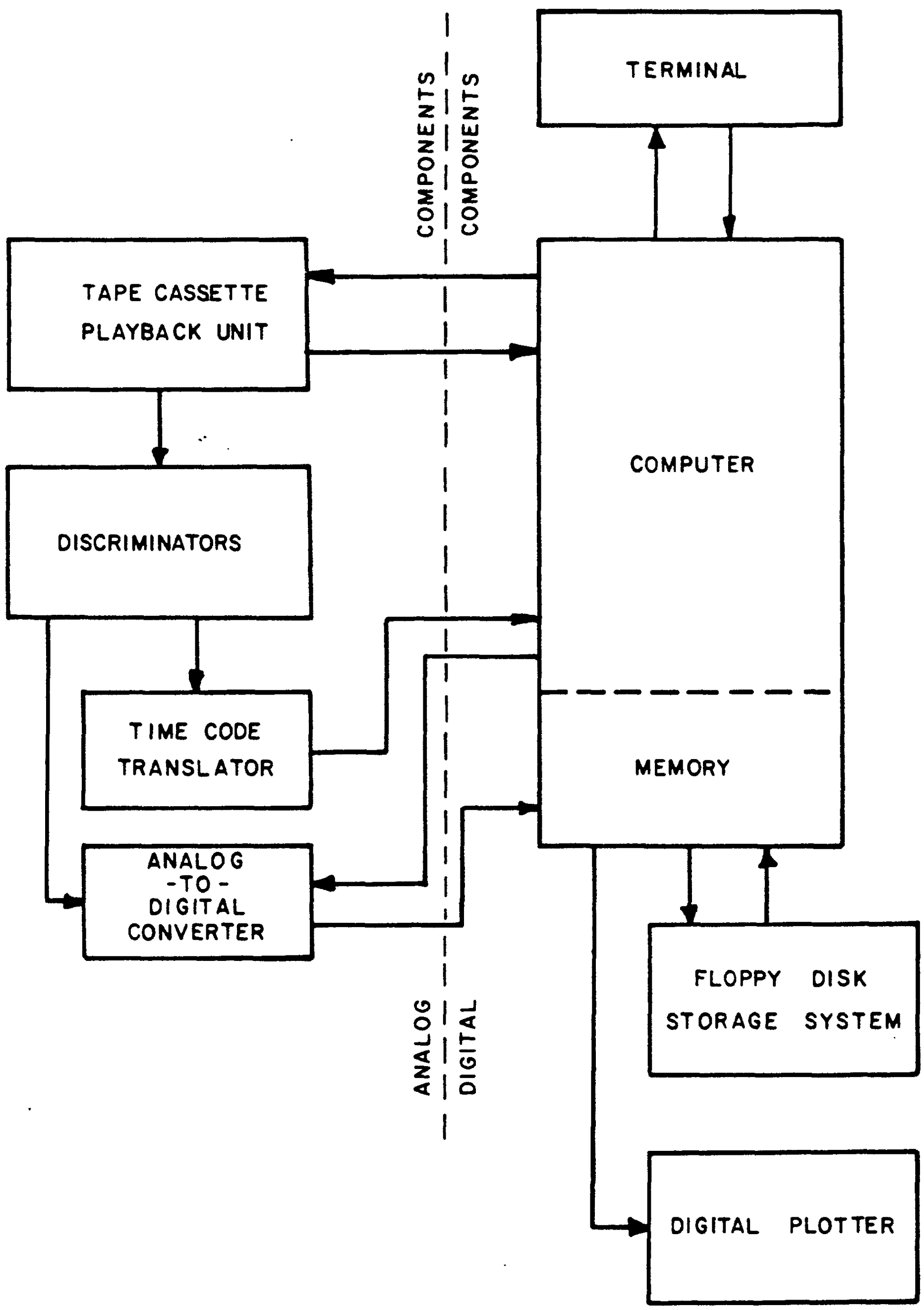


Figure 16.--Schematic diagram of seismic data processing system showing control and data lines.

the carrier signal must be demultiplexed by a set of discriminators in the processing system. The time code is, of course, a major part of the data, but it is also used to identify data segments, as it was in the tape-dubbing process. After the time code passes through the discriminator it is decoded by the time-code translator and can then be used by the computer as a digitize-start signal.

Digitizing and plotting are an interactive process between operator and computer. The operator enters control codes, such as the identifying times of segments to be digitized and the sampling rate, through a terminal, then advances the tape to the first of the data segments. Upon a start command from the operator, the computer activates the playback unit and reads the time-code output from the translator, which triggers the start of digitizing.

The digitized data are stored in the computer memory. The data can be plotted as a seismic trace on the digital plotter at this point, or can be transferred to a removable computer disk for permanent storage, and later recalled for processing. Plotting a record section of 100 traces takes about two hours (see sample record section, fig. 17).

Computing equipment (hardware). The central controlling computer is a Digital Equipment Corporation (DEC) LSI-11, a 16-bit word "microcomputer" or computer-on-a-card that has about 32,000 words of memory. It is the smallest member of the well-known DEC PDP-11 family. Its central processing unit (CPU) is contained on one 22- by 25-cm printed circuit board, and the entire unit, including the memory board and several interface cards, measures approximately 28 by 28 by 8 cm. The LSI-11, which has the same instruction set and software features as the much larger and faster PDP-11/40 computer, is a general-purpose computer that can be tailored for many instrumentation, data-processing, and controller applications.

The Phi-Deck cassette playback unit is the same model as that used in the recorders and dubbers. The discriminators are manufactured by Tri-Com, and the time-code translator is a Datum Model 9200. The DEC ADV11-A 12-bit successive-approximation analog-to-digital converter has a built-in multiplexer accomodating 16 single-ended or eight differential-mode inputs. The floppy disk system is a DEC RXV-11. The digital plotting system, manufactured by Houston Instruments, consists of two units: a PTC-5A plotter controller containing a microprocessor, and a model DP-1 digital incremental pen plotter with 200-step/inch resolution. The plotter controller has a read-only memory that controls step-by-step pen movements given the end coordinates of a vector or the character code, which simplifies designing programs for plotting.

Except for the terminal and plotter, all components are specially packaged in three lightweight fiberglass cabinets; racks within the cabinets are suspended on rubber shock mounts. Figure 18 shows the physical layout of the components inside the cabinets. The terminal is packaged in its own carrying case, and the plotter is transported in a wooden box. In addition, an Ultra Isolation Transformer manufactured by Topaz Electronics is interfaced between the computer system and the local power source, such as a gasoline generator, as protection against voltage surges or spikes. Heavy-duty cooling fans in the cabinet cases reduce the operating temperature.

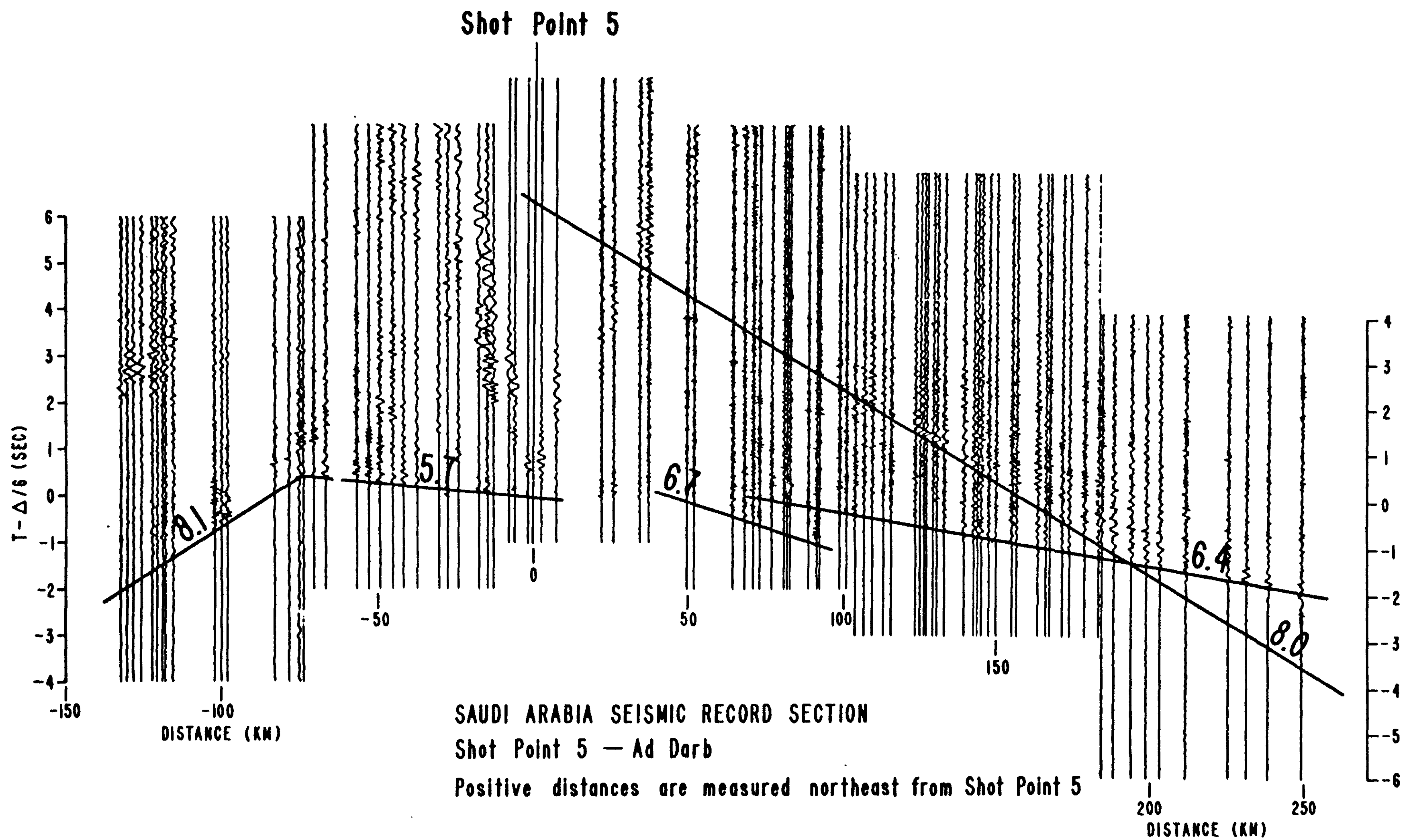


Figure 17.--Sample record section from a refraction survey.

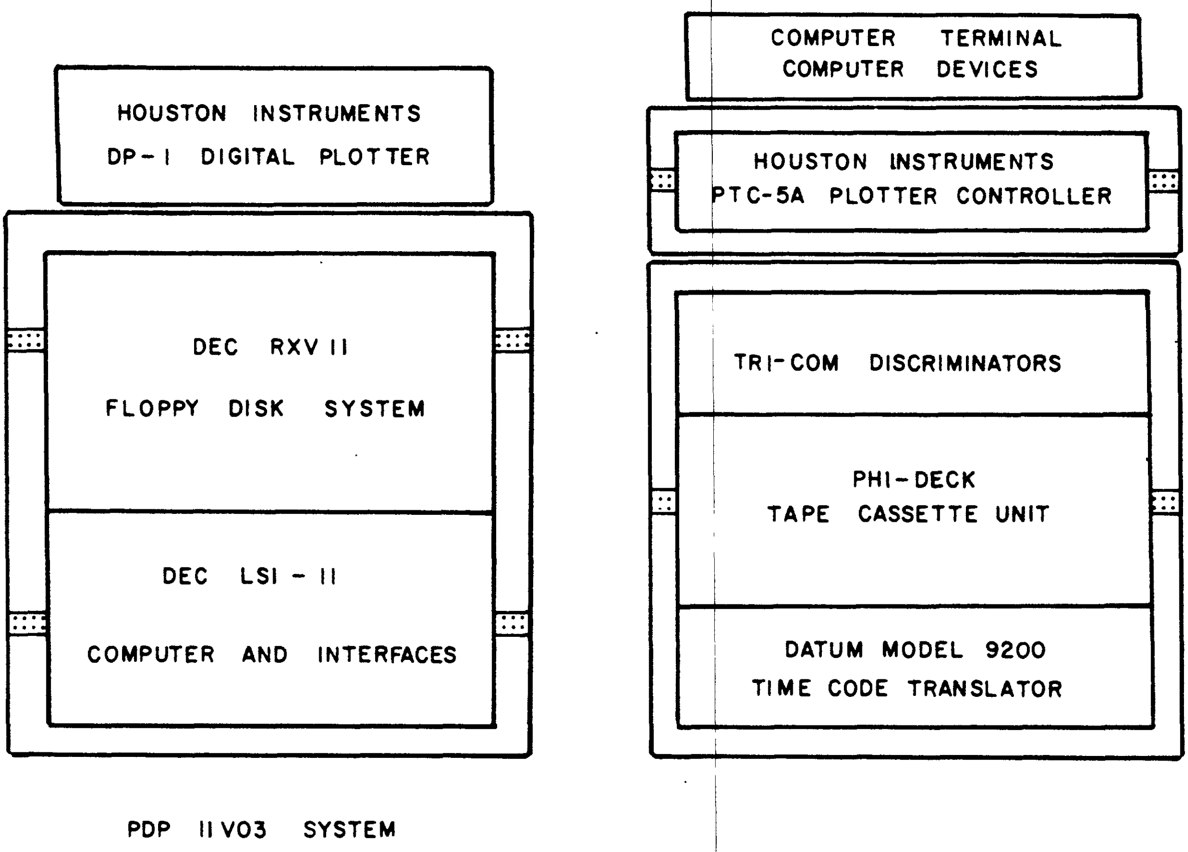


Figure 18.--Components of the seismic data processing system.

The seismic processing system can be set up and put into operation in approximately four hours. The fiberglass cabinets must be positioned, the lids removed, and cables connected between components and computer. The system boxes can be installed in a van on a foam-and-plywood sandwich platform and tied down using ordinary rope or parachute cord. The crew hauled the system approximately 1,500 km on desert tracks and highways and the only apparent resulting equipment failure was a snapped rubber drive belt on a cassette playback unit.

Geosystems, Inc., of Palo Alto, California, USA, developed the seismic processing system using components selected by the USGS and according to USGS specifications.

Operating systems (software). The LSI-11, the DEC RXVII floppy-disk mass-storage system, and any standard computer terminal make up a PDP-77V03 development system; the manufacturer provides DEC RT-11 operating system software, which includes single-job and foreground/background system monitors. All the normal tools used in software development are available with the RT-11 system, including FORTRAN, BASIC, and MACRO (assembly) language processors, system utilities such as a text editor, a linker, and a program librarian, file-management utilities such as the DEC Products Peripheral Interchange Program (PIP), which transfers, deletes, or renames files, FILEX, which reformats files, and DUMP, which displays all or selected portions of a file on a terminal.

The operating program for producing seismic record sections, written in FORTRAN, is called TRACES. TRACES provides all functions required to process a record in a series of 25 commands called macros (table 4), which the operator enters at the terminal. TRACES is written in modules to facilitate adding more commands, so many macros in turn require additional input or offer selected options. The macros fall into several logical groupings. Some accept descriptive or control parameters relating to shot time and location, recorder identification and location, record section plot specifications, or digitization rates and windows. Others control cassette tape motion. One set manages data files on the floppy disks. A single macro will initiate plotting an entire 120-record seismic section using data files stored on one disk. Another grouping is used for diagnostics if problems develop during processing. Finally, one sequence is used for computer system and component check-out. During normal processing of a batch of seismic records, the operator uses five commands for set-up and three in a repetitive cycle for processing.

We also used the computer system during the refraction survey as a tool for maintaining and listing various information files. A recorder performance summary file documented the success or specific ills of all geophone and recorder units. A shot schedule was regularly published showing scheduled and re-scheduled shot dates and supporting information. A diskette file held all recorder and shot locations in latitude and longitude. We computed distances from shots to recorders and the expected seismic wave arrival times according to various velocity models; this information was used to guide parameter settings during processing. Distances and azimuths between recorder sites were calculated and listed to help observer teams locate the recorder stations. The attenuation settings for the three data channels for all shot sites and all recorder locations were listed. Finally, a computer program using the standardized diskette-file-access routines developed for TRACES was written for computing the power spectra of individual seismograms.

Table 4.--Program TRACES - macro commands

Macro number	Function
1	Enter shot data
2	Initialize plotter, draw time axis, and label plot
3	Enter recorder data
4	Digitize, store, plot trace
5	Re-initialize plotter pen position
6	Set polarity flag
7	Enter digitization parameters
8	Enter plot parameters
9	Initialize Phi-Deck and rewind tape
10	Stop tape
11	Play tape
12	Fast forward tape
13	Rewind tape
14	Print tape status
15	"Monkey mode" - initiate A/D conversion from terminal
16	Relative tape motion
17	Read print time code
18	Load shot and recorder locations from diskette into memory
19	Initialize Phi-Deck but do not rewind
20	Initialize diskette
21	Open diskette file for access
22	Close diskette file
23	List contents of data diskette
24	Delete data trace from diskette
25	Automatic plot of diskette

Field procedures

Shots were fired on seven days between February 3 and February 22, so there was usually at least a two-day interval between shots to pick up the recorders, dub the tapes, digitize and plot the data, and move to the next segment of the profile line and set out the recorders.

The five two-man recording teams carried out the following activities:

(1) In the morning of the day preceding the scheduled shots, each team set the chronometer of its hand-held tester (HHT) by comparison with a master clock, then entered the specified start and stop times for recording all scheduled shots into the HHT.

(2) Each team then connected the HHT sequentially to each of the their 20 recording instruments to set the chronometer to within 0.1 millisec of the HHT chronometer time and to deliver the recording information programmed into the HHT to the memory of the recording instrument. They then used the HHT to query the instrument on how it was programmed to make certain that it had accepted the instructions.

(3) The crews cleaned the tape heads in the recording instruments and mounted the tape cassettes in the recorders.

(4) The afternoon and evening of the day before the scheduled shots, the teams, accompanied by guides who had surveyed the locations, drove to their 20 assigned locations, where they buried each instrument's seismometer in a hole about 0.3 m deep and put the instrument box in some inconspicuous location after setting attenuation switches at levels the field manager calculated. These activities took only a few minutes at each location. Based on the

distance between the teams' assigned locations and the nearest camp, the teams then elected either to spend the night in the field or to drive back to the camp.

(5) Immediately after the shot, the teams picked up their 20 instruments, noting on their log sheets which recording instrument was installed at each location.

(6) After the teams returned to the nearest camp, they compared the time on the chronometer of each recording instrument with the time on the HHT chronometer (which was first set by comparison with a master clock) and noted any discrepancy on the log sheet. They removed and carefully labeled the recorded tape cassettes and put the instrument batteries on charge.

(7) The teams dubbed the tapes, also making a visual record on photosensitive paper of the recording of at least one shot of each tape to establish that the instrument was operating properly.

(8) Any instrument problems identified from the visual recordings were referred to the repair staff. Repairs had to be completed that afternoon or evening when the shots were scheduled two days apart, because most of the following day was dedicated to programming and deploying the instruments.

During the last two shooting days, when the recording instruments were deployed along the Asir escarpment and in the Farasan Islands, the field operations were carried out with helicopter support rather than with trucks. The procedures used were essentially the same as those developed for use with surface vehicles.

Data quality

The Saudi Arabian seismic refraction data are of excellent quality by all standards of modern long-range refraction profiles. The 2-km station spacing is adequate to resolve features in the crust on the order of 4-6 km in breadth; shorter features appear at only one recording point. Most profiles have an adequate signal-to-noise ratio to allow reliable determination of first arrivals. This favorable situation is due to three factors: large shot sizes, generally low cultural noise levels on the shield due to low population density, and the relatively high Q (low seismic attenuation) of the crystalline crust. We estimate that first arrivals can be determined with an accuracy of four digital sample points, or to 0.02 s. As previously described, the locations of shot points and stations were determined with an accuracy of ±93 m horizontally and ±5 m vertically. The maximum error in location would result in a traveltime error of (.09 km)/(6.1 km/s) = ±.015 s. The maximum error is probably less than the traveltime variations due to near-surface lithologic variations along the profile (estimated to be ±0.05 s). Another possible source of traveltime errors in the data is human error - specifically, entering the chronometer correction with the wrong sign or the wrong value. Since the average value of the chronometer correction is 0.020 s, a sign error would cause a 0.04 s error in the plotted trace. In some very rare cases the chronometer correction is 0.1-0.3 s and a sign error would then amount to 0.2-0.6 s. Sudden traveltime changes of magnitudes greater than 0.1 s were generally double-checked if they occurred on isolated traces, so it is unlikely that errors greater than 0.1 s remain in the data. In summary, we believe that the maximum possible error in first arrival times is on the order of 0.05 s and in most cases is 0.01 s.

In addition to possible traveltime errors, some systematic errors in the amplitude of the recordings due to instrument errors are also possible. The largest probable cause of error is due to variation in calibrator signal level. The calibration boards in the instruments were designed to give 1, 10, 100, and 1000 microvolts at 10 Hz. While the 10-Hz frequency was accurate to better than 1%, the microvolt output level varied by $\pm$10%. This variation is undesirable (and has since been corrected). However, in comparison, conditions at the recorder sites are generally believed to contribute a variation in amplitude of up to a factor of 2; for example, a ring of stations at a given distance from a shot will have an average peak signal level of, say, 100 units, with a low of 50 and a high of 200 units. This variation is particularly pronounced when going from crystalline rock to alluvial fill. Although such variations are not likely to be as pronounced in the Saudi Arabian Shield as in areas with large fault-bounded alluvial valleys (e.g., the Basin and Range Province of North America), significant variations may be present due to recorder stations on the sand and alluvial sheet areas that occur at several places along the profile. Corrections for these variations can be made with limited supplemental field work along the profile to determine surface velocities (see "Recommended further work," below).

RECORD SECTIONS

Plotting methods and format

Plates 1-6 display data for each of the six shot points. The data for each shot point is shown in two record sections, one in true-amplitude and one in normalized form. The true-amplitude record section shows the entire 20 seconds of data that were digitized for each record, and the normalized section shows 10 seconds of data around the shot arrival at twice the time scale. Distance scale is uniformly 8 km/in. Table 5 gives distance parameters for each shot point.

We produced all record sections with the same computer digitization and plotting techniques. Using a data base that included a comprehensive shot and recorder site location list, precise shot times, and recording instrument identifications (see app. 5), every usable record for each of the 19 shots was digitized. For each record, we digitized a 20-second data segment that began 1 second before the estimated arrival of shot energy, assuming a velocity of 8 km/s. We used a sampling rate of 5 msec per sample, so each record consists of 4001 digital values, or "points." The records are stored on data files, with one file per shot.

Each digitized record was plotted, examined, and edited using a Digital Equipment Corporation PDP 11/03 minicomputer equipped with a Houston Instruments Model DP-11 COMPLOT plotter. In the case of more than one recording at the same site (due to re-occupation of a site), the records that were subjectively judged to have the smallest signal-to-noise ratio were omitted, as were records for which instrument malfunctions obscured any useful data. Final record sections were produced from these edited data files.

10- and 20-second plots

In order to best see the arrivals of seismic waves that have traveled through the crust (Pg [upper crust] and Pi [middle crust] arrivals) and of those that have refracted through the mantle (Pn arrivals), we used reduction

Table 5.--Distances and plot lengths for the record sections for each shot point

Shot point	Distance from shot point (km) southwest(-)	northeast(+)	Total plot length (km)	(in)
1	-675	100	775	96.875
2	-350	225	575	71.875
3	-350	75	425	53.125
4	-400	300	700	87.5
5	-150	275	425	53.125
6 (normalized)	-50	300	350	43.75
(true-amplitude)	-50	550	600	75.0

velocities of 6 and 8 km/s, respectively. In addition, we need to see arrival patterns at a small time scale for an overview and at a larger time scale to make accurate measurements. Therefore, 10- and 20-second time scales were chosen, respectively. In order to examine the data from every useful perspective, we would have to plot it with varying reduction velocities and time and distance scales in both normalized and true-amplitude forms. We chose plotting standards to satisfy the majority of scientific needs with the minimum number of plots. Additional plots may be made from the digital magnetic tapes, whose format is described in appendix 1.

Normalized and true-amplitude record sections

The difference between normalized and true-amplitude record sections is in the significance of comparative trace widths. In normalized record sections, the maximum peak-to-peak amplitude of each trace is scaled to have the same width, in this case 0.4 inches. In the true-amplitude record sections, the width of each trace represents the actual amplitude of the record, after adjustments for amplification level, distance from energy source, and shot efficiency. Thus, the true amplitude A(t) is computed from the observed amplitude $A_o(t)$ by

$$A(t) = A_o(t)f_af_df_s$$

where f_a, f_d, and f_s are multiplicative factors correcting for instrument amplifier gain, distance from the shot, and shot efficiency, respectively.

The multiplication factor for amplification is:

$$f_a = 10^{(dB/20)}$$

where dB is the gain setting of the selected channel in decibels. For example, the amplitude value of a sample recorded with a gain setting of exactly 18 dB would be multiplied by 10 to the 18/20 power, or approximately 7.943. In order to check the consistency among calibrators and amplifiers, the 1-, 10-, 100-, and 1000-microvolt portion of the 10-Hz sine wave calibration signal that precedes each seismic record was recorded and digitized. The amplitudes of the calibration signal were compared among the instruments for each gain setting. Variations among instruments were found to be within an acceptable range, so a uniform set of factors was adopted for all instruments. The factors are given in table 6.

The formula used in adjusting for distance is:

$$f_d = \left[\frac{\text{Distance from shot point}}{\text{Crossover distance}}\right]^{\text{exp}}$$

where exp is an exponent to account for geometric spreading; it is specified for each plot and varies within and beyond a chosen "crossover distance." The exponent generally used for plots on the continental side of the Arabian Shield was 1.5, while an exponent of 2.0 was used southwest of shot point 5, in the Red Sea Depression. Because shot point 5 is located roughly at that boundary, the exponent changes from 1.5 to 2.0 for the southwest portion of the shot point 5 plot. The "crossover distance" chosen was 170 km from the shot point for all plots. Therefore, the amplitude value of a record for a location exactly 170 km from shot point 5 would be unchanged. For a location 85 km away, the amplitude value would be multiplied by $(85/170)^{1.5}$ or $(0.5)^{1.5}$ to the northeast (continental side) of shot point 5, and $(0.5)^{2.0}$, or 0.25, to the southwest (oceanic side) of shot point 5. Exponent values for the various shot points are given in table 7.

Table 6.--Amplification factors adopted for listed instrument gain settings

Gain setting (dB)	Decimal value of $10^{dB/20}$ amplification factor
0	1.000
18	7.943
36	63.096
42	125.896
48	251.189
56	630.957
62	1258.925
68	2511.887
76	6309.573

Table 7.--Distance factor exponent values (exp) used for the true-amplitude calculations

	Southwest		Northeast	
	170 km	170 km	170 km	170 km
Shot point 1	1.5	1.5	1.5	-
Shot point 2	1.5	2.0	1.5	2.0
Shot point 3	1.5	1.5	1.5	-
Shot point 4	1.5	1.5	2.0	3.0
Shot point 5	2.0	-	1.5	1.5
Shot point 6	2.0	-	2.0	2.0

Shot efficiency is, ideally, exactly uniform, i.e., the amount of energy produced is directly proportional to shot size. In a record section displaying records from several shots, the change from one shot to the next should be unnoticeable after adjustment for shot size. However, the signals from some shots were noticeably stronger or weaker than others in relation to the size of the shots. Amplification factors were adjusted accordingly, on the basis of amplitude measurements taken from a representative sampling of records from neighboring shots. In some cases sites were occupied twice for different shots, so amplitude comparisons between shots at reoccupied sites allowed more accurate amplification adjustments. The factors determined by such plot measurements are as given in table 8.

Record recovery

Recovery rate was essentially determined by instrument performance. A total of 100 portable seismographs were in the field, so if all instruments had functioned correctly for all 19 shots, there would be 1900 records; the actual number of usable records is about 1270, including approximately 150 duplications due to site reoccupations. Given that this was the first full-scale seismic refraction experiment executed with these newly-developed instruments, a recovery rate of nearly 70% is remarkable.

TRAVELTIME INTERPRETATION OF THE REFRACTION PROFILE

Methods

Data analysis consisted of the following steps:

(1) Primary and secondary arrivals were determined from record sections reduced to 6.0 or 8.0 km/s. The arrival times are listed in appendix 2.

Table 8.--Shot efficiency factors used in the true-amplitude calculations

	Shot no.	Shot size (lbs)	Multiplication factor f_s to adjust for shot efficiency
Shot Point 1	1	1800	0.2
	3	7500	0.1
	5	9700	0.1
	11	11,000	0.1
Shot Point 2	2	2900	0.15
	4	3000	0.15
	6	4500	0.15
	8	10,500	0.075
Shot Point 3	9	2200	0.14
	12	18,800	0.07
Shot Point 4	10	5800	0.1
	13	3000	0.5
	18	12,000	0.2
Shot Point 5	15	8800	0.1, 0.2*
	17	3200	0.1, 0.2*
Shot Point 6	7	3000	0.1
	14	5000	0.088
	16	5000	0.1
	19	5000	0.31

* 0.1 used northeast of shot point; 0.2 used southeast of shot point.

(2) The phases were identified as either refracted or reflected waves based on their amplitudes and traveltime behavior. Once the apparent velocities and time intercepts of the main refractors were identified, the slope-intercept method (Steinhart and Meyer, 1961) was used to obtain a starting model. Reflected phases were then fit by iterative one-dimensional ray-tracing.

(3) The one-dimensional models (velocity as a function of depth only) to the southwest and northeast of each shot point were combined to make preliminary two-dimensional models. The theoretical traveltimes for these models were compared with the observations using a modified version of a two-dimensional ray-tracing program described by Červený and others (1977).

(4) Qualitative judgments were made concerning the relative sharpness of the seismic discontinuities on the basis of the apparent amplitude relations of the various phases, and these judgments were used to vary the two-dimensional model. For example, in order to shift critical points, sharp boundaries were converted into transition zones.

The true-amplitude record sections presented in this report were not available at the time this traveltime interpretation was completed. The refinement of the derived velocity structure based on the calculation of synthetic seismograms is an important step that has yet to be carried out.

Because of the large amount of data, this section is limited to a discussion of the reduced traveltime plots made from the arrival times of the primary and secondary phases. The main traveltime and amplitude features can be examined on the record sections (pls. 1-6), but we keep reference to these to a minimum for the sake of readability.

Flat-layer, unreversed models

Calculating flat-layer models is only a first step in modeling seismic refraction data. These models are clearly only approximations because they do not take into account lateral changes in velocity (e.g., resulting from dips and faults). Therefore, while the general features of the crustal structure presented in this section are reasonably accurate, many details will be changed in the succeeding section on two-dimensional modeling.

The nomenclature of the phases identified in the data is as follows. "Pg" refers to a phase refracted through the basement, "Pi" refracts in the middle crust, "PiP" reflects from the middle crustal boundary (when more than one such reflections are identified they are numbered PiP1 and PiP2), "PmP" reflects from the crust/mantle boundary (variously referred to as the Moho, Mohorovicic discontinuity, or M-discontinuity), and "Pn" refracts through the upper mantle. Upper mantle phases that arrive after Pn are numbered and referred to as "P1" and "P2".

Shot point 1

Northeast (fig. 19): This profile is entirely within the Arabian Platform. The data, recorded only to ∿85 km, reveal low velocities at the near-surface and an apparent high gradient in the uppermost basement. The apparent velocity of the first arrivals is ∿5.9 km/s to a distance of 40 km, and then becomes ∿6.3 km/s. There is considerable scatter in first arrival times between 70 and 85 km. One-dimensional modeling does not adequately represent these features where lateral changes are known to occur. A more complete interpretation is given in the "Discussion" section.

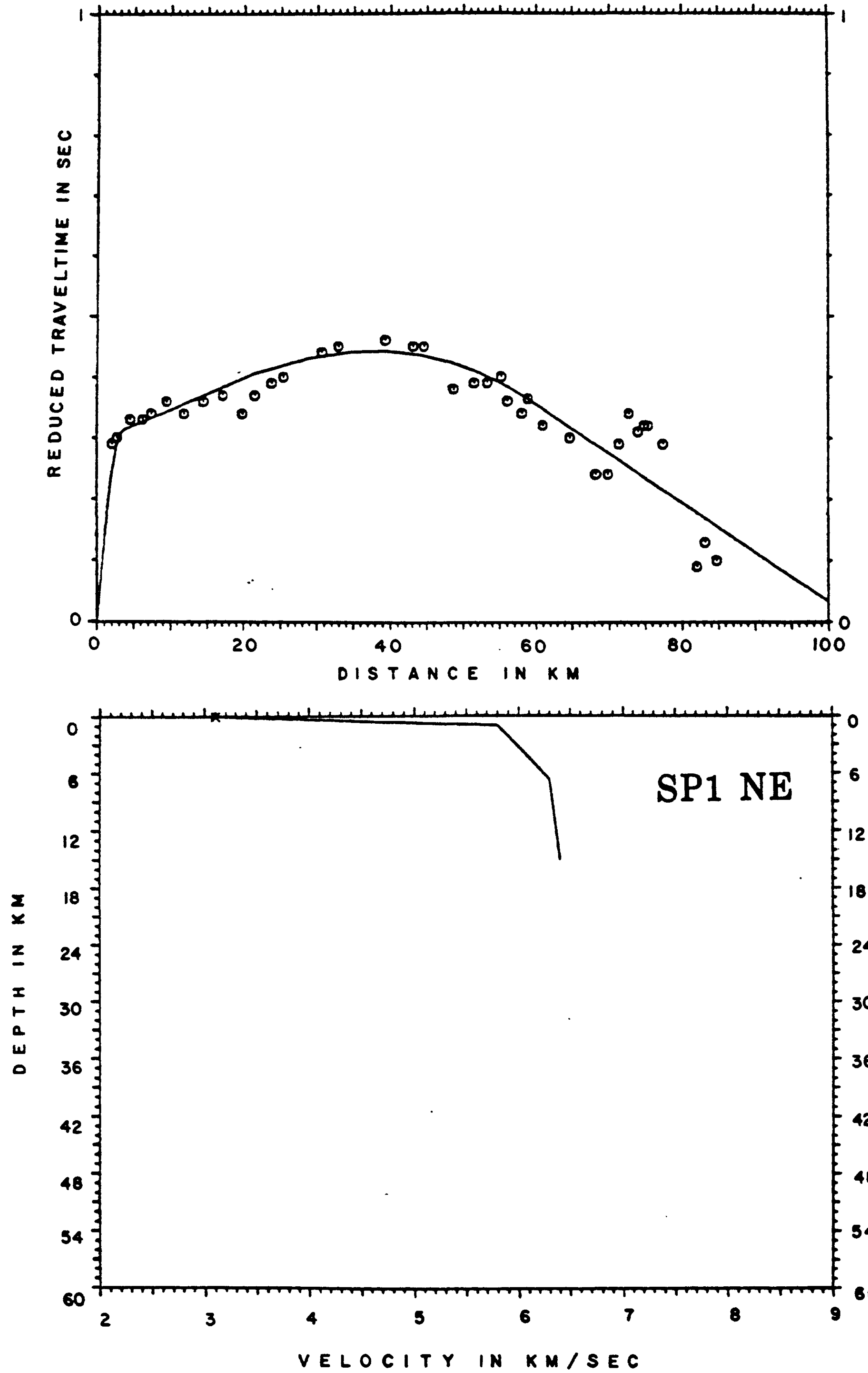


Figure 19.--Flat-layer model for data from shot point 1 northeast. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

Southwest (fig. 20): This profile begins in the Arabian Platform and enters the shield 43 km southwest of the shot point. Data were recorded to a maximum of 655 km, nearly across the entire shield, with clear arrivals to as far as 550 km. In this discussion we consider only the data to 370 km. Low velocities are evident directly beneath the shot point, with the basement refractor apparently at ∿1.0 km depth (c.f., fig. 52). Pg (basement) arrivals have been fit most accurately between 90 and 150 km. The arrivals between 20 and 80 km appear to be traveling through a medium with a higher average velocity than those beyond 90 km. The change to higher velocity occurs near the point at which the profile crosses the Al Amar-Idsas fault (pl. 8). Clear arrivals between 136 and 180 km are seen intermediate in time between the Pg and PmP/Pn phases. We refer to these phases as PiP if we believe them to be reflections from an intermediate crustal boundary, and as Pi if we believe them to be refractions from that boundary. In order to fit the high apparent velocity of these PiP arrivals, we have used a continuous velocity gradient increasing from 6.15 km/s at 1.5 km depth to 7.2 km/s at 39 km depth. A discontinuity occurs at 39 km depth where the velocity increases to 7.6 km/s. Below 39 km, the velocity increases slowly, reaching 7.7 km/s at 47 km depth, the crust/mantle boundary. The best fitting Pn velocity is 8.15 km/s at 47 km depth. The velocity model is unique among the shield profiles in that it lacks a velocity discontinuity at ∿20 km depth, which may be in part due to a lateral change in crustal composition that occurs 120 km southwest of shot point 1. This change is discussed more thoroughly in later sections.

Shot point 2

Northeast (fig. 21): This profile begins in the Shammar tectonic province of the shield (Greenwood and others, 1980) and enters the platform at a distance of ∿100 km from the shot point. The first arrivals in the distance range 0-150 km (Pg) are fit with a velocity gradient in the upper crust from 6.2 km/s at 1 km depth to 6.5 km/s at 21 km depth. Clear intermediate arrivals (PiP) between 85 and 150 km are modeled as reflections from a discontinuity at 21 km depth where the velocity increases from 6.5 to 6.85 km/s. A mantle depth of 38 km matches the average arrival time of presumed mantle (PmP) arrivals but fails to match the low apparent velocity of this phase. Comparing the velocity model for this profile with that of shot point 1 southwest (fig. 20), we note that both indicate a velocity discontinuity at ∿38 km depth, but neither clearly indicate that this is the M-discontinuity. This raises the possibility that a high-velocity lower crustal layer is present between shot points 1 and 2.

Southwest (fig. 22): This profile (and the next four to be discussed) was recorded entirely within the Arabian Shield, crossing three tectonic provinces and the faults that separate them (pls. 8 and 9). The data on this profile have some of the highest signal-to-noise ratios of all the data recorded during the project. The flat-layer model was very successful in modeling the arrival times of both primary and secondary phases. Pg is modeled with a velocity gradient from 6.1 km/s at 1 km depth to 6.3 km/s at 18 km depth. This upper crustal velocity structure is remarkably different from those of the previous three profiles discussed, all of which indicate significantly higher velocities. The data from shot point 1 southwest, for

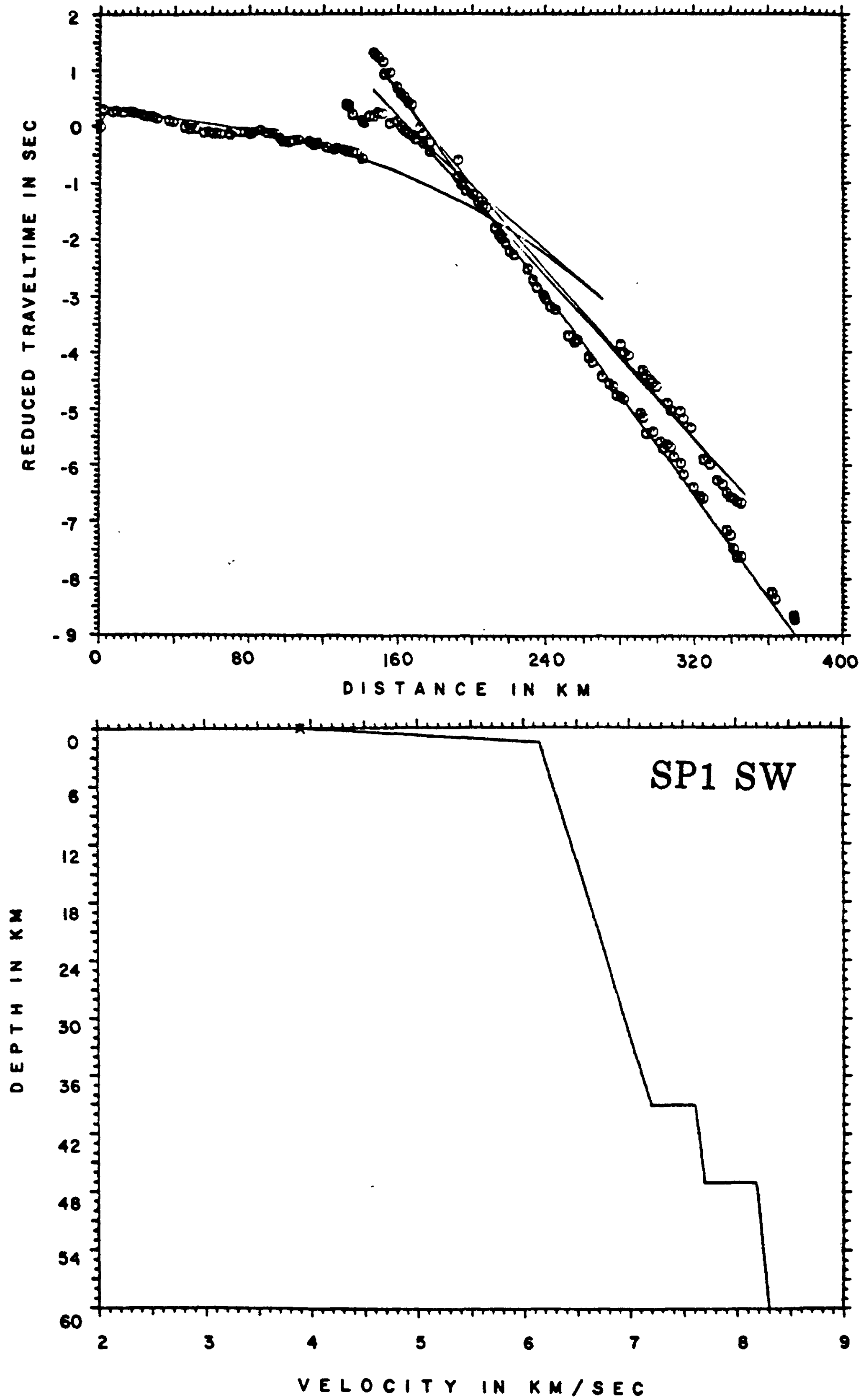


Figure 20.--Flat-layer model for data from shot point 1 southwest. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

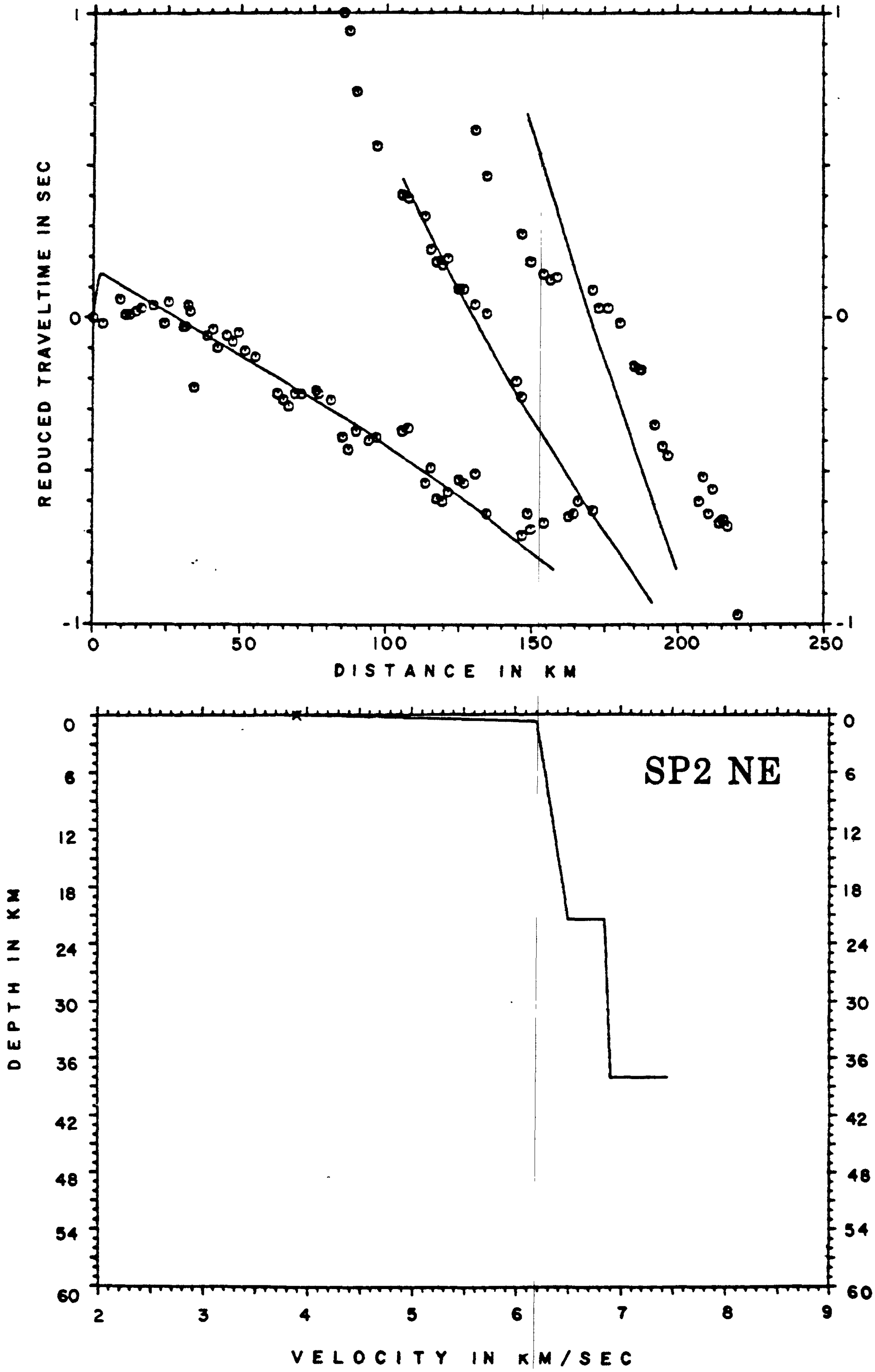


Figure 21.--Flat-layer model for data from shot point 2 northeast. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

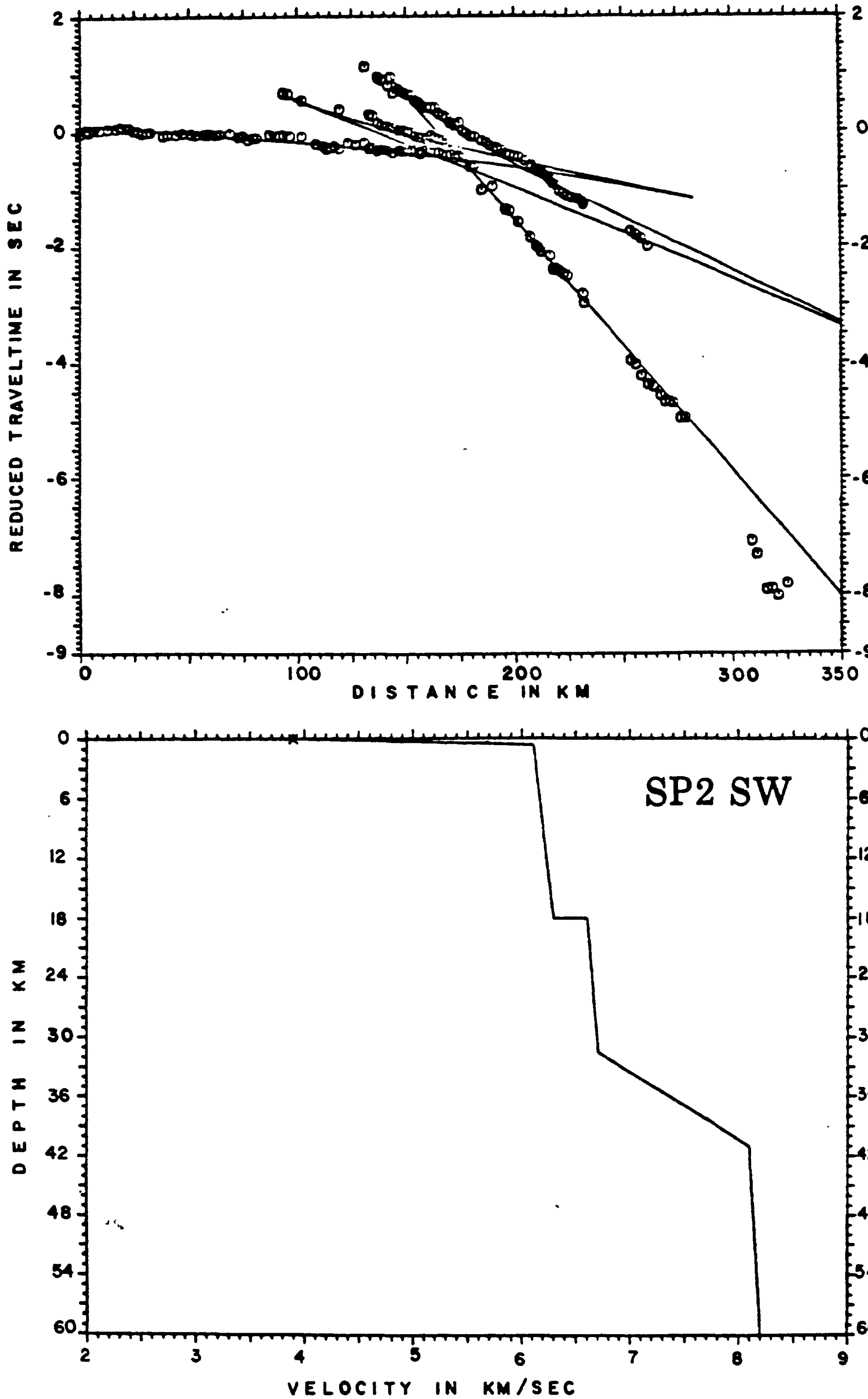


Figure 22.--Flat-layer model for data from shot point 2 southwest. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

example, have a traveltime that is 0.25 s faster at a range of 140 km than the data from shot point 2 southwest. Intermediate crustal arrivals are modeled as reflections (PiP) from a discontinuity at 18 km depth.

The profile provides crucial evidence that the M-discontinuity in this region is not a first-order discontinuity but is transitional. The evidence is the ∿150 km critical distance for the PmP arrivals, the high amplitudes of the post-critical PmP arrivals, and the low amplitudes of the pre-critical PmP arrivals. The transition from the crust to the mantle is modeled as occurring between 31.5 and 41 km depth, with the velocity increasing from 6.7 to 8.1 km/s. Clearly, comparison of synthetic seismograms with the true-amplitude record sections presented in this report (pls. 1-6) is needed to examine the validity of this structure. Partly because of this profile a crust/mantle transition zone (specifically, a velocity gradient followed by a small velocity discontinuity to the mantle) is a feature of the two-dimensional ray-trace models discussed below. Pn arrivals on this profile have been fit with a mantle velocity that increases from 8.1 km/s at 41 km depth to 8.2 km/s at 60 km depth.

Shot point 3

Northeast (fig. 23): This profile was recorded entirely in the Najd tectonic province and crossed no major mapped faults (pl. 9). Data were recorded to a distance of 56 km. They indicate a refraction velocity of 6.0-6.1 km/s with essentially no (∿ 100 m) near-surface delay. The shot length of this profile leaves profile 2 southwest essentially unreversed, so the subsurface structure between shot points 2 and 3 is indicated by dashed lines on plate 9.

Southwest (figs. 24 and 25): This profile extends across several important features of the shield. It begins in the Najd tectonic province, crosses the southwest Najd fault zone, and enters the Hijaz-Asir tectonic province. Within the latter province it crosses the Nabitah zone (a region of ultramafic outcrop; see "Geologic Setting" section), the Al Qarah gneiss dome, and the Al Junaynah fault zone.

At near ranges Pg has an apparent velocity of 6.0 km/s. This apparent velocity is followed at greater range (30 km) by an apparent velocity of 6.3 km/s, which continues to 175 km. Intermediate arrivals (PiP) are clearly observed and are modeled by a discontinuity at 22.5 km depth from 6.45 to 6.7 km/s (fig. 25). The PmP arrivals are modeled with a sharp M-discontinuity at 35 km depth where the velocity increases from 6.7 to 8.0 km/s. In light of the low amplitudes of the PmP reflections, however, it is unlikely that the sharp M-discontinuity is real, and a transition zone has been used in the two-dimensional ray-tracing model. Pn arrivals have been fit by using a positive velocity gradient in the upper mantle of 0.008 km/s/km.

We have made an alternative model for profile 3 southwest to attempt to explain some clear secondary arrivals that are observed at ∿85 km range at a reduced traveltime of 0.0 s. These are modeled (fig. 24) with a discontinuity at 13 km depth where the velocity increases from 6.35 to 6.65 km/s. Bringing this high velocity to shallow depth makes it difficult to fit other secondary arrivals that are observed between 140 and 175 km at a reduced traveltime of -0.5 s. These secondary PiP arrivals are important, for they appear to be from the boundary between the upper and lower crust. A possible model, as yet untested, is one with a low velocity zone (LVZ) at 16-21 km depth. A strong reflection that could fit the PiP arrivals would occur off the bottom of the

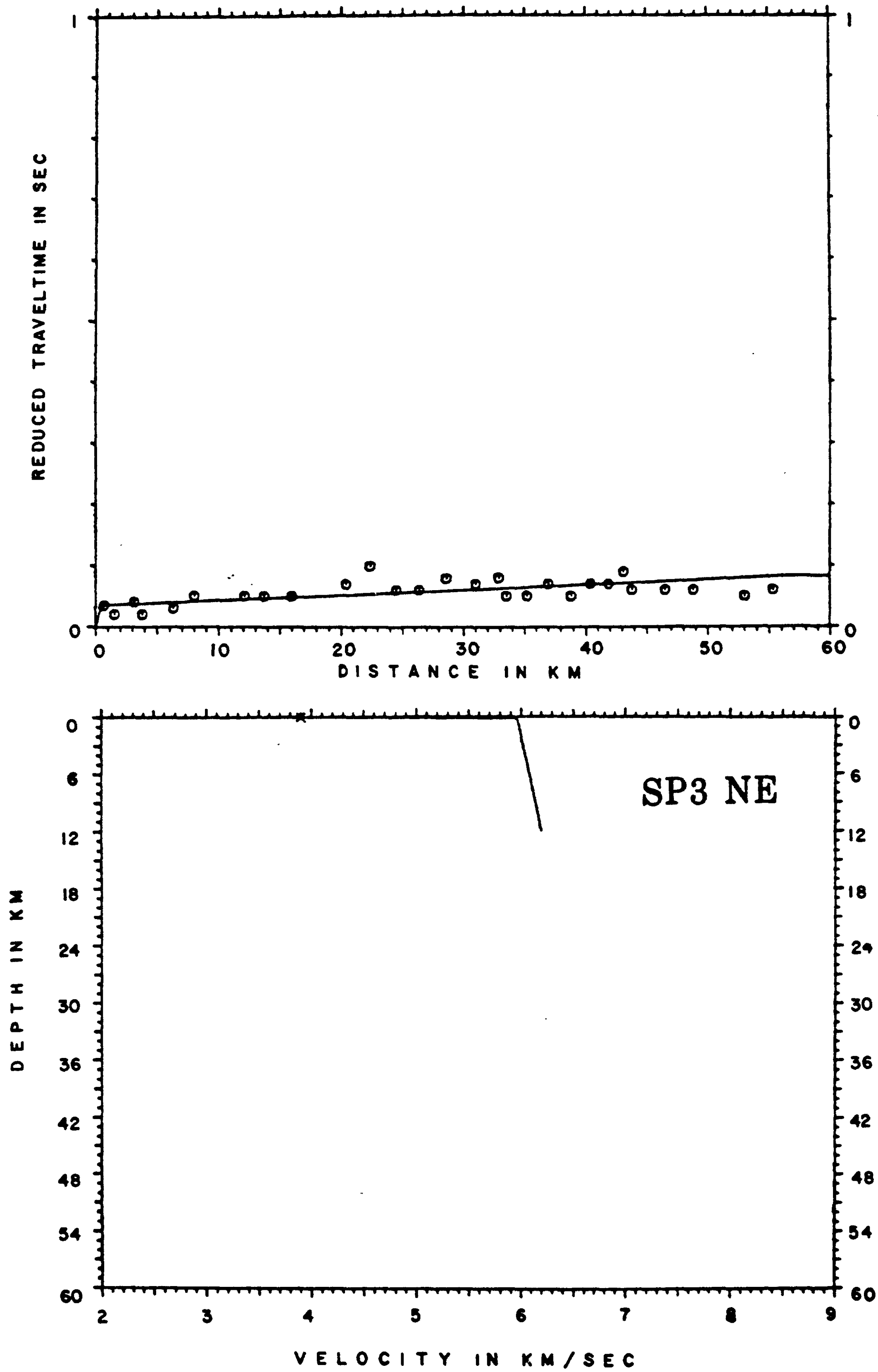


Figure 23.--Flat-layer model for data from shot point 3 northeast. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

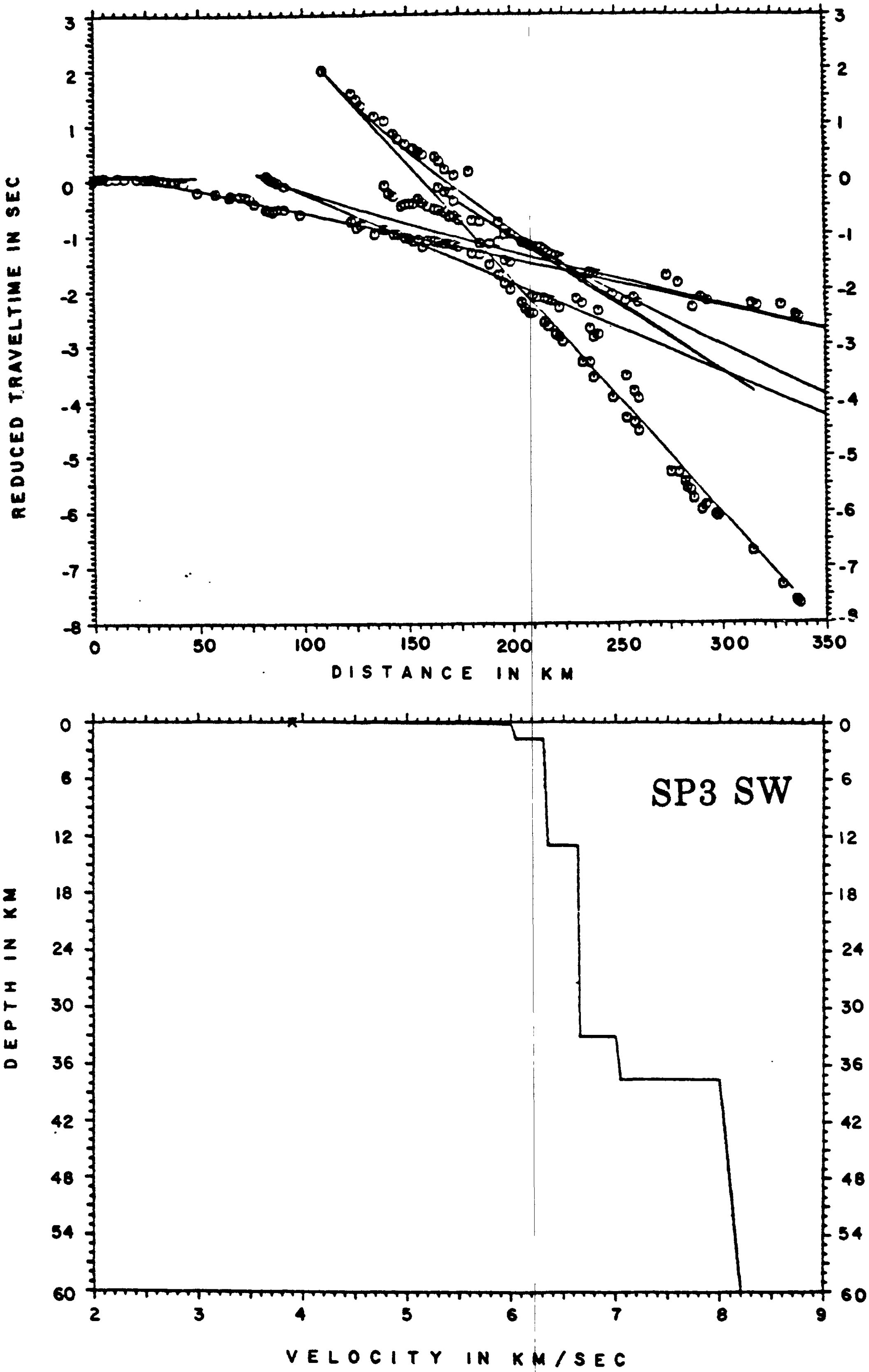


Figure 24.--Flat-layer model for data from shot point 3 southwest. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

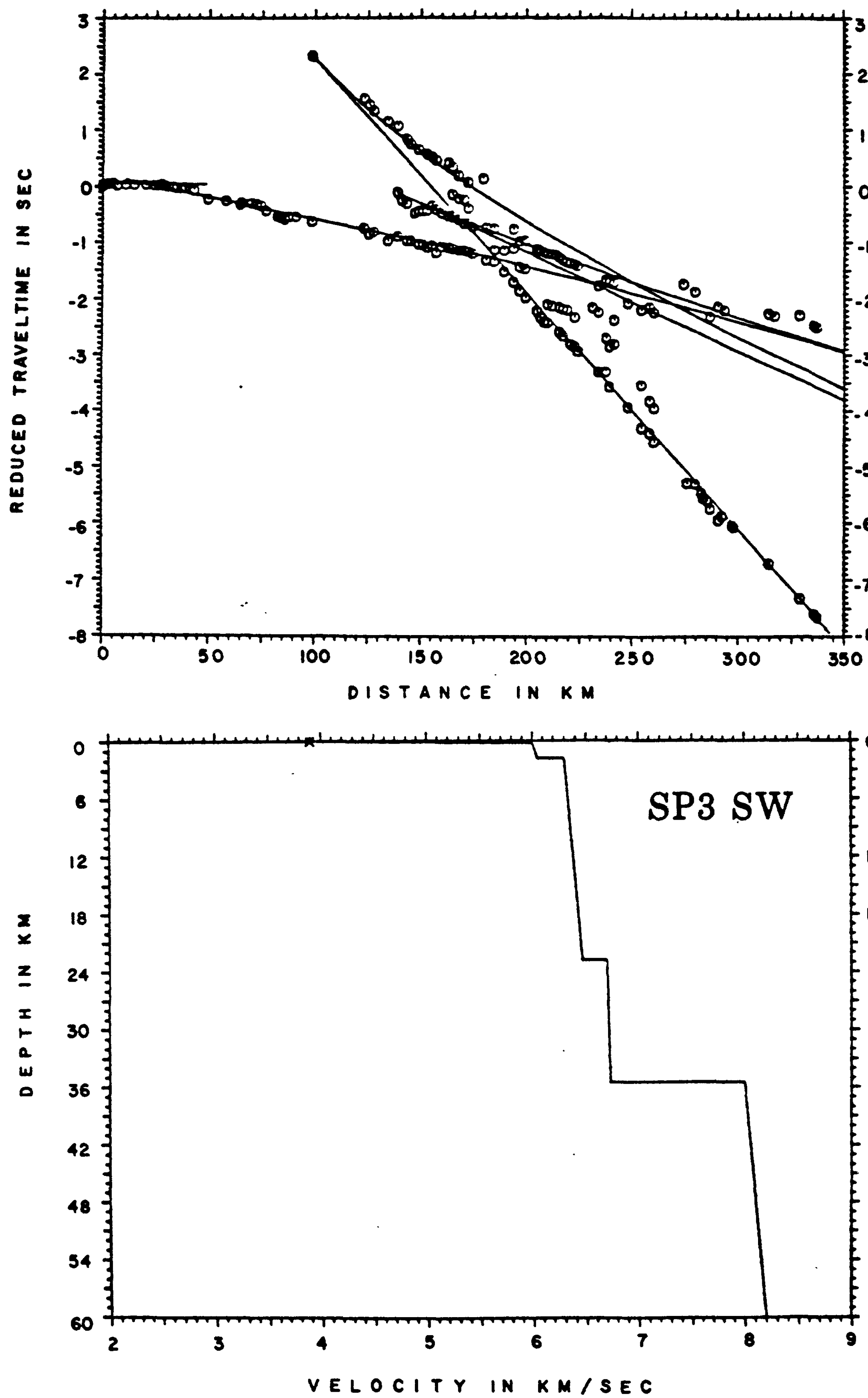


Figure 25.--Flat-layer model for data from shot point 3 southwest (alternate). In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

LVZ. The possibility of LVZ's is examined further in the "Discussion" section. Both PmP and Pn arrivals are adequately fit by the mantle depth (37.5 km) and velocity (8.0 km/s) used in this alternative model.

Shot point 4

Northeast (figs. 26 and 27): This profile starts in the Hijaz-Asir tectonic province and crosses into the Najd province; en route it crosses the Al Junaynah fault zone, the Al Qarah gneiss dome, and the Nabitah zone (pls. 8 and 9). A simple 6.2 km/s refractor fits the data up to 40 km, but beyond this point a traveltime advance of some 0.2-0.3 s is apparent. A laterally-varying model is required to fit these traveltimes, which are advanced because of the high-velocity Al Qarah gneiss dome. We propose two models to fit the intermediate arrivals. In the first (fig. 26) we assume that two distinct phases are present (PiP1 and PiP2) and use two intracrustal discontinuities (at 13 and 34 km depth) to fit the arrivals. The Moho is modeled by a discontinuity at 42 km from 7.2 to 7.8 km/s. This model fits most of the data adequately, but the high velocity of the lowermost crust (needed to fit the PiP2 arrivals) then causes the theoretical wide-angle PmP reflection to arrive early. A low velocity zone beneath the lower crustal discontinuity could explain this. Alternatively, a simpler model (fig. 27) associates the PiP2 arrivals with wide-angle reflections from a single discontinuity at 13 km depth. In this case, the lower crust has a velocity of $\sim$ 6.8 km/s, and the wide-angle PmP phase fits the observations at 240-280 km. Amplitude modeling would be effective in better resolving these uncertainties in structure.

Southwest (fig. 28): This profile crosses from the Hijaz-Asir tectonic province to the Red Sea. It reaches the Khamis Mushayt gneiss ($\sim$35 km wide) at a distance of 130 km and the Hijaz-Asir escarpment at ∿225 km. The Pg velocity is 6.1 km/s, and arrivals from a mid-crustal reflection (PiP) are evident at 100 km and beyond. These are modeled with a velocity discontinuity at 23 km, where the velocity increases from 6.6 to 7.1 km/s. It was very difficult to pick additional secondary arrivals with certainty on this profile because of the high dominant frequency throughout the seismograms. This may be due in part to the low seismic attenuation and high amount of scattering that occurs as the profile crosses the Khamis Mushayt gneiss (which occurs at just the distance where secondary arrivals should be the strongest). The Pn arrivals were fitted with a mantle velocity of 8.15 km/s. All other phases are discontinuous and uncertain.

Shot point 5

Northeast (fig. 29): This profile begins just northeast of the Tihamat-Asir, extends across the Hijaz-Asir escarpment and Khamis Mushayt gneiss, and ends within 9 km of shot point 4 (pls. 8 and 9). The Pg traveltime curve gives unmistakable evidence for high upper-crustal velocities (∿6.45 km/s) beginning ∿50 km northeast of the shot point. This higher velocity persists as the profile passes through the Khamis Mushayt gneiss. Secondary arrivals (PiP) are evident at 110-175 km and have been modeled by a discontinuity at 17 km depth where the velocity increases from 6.45 to 6.75 km/s. PmP (mantle reflection) arrivals are clear between 120 and 150 km but are very difficult to correlate at larger ranges, possibly because the seismic energy passes through a disrupted lower crust beneath the Khamis Mushayt gneiss. The velocity in the lower crust increases from 6.75 to 7.1 km/s between 17 and 41

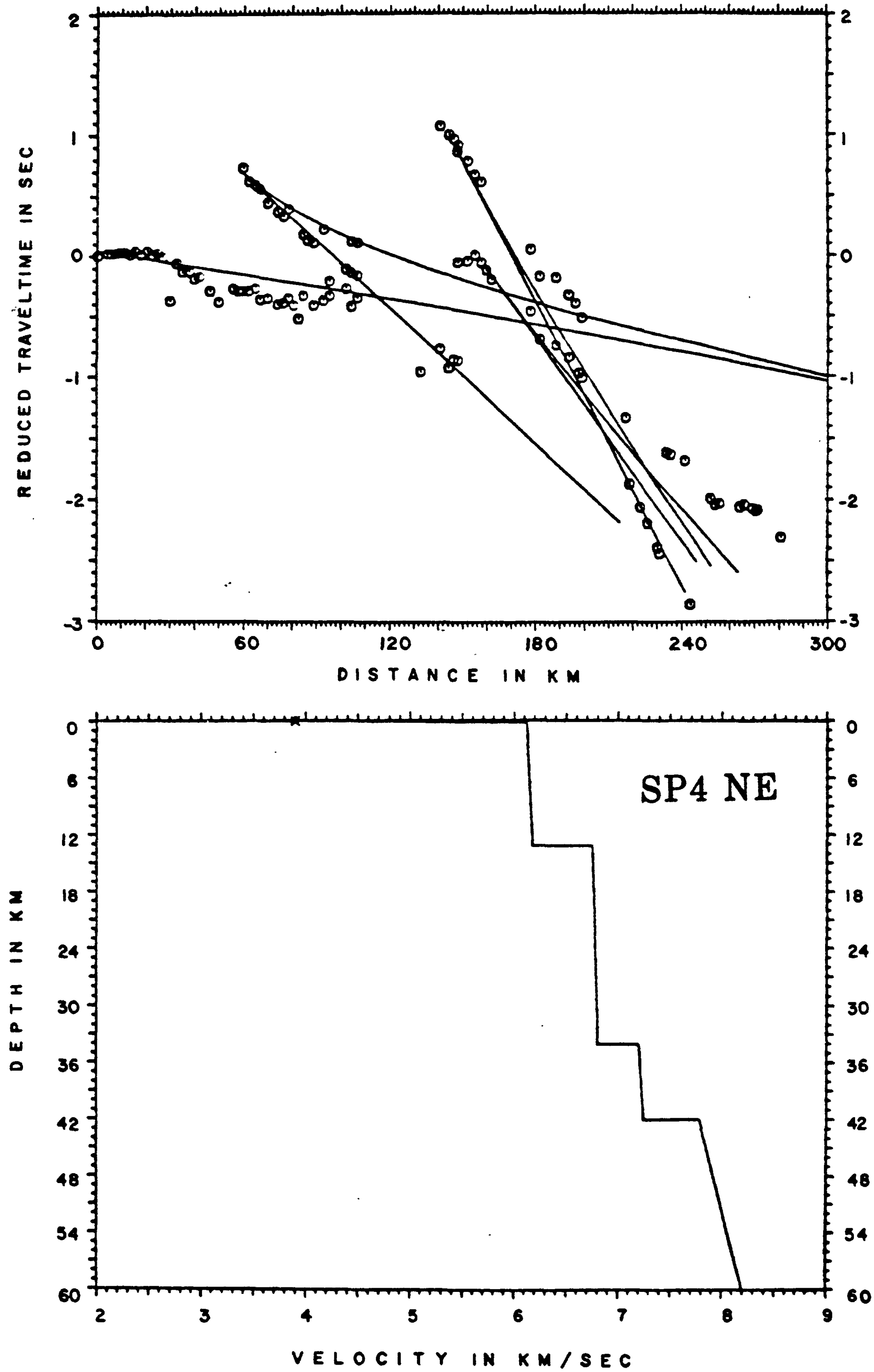


Figure 26.--Flat-layer model for data from shot point 4 northeast. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

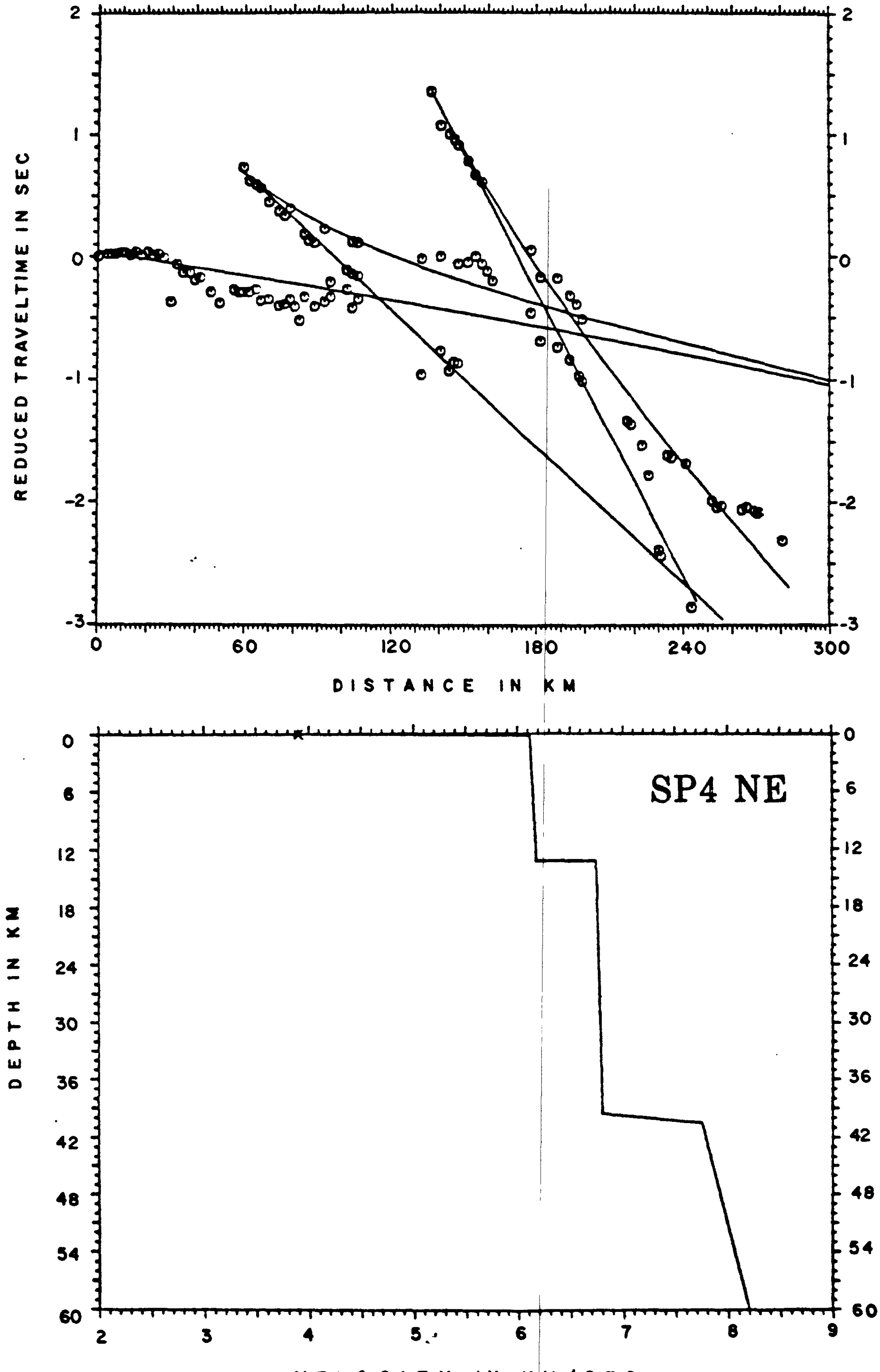


Figure 27.--Flat-layer model for data from shot point 4 northeast (alternate). In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

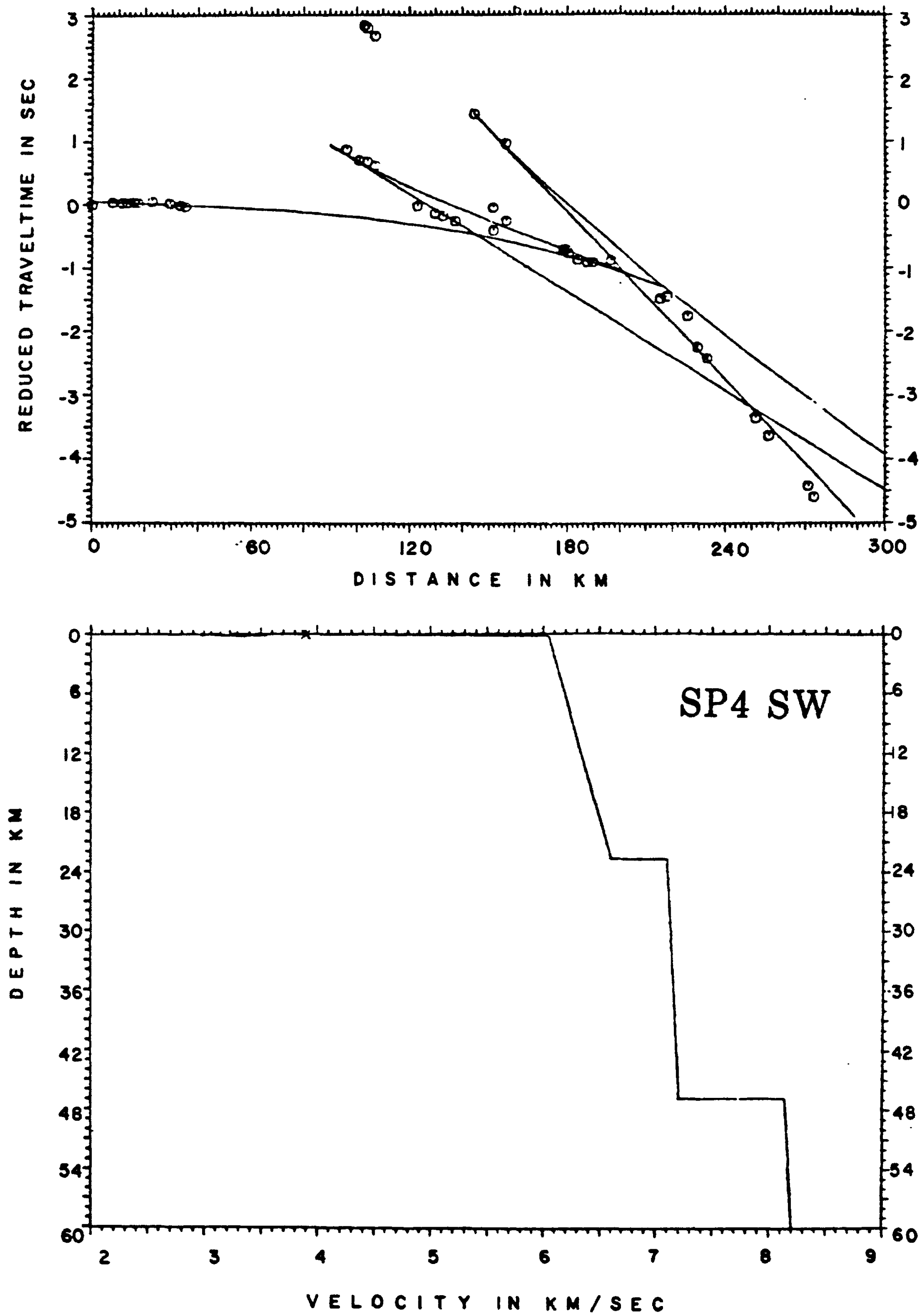


Figure 28.--Flat-layer model for data from shot point 4 southwest. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

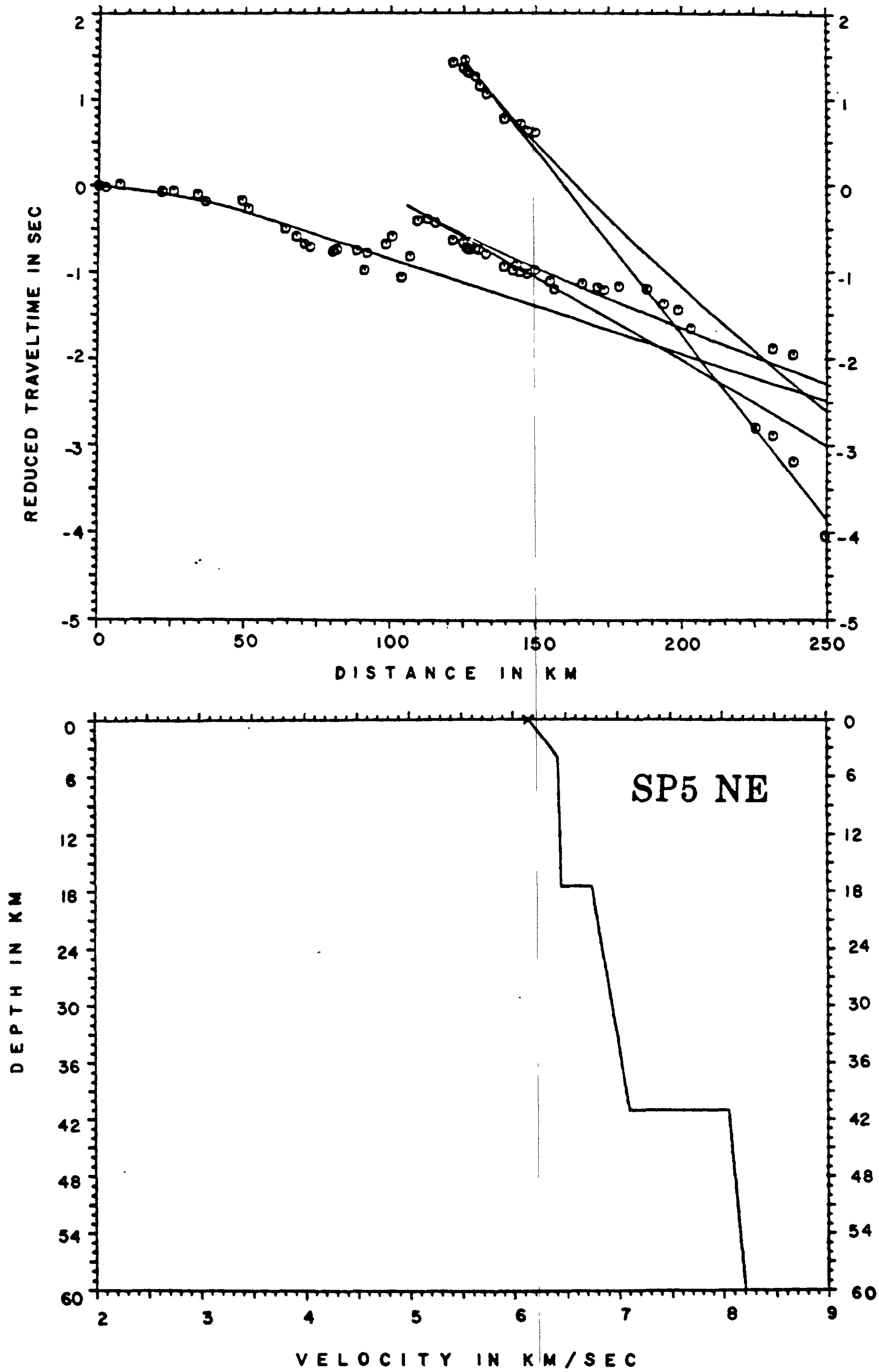


Figure 29.--Flat-layer model for data from shot point 5 northeast. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

km depth. The available mantle arrivals (PmP and Pn) are fit reasonably well with the M-discontinuity at 41 km depth and a velocity of 8.1 km/s.

Southwest (fig. 30): This profile crosses the Tihamat-Asir (coastal plain) and continues onto the Red Sea shelf, where several islands were used as recording sites. At the eastern edge of the Tihamat-Asir the profile crosses a dike complex intruded by gabbros and related rocks; this region may be considered the Red Sea-shield boundary (pl. 9). The clearest evidence that this data was recorded in a region of strong lateral variation is given by the Pn velocity of ∿9.0 km/s. Since this is an unreasonably high velocity for the uppermost mantle, it is obvious that either the crust is thinning toward the Red Sea so that the profile is shooting up-dip or that the average crustal velocity increases rapidly seaward. Despite the evidence that this region has strong lateral velocity variations, the profile was modeled with a flat-layer solution. Basement velocity (Pg) is the lowest observed on any profile in this data set, 5.85 km/s. In view of the local geology the basement rocks should have a velocity greater than 5.85 km/s, so we assume the Pg apparent velocity is a down-dip measurement. Both the mantle refraction (Pn) and reflection (PmP) traveltimes indicate a much thinner crust (∿17.5 km) beneath the coastal plain than was observed on the shield. The flat-layer velocity model must include a broad transition zone from 5.9 to 8.0 km/s occurring between 11 and 24 km depth (mid-depth is therefore 17.5 km) in order to fit the critical reflection point.

Shot point 6

Northwest (no fig.): This profile has not been modeled with a flat-layer solution.

Two-dimensional models

Using the results of the flat-layer modeling presented in the previous section, we have constructed two-dimensional velocity models for profile sets 3-2-1, 5-4-3, and 6-5. Combining the flat-layer velocity models required subjective decisions about how the velocity-depth functions for neighboring shot points should be made compatible. In order to obtain the simplest model consistent with the data, we decided to use as few layers as possible. Specifically, this means that strictly local features were not included in the two-dimensional ray-trace model, although some such features have been included in the interpretive crustal section (pl. 9). We expect that this simple model can be elaborated on with the aid of the true-amplitude record sections (pls. 1-6).

The basic model chosen consists of an upper and lower crust, each with two layers, and a two-layer mantle. In the upper crust two layers are needed to model the near-surface rocks (which often have velocities less than 6.0 km/s) and the basement rocks. In the lower crust two layers are needed to model the region just below the mid-crustal discontinuity (∿20 km deep) and the crust/mantle transition zone. Two mantle layers are used for most of the ray-trace calculations, the first directly beneath the crust (where the Pn phase propagates), and the second at ∿60 km depth. An additional mantle layer at 70 km depth was used from shot point 6 northeast.

Shot points 3-2-1

The profile sets for shot points 1, 2, and 3 (figs. 31-34) cover the transition from the Arabian Platform to the shield and encompass the Shammar

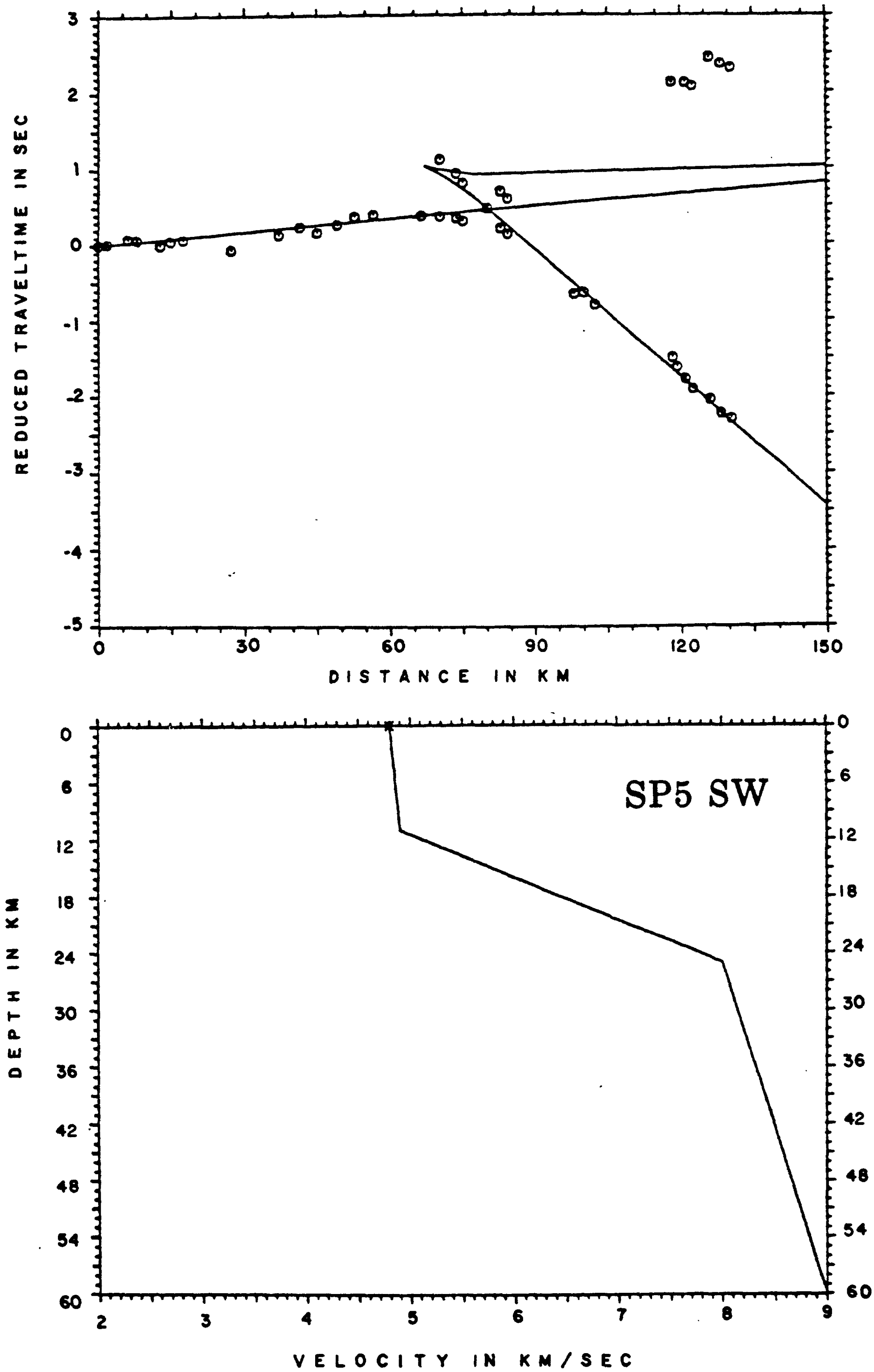


Figure 30.--Flat-layer model for data from shot point 5 southwest. In upper plot observed reduced traveltimes are open circles and the solid line is the reduced traveltime curve calculated from the velocity-depth function in the lower plot.

and Najd tectonic zones (pl. 9). We discuss the model for the basement along the profile from shot point 1 northeast separately in a later section.

The Pg arrivals from shot point 1 southwest match the calculated traveltimes quite closely (fig. 31), but the velocity discontinuity at 21 km depth predicts PiP arrivals about 0.5 s ahead of the observed arrivals. However, the depth to this boundary was not increased because its position provided an excellent fit to the PiP arrivals recorded on profile 2 northeast. Therefore, there are probably upper crustal heterogeneities between shot points 1 and 2 that have not been resolved in the present modeling.

The composite model fits the PmP and Pn phases for profile 1 southwest reasonably closely, but it predicts a PmP phase where none is visible from shot point 2 northeast (fig. 32). In addition, the phase P1 (which is labeled P1 [theory] in fig. 31) has not been successfully modeled with the deep-mantle reflection. These difficulties in modeling the lower crust between shot points 1 and 2 suggest that strong lateral heterogeneity characterizes the entire crust in this region.

The composite model reasonably fits all arrivals from shot point 2 southwest (fig. 32), which is not unexpected as the model is very similar to the successful flat-layer solution (fig. 22). The data from shot point 3 northeast (the reverse of shot point 2 northeast) provide only Pg arrivals (fig. 33). These indicate a near-surface velocity of $\sim$6.0 km/s.

The average upper-crustal velocity of profile 2 southwest (6.2 km/s) is significantly lower than that used to model profile 2 northeast (6.35 km/s). The mid-crustal discontinuity occurs at 21 km depth (fig. 34). A strong velocity gradient is seen in the lower crust between 31 and 43 km (from 6.8 to

7.9 km/s); the velocity contrast at the M-discontinuity is only 0.2 km/s. The effect of the high lower-crustal gradient is shown quite clearly in the ray-trace of figure 32, where rays are focused between 128 and 160 km on the range scale. Synthetic seismogram calculations are needed to assess the validity of this high velocity gradient.

In summary, strong lateral velocity variations are evident between shot points 1 and 2. To the west of shot point 2 is a region of refraction overlap (both profiles 1 southwest and 2 southwest extend into it), but not of refraction reversal. The differences in crustal structure northeast and southwest of shot point 2 seem resolvable; we suggest (fig. 34) that a major crustal boundary occurs near the shot point.

Shot points 5-4-3

The profile sets for shot points 3, 4, and 5 (figs. 35-38) cover the southwestern portion of the Najd and all of the Hijaz-Asir tectonic provinces, crossing several major crustal features including the Nabitah zone, the Al Qara gneiss dome, and the Hijaz-Asir escarpment. We have discussed these features in a previous section.

The arrivals through the basement (Pg) have been reasonably well fit for the four profiles considered here with the exception of the data from profile 5 northeast across the Khamis Mushayt gneiss (fig. 37). The high upper-crustal velocity there was discussed in the section on flat-layer models. For profile 3 southwest the composite model gives reasonably good traveltime fits for all phases except the portion of the PmP reflection near the critical point (labeled A on fig. 35). This may indicate lateral

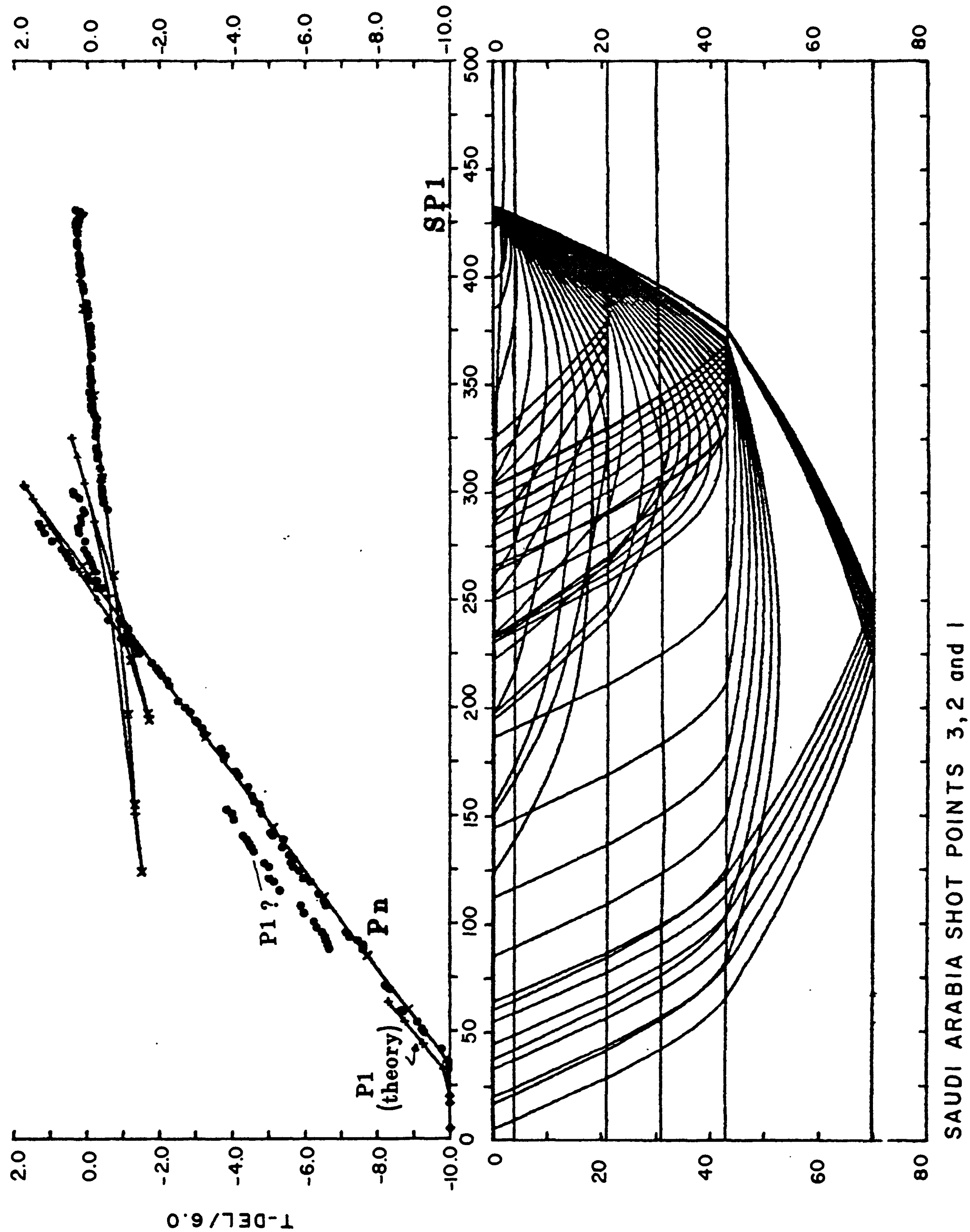


Figure 31.--Two-dimensional ray-trace diagram for the data from shot point 1 southwest. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 34). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

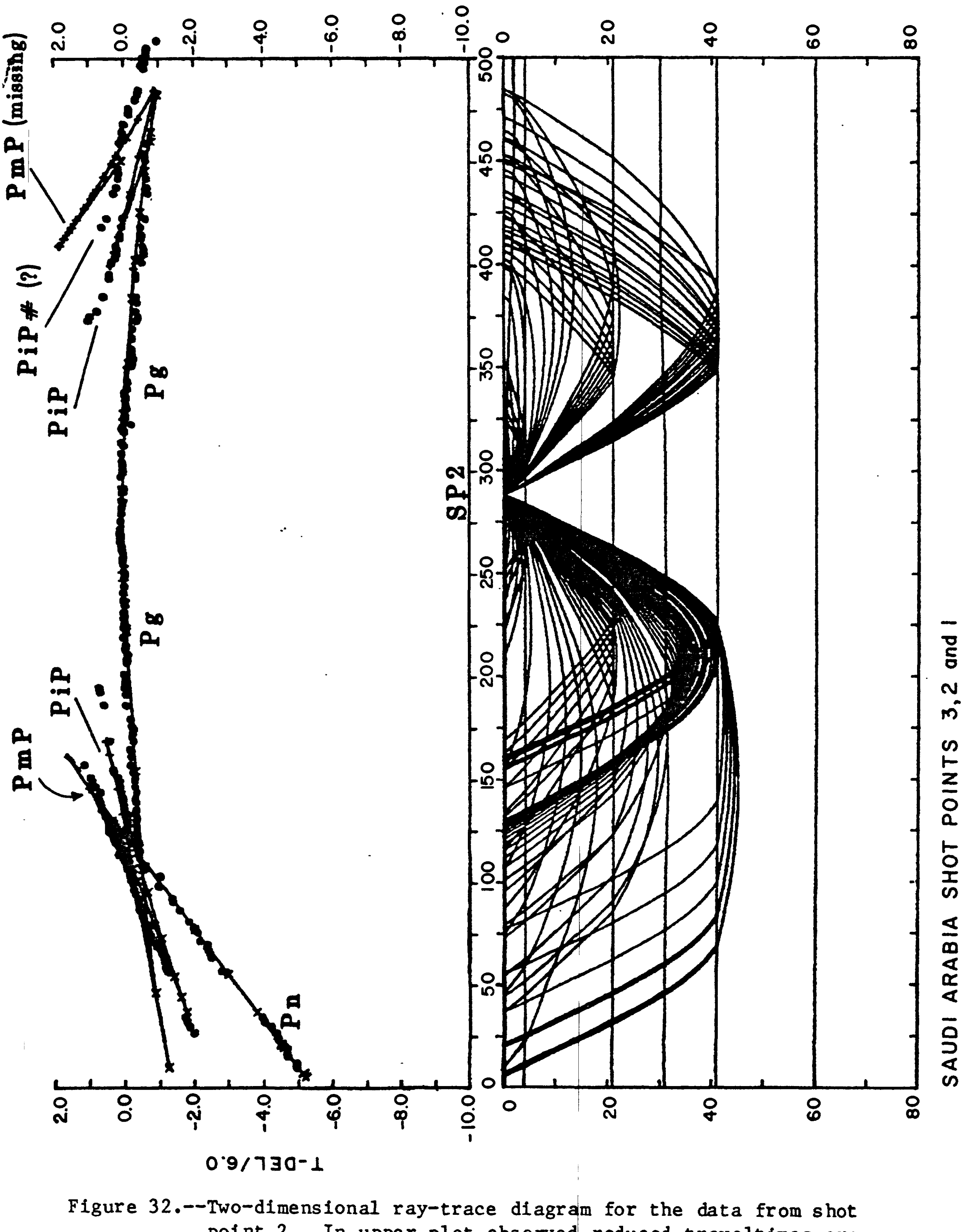


Figure 32.--Two-dimensional ray-trace diagram for the data from shot point 2. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 34). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

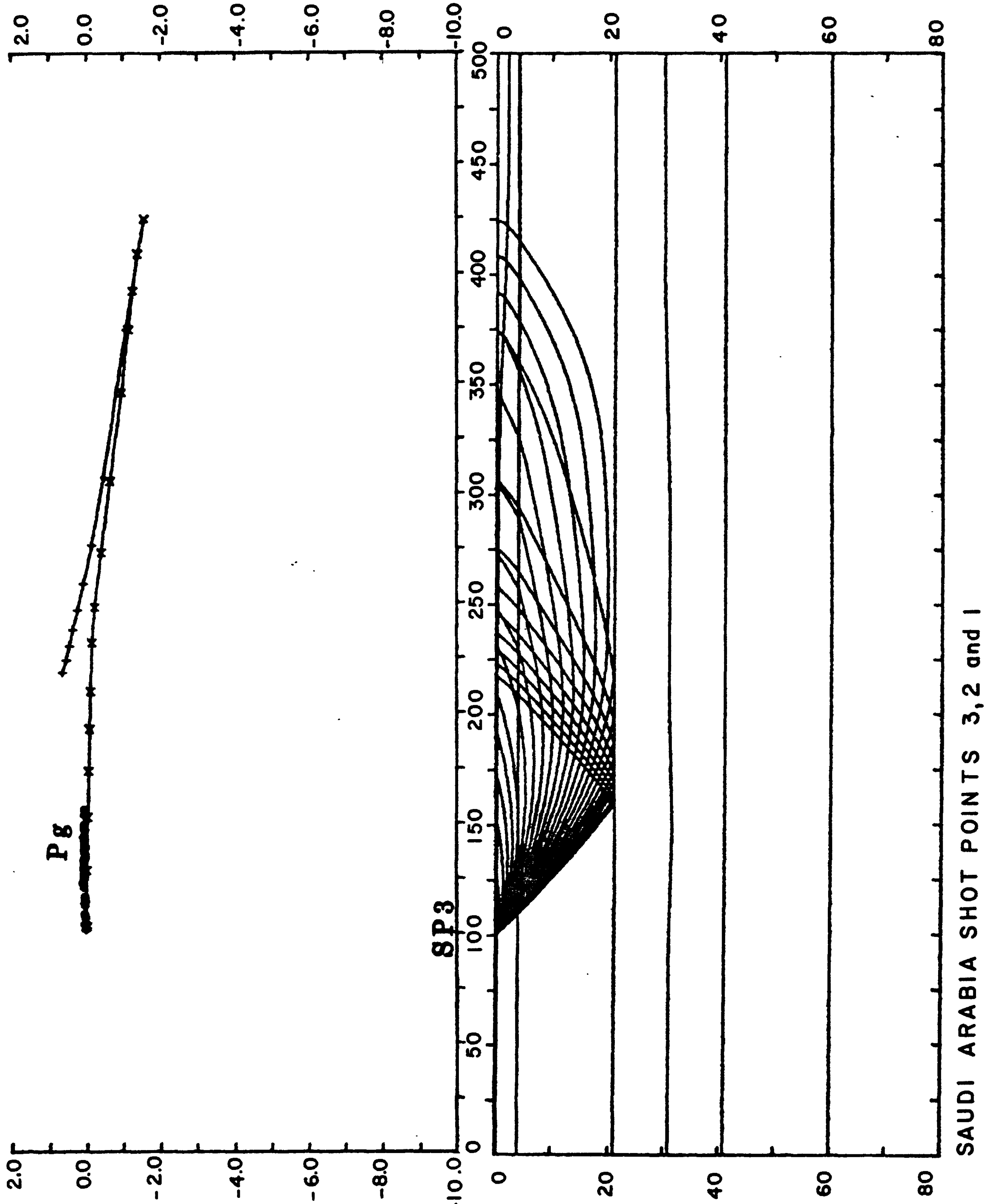


Figure 33.--Two-dimensional ray-trace diagram for the data from shot point 3 northeast. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 34). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

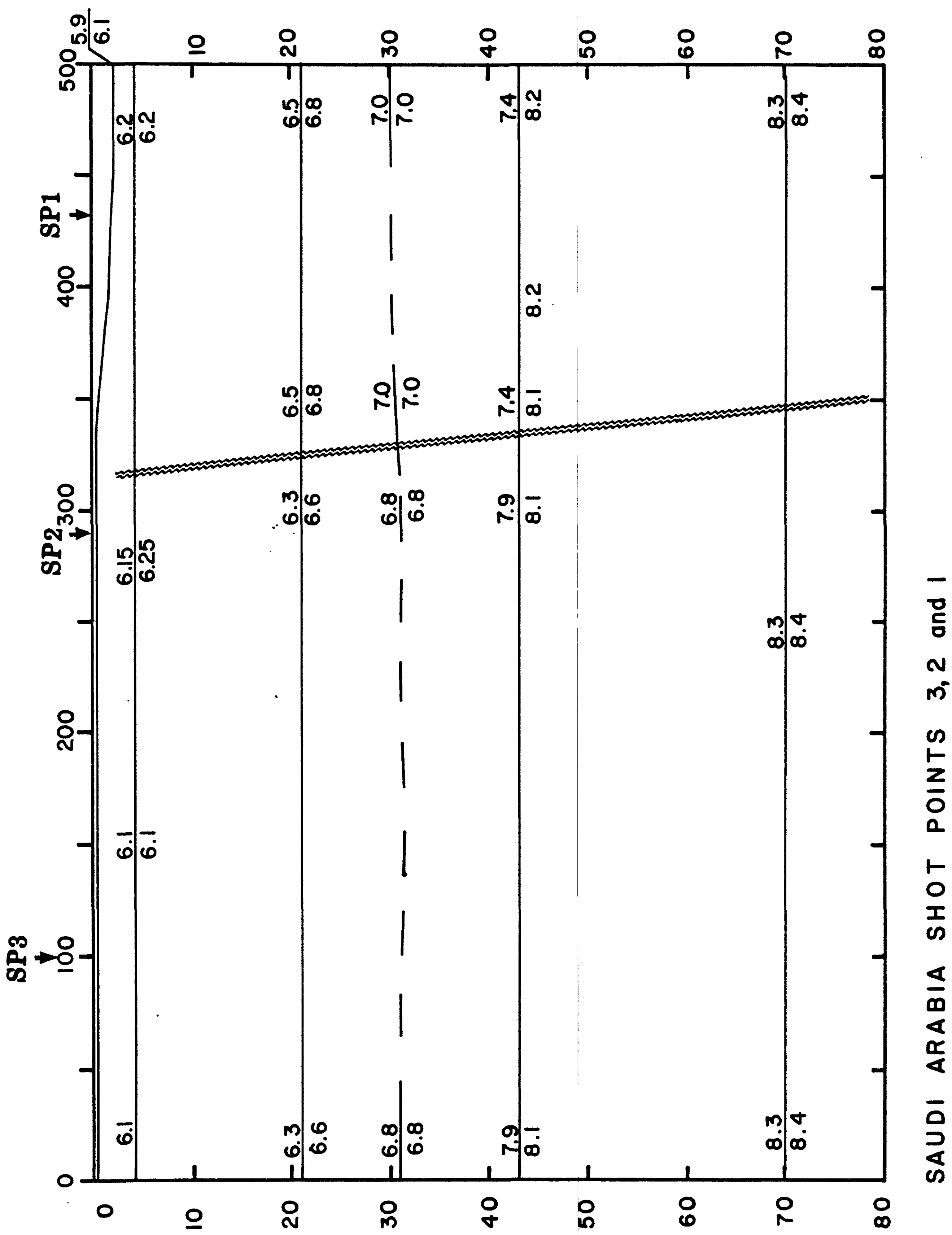


Figure 34.--Velocity-depth structure beneath shot points 1, 2, and 3 obtained by fitting traveltimes from ray-tracing calculations to the observed data. Heavy vertical line is a lateral crustal velocity discontinuity; velocities are given in km/s. Solid lines are velocity discontinuities and dashed lines are isovelocity lines. Shot point locations are indicated by arrows.

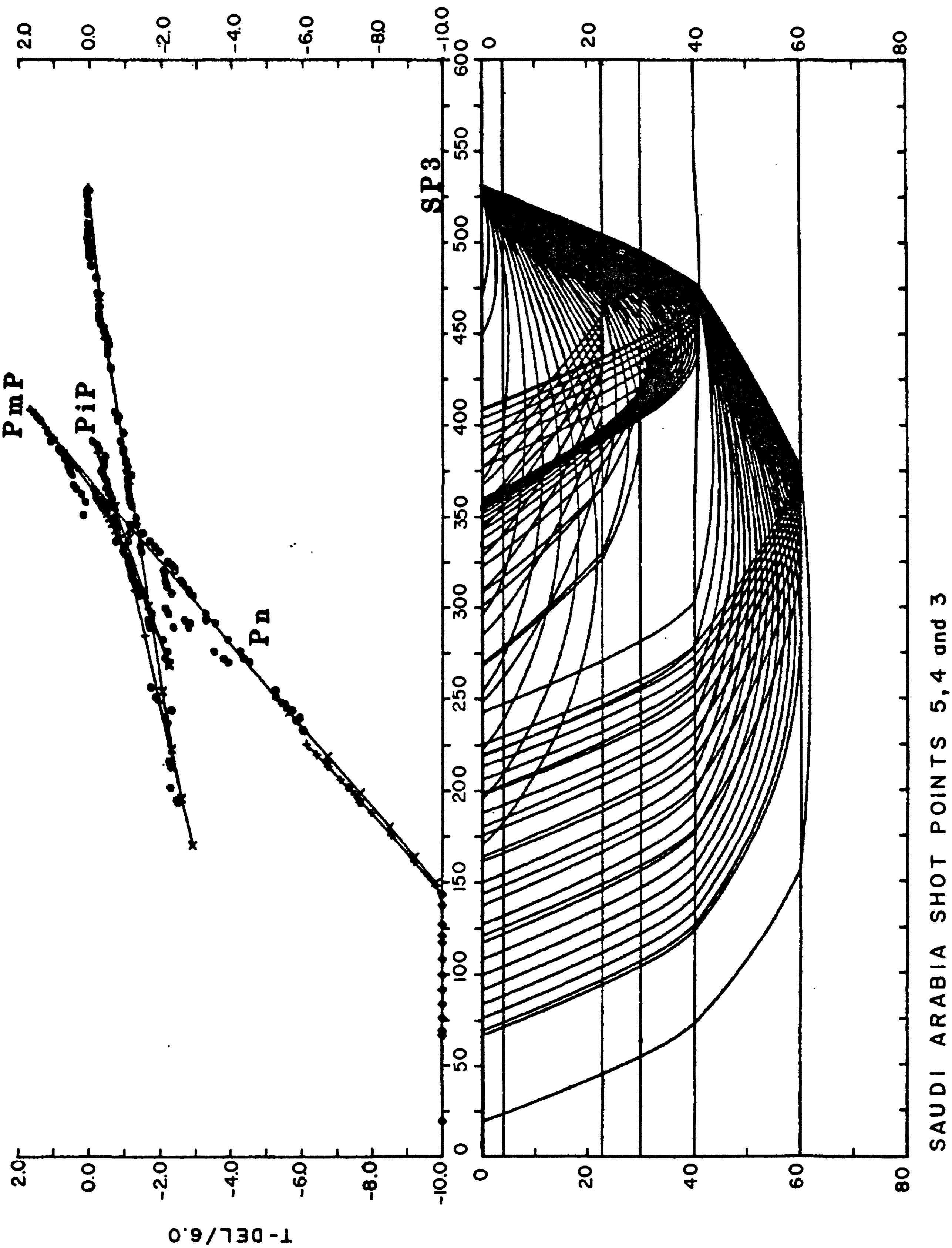


Figure 35.--Two-dimensional ray-trace diagram for the data from shot point 3 southwest. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 38). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

heterogeneity in the lower crust southeast of shot point 3. Traveltimes of the composite velocity model fit the Pn arrivals very reasonably.

In discussing the data of shot point 4 northeast and southwest, we reemphasize an observation made previously: the seismograms on this profile have a high dominant frequency coda that makes phase correlation of secondary arrivals very difficult. Therefore, we gave greater weight to the traveltime models of profiles 5 northeast and 3 southwest in constructing the composite model.

Even considering the difficulty in identifying secondary arrivals in the data from shot point 4, the disagreement between the picked secondary arrivals and those calculated for the composite model is astonishing; we interpret it to indicate anomalous crustal material beneath shot point 4. The composite model does not account for prominent secondary arrivals at ∿80 km northeast of shot point 4 (labeled A on fig. 36). (These arrivals, calculated to be due to a reflector at 13 km depth, are included in the interpretive section [pl. 9].) The observed PmP arrivals northeast of shot point 4 are ∿0.4 s later than the calculated arrivals, indicating that the composite velocity model (fig. 38) is too fast in the lower crust beneath shot point 4. Pn arrivals also are not fit by the calculated model. In profile 4 southwest, the mid-crustal reflector at 22 km appears to fit observed PiP arrivals reasonably well. Some PmP arrivals (labeled B in fig. 36) are ∿0.6 s later than calculated from the model, indicating, as in profile 4 northeast, that the velocity in the lower crust is lower than indicated in the composite velocity model (fig. 38).

The composite velocity model fits the data of profile 5 northeast considerably more successfully (fig. 37). We have already discussed the high-velocity upper crust in the vicinity of the Khamis Mushayt gneiss; this abrupt traveltime advance has not been accurately modeled, but the high velocity has been included in the interpretive section (pl. 9).

The gneiss body possibly has disrupted the middle crustal boundary, for the predicted intermediate crustal phases Pi and PiP apparently do not have observed arrival times to match. The ray-trace model fits the mantle reflection (PmP) and refraction (Pn) quite well, indicating that the average crustal velocity and thickness of the model are consistent with the data.

In summary, the composite velocity model for profile sets 3, 4, and 5 is an adequate representation of the velocity structure near shot points 3 and 5 but some significant deviations are seen beneath shot point 4, including lower-than-average lower-crustal velocities of 6.7 km/s, which amounts to a reduction of 0.3 km/s from the shield average of 7.0 km/s. There is also evidence for a 13-km deep reflector between shot points 3 and 4.

Shot points 6-5

The region between shot points 5 and 6 spans the ocean-continent transition zone at the southwest end of the profile (figs. 39-41). Shot point 5 is $\sim$ 5 km to the northeast of the dike swarms of the Tihamat-Asir, which are believed to be at the margin of the Red Sea rift. Southwest of shot point 5 are the sediments of the coastal plain and Red Sea shelf, which have been drilled to 4 km depth in the offshore regions (Gillman, 1968).

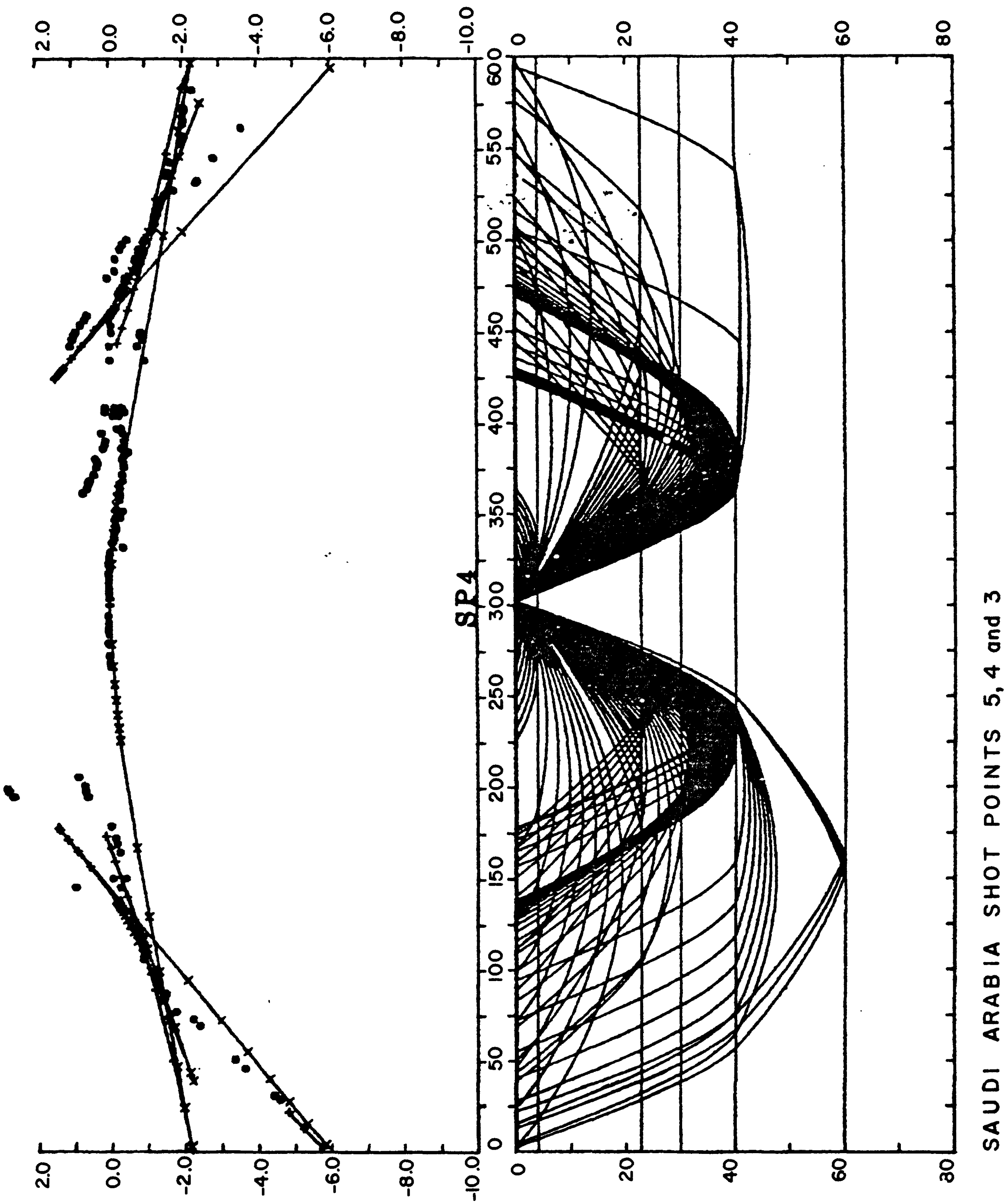


Figure 36.--Two-dimensional ray-trace diagram for the data from shot point 4. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 38). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

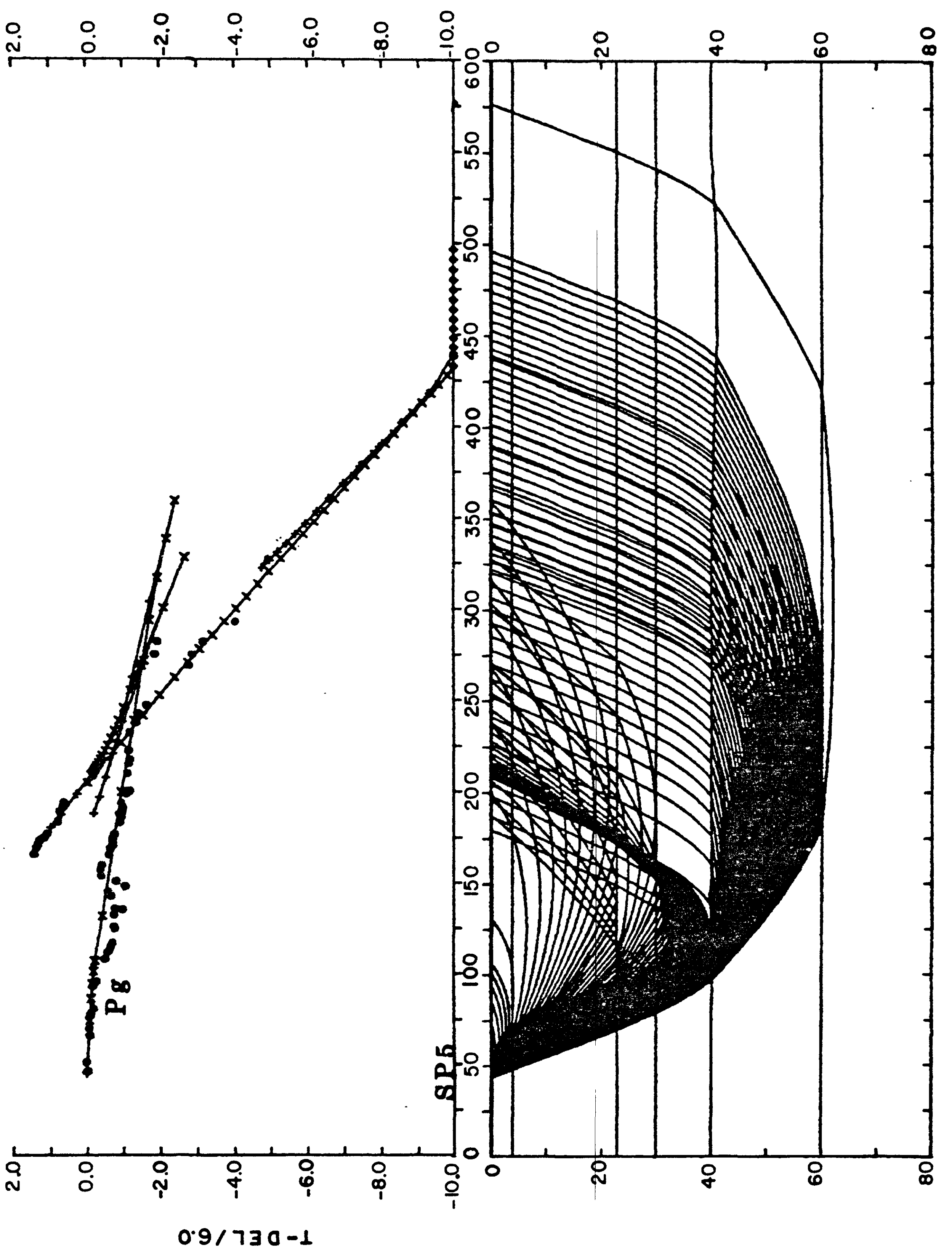


Figure 37.--Two-dimensional ray-trace diagram for the data from shot point 5 northeast. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 38). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

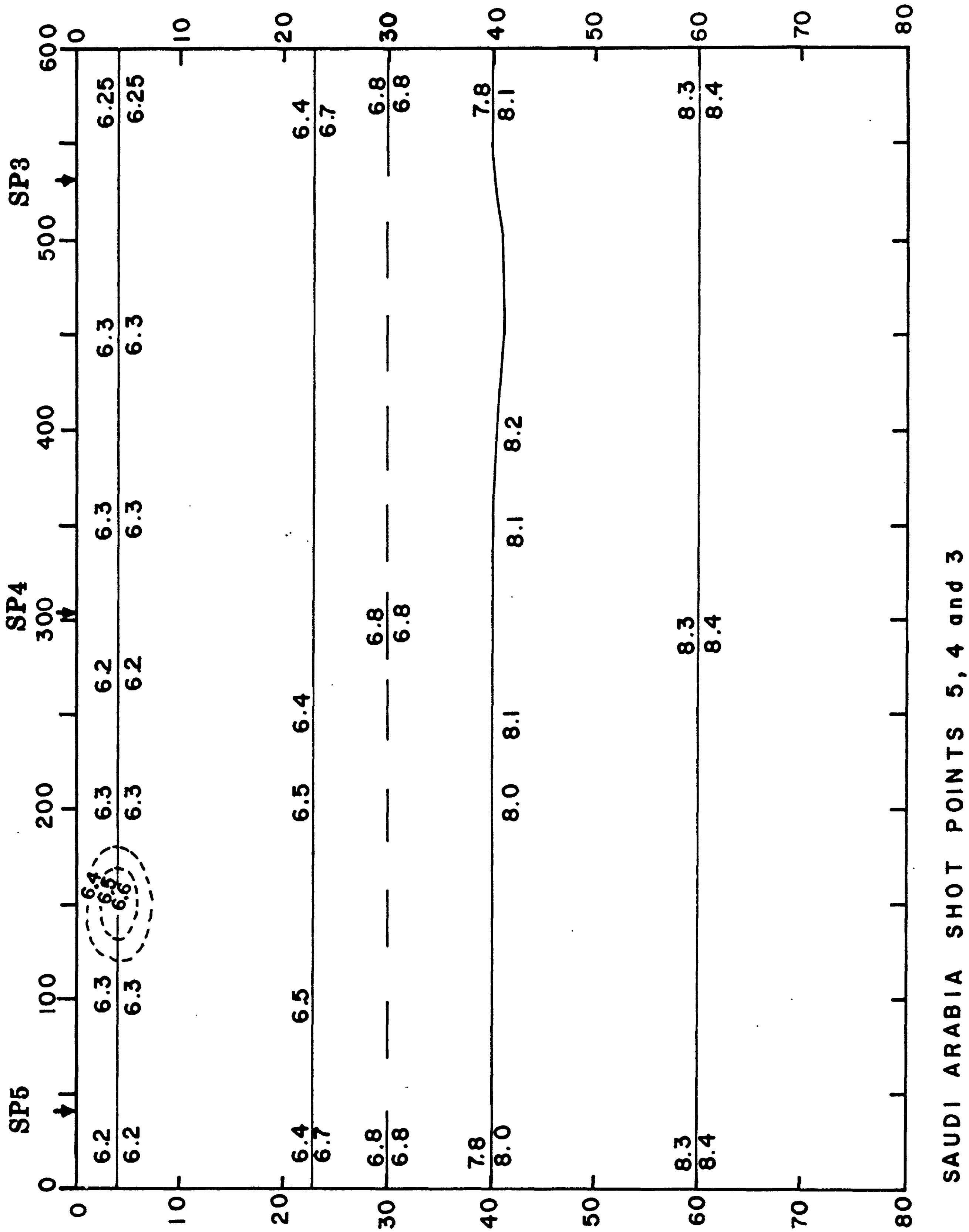


Figure 38.--Velocity-depth structure beneath shot points 3, 4, and 5 obtained by fitting traveltimes from ray-tracing calculations to the observed data. Velocities are given in km/s. Solid lines are velocity discontinuities and dashed lines are isovelocity lines. Shot point locations are indicated by arrows. A zone of anomalously high velocity upper crustal velocity is indicated at approximately 150 km on distance scale.

We did not discuss the data from shot point 6 northeast (fig. 40) in the section of flat-layer modeling. The ray-trace diagrams for these shots are all for traveltimes reduced by 8.0 km/s, unlike the previous figures. The pattern of arrivals is extremely irregular; the only certain correlations are crustal arrivals between 1 and 26 km and Pn arrivals between 105 and 125 km. Between 26 and 105 km the data show a series of traveltime advances and delays that may in part be due to large variations in the thickness of low-velocity sediments. Between 18 and 27 km, high-amplitude secondary arrivals follow the first arrival by 0.4 to 0.15 s. We interpret these secondary arrivals as mantle reflections (PmP). According to this correlation, the depth to the mantle 22 km east of shot point 6 is 8 km. However, if the PmP critical point at 22 km is connected to the clear Pn arrivals at 105 km with a straight line, the line is approximately 1.0-1.5 s ahead of the visible first arrivals. Two possible explanations exist for this. The first is that the velocity structure varies strongly laterally between 26 and 105 km and large traveltime delays occur in that range due to the thickening of sedimentary rocks. The second possibility is that the visible first arrivals are actually secondary arrivals and the mantle refractors are of extremely low amplitude due to irregular structure at the crust/mantle interface. The record section (pl. 6) indicates possible weak earlier arrivals between 58 and 105 km.

Regardless of these uncertainties, an initial, relatively simple model was derived by connecting the 8-km-thick crust at shot point 6 to the 17.5-km-thick crust southwest of shot point 5 (the latter is the midpoint of the velocity gradient derived in flat-layer modeling [fig. 30]). We used iterative two-dimensional ray-tracing to refine the initial model somewhat.

The model fits the Pg arrivals and the mantle refractions (Pn) in the traveltime data of shot point 5 southwest (fig. 39) reasonably well, but the mantle reflection arrivals (PmP) appear to be delayed by as much as 0.2 s.

For shot point 6 northeast (fig. 40), the Pg and Pn arrivals at 105-125 km are fit rather well by the ray-trace calculations. The detailed traveltime behavior of arrivals between 25 and 100 km is not well fit, the average traveltime error being 0.4 s.

In summary, the data from shot points 5 southwest and 6 northeast are interpreted to indicate a landward dip of the M-discontinuity of 4.6°. The Pn velocity is 8.0 km/s and the crustal structure consists of a 4.2 km/s layer on top of a thicker 6.2 km/s layer. More densely recorded data would be desirable to further reveal the structure in this important tectonic region.

In the region of the Arabian Shield-Red Sea transition, the especially weak and diffuse arrivals between 150 and 200 km from shot point 6 (pl. 6) probably indicate extreme structural complications.

Beyond this structural transition, strong Pn arrivals observed beginning at about 225 km from the shot point appear to show an en echelon pattern of first and secondary arrivals, with the secondary arrivals having high amplitudes at 250 and 400 km. Western European and Russian seismologists, who previously conducted investigations here, determined that these phases indicate velocity gradients or discontinuities in the upper mantle. We have attempted to model only two of the en echelon mantle phases (fig. 40), showing them as first-order discontinuities at 56 and 68 km depth where the velocity increases from 8.0 to 8.3 km/s and from 8.3 to 8.5 km/s, respectively.

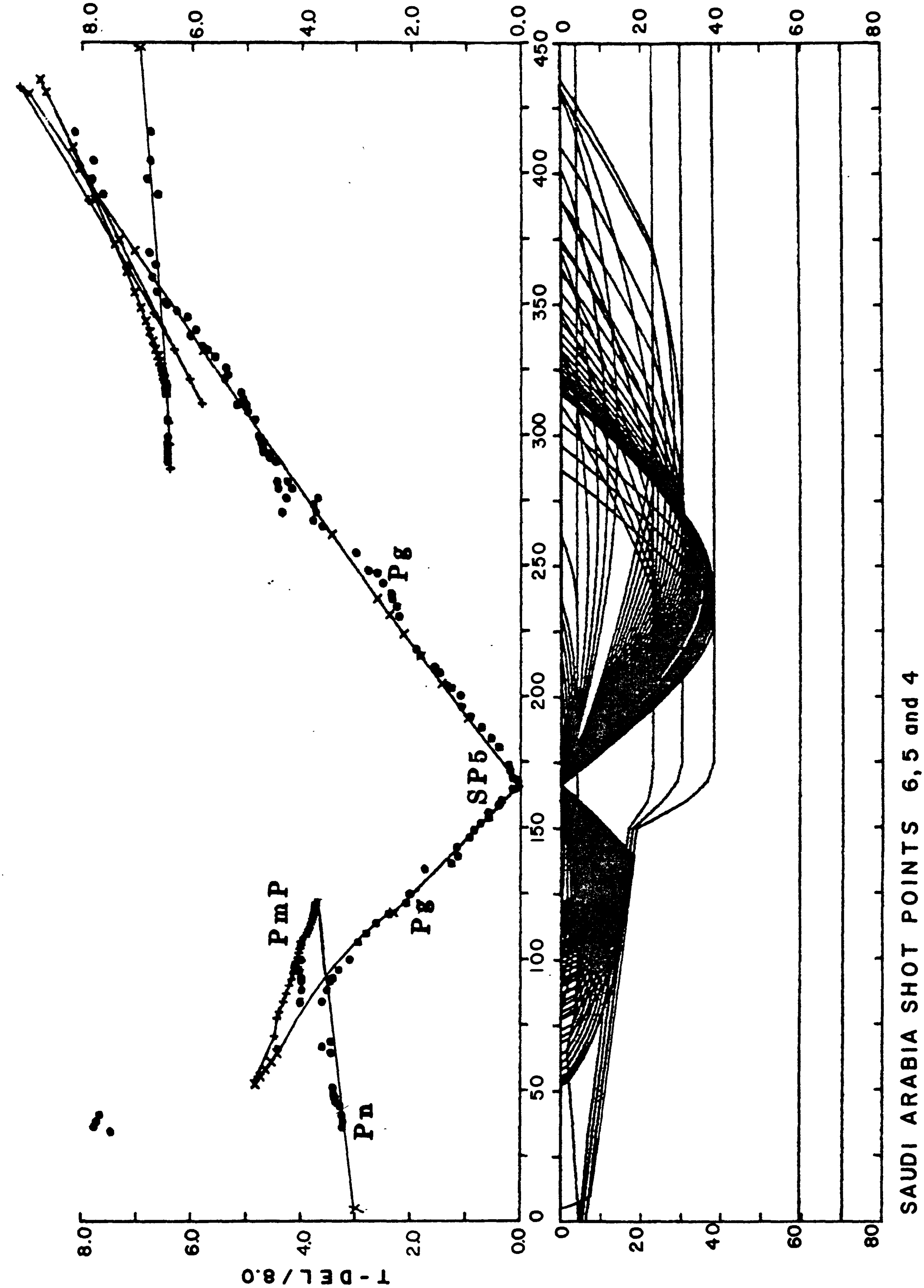


Figure 39.--Two-dimensional ray-trace diagram for the data from shot point 5. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 41). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

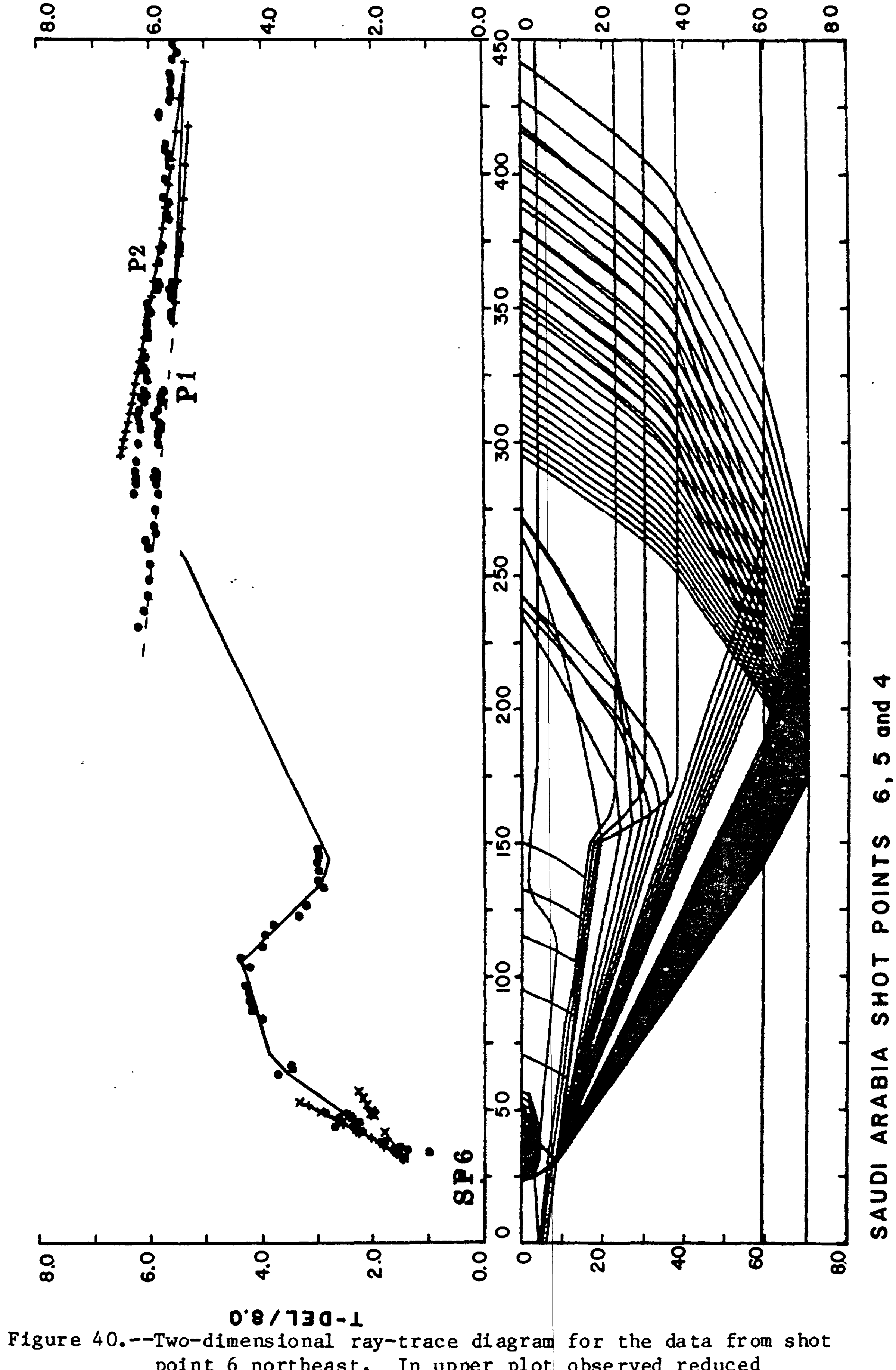


Figure 40.--Two-dimensional ray-trace diagram for the data from shot point 6 northeast. In upper plot observed reduced traveltimes are solid circles and the solid line is the reduced traveltime curve calculated from the two-dimensional velocity-depth structure shown in lower plot (and in fig. 41). The ray paths through the velocity-depth structure are shown in the lower plot; in the upper plot refracted arrivals appear as X's and reflected arrivals as +'s.

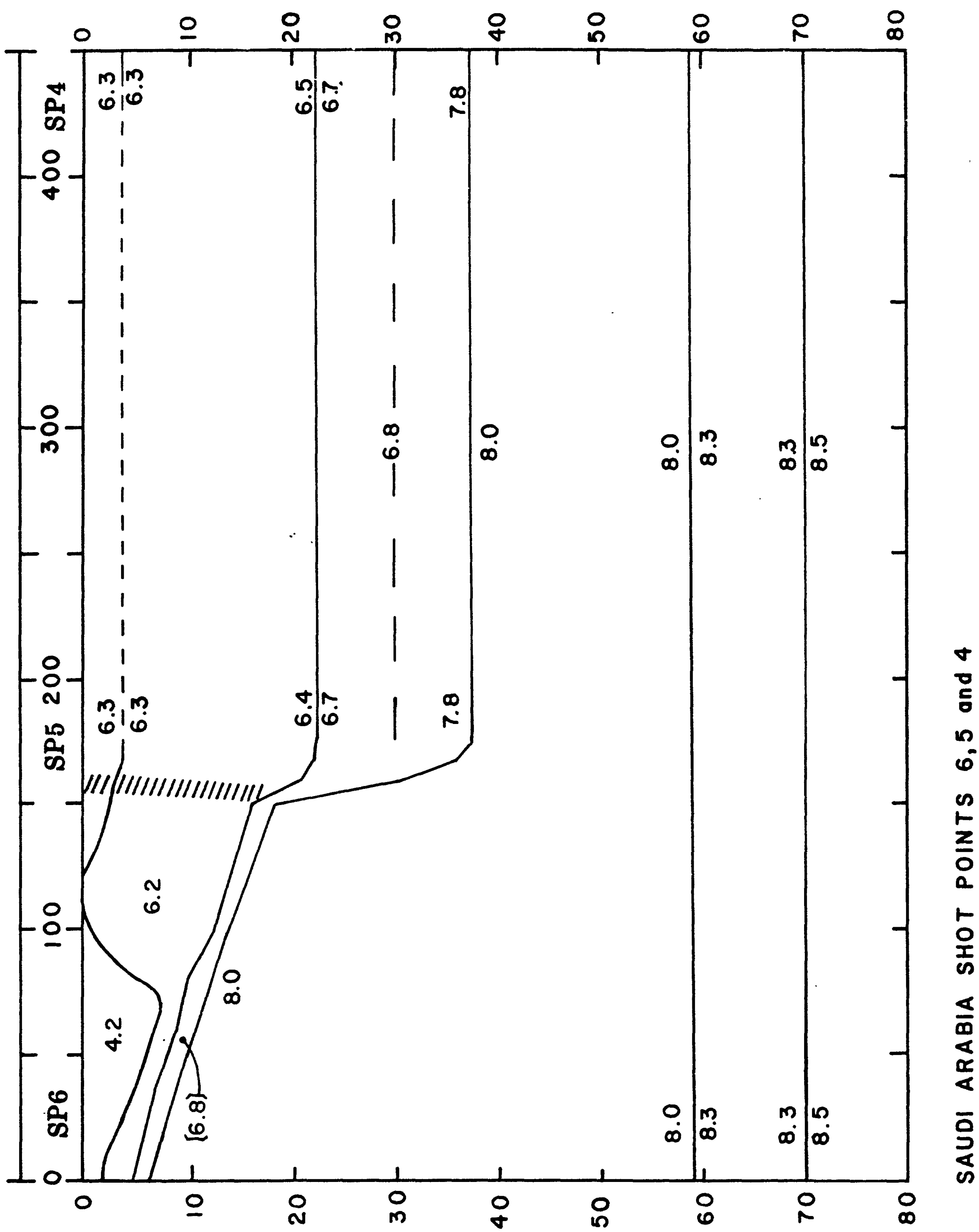


Figure 41.--Velocity-depth structure beneath shot points 4, 5, and 6 obtained by fitting traveltimes from ray-tracing calculation to the observed data. Velocities are given in km/s. Solid lines are velocity discontinuities and dashed lines are isovelocity lines. Heavy vertical line is lateral velocity discontinuity.

It is of some interest to note in the ray-trace diagram (fig. 40) that there is no true Pn phase (i.e., head or diving waves traveling along the continental M-discontinuity). This observation raises the possibility that similar phases that may have been modeled in previous offshore-onshore investigations as head waves are, in fact, upper mantle phases.

Interpretations by participants of the 1980 Commission on Controlled Source Seismology meeting

The third triannual meeting of the International Association of Seismology and Physics of the Earth's Interior (IASPEI) Commission on Controlled Source Seismology (CCSS) convened in Park City, Utah, on August 11-17, 1980, to bring together seismologists and geologists to assess the status of controlled source techniques (including explosions, air guns, and vibrators), and to evaluate their usefulness for modeling seismic velocity structure and composition of the crust and upper mantle. Progress and problems in modeling two- and three-dimensional structures received particular attention.

Half of the five-day conference was devoted to discussing interpretations of the 1978 Saudi Arabia seismic refraction data. The complete refraction data set had been distributed to the participants before the meeting, giving each seismologist (or team of seismologists) time to analyze the same data. Therefore, the participants were able to discuss issues of interpretation in more detail than is possible in traditional workshops, which are based on diverse data sets.

Because the known surface geology must constrain seismic interpretation, the session opened with a discussion of the geologic framework of Saudi Arabia and the southeastern Red Sea. (All participants received the geologic map of Saudi Arabia.) H. R. Blank introduced the geologic problems of Saudi Arabia and M. Q. Assad outlined the planning and goals of the 900-km-long refraction profile, after which a series of speakers explained their team's interpretation of the data and the methods they used to derive velocity-depth structures.

The participants' interpretations of crustal and upper mantle models along the profile have since been compiled in two formats for comparison (figs. 42-51). The first format shows crustal columns at midpoints between all shot points for which there were complete reversed refraction data (i.e., not between shot points 2 and 3). Velocity models are generally determined best between shot points, where there are records of waves traveling both ways (i.e., reversed) along the profile line. The second format overlays the participants' determinations of velocity-depth functions beneath the shot points. The crust directly beneath a shot point is often not sampled at all because of the seismic waves' angles of take-off and emergence from the various layers in the crust, an effect that is easily seen in the the two-dimensional ray-trace diagrams (e.g., fig. 36). Nonetheless, we have estimated the velocity-depth functions beneath the shot points because they are needed for many studies, such as interpretation of the heat flow data (pl. 8).

We will first consider the models between shot points 1 and 2 (fig. 42), where agreement among the models is generally excellent. (The USGS model, which has since been somewhat modified [fig. 34], is number 11 in the composite figure.) The crust is shown as 40 $\pm$ 2 km thick; the upper crust is $\sim$20 km

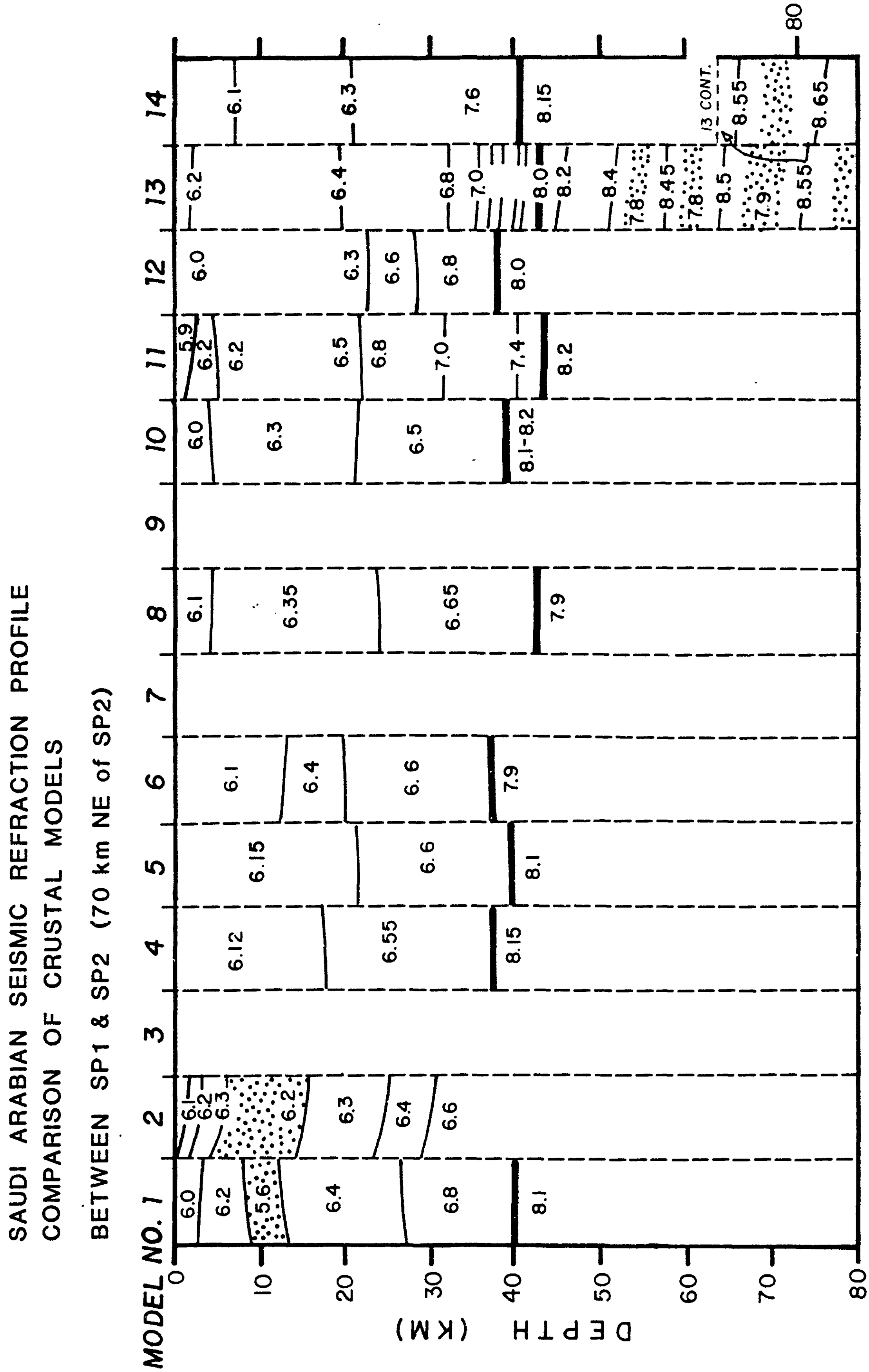


Figure 42.--Comparison of crustal models between shot points 1 and 2. Velocities are in km/s. Solid lines are velocity discontinuities, broken lines are isovelocity lines. M-discontinuity is the thick solid line. Low velocity zones are stippled. Models are those presented at the 1980 Commission on Controlled Source Seismology meeting (see text).

thick with an average velocity of $\sim$6.15 km/s, and the lower crust is also $\sim$20 km thick with an average velocity of $\sim$6.6 km/s. In quoting average thicknesses and velocities, we have generalized the features of the models. Many models do not show homogeneous crustal layers, but rather velocity gradients, discontinuities, and low velocity zones. We also note that an "average" velocity of 6.15 km/s has no physical significance in a crust composed of layers of velocities, say, 6.45 and 5.85 km/s, because the average velocity does not exist anywhere in the model.

Models 1 and 2 show low velocity zones in the upper crust; model 2 indicates only a slight velocity reduction (0.1 km/s), but that of model 1 is significant (0.6 km/s). There is considerable scatter in the details of the upper crust. Models 4, 5, and 12 have a one-layer upper crust, and models 1, 2, 6, 8, 10, and 11 have two or more layers. Models 13 and 14 depict the entire crust as characterized by velocity gradients rather than layers. Likewise, the models of the lower crust range from showing a single layer to multiple layers to a gradient. The crust-mantle boundary is modeled as a first-order discontinuity in all but one of the models, in which it is spread over several kilometers (model 13); (model 2 did not reach the crust-mantle boundary). Only models 11, 13, and 14 show velocities greater than 7.0 km/s in the lowermost crust. One model (13) shows considerable structure below the crust-mantle boundary, with successive layers of high and low velocity.

In the course of the presentations at the CCSS meeting it became evident that the differences between the models, some major and some minor, usually resulted from differing phase correlations. The term "phase correlation" refers to the process of identifying, within a seismic record section, those arrivals that refract or reflect from the same feature of the crust or mantle. For example, as previously described, the Pi phase refracts in the middle crust while the PmP phase reflects from the crust/mantle boundary. Correlation is based on the amplitude and frequency typically associated with a particular phase, but the complexity of most wave fields leads to a degree of subjectivity in the interpretation of the phases. Given identical phase correlations, different methods of traveltime and amplitude analysis of these phases will produce nearly the same models. However, different phase correlations will result in markedly divergent models regardless of further analysis methods. For example, the result of differing phase correlations is illustrated in models 5 and 6 (fig. 42). The phase correlations leading to model 6 included the identification of some arrivals as having reflected from a boundary within the upper crust at a depth of 12.5 km, but the same arrivals were not correlated this way in the analysis leading to model 5, among others. However, models 5 and 6 were apparently based on nearly the same correlation of mid-crustal and crust-mantle phases (arrivals returning from depths of $\sim$20 and $\sim$39 km, respectively), so the depths and velocities of those portions of the models are in reasonable agreement. Even these correlations must have been somewhat different, however, because model 6 has a thinner crust with a higher average velocity, which implies that the phases correlated with arrivals from the mantle were earlier in time than those of model 5. Examination of the record sections (pls. 1-6) will show how relatively small ($\pm$0.2 s) differences in arrival times can lead to very different phase correlations, especially in the case of emergent secondary arrivals.

Another reason for differences in the interpretations presented here is that most of them were prepared to facilitate discussion of analysis methods at the CCSS workshop; they are not final interpretations prepared after exhaustive trial and error modeling or direct inversion. In some cases the simplest possible model consistent with the data was sought, while in others the most detailed model permitted by the data was derived. The compiled sections should be considered with the goals of the workshop in mind.

The composite of the velocity-depth functions beneath shot point 1 (fig. 43) illustrates the range of models permitted by the data. In this figure, a simple crust with an average velocity of 6.15 km/s appears to characterize the zone from 0-15 km depth. Between 15 and 20 km depth is a zone with considerable scatter in estimated velocity; a simple crust with an average velocity of 6.6 km/s appears from 20-40 km depth. The crust-mantle boundary is marked by a large velocity discontinuity in all but one model. The upper mantle velocity is 8.2 ± 0.1 km/s.

The velocity-depth functions beneath shot point 2 (fig. 44) are of particular interest because long-range shot point 1 data were recorded southwest of shot point 2, thereby allowing analysis of both the crustal and upper mantle structure beneath shot point 2. The average upper crustal velocity here is 6.25 km/s, 0.1 km/s higher than that at shot point 1. Most interpretations of the mid-crustal boundary are clustered around 20 km depth, and the average lower crustal velocity is 6.6 km/s, the same as for shot point 1. Somewhat more scatter is seen in the interpreted depths to the M-discontinuity, but the average depth is 2 km shallower than the average interpretation at shot point 1. There is considerable scatter in the estimated velocity below the M-discontinuity, but the average is 8.1 km/s. In the depth range between 40 and 50 km, there is general agreement that either an upper mantle velocity gradient or velocity discontinuities are seen. Two of the three models that continue below 50 km show velocity discontinuities in the 60-70 km depth range as well.

The pattern of the velocity-depth functions beneath shot point 3 (fig. 45) is virtually identical to that beneath shot point 2; average crustal velocities and thicknesses are almost identical and the scatter in interpretations is of a similar magnitude. In the upper mantle, there is general agreement that the velocity increases between 40 and 60 km, either gradually or discontinuously. Two models also show velocity discontinuities at 70 km depth (on the basis of long-range data from shot points 1 and 6); one of the models shows a pronounced low velocity zone between 60 and 70 km depth.

Crustal columns were not made for the region between shot points 2 and 3 because it is not an area of refraction reversal, since shot point 3 was only recorded for 75 km northeast. The crustal columns between shot points 3 and 4 are shown in figure 46. The average crustal thickness is 40 km; however, it is immediately apparent from the figure that considerable scatter in the interpretation exists (e.g., models 5 and 6, and 13 and 14) although some models agree closely (e.g., models 10, 11, and 12). It seems likely that much of the scatter in the interpretations is due to the high dominant frequency ($\sim$10 Hz) of the seismograms recorded at these shot points. The records in this part of the profile show unusually high amplitudes, presumably due to a high average Q (low seismic attenuation) in the upper crustal rocks, which has made phase correlation of the data particularly difficult; bandpass filtering

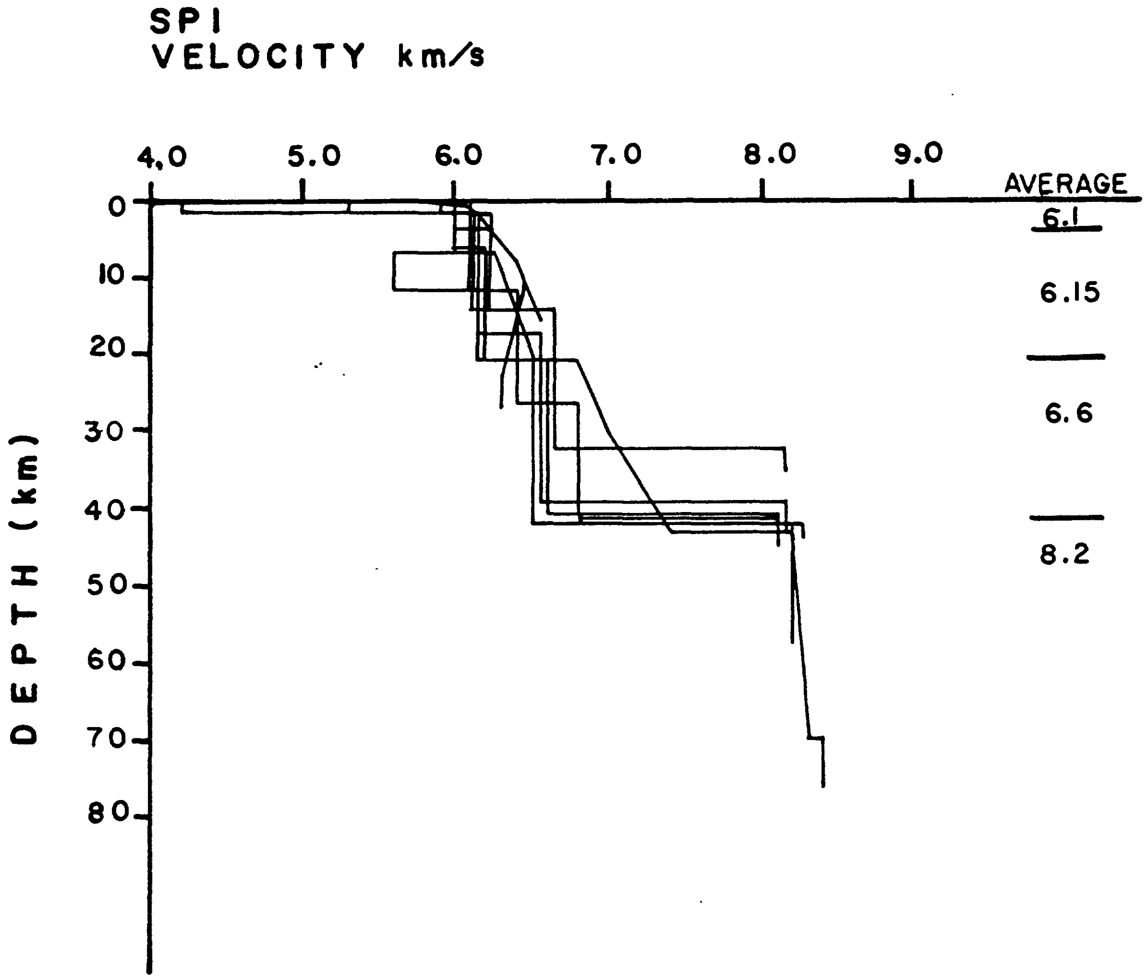


Figure 43.--Comparison of velocity-depth functions beneath shot point 1. Average velocity section was obtained by inspection.

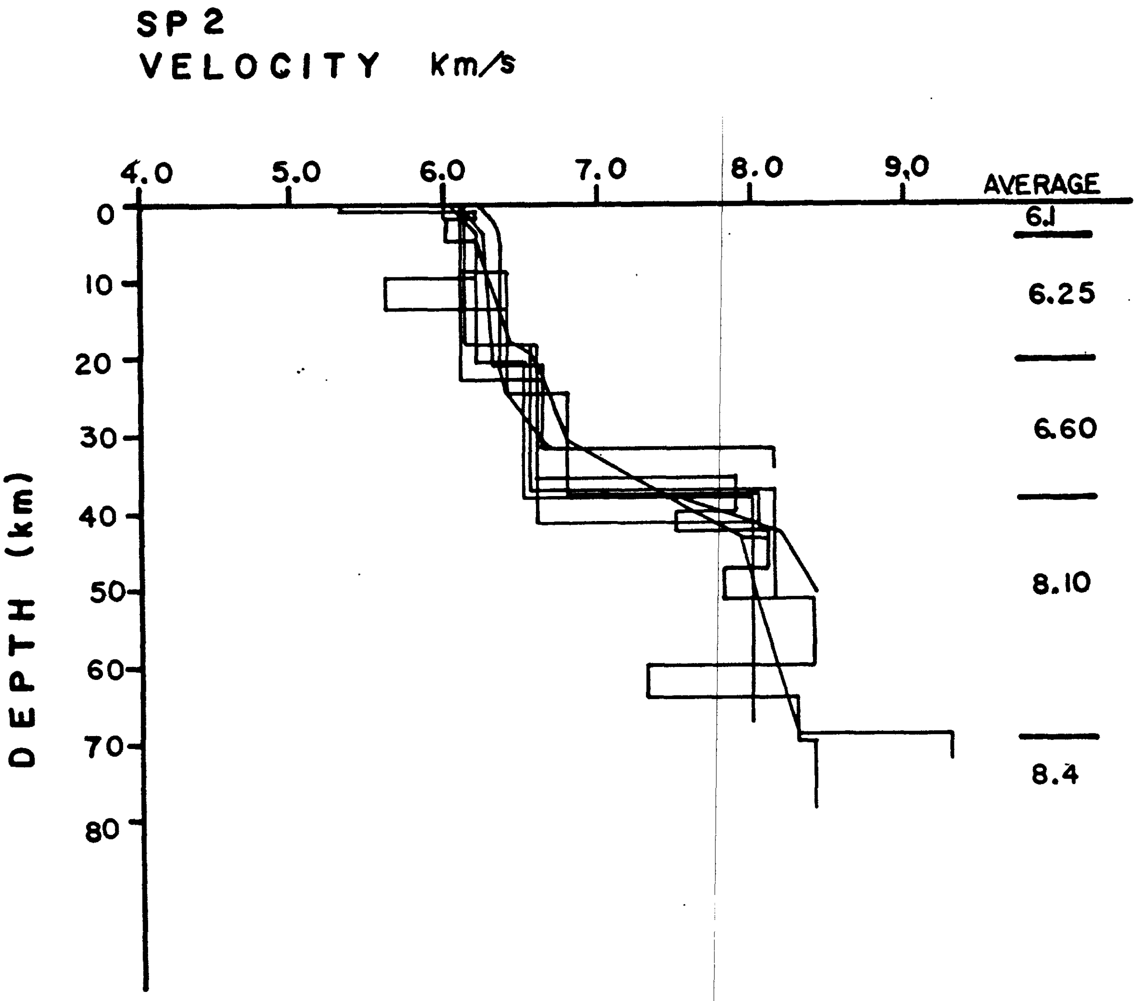


Figure 44.--Comparison of velocity-depth functions beneath shot point 2. Average velocity section was obtained by inspection.

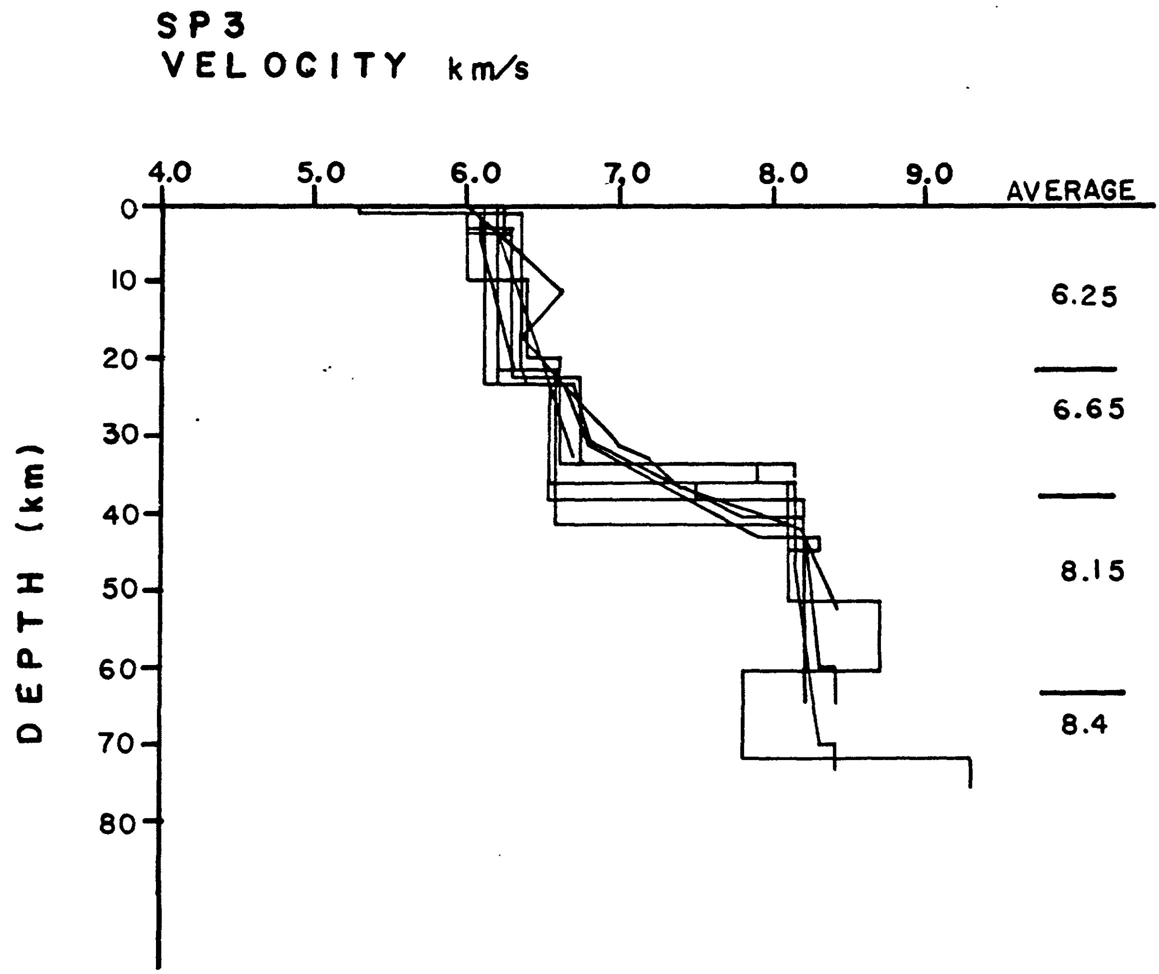


Figure 45.--Comparison of velocity-depth functions beneath shot point 3. Average velocity section was obtained by inspection.

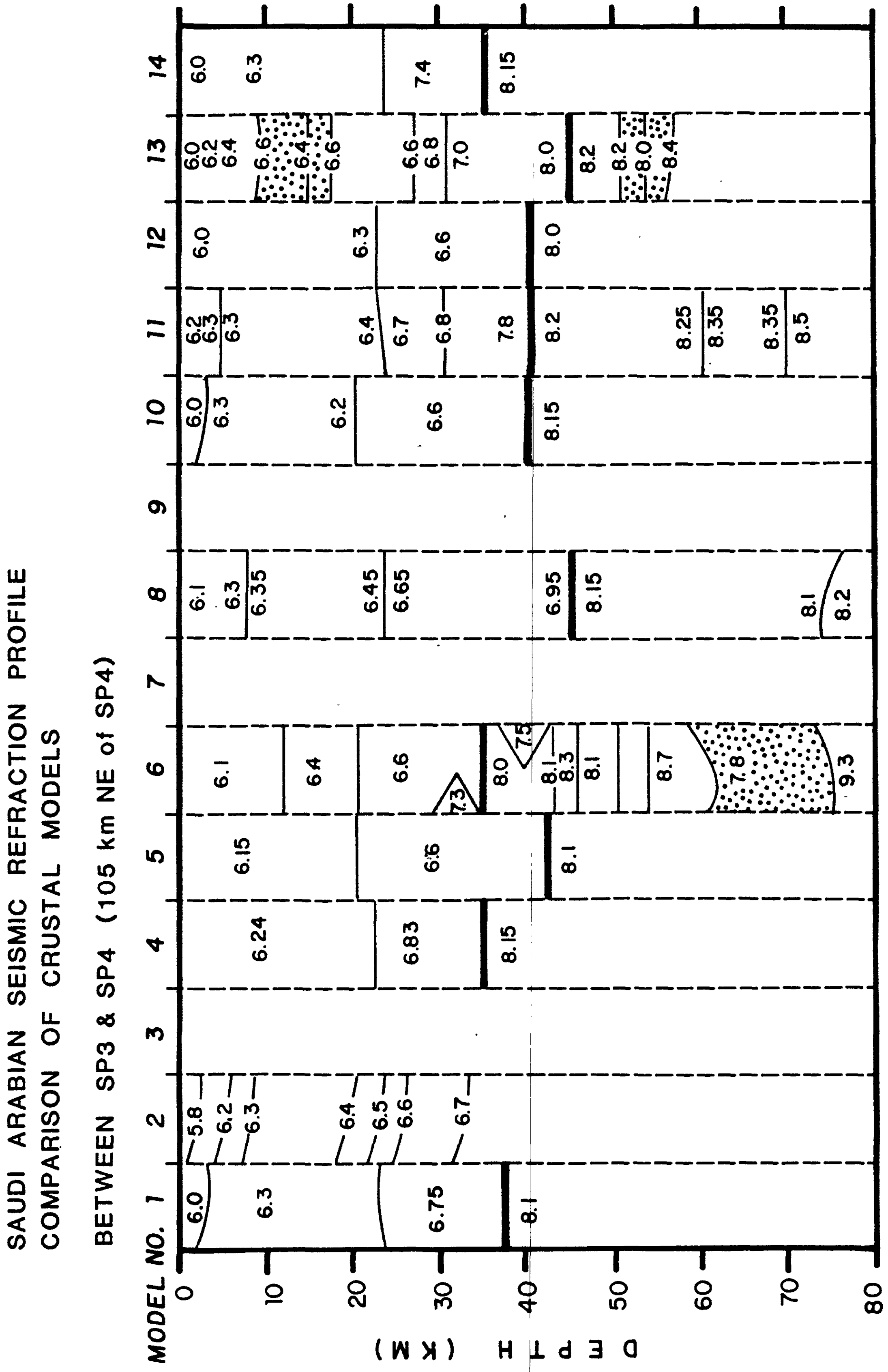


Figure 46.--Comparison of crustal models between shot points 3 and 4. Velocities are in km/s. Solid lines are velocity discontinuities, broken lines are isovelocity lines. M-discontinuity is the thick solid line. Low velocity zones are stippled. Strong lateral velocity heterogeneities are indicated in model six by wedges. Models are those presented at the 1980 Commission on Controlled Source Seismology meeting (see text).

of the data would probably improve its useability. The upper crust in most models is 22 ± 2 km thick with a 6.3 km/s average velocity. The lower crust is interpreted with a velocity of 6.7 ± 0.13 km/s in eight models; a velocity greater than 7.0 km/s is seen below the 6.7 km/s material in three of these models. The velocity of the uppermost mantle is 8.1 ± 0.1 km/s, and four of the interpretations show one or more upper mantle discontinuities.

The velocity-depth functions beneath shot point 4 (fig. 47) display a general consensus on the velocity and thickness of the upper crust (average velocity 6.3 km/s, thickness 22 km) as well as good agreement on the average velocity in the 20-30 km depth range (6.7 km/s). Models of the lower crust indicate that either the velocity continues at 6.7 km/s with depth, or increases rapidly with depth, reaching 7.6-7.8 km/s just above the M-discontinuity. Several models show upper mantle velocity structure with the velocity generally increasing with depth either in a smooth gradient or in a series of high and low velocities. Two or more models show an upper mantle discontinuity at either 55 or 72 km depth.

The crustal columns between shot points 4 and 5 (fig. 48) show less scatter in crustal thickness than those between shot points 3 and 4. The average thickness is 40 ± 2 km. Considerable disagreement exists as to the depth of an upper crustal boundary. Seven models show a discontinuity at about 15 km depth, and five models do not. Seven models show a discontinuity at about 22 km depth, and four do not. Three models show discontinuities at both depths, and several models show changes in velocity gradient at those depths.

The lower crust is modeled almost uniformly with a velocity of 6.7 $\pm$ 0.15 km/s in seven models, and with velocities greater than 7.0 km/s in the lowermost crust in four models. Based largely on the long-range data from shot point 6, five models show the upper mantle with velocity gradients and/or discontinuities.

For logistic reasons, data between shot points 5 and 6 were taken only on the Tihamat-Asir coastal plain and on islands in the Red Sea (see geologic map, pl. 7); therefore, the region of strongest lateral heterogeneity in this profile, the ocean-continent transition, had the greatest interstation spacing. This data density factor should be considered when comparing the models.

Shot point 5 is located approximately 5 km east of the Arabian Shield/Red Sea boundary, where the Precambrian rocks meet the Tertiary mafic dikes of the Tihamat-Asir. Considering shot point 5's proximity to this major crustal boundary, we are not surprised that the velocity-depth functions beneath it (fig. 49) are so scattered. Figure 49 shows good agreement between models for the value of the upper-crustal velocity, 6.25 km/s, and for its depth, 10 km. Between 10 and 30 km depth a great deal of scatter is seen in the interpreted velocity structure, although there is a cluster of values at 6.7 km/s. Two models even show mantle velocities in this depth range, and, in one case, the high-velocity layer is only a few kilometers thick. This latter model basically calls for intrusion of mantle material into the shield crust, which would have been associated with the rifting of the African-Arabian crust (B. Milkereit and E. R. Flüh, oral presentation, IASPEI-CCSS meeting, 1980). A high-velocity lowermost crust (7.4 km/s at 32 km depth) is a common feature of

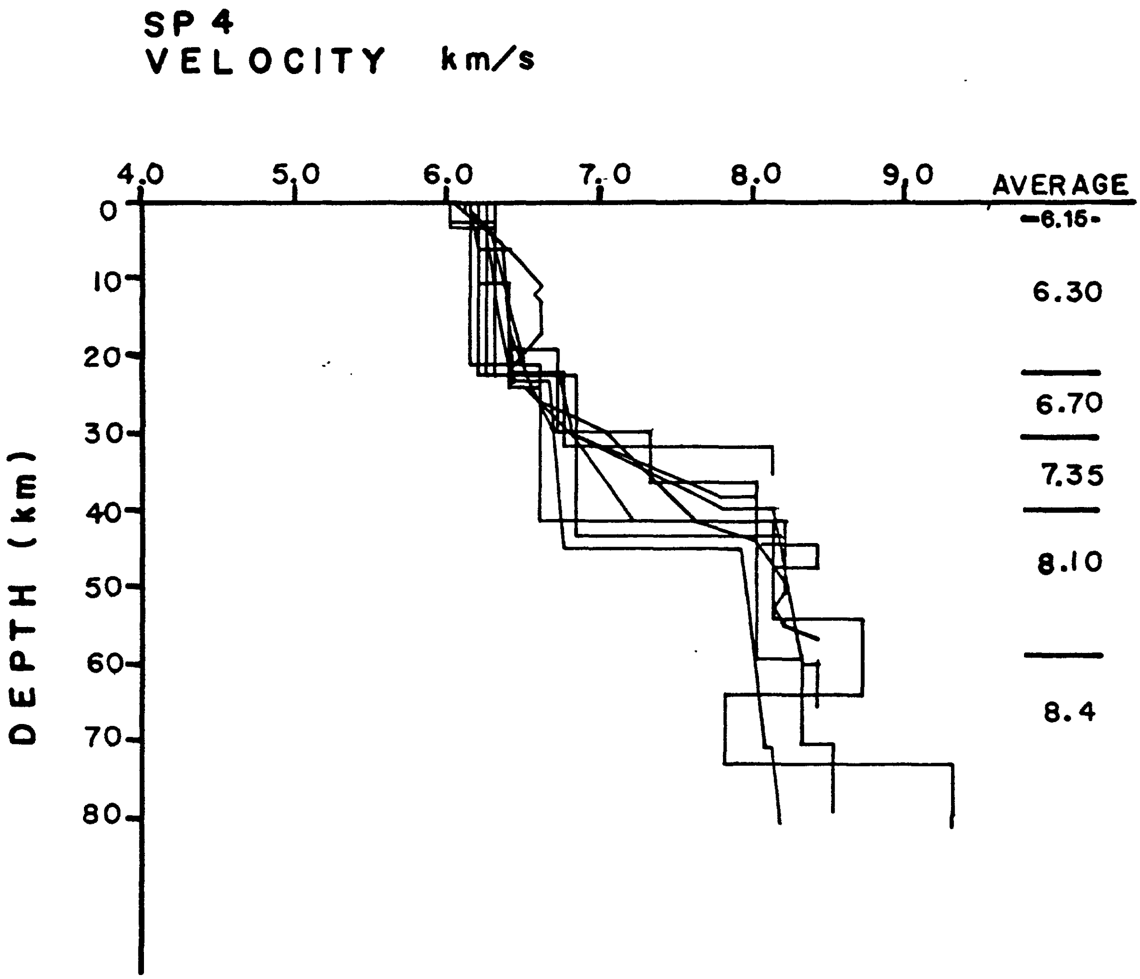


Figure 47.--Comparison of velocity-depth functions beneath shot point 4. Average velocity section was obtained by inspection.

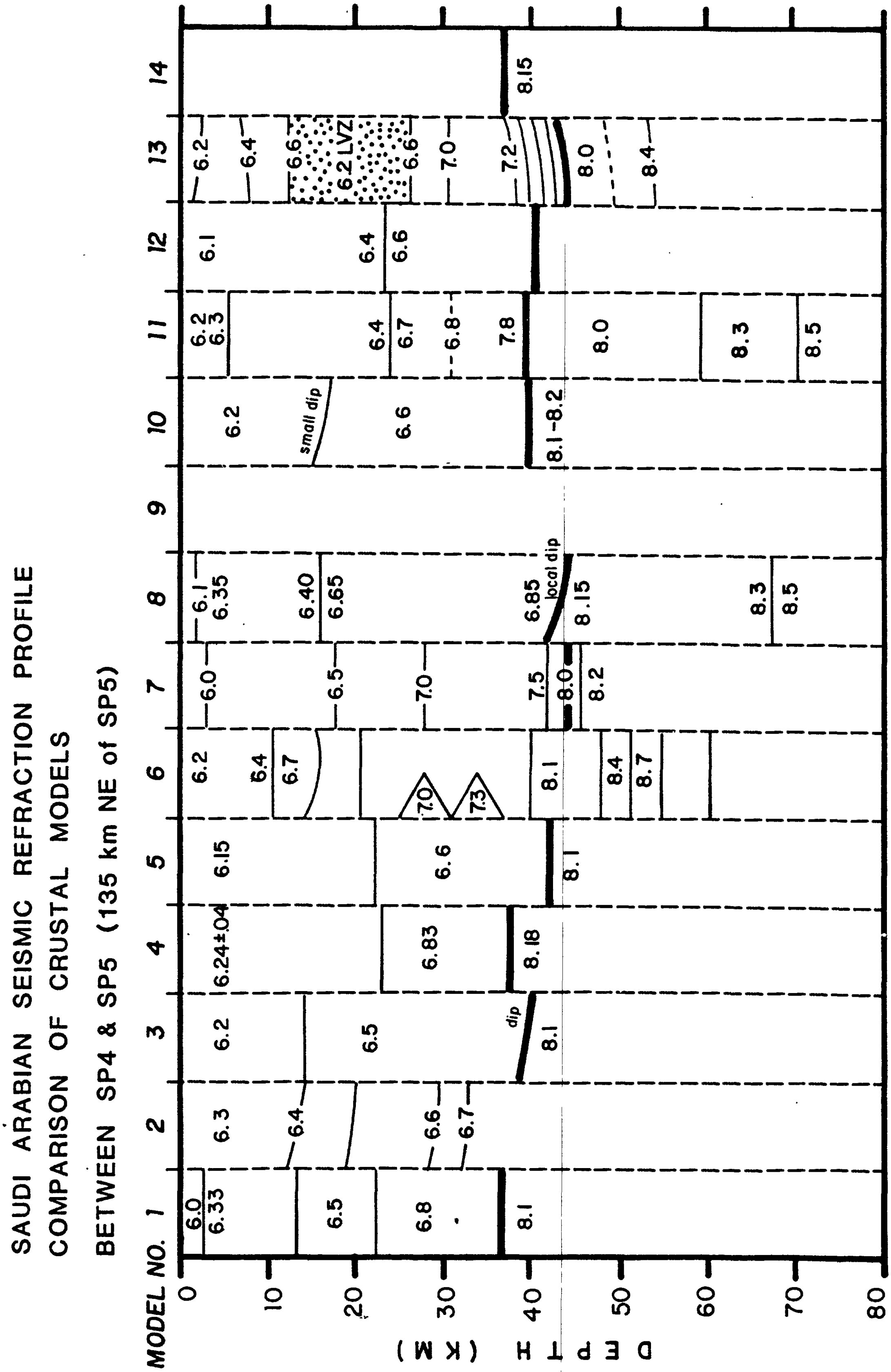


Figure 48.--Comparison of crustal models between shot points 4 and 5. Velocities are in km/s. Solid lines are velocity discontinuities, broken lines are isovelocity lines. M-discontinuity is the thick solid line. Low velocity zones are stippled. Strong lateral velocity heterogeneities are indicated in model six by wedges. Models are those presented at the 1980 Commission on Controlled Source Seismology meeting (see text).

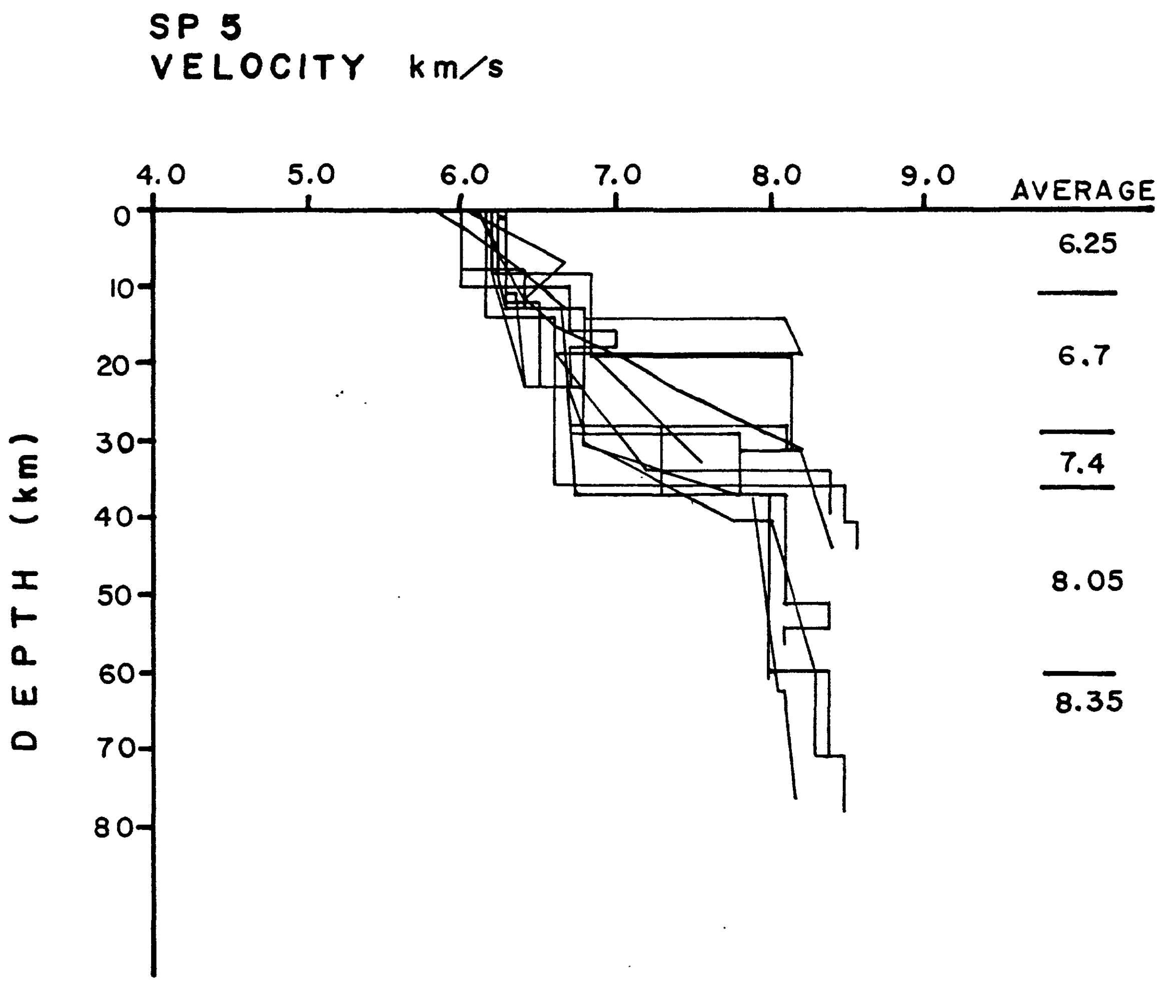


Figure 49.--Comparison of velocity-depth functions beneath shot point 5. Average velocity section was obtained by inspection.

the models, and the M-discontinuity is shallow, at a depth of 36 km. The average uppermost mantle velocity is only 8.05 km/s, and velocity discontinuities in the mantle are identified at 50 and 60 km depths.

Except for model 2, all crustal columns between shot points 5 and 6 (fig. 50) show a thin crust, 17 km thick being average. There is a wide scatter of values of upper crustal velocity in the 12 models, and above 10 km, all but one show velocities less than 6.7 km/s. Below 10 km, four models show velocities of 7.0 km/s or greater; the others reach the M-discontinuity with lower crustal velocities of less than 7.0 km/s. The upper mantle velocity models show considerable scatter, with values between 8.0 and 8.65 km/s. Nine of the models show some upper mantle structure, either a low velocity zone(s) or a velocity discontinuity; five show low velocity zones above 40 km depth.

The velocity-depth functions beneath shot point 6 (fig. 51) show general agreement that the crustal thickness is that typically found for oceanic crust, ∿12 km. The crustal velocity structure is very difficult to resolve with the available data. The consensus at the workshop was that it increased rapidly from 4.5 km/s to 6.7-6.8 km/s over the 12 km to the M-discontinuity, which is typical of oceanic crust.

The interpretations of the upper mantle structure beneath shot point 6 show a great deal of scatter. Notable features are a velocity of 8.0 km/s in the uppermost mantle, a low velocity zone between 18 and 35 km, an increase in velocity to 8.2 km/s at 35 km depth, and an increase in velocity to 8.45 km/s at ∿68 km depth. The complicated velocity structure in the upper mantle of the Red Sea may be a direct consequence of the mantle convection process that is probably operating there.

To summarize, the CCSS workshop interpretation of the Saudi Arabian data showed that:

(1) The upper crust of the shield is 21 km thick and has an average velocity of 6.25 km/s. In some regions there are small velocity discontinuities and/or low velocity zones.

(2) The lower crust of the shield (19 km thick) is separated from the upper crust by a seismic discontinuity where the velocity increases by ∿0.3 km/s. The average velocity of the lower crust is about 6.7 km/s. Velocities greater than 7.0 km/s may be present in the lowermost crust.

(3) The M-discontinuity is probably a transition zone 2-5 km thick at an average depth of about 40 km. Uppermost mantle velocity probably increases laterally from 8.0 km/s beneath the Red Sea to 8.2 km/s beneath the Arabian Platform.

(4) Considerable evidence exists for fine structure in the upper mantle between 40 and 70 km depth, including low velocity zones and velocity discontinuities.

(5) The detailed structure of the crust and upper mantle is difficult to resolve between shot points 5 and 6, the Arabian Shield-Red Sea transition zone. Models derived from the available data show a change in crustal thickness from 40 km on the shield to 12 km in the Red Sea, and considerable upper mantle structure.

Participants at the CCSS meeting recommended the following methods for future seismic refraction and reflection work in areas with strongly laterally heterogeneous velocity structure, such as the Red Sea-continent transition in western Saudi Arabia:

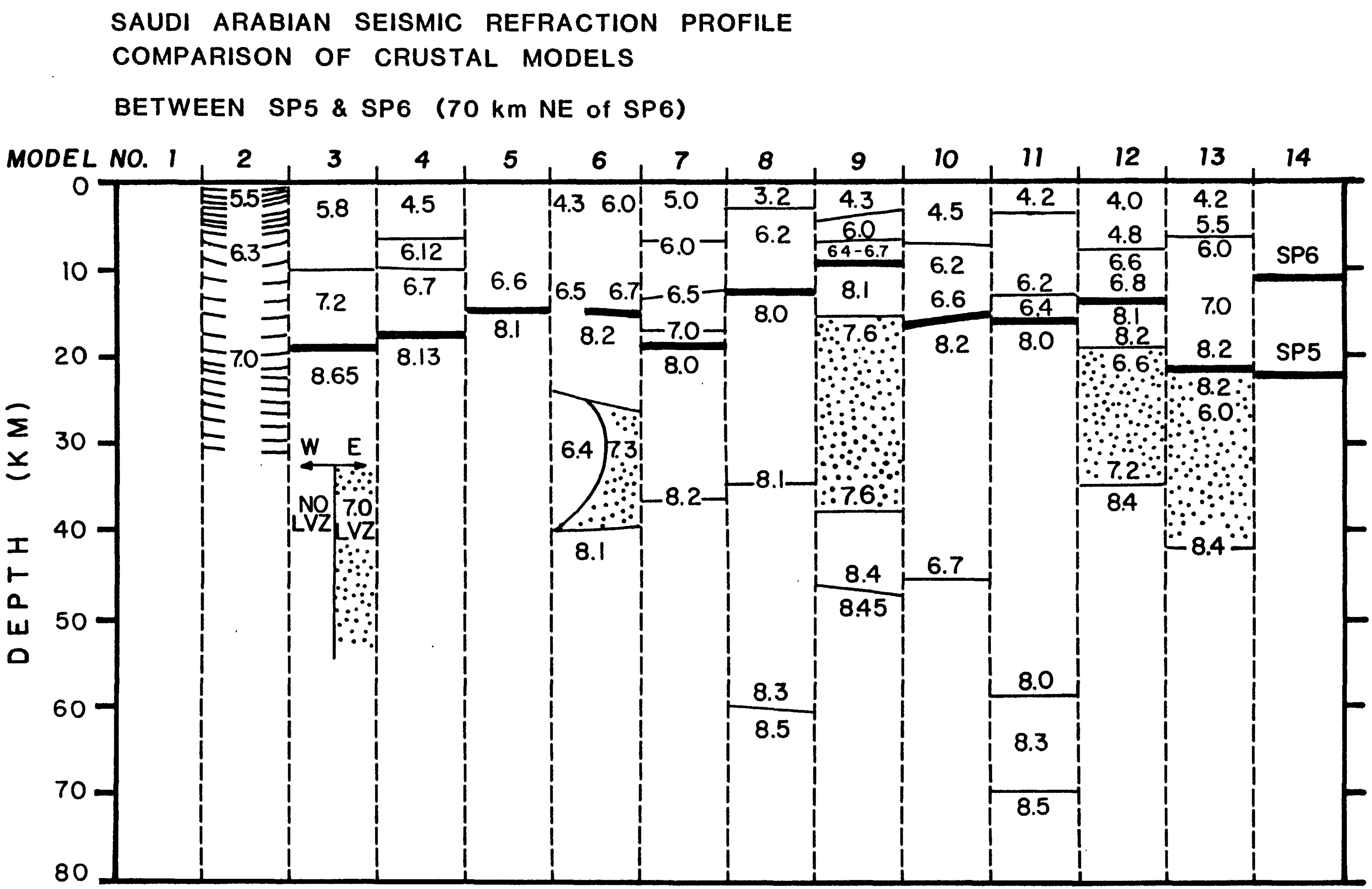


Figure 50.--Comparison of crustal models between shot points 5 and 6. Velocities are in km/s. Solid lines are velocity discontinuities, broken lines are isovelocity lines. M-discontinuity is the thick solid line. Low velocity zones are stippled. Strong lateral velocity heterogeneities are indicated in model six by wedges. Models are those presented at the 1980 Commission on Controlled Source Seismology meeting (see text).

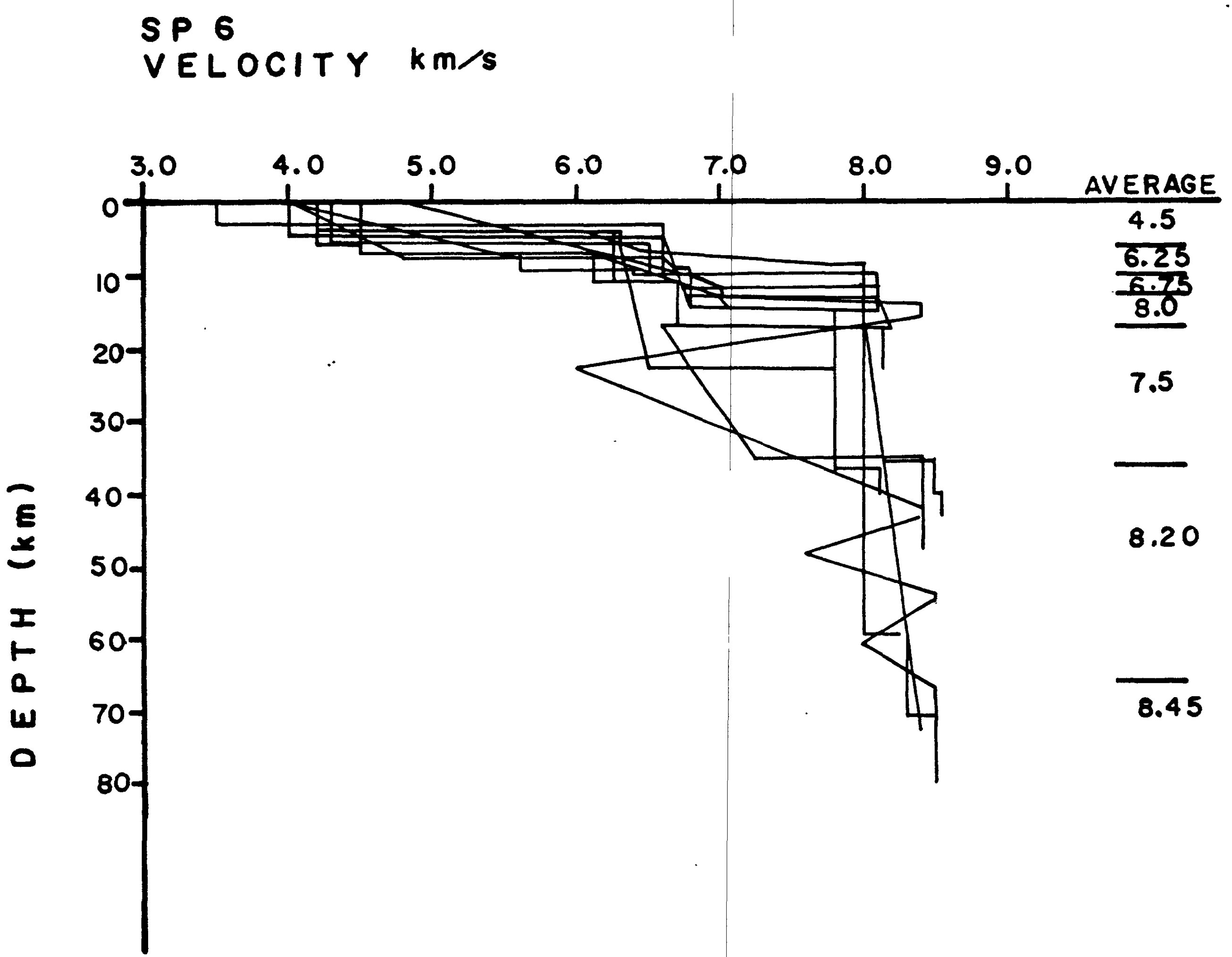


Figure 51.--Comparison of velocity-depth functions beneath shot point 6. Average velocity section was obtained by inspection.

(1) Parallel-to-structure refraction profiles are needed--in the present case, along the coastal plain and in the Red Sea.

(2) Perpendicular-to-structure profiles must be densely recorded and should include considerable data redundancy.

(3) Seismic reflection profiles would help resolve details in the areas of greatest structural complexity. In the present case, reflection profiles across the Hijaz-Asir escarpment would shed light on the structure of this rift boundary.

The commission officers at the time of the meeting were S. Mueller, Eidgenossische Technische Hochschule (ETH), Zurich, Switzerland, and I. Kosminskaya, Moscow (co-chairmen), and J. Ansorge, ETH-Zurich, Switzerland (secretary). The local organizers were D. P. Hill, U.S. Geological Survey, Menlo Park, California, J. A. Orcutt, Scripps Oceanographic Institute, La Jolla, California, and R. B. Smith, University of Utah, Salt Lake City, Utah.

DISCUSSION

In plate 9 we have combined the flat-layer and two-dimensional models of the previous sections into a single model. (We have not included the CCSS interpretations). We found it necessary to reinterpret some of the data to derive an internally-consistent model, and these reinterpretations will be discussed in the sections dealing with the individual profiles. Plate 9 shows the simplest internally-consistent model of the crust and upper mantle sampled by the seismic refraction profile that we have been able to derive, and is the basis for the following discussion.

Basement configuration beneath the Arabian Platform

The extreme northeast end of the profile, which covers the transition between the Precambrian shield and the sedimentary rocks of the Arabian Platform, is of particular geological interest. The sediments of the platform in this region are mainly shales and sandstones in the lower half of the stratigraphic section and limestones and shales in the upper half (Powers and others, 1966). The sedimentary thickness and the configuration of the basement beneath the sediments may be calculated from the seismic refraction data, but we note that a high degree of resolution of the structure at the top of the basement is not possible on the basis of the available data; additional short-range, reversed profiles with a high recorder density are needed for improved resolution. Figure 52 shows the seismic refraction data from the Arabian Platform along the profile shot point 1 northeast (0-85 km) and a portion of the profile shot point 1 southwest (0-85 km). We first discuss the general features of the profiles and then interpret the observations in terms of subsurface structure.

The first arrivals for profile 1 southwest (fig. 52) have an apparent velocity of 6.15 km/s between 0 and 30 km. Between 30 and 60 km, the apparent velocity increases to 6.31 km/s, and beyond that it decreases to 6.11 km/s. These variations in apparent velocity of the first arrivals indicate lateral variations in the near-surface structure, particularly between 30 and 60 km southwest of shot point 1. Figure 52 also shows a significant increase in high frequencies at a range of ∿43 km (between records 245 and 246; see also pl. 9), which indicates that the average attenuation of the high frequencies decreases sharply beyond ∿43 km southwest of shot point 1; the termination of the low Q sediments of the platform is the obvious explanation.

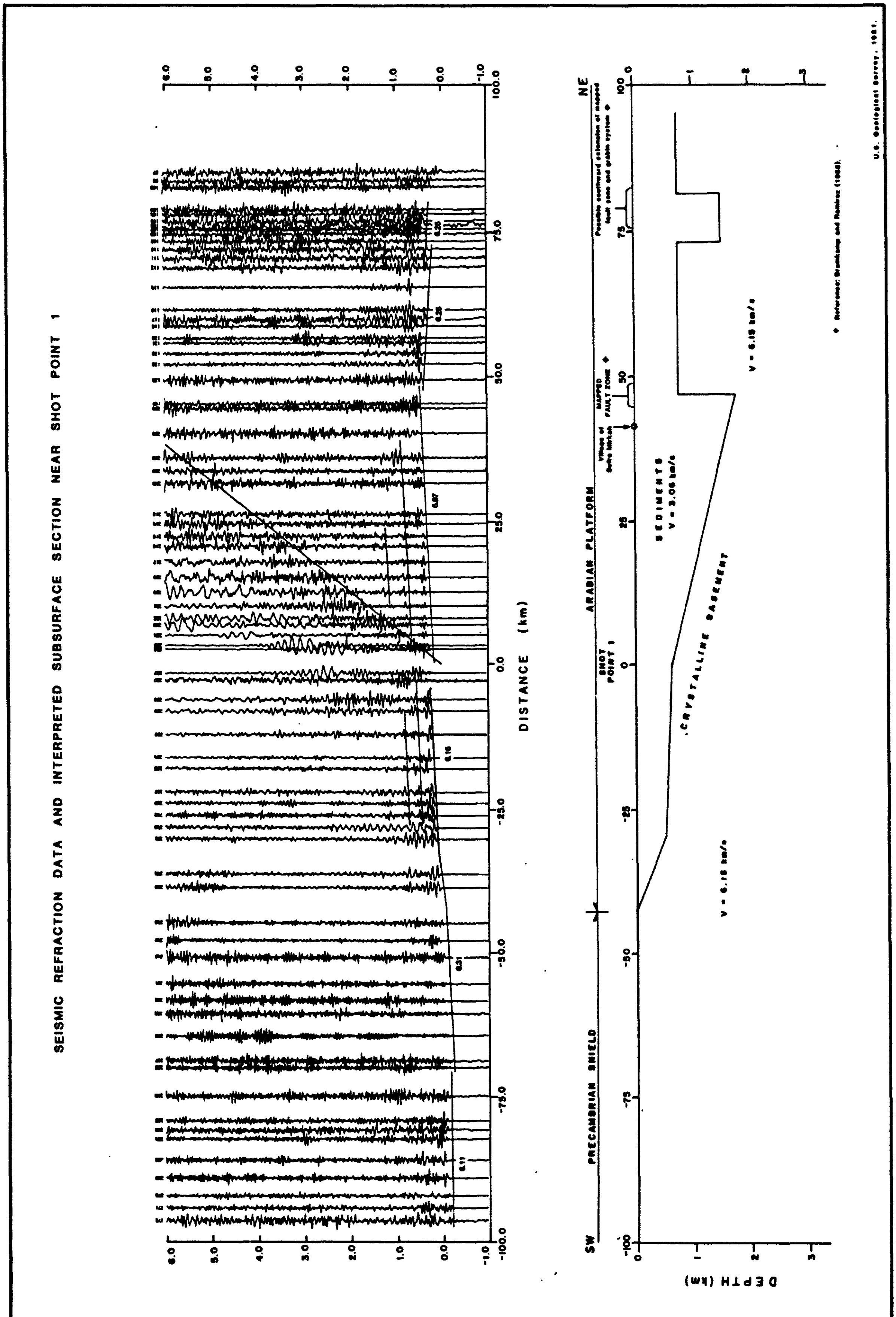


Figure 52.--Interpreted basement-depth configuration beneath the sediments near shot point 1. Upper plot is a portion of the true-amplitude record section around shot point 1 from plate 1. Correlation of phases is indicated by lines and are discussed in the text. Lower plot is the interpreted subsurface section showing basement relief beneath the platform sediments.

Secondary arrivals are difficult to correlate from record to record in profile 1 southwest. The only phase identified as such in figure 52 is one with an apparent velocity of 6.15 km/s that follows the first arrivals by 0.3 s. As will be explained below, this phase appears to be a reflected refraction (a multiple reflection within the sediments followed by critical refraction in the basement).

On profile 1 northeast, the apparent velocity of the first arrivals is 5.87 km/s to a distance of 47 km. This apparent velocity is 0.28 km/s slower than that of profile 1 southwest, indicating either a change in the composition of basement rocks or a northeastward dip of the shield basement. We prefer the second interpretation, since a thickening of the overlying sediments has been inferred from geologic field studies (Bramkamp and Ramirez, 1958).

A traveltime advance of 0.11 s occurs between 45 and 50 km (records 199 and 125) northeast of shot point 1, after which the apparent velocity of the first arrivals increases to 6.25 km/s. Then, at 73 km (record 109) a traveltime delay of 0.10 s occurs, beyond which the first arrivals resume an apparent velocity of 6.25 km/s for a distance of ∿5 km. Finally, the last three arrivals (records 100, 99, and 97) show an average traveltime advance of 0.15 s from the projection of the traveltime curve of the nearest traces. These traveltime advances and delays, and the change in apparent velocity from 5.87 to 6.25 km/s, can best be explained by successive highs and lows in the basement topography; the structure may be described in simplest terms as a series of horsts and grabens.

We also see clear secondary arrivals on profile 1 northeast (fig. 52). In the distance range 6 to 22 km two phases parallel the first-arrival curve (i.e., that with apparent velocity of 5.87 km/s), following it by 0.43 s and 0.82 s, respectively. These reflected refractions provide additional constraints on the basement structure. Another secondary arrival is a high-amplitude phase with an apparent velocity of 3.06 km/s. We have interpreted this phase as the direct compressional-wave arrival through the platform sediments for three reasons: 1) the velocity is too slow for it to be a shear-wave propagating in the basement: a velocity of $6.15/\sqrt{3} = 3.55$ km/s would be expected; 2) the velocity is too fast for a surface wave; and 3) the velocity agrees well with that expected for Paleozoic and Mesozoic shales.

The basement structure derived from these observations is illustrated in figure 52. The model is based on the following assumptions: velocities of 3.06 and 6.15 km/s are appropriate for the sedimentary section and basement, respectively; plane dipping layers and vertical faults (horsts and grabens) are the structural elements of the basement. The model shows the sediments beginning at the edge of the Precambrian shield at a distance of 43 km southwest of shot point 1. The sediments thicken to 600 m at shot point 1 and then dip at $\sim 1°$ to the northeast for 47 km, reaching a thickness of 1750 m. Beyond 47 km, the basement rises by 1000 m; the width of the zone over which the basement rise occurs is known only to be less than the seismic station separation, 4 km at this point. This basement rise corresponds to a northwestward extension of a fault zone mapped by Bramkamp and Ramirez (1958). At a distance of 72 km from shot point 1 the basement drops to 1500 m, only to rise again to 750 m at ~ 80 km. The basement structure between 70 and 80 km from shot point 1 appears to coincide with a southeastward extension of a mapped fault zone and graben system (Bramkamp and Ramirez, 1958).

In summary, variations in depth to the basement beneath the sediments of the Arabian Platform near shot point 1 coincide with mapped fault zones. The basement structures are horsts and grabens, with vertical relief on the order of 1000 m.

General seismic features of the Arabian Shield

First-order seismic structure of the shield

To a first-order approximation, the Precambrian shield (pl. 9) is composed of two layers. The upper crust is 21 km thick with an average velocity of about 6.3 km/s; a first-order velocity discontinuity at which velocities increase from about 6.4 to 6.7 km/s marks its base. The lower crust is about 19 km thick with an average velocity of approximately 7.0 km/s; a velocity increase from 7.8-7.9 km/s to 8.0-8.1 km/s marks the base of the crust (Mohorovicic discontinuity). The depth to the M-discontinuity generally decreases toward the Red Sea, from $\sim$43 km in the northeast to $\sim$38 km in the southwest. Across the ocean-continent transition at the western margin of the shield, the crust thins abruptly, to less than 20 km. Beneath the sedimentary section of the Tihamat-Asir coastal plain and Red Sea shelf, the average crustal velocity is 6.2 km/s.

Although this first-order model fits the average traveltimes of the record sections, significant deviations from predicted arrival times and varying frequency content and amplitude of individual seismograms indicate lateral inhomogeneities within the crust. Detailed comparison of the geologic sections (pl. 8) with the record sections shows considerable correlation between velocity variations and lithologic and structural features. We proceed in our discussion from northeast to southwest.

Some second-order structures of the shield

Lateral crustal discontinuity at the northeast end of the profile. We identify a lateral crustal boundary 30 km northeast of shot point 2 across which velocities increase to the northeast by about 0.2 km/s. These relatively high upper crustal velocities (6.3-6.5 km/s) may be attributed to the higher metamorphic grade of these rocks, and the velocity change indicates that the crust here is different from that to the west, as suggested by Schmidt and others (1978). We note that northeast of the boundary the lower crustal velocities below 30 km have a lower gradient than those of other portions of the profile, and that the mantle velocities are higher than those along other portions of the profile. The boundary zone, as seismically determined, is about 40 km southwest (along the profile) of the Al Amar-Idsas fault, which has been commonly accepted (Schmidt and others, 1978) as marking the western edge of an allochthonous continental block. On the basis of the seismic evidence, uncertainty as to the location of the boundary is about ±15 km; therefore, it occurs at least 25 km southeast (along the profile) of the Al Amar-Idsas fault. Delfour (1979) has suggested that the Abt schist formation, which extends from the Al Amar-Idsas fault southwest to the seismic boundary, may contain unidentified thrust faults; an imbricate structure for the Precambrian collision zone (Schmidt and others, 1978) would explain the displacement of the seismically-determined zone from the Al Amar-Idsas fault.

The refraction data at this level of interpretation cannot resolve the dip of the zone or even its direction, so we have drawn it vertically in plate 9, as we have drawn all other zones between laterally-inhomogeneous portions of the crust.

Seismic characteristics of the Shammar and Najd tectonic provinces. We cannot distinguish the southwest part of the Shammar tectonic province from the Najd province at this level of seismic interpretation. This is in part due to the lack of data from shot point 3 northeast; the crustal structure is undoubtedly more complicated than plate 9 represents. The velocities observed are typical of those in crystalline upper crustal rocks. However, the lower crustal velocities (20-40 km depth) are anomalously high and atypical of granitic crust; they are more indicative of a mafic crust. The evolutionary models of Schmidt and others (1978) involve crustal formation from collisions of island arc systems.

At the southwest Najd fault zone, which delimits the southwest boundary of the Najd tectonic province (between 35 and 80 km southwest of shot point 3), we find a lateral seismic discontinuity across which uppermost crustal velocities go from 6.1 km/s in the northeast to 6.3 km/s in the southwest. The high-velocity region apparently includes the fault zone. We interpret a high-velocity zone beneath the fault zone as a velocity discontinuity at $\sim$13 km depth. This high-velocity zone correlates well with the gravity anomaly highs and large magnetic signatures (pl. 8). Estimates of the center of mass of the gravity anomaly yield a depth of 15-20 km, and we infer that the seismic discontinuity marks the top of the source. We interpret this zone as mafic intrusions into the fault zone at lower crustal levels.

On the basis of gravity and magnetic evidence, we postulate that the northeast Najd fault zone also has an analogous zone of intrusions beneath it. Unfortunately, the most definitive test of this hypothesis would be from a record section northeast of shot point 3, where there is no data coverage. In the data southwest from shot point 2, the zone in question is too far away to be detected as a reflector and thus is not obvious on the record section.

Velocity structure of the Hijaz-Asir tectonic province. Approximately 100 km southwest of shot point 3, a lateral velocity boundary occurs in the lower crust, with the lower velocities to the southwest. This low-velocity lower crust begins beneath the Nabitah suture zone mapped at the surface (Schmidt and others, 1978) and extends for about 220 km, to about 70 km southwest of shot point 4. It may correspond to the remnants of the upper part of a subducted plate hypothesized by Schmidt and others (1978). In the upper crust, the high-velocity zone that began at the southwest Najd fault zone continues across the Al Qarah gneiss domes (Schmidt and others, 1978) to the Al Junaynah fault zone, which is about 30 km northeast of shot point 4. Between the Al Junaynah fault zone and a point about 65 km northeast of shot point 4, another 13 km-deep seismic discontinuity is inferred, at a depth corresponding to the lower regions of the Al Qarah gneiss dome (Schmidt and others, 1978).

In the uppermost crust, a lateral velocity discontinuity is seen in the vicinity of shot point 4, at the Al Junaynah fault zone. Velocities are lower to the southwest, $\sim$6.2 km/s, for about 60 km. They increase dramatically approaching the Khamis Mushayt gneiss (Coleman, 1973), reaching 6.6 km/s at depths of only 5 km in the core of the gneiss. The high-velocity region, which correlates closely with the outcrop pattern of the Khamis Mushayt gneiss, appears to penetrate the entire upper crust. This may be the best geophysical example along the profile of a nappe-type structure, in which lower crustal material has been brought to the present-day surface. The velocity structure of the lower crust beyond about 80 km southwest of shot point 4 returns to the higher velocities found between shot points 3 and 2. Lowermost crustal and upper mantle velocities, however, seem to be systematically lower by about 0.2 km/s than those to the northeast. This part of the profile is a logical starting point for a detailed, integrated geological and geophysical study of the western part of the shield. The excellent geophysical response of this area should make it possible to construct a good three-dimensional model of at least the upper crust, against which various theories of shield evolution could be tested.

The true-amplitude record sections along the profile show strong variations in seismic wave attenuation (Q). The large, batholithic-size granitoid bodies, particularly the gneiss dome areas, have a very high Q; that is, they propagate seismic energy very efficiently. In general, the traces recorded at stations on these rocks have high amplitudes and large high-frequency content. For stations on greenstones and greenschists and at the large fault zones (see pl. 8), the Q is much lower, and the higher frequencies are generally lost. Higher Q and higher upper-crustal velocities seem to be related to higher metamorphic grade; detailed correlations between the true-amplitude record sections and geologic maps at 1:100,000 and 1:250,000 scales may assist in mapping metamorphic grade changes along the profile. Attenuation studies hold promise for estimates of depth and average lithology of these zones, although corrections for weathering and local geologic variation (alluvium and so forth) at recorder sites must precede depth and lithology estimates. Further field work is required (see below, "Recommended further work") before the data can be corrected.

The intracrustal discontinuities in the upper crust, which seem to cluster at ∿13 km depth, are probably due to an increase in crustal rigidity due to intrusive activity above this depth (for example, the inferred intrusives in the Najd fault zones). The ages of these events are consistent with the final thermal pulse of the Pan-African event. We note further that the 13 km depth is the same as the maximum depth of earthquakes along the San Andreas fault of central California (Eaton and others, 1970). If we postulate that the crustal heat flow in Saudi Arabia during the Pan-African event was comparable to the present-day heat flow in California (∿ 2 HFu), we can infer that the seismic refraction interpretation points to a generalized crustal model consisting of a brittle upper crust overlying a more ductile lower crust.

<u>Western shield margin and the Red Sea rift and shelf</u>

The most dramatic crustal and upper mantle transition along the profile is that from the westernmost shield to the Red Sea rift and shelf. The shield directly beneath shot point 5 appears to have roughly the same velocity structure as the average throughout the shield, except that the lower crust apparently thins by 6 km (pl. 9). The transition to the thin crust of the shelf occurs over the short distance of 20 km southwest from shot point 5. The crust changes more abruptly here than almost anywhere in the world. The seismically-determined transition is characterized at the surface of the

Tihamat-Asir by a sharp boundary between the Precambrian rocks and the Tertiary volcanic and intrusive rocks (pl. 9).

A simple three-layer crust of sediments (4.2 km/s), upper crust (6.2 km/s), and a thin lower crust (6.8 km/s) characterizes the Red Sea shelf and rift. The crust thins from 17.5 km at the coast to 8 km at shot point 6. Mantle velocity is 8.0 km/s.

Any seismic crustal model is subject to constraints imposed by the gravity and magnetic data. The Bouguer gravity anomaly profile for the coastal region (pl. 8) shows the steepest gradient centered over the exposed margin of the Arabian Shield, some 60-70 km west of the Hijaz-Asir escarpment. This gradient connects the highly negative (-100 to -140 mgal) field of the shield interior to that of the coastal plain and Red Sea shelf, where values are close to zero. The steepness of the gradient is accentuated by the hypabyssal gabbroic intrusive bodies in the marginal zone.

The mean velocity of the seismic basement beneath the coastal plain and Red Sea shelf in this region, 6.2 km/s, falls well within the range for diabase, 6.1-6.7 km/s (Nafe and Drake, 1968). Therefore, we interpret the basement as consisting largely of diabase of a sheeted dike complex, which agrees reasonably well with the gravity data. Gettings (1977), assuming isostatic equilibrium and taking into account the known thickness of low-density sedimentary rocks, has shown that the gravity level change is compatible with a density contrast between oceanic and continental crust, but not with that of an intracontinental crustal boundary.

Aeromagnetic data onshore and offshore in the vicinity of the seismic profile support the hypothesis of a diabase basement beneath the shelves and coastal plain. Girdler and Styles (1975), Hall and others (1977), and Hall (1980) mapped large-amplitude, long-wavelength linear magnetic anomalies along the shelves of the southern Red Sea and interpreted them as the expression of oceanic crustal strips of alternating remanent polarization that were emplaced during Tertiary seafloor spreading, and subsequently buried by Miocene sedimentary deposits. These anomalies extend onto the coastal plain and inland as far as the exposed margin of the shield, where they are associated by Blank and others (1981) and Kellogg and Blank (1982) with the diabase dike swarm in the structural transition zone.

In our seismic interpretation we have presented a continental crust of "normal" thickness and velocity structure beneath the Arabian Shield, a crust of "transitional" thickness and velocity structure near the shield margin, and a crust of "normal" oceanic thickness and "transitional" velocity beneath the Red Sea shelf. The crust near the shield margin (shot point 5) is probably about 16 ± 4 km thick; it probably consists chiefly of diabase, since it has an average velocity of about 6.1 km/s, and diabase is the chief component where basement is exposed. This velocity is intermediate between the velocities of typical oceanic Layers 2 and 3 of ocean basins, but the seismic data do not discriminate between diabase, a mixture of Layers 2 and 3, and a typical sialic crust. This 6.1 km/s crust apparently passes westward into crust of "normal" oceanic thickness underlying the outer Red Sea shelf; the 6.1 km/s crust beneath the Miocene sediments is only about 4 km thick, which seems much too thin to have resulted from attenuation of continental crust, so the hypothesis that this is oceanic crust is strengthened.

Upper mantle structure

Upper mantle velocities at the M-discontinuity vary from 8.0 km/s between shot points 6 and 3 to 8.1-8.2 km/s between shot points 3 and 1. The velocity-depth function of the upper mantle is unexpectedly uniform along the length of the profile; we see a first order discontinuity at 60 km with a velocity increase from 8.0 or 8.1 to 8.3 km/s and another 10 km deeper, from 8.3 to 8.5 km/s. The M-discontinuity seems to be sharp, occurring across a zone of narrow width along the entire profile. In the Arabian Shield southwest of the Nabitah zone (between shot points 3 and 4), we see a constant 0.2 km/s increase at the M-discontinuity, although absolute velocity values of the crust and mantle decrease to the southwest. Most participants of the CCSS workshop obtained the same results (see figs. 42-51), so it is probably relatively model-independent. The M-discontinuity is also sharp beneath the Red Sea shelf, with a velocity contrast of about 1.2 km/s over a very narrow zone.

The thickness of the crust, defined by the depth to the M-discontinuity, increases eastwards in our model, varying from ∿8 km near the Red Sea axis to 18 km beneath the shelf and coastal plain, increasing abruptly beneath the western margin of the shield to 38 km, and increasing gradually to 43 km beneath the allochthonous continental block near shot point 1. Most of the interpretations by CCSS participants show roughly the same relationships, except that several have a zone of thickened crust (to about 42 km) in the area of shot point 4 and westwards.

In any case, none of the interpretations put forward to date show the thickest crust coincident with the area of greatest topographic relief; models that feature a thickened crust between shot points 5 and 4 all show the thickest crust displaced by varying degrees (up to 200 km) to the east of the topographic maximum. This observation implies a less dense upper mantle towards the west, at least from shot point 4 onwards, if isostatic equilibrium is to be maintained. The more mafic character of the crust from the Nabitah suture zone westwards (Schmidt and others, 1978) offsets the need for a less dense upper mantle somewhat, but not entirely. The seismic observations are in agreement with the peculiar shape of the regional gravity profile described above. The gravity relations, as constrained by isostasy, seismic refraction, and geologic considerations, require both a more dense crust west of the Nabitah zone and a less dense upper mantle (Gettings and Blank, unpub. data). These observations are in reassuring agreement with intuitive models of an upper mantle convective system that one might expect to be associated with the Red Sea spreading system. Assuming that the minimum mantle flow rates comparable with the Red Sea floor spreading rates have been operating throughout the Tertiary, we deduce that most of the mantle beneath the profile would have moved and homogenized into the rather uniform structure we now observe (Gettings and Blank, unpub. data).

Comparison of the crustal velocity structure of Saudi Arabia with those of other regions

In this brief discussion we compare the crustal velocity structure of the Arabian Shield with that of other shields and platforms, and with other geologic provinces of similar crustal thickness. The comparison is restricted to that of crustal layer thicknesses and average velocities because of the great disparity of methods and detail used in interpretation of refraction data. (Several of the crustal sections are from studies completed before digital computer methods of analysis were routinely available.) Therefore, we have generalized the velocity structures and, in so doing, have removed many of the significant lateral variations. These lateral variations may contain important clues to the tectonic styles that characterize the evolution of shields and platforms; the recognition of similar structural trends in different shields, an important problem, is well beyond the scope of this report.

The Arabian Shield shares many characteristics with the Ukranian and Baltic shields and the Turanian and Russian Platforms (fig. 53; Kosminskaya and others, 1969; Sollogub, 1969). The thickness of the upper crust in those regions is 20 ± 5 km, and the average velocity below the sediments is 6.2 km/s; the mean crustal thickness is 40.4 km, and the average lower crustal velocity is 7.0 km/s. These values are remarkably similar to those determined for the Arabian Shield (fig. 53).

Mykkeltveit's (1980) interpretation of the crustal structure of the Fennoscandian shield is also quite similar to that of Saudi Arabia. The upper crust is 19.5 km thick and has an average velocity of 6.2 km/s. The average velocity of the lower crust is 6.8 km/s, and the total crustal thickness is 40 km. Mykkeltveit also shows details in the structure of the Fennoscandian Shield that correlate with features in some of the CCSS interpretations of the Saudi Arabian Shield (figs. 42-49), although they do not appear in our average sections (fig. 53). The velocity in the upper Fennoscandian crust reaches 6.6 km/s at 15 km depth and decreases to 6.0 km/s in a low velocity zone between 15.1 and 19 km. It increases to 6.65 km /s at 19.1 km and increases again, to

6.9 km/s, in a mid-crustal gradient zone between 25 and 28 km depth, then remains constant at 6.9 km/s until the M-discontinuity is reached. Several interpretations presented at the CCSS meeting show similar features; low velocity zones are evident in models 1 and 2 of figure 42, model 13 of figure 46, and model 13 of figure 48. Since the heat flow is low in both the Fennoscandian (Grønlie and others, 1977) and Arabian (Gettings, 1982; pl. 8) Shields, these low velocity zones are probably the product of Precambrian nappe (or similar) structures rather than velocity inversions due to heating in the crust.

The western Canadian Shield (Hall and Hajnal, 1973) appears to have a lower upper-crustal velocity (6.05 km/s) than the Arabian Shield, but a similar lower-crustal velocity (average 7.0 km/s). The upper crust is 19 km thick, much like that of the Arabian Shield, but the lower crust is about 5 km thinner, for a total crustal thickness of only 34 km; the western Canadian Shield appears to be anomalously thin compared to the Arabian and other shields (and platforms).

In contrast, the Grenville province of the northeastern Canadian Shield shows a crustal thickness of about 43 km; the M-discontinuity is modeled as a gradient from 40-45 km depth across which the velocity increases from 7.2 to 8.6 km/s (Berry and Fuchs, 1973). The lower crust above the M-discontinuity zone is approximately the same thickness and has nearly the same average velocity as that of the Arabian Shield. The upper crust also has a similar average velocity and thickness to that of the Arabian Shield; moreover, upper-crustal low velocity zones show marked similarity to those in some of the CCSS interpretations (figs. 42, 46, and 48).

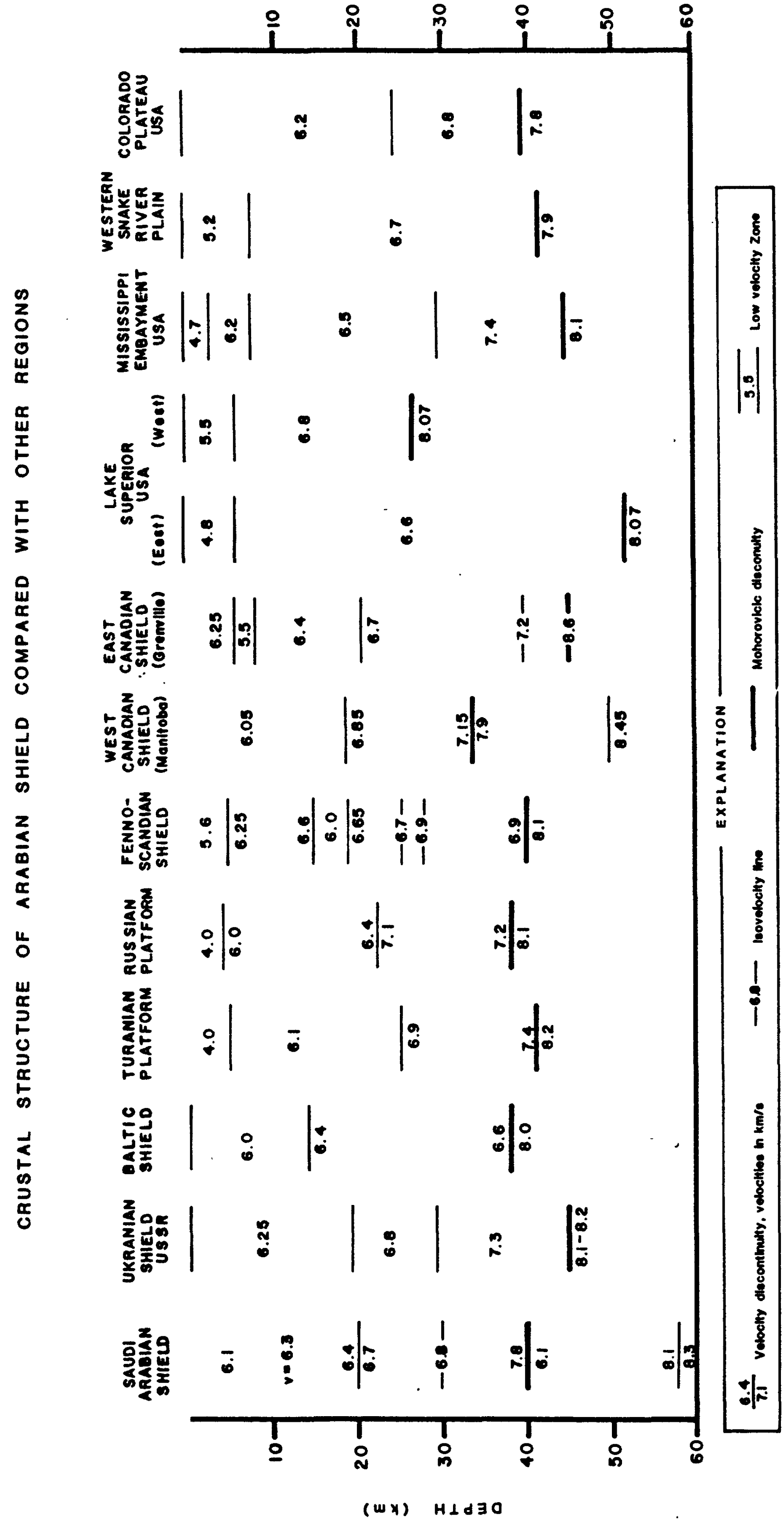


Figure 53.--Comparison of seismically determined crustal structure of the Arabian Shield with that of other regions. Solid lines are velocity discontinuities; lines with velocities on them are isovelocities. Stipped pattern indicates a low velocity zone. Velocity gradients indicated by two or more velocities between a set of solid lines. References are given in the text.

The crust of the Arabian Shield is very different from some of the well-studied interior regions of the United States and Canada. Lake Superior (Smith and others, 1966), the Mississippi embayment (McCamy and Meyer, 1966), and the western Snake River Plain (Hill and Pakiser, 1966) all have comparable crustal thicknesses but show high velocities at depths as shallow as 6 km; that is, 14 km shallower than that determined for the Arabian Shield. One interpretation of the shallow high-velocity zones of these regions is that they are due to episodes of crustal rifting that are believed to have occurred at some time in their geologic history. These episodes would bring dense mafic material into the upper crust. The Arabian Shield, by contrast, appears to have evolved by a series of island arc collisions, a process that tends to bury the denser, higher-velocity crust below 20 km depth. We note in passing that the regions provide an interesting series of examples of stages of continental rifting. The Lake Superior sections (fig. 53) may represent an ancient failed continental rift that did not reach the surface. The Mississippi embayment is still seismically active (Nuttli, 1973), and the Snake River Plain is volcanically active. Finally, the Red Sea represents a system in which rifting has continued to the formation of a paar (see pl. 9, shot points 5 to 6).

The Colorado Plateau (Roller, 1965) shares several characteristics with the Arabian Shield. The crustal thickness (40 km) and average upper and lower crustal velocities (6.2 and 6.8 km/s) are comparable; however, the upper crust of the Colorado Plateau is 5 km thicker than the 20-km average found in Saudi Arabia.

In terms of average crustal velocity structure, the Arabian Shield falls very near the mean for the shield and platform regions compared. Although the average structure is quite uniform, variations between shields, probably related to variations in age, average composition, and degree of metamorphism, are certainly apparent. Identifying these relationships will be a formidable, but potentially very fruitful, task.

Recommended further work

Refined interpretations of the seismic refraction data

The major objectives of the interpretation presented here were to assess the quality of the record sections, to provide a reasonably detailed starting model of the Arabian Shield and Red Sea shelf and coastal plain, and to identify parts of the data set worthy of intensive study. Although the data will continue to be analyzed for many purposes for many years, two subsequent investigations stand out as logical and obviously important: a detailed interpretation of the record sections from shot points 5 to 3, and crustal attenuation or "Q" studies.

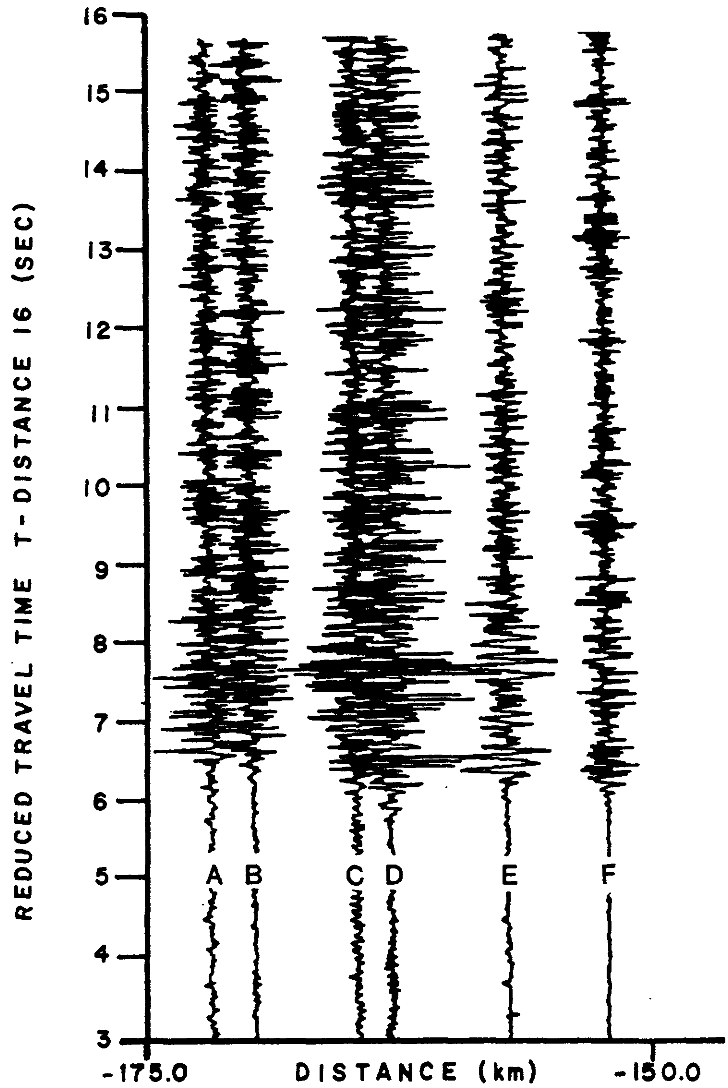
The record sections of plates 1 to 6 constitute one of the finest seismic refraction data sets recorded across a Precambrian shield available in the world today. Because of the relatively close recorder station spacing, the data will permit us to resolve much of the shield's upper crustal structure, and, when constrained by gravity, aeromagnetic, and geologic observations, will yield a three-dimensional crustal model of superior reliability. For the most part, completion of this work would be an office task, consisting of detailed quantitative interpretation of the seismic, gravity, and aeromagnetic data. However, a modest amount of field work at the recorder station points would allow derivation of the most information possible from the three geophysical data sets. (Gettings and Showail [1982] have previously reported the geology and some physical properties of the shot points.)

Interpretation of the refraction data should utilize various filtering, synthetic seismogram, and ray-tracing methods. In order to maximally constrain the models, a team of three geophysicists should be used: a seismologist, and gravity and aeromagnetic specialists; a geologist experienced in the geology of the Arabian Shield should supplement this team at least part time.

The field work would consist of geophysical sampling at the stations for density and magnetic susceptibility, possibly physical sampling for sonic-velocity laboratory determinations, and in-situ measurements of surface velocities to determine the weathered zone correction to be applied to the seismic refraction data. The field work would require about three man-months of a professional geophysicist's time and only modest field support. The USGS Saudi Arabian Mission in Jiddah would perform laboratory physical property determinations. The field phase should be completed soon since the recorder sites become more difficult to relocate as time goes on.

A thorough study of the seismic attenuation properties (Q) of the upper crustal rocks of the shield will also require completion of the additional field work because laboratory measurements of their physical properties are needed. The effect of various lithologies on the frequency content of the recorded seismogram is an important aspect of seismic wave propagation. This attenuation property, referred to as the seismic quality, or Q factor, is inversely proportional to attenuation. Thus, a rock with low Q (e.g., poorly consolidated sediments) attenuates seismic waves much more strongly than high Q rocks (e.g., typical crystalline basement). The attenuation affects high frequencies more strongly than low frequencies because they have more cycles per unit distance. Whereas the seismic velocity of crustal rocks ranges from about 2.0 to 7.0 km/s, the Q of these rocks varies from about 50 to 750. We have discussed variations in seismic traveltimes away from the predicted times extensively in this report, but have referred to variations in frequency content of the recorded seismograms only in a few instances. However, even a casual examination of the record sections (pls. 1-6) shows numerous examples of these frequency variations, both from trace to trace and as a function of time through the trace. Because of the large range of Q for rocks (50 to 750), we believe that Q can provide some information about the distribution of lithologies in the subsurface that cannot be obtained from traveltime information. For example, we obtained records along a profile through a greenstone body surrounded by quartz monzonite and gneiss on profile 4 southwest (fig. 54). The dominant frequency seen at site E is visibly lower ($\sim$ 6 Hz) than that at the other sites ($\sim$ 12 Hz). Careful calculation of the attenuating effect of the greenstone body may identify its subsurface extent with an accuracy that is not possible based on traveltime data.

As a final comment on the utility of Q studies, we note that identifying the Q of rocks may be particularly important to mineral exploration efforts. Since the hydrothermal activity associated with mineralization alters the host rock, we can expect that mineralized rocks will in many cases have a different



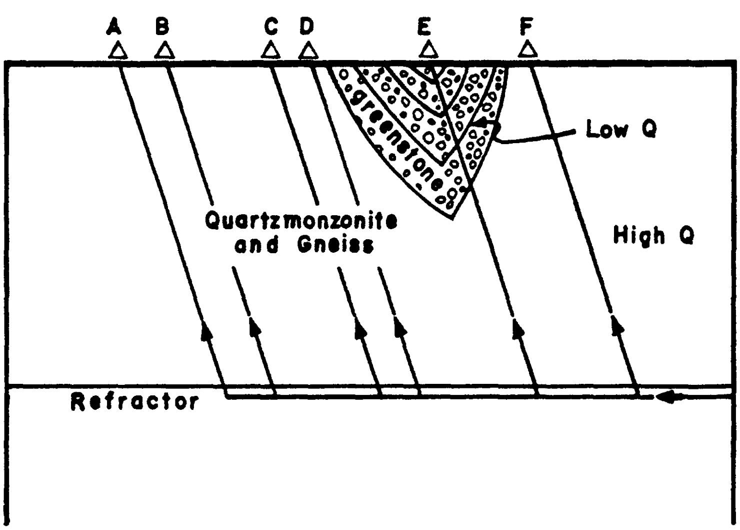


Figure 54.--Diagram illustrating the effect of lithologic variations on seismic quality factor Q. Paths to sites A, B, C, D, and F traverse only high Q quartz monzonite and gneiss while the path to site E traverses a low Q greenstone body. The seismogram at site E is noticeably lower in dominant frequency than the other seismograms.

Q than unmineralized rocks. A careful study of the seismic quality factor (Q) and its correlation to local geology along the refraction profile would be an important step toward using seismic refraction data to delineate metalliferous deposits in the shield.

Additional seismic refraction field work

Completion of the Trans-Arabian seismic refraction profile. Ultimately, the seismic refraction profile should be extended to the Arabian Gulf to provide a complete crustal structure section for the Arabian Plate. This should be carried out in close cooperation with the Arabian American Oil Company (ARAMCO) so that the best link with their seismic data can be selected. Depth and structure of crystalline basement, structure in the Zagros foreland, and upper and lower crustal velocity structure would be the major objectives of this part of the profile.

Short normal profiles. The participants of the CCSS workshop (Mooney, 1980) unanimously concluded that, to resolve ambiguities in the refraction line data in zones of great lateral inhomogeneity, short refraction profiles parallel to the strike of the shield boundary should be recorded (perpendicular to the existing refraction profile). Accordingly, profiles to improve structural resolution should be recorded along the Precambrian shield margin on the Tihamat-Asir (coastal plain) and at selected sites in the shield, e.g., at the Khamis Mushayt gneiss, the Nabitah zone, and the Al Amar-Idsas zone.

SUMMARY AND CONCLUSIONS

Using an advanced seismic recorder and digital data-processing system, we have recorded a detailed seismic deep-refraction section across the major structures of the southern Arabian Precambrian shield and well onto the Red Sea shelf. These data have yielded a set of true-amplitude and normalized record sections with reduction velocities of 8 and 6 km/s, respectively; the record sections of the entire data set are of sufficiently high quality and appropriate scale for further, detailed analysis. Moreover, all of the usable seismograms are available on computer-compatible digital magnetic tape, which can be reprocessed and plotted for special-purpose studies.

We have used two-dimensional ray-tracing methods to interpret the record sections, deriving simple layered models that delineate the major first- and second-order seismic features of the portions of the Arabian Shield, Arabian Platform, and Red Sea shelf and coastal plain sampled by the profile. Comparison of these seismically-defined features with surface geology and other geophysical data yields good correlation and a consistent model of the major features of the crust.

We distinguish a crust of two layers for the Arabian Shield, each of approximately 20 km thickness. A major lateral crustal discontinuity in both the upper and lower crust intersects the profile about 25 km northeast of shot point 2. Crustal velocities generally increase across this boundary to the northeast by about 0.2 km/s. This boundary is substantially west of the Al Amar-Idsas fault, which is generally regarded as the best candidate for a suture zone between two Precambrian blocks (Schmidt and others, 1978); we infer that the actual crustal boundary is the seismically-defined one and that the Al Amar-Idsas zone may be one of a series of imbricate thrust faults that are the surface expression of the suture. The suture zone apparently extends from the Al Amar-Idsas fault almost to shot point 2. In any case, the seismic refraction data support the hypothesis that the two blocks of crust are quite different.

Another first-order lateral inhomogeneity occurs 5-10 km southwest of shot point 5, at the outcrop margin of the Precambrian shield where it abuts against Tertiary volcanics and volcaniclastic rocks. The thickness of the crust decreases abruptly across a zone that includes this boundary, from about 40 km beneath the shield to about 18 km beneath the coastal plain. The crust continues to thin to a thickness of about 8 km near shot point 6. No major velocity discontinuity occurs across this zone, so an upper crustal compositional change is not necessarily required; however, neither is it ruled out. In fact, after consideration of gravity, aeromagnetic, and surface geologic evidence, we interpret the crust of the Red Sea shelf and coastal plain to be oceanic in origin (Blank and others, unpub. data).

In the lower crust of the shield southwest of shot point 3, we distinguish a zone of average velocity about 6.7 km/s that extends from beneath the Nabitah fault zone southwest along the profile for about 200 km. This zone is bracketed by lower crust of average velocity about 7.0 km/s. If the models of crustal evolution of Schmidt and others (1978) are correct, the lower crustal block of 6.7 km/s material may represent the remnants of the upper part of a subducted plate.

We have identified a distinctive, high-velocity anomaly in the upper crust of the shield, about midway between shot points 4 and 5; it correlates well with the outcrop of high-grade gneisses and amphibolites of the Khamis Mushayt gneiss of Coleman (1973). The velocity anomaly, which is probably the seismic expression of this extensive gneiss dome or batholithic structure, apparently penetrates the entire upper crust. A similar, although less pronounced, velocity anomaly occurs between the Al Junaynah and Nabitah fault zones; it correlates with the Al Qarah gneiss dome of Schmidt and others (1978).

Upper crustal average velocities are higher to the west of the southwestern Najd fault zone than to the east; this probably reflects the more mafic average composition of the volcanic rocks west of the Nabitah fault zone. Two intracrustal reflectors that have been identified at depths of about 13 km beneath the Al Junaynah and southwestern Najd fault zones probably indicate the upper limits of extensive mafic intrusive activity within the zones.

We have mapped the basement surface beneath the sediments of the platform at the northeast end of the profile; it is faulted in a horst and graben pattern northeast of shot point 1 on extensions of fault zones mapped at the surface. Offsets due to faulting are of the order of 1000 m, and maximum sediment thickness obtained was about 1.75 km.

Velocities beneath the Mohorovicic discontinuity in our interpretation are about 8.0 km/s southwest of shot point 3, 8.1 km/s between shot points 3 and 2, and about 8.2 km/s northeast of shot point 2. M-discontinuity depths in our model decrease gradually from 43 km near shot point 1 to about 38 km between shot points 4 and 5. Finally, we distinguish two velocity discontinuities below the M-discontinuity, one at 59 km and one at 70 km depth.

Our crustal model can form the basis for refined interpretations of the seismic data, and also for future geophysical and geologic investigations. Refined analyses of the data should include filtering and synthetic seismogram techniques and consideration of attenuation properties. The data from the area of the gneiss domes (particularly the Khamis Mushayt gneiss) holds particular promise for upper crustal structural studies. A three-month field program to sample rocks and measure surface seismic velocities at the recorder sites should be completed so that weathering corrections can be applied to the record sections. These will allow the most meaningful interpretations of lithology to be made from the data.

Future seismic refraction field work should include extension of the profile to the Arabian Gulf in cooperation with the Arabian American Oil Company, and some short profiles perpendicular to the existing refraction profile, one along the Tihamat-Asir, and several at selected targets in the shield.

REFERENCES CITED

Abdel-Gawad, M., 1970, Interpretation of satellite photographs of the Red Sea and Gulf of Aden: Philosophical Transactions of the Royal Society of London,, Ser. A, v. 264, p. 23-50.

Aldrich, L. T., 1978, Geochronologic data for the Arabian Shield, section 1. Radiometric age determinations of some rocks from the Arabian Shield: U.S. Geological Survey Open-File Report 78-75, (IR)SA-240, 22 p.

Andreasen, G. E., Petty, A. J., and Blank, H. R., 1980, Total-intensity aeromagnetic map of the Precambrian Arabian Shield, Kingdom of Saudi Arabia: Saudi Arabian Directorate General of Mineral Resources special edition for the 26th Internation Geological Congress, Paris, 1980, scale 1:2,000,000.

Anonymous, 1976, USGS/DGMR Geophysical Investigations in Saudi Arabia: Seismic refraction profile - status report no. 1: U.S. Geological Survey Mission, internal report, 19 p., 6 figs.

Baker, B. H., Mohr, P. A., and Williams, L. A. J., 1972, Geology of the eastern rift system of Africa: Geological Society of America, Special Paper 136, 67 p.

Barberi, F. and Varet J., 1977, Volcanism of Afar, small-scale plate tectonics implications: Geological Society of America Bulletin, v. 88, no. 9, p. 1251-1266.

Bartov, Y., Steinitz, G., Eyal, M., and Eyal, Y., 1980, Sinistral movement along the Gulf of Aqaba - its age and relation to the opening of the Red Sea: Nature, v. 835, p. 220-225.

Baubron, J. C., Delfour, J., and Vialette, Y., 1976, Geochronological measurements (Rb/Sr; K/Ar) on rocks of Saudi Arabia: Bureau de Recherches Géologiques et Minières Open-File Report 76-JES-22, 152 p.

Berry, M. J. and Fuchs, K., 1973, Crustal structure of the Superior and Grenville provinces of the northeastern Canadian Shield: Bulletin of the Seismological Society of America, v. 63, no. 4, p. 1393-1432.

Blank, H. R., 1977, Aeromagnetic and geologic study of Tertiary dikes and related structures of the Arabian margin of the Red Sea: Red Sea Research 1970-1975, Bulletin No. 22, prepared by the Ministry of Petroleum and Mineral Resources Directorate General of Mineral Resources, Jiddah, Saudi Arabia, G1-G18.

Blank, H. R., Healy, J. H., Roller, J. C., Lamson, R. J., Fisher, F., McClearn, R., and Allen, S., 1979, Seismic refraction profile, Kingdom of Saudi Arabia--field operations, instrumentation and initial results: U.S. Geological Survey Open-File Report 79-1568, (IR)SA-259, 52 p.

Blank, H. R., Gettings, M. E., and Kellogg, K. S., 1981, Linear magnetic anomalies onshore and offshore in southwest Saudi Arabia (abs.): EOS, American Geophysical Union Transactions, v. 62, no. 17, p. 407.

Bramkamp, R. A. and Ramirez, L. F., 1958, Geologic map of the northern Tuwayq quadrangle, Kingdom of Saudi Arabia: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-207A, scale 1:500,000.

Brown, G. F., 1972, Tectonic map of the Arabian Peninsula: Saudi Arabian Directorate General of Mineral Resources Arabian Peninsula Map AP-2, scale 1:4,000,000.

Brown, G. F. and Jackson, R. O., 1960, The Arabian Shield: International Geological Congress. Proceedings, 21st, Copenhagen, 1960, sec. 9, p. 69-77.

Brown, G. F., 1970, Eastern margin of the Red Sea and the coastal structures in Saudi Arabia: Philosophical Transactions of the Royal Society of London, Ser. A, v. 267, p. 75-87.

Brown, G. F., Hedge, C., and Marvin, R., 1978, Geochronologic data for the Arabian Shield, section 2. Tabulation of Rb-Sr and k-Ar ages given by rocks of the Arabian Shield: U.S. Geological Survey Open-File Report 78-75, (IR)SA-240, 22 p.

Brown, G. F. and Jackson, R. O., 1978, An overview of the geology of western Arabia: King Abdulaziz University Institute of Applied Geology Symposium on the evolution and mineralization of the Arabian-Nubian Shield, Jiddah, February 1978, Bulletin 3, v. 1, p-3-10.

Burek, P. J., 1970, Tectonic effect of sea-floor spreading on the Arabian Shield: Geologisches Rundschau, v. 59, no. 2, p. 382-390.

Burek, P. J., 1972, Evidence for the rotation of the Danakil Alps and the presence of oceanic crust within the Danakil Depression (abs.): Abstracts of the Twenty-Fourth International Geological Congress, Montreal, Canada.

Červený, V., Molotkov, I. A., and Pšenčik, I., 1977, Ray method in seismology: Univerzita Karlova, Praha, 214 p.

Cochran, J. R., 1981, The Gulf of Aden: Structure and evolution of a young ocean basin and continental margin: Journal of Geophysical Research, v. 86, no. B1, p. 263-287.

Coleman, R. G., Brown, G. F., and Keith, T. E., 1972, Layered gabbros in southwest Saudi Arabia: U.S. Geological Survey Professional Paper 800-D, p. D143-D150.

Coleman, R. G., 1973, Reconnaissance geology of the Khaybar quadrangle, Kingdom of Saudi Arabia: Saudi Arabian Directorate General of Mineral Resources Map GM-4, scale 1:100,000.

Cooper, J. A., Stacey, J. S., Stoeser, D. B., and Fleck, R. J., 1979, An evaluation of the zircon method of isotopic dating in the southern Arabian craton, Kingdom of Saudi Arabia: U.S. Geological Survey Open-File Report 79-1187, (IR)SA-257, 32 p.

Delfour, J., 1979, Geologic map of the Halaban quadrangle, sheet 23G, Kingdom of Saudi Arabia: Arabian Directorate General of Mineral Resources Map GM-46A, scale 1:250,000.

Dodge, F. C. W. and Helaby, A. M., 1979, The Uyaijah ring structure, Kingdom of Saudi Arabia: U.S. Geological Survey Professional Paper 774-E, 17 p.

Drake, C. L. and Girdler, R. W., 1964, A geophysical study of the Red Sea: Geophysical Journal of the Royal Astronomical Society, v. 8, p. 473-495.

Eaton, J. P., O'Neill, M. E., and Murdock, J. N., 1970, Aftershocks of the 1966 Parkfield-Cholame, California, earthquake: A detailed study: Bulletin of the Seismological Society of America, v. 60, p. 1151-1197.

Fitch, F. H., 1978, Informal lithostratigraphic lexicon for the Arabian Shield, Kingdom of Saudi Arabia: Directorate General of Mineral Resources technical record TR-1978-1, 158 p.

Fleck, R. J., Coleman, R. G., Cornwall, H. R., Greenwood, W. R., Hadley, D. G., Prinz, W. C., Ratte, J. C., and Schmidt, D. L., 1976, Potassium-argon geochronology of the Arabian Shield, Kingdom of Saudi Arabia: Bulletin of the Geological Society of America, v. 87, p. 9-21.

Fleck, R. J., 1980, Rubidium-strontium geochronology and plate tectonic evolution of the southern part of the Arabian Shield: U.S. Geological Survey Professional Paper 1131.

Freund, R., Zak, I., and Garfunkel, Z., 1968, Age and rate of the sinistral movement along the Dead Sea rift: Nature, v. 220, p. 253-255.

Freund, R., Garfunkel, Z., Zak, I., Goldberg, M., Weissbrod, T., and Derin, B., 1970, The shear along the Dead Sea Rift: Philosophical Transactions of the Royal Society of London, Ser. A, v. 267, p. 107-130.

Gettings, M. E., 1977, Delineation of the continental margin in the southern Red Sea region from new gravity evidence: Red Sea Research 1970-1975, Bulletin No. 22-K, prepared by the Ministry of Petroleum and Mineral Resources Directorate General of Mineral Resources, Jiddah, Saudi Arabia, K1-K11.

Gettings, M. E., 1981, Status of regional gravity project, Kingdom of Saudi Arabia as of 1 January 1979: U.S. Geological Survey Open-File Report 81-165, 26 p.

Gettings, M. E., 1982, Heat-flow measurements at shot points along the 1978 Saudi Arabian seismic deep-refraction line, Part 2: Discussion and interpretation: U.S. Geological Survey Open-File Report 82-794, (IR)SA-443.

Gettings, M. E. and Showail, Abdullah, 1982, Heat-flow measurements at shot points along the 1978 Saudi Arabian seismic deep-refraction line, Part 1: Results of the measurements: U.S. Geological Survey Open-File Report 82-794, (IR)SA-444.

Gettings, M. E., 1981, A heat flow profile across the Arabian Shield and Red Sea (abs.): EOS, American Geophysical Union Transactions, v. 62, no. 17, p. 407.

Ghent, E. D., Coleman, R. G., and Hadley, D. G., 1980, Ultramafic inclusions and host alkalai olivine basalts of the southern coastal plain of the Red Sea, Saudi Arabia: American Journal of Science, v. 280A, p. 499-527.

Gillmann, M., 1968, Primary results of a geological and geophysical reconnaissance of the Jizan coastal plain in Saudi Arabia: Society of Petroleum Engineers AIME, Saudi Arabia Section, Second Regional Technical Symposium, Dhahran, Saudi Arabia, March 27-29, p. 189-212.

Girdler, R. W., 1969, The Red Sea--a geophysical background: in Degens, E. T. and Ross, D. A., eds., Hot brines and recent heavy metal deposits in the Red Sea, New York, Springer-Verlag, New York, Inc., p. 38-58.

Girdler, R. W., 1970, A review of Red Sea heat flow: Philosophical Transactions of the Royal Society of London, v. 267A, no. 1181, p. 191-204.

Girdler, R. W. and Darracott, B. W., 1972, African poles of rotation: Comments on Earth-Sciences Geophysics, v. 2, p. 131-138.

Girdler, R. W. and Styles, P., 1974, Two stage Red Sea floor spreading: Nature, v. 274, p. 7-11.

Girdler, R. W. and Styles, P., 1975, The relevance of magnetic anomalies over the southern Red Sea between continental and oceanic rifting: in Pilger, A. and Roesler, A., eds., Afar depression of Ethiopia, Symposium of the Afar Region of Ethiopia and Related Rift Problems, Proceedings, v. II, Nagele U. Obermiller, Stuttgart.

Girdler, R. W. and Styles, P., 1976, The relevance of magnetic anomalies over the southern Red Sea and Gulf of Aden to Afar: in Pilger, A. and Roesler, A., eds., Afar depression of Ethiopia, Symposium of the Afar Region of Ethiopia and Related Rift Problems, Proceedings, v. I, Stuttgart, E. Schweizerbart'sche Verlogsbachhandlung (Naegele U. Obermiller), p. 156-170.

Girdler, R. W. and Evans, T. R., 1977, Red Sea heat flow: Geophysical Journal of the Royal Astronomical Society, v. 51, p. 245-251.

Girdler, R. W., Brown, C., Noy, D. J., and Styles, P., 1980, A geophysical survey of the westernmost Gulf of Aden: Philosophical Transactions of the Royal Society of London, Ser. A, v. 298, p. 1-43.

Greenwood, W. R. and Anderson, R. E., 1977, Palinspastic map of the Red Sea area prior to Miocene sea floor spreading: Red Sea Research 1970-1975, Bulletin No. 22, prepared by the Ministry of Petroleum and Mineral Resources, Directorate General of Mineral Resources, Jiddah, Saudi Arabia, Q1-Q6.

Greenwood, W. R., Anderson, R. E., Fleck, R. J., and Roberts, R. J., 1980, Precambrian geologic history and plate tectonic evolution of the Arabian Saudi Arabian Directorate General of Mineral Resources Bulletin 24, 35 p.

Grønlie, G., Heier, K. S., and Swanberg, C. A., 1977, Terrestrial heat-flow determinations from Norway: Norsk Geologisk Tidsskrift, v. 57, p. 153-162.

Hadley, D. G. and Schmidt, D. L., 1979, Proterozoic sedimentary rocks and basins of the Arabian Shield and their evolution: U.S. Geological Survey Open-File Report 79-1189, (IR)SA-242.

Hall, D. H. and Hajnal, Z., 1973, Deep seismic crustal studies in Manitoba: Bulletin of the Seismological Society of America, v. 63, p. 885-910.

Hall, S. A., Andreasen, G. E., and Girdler, R. W., 1977, Total-intensity magnetic anomaly map of the Red Sea and adjacent coastal areas: a description and preliminary interpretation: Saudi Arabian Directorate General of Mineral Resources Bulletin 22, p. F1-F15.

Hall, S. A., 1980, A total intensity magnetic anomaly map of the Red Sea and its interpretation: U.S. Geological Survey U.S. Geological Survey Open-File Report 80-131, (IR)SA-275.

Heybroek, F., 1965, The Red Sea Miocene evaporite basin: in Salt Basins around Africa, Institute of Petroleum, London, Elsevier, Amsterdam, p. 17-40.

Hill, M. N., 1957, Recent geophysical exploration of the ocean floor: Progr. Phys. Chem. Earth, v. 2, p. 129-163.

Hill, D. P. and Pakiser, L. C., 1966, Crustal structure between the Nevada test site and Boise, Idaho, from seismic-refraction measurements: in Steinhart, J. S. and Smith, T. J., eds., The Earth beneath the Continents, American Geophysical Union monograph 10, p. 391-419.

Jackson, R. O., Bogue, R. G., Brown, G. F., and Gierhart, R. D., 1963, Geologic map of the southern Najd quadrangle, Kingdom of Saudi Arabia: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-211A, scale 1:500,000.

Kellogg, K. S. and Blank, H. R., 1982, Paleomagnetic evidence bearing on Tertiary tectonics of the Tihamat Asir, southwestern Saudi Arabia: U.S. Geological Survey Open-File Report 82-1047, (IR)SA-469.

Knopoff, L. and Fouda, A. A., 1975, Upper-mantle structure under the Arabian Peninsula: Tectonophysics, v. 26, no. 1-2, p. 121-134.

Knott, S. T., Bunce, E. T., and Chase, R. L., 1966, Red Sea seismic reflection studies: Canada Geological Survey Paper 66-14, p. 33-61.

Kohler, W. M., Lamson, R. J., and Healy, J. H, 1979, A study of P-wave attenuation in the Arabian shield using spectral ratios (abs.): EOS, American Geophysical Union Transactions, v. 60, no. 46, p. 881.

Kosminskaya, I. P., Belyaevsky, N. A., and Volvovsky, I. S., 1969, Explosion seismology in the USSR: in Hart, P. J., ed., The Earth's Crust and Upper Mantle, American Geophysical Union monograph 13, p. 195-208.

Lachenbruch, A. H., 1970, Crustal temperature and heat flow production: implications of the linear heat flow relation: Journal of Geophysical Research, v. 75, no. 17, p. 3291-3300.

Lamson, R. J. and Blank H. R., 1978, USGS/DGMR Geophysical Investigations in Saudi Arabia: seismic refraction profile, status report no. 2, with a section on operational strategy by J. H. Healy: U.S. Geological Survey Open-File Report 78-772, (IR)SA-234, 83 p.

Lamson, R. J., Blank H. R., Mooney W., and Healy, J. H., 1979, Seismic refraction observations across the oceanic-continental rift zone, southwest Saudi Arabia (abs.): EOS, American Geophysical Union Transactions, v. 60, no. 46, p. 954.

Lamson, R. J. and Leone, L. E., 1979, Saudi Arabian seismic refraction profile data set: U.S. Geological Survey Open-File Report 79-1601, (IR)SA-298.

Laughton, A. S., 1966, The Gulf of Aden, in relation to the Red Sea and the Afar depression of Ethiopia: in Irvine, T. N., ed., The world rift system, Canada Geological Survey Paper 66-14, p. 78-97.

Laughton, A. S., Whitmarsh, R. B., and Jones, M. T., 1970, The evolution of the Gulf of Aden: Philosophical Transactions of the Royal Society of London, Ser. A, v. 267, p. 227-266.

Laughton, A. S., 1970, A new bathymetric chart of the Red Sea: Philosophical Transactions of the Royal Society of London, Ser. A, v. 267, p. 21-22.

Le Pichon, X. and Heirtzler, J. R., 1968, Magnetic anomalies in the Indian Ocean and sea-floor spreading continents: Journal of Geophysical Research, v. 73, no. 6, p. 2101-2117.

Le Pichon, X., Francheteau, J., and Bonnin, J., 1973, Plate Tectonics, Elsevier, Amsterdam, 311 p.

Le Pichon, X. and Francheteau, J., 1978, A plate-tectonic analysis of the Red Sea-Gulf of Aden area: Tectonophysics, v. 45, no. 3-4, p. 369-405.

Lowell, J. D. and Genik, G. J., 1972, Sea floor spreading and structural evolution of the southern Red Sea: American Association Petroleum Geologists Bulletin, v. 56, p. 247-259.

McCamy, K. and Meyer, R. P., 1966, Crustal results of fixed multiple shots in the Mississippi embayment: in Steinhart, J. S. and Smith, T. J., eds., The Earth beneath the Continents, American Geophysical Union monograph 10, p. 370-381.

McKenzie, D. P., Davies, D., and Molnar, P., 1970, Plate tectonics of the Red Sea and East Africa: Nature, v. 226, p. 243-248.

Merghelani, H. M. and Gallanthine, S. K., 1980, Microearthquakes in the Tihamat-Asir region of Saudi Arabia: Bulletin of the Seismological Society of America, v. 70, no. 6, p. 2291-2293.

Mohr, P. A., 1970, The Afar triple junction and sea-floor spreading: Journal of Geophysical Research, v. 75, no. 35, p. 7340-7351.

Mooney, W. D., 1980, IASPEI workshop--seismic modelling of laterally varying structures (Arabian Shield to the Red Sea): EOS, American Geophysical Union Transactions, v. 61, p. 19.

Mykkeltveit, S. 1980, A seismic profile in southern Norway: Pure and Applied Geophysics, v. 118, p. 1310-1324.

Nafe, J. E. and Drake, C. L., 1968, Physical properties of rocks of basaltic composition: in Basalts: The Poldervaart Treatise on Rocks of Basaltic Composition, Interscience Publishers, New York, p. 483-502.

Niazi, M., 1968, Crustal thickness in the Saudi Arabian Peninsula: Geophysical Journal of the Royal Astronomical Society, v. 15, no. 5, p. 545-547.

Noy, D. J., 1978, A comparison of magnetic anomalies in the Red Sea and the Gulf of Aden: in Ramberg, I.B. and Neumann, E.-R., eds., Tectonics and Geophysics of Continental Rifts, Reidel Publishing Company, p. 279-287.

Nuttli, O., 1973, The Mississippi Valley earthquakes of 1811 and 1812: intensities, ground motion and magnitudes: Bulletin of the Seismological Society of America, v. 63, no. 1, p. 227-248.

Phillips, J. O., 1970, Magnetic anomalies in the Red Sea: Philosophical Transactions of the Royal Society of London, Ser. A, v. 257, p. 205-217.

Phillips, J. D. and Ross, D. A., 1970, Continuous seismic reflection profiles in the Red Sea: Philosophical Transactions of the Royal Society of London, Ser. A, v. 257, p. 205-217.

Powers, R. W., Ramirez, L. F., Redmond, C. D., and Elberg, Jr., E. L., 1966, Geology of the Arabian Peninsula: sedimentary geology of Saudi Arabia: U.S. Geological Survey Professional Paper 560-D, 147 p.

Quennell, A. M., 1958, The structural and geomorphic evolution of the Dead Sea rift: Quarterly Journal of the Geological Society of London, v. 114, p. 1-24.

Raitt, R. W., 1963, The crustal rocks: in Hill, M. N., ed., The Sea, Interscience, New York, p. 85-101.

Ramsay, C. R., Jackson, N. J. and Roobol, M. J., 1979, Structural/lithologic provinces in a Saudi Arabian Shield geotraverse: in Evolution and Mineralization of the Arabian-Nubian Shield, v. I, I.A.G. Bulletin no. 3, King Abdulaziz University, Jiddah, Saudi Arabia, p. 64-84.

Roberts, D. G., 1969, Structural evolution of the rift zones in the Middle East: Nature, v. 223, p. 55-57.

Roeser, H. A., 1975, A detailed magnetic survey of the southern Red Sea: Geologisches Jahrbuch, Reihe D. No. 13, p. 131-153.

Roller, J. C., 1965, Crustal structure in the eastern Colorado plateaus province - seismic refraction measurement: Bulletin of the Seismological Society of America, v. 55, p. 107-120.

Ruegg, J. C., 1975, Main results about the crustal and upper mantle structures of the Djibouti Region (T.F.A.I.): in Pilger, A. and Roesler, A., eds., Afar depression of Ethiopia, Symposium of the Afar Region of Ethiopia and Related Rift Problems, Proceedings, v. I, Stuttgart, E. Schweizerbart'sche Verlogsbachhandlung (Naegele U. Obermiller), p. 120-134.

Schmidt, D. L., Hadley, D. G., Greenwood, W. R., Gonzalez, L., Coleman, R. G., and Brown, G. F., 1973, Stratigraphy and tectonism of the southern part of the Precambrian Shield of Saudi Arabia: Saudi Arabian Directorate General of Mineral Resources Bulletin 8, Jiddah, Saudi Arabia, 13 p.

Schmidt, D. L., Hadley, D. G., and Stoeser, D. B., 1978, Late Proterozoic crustal history of the Arabian Shield, southern Najd province, Kingdom of Saudi Arabia: King Abdulaziz University Institue of Applied Geology Symposium on the Evolution and Mineralization of the Arabian-Nubian shield, Jiddah, February 1978, Bulletin 3, v. 2, p. 41-58.

Smith, J. T., Steinhart, J. S., and Aldrich, L. T., 1966, Crustal structure under Lake Superior: in Steinhart, J. S. and Smith, T. J., eds., The Earth beneath the Continents, American Geophysical Union monograph 10, p. 181-197.

Sollogub, V. B., 1969, Seismic crustal studies in southeastern Europe: in Hart, P. J., ed., The Earth's Crust and Upper Mantle, American Geophysical Union monograph 13, p. 189-195.

Stacey, J. S., Delevaux, M. H., Gramlich, J. W., Doe, B. R., and Roberts R. J., 1981, A lead-isotope study of mineralization in the Arabian Shield: U.S. Geological Survey Open-File Report 81-193, (IR)SA-347.

Steinhart, J. S. and R. P. Meyer, 1961, Explosion studies of continental structure: Carnegie Institute of Washington Publication 622, 409 p.

Stoeser, D. B. and Elliott, J. E., 1979, Post-orogenic peralkaline and calc-alkaline granites and associated mineralization of the Arabian Shield, Kingdom of Saudi Arabia: U.S. Geological Survey Open-File Report 79-1323, (IR)SA-265.

Streckeisen, A. L. (chairman), 1973, Plutonic rocks, classification and nomenclature recommended by the IUGS Subcommission on systematics of igneous rocks: Geotimes, v. 18, no. 10, p. 26-30.

Tazieff, H. and Varet, J., 1969, Signification tectonique et magmatique de l'Afar septentrional (Ethiopie): Revue de Geographic Physique et de Geologie Dynamique, v. 11, Ser. 4, p. 429-450.

Tramontini, C. and Davies, D., 1969, A seismic refraction survey in the Red Sea: Geophysical Journal of the Royal Astronomical Society, v. 17, p. 225-241.

U.S. Geological Survey-Arabian American Oil Company, 1963, Geologic map of the Arabian Peninsula: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-270A, scale 1:2,000,000.

Vincent, G., 1968, Geology and mineral resources of the Halaban-Sahbah region (sheet 118, Zone Z): Bureau de Recherche Géologiques et Minières Project Report 68-JED-1, 47 p.

Vine, R. J., 1966, Spreading of the ocean floor--new evidence: Science, v. 154, p. 1405-1415.

Wegener, A., 1915, Die entstehung der kontinente und ozeane: Vieweg und Sohn, Braunschweig.

APPENDIX 1. Index and format of the digital magnetic tape data set.

Hardware Specifications - Equipment used to make this tape

Computer system:	Digital Equipment PDP11/03
Operating system:	RT11 Version 4.0
Tape transport:	Kennedy Model 9700-3
Tape controller:	Western Peripherals Model TC150
Tape format:	9 track - 800 bpi

Character data is stored in ASCII.
File headers and data points are stored as 16 bit integers.
Tape device handler software written by ARGOS systems, Sunnyvale, CA., 1980.

Data Tape File Structure Description

Record length in 16 bit words		Contents
256		Description of tape contents (ASCII char)
4096		Description of tape format (ASCII char)
	End of file	
256		File header for trace number 1
4096		Trace number 1 data record (padded with zeros)
	End of file	
256		File header for trace number 2
4096		Trace number 2 data record (padded with zeros)
	End of file	
***		***
***		***
256		File header for trace number N
4096		Trace number N data record (padded with zeros)
	End of file	
	End of file	
	End of file	

Date Trace Header Description

Word	Contents
1	File number in tape
2	Experiment number
3	Shot number
4	Shot point location number
5	Shot location subnumber
6	Recorder site location number
7	Geology code
8	Year of first sample in file
9	Julian day of first sample in file
10	Hour of first sample in file
11	Minute of first sample in file
12	Second of first sample in file
13	Millisecond of first sample in file
14	Microsecond of first sample in file
15	Year of shot
16	Julian day of shot
17	Hour of shot
18	Minute of shot
19	Second of shot
20	Millisecond of shot
21	Microsecond of shot
22	Reduction velocity in tenths of a km/s
23	Reduced start time of trace in seconds
24	Sampling rate in hertz
25	Number of samples in trace
26	Shot latitude degrees
27	Shot latitude minutes
28	Shot latitude seconds
29	Shot latitude milliseconds
30	Shot longitude degrees
31	Shot longitude minutes
32	Shot longitude seconds
33	Shot longitude milliseconds
34	Shot elevation in feet
35	Recorder latitude degrees
36	Recorder latitude minutes
37	Recorder latitude seconds
38	Recorder latitude milliseconds
39	Recorder longitude degrees
40	Recorder longitude minutes
41	Recorder longitude seconds
42	Recorder longitude milliseconds
43	Recorder elevation in feet
44	Range in kilometers
45	Range in tenths of a meter
46	Azimuth in degrees
47	Azimuth in millidegrees
48	Shot size in pounds
49	Earthquake or shot code (1=Earthquake, 2=shot)
50	Recorder unit number
51	Channel number
52	Attenuation setting in db
53-149	Unused integer storage
150-256	ASCII characters

Tape Access Subroutines

Fortran code for these subroutines is stored in file TAPLIB.FOR. The routines call ARGOS Systems subroutines MTPINI and MTPIO. Array IDATA must be dimensional to 4352 and IFP must be dimensioned to 2 in the calling program.

Subroutine INITAP

INITAP initializes and rewinds a tape drive.

Calling sequence: CALL INITAP(IUNIT, IFP, IERR, ISTAT)

IUNIT - Tape unit number

IFP - File position marker (2 element array)

IERR - Error status returned here

ISTAT - Tape status word returned here

Subroutine REWIND

REWIND rewinds a tape drive.

Calling sequence: CALL REWIND(IUNIT, IFP, IERR, ISTAT)

Arguments are the same as for INITAP.

Program WHEAD

WHEAD writes header information into file 1 of a new tape. Text is read from a disk file named DLO: TPHEAD.DAT.

Calling sequence: RUN WHEAD

Subroutine GETAPE

GETAPE reads data from tape file N into array IDATA.

Calling sequence: CALL GETAPE(IUNIT, N, IFP, IERR, ISTAT)

IUNIT - Tape unit number

IDATA - Integer array to receive data

N - File number to read from tape

IFP - File position marker

IERR - Error status returned here

ISTAT - Tape status word returned here

Subroutine PUTAPE

PUTAPE writes data from array IDATA to tape file N.

Calling sequence: CALL PUTAPE(IUNIT, IDATA, N, IFP, IERR, ISTAT)

IDATA - Array containing data to transfer

N - file number to write to tape

Subroutine EOT

EOT writes an end of tape mark (2 EOFS) at tape position N. Then the tape is rewound.

Calling sequence: CALL EOT(IUNIT, N, IFP, IERR, ISTAT)

N - Tape position to write an end of tape mark

Subroutine TPOS

TPOS positions a tape at file N. No data input or output is done.

Calling sequence: CALL TPOS(IUNIT, N, IFP, IERR, ISTAT)

Subroutine FHEAD

FHEAD reads file 1 from tape (header file) and prints the content on the console terminal.

Calling sequence: CALL FHEAD(IUNIT, IDATA, IFP, IERR, ISTAT)

Subroutine DHEAD

DHEAD reads and prints file 1 from tape. Then it reads the header record from each data file and prints selected header parameters on the terminal.

Calling sequence: CALL DHEAD(IUNIT, IDATA, IFP, IERR, ISTAT)

Saudi Arabia - Shot Point 1   Tape 1 of 5

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
2	1	1	1	97	652	87	84	6643	10	-1	200	4001	1799	3	0
3	1	1	1	99	659	26	83	1407	12	-1	200	4001	1799	3	0
4	1	1	1	100	660	108	82	343	13	-1	200	4001	1799	3	0
5	1	1	1	103	668	65	78	1571	16	-1	200	4001	1799	2	18
6	1	1	1	104	673	115	77	3643	17	-1	200	4001	1799	3	0
7	1	1	1	105	678	28	76	1961	19	-1	200	4001	1799	3	0
8	1	1	1	106	681	143	75	4282	21	-1	200	4001	1799	3	0
9	1	1	1	107	686	33	74	7656	22	-1	200	4001	1799	2	18
10	1	1	1	108	682	79	73	9874	23	-1	200	4001	1799	3	0
11	1	1	1	109	681	24	72	6880	24	-1	200	4001	1799	2	18
12	1	1	1	110	679	10	71	3229	25	-1	200	4001	1799	3	0
13	1	1	1	111	683	90	69	7921	26	-1	200	4001	1799	3	0
14	1	1	1	112	681	34	68	1647	27	-1	200	4001	1799	3	0
15	1	1	1	114	671	66	64	7124	28	-1	200	4001	1799	2	18
16	1	1	1	116	665	3	60	8622	30	-1	200	4001	1799	2	18
17	1	1	1	117	663	105	59	2274	29	-1	200	4001	1799	3	0
18	1	1	1	118	670	132	58	434	31	-1	200	4001	1799	2	18
19	1	1	1	120	652	74	56	18	34	-1	200	4001	1799	2	18
20	1	1	1	121	648	64	55	1508	36	-1	200	4001	1799	2	18
21	1	1	1	122	639	101	53	3357	36	-1	200	4001	1799	2	18
22	1	1	1	123	678	52	51	4894	37	-1	200	4001	1799	2	18
23	1	1	1	125	686	137	48	7245	40	-1	200	4001	1799	2	18
24	1	1	1	199	749	38	44	5635	46	-1	200	4001	1799	2	18
25	1	1	1	200	732	44	44	1765	52	-1	200	4001	1799	2	18
26	1	1	1	203	773	23	43	7423	58	-1	200	4001	1799	2	18
27	1	1	1	208	689	49	35	1687	67	-1	200	4001	1799	2	18
28	1	1	1	209	684	58	32	8633	68	-1	200	4001	1799	2	18
29	1	1	1	210	682	122	30	7470	68	-1	200	4001	1799	2	18
30	1	1	1	213	687	77	25	4049	69	-1	200	4001	1799	2	18
31	1	1	1	214	690	89	23	7451	69	-1	200	4001	1799	2	18
32	1	1	1	215	687	96	21	5898	69	-1	200	4001	1799	2	18
33	1	1	1	216	686	133	19	8467	69	-1	200	4001	1799	2	18
34	1	1	1	217	695	107	17	1324	68	-1	200	4001	1799	1	36
35	1	1	1	218	706	110	14	4925	68	-1	200	4001	1799	1	36
36	1	1	1	220	722	119	11	9449	68	-1	200	4001	1799	1	42
37	1	1	1	221	731	121	9	5185	69	-1	200	4001	1799	1	48
38	1	1	1	222	747	103	7	3939	71	-1	200	4001	1799	1	48
39	1	1	1	223	721	19	6	2390	73	-1	200	4001	1799	1	56
40	1	1	1	224	714	30	4	4736	79	-1	200	4001	1799	1	62
41	1	1	1	225	707	31	2	7164	94	-1	200	4001	1799	1	68
42	1	1	1	226	699	39	2	308	115	-1	200	4001	1799	1	76
43	1	1	1	227	703	75	-2	-1143	169	-1	200	4001	1799	1	56
44	1	1	1	205	757	25	39	4074	64	-1	200	4001	1799	2	18
45	1	1	1	228	716	60	-3	-3475	195	-1	200	4001	1799	1	68
46	1	1	1	229	692	35	-6	-7091	216	-1	200	4001	1799	1	56
47	1	1	1	230	695	106	-8	-7281	220	-1	200	4001	1799	1	48
48	1	1	1	232	699	139	-12	-7737	226	-1	200	4001	1799	1	42
49	1	1	1	234	708	138	-16	-7809	230	-1	200	4001	1799	1	36
50	1	1	1	235	712	85	-18	-6630	231	-1	200	4001	1799	1	36
51	1	1	1	237	719	18	-22	-7042	233	-1	200	4001	1799	2	18
52	1	1	1	238	726	70	-24	-6212	233	-1	200	4001	1799	1	36
53	1	1	1	239	734	129	-26	-7093	233	-1	200	4001	1799	2	18
54	1	1	1	240	744	136	-28	-8210	233	-1	200	4001	1799	2	18
55	1	1	1	241	760	51	-30	-8123	233	-1	200	4001	1799	1	36
56	1	1	1	248	869	145	-51	-3201	234	-1	200	4001	1799	2	18
57	1	1	1	244	802	124	-36	-8690	233	-1	200	4001	1799	2	18
58	1	1	1	245	825	40	-39	-2041	234	-1	200	4001	1799	2	18
59	1	1	1	246	840	17	-45	-3208	235	-1	200	4001	1799	2	18
60	1	1	1	247	848	131	-48	-3995	234	-1	200	4001	1799	2	18
61	1	1	1	251	882	88	-55	-9587	234	-1	200	4001	1799	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
62	1	1	1	252	893	97	-58	-8392	234	-1	200	4001	1799	2	12
63	1	1	1	253	910	146	-61	-510	234	-1	200	4001	1799	2	18
64	1	1	1	255	926	118	-64	-9144	233	-1	200	4001	1799	3	6
65	1	1	1	257	949	76	-69	-2391	233	-1	200	4001	1799	2	18
66	1	1	1	258	950	56	-70	-4321	234	-1	200	4001	1799	2	18
67	1	1	1	260	920	72	-75	-3932	233	-1	200	4001	1799	2	18
68	1	1	1	262	932	63	-79	-7090	232	-1	200	4001	1799	3	0
69	1	1	1	263	926	12	-81	-3288	231	-1	200	4001	1799	3	0
70	1	1	1	264	901	14	-82	-8530	230	-1	200	4001	1799	2	18
71	1	1	1	266	889	36	-86	-5252	229	-1	200	4001	1799	2	18
72	1	3	1	268	884	115	-89	-6243	228	-1	200	4001	7518	2	18
73	1	3	1	270	884	3	-92	-7181	227	-1	200	4001	7518	2	18
74	1	3	1	271	888	143	-94	-8429	226	-1	200	4001	7518	2	18
75	1	3	1	272	891	34	-97	-273	226	-1	200	4001	7518	2	18
76	1	3	1	274	908	108	-102	-1843	226	-1	200	4001	7518	2	18
77	1	3	1	275	917	53	-104	-4848	227	-1	200	4001	7518	2	18
78	1	3	1	276	929	98	-106	-9874	227	-1	200	4001	7518	2	18
79	1	3	1	279	931	65	-111	-6773	227	-1	200	4001	7518	3	0
80	1	3	1	280	928	87	-112	-6000	226	-1	200	4001	7518	2	18
81	1	3	1	281	942	10	-113	-9793	227	-1	200	4001	7518	2	18
82	1	3	1	282	945	33	-115	-3166	227	-1	200	4001	7518	2	18
83	1	3	1	283	949	79	-116	-2746	227	-1	200	4001	7518	2	18
84	1	3	1	284	957	26	-117	-4195	227	-1	200	4001	7518	2	18
85	1	3	1	287	951	24	-122	-448	227	-1	200	4001	7518	2	18
86	1	3	1	300	886	142	-142	-6477	221	-1	200	4001	7518	2	18
87	1	3	1	290	934	78	-126	-1377	225	-1	200	4001	7518	2	18
88	1	3	1	291	932	92	-127	-5945	225	-1	200	4001	7518	2	18
89	1	3	1	292	943	62	-129	-3457	224	-1	200	4001	7518	2	18
90	1	3	1	293	946	52	-130	-9176	224	-1	200	4001	7518	2	18
91	1	3	1	294	949	64	-132	-7552	223	-1	200	4001	7518	2	18
92	1	3	1	295	953	44	-134	-1277	223	-1	200	4001	7518	2	18
93	1	3	1	296	931	55	-135	-9597	223	-1	200	4001	7518	2	18
94	1	3	1	297	908	38	-138	-842	222	-1	200	4001	7518	2	18
95	1	3	1	299	880	82	-141	-2208	221	-1	200	4001	7518	2	18
96	1	3	1	308	846	23	-155	-8883	220	-1	200	4001	7518	2	12
97	1	3	1	302	889	25	-145	-413	221	-1	200	4001	7518	2	18
98	1	3	1	304	878	74	-147	-3658	220	-1	200	4001	7518	2	18
99	1	3	1	305	878	137	-149	-5057	220	-1	200	4001	7518	2	18
100	1	3	1	307	885	45	-152	-734	220	-1	200	4001	7518	2	18
101	1	3	1	330	902	17	-200	-4768	220	-1	200	4001	7518	3	0
102	1	3	1	332	924	48	-203	-2836	221	-1	200	4001	7518	3	0
103	1	3	1	310	810	49	-159	-7555	221	-1	200	4001	7518	2	18
104	1	3	1	311	804	68	-161	-8340	221	-1	200	4001	7518	2	18
105	1	3	1	312	796	75	-163	-9102	221	-1	200	4001	7518	2	18
106	1	3	1	313	788	112	-165	-9427	221	-1	200	4001	7518	2	18
107	1	3	1	314	782	39	-167	-9232	221	-1	200	4001	7518	2	18
108	1	3	1	315	775	119	-169	-9640	221	-1	200	4001	7518	2	18
109	1	3	1	317	764	95	-174	-635	221	-1	200	4001	7518	3	0
110	1	3	1	316	768	30	-172	-489	221	-1	200	4001	7518	3	0
111	1	3	1	318	779	89	-175	-5627	221	-1	200	4001	7518	3	0
112	1	3	1	319	761	77	-177	-5963	221	-1	200	4001	7518	2	18
113	1	3	1	321	768	103	-181	-5883	221	-1	200	4001	7518	2	18
114	1	3	1	322	771	122	-183	-5664	221	-1	200	4001	7518	2	18
115	1	3	1	323	784	31	-185	-4151	221	-1	200	4001	7518	3	0
116	1	3	1	325	811	83	-189	-2813	220	-1	200	4001	7518	2	18
117	1	3	1	326	824	110	-190	-7470	220	-1	200	4001	7518	2	18
118	1	3	1	327	834	107	-192	-5861	220	-1	200	4001	7518	2	18
119	1	3	1	328	843	121	-194	-5518	220	-1	200	4001	7518	2	18
120	1	3	1	329	854	133	-196	-6502	220	-1	200	4001	7518	3	0
121	1	3	1	333	930	60	-204	-5719	221	-1	200	4001	7518	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
122	1	3	1	334	943	131	-206	-361	221	-1	200	4001	7518	3	0
123	1	3	1	335	962	70	-207	-9690	221	-1	200	4001	7518	3	0
124	1	3	1	336	979	100	-210	-7203	221	-1	200	4001	7518	3	0
125	1	3	1	337	972	136	-212	-5670	221	-1	200	4001	7518	3	0
126	1	3	1	338	966	18	-214	-9302	221	-1	200	4001	7518	3	0
127	1	3	1	339	957	106	-216	-3235	221	-1	200	4001	7518	3	0
128	1	3	1	340	949	124	-218	-4152	221	-1	200	4001	7518	3	0
129	1	3	1	341	935	138	-220	-6628	221	-1	200	4001	7518	3	0
130	1	3	1	342	941	40	-223	-469	222	-1	200	4001	7518	2	12
131	1	3	1	343	946	129	-224	-5619	222	-1	200	4001	7518	3	0
132	1	3	1	344	990	113	-227	-1647	222	-1	200	4001	7518	3	0
133	1	3	1	346	976	85	-230	-3359	222	-1	200	4001	7518	3	0
134	1	3	1	347	944	139	-233	-2615	222	-1	200	4001	7518	3	0
135	1	3	1	348	953	51	-235	-2709	222	-1	200	4001	7518	3	0
136	1	3	1	349	951	93	-236	-9421	222	-1	200	4001	7518	3	0
137	1	3	1	350	952	94	-239	-1391	221	-1	200	4001	7518	3	0
138	1	3	1	351	958	97	-240	-746	221	-1	200	4001	7518	3	0
139	1	3	1	352	955	88	-241	-3005	221	-1	200	4001	7518	3	0
140	1	3	1	353	951	14	-242	-7680	221	-1	200	4001	7518	3	0
141	1	3	1	354	967	76	-245	-5489	221	-1	200	4001	7518	3	0
142	1	3	1	355	979	104	-247	-6237	221	-1	200	4001	7518	3	0
143	1	3	1	357	957	63	-252	-2029	221	-1	200	4001	7518	3	0
144	1	3	1	358	962	71	-255	-4153	221	-1	200	4001	7518	3	0
145	1	3	1	359	961	56	-257	-158	221	-1	200	4001	7518	3	0
146	1	3	1	360	962	72	-258	-9455	221	-1	200	4001	7518	3	0
147	1	3	1	362	974	73	-262	-9230	222	-1	200	4001	7518	3	0
148	1	3	1	363	982	12	-264	-9438	221	-1	200	4001	7518	3	0
149	1	3	1	364	993	43	-266	-7932	222	-1	200	4001	7518	3	0
150	1	3	1	374	1007	145	-270	-3095	222	-1	200	4001	7518	3	0
151	1	3	1	376	1031	36	-274	-3248	222	-1	200	4001	7518	3	0
152	1	3	1	377	1074	146	-276	-5662	222	-1	200	4001	7518	3	0
153	1	5	1	378	1069	10	-278	-1113	221	-1	200	4001	9722	3	0
154	1	5	1	379	1063	79	-280	-4869	221	-1	200	4001	9722	3	0
155	1	5	1	380	1094	53	-282	-2433	221	-1	200	4001	9722	2	18
156	1	5	1	381	1053	34	-284	-9971	221	-1	200	4001	9722	3	0
157	1	5	1	384	1028	143	-290	-1874	221	-1	200	4001	9722	3	0
158	1	5	1	385	1021	26	-291	-2500	221	-1	200	4001	9722	3	0
159	1	5	1	386	1017	87	-292	-5731	221	-1	200	4001	9722	3	0
160	1	5	1	387	1008	66	-294	-3243	221	-1	200	4001	9722	3	0
161	1	5	1	388	998	24	-296	-3074	222	-1	200	4001	9722	3	0
162	1	5	1	389	995	33	-297	-9468	221	-1	200	4001	9722	3	0
163	1	5	1	390	993	3	-299	-7603	221	-1	200	4001	9722	3	0
164	1	5	1	392	996	98	-301	-6929	221	-1	200	4001	9722	3	0
165	1	5	1	393	983	108	-303	-2935	221	-1	200	4001	9722	3	0
166	1	5	1	394	979	90	-305	-3143	221	-1	200	4001	9722	3	0
167	1	5	1	395	983	65	-307	-1024	220	-1	200	4001	9722	3	0
168	1	5	1	396	980	28	-308	-8061	220	-1	200	4001	9722	3	0
169	1	5	1	397	974	128	-310	-6333	220	-1	200	4001	9722	3	0
170	1	5	1	398	974	44	-312	-4164	220	-1	200	4001	9722	3	0
171	1	5	1	409	955	52	-332	-3717	218	-1	200	4001	9722	3	0
172	1	5	1	411	948	64	-335	-1952	218	-1	200	4001	9722	3	0
173	1	5	1	412	950	45	-337	-2697	218	-1	200	4001	9722	3	0
174	1	5	1	413	936	82	-339	-4174	218	-1	200	4001	9722	3	0
175	1	5	1	414	938	62	-341	-1140	218	-1	200	4001	9722	3	0
176	1	5	1	415	928	137	-343	-1187	218	-1	200	4001	9722	3	0
177	1	5	1	416	925	38	-345	-1442	217	-1	200	4001	9722	3	0
178	1	5	1	417	931	92	-348	-1735	217	-1	200	4001	9722	3	0
179	1	5	1	418	922	30	-350	-6812	217	-1	200	4001	9722	3	0
180	1	5	1	420	911	49	-353	-1841	217	-1	200	4001	9722	3	0
181	1	5	1	421	908	122	-354	-4344	216	-1	200	4001	9722	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
182	1	5	1	422	907	121	-355	-5567	216	-1	200	4001	9722	3	0
183	1	5	1	424	896	133	-357	-1330	215	-1	200	4001	9722	3	0
184	1	5	1	426	902	89	-359	-4363	215	-1	200	4001	9722	3	0
185	1	5	1	427	904	112	-360	-8588	215	-1	200	4001	9722	3	0
186	1	5	1	428	897	77	-361	-9413	214	-1	200	4001	9722	3	0
187	1	5	1	429	889	19	-363	-5561	214	-1	200	4001	9722	3	0
188	1	5	1	430	882	31	-365	-4657	214	-1	200	4001	9722	3	0
189	1	5	1	431	876	58	-367	-1081	214	-1	200	4001	9722	3	0
190	1	5	1	432	872	68	-369	-3406	214	-1	200	4001	9722	3	0
191	1	5	1	433	866	103	-372	-617	214	-1	200	4001	9722	3	0
192	1	5	1	434	857	107	-373	-7309	214	-1	200	4001	9722	3	0
193	1	5	1	435	856	75	-374	-1915	214	-1	200	4001	9722	3	0
194	1	5	1	437	845	96	-378	-9992	214	-1	200	4001	9722	3	0
195	1	5	1	438	842	17	-382	-2166	214	-1	200	4001	9722	3	0
196	1	5	1	439	836	48	-383	-6611	214	-1	200	4001	9722	3	0
197	1	5	1	440	839	60	-386	-118	213	-1	200	4001	9722	3	0
198	1	5	1	441	827	100	-388	-7445	213	-1	200	4001	9722	3	0
199	1	5	1	442	830	131	-388	-9379	213	-1	200	4001	9722	3	0
200	1	5	1	443	829	70	-391	-4674	213	-1	200	4001	9722	3	0
201	1	5	1	446	836	136	-397	-7911	213	-1	200	4001	9722	3	0
202	1	5	1	970	840	40	-400	-2075	213	-1	200	4001	9722	3	0
203	1	5	1	448	847	129	-403	-3410	213	-1	200	4001	9722	3	0
204	1	5	1	449	855	18	-405	-6823	213	-1	200	4001	9722	3	0
205	1	5	1	451	856	139	-408	-9376	213	-1	200	4001	9722	3	0
206	1	5	1	452	858	124	-410	-9757	213	-1	200	4001	9722	3	0
207	1	5	1	454	862	113	-414	-6016	213	-1	200	4001	9722	3	0
208	1	5	1	972	872	85	-417	-9990	212	-1	200	4001	9722	3	0
209	1	5	1	456	871	51	-420	-1155	212	-1	200	4001	9722	3	0
210	1	5	1	971	863	138	-413	-1681	212	-1	200	4001	9722	3	0
211	1	5	1	459	889	63	-430	-3194	212	-1	200	4001	9722	3	0
212	1	5	1	460	891	72	-432	-756	213	-1	200	4001	9722	3	0
213	1	5	1	462	896	76	-435	-5046	213	-1	200	4001	9722	3	0
214	1	5	1	463	918	97	-437	-7896	213	-1	200	4001	9722	3	0
215	1	5	1	464	905	43	-439	-5280	213	-1	200	4001	9722	3	0
216	1	5	1	465	908	14	-441	-5066	213	-1	200	4001	9722	3	0
217	1	5	1	469	921	104	-448	-5709	213	-1	200	4001	9722	3	0
218	1	5	1	470	926	145	-450	-9609	213	-1	200	4001	9722	3	0
219	1	5	1	471	931	94	-453	-1076	213	-1	200	4001	9722	3	0
220	1	5	1	473	940	12	-457	-7357	213	-1	200	4001	9722	3	0
221	1	5	1	477	957	146	-466	-5736	212	-1	200	4001	9722	3	0
222	1	5	1	399	973	23	-313	-9651	220	-9	100	1001	9722	3	0
223	1	5	1	401	967	142	-318	-1536	219	-9	100	1001	9722	3	0
224	1	5	1	402	962	120	-319	-6069	219	-9	100	1001	9722	3	0
225	1	5	1	404	956	78	-323	-4262	219	-9	100	1001	9722	3	0
226	1	5	1	405	957	25	-325	-364	218	-9	100	1001	9722	3	0
227	1	5	1	407	967	101	-328	-4212	218	-9	100	1001	9722	3	0
228	1	5	1	408	956	132	-330	-5436	218	-9	100	1001	9722	3	0
229	1	11	1	478	958	115	-468	-9867	212	-1	200	4001	11023	3	0
230	1	11	1	479	966	87	-470	-7769	212	-1	200	4001	11023	3	0
231	1	11	1	480	973	125	-472	-8153	212	-1	200	4001	11023	3	0
232	1	11	1	481	981	66	-474	-7375	212	-1	200	4001	11023	3	0
233	1	11	1	482	992	24	-476	-6054	212	-1	200	4001	11023	3	0
234	1	11	1	483	994	28	-478	-7044	212	-1	200	4001	11023	3	0
235	1	11	1	484	993	34	-481	-982	212	-1	200	4001	11023	3	0
236	1	11	1	485	994	143	-482	-9005	212	-1	200	4001	11023	3	0
237	1	11	1	486	998	108	-485	-4111	212	-1	200	4001	11023	3	0
238	1	11	1	487	1015	98	-488	-7095	212	-1	200	4001	11023	3	0
239	1	11	1	488	1012	3	-490	-6384	212	-1	200	4001	11023	3	0
240	1	11	1	489	1022	79	-493	-3996	212	-1	200	4001	11023	3	0
241	1	11	1	490	1010	53	-495	-9428	212	-1	200	4001	11023	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
242	1	11	1	491	1011	65	-497	-8545	212	-1	200	4001	11023	3	0
243	1	11	1	492	1025	33	-499	-8742	212	-1	200	4001	11023	3	0
244	1	11	1	495	1043	128	-506	-1969	212	-1	200	4001	11023	3	0
245	1	11	1	497	1053	90	-510	-353	212	-1	200	4001	11023	3	0
246	1	11	1	501	1089	38	-519	-2302	212	-1	200	4001	11023	3	0
247	1	11	1	502	1097	92	-522	-2381	212	-1	200	4001	11023	3	0
248	1	11	1	503	1114	142	-524	-9790	212	-1	200	4001	11023	3	0
249	1	11	1	504	1095	23	-527	-8422	212	-1	200	4001	11023	3	0
250	1	11	1	505	1096	105	-530	-6906	212	-1	200	4001	11023	3	0
251	1	11	1	506	1090	120	-532	-6282	212	-1	200	4001	11023	3	0
252	1	11	1	507	1098	137	-534	-6064	212	-1	200	4001	11023	3	0
253	1	11	1	508	1096	64	-536	-4042	212	-1	200	4001	11023	3	0
254	1	11	1	509	1115	82	-538	-7083	212	-1	200	4001	11023	3	0
255	1	11	1	510	1119	25	-540	-8157	212	-1	200	4001	11023	3	0
256	1	11	1	512	1120	101	-544	-4465	212	-1	200	4001	11023	3	0
257	1	11	1	514	1134	132	-548	-3309	213	-1	200	4001	11023	3	0
258	1	11	1	515	1137	74	-550	-1163	213	-1	200	4001	11023	3	0
259	1	11	1	516	1138	32	-551	-5942	213	-1	200	4001	11023	3	0
260	1	11	1	518	1152	110	-558	-5404	212	-1	200	4001	11023	3	0
261	1	11	1	519	1181	122	-560	-9835	212	-1	200	4001	11023	3	0
262	1	11	1	520	1170	133	-562	-7057	212	-1	200	4001	11023	3	0
263	1	11	1	521	1170	119	-564	-2804	212	-1	200	4001	11023	3	0
264	1	11	1	522	1186	96	-565	-9382	212	-1	200	4001	11023	3	0
265	1	11	1	523	1196	30	-567	-9559	212	-1	200	4001	11023	3	0
266	1	11	1	524	1216	107	-569	-5410	212	-1	200	4001	11023	3	0
267	1	11	1	526	1230	89	-572	-3062	212	-1	200	4001	11023	3	0
268	1	11	1	527	1238	39	-574	-1054	211	-1	200	4001	11023	3	0
269	1	11	1	528	1241	121	-575	-9964	211	-1	200	4001	11023	3	0
270	1	11	1	530	1252	68	-580	-216	211	-1	200	4001	11023	3	0
271	1	11	1	531	1260	83	-581	-6870	211	-1	200	4001	11023	3	0
272	1	11	1	532	1263	31	-583	-7329	211	-1	200	4001	11023	3	0
273	1	11	1	533	1249	49	-585	-5986	211	-1	200	4001	11023	3	0
274	1	11	1	537	1306	19	-594	-5859	210	-1	200	4001	11023	3	0
275	1	11	1	539	1331	60	-597	-5623	210	-1	200	4001	11023	3	0
276	1	11	1	541	1366	106	-599	-9552	210	-1	200	4001	11023	3	0
277	1	11	1	544	1393	131	-603	-3873	210	-1	200	4001	11023	3	0
278	1	11	1	545	1411	136	-603	-3896	210	-1	200	4001	11023	3	0
279	1	11	1	548	1423	113	-605	-8773	210	-1	200	4001	11023	3	0
280	1	11	1	549	1434	51	-606	-3406	209	-1	200	4001	11023	3	0
281	1	11	1	550	1443	129	-608	-54	209	-1	200	4001	11023	3	0
282	1	11	1	551	1470	139	-609	-4775	209	-1	200	4001	11023	3	0
283	1	11	1	552	1483	124	-611	-2091	209	-1	200	4001	11023	3	0
284	1	11	1	553	1514	35	-613	-4345	209	-1	200	4001	11023	3	0
285	1	11	1	555	1561	100	-616	-574	209	-1	200	4001	11023	3	0
286	1	11	1	556	1563	40	-617	-3144	209	-1	200	4001	11023	3	0
287	1	11	1	557	1587	18	-619	-1902	209	-1	200	4001	11023	3	0
288	1	11	1	558	1574	97	-619	-7808	209	-1	200	4001	11023	3	0
289	1	11	1	559	1583	56	-621	-9042	209	-1	200	4001	11023	3	0
290	1	11	1	563	1559	71	-629	-7131	208	-1	200	4001	11023	3	0
291	1	11	1	565	1546	14	-633	-264	208	-1	200	4001	11023	3	0
292	1	11	1	566	1567	63	-633	-8150	207	-1	200	4001	11023	3	0
293	1	11	1	567	1594	73	-636	-4692	207	-1	200	4001	11023	3	0
294	1	11	1	568	1625	104	-639	-246	207	-1	200	4001	11023	3	0
295	1	11	1	569	1641	146	-640	-7574	207	-1	200	4001	11023	3	0
296	1	11	1	570	1689	94	-642	-5488	207	-1	200	4001	11023	3	0
297	1	11	1	572	1636	99	-644	-6506	207	-1	200	4001	11023	3	0
298	1	11	1	576	1703	12	-653	-5655	207	-1	200	4001	11023	3	0
299	1	11	1	577	1698	69	-654	-6821	206	-1	200	4001	11023	3	0

Saudi Arabia - Shot Point 2   Tape 2 of 5

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE	AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
2	1	2	2	97	652	87	220 4694	29	-1	200	4001	2910	3	0
3	1	2	2	98	655	53	220 4846	29	-1	200	4001	2910	3	0
4	1	2	2	99	659	26	220 838	30	-1	200	4001	2910	3	0
5	1	2	2	100	660	108	219 4543	30	-1	200	4001	2910	3	0
6	1	2	2	103	668	65	217 3611	32	-1	200	4001	2910	3	0
7	1	2	2	104	673	115	216 9677	32	-1	200	4001	2910	3	0
8	1	2	2	105	678	28	216 4441	33	-1	200	4001	2910	3	0
9	1	2	2	107	686	33	215 7203	34	-1	200	4001	2910	2	18
10	1	2	2	108	682	79	215 2746	34	-1	200	4001	2910	3	0
11	1	2	2	109	681	24	214 2478	35	-1	200	4001	2910	3	0
12	1	2	2	111	683	90	211 8909	36	-1	200	4001	2910	3	0
13	1	2	2	112	681	34	210 4027	36	-1	200	4001	2910	3	0
14	1	2	2	113	677	98	208 5988	36	-1	200	4001	2910	3	0
15	1	2	2	114	671	66	207 2073	36	-1	200	4001	2910	3	0
16	1	2	2	116	665	3	203 6245	37	-1	200	4001	2910	3	0
17	1	2	2	118	670	132	200 9594	38	-1	200	4001	2910	3	0
18	1	2	2	120	652	74	199 2303	38	-1	200	4001	2910	3	0
19	1	2	2	121	648	64	198 4936	39	-1	200	4001	2910	3	0
20	1	2	2	122	639	101	196 7001	39	-1	200	4001	2910	3	0
21	1	2	2	123	678	52	194 8843	39	-1	200	4001	2910	3	0
22	1	2	2	125	686	137	192 1775	40	-1	200	4001	2910	3	0
23	1	2	2	199	749	38	187 8122	42	-1	200	4001	2910	3	0
24	1	2	2	200	732	44	186 9007	43	-1	200	4001	2910	3	0
25	1	2	2	203	773	23	185 6454	44	-1	200	4001	2910	3	0
26	1	2	2	205	757	25	180 1897	45	-1	200	4001	2910	2	18
27	1	2	2	208	689	49	175 5421	45	-1	200	4001	2910	2	18
28	1	2	2	209	684	58	173 2076	45	-1	200	4001	2910	3	0
29	1	2	2	210	682	122	171 1615	45	-1	200	4001	2910	3	0
30	1	2	2	229	692	35	136 6805	40	-1	200	4001	2910	2	18
31	1	2	2	213	687	77	166 1231	45	-1	200	4001	2910	2	18
32	1	2	2	214	690	89	164 5566	44	-1	200	4001	2910	3	0
33	1	2	2	215	687	96	162 6674	44	-1	200	4001	2910	2	18
34	1	2	2	216	686	133	161 1008	44	-1	200	4001	2910	3	0
35	1	2	2	217	695	107	158 7192	43	-1	200	4001	2910	3	0
36	1	2	2	218	706	110	156 3919	43	-1	200	4001	2910	2	18
37	1	2	2	220	722	119	154 792	42	-1	200	4001	2910	3	0
38	1	2	2	221	731	121	151 8175	42	-1	200	4001	2910	2	18
39	1	2	2	222	747	103	149 7780	42	-1	200	4001	2910	2	18
40	1	2	2	223	721	19	148 6657	42	-1	200	4001	2910	2	18
41	1	2	2	224	714	30	146 9135	41	-1	200	4001	2910	2	18
42	1	2	2	225	707	31	145 172	41	-1	200	4001	2910	2	18
43	1	2	2	226	699	39	143 9115	41	-1	200	4001	2910	2	18
44	1	2	2	227	703	75	142 709	41	-1	200	4001	2910	2	18
45	1	2	2	230	695	106	134 6396	40	-1	200	4001	2910	2	18
46	1	2	2	232	699	139	130 6508	40	-1	200	4001	2910	2	18
47	1	2	2	238	726	70	119 4748	38	-1	200	4001	2910	2	18
48	1	2	2	234	708	138	126 8589	39	-1	200	4001	2910	2	18
49	1	2	2	235	712	85	125 1078	39	-1	200	4001	2910	2	18
50	1	2	2	236	717	113	123 2342	38	-1	200	4001	2910	2	18
51	1	2	2	237	719	18	121 3449	38	-1	200	4001	2910	2	18
52	1	2	2	239	734	129	117 4459	37	-1	200	4001	2910	2	18
53	1	2	2	240	744	136	115 4023	37	-1	200	4001	2910	2	18
54	1	2	2	241	760	51	113 4907	37	-1	200	4001	2910	1	36
55	1	2	2	244	802	124	107 7091	36	-1	200	4001	2910	2	18
56	1	2	2	245	825	40	105 6760	35	-1	200	4001	2910	2	18
57	1	2	2	246	840	17	100 1339	34	-1	200	4001	2910	3	0
58	1	2	2	247	848	131	96 9484	34	-1	200	4001	2910	2	18
59	1	2	2	248	869	145	94 2442	33	-1	200	4001	2910	2	18
60	1	2	2	251	882	88	89 8286	32	-1	200	4001	2910	2	18
61	1	2	2	252	893	97	87 1611	31	-1	200	4001	2910	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
62	1	2	2	253	910	146	85	2628	30	-1	200	4001	2910	2	18
63	1	2	2	255	926	118	81	4301	30	-1	200	4001	2910	2	18
64	1	2	2	257	949	76	77	3016	28	-1	200	4001	2910	2	18
65	1	2	2	258	950	56	76	4920	28	-1	200	4001	2910	2	18
66	1	2	2	260	920	72	71	3536	27	-1	200	4001	2910	2	18
67	1	2	2	261	920	71	69	1321	27	-1	200	4001	2910	2	18
68	1	2	2	262	932	63	66	9302	26	-1	200	4001	2910	2	18
69	1	2	2	263	926	12	65	1612	27	-1	200	4001	2910	2	18
70	1	2	2	264	901	14	63	3468	27	-1	200	4001	2910	2	18
71	1	2	2	266	889	36	59	1473	27	-1	200	4001	2910	2	18
72	1	4	2	268	884	115	55	5533	28	-1	200	4001	3007	2	18
73	1	4	2	270	884	3	52	1480	29	-1	200	4001	3007	2	18
74	1	4	2	271	888	143	49	9139	29	-1	200	4001	3007	2	18
75	1	4	2	272	891	34	47	8364	28	-1	200	4001	3007	2	18
76	1	4	2	274	908	108	42	7387	27	-1	200	4001	3007	2	18
77	1	4	2	275	917	53	41	1097	24	-1	200	4001	3007	2	18
78	1	4	2	276	929	98	39	1913	21	-1	200	4001	3007	2	18
79	1	4	2	279	931	65	34	8141	18	-1	200	4001	3007	1	36
80	1	4	2	280	928	87	33	2696	20	-1	200	4001	3007	1	36
81	1	4	2	281	942	10	32	6370	17	-1	200	4001	3007	2	18
82	1	4	2	282	945	33	31	8029	15	-1	200	4001	3007	1	36
83	1	4	2	283	949	79	31	863	14	-1	200	4001	3007	2	18
84	1	4	2	284	957	26	30	1115	12	-1	200	4001	3007	2	18
85	1	4	2	286	968	128	27	4553	10	-1	200	4001	3007	3	18
86	1	4	2	287	951	24	25	7571	9	-1	200	4001	3007	1	36
87	1	4	2	290	934	78	20	6219	9	-1	200	4001	3007	2	18
88	1	4	2	288	942	132	24	3590	7	-1	200	4001	3007	2	18
89	1	4	2	291	932	92	18	6727	9	-1	200	4001	3007	1	36
90	1	4	2	292	943	62	16	6352	9	-1	200	4001	3007	1	36
91	1	4	2	293	946	52	14	9435	8	-1	200	4001	3007	1	36
92	1	4	2	294	949	64	12	7056	8	-1	200	4001	3007	1	42
93	1	4	2	295	953	44	11	1371	7	-1	200	4001	3007	1	42
94	1	4	2	296	931	55	9	3313	3	-1	200	4001	3007	1	48
95	1	4	2	297	908	38	6	8187	1	-1	200	4001	3007	1	56
96	1	4	2	299	880	82	3	3477	350	-1	200	4001	3007	1	62
97	1	4	2	300	886	142	2	609	331	-1	200	4001	3007	1	62
98	1	4	2	302	889	25	-1	-9232	250	-1	200	4001	3007	1	76
99	1	4	2	304	878	74	-3	-9860	223	-1	200	4001	3007	1	62
100	1	4	2	305	878	137	-6	-1343	215	-1	200	4001	3007	1	56
101	1	4	2	307	885	45	-8	-6803	221	-1	200	4001	3007	1	48
102	1	4	2	308	846	23	-12	-4979	222	-1	200	4001	3007	2	18
103	1	4	2	310	810	49	-16	-3715	223	-1	200	4001	3007	1	36
104	1	4	2	311	804	68	-18	-4476	223	-1	200	4001	3007	1	36
105	1	4	2	312	796	75	-20	-5196	223	-1	200	4001	3007	1	36
106	1	4	2	313	788	112	-22	-5495	223	-1	200	4001	3007	1	36
107	1	4	2	314	782	39	-24	-5269	222	-1	200	4001	3007	1	36
108	1	4	2	315	775	119	-26	-5659	222	-1	200	4001	3007	1	36
109	1	4	2	316	768	30	-28	-6491	222	-1	200	4001	3007	1	36
110	1	4	2	317	764	96	-30	-6727	223	-1	200	4001	3007	1	36
111	1	4	2	318	779	89	-32	-1731	223	-1	200	4001	3007	1	36
112	1	4	2	319	761	77	-34	-1985	223	-1	200	4001	3007	2	18
113	1	4	2	321	768	103	-38	-1800	222	-1	200	4001	3007	2	18
114	1	4	2	322	771	122	-40	-1549	222	-1	200	4001	3007	2	18
115	1	4	2	323	784	31	-41	-9966	222	-1	200	4001	3007	2	18
116	1	4	2	324	801	19	-44	-2227	221	-1	200	4001	3007	2	18
117	1	4	2	326	824	110	-47	-2901	219	-1	200	4001	3007	2	18
118	1	4	2	327	834	107	-49	-1331	218	-1	200	4001	3007	3	36
119	1	4	2	328	843	121	-51	-891	219	-1	200	4001	3007	2	18
120	1	4	2	329	854	133	-53	-1813	219	-1	200	4001	3007	2	18
121	1	4	2	330	902	17	-57	-45	220	-1	200	4001	3007	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
122	1	4	2	331	915	22	-58	-6626	221	-1	200	4001	3007	2	18
123	1	4	2	332	924	48	-59	-8251	221	-1	200	4001	3007	2	18
124	1	4	2	333	930	60	-61	-1158	222	-1	200	4001	3007	3	36
125	1	4	2	334	943	131	-62	-5710	221	-1	200	4001	3007	2	18
126	1	4	2	335	962	70	-64	-5164	222	-1	200	4001	3007	2	18
127	1	4	2	374	1007	145	-127	-380	223	-1	200	4001	3007	2	18
128	1	4	2	337	972	136	-69	-1354	223	-1	200	4001	3007	2	18
129	1	4	2	338	966	18	-71	-5170	223	-1	200	4001	3007	3	36
130	1	4	2	339	957	106	-72	-9160	223	-1	200	4001	3007	2	18
131	1	4	2	340	949	124	-75	-217	223	-1	200	4001	3007	2	18
132	1	4	2	341	935	138	-77	-2853	224	-1	200	4001	3007	2	18
133	1	4	2	342	941	40	-79	-6872	224	-1	200	4001	3007	2	18
134	1	4	2	343	946	129	-81	-3094	224	-1	200	4001	3007	2	18
135	1	4	2	344	990	113	-83	-9444	224	-1	200	4001	3007	2	18
136	1	4	2	376	1031	36	-131	-555	223	-1	200	4001	3007	2	18
137	1	4	2	346	976	85	-87	-1712	225	-1	200	4001	3007	2	18
138	1	4	2	347	944	139	-90	-607	225	-1	200	4001	3007	2	18
139	1	4	2	348	953	51	-92	-346	224	-1	200	4001	3007	2	18
140	1	4	2	349	951	93	-93	-6684	223	-1	200	4001	3007	2	18
141	1	4	2	350	952	94	-95	-8120	222	-1	200	4001	3007	2	18
142	1	4	2	351	958	97	-96	-7648	223	-1	200	4001	3007	2	18
143	1	4	2	352	955	88	-97	-9791	223	-1	200	4001	3007	2	18
144	1	4	2	353	951	14	-99	-4377	222	-1	200	4001	3007	2	18
145	1	4	2	354	967	76	-102	-2042	222	-1	200	4001	3007	2	18
146	1	4	2	355	979	104	-104	-3072	223	-1	200	4001	3007	2	18
147	1	4	2	377	1074	146	-133	-2831	223	-1	200	4001	3007	2	18
148	1	4	2	357	957	63	-108	-8922	223	-1	200	4001	3007	2	18
149	1	4	2	358	962	71	-112	-1113	223	-1	200	4001	3007	2	18
150	1	4	2	359	961	56	-113	-7128	223	-1	200	4001	3007	2	18
151	1	4	2	360	962	72	-115	-6465	223	-1	200	4001	3007	2	18
152	1	4	2	361	972	118	-117	-3122	223	-1	200	4001	3007	2	18
153	1	4	2	362	974	73	-119	-6384	223	-1	200	4001	3007	2	18
154	1	4	2	363	982	12	-121	-6514	223	-1	200	4001	3007	2	18
155	1	4	2	364	993	43	-123	-5073	223	-1	200	4001	3007	2	18
156	1	6	2	378	1069	10	-134	-8065	223	-1	200	4001	4508	3	0
157	1	6	2	379	1063	79	-137	-1772	222	-1	200	4001	4508	2	18
158	1	6	2	380	1094	53	-138	-9239	222	-1	200	4001	4508	2	18
159	1	6	2	381	1053	34	-141	-6867	222	-1	200	4001	4508	2	18
160	1	6	2	384	1028	143	-146	-8693	222	-1	200	4001	4508	3	0
161	1	6	2	385	1021	26	-147	-9450	223	-1	200	4001	4508	2	18
162	1	6	2	386	1017	87	-149	-2668	222	-1	200	4001	4508	2	18
163	1	6	2	387	1008	66	-151	-259	223	-1	200	4001	4508	3	0
164	1	6	2	388	998	24	-153	-176	223	-1	200	4001	4508	3	0
165	1	6	2	389	995	33	-154	-6362	222	-1	200	4001	4508	2	18
166	1	6	2	390	993	3	-156	-4409	222	-1	200	4001	4508	2	18
167	1	6	2	392	996	98	-158	-3522	222	-1	200	4001	4508	3	0
168	1	6	2	393	983	108	-159	-9371	221	-1	200	4001	4508	2	18
169	1	6	2	394	979	90	-161	-9443	221	-1	200	4001	4508	2	18
170	1	6	2	395	983	65	-163	-7247	220	-1	200	4001	4508	2	18
171	1	6	2	396	980	28	-165	-4255	220	-1	200	4001	4508	2	18
172	1	6	2	397	974	128	-167	-2528	220	-1	200	4001	4508	2	18
173	1	6	2	409	955	52	-189	-1429	216	-1	200	4001	4508	3	0
174	1	6	2	410	957	32	-190	-1492	216	-1	200	4001	4508	3	0
175	1	6	2	411	948	64	-191	-9949	216	-1	200	4001	4508	3	0
176	1	6	2	412	950	45	-194	-738	216	-1	200	4001	4508	3	0
177	1	6	2	413	936	82	-196	-2457	216	-1	200	4001	4508	3	0
178	1	6	2	414	938	62	-197	-9531	216	-1	200	4001	4508	3	0
179	1	6	2	415	928	137	-199	-9727	216	-1	200	4001	4508	3	0
180	1	6	2	416	925	38	-202	-154	215	-1	200	4001	4508	3	0
181	1	6	2	417	931	92	-205	-466	215	-1	200	4001	4508	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
182	1	6	2	418	922	30	-207	-5921	215	-1	200	4001	4508	3	0
183	1	6	2	419	914	119	-208	-4257	214	-1	200	4001	4508	3	0
184	1	6	2	420	911	49	-210	-2542	214	-1	200	4001	4508	3	0
185	1	6	2	421	908	122	-211	-6011	213	-1	200	4001	4508	3	0
186	1	6	2	422	907	121	-212	-8048	213	-1	200	4001	4508	3	0
187	1	6	2	424	896	133	-214	-5391	212	-1	200	4001	4508	3	0
188	1	6	2	425	906	83	-215	-7858	212	-1	200	4001	4508	3	0
189	1	6	2	426	902	89	-217	-297	211	-1	200	4001	4508	3	0
190	1	6	2	427	904	112	-218	-5347	211	-1	200	4001	4508	3	0
191	1	6	2	428	897	77	-219	-6775	211	-1	200	4001	4508	3	0
192	1	6	2	429	889	19	-221	-2955	211	-1	200	4001	4508	3	0
193	1	6	2	430	882	31	-223	-2106	211	-1	200	4001	4508	3	0
194	1	6	2	432	872	68	-227	-1326	210	-1	200	4001	4508	3	0
195	1	6	2	433	866	103	-229	-8842	210	-1	200	4001	4508	3	0
196	1	6	2	434	857	107	-231	-6003	210	-1	200	4001	4508	3	0
197	1	6	2	435	856	75	-232	-1864	210	-1	200	4001	4508	3	0
198	1	6	2	437	845	96	-236	-9820	210	-1	200	4001	4508	3	0
199	1	6	2	438	842	17	-240	-2390	210	-1	200	4001	4508	3	0
200	1	6	2	439	836	48	-241	-7396	210	-1	200	4001	4508	3	0
201	1	6	2	440	839	60	-244	-1099	209	-1	200	4001	4508	3	0
202	1	6	2	441	827	100	-246	-8954	209	-1	200	4001	4508	3	0
203	1	6	2	442	830	131	-247	-1507	209	-1	200	4001	4508	3	0
204	1	6	2	443	829	70	-249	-7238	209	-1	200	4001	4508	3	0
205	1	6	2	444	832	106	-251	-6062	209	-1	200	4001	4508	3	0
206	1	6	2	446	836	136	-256	-1407	209	-1	200	4001	4508	3	0
207	1	6	2	970	840	40	-258	-6099	209	-1	200	4001	4508	3	0
208	1	6	2	448	847	129	-261	-7412	209	-1	200	4001	4508	3	0
209	1	6	2	449	855	18	-264	-1108	209	-1	200	4001	4508	3	0
210	1	6	2	451	856	139	-267	-3975	208	-1	200	4001	4508	3	0
211	1	6	2	452	858	124	-269	-4424	208	-1	200	4001	4508	3	0
212	1	6	2	971	863	138	-271	-6715	208	-1	200	4001	4508	3	0
213	1	6	2	454	862	113	-273	-844	208	-1	200	4001	4508	3	0
214	1	6	2	972	872	85	-276	-5117	208	-1	200	4001	4508	3	0
215	1	6	2	456	871	51	-278	-6174	208	-1	200	4001	4508	3	0
~~216~~	~~1~~	~~6~~	~~2~~	~~459~~	~~889~~	~~63~~	~~-288~~	~~-7930~~	~~209~~	~~-1~~	~~200~~	~~4001~~	~~4508~~	3	0
217	1	6	2	460	891	72	-290	-5222	209	-1	200	4001	4508	3	0
218	1	6	2	462	896	76	-293	-9142	209	-1	200	4001	4508	3	0
219	1	6	2	463	918	97	-296	-1723	209	-1	200	4001	4508	3	0
220	1	6	2	464	905	43	-297	-9123	209	-1	200	4001	4508	3	0
221	1	6	2	465	908	14	-299	-8881	209	-1	200	4001	4508	3	0
222	1	6	2	469	921	104	-306	-9470	209	-1	200	4001	4508	3	0
223	1	6	2	470	926	145	-309	-3421	209	-1	200	4001	4508	3	0
224	1	6	2	471	931	94	-311	-4849	209	-1	200	4001	4508	3	0
225	1	6	2	473	940	12	-316	-1191	209	-1	200	4001	4508	3	0
226	1	6	2	477	957	146	-324	-9969	209	-1	200	4001	4508	3	0
227	1	8	2	378	1069	143	-134	-8065	223	-1	200	4001	10523	2	18
228	1	8	2	379	1063	65	-137	-1772	222	-1	200	4001	10523	2	18
229	1	8	2	381	1053	90	-141	-6867	222	-1	200	4001	10523	2	18
230	1	8	2	383	1038	53	-144	-3264	223	-1	200	4001	10523	2	18
231	1	8	2	384	1028	33	-146	-8693	222	-1	200	4001	10523	2	18
232	1	8	2	385	1021	79	-147	-9450	223	-1	200	4001	10523	2	18
233	1	8	2	386	1017	10	-149	-2668	222	-1	200	4001	10523	2	18
234	1	8	2	387	1008	26	-151	-259	223	-1	200	4001	10523	2	18
235	1	8	2	388	998	28	-153	-176	223	-1	200	4001	10523	2	18
236	1	8	2	389	995	98	-154	-6362	222	-1	200	4001	10523	2	18
237	1	8	2	390	993	87	-156	-4409	222	-1	200	4001	10523	2	18
238	1	8	2	391	999	108	-157	-7772	222	-1	200	4001	10523	2	18
239	1	8	2	392	996	115	-158	-3522	222	-1	200	4001	10523	2	18
240	1	8	2	393	983	3	-159	-9371	221	-1	200	4001	10523	2	18
241	1	8	2	394	979	128	-161	-9443	221	-1	200	4001	10523	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
242	1	8	2	395	983	34	-163	-7247	220	-1	200	4001	10523	2	18
243	1	8	2	396	980	66	-165	-4255	220	-1	200	4001	10523	2	18
244	1	8	2	397	974	24	-167	-2528	220	-1	200	4001	10523	2	18
245	1	8	2	398	974	44	-169	-387	219	-1	200	4001	10523	2	18
246	1	8	2	399	973	45	-170	-5940	219	-1	200	4001	10523	2	18
247	1	8	2	400	970	82	-172	-8305	219	-1	200	4001	10523	2	18
248	1	8	2	401	967	78	-174	-8097	218	-1	200	4001	10523	2	18
249	1	8	2	402	962	137	-176	-2763	218	-1	200	4001	10523	2	18
250	1	8	2	404	956	132	-180	-1313	217	-1	200	4001	10523	3	0
251	1	8	2	405	957	120	-181	-7573	217	-1	200	4001	10523	2	18
252	1	8	2	406	964	101	-184	-3441	217	-1	200	4001	10523	3	0
253	1	8	2	407	967	52	-185	-1683	217	-1	200	4001	10523	2	18
254	1	8	2	408	956	105	-187	-2952	217	-1	200	4001	10523	2	18
255	1	8	2	409	955	32	-189	-1429	216	-1	200	4001	10523	2	18
256	1	8	2	410	957	38	-190	-1492	216	-1	200	4001	10523	2	18
257	1	8	2	411	948	55	-191	-9949	216	-1	200	4001	10523	2	18
258	1	8	2	412	950	74	-194	-738	216	-1	200	4001	10523	2	18
259	1	8	2	413	936	92	-196	-2457	216	-1	200	4001	10523	2	18
260	1	8	2	415	928	23	-199	-9727	216	-1	200	4001	10523	2	18
261	1	8	2	414	938	64	-197	-9531	216	-1	200	4001	10523	3	0
262	1	8	2	416	925	25	-202	-154	215	-1	200	4001	10523	2	18
263	1	8	2	418	922	68	-207	-5921	215	-1	200	4001	10523	2	18
264	1	8	2	420	911	75	-210	-2542	214	-1	200	4001	10523	2	18
265	1	8	2	421	908	49	-211	-6011	213	-1	200	4001	10523	2	18
266	1	8	2	422	907	30	-212	-8048	213	-1	200	4001	10523	2	18
267	1	8	2	423	905	103	-213	-5459	213	-1	200	4001	10523	2	18
268	1	8	2	424	896	31	-214	-5391	212	-1	200	4001	10523	3	0
269	1	8	2	425	906	122	-215	-7858	212	-1	200	4001	10523	3	0
270	1	8	2	426	902	119	-217	-297	211	-1	200	4001	10523	3	0
271	1	8	2	427	904	96	-218	-5347	211	-1	200	4001	10523	3	0
272	1	8	2	430	882	121	-223	-2106	211	-1	200	4001	10523	3	0
273	1	8	2	428	897	19	-219	-6775	211	-1	200	4001	10523	2	18
274	1	8	2	431	876	89	-224	-8670	211	-1	200	4001	10523	3	0
275	1	8	2	432	872	77	-227	-1326	210	-1	200	4001	10523	3	0
276	1	8	2	434	857	107	-231	-6003	210	-1	200	4001	10523	3	0
277	1	8	2	437	845	133	-236	-9820	210	-1	200	4001	10523	3	0
278	1	8	2	438	842	139	-240	-2390	210	-1	200	4001	10523	3	0
279	1	8	2	439	836	22	-241	-7396	210	-1	200	4001	10523	3	0
280	1	8	2	440	839	100	-244	-1099	209	-1	200	4001	10523	3	0
281	1	8	2	441	827	93	-246	-8954	209	-1	200	4001	10523	3	0
282	1	8	2	442	830	17	-247	-1507	209	-1	200	4001	10523	3	0
283	1	8	2	443	829	60	-249	-7238	209	-1	200	4001	10523	3	0
284	1	8	2	444	832	106	-251	-6062	209	-1	200	4001	10523	3	0
285	1	8	2	445	834	40	-253	-9341	209	-1	200	4001	10523	3	0
286	1	8	2	446	836	48	-256	-1407	209	-1	200	4001	10523	3	0
287	1	8	2	447	840	131	-258	-7380	209	-1	200	4001	10523	2	18
288	1	8	2	448	847	136	-261	-7412	209	-1	200	4001	10523	3	0
289	1	8	2	449	855	70	-264	-1108	209	-1	200	4001	10523	3	0
290	1	8	2	450	857	124	-265	-6821	208	-1	200	4001	10523	3	0
291	1	8	2	451	856	129	-267	-3975	208	-1	200	4001	10523	3	0
292	1	8	2	452	858	35	-269	-4424	208	-1	200	4001	10523	3	0
293	1	8	2	454	862	18	-273	-844	208	-1	200	4001	10523	3	0
294	1	8	2	457	875	51	-280	-9203	208	-1	200	4001	10523	3	0
295	1	8	2	468	917	56	-304	-8566	209	-1	200	4001	10523	3	0
296	1	8	2	469	921	104	-306	-9470	209	-1	200	4001	10523	3	0
297	1	8	2	470	926	12	-309	-3421	209	-1	200	4001	10523	3	0
298	1	8	2	471	931	69	-311	-4849	209	-1	200	4001	10523	3	0
299	1	8	2	474	944	76	-318	-3426	209	-1	200	4001	10523	3	0
300	1	8	2	475	949	145	-320	-8738	209	-1	200	4001	10523	3	0
301	1	8	2	477	957	63	-324	-9969	209	-1	200	4001	10523	3	0

Saudi Arabia - Shot Points 3 and 5 Tape 3 of 5

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
2	1	9	3	378	1069	143	55	3278	23	-1	200	4001	2205	2	18
3	1	9	3	379	1063	65	53	173	23	-1	200	4001	2205	2	18
4	1	9	3	381	1053	90	48	7751	21	-1	200	4001	2205	1	36
5	1	9	3	383	1038	53	46	4688	19	-1	200	4001	2205	1	36
6	1	9	3	384	1028	33	43	8325	19	-1	200	4001	2205	1	36
7	1	9	3	385	1021	79	43	894	18	-1	200	4001	2205	1	36
8	1	9	3	386	1017	10	41	8640	17	-1	200	4001	2205	1	36
9	1	9	3	387	1008	26	40	4320	15	-1	200	4001	2205	2	18
10	1	9	3	388	998	28	38	8328	14	-1	200	4001	2205	2	18
11	1	9	3	389	995	98	36	9672	14	-1	200	4001	2205	2	18
12	1	9	3	390	993	87	35	1715	13	-1	200	4001	2205	1	36
13	1	9	3	391	999	108	33	5405	13	-1	200	4001	2205	1	36
14	1	9	3	392	996	115	32	9093	13	-1	200	4001	2205	1	36
15	1	9	3	393	983	3	30	9810	14	-1	200	4001	2205	1	36
16	1	9	3	394	979	128	28	5812	14	-1	200	4001	2205	1	36
17	1	9	3	395	983	34	26	4358	15	-1	200	4001	2205	1	36
18	1	9	3	396	980	66	24	4716	16	-1	200	4001	2205	1	36
19	1	9	3	397	974	24	22	4118	16	-1	200	4001	2205	1	36
20	1	9	3	398	974	44	20	3772	17	-1	200	4001	2205	1	36
21	1	9	3	399	973	45	18	5311	18	-1	200	4001	2205	1	36
22	1	9	3	400	970	82	15	9775	20	-1	200	4001	2205	1	36
23	1	9	3	401	967	78	13	7370	22	-1	200	4001	2205	1	42
24	1	9	3	402	962	137	12	1049	24	-1	200	4001	2205	1	42
25	1	9	3	404	956	132	7	9925	31	-1	200	4001	2205	1	48
26	1	9	3	405	957	120	6	3380	36	-1	200	4001	2205	1	56
27	1	9	3	406	964	101	3	8276	47	-1	200	4001	2205	1	62
28	1	9	3	407	967	52	3	1303	57	-1	200	4001	2205	1	68
29	1	9	3	408	956	105	-1	-4752	93	-1	200	4001	2205	1	76
30	1	9	3	409	955	32	-2	-2315	154	-1	200	4001	2205	1	76
31	1	9	3	410	957	38	-3	-1797	166	-1	200	4001	2205	1	68
32	1	9	3	411	948	55	-4	-8898	178	-1	200	4001	2205	1	56
33	1	9	3	412	950	74	-6	-7150	188	-1	200	4001	2205	1	56
34	1	9	3	413	936	92	-9	-66	190	-1	200	4001	2205	1	40
35	1	9	3	414	938	64	-10	-6952	193	-1	200	4001	2205	1	42
36	1	9	3	416	925	25	-14	-8138	195	-1	200	4001	2205	1	36
37	1	9	3	418	922	68	-20	-4347	198	-1	200	4001	2205	1	36
38	1	9	3	420	911	75	-24	-3701	190	-1	200	4001	2205	1	36
39	1	9	3	421	908	49	-26	-5020	187	-1	200	4001	2205	1	36
40	1	9	3	422	907	30	-28	-3351	185	-1	200	4001	2205	1	36
41	1	9	3	423	905	103	-29	-6221	183	-1	200	4001	2205	1	36
42	1	9	3	424	896	31	-31	-3106	181	-1	200	4001	2205	1	36
43	1	9	3	425	906	122	-33	-3992	179	-1	200	4001	2205	1	36
44	1	9	3	426	902	119	-35	-921	179	-1	200	4001	2205	1	36
45	1	9	3	428	897	19	-38	-5115	178	-1	200	4001	2205	2	18
46	1	9	3	427	904	96	-37	-567	178	-1	200	4001	2205	2	18
47	1	9	3	431	876	89	-43	-653	182	-1	200	4001	2205	2	18
48	1	9	3	434	857	107	-49	-7168	184	-1	200	4001	2205	2	18
49	1	9	3	438	842	139	-58	-3855	186	-1	200	4001	2205	2	18
50	1	9	3	441	827	93	-65	-1486	187	-1	200	4001	2205	2	18
51	1	9	3	442	830	17	-65	-7272	186	-1	200	4001	2205	2	18
52	1	9	3	444	832	106	-70	-2158	187	-1	200	4001	2205	2	18
53	1	9	3	445	834	40	-72	-6191	187	-1	200	4001	2205	2	18
54	1	9	3	446	836	48	-74	-6540	187	-1	200	4001	2205	2	18
55	1	9	3	447	840	131	-77	-1486	188	-1	200	4001	2205	2	18
56	1	9	3	448	847	136	-80	-3977	188	-1	200	4001	2205	3	0
57	1	9	3	449	855	70	-82	-7386	189	-1	200	4001	2205	2	18
58	1	9	3	450	857	124	-84	-3212	189	-1	200	4001	2205	2	18
59	1	9	3	451	856	129	-85	-9552	189	-1	200	4001	2205	2	18
60	1	9	3	452	858	35	-87	-9022	190	-1	200	4001	2205	2	18
61	1	9	3	454	862	18	-91	-3975	190	-1	200	4001	2205	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
62	1	9	3	457	875	51	-98	-9694	192	-1	200	4001	2205	2	18
63	1	9	3	468	917	56	-121	-3884	196	-1	200	4001	2205	2	18
64	1	9	3	469	921	104	-123	-4437	196	-1	200	4001	2205	2	18
65	1	9	3	470	926	12	-125	-7888	197	-1	200	4001	2205	2	18
66	1	9	3	471	931	69	-127	-8590	197	-1	200	4001	2205	2	18
67	1	9	3	474	944	76	-134	-6041	197	-1	200	4001	2205	2	18
68	1	9	3	475	949	145	-137	-1188	198	-1	200	4001	2205	2	18
69	1	9	3	477	957	63	-141	-1874	198	-1	200	4001	2205	3	0
70	1	12	3	478	958	115	-143	-6076	198	-1	200	4001	18838	2	18
71	1	12	3	479	966	87	-145	-3771	198	-1	200	4001	18838	2	18
72	1	12	3	480	973	125	-147	-3524	198	0	200	4001	18838	2	18
73	1	12	3	481	981	66	-149	-2291	198	-1	200	4001	18838	2	18
74	1	12	3	482	992	24	-151	-526	199	-1	200	4001	18838	2	18
75	1	12	3	483	994	28	-153	-1852	199	-1	200	4001	18838	2	18
76	1	12	3	484	993	34	-155	-6468	199	-1	200	4001	18838	2	18
77	1	12	3	485	994	143	-157	-5004	199	-1	200	4001	18838	2	18
78	1	12	3	486	998	108	-160	0	199	-1	200	4001	18838	2	18
79	1	12	3	487	1015	98	-163	-3026	199	-1	200	4001	18838	2	18
80	1	12	3	489	1022	79	-167	-9505	199	-1	200	4001	18838	2	18
81	1	12	3	488	1012	3	-165	-2135	199	-1	200	4001	18838	1	30
82	1	12	3	491	1011	65	-172	-4487	199	-1	200	4001	18838	2	18
83	1	12	3	490	1010	53	-170	-4644	199	-1	200	4001	18838	1	36
84	1	12	3	492	1025	33	-174	-5505	199	-1	200	4001	18838	2	18
85	1	12	3	495	1043	128	-180	-9551	199	-1	200	4001	18838	2	18
86	1	12	3	497	1053	90	-184	-8393	199	-1	200	4001	18838	2	18
87	1	12	3	499	1069	55	-189	-4725	200	-1	200	4001	18838	2	18
88	1	12	3	500	1077	52	-191	-6490	200	-1	200	4001	18838	2	18
89	1	12	3	501	1089	38	-193	-9680	200	-1	200	4001	18838	2	18
90	1	12	3	502	1097	92	-196	-9350	200	-1	200	4001	18838	2	12
91	1	12	3	503	1114	142	-199	-6680	200	-1	200	4001	18838	2	18
92	1	12	3	504	1095	23	-202	-5279	200	-1	200	4001	18838	2	18
93	1	12	3	505	1096	105	-205	-1515	200	-1	200	4001	18838	2	18
94	1	12	3	506	1090	120	-206	-8498	201	-1	200	4001	18838	2	18
95	1	12	3	507	1098	137	-208	-5971	201	-1	200	4001	18838	2	18
96	1	12	3	508	1096	64	-210	-1949	202	-1	200	4001	18838	2	18
97	1	12	3	509	1115	82	-212	-2557	202	-1	200	4001	18838	2	18
98	1	12	3	521	1170	119	-237	-5514	203	-1	200	4001	18838	2	18
99	1	12	3	518	1152	110	-231	-2322	204	-1	200	4001	18838	2	18
100	1	12	3	522	1186	96	-239	-3440	203	-1	200	4001	18838	2	18
101	1	12	3	519	1181	122	-234	-172	203	-1	200	4001	18838	3	0
102	1	12	3	523	1196	30	-241	-5560	203	-1	200	4001	18838	2	18
103	1	12	3	526	1230	89	-246	-2010	202	-1	200	4001	18838	2	18
104	1	12	3	527	1238	39	-248	-1865	202	-1	200	4001	18838	2	18
105	1	12	3	530	1252	68	-254	-5500	201	-1	200	4001	18838	2	18
106	1	12	3	532	1263	31	-258	-4421	201	-1	200	4001	18838	3	0
107	1	12	3	533	1249	49	-260	-4110	201	-1	200	4001	18838	3	0
108	1	12	3	537	1306	19	-269	-9957	200	-1	200	4001	18838	3	0
109	1	12	3	539	1331	60	-273	-966	200	-1	200	4001	18838	3	0
110	1	12	3	540	1355	93	-274	-2169	200	-1	200	4001	18838	3	0
111	1	12	3	541	1366	106	-275	-8625	200	-1	200	4001	18838	3	0
112	1	12	3	544	1393	131	-279	-4258	200	-1	200	4001	18838	3	0
113	1	12	3	545	1411	136	-279	-6097	200	-1	200	4001	18838	3	0
114	1	12	3	510	1119	25	-214	-1479	202	-1	200	4001	18838	2	18
115	1	12	3	511	1113	62	-215	-7108	203	-1	200	4001	18838	2	18
116	1	12	3	512	1120	101	-217	-4246	203	-1	200	4001	18838	2	12
117	1	12	3	513	1131	78	-219	-3090	203	-1	200	4001	18838	2	18
118	1	12	3	515	1137	74	-222	-7013	204	-1	200	4001	18838	2	18
119	1	12	3	516	1138	32	-224	-1777	204	-1	200	4001	18838	3	0
120	1	12	3	548	1423	113	-282	-7338	199	-1	200	4001	18838	3	0
121	1	12	3	549	1434	51	-283	-4361	199	-1	200	4001	18838	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
122	1	12	3	550	1443	129	-285	-2674	199	-1	200	4001	18838	3	0
123	1	12	3	551	1470	139	-286	-7102	199	-1	200	4001	18838	3	0
124	1	12	3	552	1483	124	-288	-3232	199	-1	200	4001	18838	3	0
125	1	12	3	553	1514	35	-290	-6784	199	-1	200	4001	18838	3	0
126	1	12	3	554	1530	17	-292	-4791	198	-1	200	4001	18838	3	0
127	1	12	3	555	1561	100	-293	-6694	198	-1	200	4001	18838	3	0
128	1	12	3	556	1563	40	-295	-2026	198	-1	200	4001	18838	3	6
129	1	12	3	557	1587	18	-297	-2606	198	-1	200	4001	18838	3	0
130	1	12	3	558	1574	97	-298	-1255	198	-1	200	4001	18838	3	0
131	1	12	3	559	1583	56	-300	-4959	197	-1	200	4001	18838	3	0
132	1	12	3	563	1559	71	-309	-5213	196	-1	200	4001	18838	3	0
133	1	12	3	565	1546	14	-313	-4489	196	-1	200	4001	18838	2	12
134	1	12	3	566	1567	63	-314	-6548	195	-1	200	4001	18838	3	0
135	1	12	3	567	1594	73	-317	-4233	195	-1	200	4001	18838	3	0
136	1	12	3	568	1625	104	-319	-9437	195	-1	200	4001	18838	3	0
137	1	12	3	569	1641	146	-321	-6985	196	-1	200	4001	18838	3	0
138	1	12	3	570	1689	94	-323	-3864	196	-1	200	4001	18838	3	0
139	1	12	3	572	1636	99	-325	-8641	195	-1	200	4001	18838	3	0
140	1	12	3	573	1665	145	-328	-9256	195	-1	200	4001	18838	3	0
141	1	12	3	576	1703	12	-335	-8496	195	-1	200	4001	18838	3	0
142	1	12	3	577	1698	69	-337	-1669	194	-1	200	4001	18838	3	0
143	1	15	5	895	2	3	-73	-7555	178	-1	200	4001	8818	2	18
144	1	15	5	899	1	120	-82	-8826	178	-1	200	4001	8818	2	18
145	1	15	5	897	1	65	-78	-3155	178	-1	200	4001	8818	1	36
146	1	15	5	896	1	53	-75	-528	178	-1	200	4001	8818	2	18
147	1	15	5	905	1	74	-98	-1135	183	-1	200	4001	8818	2	18
148	1	15	5	906	1	31	-99	-9988	183	-1	200	4001	8818	2	18
149	1	15	5	907	1	105	-102	-3020	183	-1	200	4001	8818	2	18
150	1	15	5	908	1	62	-115	-6100	186	-1	200	4001	8818	3	0
151	1	15	5	910	1	26	-118	-1566	187	-1	200	4001	8818	3	0
152	1	15	5	911	5	52	-119	-1401	188	-1	200	4001	8818	3	0
153	1	15	5	912	10	38	-120	-9431	188	-1	200	4001	8818	3	0
154	1	15	5	913	10	82	-122	-4229	188	-1	200	4001	8818	3	0
155	1	15	5	914	14	68	-125	-9832	188	-1	200	4001	8818	3	0
156	1	15	5	915	15	44	-128	-4503	188	-1	200	4001	8818	3	0
157	1	15	5	916	17	143	-130	-4616	188	-1	200	4001	8818	3	0
158	1	15	5	917	5	142	-132	-3742	188	-1	200	4001	8818	3	0
159	1	15	5	801	68	137	-12	-7573	205	-1	200	4001	8818	1	42
160	1	15	5	802	59	110	-14	-8688	200	-1	200	4001	8818	1	36
161	1	15	5	803	45	34	-17	-4831	197	-1	200	4001	8818	1	36
162	1	15	5	804	32	64	-20	-4291	194	-1	200	4001	8818	1	36
163	1	15	5	805	22	25	-24	-597	191	-1	200	4001	8818	1	36
164	1	15	5	807	52	122	-27	-5032	167	-1	200	4001	8818	1	36
165	1	15	5	808	43	90	-30	-2396	168	-1	200	4001	8818	1	36
166	1	15	5	810	36	78	-37	-2931	170	-1	200	4001	8818	1	36
167	1	15	5	811	34	49	-41	-7081	170	-1	200	4001	8818	1	36
168	1	15	5	813	31	128	-49	-3400	172	-1	200	4001	8818	2	18
169	1	15	5	812	31	30	-45	-1739	171	-1	200	4001	8818	2	18
170	1	15	5	888	4	92	-52	-8623	175	-1	200	4001	8818	1	36
171	1	15	5	889	3	39	-56	-6899	177	-1	200	4001	8818	2	18
172	1	15	5	892	2	24	-66	-7293	179	-1	200	4001	8818	2	18
173	1	15	5	894	2	79	-70	-5405	178	-1	200	4001	8818	1	36
174	1	15	5	578	1705	106	142	6326	16	-1	200	4001	8818	2	18
175	1	15	5	580	1729	113	139	4618	16	-1	200	4001	8818	2	18
176	1	15	5	582	1795	89	132	9725	17	-1	200	4001	8818	2	18
177	1	15	5	583	1837	48	130	5961	18	-1	200	4001	8818	2	18
178	1	15	5	584	1804	10	129	3114	19	-1	200	4001	8818	2	18
179	1	15	5	585	1799	130	127	2304	19	-1	200	4001	8818	2	18
180	1	15	5	586	1814	83	126	3587	20	-1	200	4001	8818	2	18
181	1	15	5	587	1811	133	125	1086	21	-1	200	4001	8818	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
182	1	15	5	588	1812	77	123	5582	21	-1	200	4001	8818	2	18
183	1	15	5	592	1821	75	115	8063	24	-1	200	4001	8818	2	18
184	1	15	5	593	1830	112	113	2274	24	-1	200	4001	8818	2	18
185	1	15	5	595	1849	121	109	6572	23	-1	200	4001	8818	2	18
186	1	15	5	596	1819	58	107	413	23	-1	200	4001	8818	2	18
187	1	15	5	597	1835	103	104	1809	23	-1	200	4001	8818	2	18
188	1	15	5	520	1170	129	249	3988	7	-1	200	4001	8818	2	18
189	1	15	5	526	1230	85	238	4555	8	-1	200	4001	8818	2	18
190	1	15	5	529	1253	139	231	4899	8	-1	200	4001	8818	2	18
191	1	15	5	532	1263	18	225	5875	8	-1	200	4001	8818	2	18
192	1	15	5	536	1287	60	215	7174	8	-1	200	4001	8818	0	18
193	1	15	5	538	1332	35	211	7493	8	-1	200	4001	8818	0	36
194	1	15	5	541	1366	22	207	3442	8	-1	200	4001	8818	2	18
195	1	15	5	545	1411	17	203	3763	9	-1	200	4001	8818	2	18
196	1	15	5	549	1434	136	198	8161	10	-1	200	4001	8818	2	18
197	1	15	5	552	1483	93	194	397	9	-1	200	4001	8818	2	18
198	1	15	5	557	1587	40	184	5520	10	-1	200	4001	8818	2	18
199	1	15	5	555	1561	131	188	4068	10	-1	200	4001	8818	2	18
200	1	15	5	926	1	115	-140	-696	193	-1	200	4001	8818	2	18
201	1	15	5	928	1	101	-150	-3208	196	-1	200	4001	8818	2	18
202	1	15	5	929	1	107	-157	-5494	197	-1	200	4001	8818	2	18
203	1	15	5	930	1	119	-158	-5630	198	-1	200	4001	8818	2	18
204	1	15	5	558	1574	145	183	5230	11	-1	200	4001	8818	2	18
205	1	15	5	559	1583	72	181	445	11	-1	200	4001	8818	2	18
206	1	15	5	560	1557	146	178	8491	11	-1	200	4001	8818	2	18
207	1	15	5	562	1568	97	173	8281	12	-1	200	4001	8818	2	18
208	1	15	5	563	1559	14	171	5847	13	-1	200	4001	8818	2	18
209	1	15	5	565	1546	94	167	5256	13	-1	200	4001	8818	2	18
210	1	15	5	566	1567	104	166	2642	14	-1	200	4001	8818	2	18
211	1	15	5	567	1594	99	163	4909	14	-1	200	4001	8818	2	18
212	1	15	5	571	1644	12	156	6056	14	-1	200	4001	8818	2	18
213	1	15	5	572	1636	118	155	441	14	-1	200	4001	8818	2	18
214	1	15	5	574	1663	36	149	8889	15	-1	200	4001	8818	2	18
215	1	15	5	575	1657	76	147	4345	16	-1	200	4001	8818	2	18
216	1	15	5	576	1703	63	145	962	16	-1	200	4001	8818	2	18
217	1	15	5	577	1698	71	143	8097	16	-1	200	4001	8818	2	18
218	1	15	5	569	1641	56	159	2259	14	-1	200	4001	8818	2	18
219	1	17	5	895	2	3	-73	-7555	178	-1	200	4001	3208	2	18
220	1	17	5	896	1	53	-75	-528	178	-1	200	4001	3208	2	18
221	1	17	5	897	1	65	-78	-3155	178	-1	200	4001	3208	1	36
222	1	17	5	899	1	120	-82	-8826	178	-1	200	4001	3208	2	18
223	1	17	5	909	1	55	-116	-5438	187	-1	200	4001	3208	3	0
224	1	17	5	911	5	52	-119	-1401	188	-1	200	4001	3208	3	0
225	1	17	5	914	14	68	-125	-9832	188	-1	200	4001	3208	3	0
226	1	17	5	915	15	44	-128	-4503	188	-1	200	4001	3208	3	0
227	1	17	5	916	17	143	-130	-4616	188	-1	200	4001	3208	3	0
228	1	17	5	917	5	142	-132	-3742	188	-1	200	4001	3208	3	0
229	1	17	5	801	68	137	-12	-7573	205	-1	200	4001	3208	1	42
230	1	17	5	802	59	110	-14	-8688	200	-1	200	4001	3208	1	36
231	1	17	5	803	45	34	-17	-4831	197	-1	200	4001	3208	1	36
232	1	17	5	804	32	64	-20	-4291	194	-1	200	4001	3208	1	36
233	1	17	5	805	22	25	-24	-597	191	-1	200	4001	3208	1	36
234	1	17	5	807	52	122	-27	-5032	167	-1	200	4001	3208	1	36
235	1	17	5	810	36	78	-37	-2931	170	-1	200	4001	3208	2	18
236	1	17	5	811	34	49	-41	-7081	170	-1	200	4001	3208	2	18
237	1	17	5	812	31	30	-45	-1739	171	-1	200	4001	3208	2	18
238	1	17	5	889	3	39	-56	-6899	177	-1	200	4001	3208	2	18
239	1	17	5	890	2	108	-60	-1358	177	-1	200	4001	3208	2	18
240	1	17	5	892	2	24	-66	-7293	179	-1	200	4001	3208	2	18
241	1	17	5	894	2	79	-70	-5405	178	-1	200	4001	3208	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
242	1	17	5	578	1705	106	142	6326	16	-1	200	4001	3208	2	18
243	1	17	5	580	1729	113	139	4618	16	-1	200	4001	3208	2	18
244	1	17	5	582	1795	89	132	9725	17	-1	200	4001	3208	2	18
245	1	17	5	583	1837	48	130	5961	18	-1	200	4001	3208	2	18
246	1	17	5	585	1799	130	127	2304	19	-1	200	4001	3208	2	18
247	1	17	5	592	1821	75	115	8063	24	-1	200	4001	3208	2	18
248	1	17	5	595	1849	121	109	6572	23	-1	200	4001	3208	2	18
249	1	17	5	599	1831	66	100	9451	21	-1	200	4001	3208	2	18
250	1	17	5	600	1853	83	98	7505	20	-1	200	4001	3208	2	18
251	1	17	5	604	1910	10	92	2381	19	-1	200	4001	3208	2	18
252	1	17	5	605	1945	125	91	4197	17	-1	200	4001	3208	2	18
253	1	17	5	607	1983	37	88	6147	16	-1	200	4001	3208	3	0
254	1	17	5	957	1968	146	42	6012	21	-1	200	4001	3208	2	18
255	1	17	5	959	1567	15	36	8661	20	-1	200	4001	3208	2	18
256	1	17	5	960	1740	76	34	661	18	-1	200	4001	3208	2	18
257	1	17	5	956	2013	145	44	9003	20	-1	200	4001	3208	2	18
258	1	17	5	958	1621	94	37	7978	21	-1	200	4001	3208	2	18
259	1	17	5	961	1109	12	29	5637	11	-1	200	4001	3208	1	36
260	1	17	5	962	659	36	25	7716	6	-1	200	4001	3208	1	36
261	1	17	5	963	658	118	21	8511	6	-1	200	4001	3208	1	36
262	1	17	5	964	536	56	17	5517	3	-1	200	4001	3208	2	18
263	1	17	5	966	441	71	14	987	17	-1	200	4001	3208	1	36
264	1	17	5	968	480	63	7	3170	12	-1	200	4001	3208	1	36
265	1	17	5	626	229	14	5	1203	23	-1	200	4001	3208	1	36
266	1	17	5	627	207	97	2	4644	3	-1	200	4001	3208	1	36
267	1	17	5	697	152	69	-1	-8250	196	-1	200	4001	3208	1	36
268	1	17	5	699	116	104	-6	-1070	217	-1	200	4001	3208	1	36
269	1	17	5	700	93	43	-7	-9726	223	-1	200	4001	3208	1	36
270	1	17	5	800	136	72	-10	-8382	211	-1	200	4001	3208	1	36
271	1	17	5	611	2000	85	81	8600	18	-2	100	1001	3208	2	18
272	1	17	5	612	2026	18	80	7910	18	-2	100	1001	3208	2	18
273	1	17	5	614	2003	22	76	8379	19	-2	100	1001	3208	2	18
274	1	17	5	616	2050	139	72	8949	18	-2	100	1001	3208	2	18
275	1	17	5	617	2063	131	70	8440	19	-2	100	1001	3208	2	18
276	1	17	5	618	2087	93	67	9710	19	-2	100	1001	3208	2	18
277	1	17	5	620	2122	136	64	2379	20	-2	100	1001	3208	2	18
278	1	17	5	624	2280	35	51	7420	22	-2	100	1001	3208	2	18
279	1	17	5	955	2276	124	49	4379	23	-2	100	1001	3208	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
2	1	10	4	378	1069	143	283	1504	24	-1	200	4001	5811	3	0
3	1	10	4	379	1063	65	280	8212	24	-1	200	4001	5811	3	0
4	1	10	4	381	1053	90	276	5118	24	-1	200	4001	5811	3	0
5	1	10	4	383	1038	53	274	1200	24	-1	200	4001	5811	2	18
6	1	10	4	384	1028	33	271	4613	24	-1	200	4001	5811	3	0
7	1	10	4	385	1021	79	270	6308	23	-1	200	4001	5811	3	0
8	1	10	4	386	1017	10	269	3565	23	-1	200	4001	5811	3	0
9	1	10	4	388	998	28	266	333	23	-1	200	4001	5811	3	0
10	1	10	4	389	995	98	264	1940	23	-1	200	4001	5811	3	0
11	1	10	4	390	993	87	262	3397	23	-1	200	4001	5811	3	0
12	1	10	4	391	999	108	260	7630	23	-1	200	4001	5811	3	0
13	1	10	4	392	996	115	260	1327	23	-1	200	4001	5811	3	0
14	1	10	4	393	983	3	258	2705	23	-1	200	4001	5811	3	0
15	1	10	4	394	979	128	255	9441	23	-1	200	4001	5811	3	0
16	1	10	4	395	983	34	253	8720	23	-1	200	4001	5811	3	0
17	1	10	4	396	980	66	251	9523	24	-1	200	4001	5811	3	0
18	1	10	4	397	974	24	249	9264	24	-1	200	4001	5811	3	0
19	1	10	4	398	974	44	247	9333	24	-1	200	4001	5811	3	0
20	1	10	4	400	970	82	243	6402	24	-1	200	4001	5811	3	0
21	1	10	4	402	962	137	239	8016	24	-1	200	4001	5811	3	0
22	1	10	4	404	956	132	235	6165	25	-1	200	4001	5811	3	0
23	1	10	4	405	957	120	233	8786	25	-1	200	4001	5811	3	0
24	1	10	4	401	967	78	241	4288	24	-1	200	4001	5811	3	0
25	1	10	4	406	964	101	231	1962	25	-1	200	4001	5811	3	0
26	1	10	4	407	967	52	230	3175	25	-1	200	4001	5811	3	0
27	1	10	4	409	955	32	226	2453	25	-1	200	4001	5811	3	0
28	1	10	4	410	957	38	225	1687	25	-1	200	4001	5811	3	0
29	1	10	4	411	948	55	223	2549	25	-1	200	4001	5811	3	0
30	1	10	4	412	950	74	221	1887	25	-1	200	4001	5811	3	0
31	1	10	4	413	936	92	218	9077	25	-1	200	4001	5811	2	18
32	1	10	4	414	938	64	217	1685	25	-1	200	4001	5811	3	0
33	1	10	4	415	928	23	215	1013	25	-1	200	4001	5811	3	0
34	1	10	4	418	922	68	207	3171	25	-1	200	4001	5811	3	0
35	1	10	4	416	925	25	213	9	25	-1	200	4001	5811	2	18
36	1	10	4	420	911	75	204	689	26	-1	200	4001	5811	3	0
37	1	10	4	421	908	49	202	4717	27	-1	200	4001	5811	3	0
38	1	10	4	422	907	30	201	1028	27	-1	200	4001	5811	3	0
39	1	10	4	423	905	103	200	2471	28	-1	200	4001	5811	2	18
40	1	10	4	424	896	31	199	1340	28	-1	200	4001	5811	3	0
41	1	10	4	425	906	122	197	7785	29	-1	200	4001	5811	3	0
42	1	10	4	426	902	119	196	4865	29	-1	200	4001	5811	3	0
43	1	10	4	428	897	19	193	7859	30	-1	200	4001	5811	2	18
44	1	10	4	431	876	89	188	5944	30	-1	200	4001	5811	3	0
45	1	10	4	434	857	107	181	8547	30	-1	200	4001	5811	2	18
46	1	10	4	438	842	139	173	2450	31	-1	200	4001	5811	2	18
47	1	10	4	441	827	93	166	6491	31	0	200	4001	5811	3	0
48	1	10	4	442	830	17	166	4363	32	0	200	4001	5811	3	0
49	1	10	4	444	832	106	162	467	32	-1	200	4001	5811	2	18
50	1	10	4	445	834	40	159	7697	32	-1	200	4001	5811	2	18
51	1	10	4	446	836	48	157	5663	32	-1	200	4001	5811	2	18
52	1	10	4	447	840	131	154	9914	33	-1	200	4001	5811	2	18
53	1	10	4	448	847	136	152	226	33	-1	200	4001	5811	2	18
54	1	10	4	449	855	70	149	6878	33	-1	200	4001	5811	2	18
55	1	10	4	450	857	124	148	1485	33	-1	200	4001	5811	2	18
56	1	10	4	451	856	129	146	4434	33	-1	200	4001	5811	2	18
57	1	10	4	452	858	35	144	4096	33	-1	200	4001	5811	2	18
58	1	10	4	454	862	18	140	7937	34	-1	200	4001	5811	2	18
59	1	10	4	457	875	51	133	245	34	-1	200	4001	5811	2	18
60	1	10	4	468	917	56	108	8988	34	-1	200	4001	5811	2	18
61	1	10	4	469	921	104	106	8218	34	-1	200	4001	5811	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
62	1	10	4	470	926	12	104	4376	34	-1	200	4001	5811	2	18
63	1	10	4	471	931	69	102	2919	34	-1	200	4001	5811	2	18
64	1	10	4	474	944	76	95	4771	34	-1	200	4001	5811	1	36
65	1	10	4	475	949	145	92	9754	35	-1	200	4001	5811	2	18
66	1	10	4	477	957	63	88	8871	35	-1	200	4001	5811	2	18
67	1	13	4	478	958	115	86	4958	35	-1	200	4001	3007	3	0
68	1	13	4	479	966	87	84	7168	35	-1	200	4001	3007	3	0
69	1	13	4	480	973	125	82	6809	35	0	200	4001	3007	3	0
70	1	13	4	481	981	66	80	7647	36	-1	200	4001	3007	3	0
71	1	13	4	482	992	24	78	7199	36	-1	200	4001	3007	3	0
72	1	13	4	483	994	28	76	6613	36	-1	200	4001	3007	2	18
73	1	13	4	484	993	34	74	3307	37	-1	200	4001	3007	3	0
74	1	13	4	485	994	143	72	5820	37	-1	200	4001	3007	3	0
75	1	13	4	486	998	108	70	1148	37	-1	200	4001	3007	3	0
76	1	13	4	487	1015	98	66	8884	38	-1	200	4001	3007	3	0
77	1	13	4	488	1012	3	64	9938	38	-1	200	4001	3007	2	18
78	1	13	4	489	1022	79	62	2857	39	-1	200	4001	3007	2	18
79	1	13	4	490	1010	53	59	7906	39	-1	200	4001	3007	2	18
80	1	13	4	491	1011	65	57	9848	40	-1	200	4001	3007	2	18
81	1	13	4	492	1025	33	56	953	41	-1	200	4001	3007	2	18
82	1	13	4	495	1043	128	50	1091	43	-1	200	4001	3007	2	18
83	1	13	4	501	1089	38	37	8861	49	-1	200	4001	3007	2	18
84	1	13	4	502	1097	92	35	837	51	-1	200	4001	3007	2	18
85	1	13	4	503	1114	142	32	6162	53	-1	200	4001	3007	2	18
86	1	13	4	504	1095	23	30	992	56	-1	200	4001	3007	2	18
87	1	13	4	505	1096	105	27	1340	56	-1	200	4001	3007	2	18
88	1	13	4	506	1090	120	24	9062	56	-1	200	4001	3007	2	18
89	1	13	4	507	1098	137	22	6476	55	-1	200	4001	3007	2	18
90	1	13	4	508	1096	64	20	6056	55	-1	200	4001	3007	2	18
91	1	13	4	509	1115	82	18	37	54	-1	200	4001	3007	1	36
92	1	13	4	510	1119	25	15	6270	54	-1	200	4001	3007	1	36
93	1	13	4	511	1113	62	13	5498	52	-1	200	4001	3007	1	42
94	1	13	4	512	1120	101	11	5470	51	-1	200	4001	3007	1	42
95	1	13	4	513	1131	78	9	4475	52	-1	200	4001	3007	1	48
96	1	13	4	514	1134	132	7	3464	49	-1	200	4001	3007	1	48
97	1	13	4	515	1137	74	5	4812	49	-1	200	4001	3007	1	56
98	1	13	4	499	1069	55	42	589	47	-1	200	4001	3007	2	18
99	1	13	4	516	1138	32	4	1378	57	-1	200	4001	3007	1	62
100	1	13	4	518	1152	110	-4	-3503	169	-1	200	4001	3007	1	62
101	1	13	4	519	1181	122	-7	-8418	167	-1	200	4001	3007	1	48
102	1	13	4	521	1170	119	-11	-5104	172	-1	200	4001	3007	1	42
103	1	13	4	522	1186	96	-13	-4314	173	-1	200	4001	3007	1	42
104	1	13	4	523	1196	30	-15	-8875	174	-1	200	4001	3007	1	36
105	1	13	4	524	1216	107	-17	-6460	175	-1	200	4001	3007	1	36
106	1	13	4	526	1230	89	-20	-7000	176	-1	200	4001	3007	1	36
107	1	13	4	527	1238	39	-22	-9239	176	-1	200	4001	3007	1	36
108	1	13	4	530	1252	68	-29	-6278	177	-1	200	4001	3007	2	18
109	1	13	4	531	1260	83	-31	-3486	178	-2	200	4001	3007	2	18
110	1	13	4	532	1263	31	-33	-5038	179	-1	200	4001	3007	2	18
111	1	13	4	533	1249	49	-35	-4976	179	-1	200	4001	3007	2	18
112	1	13	4	544	1393	131	-55	-2506	181	-1	200	4001	3007	2	18
113	1	13	4	540	1355	93	-49	-8929	180	-1	200	4001	3007	2	18
114	1	13	4	541	1366	106	-51	-7492	180	-1	200	4001	3007	2	18
115	1	13	4	545	1411	136	-55	-7696	180	-1	200	4001	3007	2	18
116	1	13	4	548	1423	113	-59	-8587	178	-1	200	4001	3007	2	18
117	1	13	4	549	1434	51	-60	-9746	177	-1	200	4001	3007	2	18
118	1	13	4	550	1443	129	-62	-9488	177	-1	200	4001	3007	2	18
119	1	13	4	552	1483	124	-65	-4042	179	-1	200	4001	3007	2	18
120	1	13	4	553	1514	35	-67	-7866	179	-1	200	4001	3007	2	18
121	1	13	4	554	1530	17	-69	-8573	178	-1	200	4001	3007	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
122	1	13	4	556	1563	40	-73	-977	178	-1	200	4001	3007	2	18
123	1	13	4	557	1587	18	-75	-2992	178	-1	200	4001	3007	2	18
124	1	13	4	558	1574	97	-76	-5945	177	-1	200	4001	3007	2	18
125	1	13	4	563	1559	71	-89	-9499	175	-1	200	4001	3007	2	18
126	1	13	4	566	1567	63	-96	-4552	174	-1	200	4001	3007	3	0
127	1	13	4	567	1594	73	-99	-1433	174	-1	200	4001	3007	3	0
128	1	13	4	568	1625	104	-101	-3500	175	-1	200	4001	3007	3	0
129	1	13	4	569	1641	146	-102	-9757	175	-1	200	4001	3007	3	0
130	1	13	4	570	1689	94	-104	-3300	176	-1	200	4001	3007	3	0
131	1	13	4	572	1636	99	-107	-2247	176	-1	200	4001	3007	3	0
132	1	13	4	573	1665	145	-110	-4343	176	-1	200	4001	3007	3	0
133	1	13	4	576	1703	12	-118	-1022	175	-1	200	4001	3007	3	0
134	1	13	4	577	1698	69	-119	-6315	175	-1	200	4001	3007	3	0
135	1	13	4	497	1053	90	46	5247	45	-1	200	4001	3007	2	18
136	1	13	4	500	1077	52	39	9729	48	-1	200	4001	3007	2	18
137	1	18	4	895	2	3	-332	-3613	185	-1	200	4001	12225	3	0
138	1	18	4	896	1	53	-333	-6567	185	-1	200	4001	12225	3	0
139	1	18	4	897	1	65	-336	-8832	185	-1	200	4001	12225	3	0
140	1	18	4	899	1	120	-340	-9725	184	-1	200	4001	12225	3	0
141	1	18	4	905	1	74	-356	-8329	186	-1	200	4001	12225	3	0
142	1	18	4	907	1	105	-361	-12	186	-1	200	4001	12225	3	0
143	1	18	4	906	1	31	-358	-6881	186	-1	200	4001	12225	3	0
144	1	18	4	909	1	55	-375	-4048	187	-1	200	4001	12225	3	0
145	1	18	4	910	1	26	-377	-136	187	-1	200	4001	12225	3	0
146	1	18	4	911	5	52	-377	-9758	187	-1	200	4001	12225	3	0
147	1	18	4	914	14	68	-384	-8136	187	-1	200	4001	12225	3	0
148	1	18	4	915	15	44	-387	-2724	187	-1	200	4001	12225	3	0
149	1	18	4	916	17	143	-389	-2859	187	-1	200	4001	12225	3	0
150	1	18	4	917	5	142	-391	-1931	187	-1	200	4001	12225	3	0
151	1	18	4	801	68	137	-271	-528	187	-1	200	4001	12225	3	0
152	1	18	4	802	59	110	-273	-3804	187	-1	200	4001	12225	3	0
153	1	18	4	803	45	34	-276	-1725	187	-1	200	4001	12225	3	0
154	1	18	4	807	52	122	-285	-474	185	-1	200	4001	12225	3	24
155	1	18	4	810	36	78	-294	-9343	185	-1	200	4001	12225	3	0
156	1	18	4	811	34	49	-299	-3323	184	-1	200	4001	12225	3	0
157	1	18	4	812	31	30	-302	-8802	184	-1	200	4001	12225	3	0
158	1	18	4	889	3	39	-315	-1109	185	-1	200	4001	12225	3	0
159	1	18	4	890	2	108	-318	-6568	185	-1	200	4001	12225	3	0
160	1	18	4	892	2	24	-325	-4382	185	-1	200	4001	12225	3	0
161	1	18	4	894	2	79	-329	-1029	185	-1	200	4001	12225	3	0
162	1	18	4	578	1705	106	-120	-873	176	-1	200	4001	12225	2	18
163	1	18	4	580	1729	113	-123	-3638	176	-1	200	4001	12225	3	0
164	1	18	4	582	1795	89	-130	-56	176	-1	200	4001	12225	2	18
165	1	18	4	583	1837	48	-132	-9509	176	-1	200	4001	12225	2	18
166	1	18	4	585	1799	130	-137	-6356	175	-1	200	4001	12225	3	0
167	1	18	4	592	1821	75	-151	-8983	174	-1	200	4001	12225	3	0
168	1	18	4	595	1849	121	-156	-9403	175	-1	200	4001	12225	2	18
169	1	18	4	599	1831	66	-162	-8440	178	-1	200	4001	12225	2	18
170	1	18	4	600	1853	83	-164	-5727	179	-1	200	4001	12225	2	18
171	1	18	4	604	1910	10	-169	-8265	180	-1	200	4001	12225	3	0
172	1	18	4	605	1945	125	-169	-9117	181	-1	200	4001	12225	3	0
173	1	18	4	607	1983	37	-172	-716	182	-1	200	4001	12225	2	18
174	1	18	4	956	2013	145	-215	-3544	184	-1	200	4001	12225	3	0
175	1	18	4	957	1968	146	-217	-7632	184	-1	200	4001	12225	3	0
176	1	18	4	958	1621	94	-222	-3622	184	-1	200	4001	12225	2	18
177	1	18	4	960	1740	76	-225	-4309	185	-1	200	4001	12225	3	0
178	1	18	4	961	1109	12	-229	-2612	186	-1	200	4001	12225	2	18
179	1	18	4	966	441	71	-244	-9256	186	-1	200	4001	12225	3	0
180	1	18	4	968	480	63	-251	-5444	187	-1	200	4001	12225	3	0
181	1	18	4	626	229	14	-253	-9303	186	-1	200	4001	12225	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
182	1	18	4	627	207	97	-256	-3925	187	-1	200	4001	12225	3	0
183	1	18	4	697	152	69	-260	-6687	187	-1	200	4001	12225	3	0
184	1	18	4	699	116	104	-264	-1423	187	-1	200	4001	12225	3	0
185	1	18	4	963	658	118	-236	-9137	187	-1	200	4001	12225	3	0
186	1	18	4	800	136	72	-268	-8443	188	-1	200	4001	12225	2	18
187	1	18	4	610	1997	17	-178	-4929	181	-4	100	1001	12225	2	18
188	1	18	4	611	2000	85	-179	-4779	181	-4	100	1001	12225	2	18
189	1	18	4	612	2026	18	-180	-4199	182	-4	100	1001	12225	2	18
190	1	18	4	614	2003	22	-184	-249	182	-4	100	1001	12225	2	18
191	1	18	4	616	2050	139	-187	-7460	182	-4	100	1001	12225	2	18
192	1	18	4	617	2063	131	-189	-8419	182	-4	100	1001	12225	2	18
193	1	18	4	618	2087	93	-192	-7270	182	-4	100	1001	12225	2	18
194	1	18	4	620	2122	136	-196	-5039	182	-4	100	1001	12225	2	18
195	1	18	4	624	2280	35	-209	-2270	183	-4	100	1001	12225	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
2	1	7	6	378	1069	10	673	1136	15	-1	200	4001	5009	3	0
3	1	7	6	379	1063	79	670	8889	15	-1	200	4001	5009	3	0
4	1	7	6	380	1094	53	669	1254	15	-1	200	4001	5009	3	0
5	1	7	6	381	1053	34	666	8317	15	-1	200	4001	5009	3	0
6	1	7	6	384	1028	143	662	239	15	-1	200	4001	5009	3	0
7	1	7	6	385	1021	26	661	3373	15	-1	200	4001	5009	3	0
8	1	7	6	386	1017	87	660	1296	15	-1	200	4001	5009	3	0
9	1	7	6	387	1008	66	658	7201	15	-1	200	4001	5009	3	0
10	1	7	6	388	998	24	657	1132	14	-1	200	4001	5009	3	0
11	1	7	6	390	993	3	653	4296	14	-1	200	4001	5009	3	0
12	1	7	6	392	996	98	651	1640	14	-1	200	4001	5009	3	0
13	1	7	6	389	995	33	655	2416	14	-1	200	4001	5009	3	0
14	1	7	6	396	980	28	642	6993	15	-1	200	4001	5009	3	0
15	1	7	6	393	983	108	649	2338	14	-1	200	4001	5009	3	0
16	1	7	6	397	974	128	640	6289	15	-1	200	4001	5009	3	0
17	1	7	6	394	979	90	646	8281	14	-1	200	4001	5009	3	0
18	1	7	6	395	983	65	644	6737	15	-1	200	4001	5009	3	0
19	1	7	6	409	955	52	616	4470	15	-1	200	4001	5009	3	0
20	1	7	6	410	957	32	615	3406	15	-1	200	4001	5009	3	0
21	1	7	6	411	948	64	613	4247	15	-1	200	4001	5009	3	0
22	1	7	6	412	950	45	611	4377	15	-1	200	4001	5009	3	0
23	1	7	6	413	936	82	609	1244	15	-1	200	4001	5009	3	0
24	1	7	6	414	938	62	607	4099	15	-1	200	4001	5009	3	0
25	1	7	6	415	928	137	605	3614	15	-1	200	4001	5009	3	0
26	1	7	6	416	925	38	603	2691	14	-1	200	4001	5009	3	0
27	1	7	6	417	931	92	600	4255	14	-1	200	4001	5009	3	0
28	1	7	6	420	911	49	593	7586	15	-1	200	4001	5009	3	0
29	1	7	6	421	908	122	591	7929	15	-1	200	4001	5009	3	0
30	1	7	6	422	907	121	590	1315	15	-1	200	4001	5009	3	0
31	1	7	6	424	896	133	587	5927	15	-1	200	4001	5009	3	0
32	1	7	6	425	906	83	585	8440	15	-1	200	4001	5009	3	0
33	1	7	6	426	902	89	584	3200	15	-1	200	4001	5009	3	0
34	1	7	6	427	904	112	582	5255	16	-1	200	4001	5009	3	0
35	1	7	6	428	897	77	581	1849	16	-1	200	4001	5009	3	0
36	1	7	6	429	889	19	579	6188	16	-1	200	4001	5009	3	0
37	1	7	6	430	882	31	577	7590	16	-1	200	4001	5009	3	0
38	1	7	6	431	876	58	576	1130	15	-1	200	4001	5009	3	0
39	1	7	6	432	872	68	573	8060	15	-1	200	4001	5009	3	0
40	1	7	6	434	857	107	569	2119	15	-1	200	4001	5009	3	0
41	1	7	6	435	856	75	568	1881	16	-1	200	4001	5009	3	0
42	1	7	6	437	845	96	563	6101	15	-1	200	4001	5009	3	0
43	1	7	6	438	842	17	560	3297	15	-1	200	4001	5009	3	0
44	1	7	6	439	836	48	558	6845	15	-1	200	4001	5009	3	0
45	1	7	6	440	839	60	556	3301	15	-1	200	4001	5009	3	0
46	1	7	6	441	827	100	553	4595	15	-1	200	4001	5009	3	0
47	1	7	6	442	830	131	553	59	16	-1	200	4001	5009	3	0
48	1	7	6	443	829	70	550	3759	16	-1	200	4001	5009	3	0
49	1	7	6	446	836	136	543	8706	15	-1	200	4001	5009	3	0
50	1	7	6	970	840	40	541	3144	16	-1	200	4001	5009	3	0
51	1	7	6	448	847	129	538	2894	15	-1	200	4001	5009	3	0
52	1	7	6	449	855	18	535	9062	15	-1	200	4001	5009	3	0
53	1	7	6	451	856	139	532	6245	15	-1	200	4001	5009	3	0
54	1	7	6	452	858	124	530	6226	15	-1	200	4001	5009	3	0
55	1	7	6	971	863	138	528	3482	15	-1	200	4001	5009	3	0
56	1	7	6	454	862	113	527	455	15	-1	200	4001	5009	3	0
57	1	7	6	972	872	85	523	6312	15	-1	200	4001	5009	3	0
58	1	7	6	456	871	51	521	6282	15	-1	200	4001	5009	3	0
59	1	7	6	462	896	76	507	1795	14	-1	200	4001	5009	3	0
60	1	7	6	459	889	63	511	8869	15	-1	200	4001	5009	3	0
61	1	7	6	463	918	97	505	1065	14	-1	200	4001	5009	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
62	1	7	6	464	905	43	503	4248	14	-1	200	4001	5009	3	0
63	1	7	6	465	908	14	501	5349	14	-1	200	4001	5009	3	0
64	1	7	6	469	921	104	494	7684	14	-1	200	4001	5009	3	0
65	1	7	6	470	926	145	492	4453	14	-1	200	4001	5009	3	0
66	1	7	6	471	931	94	490	4038	14	-1	200	4001	5009	3	0
67	1	7	6	473	940	12	485	9290	14	-1	200	4001	5009	3	0
68	1	7	6	477	957	146	477	2382	13	-1	200	4001	5009	3	0
69	1	14	6	478	958	115	474	8444	13	-1	200	4001	5009	3	0
70	1	14	6	479	966	87	473	1031	13	-1	200	4001	5009	3	0
71	1	14	6	480	973	125	471	1750	13	-1	200	4001	5009	3	0
72	1	14	6	481	981	66	469	3406	13	-1	200	4001	5009	3	0
73	1	14	6	482	992	24	467	5604	13	-1	200	4001	5009	3	0
74	1	14	6	483	994	28	465	4460	13	-1	200	4001	5009	3	0
75	1	14	6	484	993	34	462	9936	13	-1	200	4001	5009	3	0
76	1	14	6	485	994	143	461	1466	13	-1	200	4001	5009	3	0
77	1	14	6	486	998	108	458	6898	13	-1	200	4001	5009	3	0
78	1	14	6	487	1015	98	455	4376	13	-1	200	4001	5009	3	0
79	1	14	6	488	1012	3	453	5664	13	-1	200	4001	5009	3	0
80	1	14	6	489	1022	79	450	8876	13	-1	200	4001	5009	3	0
81	1	14	6	490	1010	53	448	4331	13	-1	200	4001	5009	3	0
82	1	14	6	491	1011	65	446	4469	13	-1	200	4001	5009	3	0
83	1	14	6	492	1025	33	444	3402	13	-1	200	4001	5009	3	0
84	1	14	6	495	1043	128	438	80	12	-1	200	4001	5009	3	0
85	1	14	6	497	1053	90	434	1707	12	-1	200	4001	5009	3	0
86	1	14	6	499	1069	55	429	6607	12	-1	200	4001	5009	3	0
87	1	14	6	500	1077	52	427	5460	12	-1	200	4001	5009	3	0
88	1	14	6	501	1089	38	425	2634	12	-1	200	4001	5009	3	0
89	1	14	6	502	1097	92	422	3870	12	-1	200	4001	5009	3	0
90	1	14	6	503	1114	142	419	7200	12	-1	200	4001	5009	3	0
91	1	14	6	505	1096	105	414	5388	12	-1	200	4001	5009	3	0
92	1	14	6	506	1090	120	413	868	11	-1	200	4001	5009	3	0
93	1	14	6	507	1098	137	411	6038	11	-1	200	4001	5009	3	0
94	1	14	6	509	1115	82	408	5341	11	-1	200	4001	5009	3	0
95	1	14	6	510	1119	25	406	9702	10	-1	200	4001	5009	3	0
96	1	14	6	511	1113	62	405	7449	10	-1	200	4001	5009	3	0
97	1	14	6	512	1120	101	404	3014	10	-1	200	4001	5009	3	0
98	1	14	6	513	1131	78	402	6783	10	-1	200	4001	5009	3	0
99	1	14	6	514	1134	132	401	3200	9	-1	200	4001	5009	3	0
100	1	14	6	515	1137	74	399	8807	9	-1	200	4001	5009	3	0
101	1	14	6	516	1138	32	398	4794	9	-1	200	4001	5009	3	0
102	1	14	6	518	1152	110	391	5894	9	-1	200	4001	5009	3	0
103	1	14	6	519	1181	122	388	3665	9	-1	200	4001	5009	3	0
104	1	14	6	520	1170	133	386	3359	9	-1	200	4001	5009	3	0
105	1	14	6	521	1170	119	384	6210	9	-1	200	4001	5009	3	0
106	1	14	6	522	1186	96	382	7032	9	-1	200	4001	5009	3	0
107	1	14	6	523	1196	30	380	3007	9	-1	200	4001	5009	3	0
108	1	14	6	526	1230	89	375	4326	9	-1	200	4001	5009	3	0
109	1	14	6	527	1238	39	373	2747	9	-1	200	4001	5009	3	0
110	1	14	6	528	1241	121	371	677	10	-1	200	4001	5009	3	0
111	1	14	6	530	1252	68	366	5798	10	-1	200	4001	5009	3	0
112	1	14	6	531	1260	83	364	8074	10	-1	200	4001	5009	3	0
113	1	14	6	532	1263	31	362	6068	10	-1	200	4001	5009	3	0
114	1	14	6	533	1249	49	360	5836	10	-1	200	4001	5009	3	0
115	1	14	6	537	1306	19	350	6381	10	-1	200	4001	5009	3	0
116	1	14	6	539	1331	60	347	4997	10	-1	200	4001	5009	3	0
117	1	14	6	540	1355	93	346	2122	10	-1	200	4001	5009	3	0
118	1	14	6	541	1366	106	344	4320	10	-1	200	4001	5009	3	0
119	1	14	6	544	1393	131	340	8402	10	-1	200	4001	5009	3	0
120	1	14	6	545	1411	136	340	4882	10	-1	200	4001	5009	3	0
121	1	14	6	548	1423	113	336	8954	11	-1	200	4001	5009	3	0

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE	AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
122	1	14	6	549	1434	51	336 270	11	-1	200	4001	5009	3	0
123	1	14	6	550	1443	129	334 1129	11	-1	200	4001	5009	3	0
124	1	14	6	552	1483	124	331 2277	11	-1	200	4001	5009	3	0
125	1	14	6	553	1514	35	328 8238	11	-1	200	4001	5009	3	0
126	1	14	6	554	1530	17	326 8906	11	-1	200	4001	5009	3	0
127	1	14	6	555	1561	100	325 6289	11	-1	200	4001	5009	3	0
128	1	14	6	556	1563	40	323 9424	11	-1	200	4001	5009	3	0
129	1	14	6	557	1587	18	321 8068	11	-1	200	4001	5009	3	0
130	1	14	6	558	1574	97	320 7982	12	-1	200	4001	5009	3	0
131	1	14	6	559	1583	56	318 3309	12	-1	200	4001	5009	3	0
132	1	14	6	563	1559	71	308 9022	13	-1	200	4001	5009	3	0
133	1	14	6	564	1569	118	306 8457	13	-1	200	4001	5009	3	0
134	1	14	6	565	1546	14	304 8356	13	-1	200	4001	5009	2	18
135	1	14	6	566	1567	63	303 5566	13	-1	200	4001	5009	3	0
136	1	14	6	567	1594	73	300 7805	13	-1	200	4001	5009	3	0
137	1	14	6	568	1625	104	298 2743	13	-1	200	4001	5009	3	0
138	1	14	6	569	1641	146	296 5225	13	-1	200	4001	5009	3	0
139	1	14	6	570	1689	94	294 8600	13	-1	200	4001	5009	3	0
140	1	14	6	572	1636	99	292 3299	14	-1	200	4001	5009	3	0
141	1	14	6	573	1665	145	289 2462	14	-1	200	4001	5009	3	0
142	1	14	6	576	1703	12	282 2892	14	-1	200	4001	5009	3	0
143	1	14	6	577	1698	69	280 9756	15	-1	200	4001	5009	3	0
144	1	16	6	895	2	3	67 7816	28	-1	200	4001	5009	1	36
145	1	16	6	896	1	53	66 6607	29	-1	200	4001	5009	1	36
146	1	16	6	897	1	65	64 222	31	-1	200	4001	5009	1	36
147	1	16	6	899	1	120	60 9487	33	-1	200	4001	5009	1	36
148	1	16	6	905	1	74	43 6485	35	-1	200	4001	5009	1	36
149	1	16	6	906	1	31	42 3897	37	-1	200	4001	5009	1	36
150	1	16	6	907	1	105	40 3591	38	-1	200	4001	5009	1	36
151	1	16	6	908	1	62	25 7956	42	-1	200	4001	5009	1	36
152	1	16	6	910	1	26	22 4596	42	-1	200	4001	5009	1	36
153	1	16	6	911	5	52	20 7347	39	-1	200	4001	5009	1	36
154	1	16	6	909	1	55	24 1551	41	-1	200	4001	5009	1	36
155	1	16	6	912	10	38	19 264	41	-1	200	4001	5009	1	36
156	1	16	6	914	14	68	15 1753	52	-1	200	4001	5009	1	36
157	1	16	6	915	15	44	13 2051	58	-1	200	4001	5009	1	42
158	1	16	6	916	17	143	12 1293	66	-1	200	4001	5009	1	36
159	1	16	6	917	5	142	11 66	74	-1	200	4001	5009	1	48
160	1	16	6	801	68	137	124 8353	11	-1	200	4001	5009	2	18
161	1	16	6	802	59	110	122 5470	12	-1	200	4001	5009	2	18
162	1	16	6	803	45	34	119 8091	12	-1	200	4001	5009	2	18
163	1	16	6	804	32	64	116 8056	12	-1	200	4001	5009	2	18
164	1	16	6	805	22	25	113 1595	13	-1	200	4001	5009	2	18
165	1	16	6	807	52	122	113 140	19	-1	200	4001	5009	1	36
166	1	16	6	808	43	90	110 3970	19	-1	200	4001	5009	1	36
167	1	16	6	810	36	78	103 7761	21	-1	200	4001	5009	1	36
168	1	16	6	811	34	49	99 7660	22	-1	200	4001	5009	1	36
169	1	16	6	812	31	30	96 4279	22	-1	200	4001	5009	1	36
170	1	16	6	888	4	92	88 2079	23	-1	200	4001	5009	1	36
171	1	16	6	813	31	128	92 5905	24	-1	200	4001	5009	2	18
172	1	16	6	889	3	39	84 305	23	-1	200	4001	5009	1	36
173	1	16	6	892	2	24	73 5787	25	-1	200	4001	5009	1	36
174	1	16	6	894	2	79	70 7878	27	-1	200	4001	5009	1	36
175	1	16	6	520	1170	129	386 3359	9	-1	200	4001	5009	3	0
176	1	16	6	523	1196	124	380 3007	9	-1	200	4001	5009	3	0
177	1	16	6	526	1230	85	375 4326	9	-1	200	4001	5009	3	0
178	1	16	6	585	1799	130	264 911	16	-1	200	4001	5009	3	0
179	1	16	6	584	1804	10	266 2485	16	-1	200	4001	5009	3	0
180	1	16	6	586	1814	83	263 1352	16	-1	200	4001	5009	3	0
181	1	16	6	587	1811	133	261 8204	16	-1	200	4001	5009	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE	AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
182	1	16	6	588	1812	77	260 1267	17	-1	200	4001	5009	2	18
183	1	16	6	589	1811	87	257 9977	17	-1	200	4001	5009	3	0
184	1	16	6	592	1821	75	251 9707	18	-1	200	4001	5009	3	0
185	1	16	6	595	1849	121	245 9267	17	-1	200	4001	5009	3	0
186	1	16	6	596	1819	58	243 3551	17	-1	200	4001	5009	3	0
187	1	16	6	597	1835	103	240 5883	17	-1	200	4001	5009	2	18
188	1	16	6	580	1729	113	276 6587	14	-1	200	4001	5009	3	0
189	1	16	6	582	1795	89	270 1209	15	-1	200	4001	5009	2	18
190	1	16	6	529	1253	139	368 5094	10	-1	200	4001	5009	3	0
191	1	16	6	532	1263	18	362 6068	10	-1	200	4001	5009	3	0
192	1	16	6	536	1287	60	352 7441	10	-1	200	4001	5009	3	0
193	1	16	6	538	1332	35	348 7896	10	-1	200	4001	5009	3	30
194	1	16	6	541	1366	22	344 4320	10	-1	200	4001	5009	3	0
195	1	16	6	545	1411	17	340 4882	10	-1	200	4001	5009	3	0
196	1	16	6	549	1434	136	336 270	11	-1	200	4001	5009	3	0
197	1	16	6	552	1483	93	331 2277	11	-1	200	4001	5009	3	0
198	1	16	6	555	1561	131	325 6289	11	-1	200	4001	5009	3	0
199	1	16	6	557	1587	40	321 8068	11	-1	200	4001	5009	3	0
200	1	16	6	926	1	115	-2 -7677	201	-1	200	4001	5009	1	64
201	1	16	6	928	1	101	-15 -3159	226	-1	200	4001	5009	1	64
202	1	16	6	929	1	107	-23 -7743	227	-1	200	4001	5009	1	36
203	1	16	6	930	1	119	-25 -3625	229	-1	200	4001	5009	1	36
204	1	16	6	558	1574	145	320 7982	12	-1	200	4001	5009	3	0
205	1	16	6	559	1583	72	318 3309	12	-1	200	4001	5009	3	0
206	1	16	6	560	1557	146	316 1464	12	-1	200	4001	5009	3	0
207	1	16	6	562	1568	97	311 1440	12	-1	200	4001	5009	3	0
208	1	16	6	563	1559	14	308 9022	13	-1	200	4001	5009	3	0
209	1	16	6	565	1546	94	304 8356	13	-1	200	4001	5009	3	0
210	1	16	6	566	1567	104	303 5566	13	-1	200	4001	5009	3	0
211	1	16	6	567	1594	99	300 7805	13	-1	200	4001	5009	3	0
212	1	16	6	569	1641	56	296 5225	13	-1	200	4001	5009	3	0
213	1	16	6	571	1644	12	293 8916	14	-1	200	4001	5009	3	0
214	1	16	6	572	1636	118	292 3299	14	-1	200	4001	5009	3	0
215	1	16	6	574	1663	36	287 1447	14	-1	200	4001	5009	3	0
216	1	16	6	575	1657	76	284 6590	14	-1	200	4001	5009	3	0
217	1	16	6	576	1703	63	282 2892	14	-1	200	4001	5009	3	0
218	1	16	6	577	1698	71	280 9756	15	-1	200	4001	5009	3	0
219	1	19	6	895	2	3	67 7816	28	-1	200	4001	5009	1	36
220	1	19	6	896	1	53	66 6607	29	-1	200	4001	5009	1	36
221	1	19	6	897	1	65	64 222	31	-1	200	4001	5009	1	36
222	1	19	6	899	1	120	60 9487	33	-1	200	4001	5009	1	36
223	1	19	6	905	1	74	43 6485	35	-1	200	4001	5009	1	36
224	1	19	6	906	1	31	42 3897	37	-1	200	4001	5009	1	36
225	1	19	6	907	1	105	40 3591	38	-1	200	4001	5009	1	36
226	1	19	6	909	1	55	24 1551	41	-1	200	4001	5009	1	36
227	1	19	6	910	1	26	22 4596	42	-1	200	4001	5009	1	36
228	1	19	6	911	5	52	20 7347	39	-1	200	4001	5009	1	36
229	1	19	6	912	10	38	19 264	41	-1	200	4001	5009	1	36
230	1	19	6	914	14	68	15 1753	52	-1	200	4001	5009	1	36
231	1	19	6	915	15	44	13 2051	58	-1	200	4001	5009	1	42
232	1	19	6	916	17	143	12 1293	66	-1	200	4001	5009	1	36
233	1	19	6	917	5	142	11 66	74	-1	200	4001	5009	1	48
234	1	19	6	801	68	137	124 8353	11	-1	200	4001	5009	3	0
235	1	19	6	802	59	110	122 5470	12	-1	200	4001	5009	2	18
236	1	19	6	807	52	122	113 140	19	-1	200	4001	5009	3	0
237	1	19	6	803	45	34	119 8091	12	-1	200	4001	5009	3	0
238	1	19	6	810	36	78	103 7761	21	-1	200	4001	5009	2	18
239	1	19	6	811	34	49	99 7660	22	-1	200	4001	5009	2	18
240	1	19	6	812	31	30	96 4279	22	-1	200	4001	5009	2	18
241	1	19	6	889	3	39	84 305	23	-1	200	4001	5009	2	18

FILE	EXP NO	SHOT	SHOTPT	LOC	ELEV	UNIT	RANGE		AZIMUTH	TMIN	NSRATE	NSAMP	SIZE	CHAN	DB
242	1	19	6	890	2	108	80	5529	24	-1	200	4001	5009	2	18
243	1	19	6	892	2	24	73	5787	25	-1	200	4001	5009	2	18
244	1	19	6	894	2	79	70	7878	27	-1	200	4001	5009	2	18
245	1	19	6	578	1705	106	279	8522	14	-1	200	4001	5009	3	0
246	1	19	6	580	1729	113	276	6587	14	-1	200	4001	5009	3	0
247	1	19	6	581	1745	100	273	8836	15	-1	200	4001	5009	3	0
248	1	19	6	582	1795	89	270	1209	15	-1	200	4001	5009	3	0
249	1	19	6	583	1837	48	267	6652	15	-1	200	4001	5009	3	0
250	1	19	6	585	1799	130	264	911	16	-1	200	4001	5009	3	0
251	1	19	6	587	1811	133	261	8204	16	-1	200	4001	5009	3	0
252	1	19	6	592	1821	75	251	9707	18	-1	200	4001	5009	3	0
253	1	19	6	595	1849	121	245	9267	17	-1	200	4001	5009	3	0
254	1	19	6	599	1831	66	237	6750	16	-1	200	4001	5009	3	0
255	1	19	6	600	1853	83	235	5509	16	-1	200	4001	5009	3	0
256	1	19	6	602	1886	58	231	6132	16	-1	200	4001	5009	3	0
257	1	19	6	604	1910	10	229	2313	15	-1	200	4001	5009	3	0
258	1	19	6	605	1945	125	228	5459	15	-1	200	4001	5009	3	0
259	1	19	6	607	1983	77	225	8327	14	-1	200	4001	5009	3	0
260	1	19	6	956	2013	145	182	771	15	-1	200	4001	5009	3	0
261	1	19	6	957	1968	146	179	7060	15	-1	200	4001	5009	3	0
262	1	19	6	958	1621	94	174	9191	14	-1	200	4001	5009	3	0
263	1	19	6	960	1740	76	171	4002	14	-1	200	4001	5009	3	0
264	1	19	6	961	1109	12	167	12	12	-1	200	4001	5009	2	18
265	1	19	6	962	659	36	163	820	12	-1	200	4001	5009	3	0
266	1	19	6	963	658	118	159	1338	12	-1	200	4001	5009	3	0
267	1	19	6	966	441	71	151	4455	13	-1	200	4001	5009	3	0
268	1	19	6	968	480	63	144	6660	13	-1	200	4001	5009	3	0
269	1	19	6	626	229	14	142	3788	13	-1	200	4001	5009	2	18
270	1	19	6	627	207	97	139	7567	12	-1	200	4001	5009	3	0
271	1	19	6	697	152	69	135	4889	13	-1	200	4001	5009	3	0
272	1	19	6	699	116	104	131	7837	11	-1	200	4001	5009	3	0
273	1	19	6	700	93	43	130	4622	11	-1	200	4001	5009	3	0
274	1	19	6	800	136	72	127	118	11	-1	200	4001	5009	2	18
275	1	19	6	612	2026	18	217	8710	15	-5	100	1001	5009	3	0
276	1	19	6	611	2000	85	218	9210	15	-5	100	1001	5009	3	0
277	1	19	6	610	1997	17	219	8890	15	-5	100	1001	5009	3	0
278	1	19	6	613	2029	129	216	4600	15	-5	100	1001	5009	3	0
279	1	19	6	614	2003	22	214	2079	15	-5	100	1001	5009	3	0
280	1	19	6	616	2050	139	210	2760	15	-5	100	1001	5009	3	0
281	1	19	6	617	2063	131	208	1920	15	-5	100	1001	5009	3	0
282	1	19	6	624	2280	35	188	7519	15	-5	100	1001	5009	3	0

APPENDIX 2. Observed arrival times (reduction velocities 6 and 8 km/s) used in the traveltime interpretation.

SP 1 NE

UNIT	DISTANCE	T-Δ/6
226	-002.0,	+00.29
225	-002.7,	+00.30
224	-004.5,	+00.33
223	-006.2,	+00.33
222	-007.4,	+00.34
221	-009.5,	+00.36
220	-011.9,	+00.34
218	-014.5,	+00.36
217	-017.1,	+00.37
216	-019.9,	+00.34
215	-021.6,	+00.37
214	-023.8,	+00.39
213	-025.4,	+00.40
210	-030.7,	+00.44
209	-032.9,	+00.45
205	-039.4,	+00.46
203	-043.1,	+00.45
199	-044.6,	+00.45
125	-048.7,	+00.38
123	-051.5,	+00.39
122	-053.3,	+00.39
121	-055.2,	+00.40
120	-056.0,	+00.36
118	-058.0,	+00.34
116	-060.9,	+00.32
114	-064.7,	+00.30
112	-068.2,	+00.24
111	-069.8,	+00.24
110	-071.3,	+00.29
109	-072.7,	+00.34
108	-074.0,	+00.31
107	-074.8,	+00.32
106	-075.4,	+00.32
104	-077.4,	+00.29
100	-082.0,	+00.09
099	-083.1,	+00.13
097	-084.7,	+00.10

SP 1 SW

UNIT	DISTANCE	T-Δ/6
227	002.1,	+00.30
229	006.7,	+00.26
230	008.7,	+00.28
232	012.8,	+00.25
234	016.8,	+00.26
235	018.7,	+00.25
237	022.7,	+00.22
238	024.6,	+00.19
239	026.7,	+00.19
240	028.8,	+00.18
241	030.8,	+00.15
244	036.9,	+00.11
245	039.2,	+00.09
246	045.3,	+00.00
247	048.4,	-00.04
248	051.3,	-00.03
251	056.0,	-00.11
252	058.8,	-00.09
253	061.1,	-00.13
254	063.0,	-00.11
255	064.9,	-00.13
257	069.2,	-00.12
258	070.4,	-00.15
260	075.4,	-00.10
261	077.5,	-00.10
262	079.7,	-00.11
263	081.3,	-00.14
264	082.9,	-00.11
266	086.5,	-00.08
268	089.6,	-00.12
270	092.7,	-00.13
271	094.8,	-00.14
272	097.0,	-00.21
273	098.9,	-00.27
274	102.2,	-00.28
275	104.5,	-00.26
276	107.0,	-00.25
280	112.6,	-00.27
281	114.0,	-00.29
282	115.3,	-00.33
283	116.3,	-00.31
284	117.4,	-00.30
287	122.0,	-00.37
290	126.1,	-00.41
291	127.6,	-00.39
293	130.9,	-00.41
294	132.8,	-00.44
295	134.1,	-00.43
296	136.0,	-00.46
297	138.1,	-00.47
299	141.2,	-00.57
327	192.6,	-00.90
328	194.6,	-01.03
329	196.6,	-01.14
330	200.5,	-01.21
332	203.3,	-01.34
334	206.0,	-01.42
335	208.0,	-01.45
337	212.6,	-01.81
338	214.9,	-01.93
339	216.3,	-01.99
340	218.4,	-02.07

UNIT	DISTANCE	T-Δ/6
341	220.7,	-02.22
342	223.0,	-02.28
346	230.3,	-02.53
347	233.3,	-02.72
348	235.3,	-02.85
350	239.1,	-02.99
351	240.1,	-03.05
353	242.8,	-03.19
354	245.5,	-03.24
357	252.2,	-03.71
358	255.4,	-03.82
359	257.0,	-03.78
362	262.9,	-04.09
363	264.9,	-04.18
374	270.3,	-04.43
376	274.3,	-04.55
377	276.6,	-04.60
378	278.1,	-04.75
379	280.5,	-04.77
380	282.2,	-04.00
381	285.0,	-04.05
386	292.6,	-04.31
387	294.3,	-04.40
388	296.3,	-04.47
389	297.9,	-04.52
390	299.8,	-04.59
394	305.3,	-04.89
395	307.1,	-05.01
398	312.4,	-05.03
399	314.0,	-05.16
401	318.2,	-05.32
405	325.0,	-05.89
407	328.4,	-05.97
409	332.4,	-06.26
411	335.2,	-06.33
412	337.3,	-06.48
413	339.4,	-06.56
414	341.1,	-06.58
415	343.1,	-06.64
416	345.1,	-06.67
304	147.4,	+01.30
305	149.5,	+01.23
307	152.1,	+01.14
308	155.9,	+00.94
310	159.8,	+00.68
311	161.8,	+00.57
312	163.9,	+00.51
313	165.9,	+00.42
314	167.9,	+00.37
316	172.0,	-00.04
317	174.1,	-00.13
319	177.6,	-00.29
508	536.4,	-15.84
512	544.4,	-16.14
522	565.9,	-16.82
523	568.0,	-16.83
524	569.5,	-17.26
526	572.3,	-17.44
527	574.1,	-17.48

SP 2 NE

UNIT	DISTANCE	T-△/6
302	-001.9,	-00.01
299	-003.3,	-00.02
296	-009.3,	+00.06
295	-011.1,	+00.01
294	-012.7,	+00.01
293	-014.9,	+00.02
292	-016.6,	+00.03
290	-020.6,	+00.04
288	-024.4,	-00.02
287	-025.8,	+00.05
283	-031.1,	-00.03
282	-031.8,	-00.03
281	-032.6,	+00.04
280	-033.3,	+00.02
279	-034.8,	-00.23
276	-039.2,	-00.06
275	-041.1,	-00.04
274	-042.7,	-00.10
273	-045.8,	-00.06
272	-047.8,	-00.08
271	-049.9,	-00.05
270	-052.1,	-00.11
268	-055.6,	-00.13
264	-063.3,	-00.25
263	-065.2,	-00.27
262	-066.9,	-00.29
261	-069.1,	-00.25
260	-071.4,	-00.25
258	-076.5,	-00.24
257	-077.3,	-00.25
255	-081.4,	-00.27
253	-085.3,	-00.39
252	-087.2,	-00.43
251	-089.8,	-00.37
248	-094.2,	-00.40
247	-096.9,	-00.39
245	-105.7,	-00.37
244	-107.7,	-00.36
241	-113.5,	-00.54
240	-115.4,	-00.49
239	-117.4,	-00.59
238	-119.5,	-00.60
237	-121.3,	-00.57
235	-125.1,	-00.53
234	-126.8,	-00.54
232	-130.6,	-00.51
230	-134.6,	-00.64
224	-146.9,	-00.71
223	-148.7,	-00.64
222	-149.8,	-00.69
220	-154.1,	-00.67
215	-162.7,	-00.65
214	-164.6,	-00.64
213	-166.1,	-00.60
210	-171.2,	-00.63
253	-085.3,	+01.00
252	-087.2,	+00.94
251	-089.8,	+00.74
247	-096.9,	+00.56
245	-105.7,	+00.40
244	-107.7,	+00.39

UNIT	DISTANCE	T-△/6
241	-113.5,	+00.33
240	-115.4,	+00.22
239	-117.4,	+00.18
238	-119.5,	+00.17
237	-121.3,	+00.19
235	-125.1,	+00.09
234	-126.8,	+00.09
232	-130.6,	+00.04
230	-134.6,	+00.01
225	-145.0,	-00.21
224	-146.9,	-00.26
232	-130.6,	+00.61
230	-134.6,	+00.46
224	-146.9,	+00.27
222	-149.8,	+00.18
220	-154.1,	+00.14
218	-156.4,	+00.12
217	-158.7,	+00.13
210	-171.2,	+00.09
209	-173.2,	+00.03
207	-176.3,	+00.03
205	-180.2,	-00.02
203	-185.2,	-00.16
200	-187.0,	-00.17
199	-187.8,	-00.17
125	-192.2,	-00.35
123	-194.9,	-00.42
122	-196.7,	-00.45
114	-207.2,	-00.60
113	-208.6,	-00.52
112	-210.4,	-00.64
111	-211.9,	-00.56
109	-214.2,	-00.67
108	-215.3,	-00.66
107	-215.7,	-00.66
104	-217.0,	-00.68
097	-220.5,	-00.97

SP 2 SW

UNIT	DISTANCE	T-△/6
303	002.5,	+00.05
304	004.0,	+00.02
305	006.1,	+00.05
307	008.7,	+00.05
308	012.5,	+00.07
310	016.4,	+00.08
311	018.4,	+00.10
312	020.5,	+00.09
313	022.6,	+00.09
314	024.5,	+00.05
315	026.6,	+00.04
316	028.6,	+00.00
317	030.7,	+00.01
318	032.2,	+00.02
321	038.2,	-00.05
322	040.2,	-00.03
324	044.2,	-00.03
326	047.3,	-00.01
328	051.1,	-00.02
329	053.2,	-00.04
330	057.0,	-00.03
331	058.7,	-00.04
332	059.8,	-00.02
334	062.6,	-00.04
335	064.5,	-00.03
337	069.1,	-00.01
339	072.9,	-00.07
340	075.0,	-00.05
341	077.3,	-00.12
342	079.7,	-00.09
343	081.3,	-00.09
346	087.2,	-00.03
347	090.1,	-00.06
348	092.0,	-00.05
349	093.7,	-00.04
351	096.8,	-00.06
354	102.2,	-00.07
357	108.9,	-00.20
358	112.1,	-00.23
359	113.7,	-00.29
360	115.6,	-00.27
361	117.3,	-00.24
362	119.6,	-00.29
364	123.5,	-00.19
374	127.0,	-00.22
376	131.1,	-00.19
377	133.3,	-00.29
378	134.8,	-00.27
379	137.2,	-00.33
380	138.9,	-00.31
381	141.7,	-00.32
383	144.3,	-00.36
384	146.9,	-00.33
385	147.9,	-00.32
386	149.2,	-00.34
388	153.0,	-00.34
389	154.6,	-00.31
390	156.4,	-00.37
391	157.8,	-00.38
392	158.4,	-00.33
393	159.9,	-00.32
394	161.9,	-00.36

SP 2 SW, cont.

UNIT	DISTANCE	T-Δ/6
395	163.7,	-00.36
396	165.4,	-00.35
397	167.3,	-00.39
398	169.0,	-00.42
399	170.6,	-00.40
400	172.8,	-00.46
401	174.8,	-00.41
402	176.3,	-00.45
404	180.1,	-00.61
405	181.8,	-00.59
407	185.2,	-01.02
410	190.1,	-00.96
413	196.2,	-01.36
414	198.0,	-01.38
416	202.0,	-01.57
418	207.6,	-01.84
420	210.3,	-01.98
421	211.6,	-02.02
422	212.8,	-02.09
426	217.0,	-02.16
427	218.5,	-02.39
428	219.7,	-02.37
429	221.3,	-02.41
430	223.2,	-02.46
431	224.9,	-02.50
434	231.6,	-02.81
435	232.2,	-02.96
445	253.9,	-03.96
446	256.1,	-04.03
447	258.6,	-04.23
448	261.7,	-04.38
449	264.1,	-04.42
451	267.4,	-04.57
452	269.4,	-04.68
453	271.7,	-04.68
454	273.1,	-04.70
455	276.5,	-04.96
456	278.6,	-04.96
470	309.3,	-07.08
471	311.5,	-07.30
473	316.1,	-07.91
474	318.3,	-07.89
475	320.9,	-08.01
477	325.0,	-07.81
349	093.7,	+00.69
350	095.8,	+00.67
354	102.2,	+00.56
362	119.6,	+00.39
377	133.3,	+00.30
378	134.8,	+00.28
379	137.2,	+00.16
380	138.9,	+00.11
381	141.7,	+00.10
383	144.3,	+00.08
384	146.9,	+00.03
385	147.9,	+00.03
386	149.3,	+00.03
387	151.0,	+00.00
388	153.0,	-00.01
389	154.6,	-00.07
390	156.4,	-00.09
391	157.8,	-00.10
393	159.9,	-00.13

UNIT	DISTANCE	T-Δ/6
394	161.9,	-00.06
395	163.7,	-00.11
396	165.4,	-00.13
397	167.3,	-00.14
398	169.0,	-00.20
376	131.1,	+01.13
379	137.2,	+00.94
380	138.9,	+00.90
381	141.7,	+00.80
383	144.3,	+00.67
384	146.9,	+00.74
385	147.9,	+00.71
386	149.3,	+00.68
387	151.0,	+00.65
388	153.0,	+00.63
389	154.6,	+00.54
390	156.4,	+00.51
391	157.8,	+00.46
393	159.9,	+00.42
394	161.9,	+00.42
395	163.7,	+00.42
396	165.4,	+00.32
397	167.3,	+00.28
398	169.0,	+00.24
399	170.6,	+00.16
400	172.8,	+00.11
401	174.8,	+00.16
402	176.3,	+00.02
403	178.0,	-00.02
404	180.1,	-00.08
405	181.8,	-00.09
407	185.2,	-00.16
408	187.3,	-00.19
409	189.1,	-00.25
411	192.0,	-00.28
412	194.1,	-00.33
413	196.2,	-00.40
414	198.0,	-00.41
415	200.0,	-00.43
416	202.0,	-00.45
417	205.0,	-00.51
419	208.4,	-00.59
420	210.3,	-00.65
421	211.6,	-00.68
422	212.8,	-00.69
423	213.5,	-00.72
424	214.5,	-00.75
425	215.8,	-00.79
426	217.0,	-00.82
427	218.5,	-00.90
428	219.7,	-00.92
429	221.3,	-01.03
430	223.2,	-01.07
431	224.9,	-01.12
432	227.1,	-01.15
433	229.9,	-01.17
434	231.6,	-01.22
435	232.2,	-01.27
445	253.9,	-01.73
446	256.1,	-01.79
447	258.6,	-01.86
448	261.7,	-02.00

SP 3 NE

UNIT	DISTANCE	T-Δ/6
408	-001.5,	+00.02
407	-003.1,	+00.04
406	-003.8,	+00.02
405	-006.3,	+00.03
404	-008.0,	+00.05
402	-012.1,	+00.05
401	-013.7,	+00.05
400	-016.0,	+00.05
398	-020.4,	+00.07
397	-022.4,	+00.10
396	-024.5,	+00.06
395	-026.4,	+00.06
394	-028.6,	+00.08
393	-031.0,	+00.07
392	-032.9,	+00.08
391	-033.5,	+00.05
390	-035.2,	+00.05
389	-037.0,	+00.07
388	-038.8,	+00.05
387	-040.4,	+00.07
386	-041.9,	+00.07
385	-043.1,	+00.09
384	-043.8,	+00.06
383	-046.5,	+00.06
381	-048.8,	+00.06
379	-053.0,	+00.05
378	-055.3,	+00.06

SP 3 SW

UNIT	DISTANCE	T-Δ/6
409	002.2	+00.04
410	003.2,	+00.05
411	004.9,	+00.06
412	006.7,	+00.02
414	010.7,	+00.03
416	014.8,	+00.03
418	020.4,	+00.03
420	024.4,	+00.02
421	026.5,	+00.02
422	028.3,	+00.04
423	029.6,	+00.02
424	031.3,	+00.00
425	033.4,	+00.00
426	035.1,	-00.02
427	037.1,	-00.03
428	038.5,	-00.03
431	043.1,	-00.07
434	049.7,	-00.23
438	058.4,	-00.26
441	065.1,	-00.33
442	065.7,	-00.30
444	070.2,	-00.31
445	072.6,	-00.32
446	074.7,	-00.35
447	077.1,	-00.44
449	082.7,	-00.54
450	084.3,	-00.56
451	086.0,	-00.59
452	087.9,	-00.55
454	091.4,	-00.55
457	099.0,	-00.64
469	123.4,	-00.76
470	125.8,	-00.87
471	127.9,	-00.83
474	134.6,	-00.99
476	139.3,	-00.91
478	143.6,	-00.99
479	145.4,	-00.99
481	149.2,	-01.05
482	151.1,	-01.06
483	153.2,	-01.11
484	155.6,	-01.08
485	157.5,	-01.21
486	160.0,	-01.10
487	163.3,	-01.11
488	165.2,	-01.13
489	168.0,	-01.16
490	170.5,	-01.16
491	172.4,	-01.18
492	174.6,	-01.22
495	181.0,	-01.34
497	184.8,	-01.36
499	189.5,	-01.54
501	194.0,	-01.72
502	196.9,	-01.87
503	199.7,	-01.99
505	205.2,	-02.22
506	206.8,	-02.33
507	208.6,	-02.41
508	210.2,	-02.42
511	215.7,	-02.59
512	217.4,	-02.66

UNIT	DISTANCE	T-Δ/6
514	221.0,	-02.81
515	222.7,	-02.85
516	224.2,	-02.94
519	234.0,	-03.31
521	237.6,	-03.31
522	239.3,	-03.58
527	248.2,	-03.94
530	254.6,	-04.31
532	258.4,	-04.40
533	260.4,	-04.55
541	275.9,	-05.29
545	279.6,	-05.30
548	282.7,	-05.46
549	283.4,	-05.56
550	285.3,	-05.60
551	286.7,	-05.75
553	290.7,	-05.95
554	292.5,	-05.87
557	297.3,	-06.04
558	298.1,	-06.07
566	314.7,	-06.71
573	328.9,	-07.33
576	335.8,	-07.61
577	337.2,	-07.66
476	139.3,	-00.12
477	141.2,	-00.26
478	143.6,	-00.32
480	147.4,	-00.49
481	149.2,	-00.46
482	151.1,	-00.45
483	153.2,	-00.45
484	155.6,	-00.36
485	157.5,	-00.43
486	160.0,	-00.49
487	163.3,	-00.54
488	165.2,	-00.56
489	168.0,	-00.60
490	170.5,	-00.68
491	172.4,	-00.67
497	184.8,	-01.16
499	189.5,	-01.17
501	194.0,	-01.13
502	196.9,	-01.46
503	199.7,	-01.49
508	210.2,	-02.10
509	212.3,	-02.13
511	215.7,	-02.15
512	217.4,	-02.18
513	219.3,	-02.20
515	222.7,	-02.33
521	237.6,	-02.70
522	239.3,	-02.86
523	241.6,	-02.81
530	254.6,	-03.55
532	258.4,	-03.83
533	260.4,	-03.96
488	165.2,	-00.16
489	168.0,	-00.23
490	170.5,	-00.25
491	172.4,	-00.41
495	181.0,	-00.76

SP 3 SW

UNIT	DISTANCE	T-Δ/6
497	184.8,	-00.78
501	194.0,	-00.79
502	96.9,	-01.00
503	199.7,	-00.99
505	205.2,	-01.13
506	206.8,	-01.15
507	208.6,	-01.18
508	210.2,	-01.21
509	212.3,	-01.22
510	214.1,	-01.23
511	215.7,	-01.27
512	217.4,	-01.32
513	219.3,	-01.36
514	221.0,	-01.38
515	222.7,	-01.40
516	224.2,	-01.43
518	231.2,	-02.16
519	234.0,	-02.24
523	241.6,	-02.38
469	123.4,	+01.56
470	125.8,	+01.45
471	127.9,	+01.34
474	134.6,	+01.14
476	139.3,	+01.06
478	143.6,	+00.83
479	145.4,	+00.74
481	149.2,	+00.64
483	153.2,	+00.56
484	155.6,	+00.51
485	157.5,	+00.45
487	163.3,	+00.41
488	165.2,	+00.33
489	168.0,	+00.18
490	179.5,	+00.12
491	172.4,	+00.06
519	234.0,	-01.78
521	237.6,	-01.68
522	239.3,	-01.70
523	241.6,	-01.72
527	248.2,	-02.08
530	254.6,	-02.20
532	258.4,	-02.15
533	260.4,	-02.24
540	274.2,	-01.75
545	279.6,	-01.88
551	286.7,	-02.32
553	290.7,	-02.14
555	293.7,	-02.20
566	314.7,	-02.26
567	317.4,	-02.30
573	328.9,	-02.29
576	335.8,	-02.47
577	337.2,	-02.50

SP 4 NE

UNIT	DISTANCE	T-Δ/6
516	-004.1,	+00.02
515	-005.5,	+00.02
514	-007.3,	+00.02
513	-009.4,	+00.03
512	-011.5,	+00.03
511	-013.6,	+00.01
510	-015.6,	+00.04
509	-018.0,	+00.01
508	-020.6,	+00.04
507	-022.6,	+00.01
506	-024.9,	+00.02
505	-027.1,	-00.01
504	-030.1,	-00.37
503	-032.6,	-00.06
502	-035.1,	-00.13
501	-037.9,	-00.13
500	-040.0,	-00.19
499	-042.1,	-00.17
497	-046.5,	-00.29
495	-050.1,	-00.38
492	-056.1,	-00.27
491	-058.0,	-00.29
490	-059.8,	-00.29
489	-062.3,	-00.29
488	-065.0,	-00.27
487	-066.9,	-00.36
486	-070.1,	-00.35
484	-074.3,	-00.40
483	-076.7,	-00.39
482	-078.7,	-00.35
481	-080.8,	-00.41
480	-082.7,	-00.52
479	-084.7,	-00.33
477	-088.9,	-00.41
475	-093.0,	-00.37
474	-095.5,	-00.33
471	-102.3,	-00.27
470	-104.4,	-00.42
469	-106.8,	-00.35
457	-133.0,	-00.96
454	-140.8,	-00.77
450	-148.1,	-00.87
490	-059.8,	+00.73
489	-062.3,	+00.62
488	-065.0,	+00.59
487	-066.9,	+00.56
486	-070.1,	+00.44
484	-074.3,	+00.37
483	-076.7,	+00.33
482	-078.7,	+00.39
479	-084.7,	+00.18
478	-086.5,	+00.13
477	-088.9,	+00.11
475	-093.0,	+00.22
474	-095.5,	-00.21
471	-102.3,	-00.11
470	-104.4,	-00.14
469	-106.8,	-00.16
457	-133.0,	-00.02
454	-140.8,	+00.00

UNIT	DISTANCE	T-Δ/6
450	-148.1,	-00.06
448	-152.0,	-00.05
447	-155.0,	+00.00
446	-157.6,	-00.06
445	-159.8,	-00.12
444	-162.0,	-00.20
436	-178.1,	-00.46
434	-181.9,	-00.69
431	-188.6,	-00.74
428	-193.8,	-00.84
425	-197.8,	-00.97
424	-199.1,	-01.01
414	-217.2,	-01.33
413	-218.9,	-01.36
411	-223.3,	-01.53
409	-226.2,	-01.78
407	-230.3,	-02.39
406	-231.2,	-02.44
405	-233.9,	-01.61
404	-235.6,	-01.63
401	-241.4,	-01.68
400	-243.6,	-02.86
396	-252.0,	-01.99
395	-253.9,	-02.04
394	-255.9,	-02.03
392	-260.1,	-03.61
390	-262.3,	-02.03
389	-264.2,	-02.06
388	-266.0,	-02.04
386	-269.4,	-02.07
385	-270.6,	-02.09
384	-271.5,	-02.08
379	-280.8,	-02.31
470	-104.4,	+00.12
469	-106.8,	+00.11
454	-140.8,	+01.07
452	-144.4,	+01.00
451	-146.4,	+00.96
450	-148.1,	+00.91
448	-152.0,	+00.78
447	-155.0,	+00.67
446	-157.6,	+00.61
436	-178.1,	+00.05
434	-181.9,	-00.17
431	-188.6,	-00.18
428	-193.8,	-00.32
426	-196.5,	-00.39
424	-199.1,	-00.51

SP 4 SW

UNIT	DISTANCE	T-Δ/6
519	007.8 ,	+00.04
521	011.5 ,	+00.03
522	013.4 ,	+00.03
523	015.9 ,	+00.04
524	017.6 ,	+00.03
527	022.9 ,	+00.05
530	029.6 ,	+00.02
532	033.5 ,	-00.01
533	035.5 ,	-00.03
566	096.5 ,	+00.88
568	101.4 ,	+00.71
570	104.3 ,	+00.69
572	107.2 ,	+00.63
580	123.4 ,	-00.02
582	130.0 ,	-00.14
583	133.0 ,	-00.18
585	137.6 ,	-00.26
592	151.9 ,	-00.41
595	156.9 ,	-00.26
610	178.5 ,	-00.71
611	179.5 ,	-00.71
612	180.4 ,	-00.76
614	184.0 ,	-00.87
616	187.7 ,	-00.91
617	189.8 ,	-00.91
620	196.5 ,	-00.88
956	215.4 ,	-01.48
957	217.8 ,	-01.45
960	225.4 ,	-01.76
961	229.3 ,	-02.25
962	233.0 ,	-02.42
968	251.5 ,	-03.35
627	256.4 ,	-03.63
801	271.1 ,	-04.42
802	273.4 ,	-04.59
569	103.0 ,	+02.84
570	104.3 ,	+02.80
572	107.2 ,	+02.67
592	151.9 ,	-00.05
595	156.9 ,	+00.97

SP 5 NE

UNIT	DISTANCE	T-Δ/6
627	-002.5,	-00.02
968	-007.3,	+00.01
963	-021.9,	-00.08
962	-025.8,	-00.07
960	-034.1,	-00.11
959	-036.9,	-00.19
955	-049.4,	-00.18
624	-051.7,	-00.27
620	-064.2,	-00.50
618	-068.0,	-00.59
617	-070.8,	-00.67
616	-072.9,	-00.71
612	-080.8,	-00.76
611	-081.9,	-00.74
607	-088.6,	-00.75
605	-091.4,	-00.98
604	-092.2,	-00.78
600	-098.8,	-00.68
599	-100.9,	-00.59
597	-104.2,	-01.06
596	-107.0,	-00.82
532	-225.6,	-02.79
529	-231.5,	-02.88
526	-238.5,	-03.18
520	-249.4,	-04.04
595	-109.7,	-00.41
593	-113.2,	-00.39
592	-115.8,	-00.43
589	-121.6,	-00.63
587	-125.1,	-00.66
586	-126.4,	-00.72
585	-127.2,	-00.74
584	-129.3,	-00.73
583	-130.6,	-00.74
582	-133.0,	-00.79
580	-139.5,	-00.94
578	-142.6,	-00.98
577	-143.8,	-00.92
576	-145.1,	-01.00
575	-147.4,	-01.02
574	-149.9,	-00.98
572	-155.0,	-01.11
571	-156.6,	-01.20
566	-166.3,	-01.14
563	-171.6,	-01.18
562	-173.8,	-01.21
560	-178.8,	-01.17
555	-188.4,	-01.20
552	-194.0,	-01.37
549	-198.8,	-01.44
545	-203.4,	-01.65
529	-231.5,	-01.88
526	-238.5,	-01.95
589	-121.6,	+01.42
587	-125.1,	+01.36
586	-126.4,	+01.32
585	-127.2,	+01.30
584	-129.3,	+01.26
583	-130.6,	+01.15
582	-133.0,	+01.06
580	-139.5,	+00.77
576	-145.1,	+00.71
575	-147.4,	+00.63
574	-149.9,	+00.61

SP 5 SW

UNIT	DISTANCE	T-Δ/6
697	001.8,	+00.02
699	006.1,	+00.08
700	008.0,	+00.07
801	012.8,	+00.00
802	014.9,	+00.05
803	017.5,	+00.07
807	027.5,	-00.07
810	037.3,	+00.13
811	041.7,	+00.23
812	045.2,	+00.16
813	049.3,	+00.26
888	052.9,	+00.37
889	056.7,	+00.39
892	066.7,	+00.38
894	070.5,	+00.37
895	073.8,	+00.35
896	075.1,	+00.31
899	082.9,	+00.21
900	084.4,	+00.13
905	098.1,	-00.66
906	100.0,	-00.64
907	102.3,	-00.80
910	118.2,	-01.50
911	119.1,	-01.63
912	120.9,	-01.78
913	122.4,	-01.91
914	126.0,	-02.05
915	128.4,	-02.23
916	130.5,	-02.30
894	070.5,	+01.12
895	073.8,	+00.94
896	075.1,	+00.81
899	082.9,	+00.70
900	084.4,	+00.60
910	118.2,	+02.12
912	120.9,	+02.11
913	122.4,	+02.07
914	126.0,	+02.44
915	128.4,	+02.36
916	130.5,	+02.31

SP 5 NE

UNIT	DISTANCE	T-Δ/8
956	44.900,	+1.56
955	49.438,	+1.83
620	64.238,	+2.21
618	67.971,	+2.25
617	70.844,	+2.34
616	72.895,	+2.35
612	80.791,	+2.61
611	81.860,	+2.78
607	88.615,	+3.00
599	100.945,	+3.79
597	104.181,	+3.74
596	107.041,	+3.78
597	104.041,	+4.35
595	109.657,	+3.70
595	109.657,	+4.27
593	113.227,	+4.18
592	115.806,	+4.25
627	2.464,	+0.14
626	5.120,	+0.18
968	7.317,	+0.21
964	17.552,	+0.53
963	21.851,	+0.70
962	25.772,	+0.91
961	29.564,	+1.08
966	14.099,	+0.39
959	36.866,	+1.26
958	37.798,	+1.34
957	42.601,	+1.48
588	123.558,	+4.47
588	123.558,	+6.44
587	125.109,	+4.58
587	125.109,	+6.44
586	126.359,	+4.60
586	126.359,	+6.44
585	127.230,	+4.69
585	127.230,	+6.44
584	129.311,	+4.70
584	129.311,	+6.44
583	130.596,	+4.72
583	130.596,	+6.44

UNIT	DISTANCE	T-Δ/8
582	132.973,	+4.78
582	132.973,	+6.44
580	139.462,	+4.84
580	139.462,	+6.44
578	142.633,	+4.98
576	145.096,	+5.00
576	145.096,	+5.18
575	147.435,	+5.06
574	149.889,	+5.10
572	155.044,	+5.40
571	156.606,	+5.34
569	159.226,	+5.37
567	163.491,	+5.57
566	166.264,	+5.70
565	167.526,	+5.80
563	171.585,	+6.02
562	173.828,	+5.92
560	178.849,	+6.08
559	181.045,	+6.28
558	183.523,	+6.46
557	184.486,	+6.48
555	188.340,	+6.64
552	194.040,	+6.72
549	198.816,	+6.66
545	203.376,	+6.77
532	225.588,	+6.62
532	225.588,	+7.62
529	231.490,	+6.82
529	231.490,	+7.82
526	238.456,	+6.76
526	238.456,	+7.80
520	249.399,	+6.75
624	51.742,	+1.90
614	76.838,	+2.50
600	98.751,	+3.61
593	113.227,	+4.42
592	115.806,	+4.44
960	34.066,	+1.10
520	249.399,	+8.14

SP 5 SW

UNIT	DISTANCE	T-Δ/8
699	-6.107,	+0.34
700	-7.973,	+0.39
800	-10.838,	+0.58
801	-12.757,	+0.58
804	-20.429,	+0.92
805	-24.060,	+1.16
807	-27.503,	+1.14
808	-30.240,	+1.26
810	-32.293,	+1.74
811	-41.708,	+2.01
812	-45.174,	+2.07
813	-49.340,	+2.38
888	-52.862,	+2.61
889	-56.690,	+2.79
890	-60.136,	+2.94
894	-70.541,	+3.30
895	-73.756,	+3.40
896	-75.053,	+3.45
897	-78.316,	+3.51
899	-82.883,	+3.60
905	-98.114,	+3.44
906	-99.999,	+3.60
907	-102.302,	+3.44
908	-115.610,	+3.40
910	-118.157,	+3.39
913	-122.423,	+3.27
915	-128.450,	+3.22
916	-130.462,	+3.23
917	-132.374,	+7.46
916	-130.462,	+7.76
915	-128.450,	+7.72
914	-125.983,	+7.66
899	-82.883,	+4.01
897	-78.316,	+3.98
896	-75.053,	+3.99
895	-73.756,	+3.99
697	- 1.825,	+0.14
802	-14.869,	+0.72
803	-17.483,	+0.84
892	-66.729,	+3.10
911	-119.140,	+3.38
912	-120.943,	+3.35
914	-125.983,	+3.24
894	-70.541,	+4.02

SP 6 NE

UNIT	DISTANCE	T-Δ/8
501	425.263,	+5.55
502	422.387,	+5.48
503	419.720,	+5.56
506	413.087,	+5.58
507	411.604,	+5.59
510	406.970,	+5.59
511	405.745,	+5.59
516	398.479,	+5.81
519	388.367,	+5.69
520	386.336,	+5.70
521	384.621,	+5.64
522	382.703,	+5.63
523	380.301,	+5.59
529	368.509,	+5.73
530	366.580,	+5.62
532	362.607,	+5.66
537	350.638,	+5.42
537	350.638,	+5.74
538	348.790,	+5.43
538	348.790,	+5.78
541	344.432,	+5.80
548	336.895,	+5.56
548	336.895,	+5.82
549	336.027,	+5.57
549	336.027,	+5.80
550	334.113,	+5.62
550	334.113,	+5.84
552	331.228,	+5.59
553	328.824,	+6.02
554	326.891,	+6.00
555	325.629,	+5.59
555	325.629,	+5.95
558	320.798,	+6.02
560	316.146,	+6.00
563	308.902,	+6.05
565	304.836,	+6.08
566	303.557,	+6.04
569	296.523,	+5.72
569	296.523,	+6.08
570	294.860,	+5.78
570	294.860,	+6.02
571	293.892,	+5.79
572	292.330,	+5.78
572	292.330,	+6.08
573	289.246,	+5.83
573	289.246,	+6.16
574	287.145,	+6.19
575	284.659,	+5.80
575	284.659,	+6.16
576	282.289,	+5.80
577	280.976,	+5.82
580	276.659,	+5.82
580	276.659,	+6.18
582	270.121,	+6.22
584	266.249,	+5.87
585	264.091,	+6.22
586	263.135,	+5.86
586	263.135,	+6.23
587	261.820,	+6.22
589	257.998,	+5.82
592	251.971,	+5.88
595	245.927,	+5.90
596	243.355,	+5.87
597	240.588,	+6.05
599	237.675,	+6.00

UNIT	DISTANCE	T-Δ/8
607	225.833,	+5.99
614	214.208,	+6.08
929	23.774,	+2.41
930	25.363,	+2.45
896	66.661,	+4.20
897	64.022,	+4.19
899	60.949,	+4.00
905	43.649,	+3.48
906	42.390,	+3.46
907	40.359,	+3.72
908	25.796,	+2.48
911	20.735,	+2.37
914	15.175,	+1.78
917	11.007,	+ .99
801	124.835,	+3.00
803	119.809,	+3.01
805	116.806,	+2.98
807	113.014,	+2.99
810	103.776,	+3.21
813	92.591,	+3.95
888	88.208,	+4.00
889	84.031,	+4.08
890	80.553,	+4.22
892	73.579,	+4.30
894	70.788,	+4.24
499	429.661,	+5.56
505	414.539,	+5.61
509	408.534,	+5.60
523	380.301,	+5.62
526	375.433,	+5.70
533	360.584,	+5.62
556	323.910,	+5.59
556	323.910,	+6.01
557	321.738,	+6.02
559	318.331,	+6.01
567	300.781,	+6.03
571	283.892,	+6.13
574	287.145,	+5.90
576	282.289,	+6.14
578	279.825,	+5.82
584	266.249,	+6.24
585	264.091,	+5.90
515	399.881,	+5.80
589	257.998,	+6.26
602	231.613,	+5.98
610	219.889,	+6.01
617	208.192,	+6.19
926	2.768,	+ .41
895	67.782,	+4.23
908	25.796,	+2.86
909	24.155,	+2.38
909	24.155,	+2.62
910	22.460,	+2.24
910	22.460,	+2.62
911	20.735,	+2.70
912	19.026,	+2.19
915	13.205,	+1.51
916	12.129,	+1.38
802	122.547,	+2.98
808	110.397,	+2.90
812	96.428,	+3.80
587	261.820,	+5.86
512	404.301,	+5.62
811	99.766,	+3.34

APPENDIX 3. Computer program source code listings.

```
      PROGRAM AUTODG
C
C   AUTODG IS THE DIGITIZING PROGRAM FOR
C   HEALY SEISMIC REFRACTION DATA.
C
      BYTE ANS
      INTEGER*2 IDUM(1),ICODE(3)
      REAL*4 RRLAT(20),RRLONG(20)
      EQUIVALENCE (IDUM(1),LOC(1))
C
      COMMON/DXCOM/IOPEN,NSAMP,MREC,MAXR,IHEAD(3,150),
     *RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
      COMMON/PTCOM/IDATA(4001),ITYPE(11,12)
      COMMON/BUFCOM/IBUF(256),LCHAN
C
      DATA NDC/100/,KCHAN/1/
      DATA IDCAL/1/
C
C   DKDAT COMMON BLOCKS
      COMMON/DKCOM1/JOPEN,JSHOT,JTEAM,JSAMP,JREC,DTIT(20),
     * JMONTH(30),JIDAY(30),JISP(30),JJDAY(30),JJHR(30),JJMIN(30),
     * DSEC(30),JIELEV(30),JISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),
     * IROCK(5,30),IEX(150)
      COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),ITGR2(20),
     * ITGR3(20),DISTAN(20),ICHAN(20),ICAL(12,20),IDB(3,20)
C
C   STATEMENT FUNCTION
      DECIF(IID)=IAND(IID,'17)+10*ISHFT(IAND(IID,'360),-4)+100*ISHFT(
     *IAND(IID,'7400),-8)
C
      TYPE 5
5     FORMAT('$PRINT DESCRIPTION OF MACROS(Y OR N)?   ')
      ACCEPT 6,ANS
6     FORMAT(A1)
      IF (ANS .EQ. 1HY) TYPE 7
7     FORMAT(' DESCRIPTION OF AUTODG MACROS'//
     *  ' 1 = ENTER SHOT DATA'/
     *  ' -1 = PRINT SHOT DATA'/
     *  ' 3 = ENTER RECORDER DATA FROM THE TERMINAL'/
     *  ' -3 = PRINT RECORDER DATA'/
     *  ' 4 = DIGITIZE ONE TEAM SHOT'/
     *  ' 5 = SET FLAG TO DIGITIZE OR NOT DIGITIZE CALIBRATIONS'/
     *  '      (DEFAULT = DIGITIZE CALIBRATIONS)'/
     *  ' -5 = PRINT FLAG TO DIGITIZE OR NOT DIGITIZE CALIBRATIONS.'/
     *  '        ALSO, PRINT RECORDER TURN-ON TIME.'/
     *  ' 6 = READ DKDAT DATA FROM DKDAT DISK FILE'/
     *  ' -6 = PRINT DATA READ IN BY MACRO 6'/
     *  ' 8 = ENTER CHANNEL NUMBER TO DIGITIZE'/
     *  ' -8 = PRINT CHANNEL NUMBER TO DIGITIZE'/
     *  ' 9 = WRITE DIGITIZING DATA TO DKDAT DISK FILE'/
     *  ' 17 = READ TIME FROM TIME CODE TRANSLATOR AND PRINT ON'/
     *  '      TERMINAL'/
     *  ' 20 = INITIALIZE A DATA DISK'/
     *  ' 21 = OPEN DATA DISK FILE'/
     *  ' 22 = CLOSE DATA DISK FILE'/
     *  ' 23 = PRINT DIRECTORY OF DATA DISK FILE'/
     *  ' 24 = DELETE RECORD FROM DATA DISK FILE'/
     *  ' 26 = ENTER CHANNEL NUMBERS ON DATA DISK'/
     *  ' 27 = CHANGE DATA DISK TITLE'/
     *  ' 28 = MULTIPLY DISTANCES ON DISK BY -1'/
     *  ' 31 = OPEN HARD DISK FILE'/
     *  ' 32 = CLOSE HARD DISK FILE'/)
C
200   CONTINUE
```

```
        WRITE(5,1)
1      FORMAT('$>')
        READ(5,2,ERR=200) ICMD
2      FORMAT(I10)
        IF (ICMD .EQ. 1) GOTO 1000
        IF (ICMD .EQ. -1) GOTO 1500
        IF (ICMD .EQ. 3) GOTO 3000
        IF (ICMD .EQ. -3) GOTO 3500
        IF (ICMD .EQ. 4) GOTO 4000
        IF (ICMD .EQ. 5) GOTO 5000
        IF (ICMD .EQ. -5) GOTO 5500
        IF (ICMD .EQ. 6) GOTO 6000
        IF (ICMD .EQ. -6) GOTO 6500
        IF (ICMD .EQ. 8) GOTO 8000
        IF (ICMD .EQ. -8) GOTO 8500
        IF (ICMD .EQ. 9) GOTO 9000
        IF (ICMD .EQ. 17) GOTO 17000
        IF (ICMD .EQ. 20) GOTO 20000
        IF (ICMD .EQ. 21) CALL DXOPEN
        IF (ICMD .EQ. 22) CALL DXCLOS
        IF (ICMD .EQ. 23) CALL DXLIST
        IF (ICMD .EQ. 24) GOTO 24000
        IF (ICMD .EQ. 26) GOTO 26000
        IF (ICMD .EQ. 27) GOTO 27000
        IF (ICMD .EQ. 28) GOTO 28000
        IF (ICMD .EQ. 31) CALL DLOPEN
        IF (ICMD .EQ. 32) CALL DXCLOS
        GOTO 200
C
C   INPUT SHOT DATA
C
1000    CONTINUE
1030   WRITE(5,1100)
1100   FORMAT('$SHOT LOCATION NUMBER?   ')
        READ(5,1010,ERR=1030) JLOC
        IF (VREDUC .EQ. 0.) GOTO 1230
        DEFINE FILE 10(1500,12,U,IREC)
        CALL ASSIGN(10,'DX0:M.LOC',0,'OLD','NC')
        READ(10'JLOC) LATDS,LATMS,ALATSS,LONDS,LONMS,ALONSS
        CALL CLOSE(10)
        SLAT=LATDS+LATMS/60.+ALATSS/3600.
        IF (LONDS .GE. 0) SLONG=LONDS+LONMS/60.+ALONSS/3600.
        IF (LONDS .LT. 0) SLONG=LONDS-LONMS/60.-ALONSS/3600.
1230    CONTINUE
1200   WRITE(5,1220)
1220   FORMAT('$SHOT TIME?   ')
        READ(5,1010,ERR=1200) KDAY,KHR,KMIN,RKSEC
1010   FORMAT(3I10,F10.0)
        GOTO 200
1500   CONTINUE
        WRITE(5,1510) JLOC
1510    FORMAT(/' SHOT LOCATION NUMBER =',I5)
        WRITE(5,1520) LATDS,LATMS,ALATSS,LONDS,LONMS,ALONSS
1520   FORMAT(' LOC =',2(I5,I3,1X,F5.2))
        WRITE(5,1530) KDAY,KHR,KMIN,RKSEC
1530   FORMAT(' SHOT TIME =',I4,':',I2,':',I2,':',F6.3)
        IF (ICMD .EQ. -6) GOTO 3500
        GOTO 200
C
C   ENTER RECORDER ID'S, LOCATIONS, TIMING ERRORS
C
3000    CONTINUE
        IF (VREDUC .EQ. 0.) GOTO 3050
        DEFINE FILE 10(1500,12,U,IREC)
        CALL ASSIGN(10,'DX0:M.LOC',0,'OLD','NC')
3050    CONTINUE
```

```
      WRITE(5,3010)
3010  FORMAT(' ENTER RECORD NO., RECORDER LOCATION NO., ',
     * 'RECORDER I.D., TIMING ERROR(MSEC).'/
     *  ' TERMINATE BY TYPING ''21''.')
3020  READ(5,3025,ERR=3020) I,I1,I2,I3
3025  FORMAT(8I10)
      IF (I .EQ. 21) GOTO 3021
      LOC(I)=I1
      IUNIT(I)=I2
      ICHRON(I)=I3
      IF (VREDUC .EQ. 0.) GOTO 3020
      READ(10'LOC(I)) LATD,LATM,ALATS,LOND,LONM,ALONS
      RRLAT(I)=LATD+LATM/60.+ALATS/3600.
      IF (LOND .GE. 0) RRLONG(I)=LOND+LONM/60.+ALONS/3600.
      IF (LOND .LT. 0) RRLONG(I)=LOND-LONM/60.-ALONS/3600.
      GOTO 3020
3021  CONTINUE
      IF (VREDUC .NE. 0.) CALL CLOSE(10)
      GOTO 200
3500  CONTINUE
      WRITE(5,3510) (I,LOC(I),IUNIT(I),ICHRON(I),I=1,20)
3510  FORMAT(///8X,'REC LOC   REC ID   TIMING ERROR'//
     * (1H ,I2,6X,I4,7X,I3,6X,I4))
      IF (ICMD .EQ. -6) GOTO 5500
      GOTO 200
C
C   DIGITIZE ONE TEAM SHOT
C
4000  CONTINUE
      WRITE(5,4002)
4002  FORMAT(' REWIND TAPE AND PUT INTO PLAY MODE')
C
C   IDENTIFY CASSETTE DATA RECORD BY READING THE TIME CODE
4300    CONTINUE
        CALL DXCNT(N)
        IF (N .LT. MREC) GOTO 4003
        TYPE 4004
4004    FORMAT(' DATA DISK FULL.')
        CALL WAKEUP(3)
        GOTO 200
4003    CONTINUE
        JID1=-30000
4400    CONTINUE
C   TEST FOR OPERATOR RETURN TO MACRO LEVEL
        IF (ITTINR() .GE. 0) GOTO 200
        NUMSEC=5
        DO 4490 I=1,NUMSEC
        CALL WAITM(1000)
4490  CONTINUE
        CALL TCIN(ICODE)
        CALL TCVAL(ICODE(1),ICODE(2),ICODE(3),IID,IDAY,
     *  IHR,IMINS,ISEC)
        JID2=DECIF(IID)
        IF (JID2 .EQ. JID1) GOTO 4600
        JID1=JID2
        GOTO 4400
C   LOOK UP ID NO. IN TABLE
4600  CONTINUE
        DO 4610 I=1,20
        IF (JID1 .EQ. IUNIT(I)) GOTO 4620
4610  CONTINUE
        WRITE(5,4630) JID2
4630  FORMAT(' UNIT',I4,' FOUND ON TAPE BUT NOT KNOWN TO
     *PROGRAM')
        GOTO 4003
C
```

```
C   COMPUTE DIGITIZE TIME
4620    CONTINUE
        IF (VREDUC .NE. 0.) GOTO 4010
        DIST=0.
        DELTAT=0.
        GOTO 4011
4010    CONTINUE
        RLAT=RRLAT(I)
        RLONG=RRLONG(I)
        IF (RLAT .LT. 99.) GOTO 4006
        WRITE(5,4007)
4007  FORMAT(' RECORDER LOCATION NOT IN DATA BASE')
        GOTO 4003
4006  CALL DSTAZ(SLAT,SLONG,RLAT,RLONG,DIST,AZIM)
        IF (DIST .GT. 80.) CALL DSTAZ2(SLAT,SLONG,RLAT,RLONG,DIST)
        DISTAN(I)=DIST
        IAZIM(I)=10.*AZIM+.5
        DELTAT=ABS(DIST)/VREDUC
4011    CONTINUE
        WRITE(5,4005) JID2,DIST,DELTAT
4005  FORMAT(' RECORDER ID',I4,'   DISTANCE =',F8.2,
     *'   TRAVEL TIME =',F8.3,' SECS')
C
C   DIGITIZE 10 HZ CALIBRATIONS
        IF (IDCAL .NE. 1) GOTO 4604
        IF (ICAL(12,I) .GT. 4096) GOTO 4606
        IF (ICAL(12,I) .LT. 1) GOTO 4606
        TYPE 4605
4605    FORMAT(' CALIBRATIONS ALREADY DIGITIZED.')
        GOTO 4604
4606    CONTINUE
        CALL DCAL(LDAY,LHOUR,LMIN,I,ISTAT)
        IF (ISTAT .EQ. 1) GOTO 200
        IF (ISTAT .EQ. 2) GOTO 4003
        TYPE 4603,(ICAL(L,I),L=1,12)
4603    FORMAT(' 10 HZ CALIBRATIONS',3(/1H ,4I5))
4604    CONTINUE
C
C   COMPUTE SHOT DIGITIZE TIME
        TSHIFT=DELTAT+ICHRON(I)/1000.+IHEAD(3,1)
        CALL TIME(KDAY,KHR,KMIN,RKSEC,JDAY,JHR,JMIN,JSEC,MSEC,
     * TSHIFT,0.)
        WRITE(5,4420) JDAY,JHR,JMIN,JSEC,MSEC
4420  FORMAT(' DIGITIZE TIME =',I4,':',I2,':',I2,':',I2,'.',I3)
4500  CONTINUE
        IF (ITTINR() .GE. 0) GOTO 200
        CALL TCIN(ICODE)
        CALL TCVAL(ICODE(1),ICODE(2),ICODE(3),IID,IDAY,
     *  IHR,IMINS,ISEC)
        JID2=DECIF(IID)
        IF (JID2 .EQ. JID1) GOTO 4700
        WRITE(5,4710)
4710  FORMAT(' DIGITIZE TIME NOT FOUND.')
        GOTO 4003
4700  IF (IDAY .NE. JDAY) GOTO 4500
        IF (IHR .NE. JHR) GOTO 4500
        IF (IMINS .NE. JMIN) GOTO 4500
        IF (ISEC .NE. JSEC) GOTO 4500
        IF (MSEC .GT. 0) CALL TWAITM(MSEC,ISTAT)
C
C   DIGITIZE ONE RECORD AND WRITE TO DISK
        CALL MATOD(IDATA,NSAMP,KCHAN,1,NSRATE)
        CALL AVE(IDATA,NDC,IDC)
        CALL MINMAX(IDATA,NSAMP,IVMIN,IVMAX)
        MAXDEV=MAX0(IVMAX-IDC,IDC-IVMIN)
        WRITE(5,4640) KCHAN,IDC,MAXDEV
```

```
4640  FORMAT(' CHANNEL',I3,' DIGITIZED.  DC OFFSET =',I5,'   DEV =',I5)
        WRITE(5,4601)
4601    FORMAT('$WRITE DIGITIZED RECORD TO DISK(Y OR N)?   ')
        READ(5,6) ANS
        IF (ANS .NE. 1HY) GOTO 200
        KDB=IDB(KCHAN,I)
        CALL DXPUT(IDATA,JID2,LOC(I),IHEAD(3,1),DIST,KDB,KK)
        CALL DXCNT(N)
        WRITE(5,4602) KK,N,MREC
4602    FORMAT(' RECORD',I3,' WRITTEN TO DISK.'/
     *  ' THE DISK NOW CONTAINS',I3,' RECORDS.  MAX RECORDS PER
     * DISK =',I3/
     *' *********************************************
     ********************')
        ICHAN(I)=KCHAN
        GOTO 4300
C
C   SET FLAG TO DIGITIZE CALIBRATIONS
C
5000    CONTINUE
        IDCAL=0
        TYPE 5010
5010    FORMAT('$DIGITIZE 10 HZ CALIBRATIONS(Y OR N)?   ')
        ACCEPT 5020,ANS
5020    FORMAT(A1)
        IF (ANS .NE. 1HY) GOTO 200
        IDCAL=1
        TYPE 5030
5030    FORMAT(' ENTER RECORDER TURN-ON TIME(DAY,HOUR,MIN).   ')
        ACCEPT 5040,LDAY,LHOUR,LMIN
5040    FORMAT(8I10)
        GOTO 200
5500    CONTINUE
        IF (IDCAL .EQ. 1) GOTO 5600
        TYPE 5510
5510    FORMAT(/' FLAG NOT SET TO DIGITIZE 10 HZ CALIBRATIONS.')
        GOTO 200
5600    CONTINUE
        TYPE 5610,LDAY,LHOUR,LMIN
5610    FORMAT(/' FLAG SET TO DIGITIZE 10 HZ CALIBRATIONS.'/
     *  ' RECORDER TURN-ON TIME =',3I5)
        GOTO 200
C
C   READ DKDAT DATA FROM DKDAT DISK
C
6000  CONTINUE
        IF (IOPEN .EQ. 1) CALL CLOSE(1)
        IOPEN=0
        PAUSE 'PUT DKDAT DISK IN DX1'
        DEFINE FILE 1(153,800,U,IREC)
        CALL ASSIGN(1,'DX1:K.DAT',0,'OLD','NC')
        WRITE(5,6010)
6010  FORMAT('$SHOT NO., TEAM NO.?   ')
        READ(5,1010) ISHOT,ITEAM
        READ(1'1) JSHOT,JTEAM,JSAMP,JREC,DTIT,JMONTH,JIDAY,
     * JISP,JJDAY,JJHR,JJMIN,DSEC,JIELEV,JISIZE,IDTOP,
     * IDBOT,IWAT,IROCK,IEX
        JLOC=JISP(ISHOT)
        KDAY=JJDAY(ISHOT)
        KHR=JJHR(ISHOT)
        KMIN=JJMIN(ISHOT)
        RKSEC=DSEC(ISHOT)
C
C   COMPUTE RECORDER TURN-ON TIME
        LDAY=KDAY
        LHOUR=KHR
```

```
      IF (KMIN.GE.14 .AND. KMIN.LE.28) LMIN=5
      IF (KMIN.GE.29 .AND. KMIN.LE.43) LMIN=20
      IF (KMIN.GE.44 .AND. KMIN.LE.58) LMIN=35
      IF (KMIN.EQ.59) LMIN=50
      IF (KMIN.GE.14) GOTO 6030
      LMIN=50
      LHOUR=KHR-1
      IF (LHOUR .GE. 0) GOTO 6030
      LHOUR=LHOUR+24
      LDAY=LDAY-1
6030  CONTINUE
C
      I=ISHOT*5-2+ITEAM
      READ(1'I) LOC,IUNIT,IFOOT,NT,ICHRON,IVB,IAZIM,ITPGRD,
     * IRGRD,FIRST,ITGR2,ITGR3,DISTAN,ICHAN,ICAL,IDB
      CALL CLOSE(1)
      CALL ASSIGN(10,'DX0:M.LOC',0,'OLD','NC')
      DEFINE FILE 10(1500,12,U,IREC)
      LLOC=JLOC
C   BAD LOCATION
      IF (LLOC.LT.1 .OR. LLOC.GT.1500) TYPE 6110,LLOC
      IF (LLOC.LT.1 .OR. LLOC.GT.1500) GOTO 6021
      READ(10'LLOC) LATDS,LATMS,ALATSS,LONDS,LONMS,ALONSS
      SLAT=LATDS+LATMS/60.+ALATSS/3600.
      IF (LONDS .GE. 0) SLONG=LONDS+LONMS/60.+ALONSS/3600.
      IF (LONDS .LT. 0) SLONG=LONDS-LONMS/60.-ALONSS/3600.
      DO 6020 I=1,20
      LLOC=LOC(I)
      IF (LLOC .EQ. -1) GOTO 6020
      IF (LLOC.LT.1 .OR. LLOC.GT.1500) GOTO 6100
      READ(10'LLOC) LATD,LATM,ALATS,LOND,LONM,ALONS
      IF (LATD .EQ. 100) GOTO 6020
      RRLAT(I)=LATD+LATM/60.+ALATS/3600.
      IF (LOND .GE. 0) RRLONG(I)=LOND+LONM/60.+ALONS/3600.
      IF (LOND .LT. 0) RRLONG(I)=LOND-LONM/60.-ALONS/3600.
      GOTO 6020
C   BAD LOCATION
6100  CONTINUE
      TYPE 6110,LLOC
6110  FORMAT(' BAD LOCATION NO.',I10)
6020 CONTINUE
6021  CONTINUE
      CALL CLOSE(10)
      GOTO 200
6500  CONTINUE
      TYPE 6510,ISHOT,ITEAM
6510  FORMAT(' SHOT NUMBER =',I5/' TEAM NUMBER =',I5)
      GOTO 1500
C
C   ENTER CHANNEL NUMBER
C
8000  CONTINUE
      TYPE 8010
8010  FORMAT('$CHANNEL NUMBER TO DIGITIZE(1,2, OR 3)?   ')
      READ(5,8020,ERR=8000) KCHAN
8020  FORMAT(8I10)
      GOTO 200
8500  CONTINUE
      TYPE 8510,KCHAN
8510  FORMAT(' CHANNEL NUMBER =',I8)
      GOTO 200
C
C   WRITE DIGITIZING DATA TO DKDAT DISK FILE
C
9000 CONTINUE
      IF (IOPEN .EQ. 1) CALL CLOSE(1)
```

```
        IOPEN=0
        PAUSE 'PUT DKDAT DISK IN DX1'
        DEFINE FILE 1(153,800,U,IREC)
        CALL ASSIGN(1,'DX1:K.DAT',0,'OLD','NC')
        KREC=ISHOT*5-2+ITEAM
        WRITE(1'KREC) LOC,IUNIT,IFOOT,NT,ICHRON,IVB,IAZIM,ITPGRD,
     * IRGRD,FIRST,ITGR2,ITGR3,DISTAN,ICHAN,ICAL,IDB
        CALL CLOSE(1)
        TYPE 9010,ISHOT,ITEAM
9010    FORMAT(' DKDAT DATA FOR SHOT',I3,' TEAM',I2,
     *  ' WRITTEN TO DISK')
        GOTO 200
C
C   READ TIME CODE FROM TIME CODE TRANSLATOR
C
17000   CONTINUE
        CALL TCIN(ICODE)
        CALL TCVAL(ICODE(1),ICODE(2),ICODE(3),IID,IDAY,
     *  IHR,IMINS,ISEC)
        JI=DECIF(IID)
        WRITE(5,17010) JI,IDAY,IHR,IMINS,ISEC
17010 FORMAT(' ID=',I5,I8,3(':',I2))
        GOTO 200
C
C   INITIALIZE DATA DISK
C
20000   CONTINUE
        TYPE 20010
20010   FORMAT(' THIS MACRO IS USED TO SET UP A DISK FOR DIGITIZING.'/
     * ' A NEW DISK MUST BE INITIALIZED BEFORE RUNNING THE AUTODG'/
     * ' PROGRAM BY PUTTING THE DISK IN DX1 AND TYPING:'/
     * ' "INITIALIZE/BADBLOCKS DX1:"'/
     * '$DO YOU WISH TO CONTINUE(Y OR N)?   ')
        READ(5,6) ANS
        IF (ANS .NE. 1HY) GOTO 200
        TYPE 20020
20020   FORMAT('$REDUCTION VELOCITY(KM/SEC)(0=DO NOT REDUCE)?   ')
        READ(5,20030) VREDUC
20030   FORMAT(8F10.0)
        TYPE 20040
20040   FORMAT('$SAMPLING INTERVAL(MSEC)?   ')
        READ(5,20050) NSRATE
20050   FORMAT(8I10)
        TYPE 20060
20060   FORMAT('$NUMBER OF SECONDS TO DIGITIZE?   ')
        READ(5,20050) NSEC
        NSAMP=1000/NSRATE*NSEC+1
        TYPE 20070
20070   FORMAT('$TMIN(SEC)?   ')
        READ(5,20030) TMIN
        IHEAD(3,1)=IFIX(TMIN)
        CALL DXCR(NSAMP)
        GOTO 200
C
C   DELETE ONE RECORD FROM DATA DISK FILE
C
24000 CONTINUE
        TYPE 250
250     FORMAT('$RECORD NO. OF RECORD TO DELETE?   ')
        ACCEPT 1010,I1
        CALL DXDEL(I1,IFOUND)
        GOTO 200
C
C   ENTER CHANNEL NUMBERS
C
26000   CONTINUE
```

```
       TYPE 26010
26010  FORMAT(' ENTER RECORD NO., CHANNEL NO.(0=RETURN TO MACRO)')
26020  CONTINUE
       READ(5,*,ERR=26020) I1,JCHAN
       IF (I1 .LT. 1) GOTO 26030
       IF (I1 .GT. 150) GOTO 26030
       ICHANL(I1)=JCHAN
       GOTO 26020
26030  CONTINUE
       JCODE=IWRITW(1024,NSAMP,0,LCHAN)
       GOTO 200
C
C   CHANGE DATA DISK TITLE
C
27000 CONTINUE
       WRITE(5,27001)
27001 FORMAT(' ENTER NEW DATA DISKETTE TITLE(UP TO 80 CHARACTERS)')
       READ(5,27002) TIT
27002 FORMAT(20A4)
       JCODE=IWRITW(1024,NSAMP,0,LCHAN)
       GOTO 200
C
C   MULTIPLY DISTANCES ON DISK BY -1
C
28000  CONTINUE
       TYPE 28010
28010  FORMAT(' THIS MACRO MULTIPLIES DISTANCES ON A DATA DISK BY -1'/
     * '$MIN,MAX RECORD NUMBER OF RECORDS TO CHANGE?   ')
       ACCEPT 1010,I1,I2
       DO 28020 I=I1,I2
28020  RRDIST(I)=-RRDIST(I)
       JCODE=IWRITW(1024,NSAMP,0,LCHAN)
       GOTO 200
       END
C
       SUBROUTINE DXCNT(N)
       COMMON/DXCOM/IOPEN,NSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
       N=0
       DO 10 I=1,MREC
       IF (IHEAD(1,I) .EQ. -1) GOTO 10
       N=N+1
10     CONTINUE
       RETURN
       END
C
       SUBROUTINE WAKEUP(N)
C   WAKEUP RINGS THE BELL N TIMES
       BYTE BELL
       DATA BELL/"7/
       CALL WAITM(600)
       DO 10 I=1,N
       CALL WAITM(400)
       TYPE 20,BELL
20     FORMAT(1H+,A1)
10     CONTINUE
       RETURN
       END
C
       SUBROUTINE DCAL(LDAY,LHOUR,LMIN,IR,ISTAT)
C   DCAL DIGITIZES 10 HZ CALIBRATIONS
       INTEGER*2 ICODE(3)
       COMMON/PTCOM/JDATA(4001),ITYPE(11,12)
       COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),ITMGRD(20),ITPGRD(20),IRGRD(20),FIRST(20),ITGR2(20),
     * ITGR3(20),IAMP(20),IVAL(20),ICHAN(20),ICAL(12,20),IDB(3,20)
```

```
      DECIF(IID)=IAND(IID,'17)+10*ISHFT(IAND(IID,'360),-4)+
     *  100*ISHFT(IAND(IID,'7400),-8)
C
C    DIGITIZE FOUR TIME PERIODS
      DO 10 I=1,4
C    COMPUTE DIGITIZE TIME
      ADD=548.+10.*I
      CALL TIME(LDAY,LHOUR,LMIN,0.,JDAY,JHR,JMIN,JSEC,MSEC,
     *  ADD,0.)
      CALL TCIN(ICODE)
      CALL TCVAL(ICODE(1),ICODE(2),ICODE(3),IID,IDAY,
     *  IHR,IMIN,ISEC)
      JID1=DECIF(IID)
20    CONTINUE
      IF (ITTINR() .GE. 0) GOTO 100
      CALL TCIN(ICODE)
      CALL TCVAL(ICODE(1),ICODE(2),ICODE(3),IID,IDAY,
     *  IHR,IMIN,ISEC)
      JID2=DECIF(IID)
      IF (JID2 .NE. JID1) GOTO 200
      IF (IDAY .NE. JDAY) GOTO 20
      IF (IHR .NE. JHR) GOTO 20
      IF (IMIN .NE. JMIN) GOTO 20
      IF (ISEC .NE. JSEC) GOTO 20
      CALL MATOD(JDATA,220,1,3,5)
      DO 30 J=1,3
C    FIND MIN,MAX VALUES IN 20 POINT, 1 CYCLE WINDOWS
      M=(J-1)*4+I
      DO 31 L=1,11
      MIN=30000
      MAX=-30000
      DO 40 K=1,20
      N=(J-1)*220+(L-1)*20+K
      IF (JDATA(N) .GT. MAX) MAX=JDATA(N)
      IF (JDATA(N) .LT. MIN) MIN=JDATA(N)
40    CONTINUE
      ITYPE(L,M)=MAX-MIN
31    CONTINUE
C    COMPUTE THE AVERAGE OF 11 WINDOWS AND DELETE THE MOST DEVIANT
C    VALUE
      AVE=0.
      DO 32 L=1,11
32    AVE=AVE+ITYPE(L,M)
      AVE=AVE/11.
      DEV=-1.
      NUM=0
      DO 33 L=1,11
      DIF=ABS(ITYPE(L,M)-AVE)
      IF (DIF .LT. DEV) GOTO 33
      DEV=DIF
      NUM=L
33    CONTINUE
C    RECOMPUTE AVERAGE
      AVE=0.
      DO 34 N=1,11
      IF (N .EQ. NUM) GOTO 34
      AVE=AVE+ITYPE(N,M)
34    CONTINUE
      ICAL(M,IR)=AVE/10.
30    CONTINUE
10    CONTINUE
      ISTAT=0
      RETURN
100   CONTINUE
      ISTAT=1
      RETURN
```

```
200     CONTINUE
        ISTAT=2
        TYPE 210
210     FORMAT(' TIME CODE SYNCH LOST WHILE SEARCHING FOR
     * 10 HZ CALIBRATION')
        RETURN
        END
```

```
      SUBROUTINE SYMBH(XINCH,YINCH,H,ICHAR,ANG,NCHAR)
C**** PLOTS A USER SPECIFIED STRING AT A USER
C**** SPECIFIED LOCATION WITH A USER SPECIFIED ANGLE
C**** ORIENTATION AND A USER SPECIFIED CHARACTER HEIGHT
      COMMON /PLOTC/ X,Y,PINCH,F
      BYTE ICHAR(1)
      IF(XINCH.NE.999..OR.YINCH.NE.999.)CALL PLOT(XINCH,YINCH,3)
      M=H*PINCH*F/7.0+0.5
      IF ( M .GT. 29 ) M=29
      IF ( M .LT. 1 ) M=1
      DEL=6.0*M*NCHAR
      IDX=0
      IDY=0
      IF ( ANG .NE. 90.0 ) GO TO 10
      IA=2
      Y=Y+DEL
      IDY=1
      GO TO 40
   10 CONTINUE
      IF ( ANG .NE. 180.0 ) GO TO 20
      IA=0
      X=X-DEL
      IDX=-1
      GO TO 40
   20 CONTINUE
      IF ( ANG .NE. 270.0 ) GO TO 30
      IA=3
      Y=Y-DEL
      IDY=-1
      GO TO 40
   30 CONTINUE
      IA=1
      X=X+DEL
      IDX=1
   40 CONTINUE
      CALL PMUL(M)
      CALL PVECT(-IDX,-IDY)
      CALL PSYMB(ICHAR,NCHAR,IA)
      CALL PVECT(IDX,IDY)
      CALL PMUL(1)
      RETURN
      END

      SUBROUTINE BOX(XL,XR,YB,YT)
      COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *YBOT,YTOP,YLEN,YMIN,YMAX
      XLEFT=XL
      XRIGHT=XR
      YBOT=YB
      YTOP=YT
      XLEN=XRIGHT-XLEFT
      YLEN=YTOP-YBOT
      RETURN
      END

      SUBROUTINE UNITS(XMN,XMX,YMN,YMX)
      COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *YBOT,YTOP,YLEN,YMIN,YMAX
      XMIN=XMN
      XMAX=XMX
      YMIN=YMN
      YMAX=YMX
      RETURN
      END
```

```
      SUBROUTINE PDATA(X,Y,N)
      REAL X(1),Y(1)
      COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *YBOT,YTOP,YLEN,YMIN,YMAX
      XSCALE=XLEN/(XMAX-XMIN)
      YSCALE=YLEN/(YMAX-YMIN)
      IPEN=3
        NPRIME=N
        IF ( N .EQ. 0 ) NPRIME=IFIX(X(3)+.5)
      DO 100 I=1,NPRIME
        IF(N.NE.0)XINCH=XSCALE*(X(I)-XMIN)+XLEFT
        IF(N.EQ.0)XINCH=XSCALE*(X(1)+X(2)*FLOAT(I-1)-XMIN)+XLEFT
        YINCH=YSCALE*(Y(I)-YMIN)+YBOT
        IF ( XINCH.GT.XRIGHT ) XINCH=XRIGHT
        IF ( XINCH.LT.XLEFT ) XINCH=XLEFT
        IF ( YINCH.GT.YTOP ) YINCH=YTOP
        IF ( YINCH.LT.YBOT ) YINCH=YBOT
        CALL PLOT(XINCH,YINCH,IPEN)
        IPEN=2
100     CONTINUE
      CALL PLOT(XINCH,YINCH,3)
      RETURN
      END

      SUBROUTINE HEADER(LAB,NL)
      BYTE LAB(1)
      COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *YBOT,YTOP,YLEN,YMIN,YMAX
      DATA TALL/.3/
      XINCH=XLEFT+XLEN/2.-.5*NL*(TALL*.857143)
      CALL SYMB(XINCH,YTOP+.25,TALL,LAB,0.,NL)
      RETURN
      END

        SUBROUTINE CSYMB(XC,YC,H,ISMB,IDAT)
        INTEGER*2 TR(3,4),SQ(3,5),OCT(3,9),XX(3,4),ST(3,6),MAX(6),IP(3)
        INTEGER*2 ST1(3,6)
        DATA MAX/4,5,9,4,6,6/
        DATA TR/-577,-333,1,577,-333,2,0,667,2,-577,-333,2/
        DATA SQ/-500,-500,1,-500,500,2,500,500,2,500,-500,2,
     *  -500,-500,2/
        DATA OCT/-207,-500,1,-500,-207,2,-500,207,2,-207,500,2,
     *  207,500,2,500,207,2,500,-207,2,207,-500,2,-207,-500,2/
        DATA XX/-500,-500,1,500,500,2,-500,500,1,500,-500,2/
        DATA ST/-289,-500,1,289,500,2,-289,500,1,289,-500,2,
     *  577,0,1,-577,0,2/
        DATA ST1/-476,155,1,476,155,2,-294,-405,2,0,500,2,
     *  294,-405,2,-476,155,2/
        COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *  YBOT,YTOP,YLEN,YMIN,YMAX
        XCP=XC
        YCP=YC
        IF (IDAT .NE. 1) GOTO 9
        IF (XCP .LT. XMIN) RETURN
        IF (XCP .GT. XMAX) RETURN
        IF (YCP .LT. YMIN) RETURN
        IF (YCP .GT. YMAX) RETURN
        XCP=XLEFT+XLEN*(XCP-XMIN)/(XMAX-XMIN)
        YCP=YBOT+YLEN*(YCP-YMIN)/(YMAX-YMIN)
9       CONTINUE
        DO 10 I=1,MAX(ISMB)
        DO 20 J=1,3
        GOTO (110,120,130,140,150,160) ISMB
110     IP(J)=TR(J,I)
        GOTO 20
```

```
120     IP(J)=SQ(J,I)
        GOTO 20
130     IP(J)=OCT(J,I)
        GOTO 20
140     IP(J)=XX(J,I)
        GOTO 20
150     IP(J)=ST(J,I)
        GOTO 20
160     IP(J)=ST1(J,I)
20      CONTINUE
        X=XCP+IP(1)*H/1000.
        Y=YCP+IP(2)*H/1000.
        CALL PLOT(X,Y,IP(3))
10      CONTINUE
        RETURN
        END

        SUBROUTINE SYMB(XINCH,YINCH,HEIGHT,CHARS,ANGLE,NCHAR)
        COMMON /PLTDEV/ IDEV
        CALL SYMBH(XINCH,YINCH,HEIGHT,CHARS,ANGLE,NCHAR)
        END

      SUBROUTINE PINIT
C**** INITIALIZES THE PTC-5A PLOTTER CONTROLLER
C**** BY SENDING ';' , ':' TO THE DLV-11
      BYTE ISEMI,ICOLON
      ISEMI='73
      ICOLON='72
C**** ISEMI=OCTAL CODE FOR ASCII <;>
C**** ICOLON=OCTAL CODE FOR ASCII <:>
C**** TRANSMIT ISEMI
      CALL PBYTE(ISEMI)
C**** TRANSMIT ICOLON
      CALL PBYTE(ICOLON)
      RETURN
      END

      SUBROUTINE PSYMB(ICHAR,N,IANGLE)
C**** OUTPUTS A COMMAND TO THE PTC-5A TO
C**** PLOT A USER SPECIFIED STRING AT
C**** THE CURRENT LOCATION OF THE PEN,
C**** WITH INCLINATION IANGLE (IN DEGREES)
      BYTE ICHAR(N),NANGLE,IEQU,IUND
      INTEGER*2 IANGLE,N,I
C**** START COMMAND SEQUENCE BY OUTPUTTING ASCII <=>
      IEQU='75
      CALL PBUF(IEQU)
C**** THE SECOND CHARACTER DETERMINES ANGLE ORIENTATION
C**** CALCULATE CORRECT ANGLE CHARACTER
      IF ( IANGLE .EQ. 0 ) NANGLE='60
      IF ( IANGLE .EQ. 1 ) NANGLE='61
      IF ( IANGLE .EQ. 2 ) NANGLE='62
      IF ( IANGLE .EQ. 3 ) NANGLE='63
C**** OUTPUT STRING ORIENTATION CHARACTER
      CALL PBUF(NANGLE)
C**** OUTPUT THE USER SPECIFIED STRING
      DO 10 I=1,N
      CALL PBUF( ICHAR(I) )
   10 CONTINUE
C**** TERMINATE THE STRING WITH ASCII <_>
      IUND='137
      CALL PBUF(IUND)
      RETURN
      END

      SUBROUTINE PMUL(M)
```

```
C**** SETS THE VECTOR MULTIPLY( REPEAT COUNTER ) FACTOR
      BYTE IQ,MBYTE
      INTEGER*2 M
C**** INITIATE COMMAND, OUTPUT AN ASCII <?>
      IQ=*77
      CALL PBUF(IQ)
C**** THE MULTIPLY FACTOR MUST BE BIASED BY 77(8)
      MBYTE=M+*77
C**** OUTPUT MULTIPLY FACTOR
      CALL PBUF(MBYTE)
      RETURN
      END

      SUBROUTINE PUP
C**** RAISES THE PLOTTER PEN
      BYTE IUPPER
C**** OUTPUT AN ASCII <^>
      IUPPER=*136
      CALL PBUF(IUPPER)
      RETURN
      END

      SUBROUTINE PDOWN
C**** LOWERS THE PEN BY OUTPUTTING A SINGLE
C**** CONTROL CHARACTER TO THE DLV-11
      BYTE IGT
      IGT=*76
      CALL PBUF(IGT)
      RETURN
      END

      SUBROUTINE PFINIT
C**** TERMINATES PLOTTING MODE IN THE PTC-5A
      BYTE IUND
      IUND=*137
      CALL PFLUSH
      CALL PBYTE(IUND)
      RETURN
      END

      SUBROUTINE EVENP(IBYTE,OBYTE)
      BYTE IBYTE,OBYTE,TABLE(64)
      DATA TABLE/
     X*240,*41,*42,*243,*44,*245,*246,*47,*50,*251,*252,
     X*53,*254,*55,*56,*257,*60,*261,*262,*63,*264
     X,*65,*66,*267,*270,*71,*72,*273,*74,*275,*276
     X,*77,*300,*101,*102,*303,*104,*305,*306,*107,*110
     X,*311,*312,*113,*314,*115,*116,*317,*120,*321,*322
     X,*123,*324,*125,*126,*327,*330,*131,*132,*333,*134
     X,*335,*336,*137/
      I=IBYTE-*37
      OBYTE=TABLE(I)
      RETURN
      END

      SUBROUTINE PBYTE(ICHAR)
C**** SENDS A BYTE TO THE DLV-11 TRANSMITTED
C**** DATA BUFFER REGISTER,(XBUF),
C**** THEN WAITS FOR A TRANSMITTER READY AKNOWLEDGEMENT,
C**** IN BIT NO. 7 OF THE TRANSMITTER
C**** STATUS REGISTER BEFORE RETURNING CONTROL
      BYTE ICHAR
      INTEGER*2 IAD,ICSR
      IAD=*177570
C**** IAD=ABSOLUTE ADDRESS OF THE PLOTTER INTERFACE BOARD
C**** PUT THE BYTE INTO XBUF
```

```
      CALL BPUT(IAD+6,ICHAR)
   10 CONTINUE
      CALL WGET(IAD+4,ICSR)
      IF ( IAND('200,ICSR) .EQ. 0 ) GO TO 10
      RETURN
      END

      SUBROUTINE RBYTE(ICHAR)
C**** READS A BYTE FROM THE DLV-11
      BYTE ICHAR
      INTEGER*2 IAD,ICSR
      IAD='177570
C**** IAD=ABSOLUTE ADDRESS OF THE PLOTTER INTERFACE BOARD
C**** SET THE GO BIT
      CALL WPUT(IAD,1)
C**** WAIT FOR ACKNOWLEDGEMENT OF READ OPERATION
   10 CONTINUE
      CALL WGET(IAD,ICSR)
      IF ( IAND('200,ICSR) .EQ. 0 ) GO TO 10
C**** GET THE BYTE
      CALL BGET (IAD+'2,ICHAR)
      RETURN
      END

      SUBROUTINE NUMB(XP,YP,HGT,FPN,THETA,ND)
      DATA SAMEV/999./
      MAXN=20
      X=XP
      Y=YP
      H=HGT
      FPV=FPN
      TH=THETA
      N=ND
      IF ( N-MAXN ) 11,11,10
   10 N=MAXN
   11 IF ( N+MAXN) 12,20,20
   12 N=-MAXN
   20 IF ( FPV ) 21,30,30
   21 CALL SYMB(X,Y,H,2H- ,TH,1)
      X=SAMEV
      Y=SAMEV
   30 MN=-N
      IF ( N ) 31,32,32
   31 MN=MN-1
   32 FPV=ABS(FPV)+(0.5*10.**MN)
      I=ALOG(FPV)*0.43429448+1.0
      ILP=I
      IF ( N+1 ) 40,41,41
   40 ILP=ILP+N+1
   41 IF ( ILP ) 50,50,51
   50 CALL SYMB(X,Y,H,2H0 ,TH,1)
      X=SAMEV
      Y=SAMEV
      GO TO 61
   51 DO 60 J=1,ILP
      K=FPV*10.**(J-I)
      K1=K+48
      CALL SYMB(X,Y,H,K1,TH,1)
      FPV=FPV-(FLOAT(K)*10.**(I-J))
      X=SAMEV
   60 Y=SAMEV
   61 IF ( N ) 99,70,70
   70 CALL SYMB(X,Y,H,2H. ,TH,1)
      IF ( N ) 99,99,80
   80 DO 90 J=1,N
      K=FPV*10.
```

```
      K1=K+48
      CALL SYMB(X,Y,H,K1,TH,1)
   90 FPV=FPV*10.-FLOAT(K)
   99 RETURN
      END

        SUBROUTINE INITT(I)
        CALL CPINI(I)
        RETURN
        END

      SUBROUTINE CPINI(I)
C**** INITIALIZES THE PLOTTER AND SETS UP ORIGIN
      COMMON /PLOTC/ X,Y,PINCH,F
      COMMON /ROTCOM/ IROTAT
      COMMON /ORGCOM/ XORG,YORG
      DATA IROTAT/0/
C
      CALL PINIT
      Y=11.*PINCH
      IF ( IROTAT.EQ.1 ) Y=0.
      X=0.
      F=1.
      CALL PMUL(1)
      CALL PLOT(0.,0.,-3)
      CALL PFLUSH
      XORG=0.
      YORG=0.
      RETURN
      END

        SUBROUTINE TERM(I,J)
        RETURN
        END

        SUBROUTINE CZAXIS(I)
        RETURN
        END

        SUBROUTINE DEVICE(I)
        RETURN
        END

        SUBROUTINE FINITT(I1,I2)
        CALL CPFIN(I1,I2)
        RETURN
        END

      SUBROUTINE CPFIN(I1,I2)
C**** EXECUTES PEN UP COMMAND, TERMINATES PLOTTING MODE
      CALL PUP
      CALL PFINIT
      RETURN
      END

        SUBROUTINE PLOT(X,Y,IPEN)
        CALL CPPLOT(X,Y,IPEN)
        RETURN
        END

      SUBROUTINE CPPLOT(XXINCH,YYINCH,IPEN)
C**** PLOTS A VECTOR FROM THE CURRENT LOCATION OF THE PEN TO
C**** XNEW,YNEW, WHERE XNEW,YNEW ARE RELATIVE TO THE ORIGIN
      COMMON /PLOTC/ X,Y,PINCH,F
      COMMON /ORGCOM/ XORG,YORG
      COMMON /ROTCOM/ IROTAT
```

```
      DATA X,Y,PINCH,F/0.0 , 0.0 , 200. , 1.0 /
      DATA XORG,YORG/0.,0./
C
      XINCH=XXINCH
      YINCH=YYINCH
      IF ( IROTAT.EQ.0 ) GOTO 1
      XINCH=YYINCH
      YINCH=11./F-XXINCH
    1 CONTINUE
      IDONE=0
      IF ( IABS(IPEN) .EQ. 2 ) CALL PDOWN
      IF ( IABS(IPEN) .NE. 2 ) CALL PUP
      IF ( IPEN.LT.100 ) GOTO 9
      IF ( IPEN.NE.101 ) GOTO 7
      XNEW=-XORG
      YNEW=-YORG
      X=0.
      Y=0.
      F=1.
      GOTO 10
    7 CONTINUE
      IF ( IPEN.NE.103 ) GOTO 8
      F=XXINCH
      RETURN
8     CONTINUE
      IF ( IPEN.NE.104 ) RETURN
      XXINCH=X/PINCH/F
      YYINCH=Y/PINCH/F
      IF ( IROTAT.EQ.0 ) RETURN
      XXINCH=(11.-Y)/PINCH/F
      YYINCH=X/PINCH/F
      RETURN
C
9     CONTINUE
      XNEW=XINCH*PINCH*F
      YNEW=YINCH*PINCH*F
C**** XNEW,YNEW ARE THE PLOTTER UNITS OF THE NEW PEN POSITION DESIRED
   10 CONTINUE
C**** START A LOOP THAT GENERATES THE RELATIVE PEN MOVEMENTS
      DX=XNEW-X
      DY=YNEW-Y
      ADX=ABS(DX)
      ADY=ABS(DY)
      IF ( .NOT. ( ADX .LE. 25. .AND. ADY .LE. 25. ) ) GO TO 20
      IX=DX
      IY=DY
      IDONE=1
      GO TO 100
   20 CONTINUE
      IF ( ADX .GT. ADY ) GO TO 30
      IY=25
      IF ( DY .LT. 0.0 ) IY=-IY
      IX=25./ADY*ADX+.5
      IF ( DX .LT. 0.0 ) IX=-IX
      GO TO 100
   30 CONTINUE
      IX=25
      IF ( DX .LT. 0.0 ) IX=-IX
      IY=25./ADX*ADY+.5
      IF ( DY .LT. 0.0 ) IY=-IY
  100 CONTINUE
      CALL PVECT(IX,IY)
      X=X+IX
      Y=Y+IY
      XORG=XORG+IX
      YORG=YORG+IY
```

```
      IF ( IDONE .NE. 1 ) GO TO 10
      IF ( IPEN.GE.0 .AND. IPEN.NE.101   ) RETURN
      X=0.
      Y=0.
      IF ( IROTAT.EQ.1 ) Y=11.*PINCH
      RETURN
      END

      SUBROUTINE WHERE(XINCH,YINCH)
C**** RETURNS THE CURRENT LOCATION OF THE PEN IN INCHES
        CALL PLOT(XINCH,YINCH,104)
      RETURN
      END

      SUBROUTINE FACT(FNEW)
C**** SETS F TO A NEW VALUE
        CALL PLOT(FNEW,FNEW,103)
      RETURN
      END

        SUBROUTINE XAXIS(LAB,NL,HLAB,OFFLAB,NDIV,ND,NDEC,HNUM,
     *  OFFNUM,TIC)
        BYTE LAB(1)
        COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,YBOT,YTOP,
     *  YLEN,YMIN,YMAX
        FACT=.857143
        XINCH=XLEFT+.5*XLEN-.5*NL*HLAB*FACT
        YINCH=YBOT-OFFLAB
        IF (NL .GT. 0) CALL SYMB(XINCH,YINCH,HLAB,LAB,0.,NL)
        NXTIC=NDIV+1
        XDIV=XLEN/NDIV
        XSC=(XMAX-XMIN)/NDIV
        DO 10 I=1,NXTIC,ND
        VAL=XMIN+(I-1)*XSC
        XINCH=XLEFT+(I-1)*XDIV-.5*NNUM(VAL,NDEC)*HNUM*FACT
        YINCH=YBOT-OFFNUM
        CALL NUMB(XINCH,YINCH,HNUM,VAL,0.,NDEC)
10      CONTINUE
        CALL PLOT(XRIGHT,YBOT,3)
        DO 20 I=1,NXTIC
        CALL PLOT(XLEFT+(NXTIC-I)*XDIV,YBOT,2)
        CALL PLOT(XLEFT+(NXTIC-I)*XDIV,YBOT-TIC,2)
        CALL PLOT(XLEFT+(NXTIC-I)*XDIV,YBOT,2)
20      CONTINUE
        CALL PUP
        RETURN
        END

        SUBROUTINE YAXIS(LAB,NL,HLAB,OFFLAB,NDIV,ND,NDEC,HNUM,
     *  OFFNUM,TIC)
        BYTE LAB(1)
        COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,YBOT,YTOP,
     *  YLEN,YMIN,YMAX
        FACT=.857143
        XINCH=XLEFT-OFFLAB
        YINCH=YBOT+.5*YLEN-.5*NL*HLAB*FACT
        IF (NL .GT. 0) CALL SYMB(XINCH,YINCH,HLAB,LAB,90.,NL)
        NYTIC=NDIV+1
        YDIV=YLEN/NDIV
        YSC=(YMAX-YMIN)/NDIV
        DO 10 I=1,NYTIC,ND
        VAL=YMIN+(I-1)*YSC
        XINCH=XLEFT-OFFNUM-NNUM(VAL,NDEC)*HNUM*FACT
        YINCH=YBOT+(I-1)*YDIV-.5*HNUM
        CALL NUMB(XINCH,YINCH,HNUM,VAL,0.,NDEC)
10      CONTINUE
```

```
      CALL PLOT(XLEFT,YTOP,3)
      DO 20 I=1,NYTIC
      CALL PLOT(XLEFT,YBOT+(NYTIC-I)*YDIV,2)
      CALL PLOT(XLEFT-TIC,YBOT+(NYTIC-I)*YDIV,2)
      CALL PLOT(XLEFT,YBOT+(NYTIC-I)*YDIV,2)
20    CONTINUE
      CALL PUP
      RETURN
      END

      FUNCTION NNUM(VAL,NDEC)
C   NNUM COMPUTES THE NUMBER OF CHARACTERS PLOTTED BY SUBROUTINE NUMB
      DO 10 I=1,20
      IF (ABS(VAL) .LT. 10.**I) GOTO 20
10    CONTINUE
20    NNUM=I
      IF (VAL .LT. 0.) NNUM=NNUM+1
      IF (NDEC .EQ. -1) RETURN
      NNUM=NNUM+NDEC+1
      RETURN
      END

      SUBROUTINE PBUF(IBYTE)
C**** INSERTS BYTES INTO THE PLOTTER COMMAND BUFFER
      BYTE IBYTE,CR,ONE,ICR,IONE,IBUF(96)
      COMMON /BUFFER/ NCHAR,IBUF,CR,ONE,LENBUF
      NCHAR=NCHAR+1
      IBUF(NCHAR)=IBYTE
      IF ( NCHAR .EQ. LENBUF ) CALL PFLUSH
      RETURN
      END

      SUBROUTINE PVECT(IDX,IDY)
C**** OUTPUTS A RELATIVE VECTOR PEN MOVEMENT COMMAND
C**** THROUGH THE DLV-11 TO THE PTC-5A PLOTTER CONTROLLER
      BYTE NDX,NDY
      INTEGER*2 IDX,IDY
C**** NDX AND NDY ARE BIASED VALUES OF IDX AND IDY RESPECTIVELY
C**** POSITIVE INPUT VALUES ARE BIASED BY 100(8)
C**** NEGATIVE INPUT VALUES ARE BIASED BY 40(8)
C**** CALCULATE CORRECT CHARACTERS, TRUNCATE TO BYTES
      IF ( IDX .GE. 0 ) NDX=IDX+'100
      IF ( IDX .LT. 0 ) NDX='40-IDX
      IF ( IDY .GE. 0 ) NDY=IDY+'100
      IF ( IDY .LT. 0 ) NDY='40-IDY
C**** OUTPUT CHARACTERS TO DLV-11
      CALL PBUF(NDX)
      CALL PBUF(NDY)
      RETURN
      END

      SUBROUTINE PFLUSH
C**** DUMPS THE CONTENS OF IBUF INTO THE PTC-5A
      BYTE IBUF(96),CR,ONE,THREE,ICR,IONE,ECHAR
      COMMON /BUFFER/ NCHAR,IBUF,CR,ONE,LENBUF
      DATA NCHAR/0/,LENBUF/96/,CR/'215/,ONE/'261/,THREE/'63/
      IF ( NCHAR .LE. 0 ) RETURN
   10 DO 20 I=1,NCHAR
      CALL EVENP(IBUF(I),ECHAR)
      CALL PBYTE(ECHAR)
   20 CONTINUE
      CALL PBYTE('012)
      CALL PBYTE('021)
      CALL RBYTE(IONE)
      CALL RBYTE(ICR)
      CALL PBYTE('012)
```

```
         IF (ICR .NE. CR) GOTO 50
         IF (IONE.NE.ONE .AND. IONE.NE.THREE) GOTO 50
   30 CONTINUE
      NCHAR=0
      RETURN
   50 CONTINUE
      WRITE(5,60) IONE,ICR
   60 FORMAT(' **PFLUSH ERROR**',2O7 )
      IF ( ICR.EQ.ONE.AND.IONE.EQ.CR ) GOTO 70
      IF (ICR.EQ.THREE.AND.IONE.EQ.CR) GOTO 70
      GO TO 10
   70 CONTINUE
      CALL RBYTE(ICR)
      GOTO 30
      END

        SUBROUTINE ROTATE(I)
C
C*** SUBROUTINE TO SET THE ROTATE FLAG FOR THE
C*** COMPLOT PLOTTER SOFTWARE.
C*** FLAG=0 , NORMAL, NO ROTATION
C*** FLAG=1 , ROTATE PLOT CALLS TO MAKE PLOT
C***          COME OUT AS 8.5 X 11 INCHES
C
        COMMON/ROTCOM/IROTAT
C
        IROTAT=I
        RETURN
        END

        SUBROUTINE FRAME(MODE)
C
C   FRAME DRAWS A RECTANGULAR BOX AROUND THE PLOTTING AREA
C   IF MODE=1 DRAW RIGHT SIDE AND TOP
C   IF MODE=2 DRAW COMPLETE BOX
C
        COMMON/BOXCOM/XLEFT,XRIGHT,XLEN,XMIN,XMAX,
     *  YBOT,YTOP,YLEN,YMIN,YMAX
        COMMON/PLTDEV/IDEV
C
        IUP=1
        IF (IDEV .EQ. 1) IUP=3
        IF (MODE .EQ. 1) GOTO 10
        CALL PLOT(XLEFT,YBOT,IUP)
        CALL PLOT(XRIGHT,YBOT,2)
        GOTO 20
10      CONTINUE
        CALL PLOT(XRIGHT,YBOT,IUP)
20      CONTINUE
        CALL PLOT(XRIGHT,YTOP,2)
        CALL PLOT(XLEFT,YTOP,2)
        IF (MODE .EQ. 1) GOTO 30
        CALL PLOT(XLEFT,YBOT,2)
30      CONTINUE
        IF (IDEV .EQ. 1) RETURN
        CALL PUP
        CALL PFLUSH
        RETURN
        END

        SUBROUTINE CIRCLE(X,Y,R)
C
C   THIS SUBROUTINE DRAWS A POLYGON WITH NSIDES SIDES
C
        DATA PI/3.14159/
C
```

```
      NSIDES=25
      IF (R .GT. .25) NSIDES=50
      IF (R .GT. 1.0) NSIDES=100
      DANG=2.*PI/FLOAT(NSIDES)
      CALL PLOT(X+R,Y,1)
      DO 10 I=1,NSIDES
      ANG=I*DANG
      XPLOT=X+R*COS(ANG)
      YPLOT=Y+R*SIN(ANG)
      CALL PLOT(XPLOT,YPLOT,2)
10    CONTINUE
      RETURN
      END
```

```
      SUBROUTINE DXOPEN
C
C   DXOPEN OPENS A DATA DISK FILE.
C   THIS VERSION USES DEC BLOCK ACCESS SUBROUTINES
C
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),ITIT(40),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
      INTEGER*2 IDBLK(4)
      DATA IOPEN/0/,IDBLK/3RDX1,3RT  ,3R   ,3RDAT/
C
      IF (IOPEN .EQ. 0) GOTO 1
      CALL DXERR(1)
      RETURN
1     CONTINUE
      PAUSE 'PUT DATA DISK IN DX1'
C   OPEN FILE
      ICHAN=IGETC()
      IF (ICHAN .LT. 0) STOP 'NO AVAILABLE CHANNEL'
      IF (IFETCH(IDBLK).NE.0) STOP 'DEVICE FETCH ERROR'
      IF (LOOKUP(ICHAN,IDBLK).LT.0) STOP 'BAD LOOKUP'
C   READ DIRECTORY
      ICODE=IREADW(768,MSAMP,0,ICHAN)
      IF (ICODE .EQ. -2) STOP 'HARDWARE READ ERROR ON DX1'
      ICODE=IREADW(256,IBUF,3,ICHAN)
      DO 10 I=1,178
      J=I+15
10    ITIT(J)=IBUF(I)
      IOPEN=1
      RETURN
      END

      SUBROUTINE DLOP2
C
C   DLOPEN OPENS A DATA DISK FILE.
C   THIS VERSION USES DEC BLOCK ACCESS SUBROUTINES
C
      COMMON/DLCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),ITIT(40),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
      INTEGER*2 IDBLK(4)
      DATA IOPEN/0/,IDBLK/3RDL0,3RT01,3R   ,3RDAT/
C
      IF (IOPEN .EQ. 0) GOTO 1
      CALL DXERR(1)
      RETURN
1     CONTINUE
C   OPEN FILE
      ICHAN=IGETC()
      IF (ICHAN .LT. 0) STOP 'NO AVAILABLE CHANNEL'
      IF (IFETCH(IDBLK).NE.0) STOP 'DEVICE FETCH ERROR'
      IF (LOOKUP(ICHAN,IDBLK).LT.0) STOP 'BAD LOOKUP'
C   READ DIRECTORY
      ICODE=IREADW(768,MSAMP,0,ICHAN)
      IF (ICODE .EQ. -2) STOP 'HARDWARE READ ERROR ON DX1'
      ICODE=IREADW(256,IBUF,3,ICHAN)
      DO 10 I=1,178
      J=I+15
10    ITIT(J)=IBUF(I)
      IOPEN=1
      RETURN
      END

      SUBROUTINE DXCLOS
```

```
C
C     DXCLOS CLOSES A DATA FILE
C
          COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *    RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
          COMMON/BUFCOM/IBUF(256),ICHAN
C
          IF (IOPEN .EQ. 1) GOTO 1
          CALL DXERR(0)
          RETURN
1         CONTINUE
          CALL CLOSEC(ICHAN)
          CALL IFREEC(ICHAN)
          IOPEN=0
          RETURN
          END

          SUBROUTINE DLCLOS
C
C     DLCLOS CLOSES A DATA FILE
C
          COMMON/DLCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *    RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
          COMMON/BUFCOM/IBUF(256),ICHAN
C
          IF (IOPEN .EQ. 1) GOTO 1
          CALL DXERR(0)
          RETURN
1         CONTINUE
          CALL CLOSEC(ICHAN)
          CALL IFREEC(ICHAN)
          IOPEN=0
          RETURN
          END

          SUBROUTINE DXIN(IREC,IDATA,ICODE)
C
C     DXIN READS RECORD IREC FROM DISK TO ARRAY IDATA
C
          INTEGER*2 IDATA(1)
          COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *    RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
          COMMON/BUFCOM/IBUF(256),ICHAN
C
          IF (IOPEN .EQ. 1) GOTO 1
          CALL DXERR(0)
          RETURN
1         CONTINUE
C     COMPUTE BEGINNING BLOCK TO READ
          IREC1=IREC
          NB=0
          NS=0
          NBLK=MSAMP/256
          NSAMP=MSAMP-256*NBLK
          DO 10 I=1,IREC1
          NB=NB+NBLK
          NS=NS+NSAMP
          IF (NS .LT. 256) GOTO 20
          NB=NB+1
          NS=NS-256
20        CONTINUE
10        CONTINUE
C     READ FIRST DATA BLOCK AND TRANSFER TO IDATA
          ICODE=IREADW(256,IBUF,NB,ICHAN)
          IF (ICODE .LT. 0) RETURN
          NSTART=256-NS
```

```
      DO 30 I=1,NSTART
30    IDATA(I)=IBUF(I+NS)
      NB=NB+1
C   READ IN WHOLE BLOCKS TO IDATA
      NBLK=(MSAMP-NSTART)/256
      NWORD=NBLK*256
      ICODE=IREADW(NWORD,IDATA(NSTART+1),NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      NB=NB+NBLK
      NSTART=NSTART+NWORD
C   READ LAST BLOCK
      NTRANS=MSAMP-NSTART
      IF (NTRANS .EQ. 0) RETURN
      ICODE=IREADW(256,IBUF,NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      DO 50 I=1,NTRANS
50    IDATA(NSTART+I)=IBUF(I)
      RETURN
      END

      SUBROUTINE DXOUT(IREC,IDATA,ICODE)
C
C   DXOUT WRITES RECORD IREC FROM ARRAY IDATA TO DISK
C
      INTEGER*2 IDATA(1)
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
C
      IF (IOPEN .EQ. 1) GOTO 1
      CALL DXERR(0)
      RETURN
1     CONTINUE
C   COMPUTE BEGINNING BLOCK TO WRITE
      IREC1=IREC
      NB=0
      NS=0
      NBLK=MSAMP/256
      NSAMP=MSAMP-256*NBLK
      DO 10 I=1,IREC1
      NB=NB+NBLK
      NS=NS+NSAMP
      IF (NS .LT. 256) GOTO 20
      NB=NB+1
      NS=NS-256
20    CONTINUE
10    CONTINUE
C   WRITE FIRST DATA BLOCK AND TRANSFER TO IDATA
      ICODE=IREADW(256,IBUF,NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      NSTART=256-NS
      DO 30 I=1,NSTART
30    IBUF(I+NS)=IDATA(I)
      ICODE=IWRITW(256,IBUF,NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      NB=NB+1
C   WRITE WHOLE BLOCKS TO DISK FILE
      NBLK=(MSAMP-NSTART)/256
      NWORD=NBLK*256
      ICODE=IWRITW(NWORD,IDATA(NSTART+1),NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      NB=NB+NBLK
      NSTART=NSTART+NWORD
C   WRITE LAST BLOCK
      NTRANS=MSAMP-NSTART
      IF (NTRANS .EQ. 0) RETURN
```

```
      ICODE=IREADW(256,IBUF,NB,ICHAN)
      IF (ICODE .LT. 0) RETURN
      DO 50 I=1,NTRANS
50    IBUF(I)=IDATA(NSTART+I)
      ICODE=IWRITW(256,IBUF,NB,ICHAN)
      RETURN
      END

      SUBROUTINE DXDEL(I,IFOUND)
C
C   DXDEL DELETES RECORDS FROM A DATA DISK
C
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
C
      IF ( IOPEN.EQ.1 ) GOTO 1
      CALL DXERR(2)
      RETURN
1     CONTINUE
      IFOUND=1
      IF (IHEAD(1,I) .EQ. -1) GOTO 10
      IHEAD(1,I)=-1
      ICODE=IWRITW(1024,MSAMP,0,ICHAN)
      RETURN
10    CONTINUE
      IFOUND=0
      RETURN
      END

      SUBROUTINE DLOPEN(INP,OUTP)
C
C   DLOPEN OPENS DATA FILES ON THE HARD DISK
C
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),ITIT(40),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
      BYTE ERR,IFILE(15),FILE(13)
      INTEGER IDBLK(4),OUTP
      DATA IOPEN/0/
C
      IF (IOPEN .EQ. 0) GOTO 1
      CALL DXERR(1)
      RETURN
1     CONTINUE
      WRITE(OUTP,40)
40    FORMAT('$ENTER NAME OF DATA FILE   ')
      CALL GETSTR(INP,IFILE,14,ERR)
      N=LEN(IFILE)
      IF (N .EQ. 0) GOTO 100
      CALL SCOPY('DK          ',FILE)
      CALL INDEX(IFILE,':',M)
      IF (M .GT. 2) CALL INSERT(IFILE,FILE,1,M-1)
      CALL INDEX(IFILE,'.',L)
      IF (L .EQ. 0) GOTO 100
      LM=L-M-1
      IF (LM .LE. 0) GOTO 100
      CALL INSERT(IFILE(M+1),FILE,4,LM)
      NL=N-L
      IF (NL .GT. 0) CALL INSERT(IFILE(L+1),FILE,10,NL)
      N=IRAD50(12,FILE,IDBLK)
      ICHAN=IGETC()
      IF (ICHAN .LT. 0) STOP 'NO AVAILABLE CHANNEL'
      IF (IFETCH(IDBLK).NE. 0) STOP 'DEVICE FETCH ERROR'
      IF (LOOKUP(ICHAN,IDBLK).LT.0) STOP 'BAD LOOKUP'
C   READ DIRECTORY
```

```
      ICODE=IREADW(768,MSAMP,0,ICHAN)
      IF (ICODE .EQ. -2) STOP 'HARDWARE READ ERROR ON DX1'
      ICODE=IREADW(256,IBUF,3,ICHAN)
      DO 10 I=1,178
      J=I+15
10    ITIT(J)=IBUF(I)
      IOPEN=1
      RETURN
100   CONTINUE
      TYPE 110
110   FORMAT(' FILE NAME FORMAT ERROR')
      RETURN
      END

      SUBROUTINE DXPUT(IDATA,IDR,LOCN,IDREC,DIST,JCHAN,K)
C
      INTEGER IDATA(1)
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
C
      IF ( IOPEN.EQ.1 ) GOTO 1
      CALL DXERR(2)
      RETURN
1     CONTINUE
      DO 10 I=1,MREC
         K=I
         IF ( IHEAD(1,I).EQ.-1 ) GOTO 100
10       CONTINUE
      CALL DXERR(3)
      RETURN
100   IHEAD(1,K)=IDR
      IHEAD(2,K)=LOCN
      IHEAD(3,K)=IDREC
      RRDIST(K)=DIST
      ICHANL(K)=JCHAN
      CALL DXOUT(K,IDATA,ICODE)
      IF (ICODE .EQ. -2) CALL DXERR(4)
      ICODE=IWRITW(1024,MSAMP,0,ICHAN)
      IF (ICODE .EQ. -2) CALL DXERR(4)
      RETURN
      END

      SUBROUTINE DLPUT(IDATA,IDR,LOCN,IDREC,DIST,JCHAN,K)
C
      INTEGER IDATA(1)
      COMMON/DLCOM/IOPENL,MSAMPL,MRECL,MAXRL,IHEADL(3,150),
     * RRDISL(150),TITL(20),NSRATL,VREDUL,ICHALL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
C
      IF ( IOPENL.EQ.1 ) GOTO 1
      CALL DXERR(2)
      RETURN
1     CONTINUE
      DO 10 I=1,MRECL
         K=I
         IF ( IHEADL(1,I).EQ.-1 ) GOTO 100
10       CONTINUE
      CALL DXERR(3)
      RETURN
100   IHEADL(1,K)=IDR
      IHEADL(2,K)=LOCN
      IHEADL(3,K)=IDREC
      RRDISL(K)=DIST
      ICHALL(K)=JCHAN
      CALL DXOUT(K,IDATA,ICODE)
```

```
      IF (ICODE .EQ. -2) CALL DXERR(4)
      ICODE=IWRITW(1024,MSAMPL,0,ICHAN)
      IF (ICODE .EQ. -2) CALL DXERR(4)
      RETURN
      END

      SUBROUTINE DXLIST
      BYTE TIT,ERR
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(80),NSRATE,VREDUC,ICHANL(150)
      IF ( IOPEN.EQ.1 ) GOTO 1
      CALL DXERR(2)
      RETURN
1     CONTINUE
      CALL PUTSTR(5,TIT,'0',ERR)
      WRITE (5,2) MSAMP,MREC,NSRATE,VREDUC
2     FORMAT (/'  *********** DATA DISK DIRECTORY ***********'//
     * '  DATA RECORD LENGTH ='I5/
     * '  MAXIMUM FILE CAPACITY =',I4,' RECORDS'/
     * '  SAMPLING INTERVAL(MSEC) =',I4/
     * '  REDUCTION VELOCITY(KM/SEC) =',F5.1//)
      WRITE (5,3)
3     FORMAT('  .  REC #    ID   LOC   TMIN    DB',
     *'   DISTANCE'/
     * '    -----    --   ---  ----    --   --------')
      N=0
      DO 100 I=1,MREC
         IF ( IHEAD(1,I).EQ.-1 ) GOTO 100
      IF (ICHANL(I) .EQ. -1)
     * TYPE 30,I,(IHEAD(J,I),J=1,3),RRDIST(I)
30    FORMAT(1H ,I8,3I6,6X,F11.3)
      IF (ICHANL(I) .NE. -1)
     * TYPE 40,I,(IHEAD(J,I),J=1,3),ICHANL(I),RRDIST(I)
40    FORMAT(1H ,I8,4I6,F11.3)
         N=N+1
100      CONTINUE
      WRITE (5,200) N
200   FORMAT (//'  NUMBER OF DATA RECORDS =',I4//)
      RETURN
      END

      SUBROUTINE DXCR(NSAMP)
      BYTE TIT,ERR
      INTEGER IDUM(1)
      EQUIVALENCE(IDUM,MSAMP)
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TIT(80),NSRATE,VREDUC,ICHANL(150)
      DATA IOPEN/0/
      DATA MAXR/150/
      IF (IOPEN.EQ.0 ) GOTO 1
      CALL DXERR(1)
      RETURN
1     CONTINUE
      MSAMP=NSAMP
      M=480./(MSAMP/256.)
      IF ( M.LE.MAXR ) GOTO 2
      CALL DXERR(4)
      RETURN
2     CONTINUE
      MREC=M-1
      DO 10 I=1,MAXR
         IHEAD(1,I)=-1
         IHEAD(2,I)=-1
         RRDIST(I)=0.
      ICHANL(I)=-1
```

```
10      CONTINUE
        MSAMP=NSAMP
        DEFINE FILE 1(M,MSAMP,U,IREC)
        CALL ASSIGN(1,'DX1:T.DAT',0,'NEW')
30      CONTINUE
        TYPE 20
20    FORMAT('$ENTER PROJECT TITLE(UP TO 79 CHAR)    ')
        CALL GETSTR(5,TIT,79,ERR)
        IF (ERR .EQ. .TRUE.) GOTO 30
        WRITE(1'1) (IDUM(L),L=1,946)
        WRITE(1'M) (IDUM(L),L=1,946)
        CALL CLOSE(1)
        RETURN
        END


        SUBROUTINE DXERR(I)
        GOTO (10,20,30,40),I
10      TYPE 15
15      FORMAT(' DATA FILE ERROR - FILE OPEN')
        RETURN
20      TYPE 25
25      FORMAT(' DATA FILE ERROR - FILE CLOSED')
        RETURN
30      TYPE 35
35      FORMAT(' DATA FILE ERROR - DISK FULL')
        RETURN
40      TYPE 45
45      FORMAT(' DATA FILE HARDWARE ERROR')
        END


        SUBROUTINE DLCR(NSAMP,TITLE,NSRAT,VREDU)
        BYTE TITLE(1)
        BYTE TITL,ERR
        INTEGER IDUM(1)
        EQUIVALENCE(IDUM,MSAMPL)
        COMMON/DLCOM/IOPENL,MSAMPL,MRECL,MAXRL,IHEADL(3,150),
     *  RRDISL(150),TITL(80),NSRATL,VREDUL,ICHALL(150)
        DATA IOPEN/0/
        DATA MAXRL/150/
        IF (IOPENL.EQ.0 ) GOTO 1
        CALL DXERR(1)
        RETURN
1       CONTINUE
        DO 5 I=1,80
           TITL(I) = TITLE(I)
5       CONTINUE
        MSAMPL =NSAMP
        NSRATL = NSRAT
        VREDUL = VREDU
        TYPE 40
40      FORMAT('$MAX NUMBER OF TRACES/FILE(LE 150)?    ')
        READ(5,*) M1
        M=M1+1
C      THIS DECLARES THAT A HARD DISC FILE MAY HAVE M1 RECORDS
        IF ( M1.LE.MAXRL ) GOTO 2
        CALL DXERR(4)
        RETURN
2       CONTINUE
        MRECL=M-1
        DO 10 I=1,MAXRL
           IHEADL(1,I)=-1
           IHEADL(2,I)=-1
           RRDISL(I)=0.
           ICHANL(I) = -1
```

```
10      CONTINUE
        DEFINE FILE 2(M,MSAMPL,U,IREC)
        CALL ASSIGN(2,'DLO:T01.DAT ',0,'NEW')
30      CONTINUE
        WRITE(2'1) (IDUM(L),L=1,946)
        WRITE(2'M) (IDUM(L),L=1,946)
        IOPENL = 0
        CALL CLOSE(2)
        RETURN
        END

        SUBROUTINE DXGET(IDATA,IDR,LOCN,IDREC,DIST,IFOUND,
     *  ICHAN)
        INTEGER IDATA(1)
        COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *  RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
        IF ( IOPEN.EQ.1 ) GOTO 1
        CALL DXERR(2)
        RETURN
1       CONTINUE
        DO 100 I=1,MREC
           IF ( IDR.EQ. -1 ) GOTO 10
           IF ( IDR.NE.IHEAD(1,I) ) GOTO 100
10         IF ( LOCN.EQ. -1 ) GOTO 30
           IF ( LOCN.NE.IHEAD(2,I) ) GOTO 100
30         CONTINUE
           J=I
        CALL DXIN(J,IDATA,ICODE)
           IDR=IHEAD(1,I)
           LOCN=IHEAD(2,I)
           IDREC=IHEAD(3,I)
           DIST=RRDIST(I)
           IFOUND=I
           ICHAN=ICHANL(I)
           RETURN
100        CONTINUE
        IFOUND=0
        RETURN
        END

        SUBROUTINE WHEAD(ICODE)
C
C   WHEAD WRITES HEADER INFORMATION TO THE DATA FILE
C
        COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *  RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
        COMMON/BUFCOM/IBUF(256),ICHAN
C
        ICODE=IWRITW(1024,MSAMP,0,ICHAN)
        RETURN
        END
```

```
      PROGRAM DKDAT
C
C     DKDAT IS USED TO CREATE AND UPDATE DKDAT DATA FILES.
C     PROGRAM WRITTEN BY WILL KOHLER, FEBRUARY, 1979.
C
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
     * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
     * ICAL(12,20),IDB(3,20)
      DATA ISHOT/0/,ITEAM/0/,MAXREC/1500/
      DATA IBLANK/2H  /
      BYTE ANSWER
C     IRECO CONTAINS TEAM UNIT NUMBERS
      INTEGER*2 IRECO(100)
      DATA IRECO/15,17,24,25,26,32,36,38,44,58,
     *  60,71,85,90,94,103,106,125,130,146,
     *  10,13,30,34,49,51,52,55,62,63,
     *  64,97,104,105,110,118,124,137,142,145,
     *  1,18,22,35,40,43,65,74,75,76,
     *  79,87,89,98,100,101,112,113,133,143,
     *  14,19,39,48,53,56,66,69,70,72,
     *  77,93,96,115,119,121,122,132,134,139,
     *  3,12,23,28,31,45,73,78,82,83,
     *  88,92,99,107,108,120,128,129,131,136/
C
      TYPE 4
4     FORMAT('$PRINT DESCRIPTION OF MACROS(Y OR N)?   ')
      ACCEPT 6,ANSWER
6     FORMAT(A1)
      IF (ANSWER .EQ. 1HY) TYPE 5
5    FORMAT(' WELCOME TO DKDAT, A PROGRAM WHICH UPDATES DKDAT DISKS.'///
     *' DESCRIPTION OF MACROS :'//
     *' 1 = START A NEW PROJECT DISK'/
     *'     BEFORE DOING A '1' MAKE SURE TO HAVE A BLANK DISK'/
     *'     AVAILABLE WHICH HAS BEEN INITIALIZED IN THE PIP PROGRAM'/
     *'     BY TYPING DX1:/Z'/
     *' 2 = OPEN DATA DISK FILE AND READ SHOT INFORMATION FROM DISK'/
     *'     THIS MUST BE DONE BEFORE PRINTING OR UPDATING DATA'/
     *' 3 = WRITE SHOT INFORMATION TO DISK AND CLOSE DATA DISK FILE'/
     *' 4 = LIST SHOT INFORMATION'/
     *' 5 = ENTER A LINE OF NEW SHOT INFORMATION'/
     *' 6 = PRINT A LIST OF SHOT DATA NUMBERS'/
     *' 7 = UPDATE A SINGLE PIECE OF SHOT DATA'/
     *'     IF UNFAMILIAR WITH SHOT DATA NUMBERS,FIRST DO A MACRO 6'/
     *' 9 = DELETE A SHOT FROM LIST'/
     *' 10 = CHANGE PROJECT TITLE'/
     *' 11 = PRINT TEAM NUMBER OF TEAM DATA BEING MODIFIED'/
     *' 12 = READ DATA FOR ONE TEAM-SHOT FROM DISK'/
     *' 13 = WRITE DATA FOR ONE TEAM-SHOT TO DISK'/
     *' 14 = PRINT TEAM-SHOT DATA'/
     *' 15 = ENTER A COLUMN OF TEAM DATA'/
     *'      COLUMN NUMBERS ARE DESCRIBED BY MACRO 16'/
     *' 16 = PRINT A DESCRIPTION OF TEAM DATA COLUMN NUMBERS'/
     *' 17 = UPDATE A SINGLE PIECE OF TEAM DATA'/
     *' 18 = PRINT CALIBRATION DATA'/
     * ' 19 = CLEAR TEAM-SHOT FROM COMPUTER MEMORY'/
     * ' 20 = DELETE A TEAM-SHOT FROM DATA DISK'/
     *  ' 22 = UPDATE DISTANCES AND AZIMUTHS ON DKDAT DISK'/
     * ' 23 = PRINT LIST OF TEAM-SHOTS ENTERED ON DKDAT'//)
C
```

```
        TYPE 7
7       FORMAT(' DKDAT WILL MODIFY THE DATA FOR ONLY ONE TEAM DURING
     * EACH PROGRAM RUN.')
9       CONTINUE
        TYPE 8
8       FORMAT('$ENTER TEAM NUMBER(1,2,3,4, OR 5).    ')
        READ(5,30,ERR=9) ITEAM
        IF (ITEAM.LT.1 .OR. ITEAM.GT.5) GOTO 9
C
10    CONTINUE
        WRITE(5,20)
20    FORMAT('$> ')
        READ(5,30,ERR=10) ICMD
30    FORMAT(8I10)
        IF (ICMD .EQ. 1) GOTO 1000
        IF (ICMD .EQ. 2) GOTO 2000
        IF (ICMD .EQ. 3) GOTO 3000
        IF (ICMD .EQ. 4) GOTO 4000
        IF (ICMD .EQ. 5) GOTO 5000
        IF (ICMD .EQ. 6) GOTO 6000
        IF (ICMD .EQ. 7) GOTO 7000
        IF (ICMD .EQ. 9) GOTO 9000
        IF (ICMD .EQ. 10) GOTO 10000
        IF (ICMD .EQ. 11) GOTO 11000
        IF (ICMD .EQ. 12) GOTO 12000
        IF (ICMD .EQ. 13) GOTO 13000
        IF (ICMD .EQ. 14) GOTO 14000
        IF (ICMD .EQ. 15) GOTO 15000
        IF (ICMD .EQ. 16) GOTO 16000
        IF (ICMD .EQ. 17) GOTO 17000
        IF (ICMD .EQ. 18) GOTO 14000
        IF (ICMD .EQ. 19) GOTO 19000
        IF (ICMD .EQ. 20) GOTO 200
        IF (ICMD .EQ. 22) GOTO 400
        IF (ICMD .EQ. 23) GOTO 500
        GOTO 10
C
C   INITIALIZE DKDAT DATA FILE
C
1000    CONTINUE
        CALL DKCR
        GOTO 10
C
C   OPEN DKDAT DATA FILE
C
2000    CONTINUE
        PAUSE 'PUT PROJECT DATA DISK IN DX1'
        CALL DKOPEN
        DEFINE FILE 10(MAXREC,12,U,IREC)
        CALL ASSIGN(10,'DX0:M.LOC',0,'OLD','NC')
        GOTO 10
C
C   CLOSE DKDAT DATA FILE
C
3000    CONTINUE
        CALL DKCLOS
        CALL CLOSE(10)
        GOTO 10
C
C   LIST SHOT INFORMATION
C
4000    CONTINUE
        CALL DKLIST
        GOTO 10
C
C   ENTER DATA FOR ONE SHOT ONTO MASTER SHOT LIST
```

```
C
5000    CONTINUE
        CALL NEWSH
        GOTO 10
C
C   PRINT SHOT DATA NUMBERS
C
6000    CONTINUE
        WRITE(5,6010)
6010  FORMAT(' SHOT DATA COLUMN NUMBERS:'//
     *' 1 = DATE OF SHOT(MONTH NUMBER,DAY OF MONTH)'/
     *' 2 = SHOT NUMBER'/
     *' 3 = SHOT POINT NUMBER'/
     *' 4 = ORIGIN TIME(GMT)(JULIAN DAY, HOUR, MIN, SEC)'/
     *' 5 = ELEVATION OF SHOT SITE(FEET)'/
     *' 6 = SIZE OF SHOT(POUNDS)'/
     *' 7 = DEPTHS TO TOP, BOTTOM OF EXPLOSIVE(FEET)'/
     *' 8 = WETNESS OF SHOT HOLE(1=DRY, 2=WET)'/
     *' 9 = ROCK TYPE AT SHOT SITE(UP TO 10 CHAR)'/
     *' 10 = NOTES ABOUT SHOT(UP TO 40 CHAR)')
        GOTO 10
C
C   UPDATE A SINGLE PIECE OF SHOT DATA
C
7000    CONTINUE
        CALL SHIP
        GOTO 10
C
C   DELETE A SHOT FROM MASTER SHOT LIST
C
9000    CONTINUE
        WRITE(5,9010)
9010  FORMAT('$SHOT NUMBER?   ')
        READ(5,9020) ISH
9020    FORMAT(8I10)
        IF (IOPEN .EQ. 1) GOTO 9030
        CALL DKERR(2)
        GOTO 10
9030    CONTINUE
        ISP(ISH)=-1
C   WRITE SHOT HEADER TO DISK
        CALL WHEAD
        GOTO 10
C
C   CHANGE EXPERIMENT TITLE
C
10000   CONTINUE
        IF (IOPEN .EQ. 1) GOTO 10010
        CALL DKERR(2)
        RETURN
10010   CONTINUE
        WRITE(5,10020)
10020    FORMAT('$ENTER NEW PROJECT TITLE(UP TO 80 CHAR)')
        READ(5,10030) TIT
10030    FORMAT(20A4)
C   WRITE SHOT HEADER TO DISK
        CALL WHEAD
        GOTO 10
C
C   PRINT TEAM NUMBER
C
11000   CONTINUE
        TYPE 11010,ITEAM
11010   FORMAT(' DATA FOR TEAM ',I1,' IS BEING UPDATED
     * DURING THIS PROGRAM RUN.')
        GOTO 10
```

```
C
C   READ DATA FOR ONE TEAM-SHOT INTO MEMORY
C
12000   CONTINUE
        WRITE(5,12010)
12010 FORMAT('$SHOT NUMBER OF TEAM-SHOT TO READ FROM DISK?   ')
        READ(5,12020) ISHOT
12020 FORMAT(8I10)
        CALL DKGET(ISHOT,ITEAM)
        GOTO 10
C
C   WRITE DATA FOR ONE TEAM-SHOT TO DKDAT DISK
C
13000   CONTINUE
        WRITE(5,13010)
13010   FORMAT('$SHOT NUMBER OF TEAM-SHOT TO WRITE TO DISK?   ')
        READ(5,12020) ISHOT
        CALL DKPUT(ISHOT,ITEAM)
        GOTO 10
C
C   PRINT TEAM-SHOT DATA
C
14000   CONTINUE
        TYPE 14005
14005   FORMAT('$MAKE HARDCOPIES FROM TEK-TUBE SCREEN(Y OR N)?   ')
        READ(5,14006) ANSWER
14006   FORMAT(A1)
        WRITE(5,14010)
14010   FORMAT('$MIN,MAX SHOT NUMBER(CR=ALL)?   ')
        READ(5,14020) ISMIN,ISMAX
14020   FORMAT(8I10)
        IF (ISMIN .EQ. 0) ISMAX=30
        IF (ISMIN .EQ. 0) ISMIN=1
        WRITE(5,14030)
14030   FORMAT('$MIN,MAX TEAM NUMBER(CR=ALL)?   ')
        READ(5,14020) ITMIN,ITMAX
        IF (ITMIN .EQ. 0) ITMAX=5
        IF (ITMIN .EQ. 0) ITMIN=1
        PAUSE 'START A NEW PAGE'
        DO 14050 I1=ISMIN,ISMAX
        DO 14060 J1=ITMIN,ITMAX
        I=I1
        J=J1
        NUM=5*(I-1)+J
        IF (IEX(NUM) .EQ. 0) GOTO 14060
        CALL DKGET(I,J)
        IF (ICMD .EQ. 14) CALL DKPR(I,J)
        IF (ICMD .EQ. 18) CALL CALPR(I,J)
        IF (ANSWER .EQ. 1HY) CALL HCOPY
        IF (ANSWER .EQ. 1HY) CALL ERASE
14060   CONTINUE
14050   CONTINUE
        GOTO 10
C
C   ENTER A COLUMN OF TEAM DATA
C
15000   CONTINUE
        WRITE(5,15013)
15013   FORMAT('$COLUMN NUMBER?   ')
        READ(5,15023) ICOL
15023   FORMAT(8I10)
        IF (ICOL .LT. 1) GOTO 10
        IF (ICOL .GT. 14) GOTO 10
        IF (ICOL .EQ. 1) TYPE 15011
15011   FORMAT(' LOCATION NUMBER')
        IF (ICOL .EQ. 2) TYPE 15021
```

```
15021   FORMAT(' UNIT NUMBER')
        IF (ICOL .EQ. 3) TYPE 15031
15031   FORMAT(' FOOTAGE NUMBER')
        IF (ICOL .EQ. 4) TYPE 15041
15041   FORMAT(' NOTES(UP TO 10 CHAR)')
        IF (ICOL .EQ. 5) TYPE 15051
15051   FORMAT(' TIMING ERROR(MSEC)')
        IF (ICOL .EQ. 6) TYPE 15061
15061   FORMAT(' WWVB COORECTION')
        IF (ICOL .EQ. 8) TYPE 15081
15081   FORMAT(' TAPE GRADE(UP TO 3 ENTRIES)')
        IF (ICOL .EQ. 9) TYPE 15091
15091   FORMAT(' RECORD GRADE')
        IF (ICOL .EQ. 10) TYPE 15101
15101   FORMAT(' FIRST ARRIVAL')
        IF (ICOL .EQ. 12) TYPE 15121
15121   FORMAT(' CHANNEL NUMBER')
        IF (ICOL .EQ. 13) TYPE 15131
15131   FORMAT(' 12 CALIBRATION NUMBERS')
        IF (ICOL .EQ. 14) TYPE 15141
15141   FORMAT(' 3 ATTENUATION NUMBERS IN DB TO BE USED
      * FOR ENTIRE TEAM-SHOT?')
        IF (ICOL .EQ. 14) READ(5,15112) IDB1,IDB2,IDB3
        DO 15300 I=1,20
        IF (ICOL .NE. 14) WRITE(5,15301) I
15301   FORMAT('$',I2,'? ')
        GOTO (15110,15120,15130,15140,15150,
      * 15160,15300,15180,15190,15200,
      * 15300,15220,15230,15240),ICOL
15110   READ(5,15112) LOC(I)
15112   FORMAT(8I10)
        GOTO 15300
15120   READ(5,15112) IUNIT(I)
        GOTO 15300
15130   READ(5,15112) IFOOT(I)
        GOTO 15300
15140   READ(5,15142) (NT(J,I),J=1,5)
15142   FORMAT(5A2)
        GOTO 15300
15150   READ(5,15112) ICHRON(I)
        GOTO 15300
15160   READ(5,15112) IVB(I)
        GOTO 15300
15180   READ(5,15112) ITPGRD(I),ITGR2(I),ITGR3(I)
        IF (ITGR2(I) .EQ. 0) ITGR2(I)=-1
        IF (ITGR3(I) .EQ. 0) ITGR3(I)=-1
        GOTO 15300
15190   READ(5,15112) IRGRD(I)
        GOTO 15300
15200   READ(5,15202) FIRST(I)
15202   FORMAT(F10.0)
        GOTO 15300
15220   READ(5,15112) ICHAN(I)
        GOTO 15300
15230   READ(5,15231) (ICAL(J,I),J=1,12)
15231   FORMAT(12I6)
        GOTO 15300
15240   IDB(1,I)=IDB1
        IDB(2,I)=IDB2
        IDB(3,I)=IDB3
15300   CONTINUE
        GOTO 10
C
C   PRINT DESCRIPTION OF TEAM-SHOT COLUMN NUMBERS
C
16000   CONTINUE
```

```
        WRITE(5,16010)
16010 FORMAT(' TEAM-SHOT DATA COLUMN NUMBERS:'//
     *' 1 = RECORDER LOCATION NUMBER'/
     *' 2 = RECORDER UNIT NUMBER'/
     *' 3 = DUBBING FOOTAGE COUNT'/
     *' 4 = NOTES'/
     *' 5 = RECORDER TIMING ERROR AT SHOT TIME'/
     *' 6 = WWVB CORRECTION'/
     *' 8 = TAPE GRADE(UP TO 3 ENTRIES)'/
     *' 9 = RECORD GRADE'/
     *' 10 = FIRST ARRIVAL TIME(SECONDS)'/
     * ' 12 = CHANNEL NUMBER'/
     * ' 13 = CALIBRATION AMPLITUDES'/
     * ' 14 = ATTENUATIONS OF 3 DATA CHANNELS IN DB')
        GOTO 10
C
C   UPDATE A SINGLE PIECE OF TEAM-SHOT DATA
C
17000   CONTINUE
        CALL TM1P
        GOTO 10
C
C   CLEAR TEAM-SHOT DATA FROM COMPUTER MEMORY
C
19000   CONTINUE
        DO 19010 I=1,20
        LOC(I)=-1
        K=20*(ITEAM-1)+I
        IUNIT(I)=IRECO(K)
        IFOOT(I)=-1
        DO 19020 J=1,5
19020   NT(J,I)=IBLANK
        ICHRON(I)=-1
        IVB(I)=-1
        ITPGRD(I)=-1
        IRGRD(I)=-1
        FIRST(I)=-1.
        ITGR2(I)=-1
        ITGR3(I)=-1
        DISTAN(I)=2000.
        ICHAN(I)=-1
        DO 19030 J=1,12
19030   ICAL(J,I)=-1
        DO 19040 J=1,3
19040   IDB(J,I)=-1
19010   CONTINUE
        GOTO 10
C
C   DELETE A TEAM-SHOT FROM DKDAT DISK
C
200     CONTINUE
230     WRITE(5,210) ITEAM
210     FORMAT('$SHOT NUMBER TO DELETE FROM DISK(TEAM ',I1,' ONLY
     *)?   ')
        READ(5,220,ERR=230) ISHOT
220     FORMAT(8I10)
        IF (LEGAL(ISHOT,ITEAM) .EQ. 0) RETURN
        NUM=(ISHOT-1)*5+ITEAM
        IEX(NUM)=0
C   WRITE HEADER TO DISK
        CALL WHEAD
        GOTO 10
C
C   UPDATE DISTANCES ON DKDAT DISK
C
400     CONTINUE
```

```
      TYPE 410
410   FORMAT('$ENTER NAME OF LOCATION FILE  ')
      CALL ASSIGN(10,,-1,'RDO')
      DEFINE FILE 10(1500,12,U,LREC)
      TYPE 450
450   FORMAT('$MIN,MAX SHOT NUMBER?   ')
      READ(5,460) ISS1,ISS2
460   FORMAT(2I10)
      TYPE 470
470   FORMAT('$MIN,MAX TEAM NUMBER?   ')
      READ(5,460) ITT1,ITT2
      DO 420 I1=ISS1,ISS2
      DO 430 J1=ITT1,ITT2
      I=I1
      J=J1
      NUM=5*(I-1)+J
      IF (IEX(NUM) .EQ. 0) GOTO 430
      CALL DKGET(I,J)
      DO 440 K=1,20
      IF (ISP(I).LT.1 .OR. ISP(I).GT.1500) GOTO 440
      IF (LOC(K).LT.1 .OR. LOC(K).GT.1500) GOTO 440
      D=ADIST(ISP(I),LOC(K),AZ)
      DISTAN(K)=D
      IAZIM(K)=10.*AZ+.5
440   CONTINUE
      CALL DKPUT(I,J)
430   CONTINUE
420   CONTINUE
      CALL CLOSE(10)
      GOTO 10
C
C   PRINT LIST OF EXISTING TEAM-SHOTS ON DKDAT DISK
C
500   CONTINUE
      TYPE 510
510   FORMAT(/// TEAM-SHOTS ENTERED ON DKDAT DISK:'/
     * '      SHOT  TEAM 1  TEAM 2  TEAM 3  TEAM 4  TEAM 5'/)
      DO 520 I=1,30
      J1=(I-1)*5+1
      J2=J1+4
      TYPE 530,I,(IEX(J),J=J1,J2)
530   FORMAT(1H ,6I8)
520   CONTINUE
      GOTO 10
      END

.^O
```

```
      SUBROUTINE DKCR
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      DATA IOPEN/0/,NSHOT/30/,NTEAM/150/,NSAMP/800/,NREC/153/
      DATA IEX/150*0/
      INTEGER*2 IDUM(1),I1DUM(180),I2DUM(150)
      EQUIVALENCE (IDUM(1),NSHOT)
      EQUIVALENCE (I1DUM(1),MONTH(1)),(I2DUM(1),IELEV(1))
      DATA I1DUM/180*-1/,SEC/30*-1./,I2DUM/150*-1/,IROCK/150*2H  /
      DATA NOTES/600*2H  /
        BYTE ANS,YES
        DATA YES/1HY/
      IF (IOPEN .EQ. 0) GOTO 1
      CALL DKERR(1)
      RETURN
1     CONTINUE
        TYPE 10
10      FORMAT(' WARNING: THIS MACRO WILL DAMAGE ANY DATA
     * WHICH ALREADY EXISTS ON THIS DISK'/
     *  '$DO YOU WISH TO CONTINUE(Y OR N)?   ')
        ACCEPT 40,ANS
40      FORMAT(A1)
        IF (ANS .NE. YES) RETURN
      WRITE(5,20)
20    FORMAT(' ENTER PROJECT TITLE(UP TO 80 CHAR)')
      READ(5,30) TIT
30    FORMAT(20A4)
      DEFINE FILE 1(153,800,U,IREC)
      CALL ASSIGN(1,'DX1:K.DAT',0,'NEW','NC')
      WRITE(1'1) (IDUM(L),L=1,800)
      WRITE(1'153) (IDUM(L),L=1,800)
      CALL CLOSE(1)
      RETURN
      END
      SUBROUTINE SH1P
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      WRITE(5,1)
1     FORMAT('$SHOT NUMBER, COLUMN NUMBER?   ')
      READ(5,2) ISHOT,ICOL
2     FORMAT(8I10)
      IF (ISHOT .EQ. 0) RETURN
      IF (ICOL .LT. 1) RETURN
      IF (ICOL .GT. 10) RETURN
      GOTO (10,20,30,40,50,60,70,80,90,100),ICOL
10    WRITE(5,11)
11    FORMAT('$NEW DATE(MONTH NUMBER, DAY OF MONTH)?   ')
      READ(5,2) MONTH(ISHOT),IDAY(ISHOT)
      RETURN
20    WRITE(5,21)
21    FORMAT(' TO CHANGE SHOT NUMBER, DELETE OLD SHOT NUMBER AND
     * ENTER A WHOLE NEW SHOT.')
      RETURN
30    WRITE(5,31)
31    FORMAT('$NEW SHOT POINT NUMBER?   ')
      READ(5,2) ISP(ISHOT)
      RETURN
40    WRITE(5,41)
41    FORMAT('$NEW ORIGIN TIME(JULIAN DAY,HOUR,MIN,SEC)?   ')
```

```
      READ(5,42) JDAY(ISHOT),JHR(ISHOT),JMIN(ISHOT),SEC(ISHOT)
42    FORMAT(3I10,F10.0)
      RETURN
50    WRITE(5,51)
51    FORMAT('$ELEVATION OF SHOT SITE(FEET)?   ')
      READ(5,2) IELEV(ISHOT)
      RETURN
60    WRITE(5,61)
61    FORMAT('$SHOT SIZE(POUNDS)?   ')
      READ(5,2) ISIZE(ISHOT)
      RETURN
70    WRITE(5,71)
71    FORMAT('$DEPTH TO TOP,BOTTOM OF EXPLOSIVE?   ')
      READ(5,2) IDTOP(ISHOT),IDBOT(ISHOT)
      RETURN
80    WRITE(5,81)
81    FORMAT('$SHOT HOLE WETNESS(1=DRY,2=WET)?   ')
      READ(5,2) IWAT(ISHOT)
      RETURN
90    WRITE(5,91)
91    FORMAT('$ROCK TYPE AT SHOT SITE(UP TO 10 CHAR)?   ')
      READ(5,92) (IROCK(J,ISHOT),J=1,5)
92    FORMAT(20A2)
      RETURN
100   WRITE(5,101)
101   FORMAT('$NOTES(UP TO 40 CHAR)?   ')
      READ(5,92) (NOTES(J,ISHOT),J=1,20)
      RETURN
      END
      SUBROUTINE DKOPEN
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      IF (IOPEN .EQ. 0) GOTO 1
      CALL DKERR(1)
      RETURN
1     CONTINUE
      DEFINE FILE 1(153,800,U,IREC)
      CALL ASSIGN(1,'DX1:K.DAT',0,'OLD','NC')
      READ(1'1) NSHOT,NTEAM,NSAMP,NREC,TIT,MONTH,IDAY,ISP,JDAY,
     * JHR,JMIN,SEC,IELEV,ISIZE,IDTOP,IDBOT,IWAT,IROCK,IEX
      READ(1'2) NOTES
      IOPEN=1
      RETURN
      END
      SUBROUTINE DKCLOS
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      IF (IOPEN .EQ. 1) GOTO 1
      CALL DKERR(2)
      RETURN
1     CONTINUE
      WRITE(1'1) NSHOT,NTEAM,NSAMP,NREC,TIT,MONTH,IDAY,ISP,JDAY,
     * JHR,JMIN,SEC,IELEV,ISIZE,IDTOP,IDBOT,IWAT,IROCK,IEX
      WRITE(1'2) NOTES
      CALL CLOSE(1)
      IOPEN=0
      RETURN
      END
      SUBROUTINE NEWSH
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
```

```
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      WRITE(5,10)
10    FORMAT('$SHOT NUMBER?   ')
      READ(5,20) I
20    FORMAT(8I10)
      WRITE(5,30)
30    FORMAT('$MONTH NUMBER, DAY OF MONTH?   ')
      READ(5,20) MONTH(I),IDAY(I)
      WRITE(5,40)
40    FORMAT('$SHOT POINT NUMBER?   ')
      READ(5,20) ISP(I)
      WRITE(5,50)
50    FORMAT('$ORIGIN TIME(JULIAN DAY,HOUR,MIN,SEC)?   ')
      READ(5,60) JDAY(I),JHR(I),JMIN(I),SEC(I)
60    FORMAT(3I10,F10.0)
      WRITE(5,70)
70    FORMAT('$ELEVATION OF SHOT SITE(FEET)?   ')
      READ(5,20) IELEV(I)
      WRITE(5,80)
80    FORMAT('$SHOT SIZE(POUNDS)?   ')
      READ(5,20) ISIZE(I)
      WRITE(5,90)
90    FORMAT('$DEPTH TO TOP AND BOTTOM OF EXPLOSIVE(TOP,BOTTOM)(
     *FEET)?   ')
      READ(5,20) IDTOP(I),IDBOT(I)
      WRITE(5,100)
100   FORMAT('$WAS THE SHOT HOLE WET(1=NO, 2=YES)?   ')
      READ(5,20) IWAT(I)
      WRITE(5,110)
110   FORMAT('$ROCK TYPE AT SHOT SITE(UP TO 10 CHAR)?   ')
      READ(5,120) (IROCK(J,I),J=1,5)
120   FORMAT(20A2)
      WRITE(5,130)
130   FORMAT('$NOTES(UP TO 40 CHAR)?   ')
      READ(5,120) (NOTES(J,I),J=1,20)
      RETURN
      END
        FUNCTION LEGAL(ISHOT,ITEAM)
C   IF SHOT AND TEAM LEGAL, LEGAL=1
C   OTHERWISE, LEGAL=0
        LEGAL=1
        IF (ISHOT .LT. 1) LEGAL=0
        IF (ISHOT .GT. 30) LEGAL=0
        IF (ITEAM .LT. 1) LEGAL=0
        IF (ITEAM .GT. 5) LEGAL=0
        RETURN
        END
        SUBROUTINE WHEAD
C   WRITE SHOT HEADER TO DISK
        COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     *  IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     *  IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     *  IEX(150)
        WRITE(1'1) NSHOT,NTEAM,NSAMP,NREC,TIT,MONTH,IDAY,ISP,JDAY,
     *  JHR,JMIN,SEC,IELEV,ISIZE,IDTOP,IDBOT,IWAT,IROCK,IEX
        WRITE(1'1) NSHOT,NTEAM,NSAMP,NREC,TIT,MONTH,IDAY,ISP,JDAY,
     *  JHR,JMIN,SEC,IELEV,ISIZE,IDTOP,IDBOT,IWAT,IROCK,IEX
        RETURN
        END
      SUBROUTINE DKLIST
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
```

```
     * IEX(150)
      COMMON/DKCOM2/NOTES(20,30)
      BYTE OUT(132),BLANK
      REAL*4 AMO(12),YN(2)
      DATA AMO/4HJAN ,4HFEB ,4HMAR ,4HAPR ,4HMAY ,4HJUN ,
     * 4HJUL ,4HAUG ,4HSEP ,4HOCT ,4HNOV ,4HDEC /
      DATA YN/4H NO ,4HYES /,BLANK/1H /
      IF (IOPEN .EQ. 1) GOTO 10
      CALL DKERR(2)
      RETURN
10    CONTINUE
      PAUSE 'START A NEW PAGE'
      WRITE(5,20) TIT
20    FORMAT(///T56,'MASTER SHOT LIST'//1H ,20A4///
     * T15,'SHOT',T76,'DEPTH',T85,'SIZE'/
     * ' SHOT   DATE  POINT  LATITUDE     LONGITUDE    ELEV
     *      SHOT TIME        TOP  BOT  (LBS)  WATER'/)
      DO 30 I=1,30
      IF (ISP(I) .EQ. -1) GOTO 30
      DO 40 J=1,132
40    OUT(J)=BLANK
      ENCODE(3,69,OUT(1)) I
      IF (MONTH(I) .NE. -1) ENCODE(9,61,OUT(4)) AMO(MONTH(I)),IDAY(I)
      ENCODE(4,62,OUT(13)) ISP(I)
      ISS=ISP(I)
      IF (ISS .LT. 1) GOTO 60
      IF (ISS .GT. 1500) GOTO 60
      READ(10'ISS) LATD,LATM,ALATS,LOND,LONM,ALONS,IESHOT
      IF (LATD .EQ. 100) GOTO 60
      ENCODE(27,63,OUT(17)) LATD,LATM,ALATS,LOND,LONM,ALONS
60    CONTINUE
      IF (IESHOT .NE. 0) ENCODE(7,64,OUT(44)) IESHOT
      IF (JDAY(I) .NE. -1) ENCODE(19,65,OUT(51)) JDAY(I),JHR(I),
     * JMIN(I),SEC(I)
      IF (IDTOP(I) .NE. -1) ENCODE(11,66,OUT(70)) IDTOP(I),IDBOT(I)
        IF (ISIZE(I) .NE. 0) ENCODE(7,64,OUT(81)) ISIZE(I)
      IF (IWAT(I) .NE. -1) ENCODE(4,67,OUT(91)) YN(IWAT(I))
      ENCODE(42,68,OUT(97)) (NOTES(K,I),K=1,17)
      DO 110 J=1,132
      IF (OUT(133-J) .NE. BLANK) GOTO 120
110   CONTINUE
120   CONTINUE
      J=133-J
      WRITE(5,113) (OUT(L),L=1,J)
113   FORMAT(/1H ,132A1)
30    CONTINUE
      WRITE(5,50)
50    FORMAT(//)
      RETURN
61    FORMAT(3X,A4,I2)
69    FORMAT(I3)
62    FORMAT(I4)
63    FORMAT(I5,I3,F5.1,I6,I3,F5.1)
64    FORMAT(I7)
65    FORMAT(I6,2I3,F7.3)
66    FORMAT(I6,I5)
67    FORMAT(A4)
68    FORMAT(17A2)
      END
      SUBROUTINE DKGET(ISHOT,ITEAM)
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
```

```
     * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
     *  ICAL(12,20),IDB(3,20)
      IF (IOPEN .EQ. 1) GOTO 10
      CALL DKERR(2)
      RETURN
10    CONTINUE
      IF (LEGAL(ISHOT,ITEAM) .EQ. 0) RETURN
      IREC=ISHOT*5-2+ITEAM
      ITM=IREC-3
      IF (IEX(ITM) .EQ. 1) GOTO 20
      WRITE(5,30) ISHOT,ITEAM
30    FORMAT(' NO DATA FOR SHOT ',I2,' TEAM ',I1,' EXISTS ON DISK')
      RETURN
20    READ(1'IREC) LOC,IUNIT,IFOOT,NT,ICHRON,IVB,IAZIM,ITPGRD,IRGRD,
     * FIRST,ITGR2,ITGR3,DISTAN,ICHAN,ICAL,IDB
      RETURN
      END
      SUBROUTINE DKPUT(ISHOT,ITEAM)
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
     * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
     *  ICAL(12,20),IDB(3,20)
      IF (IOPEN .EQ. 1) GOTO 10
      CALL DKERR(2)
      RETURN
10    CONTINUE
      IF (LEGAL(ISHOT,ITEAM) .EQ. 0) RETURN
      IREC=ISHOT*5-2+ITEAM
      ITM=IREC-3
      IEX(ITM)=1
      WRITE(1'IREC) LOC,IUNIT,IFOOT,NT,ICHRON,IVB,IAZIM,ITPGRD,
     * IRGRD,FIRST,ITGR2,ITGR3,DISTAN,ICHAN,ICAL,IDB
      WRITE(1'1) NSHOT,NTEAM,NSAMP,NREC,TIT,MONTH,IDAY,ISP,JDAY,
     * JHR,JMIN,SEC,IELEV,ISIZE,IDTOP,IDBOT,IWAT,IROCK,IEX
      RETURN
      END
        SUBROUTINE CALPR(ISHOT,ITEAM)
        COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
        COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
     * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
     * ICAL(12,20),IDB(3,20)
        BYTE OUT(132),BLANK
        DATA BLANK/1H /
        IF (IOPEN .EQ. 1) GOTO 10
        CALL DKERR(2)
        RETURN
10      CONTINUE
        TYPE 20,TIT,ISHOT,ITEAM,ISP(ISHOT),JDAY(ISHOT),JHR(ISHOT),
     *  JMIN(ISHOT),SEC(ISHOT)
20      FORMAT(///T56,'DATA FOR ONE TEAM-SHOT'/
     *  1H ,20A4/
     *  ' SHOT NUMBER ',I2,'      TEAM ',I1/
     *  ' SHOT POINT',I4/
     *  ' SHOT TIME:',I5,2(':',I2),':',F6.3///
     *  T38,'CHANNEL 1',T60,'CHANNEL 2',T82,'CHANNEL 3'/
     *  '        LOC   UNIT  CH1 CH2 CH3',3('      1    10  100 1000')/)
        DO 30 I=1,20
        DO 40 J=1,132
```

```
40        OUT(J)=BLANK
          ENCODE(2,110,OUT(1)) I
110       FORMAT(I2)
          IF (IUNIT(I) .EQ. -1) GOTO 90
          IF (LOC(I) .NE. -1) ENCODE(6,120,OUT(3)) LOC(I)
120       FORMAT(I6)
          ENCODE(5,130,OUT(9)) IUNIT(I)
130       FORMAT(I5)
          IF (IDB(1,I) .NE. -1) ENCODE(14,140,OUT(14)) (IDB(J,I),J=1,3)
140       FORMAT(I6,2I4)
          IF (ICAL(1,I) .NE. -1) ENCODE(66,150,OUT(28)) (ICAL(J,I),J=1,12)
150       FORMAT(3(I7,3I5))
90        CONTINUE
          DO 50 J=1,132
          M=133-J
          IF (OUT(M) .NE. BLANK) GOTO 60
50        CONTINUE
60        CONTINUE
          TYPE 70,(OUT(K),K=1,M)
70        FORMAT(/1H ,132A1)
30        CONTINUE
          TYPE 80
80        FORMAT(////////////)
          RETURN
          END
        SUBROUTINE TM1P
        COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
       * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
       * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
       *  ICAL(12,20),IDB(3,20)
        WRITE(5,1)
1       FORMAT('$RECORD NUMBER, COLUMN NUMBER?    ')
        READ(5,2) IREC,ICOL
2       FORMAT(8I10)
        IF (IREC .LT. 1) RETURN
        IF (IREC .GT. 20) RETURN
        IF (ICOL .LT. 1) RETURN
        IF (ICOL .GT. 14) RETURN
        GOTO (10,20,30,40,50,60,200,80,90,100,200,120,130,140),ICOL
10      WRITE(5,11)
11      FORMAT('$LOCATION NUMBER?    ')
        READ(5,2) LOC(IREC)
        RETURN
20      WRITE(5,21)
21      FORMAT('$RECORDER UNIT NUMBER?    ')
        READ(5,2) IUNIT(IREC)
        RETURN
30      WRITE(5,31)
31      FORMAT('$DUBBING FOOTAGE NUMBER?    ')
        READ(5,2) IFOOT(IREC)
        RETURN
40      WRITE(5,41)
41      FORMAT('$NOTE(UP TO 10 CHAR)?    ')
        READ(5,42) (NT(K,IREC),K=1,5)
42      FORMAT(5A2)
        RETURN
50      WRITE(5,51)
51      FORMAT('$RECORDER CLOCK ERROR AT SHOT TIME(MSEC)?    ')
        READ(5,2) ICHRON(IREC)
        RETURN
60      WRITE(5,61)
61      FORMAT('$WWVB CORRECTION?    ')
        READ(5,2) IVB(IREC)
        RETURN
80      WRITE(5,81)
81      FORMAT('$TAPE GRADE(UP TO 3 ENTRIES)?    ')
```

```
      READ(5,2) ITPGRD(IREC),ITGR2(IREC),ITGR3(IREC)
      IF (ITGR2(IREC) .EQ. 0) ITGR2(IREC)=-1
      IF (ITGR3(IREC) .EQ. 0) ITGR3(IREC)=-1
      RETURN
90    WRITE(5,91)
91    FORMAT('$RECORD GRADE?   ')
      READ(5,2) IRGRD(IREC)
      RETURN
100   WRITE(5,101)
101   FORMAT('$FIRST ARRIVAL TIME(SECONDS AFTER SHOT)?   ')
      READ(5,102) FIRST(IREC)
102   FORMAT(8F10.0)
      RETURN
120   WRITE(5,121)
121   FORMAT('$CHANNEL NUMBER?   ')
      READ(5,2) ICHAN(IREC)
      RETURN
130   WRITE(5,131)
131     FORMAT(' 12 CALIBRATION NUMBERS?')
        READ(5,132) (ICAL(J,IREC),J=1,12)
132     FORMAT(12I6)
      RETURN
140     WRITE(5,141)
141     FORMAT(' 3 ATTENUATION NUMBERS IN DB?')
        READ(5,2) (IDB(J,IREC),J=1,3)
200     RETURN
      END
      SUBROUTINE DKPR(ISHOT,ITEAM)
      COMMON/DKCOM1/IOPEN,NSHOT,NTEAM,NSAMP,NREC,TIT(20),MONTH(30),
     * IDAY(30),ISP(30),JDAY(30),JHR(30),JMIN(30),SEC(30),
     * IELEV(30),ISIZE(30),IDTOP(30),IDBOT(30),IWAT(30),IROCK(5,30),
     * IEX(150)
      COMMON/TMCOM/LOC(20),IUNIT(20),IFOOT(20),NT(5,20),ICHRON(20),
     * IVB(20),IAZIM(20),ITPGRD(20),IRGRD(20),FIRST(20),
     * ITGR2(20),ITGR3(20),DISTAN(20),ICHAN(20),
     *  ICAL(12,20),IDB(3,20)
      BYTE OUT(132),BLANK,DASH
      DATA BLANK/1H /,DASH/1H-/
      IF (IOPEN .EQ. 1) GOTO 10
      CALL DKERR(2)
      RETURN
10    CONTINUE
      WRITE(5,20) TIT,ISHOT,ITEAM,ISP(ISHOT),JDAY(ISHOT),JHR(ISHOT),
     * JMIN(ISHOT),SEC(ISHOT)
20    FORMAT(///T46,'DATA FOR ONE TEAM-SHOT'/
     * 1H ,20A4/
     * ' SHOT NUMBER ',I2,'      TEAM ',I1/
     * ' SHOT POINT',I4/
     * ' SHOT TIME:',I5,2(':',I2),':',F6.3///
     * T60,'TAPE    REC  FIRST'/
     * '        LOC  DIST(KM)  AZIM
     *   UNIT  NOTES    FOOTAGE CHRON  GRADE    GRD ARRIVAL CHAN
     * CH1 CH2 CH3'/)
C
      DO 30 I=1,20
C
      DO 60 J=1,132
60    OUT(J)=BLANK
      OUT(46)=DASH
      OUT(47)=DASH
      OUT(53)=DASH
      OUT(54)=DASH
C
      ENCODE(2,61,OUT(1)) I
      IF (LOC(I) .EQ. -1) GOTO 70
      ENCODE(6,71,OUT(3)) LOC(I)
```

```
      AZIM=IAZIM(I)/10.
      IF (DISTAN(I).NE.2000.) ENCODE(16,240,OUT(9)) DISTAN(I),AZIM
70    IF (IUNIT(I) .NE. -1) ENCODE(6,71,OUT(25)) IUNIT(I)
      ENCODE(10,91,OUT(35)) (NT(J,I),J=1,5)
      IF (IFOOT(I) .NE. -1) ENCODE(3,251,OUT(45)) IFOOT(I)
      IF (ICHRON(I) .NE. -1) ENCODE(7,101,OUT(48)) ICHRON(I)
      IF (ITPGRD(I) .EQ. -1) GOTO 72
      IF (ITGR2(I) .EQ. -1) ENCODE(2,61,OUT(60)) ITPGRD(I)
      IF (ITGR2(I) .NE. -1) ENCODE(4,250,OUT(55)) ITPGRD(I)
      IF (ITGR2(I) .NE. -1) ENCODE(3,270,OUT(59)) ITGR2(I)
      IF (ITGR3(I) .NE. -1) ENCODE(3,270,OUT(62)) ITGR3(I)
72    CONTINUE
      IF (IRGRD(I) .NE. -1) ENCODE(4,250,OUT(65)) IRGRD(I)
      IF (FIRST(I) .NE. -1.) ENCODE(8,151,OUT(69)) FIRST(I)
      IF (ICHAN(I) .NE. -1) ENCODE(2,61,OUT(79)) ICHAN(I)
        IF (IDB(1,I).NE.-1)ENCODE(14,140,OUT(81))(IDB(J,I),J=1,3)
140     FORMAT(I6,2I4)
      DO 160 J=1,132
      M=133-J
      IF (OUT(M) .NE. BLANK) GOTO 170
160   CONTINUE
170   CONTINUE
      WRITE(5,180) (OUT(K),K=1,M)
180   FORMAT(/1H ,132A1)
30    CONTINUE
      WRITE(5,50)
50    FORMAT(////////////)
      RETURN
61    FORMAT(I2)
251   FORMAT(I3)
250   FORMAT(I4)
71    FORMAT(I6)
101   FORMAT(I7)
91    FORMAT(5A2)
151   FORMAT(F8.2)
270   FORMAT(1H/,I2)
240   FORMAT(F9.3,F7.1)
      END
        SUBROUTINE DKERR(N)
        IF (N .EQ. 1) TYPE 10
10      FORMAT(' DKDAT FILE OPEN.')
        IF (N .EQ. 2) TYPE 20
20      FORMAT(' DKDAT FILE CLOSED.')
        RETURN
        END
```

```
C       MAIN PROGRAM DXCAT
C       THIS PROGRAM WILL READ ONE OR MORE FLOPPY
C       DISKETTETS CONTAINING SEISMIC FILES NAMED
C       T.DAT FROM DEVICE DX1: AND WRITE ONE SEISMIC
C       FILE NAMED T01.DAT ON DEVICE DLO:.  THE NEW
C       FILE WILL CONTAIN ALL OF THE RECORDS OF THE
C       FLOPPIES.  THERE IS A LIMIT OF 110 RECORDS.
C       THERE IS A LIMIT OF 20 FLOPPIES.
C       THE USER ISSUES 'RUN DXCAT', THE PROGRAM
C       PROMPTS FOR THE FIRST FLOPPY, THEN ASKS IF
C       THERE IS TO BE ANOTHER FLOPPY; THE USER
C       RESPONDS 'Y' AND LOADS ANOTHER FLOPPY OR
C       RESPONDS 'N' AND THE PROGRAM WRITES THE
C       FILE TO THE HARD DISK.
C
C       WRITTEN APRIL 3, 1981, DON LEAVER (UNIV.WASH)
C
C
C       SUBROUTINE LIBRARY: THIS PROGRAM MUST BE LINKED
C       WITH THE NEW SUBROUTINE LIBRARY 'DXDAT' WRITTEN
C       APRIL 4, 1981.  IT CONTAINS NEW ROUTINES 'DLCR'
C       AND 'DLPUT', IN ADDITION TO A NEW AND MORE
C       POWERFUL VERSION OF 'DXOPEN' (THIS NEW VERSION
C       SHOULD BE COMPLETELY UPWARD COMPATIBLE.)
C
C


        COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *  RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
        COMMON/DLCOM/IOPENL,MSAMPL,MRECL,MAXRL,IHEADL(3,150),
     *  RRDISL(150),TITL(20),NSRATL,VREDUL,ICHALL(150)
        COMMON/X/IDAT(8001),NTOTAL
        COMMON/BUFCOM/IBUF(256),ICHAN
C
        TYPE 20
20      FORMAT(' THIS PROGRAM WILL READ FLOPPIES FROM DX1'/
     *         ' AND CONCATENATE T.DAT FILES INTO ONE T01.DAT'/
     *         ' FILE WHICH IT WILL CREATE ON DLO')
C
        NTOTAL = 0
C
        CALL DXOPEN
        ICH1=ICHAN
        IF(MSAMP.GT.8001) CALL OOPS('REC SIZE GT BUFFER')
        CALL DLCR(MSAMP,TIT,NSRATE,VREDUC)
        CALL DLOP2
        ICH2=ICHAN
        CALL DOIT(ICH1,ICH2)
        ICHAN=ICH1
        CALL DXCLOS
C
        DO 50 I = 1,10
            TYPE 40
40          FORMAT('$ANOTHER FLOPPY (YN)?')
            READ(5,44) A
44          FORMAT(A1)
            IF(A .EQ. 1HY) GOTO 60
            GOTO 100
60      CONTINUE
        CALL DXOPEN
        ICH1=ICHAN
            IF(MSAMP .NE. MSAMPL) CALL OOPS('RECSIZE NOT SAME')
            CALL DOIT(ICH1,ICH2)
        ICHAN=ICH1
```

```
            CALL DXCLOS
50        CONTINUE
100       CONTINUE
          ICHAN=ICH2
          CALL DLCLOS
        STOP
        END

          SUBROUTINE DOIT(ICH1,ICH2)
          COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *    RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
          COMMON/DLCOM/IOPENL,MSAMPL,MRECL,MAXRL,IHEADL(3,150),
     *    RRDISL(150),TITL(20),NSRATL,VREDUL,ICHALL(150)
          COMMON/X/IDAT(8001),NTOTAL
          COMMON/BUFCOM/IBUF(256),ICHAN

          DO 100 I = 1, MREC
               IF(IHEAD(1,I) .EQ. -1) GOTO 100
               NTOTAL = NTOTAL + 1
               IF(NTOTAL .GT. MRECL) CALL OOPS('TOO MANY RECORDS')
          ICHAN=ICH1
          CALL DXIN(I,IDAT,ICODE)
          IF (ICODE .EQ. -2) GOTO 100
          ICHAN=ICH2
               CALL DLPUT(IDAT,IHEAD(1,I),IHEAD(2,I),IHEAD(3,I),
     *                    RRDIST(I),ICHANL(I),K)
100     CONTINUE
        RETURN
        END
```

```
        PROGRAM PICK
C
C*** TIME OF ARRIVAL AND AMPLITUDE PICKING PROGRAM
C
        COMMON/DATCOM/IA(4003)
C
C   DIMENSION STATEMENTS, COMMON BLOCKS, ETC.
        COMMON/FFTPLT/TFFT(128),AFFT(128)
        COMPLEX*8 CX(128)
        EQUIVALENCE (TFFT(1),CX(1))
        INTEGER*2 NN(64),NNN(6)
        DATA NN/1,1,2,2,3,3,3,3,3,4,4,4,4,4,4,4,4,
     *  5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,5,
     *  6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,6,
     *  6,6,6,6,6,6,6,6,6,6,6/
        DATA NNN/2,2,5,8,16,31/
        REAL*4 BFFT(6)
        BYTE ICHAR,ANS
        DATA FACT/.5/,MINX/1/,MAXX/2001/,NPERSC/200/
        COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IH(3,150)
     *  ,RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
        COMMON/BUFCOM/JBUF(256),ICHAN
C   FILE RENAMING VARIABLES
        INTEGER IBUF(17)
        REAL*8 DBLK(2)
        DATA DBLK/12RDX1TT    DAT,12RDX1TT    BAK/
C
C
C*** LIST COMMAND MENU
C
        WRITE (5,1)
1       FORMAT (' LIST OF PICK PROGRAM MACROS:'/
     *          ' 1 - OPEN DISKETTE DATA FILE'/
     *          ' 2 - CLOSE DISKETTE DATA FILE'/
     *          ' 3 - LIST DIRECTORY OF DISKETTE DATA FILE'/
     *          ' 4 - READ TRACE FROM DISKETTE'/
     *          ' 5 - OPEN NEW TRAVEL TIME OUTPUT FILE'/
     *          ' 6 - CLOSE TRAVEL TIME OUTPUT FILE'/
     *          ' 8 - LIST GRADING SCALE'/
     *          ' 9 - ENTER FILTER PARAMETERS FOR OPTION A'/
     *          ' -9 - PRINT FILTER PARAMETERS FOR OPTION A'/
     *          ' 31 - OPEN HARD DISK FILE'/
     *          ' 32 - CLOSE HARD DISK FILE')
        WRITE(5,2)
2       FORMAT(//' LIST OF PICK PROGRAM TEKTUBE COMMANDS:'/
     *  ' + = EXPAND TIME AXIS OF PLOT'/
     *  ' - = CONTRACT TIME AXIS OF PLOT'/
     *  ' * = EXPAND AMPLITUDE OF PLOT'/
     *  ' / = CONTRACT AMPLITUDE OF PLOT'/
     *  ' P = PLOT TRACE'/
     *  ' S = PLOT TRUE TRAVEL TIME SCALE'/
     *  ' N = PLOT NEXT TRACE ON DATA DISK'/
     *  ' Q = RETURN TO MACRO LEVEL'/
     *  ' V = PICK A TRAVEL TIME AND AMPLITUDE'/
     *  ' W = PICK A TRAVEL TIME AND WRITE TO DISK'/
     *  ' 1,2,...9 = PICK TRAVEL TIME AND WRITE TO DISK'/
     *  '      WITH RECORD GRADE 1,2,...9'/
     *  ' F = PLOT 128 PT. FFT STARTING AT CURSOR'/
     *  ' G = PLOT FFT AND WRITE TO DISK'/
     *  ' A = FILTER TRACE')
C
10      CONTINUE
C
C*** READ COMMAND AND PROCESS IT
```

```
C
        WRITE (5,11)
11      FORMAT ('$PICK >  ')
        READ (5,12,ERR=10) ICMD
12      FORMAT (8I10)
        IF (ICMD .EQ. 1) GOTO 9010
        IF (ICMD .EQ. 2) CALL DXCLOS
        IF (ICMD .EQ. 3) CALL DXLIST
        IF (ICMD .EQ. 4) GOTO 9040
        IF (ICMD .EQ. 5) GOTO 9050
        IF (ICMD .EQ. 6) GOTO 9060
        IF (ICMD .EQ. 8) GOTO 9080
        IF (ICMD .EQ. 9) GOTO 9090
        IF (ICMD .EQ. -9) GOTO 9095
        IF (ICMD .EQ. 31) GOTO 9010
        IF (ICMD .EQ. 32) CALL DXCLOS
        GOTO 10
C
C*** OPEN DISKETTE DATA FILE
C
9010    CONTINUE
        TYPE 9012
9012    FORMAT('$SHOT NUMBER?   ')
        READ(5,*) ISHOT
        WRITE(5,9011)
9011    FORMAT('$SHOT LOCATION NUMBER(EG 901)?    ')
        READ(5,12) ISP
        IF (ICMD .EQ. 1) CALL DXOPEN
        IF (ICMD .EQ. 31) CALL DLOPEN
        NPERSC=1000/NSRATE
        GOTO 10
C
9038    CONTINUE
        TYPE 9039,IREC
9039    FORMAT(' PREVIOUS RECORD NUMBER =',I4)
C
C*** READ TRACE FROM DISKETTE AND PROCESS IT
C
9040    CONTINUE
        WRITE (5,9041)
9041    FORMAT(' ENTER RECORD NUMBER OF RECORD TO PLOT , OR'/
     *  '$HIT RETURN TO RETURN TO MACRO LEVEL.    ')
        READ(5,9042) IREC
9042    FORMAT (3I10)
8150    CONTINUE
        IF (IREC .EQ. 0) GOTO 10
        IF (IH(1,IREC) .NE. -1) GOTO 9044
        WRITE (5,9043)
9043    FORMAT (' TRACE NOT FOUND')
        GOTO 10
9044    CONTINUE
        CALL DXIN(IREC,IA,ICODE)
        IDSEC=-IH(3,IREC)
        DIST=RRDIST(IREC)
        GOTO 14
C
C   OPEN TRAVEL TIME OUTPUT FILE
C
9050    CONTINUE
        TYPE 9051
9051    FORMAT(' DO YOU WISH TO OPEN A NEW TRAVEL TIME FILE'/
     *  '$NAMED DX1:TT.DAT(Y OR N)?    ')
        READ(5,9052) ANS
9052    FORMAT(A1)
        IF (ANS .NE. 1HY) GOTO 9053
        CALL ASSIGN(2,'DX1:TT.DAT',0,'NEW')
```

```
      GOTO 10
9053  CONTINUE
      TYPE 9054
9054  FORMAT(' DO YOU WISH TO ADD PICKS TO AN EXISTING FILE'/
     * '$NAMED DX1:TT.DAT(Y OR N)?   ')
      READ(5,9052) ANS
      IF (ANS .NE. 1HY) GOTO 10
      ICHAN=IGETC()
      CALL IRENAM(ICHAN,DBLK)
      CALL IFREEC(ICHAN)
      CALL ASSIGN(2,'DX1:TT.DAT',0,'NEW')
      CALL ASSIGN(3,'DX1:TT.BAK',0,'RDO')
9055  CONTINUE
      READ(3,9056,END=9057) IBUF
9056  FORMAT(17A2)
      WRITE(2,9056) IBUF
      GOTO 9055
9057  CONTINUE
      CALL CLOSE(3)
      GOTO 10
C
C   CLOSE TRAVEL TIME OUTPUT FILE
C
9060  CONTINUE
      CALL CLOSE(2)
      GOTO 10
C
C*** OUTPUT GRADING SCALE
C
9080  CONTINUE
      WRITE(5,9081)
9081  FORMAT('      GRADING SCALE'//
     * ' 0 = GOOD ARRIVAL -'/
     * '        FIRST BREAK CERTAIN'//
     * ' 1 = FAIR ARRIVAL -'/
     * '        FIRST ENERGY CERTAIN; FIRST BREAK UNCERTAIN'//
     * ' 2 = POOR ARRIVAL -'/
     * '        ARRIVAL SEEN BUT PHASE IDENTIFICATION UNCERTAIN'//
     * ' 3 = VERY POOR ARRIVAL -'/
     * '        SOME ENERGY ON RECORD BUT IDENTIFICATION AS SHOT'/
     * '        RECORD UNCERTAIN'//
     * ' 4 = NO DISCERNABLE ARRIVAL'//
     * ' 5 = TIME CODE UNREADABLE -'/
     * '        MINOR TAPE SPEED VARIATION; DISCERNABLE ARRIVAL'//
     * ' 6 = TIME CODE UNREADABLE -'/
     * '        MAJOR TAPE SPEED VARIATION; BELT SLIPPED'//
     * ' 7 = MISCELANEOUS PROBLEMS -'/
     * '        POSSIBLY RECOVERABLE'//
     * ' 8 = NO RECORD AVAILABLE'//)
      GOTO 10
C
C   ENTER FILTER PARAMETERS FOR OPTION A
C
9090  CONTINUE
      TYPE 9091
9091  FORMAT('$FLO, FHI (HZ)?   ')
      READ(5,*) FLO,FHI
      GOTO 10
9095  CONTINUE
      TYPE 9096,FLO,FHI
9096  FORMAT(' FLO, FHI: ',2F8.3)
      GOTO 10
C
C*******************************************************************
C
C   MACRO 4 TRANSFERS HERE
```

```
C*** FIND MINIMUM AND MAXIMUM AMPLITUDES
C
14      CONTINUE
        MINY=IA(1)
        MINPOS=1
        MAXY=IA(1)
        MAXPOS=1
        DO 20 I=MINX,MSAMP
           IF ( IA(I) .LT. MAXY ) GOTO 15
           MAXY=IA(I)
           MAXPOS=I
15         CONTINUE
           IF ( IA(I) .GT. MINY ) GOTO 20
           MINY=IA(I)
           MINPOS=I
20         CONTINUE
        TMIN=(MINPOS-MINX)/FLOAT(NPERSC)-IDSEC
        TMAX=(MAXPOS-MINX)/FLOAT(NPERSC)-IDSEC
C
C*** PLOT EVERY ISTEP POINT ON INITIAL PLOT
C
        ISTEP=8
        IF (MSAMP .EQ. 4001) ISTEP=16
C
C*** SET X LIMITS FOR PLOTTING TRACE (TIME)
C
        IXMIN=MINX
        IXMAX=MSAMP
C
C*** SET Y LIMITS FOR PLOT (AMPLITUDE)
C
        IYMIN=MINY
        IYMAX=MAXY
C
C*** SET X LIMITS IN INCHES FOR PLOT
C
        XMIN=.7
        XMAX=10.
C
C*** SET Y LIMITS IN INCHES FOR PLOT
C
        YMIN=.2
        YMAX=7.8
C
C*** INITIALIZE TEKTRONIX 4014 GRAPHICS TERMINAL
C
        CALL DEVICE(1)
        CALL INITT(0)
C
C
1000    CONTINUE
C
C   SET LOCATION OF PRINTED MESSAGE
C
        XTYPE=1.
        YTYPE=7.3
C
C*** PLOT TRACE
C
        CALL NUMB(1.,7.5,.2,FLOAT(IH(1,IREC)),0.,-1)
        CALL NUMB(2.,7.5,.2,FLOAT(IH(2,IREC)),0.,-1)
        CALL NUMB(3.,7.5,.2,DIST,0.,3)
        CALL SYMB(8.5,7.5,.2,'SHOT',0.,4)
        CALL NUMB(9.25,7.5,.2,FLOAT(ISHOT),0.,-1)
        CALL SYMB(8.5,7.2,.2,'SP',0.,2)
        CALL NUMB(9.0,7.2,.2,FLOAT(ISP),0.,-1)
```

```
      CALL PTRACE(XMIN,XMAX,YMIN,YMAX,IXMIN,IXMAX,IYMIN,IYMAX,
     *            MINX,MSAMP,NPERSC,IDSEC,ISTEP)
C
C*** PLOT EVERY POINT ON SUBSEQUENT PLOTS
C
      ISTEP=1
C
1100  CONTINUE
C
C*** INITIATE INTERACTIVE CROSS-HAIR CURSOR
C
      CALL CROSSH(X,Y,ICHAR)
C
C*** CALCULATE POSITION OF CURSOR (JX,JY) IN UNITS OF TIME AND AMPLITUDE
C
      JX=(X-XMIN)/(XMAX-XMIN)*(IXMAX-IXMIN)+IXMIN+.5
      JY=(Y-YMIN)/(YMAX-YMIN)*(IYMAX-IYMIN)+IYMIN+.5
C
C*** CHECK USER SPECIFIED CHARACTER FOR DESIRED ACTION
C
      IF (ICHAR .EQ. 1HA) GOTO 1400
      IF ( ICHAR .EQ. 1HV ) GOTO 1500
      IF (ICHAR .EQ. 1HW) GOTO 1500
      IF (ICHAR .EQ. 1HF) GOTO 1550
      IF (ICHAR .EQ. 1HG) GOTO 1550
      IF ( ICHAR .EQ. 1HP ) GOTO 1600
      IF (ICHAR .EQ. 1HS) GOTO 1700
      IF ( ICHAR .EQ. 1H+ ) GOTO 2000
      IF (ICHAR .EQ. 1H;) GOTO 2000
      IF ( ICHAR .EQ. 1H- ) GOTO 2100
      IF ( ICHAR .EQ. 1H* ) GOTO 2200
      IF (ICHAR .EQ. 1H:) GOTO 2200
      IF ( ICHAR .EQ. 1H/ ) GOTO 2300
      IF ( ICHAR .EQ. 1HQ ) GOTO 8000
      IF (ICHAR .EQ. 1HN) GOTO 8100
C   INTCHR=RECORD GRADE 0 TO 9
      INTCHR=ICHAR
      INTCHR=INTCHR-48
      IF (INTCHR.GE.0 .AND. INTCHR.LE.9) GOTO 1500
C
C*** UNDEFINED CHARACTER
C
      CALL TKBELL
      GOTO 1100
C
C     APPLY A BUTTERWORTH FILTER
C
1400  CONTINUE
      STEP = NSRATE/1000.
      CALL FILCOF(FLO,FHI,STEP)
      CALL BUTTER(MSAMP,IA)
      IYMAX = (IYMAX - IYMIN) / 2
      IYMIN = -IYMAX
      CALL TKBELL
      GOTO 1100
C
C*** OUTPUT TIME OF ARRIVAL AND AMPLITUDE ESTIMATE
C
1500  CONTINUE
      TIME=(JX-MINX)/FLOAT(NPERSC)-IDSEC
      IF (VREDUC .EQ. 0.) TTM=TIME
      IF (VREDUC .NE. 0.) TTM=TIME+ABS(DIST)/VREDUC
      YTYPE=YTYPE-.2
      HS=.15
      SPACE=1.3
      CALL NUMB(XTYPE,YTYPE,HS,TIME,0.,3)
```

```
        CALL NUMB(XTYPE+SPACE,YTYPE,HS,TTM,0.,3)
        CALL NUMB(XTYPE+2*SPACE,YTYPE,HS,FLOAT(JY),0.,-1)
C   MARK THE PICK ON THE PLOT
        CALL PLOT(X,Y+1.,3)
        CALL PLOT(X,Y-1.,2)
        IF (ICHAR .EQ. 1HV) GOTO 1100
        IF (ICHAR .EQ. 1HF) GOTO 1100
        IF (ICHAR .EQ. 1HG) GOTO 1100
        IF (ICHAR .NE. 1HW) GOTO 1510
C   NO RECORD GRADE ENTERED
        WRITE(2,1501) ISP,IH(2,IREC),TTM,TIME,DIST
1501    FORMAT(2I4,4X,2F7.3,F8.3)
        CALL SYMB(XTYPE+4.0,YTYPE,HS,'TO DISK',0.,7)
        GOTO 1100
1510    CONTINUE
C   RECORD GRADE HAS BEEN ENTERED
        WRITE(2,1511) ISP,IH(2,IREC),INTCHR,TTM,TIME,DIST
1511    FORMAT(3I4,2F7.3,F8.3)
        CALL NUMB(XTYPE+3.6,YTYPE,HS,FLOAT(INTCHR),0.,-1)
        CALL SYMB(XTYPE+4.0,YTYPE,HS,'TO DISK',0.,7)
        GOTO 1100
C
C   PLOT 128 POINT FFT
C
1550    CONTINUE
        AVE=0.
        DO 1555 I=1,128
        I1=I
        I2=JX+2*(I1-1)
        AVE=AVE+IA(I2)
        CX(I1)=IA(I2)
1555    CONTINUE
        AVE=AVE/128.
        DO 1560 I=1,128
        I1=I
        CX(I1)=CX(I1)-AVE
1560    CONTINUE
        CALL WINDOW(CX,128,2)
        CALL FORK(CX,128,-1.)
        DO 1565 I=1,64
        I1=I
        AFFT(I1)=ALOG10(CABS(CX(I1+1)))
        TFFT(I1)=I1*100./128.
1565    CONTINUE
        CALL BOX(1.3,3.3,.8,2.8)
        CALL UNITS(0.,50.,0.,4.)
        CALL XAXIS('HZ.',3,.06,.24,5,1,-1,.06,.15,.06)
        CALL YAXIS('',0,.06,.24,4,1,-1,.06,.15,.06)
        CALL FRAME(1)
        CALL PDATA(TFFT,AFFT,64)
        IF (ICHAR .EQ. 1HF) GOTO 1500
C   COMPUTE FFT AVERAGES IN SPECIFIED WINDOWS
        DO 1570 I=1,6
        I1=I
1570    BFFT(I1)=0.
        DO 1575 I=1,64
        I1=I
        J=NN(I1)
1575    BFFT(J)=BFFT(J)+AFFT(I1)
        DO 1580 I=1,6
        I1=I
1580    BFFT(I1)=BFFT(I1)/FLOAT(NNN(I1))
        WRITE(2,1585) ISP,IH(2,IREC),DIST,BFFT
1585    FORMAT(2I4,F8.3,6F6.3)
        GOTO 1500
C
```

```
1600    CONTINUE
C
C*** REPLOT PORTION OF TRACE AROUND CROSS-HAIR
C
        XMUL=1.
        YMUL=1.
        GOTO 2900
C
C   PLOT TRAVEL TIME SCALE
C
1700    CONTINUE
        CALL PLOT(XMIN,Y,3)
        CALL PLOT(XMAX,Y,2)
        TABS=ABS(DIST)/VREDUC-IDSEC
        TMIN=(IXMIN-1)/FLOAT(NPERSC)+TABS
        TMAX=(IXMAX-1)/FLOAT(NPERSC)+TABS
        ITEN=10.*TMIN
        IF (TMIN .LT. 0.) ITEN=ITEN-1
1710    CONTINUE
        ITEN=ITEN+1
        TPLOT=ITEN/10.
        I=1+NPERSC*(TPLOT-TABS)
        XSCALE=(XMAX-XMIN)/(IXMAX-IXMIN)
        XPLOT=(I-IXMIN)*XSCALE+XMIN
        IF (XPLOT .LT. XMIN) GOTO 1710
        IF (XPLOT .GT. XMAX) GOTO 1100
        CALL PLOT(XPLOT,Y+.03,3)
        CALL PLOT(XPLOT,Y-.03,2)
        FRAC=ABS(TPLOT)-ABS(AINT(TPLOT))
        IF (FRAC .LT. .05)
     *  CALL NUMB(XPLOT-.04,Y-.2,.15,TPLOT,0.,-1)
        GOTO 1710
C
2000    CONTINUE
C
C*** ZOOM-IN ON X-AXIS (TIME)
C
        XMUL=FACT
        YMUL=1.
        GOTO 2900
C
2100    CONTINUE
C
C*** ZOOM-OUT ON X-AXIS (TIME)
C
        XMUL=1./FACT
        YMUL=1.
        GOTO 2900
C
2200    CONTINUE
C
C*** ZOOM-IN ON Y-AXIS (AMPLITUDE)
C
        YMUL=FACT
        XMUL=1.
        GOTO 2900
C
2300    CONTINUE
C
C*** ZOOM-OUT ON Y-AXIS (AMPLITUDE)
C
        YMUL=1./FACT
        XMUL=1.
C
2900    CONTINUE
C
```

```
C*** CALCULATE NEW LIMITS FOR PLOT
C
        WIDTH=(IXMAX-IXMIN)*XMUL
        IXMIN=JX-WIDTH/2.
        IXMAX=JX+WIDTH/2.
        IF ( IXMIN .GE. IXMAX ) IXMIN=IXMAX-1
C
        DEL=(IYMAX-IYMIN)*YMUL
        IYMIN=JY-DEL/2.
        IYMAX=JY+DEL/2.
        IF ( IYMIN .GE. IYMAX ) IYMIN=IYMAX-1
C
        IF (ICHAR .EQ. 1HP) GOTO 7000
C
C   INPUT NEXT COMMAND CHARACTER
C
3000    CONTINUE
        CALL TKINSL(IVAL,1)
C   SET TERMINAL TO GRAPH MODE
        CALL TKOUT(29,1)
        ICHAR=IVAL
        IF (ICHAR .EQ. 1H+) GOTO 2000
        IF (ICHAR .EQ. 1H;) GOTO 2000
        IF (ICHAR .EQ. 1H-) GOTO 2100
        IF (ICHAR .EQ. 1H*) GOTO 2200
        IF (ICHAR .EQ. 1H:) GOTO 2200
        IF (ICHAR .EQ. 1H/) GOTO 2300
        IF (ICHAR .EQ. 1HP) GOTO 7000
        IF (ICHAR .EQ. 1HQ) GOTO 8000
        IF (ICHAR .EQ. 1HN) GOTO 8100
        CALL TKBELL
        GOTO 3000
C
C*** ERASE SCREEN AND REPLOT TRACES
C
7000    CONTINUE
        CALL TKERS
        GOTO 1000
C
8000    CONTINUE
C
C*** DONE PROCESSING TRACE
C
        CALL FINITT(0,0)
        CALL TKERS
        GOTO 9038
C
C   PROCESS NEXT TRACE
C
8100    CONTINUE
        CALL FINITT(0,0)
        IREC=IREC+1
        GOTO 8150
        END
        SUBROUTINE PTRACE(XMIN,XMAX,YMIN,YMAX,IXMIN,IXMAX,
     *            IYMIN,IYMAX,MINX,MAXX,NPERSC,IDSEC,ISTEP)
C
C*** PLOT TRACE IN USER DEFINED WINDOW ON TEKTRONIX SCREEN
C
        BYTE BUF(300,2)
        INTEGER*2 IBAR(2)
        COMMON/DATCOM/IA(4003)
        DATA H/.15/
C
C
C*** CALCULATE X AND Y SCALE FACTORS
```

```
C
        XSCALE=(XMAX-XMIN)/(IXMAX-IXMIN)
        YSCALE=(YMAX-YMIN)/(IYMAX-IYMIN)
C
C*** DRAW AXIS
C
        CALL PLOT(XMIN,YMIN,3)
        CALL PLOT(XMAX,YMIN,2)
        CALL PLOT(XMAX,YMAX,2)
        CALL PLOT(XMIN,YMAX,2)
        CALL NUMB(XMIN-.7,YMAX-H,H,FLOAT(IYMAX),0.,-1)
        CALL PLOT(XMIN,YMAX,3)
        CALL PLOT(XMIN,YMIN,2)
        CALL NUMB(XMIN-.7,YMIN,H,FLOAT(IYMIN),0.,-1)
        IS=NPERSC/10
        IF (ISTEP .GE. 5) IS=NPERSC
        DO 50 I=MINX,MAXX,IS
                IF (I.LT.IXMIN.OR.I.GT.IXMAX) GOTO 50
        X=(I-IXMIN)*XSCALE+XMIN
        T=(I-1)/FLOAT(NPERSC)-IDSEC
                CALL PLOT(X,YMIN+.03,3)
                CALL PLOT(X,YMIN-.03,2)
                FRAC=ABS(T)-ABS(AINT(T))
                IF (FRAC .LT. .05)
     *          CALL NUMB(X-H/4.,YMIN-.2,H,T,0.,-1)
50              CONTINUE
C
C*** SET PEN POSITION TO DARK VECTOR
C
        CALL TKOUT(29,1)
C
C*** PLOT DESIRED PORTION OF TRACE
C
        I1=IXMIN
        IF ( I1 .LT. MINX ) I1=MINX
        I2=IXMAX
        IF ( I2 .GT. MAXX ) I2=MAXX
C
        IBAR(1)=IADDR(BUF(1,1))
        IBAR(2)=IADDR(BUF(1,2))
        NPT=0
        IB=1
        I=I1-ISTEP
100     CONTINUE
        I=I+ISTEP
        NPT=NPT+1
        IF (I .GT. I2) RETURN
           IX=I
           IY=IA(I)
           IF ( IY .GT. IYMAX ) IY=IYMAX
           IF ( IY .LT. IYMIN ) IY=IYMIN
        ITKX=400.*((IX-IXMIN)*XSCALE+XMIN)
        ITKY=400.*((IY-IYMIN)*YSCALE+YMIN)
        INDEX=5*(NPT-1)
        BUF(INDEX+1,IB)='40+ITKY/'200
        BUF(INDEX+2,IB)='140+(ITKY.AND.3)*'4+ITKX.AND.3
        BUF(INDEX+3,IB)='140+(ITKY.AND.'174)/'4
        BUF(INDEX+4,IB)='40+ITKX/'200
        BUF(INDEX+5,IB)='100+(ITKX.AND.'174)/'4
        IF (NPT .LT. 60) GOTO 100
        CALL IPOKE('172410,-150)
        CALL IPOKE('172412,IBAR(IB))
        CALL IPOKE('172414,'027201)
        JB=IB
        IF (JB .EQ. 1) IB=2
        IF (JB .EQ. 2) IB=1
```

```
        NPT=0
        GOTO 100
        END

      SUBROUTINE WINDOW(CX,NPROC,IFILT)
      COMPLEX*8 CX(1)
      DATA PI/3.14159265/
      IF (IFILT .EQ. 0) RETURN
      IF (IFILT .NE. 1) GOTO 10
C***HANNING WINDOW
      THETA=0.
      DTHETA=2.*PI/FLOAT(NPROC)
      DO 300 I=1,NPROC
      WEIGHT=(1.-COS(THETA))/2.
      CX(I)=CX(I)*WEIGHT
300   THETA=THETA+DTHETA
      RETURN
C***COSINE BELLS
10    M=NPROC/6
      L=NPROC/2-M
      DO 20 I=1,NPROC
      IF (I .LT. M) WEIGHT=0.5*(1.+COS(PI*FLOAT(I-M)/FLOAT(M)))
      IF (I.GE.M .AND. I.LE.NPROC-M) WEIGHT=1.
      IF (I .GT. NPROC-M)
     *WEIGHT=0.5*(1.+COS(PI*FLOAT(I-NPROC-M)/FLOAT(M)))
20    CX(I)=REAL(CX(I))*WEIGHT
      RETURN
      END

      SUBROUTINE FORK(CX,LX,SIGNI)
C***
C***FAST FOURIER TRANSFORM ROUTINE WRITTEN BY JOHN CLARBOUT,
C***GEOPHYSICS DEPARTMENT, STANFORD UNIVERSITY, 1970.
C***
      COMPLEX*8 CX(1),CARG,CEXP,CW,CTEMP
      J=1
      SC=SQRT(1./LX)
      DO 5 I=1,LX
      IF (I .GT. J) GOTO 2
      CTEMP=CX(J)*SC
      CX(J)=CX(I)*SC
      CX(I)=CTEMP
2     M=LX/2
3     IF (J .LE. M) GOTO 5
      J=J-M
      M=M/2
      IF (M .GE. 1) GOTO 3
5     J=J+M
      L=1
6     ISTEP=2*L
      DO 8 M=1,L
      CARG=(0.,1.)*(3.14159265*SIGNI*(M-1))/L
      CW=CEXP(CARG)
      DO 8 I=M,LX,ISTEP
      CTEMP=CW*CX(I+L)
      CX(I+L)=CX(I)-CTEMP
8     CX(I)=CX(I)+CTEMP
      L=ISTEP
      IF (L .LT. LX) GOTO 6
9     RETURN
      END
```

.⁻0

```
      PROGRAM RECSEC
C
C   RECORD SECTION PLOTTING PROGRAM
C
      COMMON/DXCOM/IOPEN,MSAMP,MREC,MAXR,IHEAD(3,150),
     *RRDIST(150),TIT(20),NSRATE,VREDUC,ICHANL(150)
      COMMON/BUFCOM/IBUF(256),ICHAN
      DATA DMIN,DMAX,DSCALE,TMIN,TMAX,TSCALE/0.,6.,1.,-2.,8.,1./
      DATA XSHIFT,YSHIFT/2.0,0.5/
      DATA INP/5/,OUTP/5/
      INTEGER IDATA(4001),OUTP
      INTEGER IA(4352),IFP(2)
      EQUIVALENCE (IDATA(1),IA(257))
      BYTE TX(10),ANS,PLOTID(49),ERR
      DATA TX/1HT,1H ,1H-,1H ,1HX,1H/,4*1H /
C
      TYPE 5
5     FORMAT('$PRINT DESCRIPTION OF MACROS(Y OR N)?   ')
      READ(INP,7) ANS
7     FORMAT(A1)
      IF (ANS .EQ. 1HY) TYPE 6
6     FORMAT(' DESCRIPTION OF MACROS:'//
     * ' 1 = PLOT TIME AXIS AT RIGHT SIDE OF PLOT'/
     * '     MACRO 2 MUST BE DONE BEFORE MACRO 1'/
     * ' 2 = INITIALIZE PLOTTER AND DRAW AXES'/
     * '     MACRO 8 MUST BE DONE BEFORE MACRO 2'/
     * ' 3 = DETACH PLOTTER AND ADVANCE TO NEXT PLOTTER PAGE'/
     * ' 5 = INITIALIZE PLOTTER WITHOUT DRAWING AXES'/
     * ' 7 = PLOT TRAVEL TIME PICKS ON RECORD SECTION'/
     * ' 8 = ENTER PLOT SCALING PARAMETERS'/
     * ' -8 = PRINT PLOT SCALING PARAMETERS'/
     * ' 10 = ENTER AMPLITUDE PARAMETERS FOR PLOT OPTION 12'/
     * ' -10 = PRINT AMPLITUDE PARAMETERS FOR PLOT OPTION 12'/
     * ' 11 = EXECUTE COMMANDS FROM A COMMAND FILE ON DISK'/
     * '      PUT ONE 48 CHAR COMMENT LINE AT THE START OF THE FILE'/
     * '      THE LAST COMMAND SHOULD BE -11'/
     * ' -11 = RETURN TO CONSOLE INPUT FROM COMMAND FILE'/
     * ' 19 = PRINT LIST OF PLOT OPTIONS USED IN MACRO 25'/
     * ' 21 = OPEN DISKETTE DATA FILE'/
     * ' 22 = CLOSE DISKETTE DATA FILE'/
     * ' 23 = PRINT DISK DIRECTORY'/
     * ' 25 = READ TRACES FROM DISK AND PLOT THEM'/
     * '      MACROS 2 OR 5,8,AND 21 OR 31 MUST BE DONE BEFORE 25'/
     * ' 31 = OPEN DATA FILE ON HARD DISK'/
     * ' 32 = CLOSE DATA FILE ON HARD DISK'/
     * ' 41 = INITIALIZE A TAPE DRIVE'/
     * ' 43 = REWIND TAPE DRIVE')
  200 WRITE(OUTP,1)
    1 FORMAT('$>')
      READ(INP,2,ERR=200) ICMD
    2 FORMAT(I10)
      IF (ICMD .EQ. 1) GOTO 1000
      IF (ICMD .EQ. 2) GOTO 2000
      IF (ICMD .EQ. 3) GOTO 3000
      IF (ICMD .EQ. 5) GOTO 5000
      IF (ICMD .EQ. 7) GOTO 7000
      IF (ICMD .EQ. 8) GOTO 8000
      IF (ICMD .EQ. -8) GOTO 8500
      IF (ICMD .EQ. 10) GOTO 10000
      IF (ICMD .EQ. -10) GOTO 10500
      IF (ICMD .EQ. 11) GOTO 11000
      IF (ICMD .EQ. -11) GOTO 11500
      IF (ICMD .EQ. 19) GOTO 19000
      IF (ICMD .EQ. 21) CALL DXOPEN
```

```
      IF (ICMD .EQ. 22) CALL DXCLOS
      IF (ICMD .EQ. 23) CALL DXLIST
      IF (ICMD .EQ. 25) GOTO 44000
      IF (ICMD .EQ. 31) CALL DLOPEN(INP,OUTP)
      IF (ICMD .EQ. 32) CALL DXCLOS
      IF (ICMD .EQ. 41) CALL INITAP(IUNIT,IFP,IERR,ISTAT)
      IF (ICMD .EQ. 43) CALL REWIND(IUNIT,IFP,IERR,ISTAT)
      GOTO 200
C
C   PLOT TIME AXIS AT RIGHT SIDE OF PLOT
C
1000    CONTINUE
      CALL BOX(XRIGHT,XRIGHT,YBOT,YTOP)
      CALL YAXIS('',0,0.15,0.0,NYTIC,1,1,0.15,-0.7,-0.1)
      CALL BOX(XLEFT,XRIGHT,YBOT,YTOP)
      GOTO 200
C
C   INITIALIZE PLOTTER AND DRAW AXES
C
 2000 CONTINUE
      WRITE(OUTP,2100)
2100  FORMAT('$48 OR LESS CHAR PLOT ID?   ')
      CALL GETSTR(INP,PLOTID,48,ERR)
      N=LEN(PLOTID)
      WRITE(OUTP,*) 'PAUSE -- "PREPARE PLOTTER"'
      READ(INP,2) IDUM
      CALL INITT(0)
      IF (N .GT. 0) CALL SYMB(.75,.5,.25,PLOTID,90.,N)
      XLEFT=XSHIFT
      XRIGHT=((DMAX-DMIN)/DSCALE)+XLEFT
      YBOT=YSHIFT
      YTOP=((TMAX-TMIN)/TSCALE)+YBOT
      CALL BOX(XLEFT,XRIGHT,YBOT,YTOP)
      CALL UNITS(DMIN,DMAX,TMIN,TMAX)
      CALL XAXIS('DISTANCE (KM)',13,.15,.49,NXTIC,1,1,.15,.28,0.1)
      IF (WREDUC .LT. 100.) GOTO 2130
      CALL YAXIS('TIME (SEC)',10,.15,.75,NYTIC,1,1,.15,0.15,0.1)
      GOTO 2140
2130    CONTINUE
      ENCODE(4,2131,TX(7)) WREDUC
2131    FORMAT(F4.1)
      CALL YAXIS(TX,10,.15,.75,NYTIC,1,1,.15,0.15,0.1)
2140    CONTINUE
      YLOW=YSHIFT
      YHIGH=(TMAX-TMIN)/TSCALE+YLOW
      GOTO 200
C
C    DETACH PLOTTER
C
3000  CONTINUE
      AL=XSHIFT+(DMAX-DMIN)/DSCALE
      X=8.5*FLOAT(INT(AL/8.5)+1)
      CALL PLOT(X,0.,-1)
      CALL FINITT(0,0)
      GOTO 200
C
C   INITIALIZE PLOTTER
C
 5000 CONTINUE
      WRITE(OUTP,*) 'PAUSE -- "MOVE PLOTTER PEN OVER TIME AXIS"'
      READ(INP,2) IDUM
      CALL INITT(0)
      CALL PLOT(-XSHIFT,0.0,-3)
      CALL FFLUSH
      YLOW=YSHIFT
      YHIGH=(TMAX-TMIN)/TSCALE+YLOW
```

```
      GOTO 200
C
C   PLOT TRAVEL TIME PICKS ON RECORD SECTION
C
7000  CONTINUE
      WRITE(OUTP,7010)
7010  FORMAT('$ENTER NAME OF TRAVEL TIME FILE  ')
      CALL ASSIGN(8,,-1,'RDO')
      WRITE(OUTP,7020)
7020  FORMAT('$SHOT POINT NUMBER(0=ALL)?   ')
      READ(INP,7021) ISP
7021  FORMAT(8I10)
7030  READ(8,7040,END=7100) IL,ISITE,IGR,TIME,DIST
7040  FORMAT(3I4,F7.3,7X,F8.3)
      IF (ISP.NE.0 .AND. ISP.NE.IL) GOTO 7030
      IF (IGR .GT. 2) GOTO 7030
      IF (DIST .LT. DMIN) GOTO 7030
      IF (DIST .GT. DMAX) GOTO 7030
      TM=TIME-ABS(DIST)/WREDUC
      IF (TM .LT. TMIN) GOTO 7030
      IF (TM .GT. TMAX) GOTO 7030
      XPLOT=(DIST-DMIN)/DSCALE+XSHIFT
      YPLOT=(TM-TMIN)/TSCALE+YSHIFT
      XDELT=.25*WIDTH
      CALL PLOT(XPLOT-XDELT,YPLOT,1)
      CALL PLOT(XPLOT+XDELT,YPLOT,2)
      GOTO 7030
7100  CONTINUE
      CALL PUP
      CALL PFLUSH
      CALL CLOSE(8)
      GOTO 200
C
C   PLOT PARAMETERS
C
8000  CONTINUE
      WRITE(OUTP,8001)
8001  FORMAT('$DMIN,DMAX,DSCALE?  ')
      READ(INP,1005,ERR=8000) DMIN,DMAX,DSCALE
1005  FORMAT(8F10.0)
      WRITE(OUTP,2110)
2110 FORMAT('$NUMBER OF DIVISIONS ON DISTANCE AXIS?   ')
      READ(INP,2) NXTIC
      IF (NXTIC .EQ. 0) NXTIC=1
8002  WRITE(OUTP,8003)
8003  FORMAT('$TMIN,TMAX,TSCALE?  ')
      READ(INP,1005,ERR=8002) TMIN,TMAX,TSCALE
      WRITE(OUTP,2120)
2120  FORMAT('$NUMBER OF DIVISIONS ON TIME AXIS?   ')
      READ(INP,2) NYTIC
      IF (NYTIC..EQ. 0) NYTIC=1
8006  WRITE(OUTP,8007)
8007  FORMAT('$TRACE WIDTH, REDUCTION VELOCITY?   ')
      READ(INP,1005,ERR=8006) WIDTH,WREDUC
      GOTO 200
8500  CONTINUE
      WRITE(5,8510) DMIN,DMAX,DSCALE,NXTIC
8510  FORMAT(' DMIN =',F8.3,' DMAX =',F8.3,' DSCALE =',F8.3,
     *  ' NXTIC =',I6)
      WRITE(5,8520) TMIN,TMAX,TSCALE,NYTIC
8520  FORMAT(' TMIN =',F8.3,' TMAX =',F8.3,' TSCALE =',F8.3,
     *  ' NYTIC =',I6)
      WRITE(5,8540) WIDTH,WREDUC
8540  FORMAT(' TRACE WIDTH =',F5.2,' REDUCTION VEL =',F9.2)
      GOTO 200
C
```

```
C   ENTER SCALING PARAMETERS FOR A TRUE AMPLITUDE PLOT
C
10000   CONTINUE
        WRITE(OUTP,10010)
10010   FORMAT('$CROSSOVER DISTANCE (KM)?    ')
        READ(INP,*) DCROSS
        WRITE(OUTP,10020)
10020   FORMAT('$TRACE WIDTH PER 10 MICROVOLTS AT CROSSOVER
     * DIST(IN)?    ')
        READ(INP,*) W300
        WRITE(OUTP,10030)
10030   FORMAT('$ATTENUATION EXPONENT WITHIN,BEYOND CROSSOVER?    ')
        READ(INP,*) DIE1,DIE2
        GOTO 200
10500   CONTINUE
        TYPE 10510,DCROSS
10510   FORMAT(' CROSSOVER DISTANCE(KM) =',F8.3)
        TYPE 10520,W300
10520   FORMAT(' TRACE WIDTH/10 MICROVOLTS AT CROSSOVER(IN) =',F8.4)
        TYPE 10530,DIE1,DIE2
10530   FORMAT(' ATTENUATION EXPONENTS WITHIN,BEYOND CROSSOVER =',2F8.3)
        GOTO 200
C
C   READ COMMANDS FROM DISK FILE
C
11000   CONTINUE
        INP=4
        OUTP=3
        TYPE 11010
11010   FORMAT('$ENTER NAME OF COMMAND FILE  ')
        CALL ASSIGN(INP,,-1,'RDO')
        CALL ASSIGN(OUTP,'NL:',0)
C   PRINT COMMENT LINE
        CALL GETSTR(INP,PLOTID,48,ERR)
        CALL PUTSTR(5,PLOTID,' ',ERR)
        T1=SECNDS(0.)
        GOTO 200
11500   CONTINUE
        DELTA=SECNDS(T1)/60.
        WRITE(5,11020) DELTA
11020   FORMAT(' ELAPSED TIME =',F8.2,' MINUTES')
        CALL CLOSE(INP)
        CALL CLOSE(OUTP)
        INP=5
        OUTP=5
        GOTO 200
C
C   PRINT LIST OF PLOT OPTIONS
C
19000   CONTINUE
        TYPE 19010
19010   FORMAT(' DESCRIPTION OF PLOT OPTIONS'//
     *  ' 0 = RETURN TO MACRO LEVEL'/
     *  ' 1 = PLOT TRACES'/
     *  ' 2 = ENTER MIN,MAX RECORDS TO PLOT FROM DISK'/
     *  ' 5 = ENTER MIN,MAX DISTANCES OF RECORDS TO PLOT FROM DISK'/
     *  ' 8 = ENTER DISTANCE FACTOR. IF SET TO -1, TRACES WILL BE'/
     *  '      PLOTTED AT MINUS THE DISTANCE ON THE DIRECTORY'/
     *  ' 9 = ENTER ISTEP. EVERY ISTEP POINT IS PLOTTED.'/
     *  ' 11 = PLOT TRACE AT DISTANCE EQUAL TO THE SITE NUMBER'/
     *  ' 12 = MAKE A TRUE AMPLITUDE PLOT'/
     *  ' 13 = PLOT TRACE AT A DISTANCE EQUAL TO THE DISK RECORD NO.'/
     *  ' 15 = PLOT DATA FROM A MODIFIED ROSE FORMAT TAPE')
        GOTO 200
C
C   DISK PLOT OF ALL TRACES
```

```
C
44000   CONTINUE
C   SET DEFAULTS
        DIS1=1.
        IJ1=1
        IJ2=150
        DMIN1=-10000.
        DMAX1=10000.
        IAMP=0
        IRREC=0
        IRLOC=0
        IPTAPE=0
        ISTEP1=1
        IF (TMAX-TMIN .GT. 7.5) ISTEP1=2
        IF (TMAX-TMIN .GT. 15.0) ISTEP1=4
C   SET PLOT OPTIONS
  278 WRITE(OUTP,276)
  276 FORMAT('$PLOT OPTION?   ')
        READ(INP,2,ERR=278)ICMD1
        IF (ICMD1 .EQ. 1) GOTO 277
        IF (ICMD1 .EQ. 2) GOTO 302
        IF (ICMD1 .EQ. 5) GOTO 304
        IF (ICMD1 .EQ. 8) GOTO 284
        IF (ICMD1 .EQ. 9) GOTO 287
        IF (ICMD1 .EQ. 11) GOTO 340
        IF (ICMD1 .EQ. 12) GOTO 311
        IF (ICMD1 .EQ. 13) GOTO 313
        IF (ICMD1 .EQ. 15) GOTO 330
        GOTO 200
302     CONTINUE
        WRITE(OUTP,303)
303   FORMAT('$MIN,MAX TRACE NUMBERS TO PLOT?   ')
        READ(INP,1010) IJ1,IJ2
1010    FORMAT(8I10)
        GOTO 278
C
C   ENTER DISTANCE RANGE TO PLOT
304     CONTINUE
        WRITE(OUTP,270)
270   FORMAT('$MIN,MAX DISTANCES TO PLOT?   ')
        READ(INP,1005) DMIN1,DMAX1
        GOTO 278
C
284     CONTINUE
  282 WRITE(OUTP,283)
  283 FORMAT('$DISTANCE FACTOR   ')
        READ(INP,1005,ERR=282) DIS1
        GOTO 278
C
287     CONTINUE
  285 WRITE(OUTP,286)
  286 FORMAT('$ENTER ISTEP   ')
        READ(INP,2,ERR=285) ISTEP1
        GOTO 278
C
340     CONTINUE
        WRITE(OUTP,341)
341     FORMAT('$PLOT TRACES WITH DISTANCES SET TO SITE NO.
     *(Y OR N)?   ')
        READ(INP,7) ANS
        IRLOC=0
        IF (ANS .EQ. 1HY) IRLOC=1
        GOTO 278
C
C   TRUE AMPLITUDE PLOT
311     CONTINUE
```

```
      WRITE(OUTP,312)
312   FORMAT('$SCALE TRACE BY DIGITAL COUNTS(Y OR N)?   ')
      READ(INP,332) ANS
      IAMP=0
      IF (ANS .EQ. 1HY) IAMP=1
      GOTO 278
C
313   CONTINUE
      WRITE(OUTP,314)
314   FORMAT('$SET DISTANCE(KM) EQUAL TO RECORD NO.(0 OR 1)?   ')
      READ(INP,2) IRREC
      GOTO 278
C
C   PLOT FROM TAPE
330   CONTINUE
      WRITE(OUTP,331)
331   FORMAT('$PLOT FROM TAPE(Y OR N)?   ')
      IPTAPE=0
      READ(INP,332) ANS
332   FORMAT(A1)
      IF (ANS .EQ. 1HN) GOTO 278
      IPTAPE=1
      GOTO 278
C
C   CYCLE THROUGH RECORDS
277   CONTINUE
      TYPE 279
279   FORMAT(/'    REC  UNIT   LOC  TMIN    DB      DIST    DCOFF
     *  MAXDEV'/)
      IF (IPTAPE .EQ. 1) GOTO 275
C   PLOT FROM ONE FILE
      IF (IOPEN .EQ. 0) CALL DXERR(2)
      IF (IOPEN .EQ. 0) GOTO 200
C
  275 CONTINUE
      DO 295 I=IJ1,IJ2
C
C   TAPE PARAMETERS
      IF (IPTAPE .EQ. 0) GOTO 502
      IN=I
      CALL GETAPE(IUNIT,IA,IN,IFP,IERR,ISTAT)
      DIST=DIS1*(IA(44)+IA(45)*1.0E-04)
      IF (DIST .LT. DMIN1) GOTO 295
      IF (DIST .GT. DMAX1) GOTO 295
      IID=IA(50)
      IILOC=IA(6)
      IITMIN=IA(23)
      MSAMP=IA(25)
      NSRATE=1000/IA(24)
      VREDUC=IA(22)/10.
      IICHAN=IA(52)
      GOTO 412
C   FLOPPY DISK PARAMETERS
502   CONTINUE
      DIST=RRDIST(I)*DIS1
      IID=IHEAD(1,I)
      IILOC=IHEAD(2,I)
      IITMIN=IHEAD(3,I)
      IICHAN=ICHANL(I)
      IF (IID .EQ. -1) GOTO 295
      IF (DIST .LT. DMIN1) GOTO 295
      IF (DIST .GT. DMAX1) GOTO 295
      IIN=I
      CALL DXIN(IIN,IDATA,ICODE)
      IF (ICODE .EQ. -2) GOTO 411
      GOTO 412
```

```
C   HARDWARE ERROR ON DISK
411     CONTINUE
        TYPE 413,I
413     FORMAT(' HARDWARE ERROR ON DISK. DATA RECORD =',I4)
        GOTO 295
C
C   COMPUTE POINT NUMBERS TO PLOT
412     CONTINUE
        IF (IRREC .EQ. 1) DIST=I
        IF (IRLOC .EQ. 1) DIST=IILOC
        T2=IITMIN-ABS(DIST)/VREDUC
        IF (VREDUC .NE. 0.) T2=T2+ABS(DIST)/VREDUC
        MS=1000.*(TMAX-TMIN)/NSRATE+1.
          MS1=(TMIN-T2)/(NSRATE/1000.)+1.
          MS2=MS1+MS-1
C   COMPUTE AVERAGE AND MIN,MAX DIGITAL COUNTS
        IVMIN=32000
        IVMAX=0
        DC=0.
        NDC=0
        DO 280 J=MS1,MS2
        JJ=J
        IF (JJ .LT. 1) GOTO 280
        IF (JJ .GT. MSAMP) GOTO 280
        IF (IDATA(JJ) .LT. IVMIN) IVMIN=IDATA(JJ)
        IF (IDATA(JJ) .GT. IVMAX) IVMAX=IDATA(JJ)
        NDC=NDC+1
        DC=DC+IDATA(JJ)
280     CONTINUE
        IDC=DC/FLOAT(NDC)
          MAXDEV=MAXO(IVMAX-IDC,IDC-IVMIN)
        TYPE 4600,I,IID,IILOC,IITMIN,IICHAN,DIST,IDC,MAXDEV
4600    FORMAT(1H ,5I6,F10.3,2I7)
          IMIN=IDC-MAXDEV
          IMAX=IDC+MAXDEV
C
C   COMPUTE TRACE WIDTH FOR TRUE AMPLITUDE PLOT
        WIDTH1=WIDTH
        IF (IAMP .EQ. 1) CALL TW(IMIN,IMAX,IICHAN,DCROSS,W300,
     *  DIE1,DIE2,DIST,WIDTH1)
        IF (WIDTH1 .EQ. -1.) GOTO 295
C
          XINCH=(DIST-DMIN)/DSCALE
          XTRACE=XINCH+XSHIFT
          YLOW=YSHIFT
          YHIGH=(TMAX-TMIN)/TSCALE+YLOW
          CALL TRACE(IDATA,MS1,MS2,IMIN,IMAX,XTRACE,WIDTH1,
     *   YLOW,YHIGH,0,ISTEP1,IILOC,MSAMP)
        IF (ITTINR() .GE. 0) GOTO 200
295     CONTINUE
        GOTO 200
        END

        SUBROUTINE TRACE(IDATA,MS1,MS2,IMIN,IMAX,XCNTR,WIDTH,
     *          YLOW,YHIGH,IX,ISTEP1,ILOC,NSAMP)
        INTEGER*2 IDATA(1)
        XLOW=XCNTR-WIDTH/2.0
        XHIGH=XLOW+WIDTH
        CALL WHERE(XCUR,YCUR)
        IF (IX.NE.0) YCUR=XCUR
        D1=ABS(YLOW-YCUR)
        D2=ABS(YHIGH-YCUR)
        ISTART=MS1
        ISTOP=MS2
        ISTEP=IABS(ISTEP1)
        IF (D1 .LT. D2) GO TO 10
```

```
      CALL NUMB(XCNTR+.04,YHIGH+.08,.08,FLOAT(ILOC),90.,-1)
      ISTART=MS2
      ISTOP=MS1
      ISTEP=-IABS(ISTEP1)
   10 CONTINUE
      IPEN=3
      DELTAY=(YHIGH-YLOW)/(MS2-MS1)
      SCALE=(XHIGH-XLOW)/(IMAX-IMIN)
      DO 20 I=ISTART,ISTOP,ISTEP
      IF (I .LT. 1) GOTO 20
      IF (I .GT. NSAMP) GOTO 20
      XPLOT=(IMIN-IDATA(I))*SCALE+XHIGH
      IF (XPLOT .GT. XHIGH) XPLOT=XHIGH
      IF (XPLOT .LT. XLOW) XPLOT=XLOW
      YPLOT=DELTAY*(I-MS1)+YLOW
      IF (YPLOT .GT. YHIGH) GOTO 20
      IF (IX.EQ.0) GOTO 15
      CALL PLOT(YPLOT,XPLOT,IPEN)
      GOTO 19
   15 CONTINUE
      CALL PLOT(XPLOT,YPLOT,IPEN)
   19 CONTINUE
      IPEN=2
   20 CONTINUE
      IF (D1 .GE. D2) GOTO 40
      CALL NUMB(XCNTR+.04,YHIGH+.08,.08,FLOAT(ILOC),90.,-1)
C    MM=COUNTS PER INCH
C    MM=INT((IMAX-IMIN)/WIDTH)
40    CONTINUE
      CALL PUP
      CALL PFLUSH
      RETURN
      END

      SUBROUTINE TW(IMIN,IMAX,IDXDB,DCROSS,W300,DIE1,
     * DIE2,DIST,WIDTH1)
C
C    TW COMPUTES TRACE WIDTH FOR TRUE-AMPLITUDE RECORD SECTIONS
C
      DATA CPERMV/831./
C
C    FIND TRUE DB ATTENUATION
C    FLAG WIDTH=-1. IF CHANNEL NUMBER IS UNKNOWN.
      WIDTH1=-1.
      IF (IDXDB .GT. 100) RETURN
      IF (IDXDB .LT. 0) RETURN
C    COMPUTE COUNTS FOR ZERO DB CHANNEL
      COUNT0=(IMAX-IMIN)*10.**(IDXDB/20.)
C    COMPUTE PEAK TO PEAK AMPLITUDE IN TENS OF MICROVOLTS
      AMV=COUNT0/CPERMV
C    COMPUTE WIDTH OF TRACE IF AT 300 KM.
      WT300=W300*AMV
C    COMPUTE WIDTH AT CORRECT DISTANCE
      IF (DIST .LT. DCROSS)
     * WIDTH1=WT300*(ABS(DIST/DCROSS))**DIE1
      IF (DIST .GE. DCROSS)
     * WIDTH1=WT300*(ABS(DIST/DCROSS))**DIE2
      RETURN
      END
```

.¨0

```
      PROGRAM ROSE
C
C   ROSE COPIES DATA FROM DISK TO TAPE (MODIFIED ROSE FORMAT)
C   FILE STRUCTURE IS THE SAME AS THE ROSE FORMAT
C   BUT THE CONTENTS OF THE TRACE HEADER BLOCK HAS BEEN
C   MODIFIED
C
      BYTE ANS,TITLE(80),HEADER(512),BUF(81),ERR
      BYTE H2(8192),CHAR,MTFEET
      INTEGER IH(256)
      INTEGER IA(4096)
      EQUIVALENCE (IH(1),HEADER(1))
      EQUIVALENCE (IA(1),H2(1))
      DATA MTFEET/1HN/
C
      COMMON/DXCOM/IOPEN,NSAMP,MREC,MAXR,IHEAD(3,150),
     * RRDIST(150),TITLE,NSRATE,VREDUC
C
      COMMON/DKBUF/JUNIT(100),JCHAN(100),IDB(100),ISP,ISDAY,
     * ISHOUR,ISMIN,ISSEC,ISMSEC,IEXP,IYEAR,ISIZE
C
      TYPE 1
1     FORMAT(' BEFORE OPERATING THE ROSE PROGRAM, COPY THE'/
     * ' EXPERIMENT LOCATION FILE TO THE HARD DISK (DLO:).'/
     * ' THEN, PUT THE DKDAT DISK IN DXO:. DATA DISKS GO IN DX1:'//)
      TYPE 10
10    FORMAT(' ROSE MACROS :'//
     * ' 1 = INITIALIZE AND REWIND A TAPE UNIT'/
     * ' -1 = PRINT A TAPE UNIT NUMBER'/
     * ' 2 = MOVE TAPE A SPECIFIED NUMBER OF FILES'/
     * ' 9 = WRITE A TAPE HEADER FILE'/
     * ' 10 = COPY DATA FROM DISK TO TAPE'/
     * '       DO A MACRO 10 FOR EACH SHOT'/
     * ' 11 = WRITE AN END OF TAPE MARK'/
     * ' 14 = PRINT ONE FILE'/
     * ' 15 = PRINT HEADER RECORDS FROM A ROSE FORMAT TAPE'/
     * '       MACRO 1 MUST BE DONE BEFORE MACRO 15'/
     * ' 21 = CONVERT ELEVATIONS FROM METERS TO FEET'/)
C
20    CONTINUE
      TYPE 30
30    FORMAT('$ROSE >  ')
      READ(5,*,ERR=20) ICMD
      IF (ICMD .EQ. 1) GOTO 100
      IF (ICMD .EQ. -1) GOTO 150
      IF (ICMD .EQ. 2) GOTO 200
      IF (ICMD .EQ. 9) GOTO 900
      IF (ICMD .EQ. 10) GOTO 1000
      IF (ICMD .EQ. 11) GOTO 1100
      IF (ICMD .EQ. 14) GOTO 1400
      IF (ICMD .EQ. 15) GOTO 1500
      IF (ICMD .EQ. 21) GOTO 2100
      GOTO 20
C
C
C   INTIALIZE AND REWIND A TAPE UNIT
C
100   CONTINUE
      TYPE 110
110   FORMAT('$UNIT NUMBER TO INITIALIZE(0 OR 1)?   ')
      READ(5,*) IUNIT
      IF (IUNIT .EQ. -1) GOTO 20
      PAUSE 'PREPARE TAPE DRIVE'
      CALL MTPINI(IUNIT,2HNR,IERR,ISTAT)
      NREC=1
```

```
      IF (IERR .EQ. 0) GOTO 120
121   CONTINUE
      TYPE 130,IERR,ISTAT
130   FORMAT(' ERROR. IERR =',I6,' ISTAT =',O10)
      GOTO 20
120   CONTINUE
C  REWIND TAPE
      CALL MTPIO(IUNIT,6,IA,MCNT,IERR,ISTAT)
      GOTO 20
150   CONTINUE
      TYPE 160,IUNIT
160   FORMAT(' UNIT NUMBER =',I3)
      GOTO 20
C
C  SKIP FILES
C
200   CONTINUE
      TYPE 210
210   FORMAT('$NUMBER OF FILES TO SKIP?   ')
      READ(5,*,ERR=200) MCNT
      IF (MCNT .EQ. 0) GOTO 20
      NCNT=IABS(MCNT)
      DO 220 I=1,NCNT
      IF (MCNT .LT. 0) CALL MTPIO(IUNIT,5,IA,0,IERR,ISTAT)
      IF (MCNT .GT. 0) CALL MTPIO(IUNIT,4,IA,0,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 121
220   CONTINUE
      NREC=NREC+MCNT
      GOTO 20
C
C  WRITE TAPE HEADER FILE
C
900   CONTINUE
      DO 901 I=1,512
901   HEADER(I)="200
      TYPE 910
910   FORMAT(' ENTER TAPE HEADER (UP TO 512 CHARACTERS)'/
     * ' TERMINATE INPUT WITH "ESCAPE""RETURN"'/)
      NCHAR=0
920   CONTINUE
      CHAR=ITTINR()
      IF (CHAR .LT. 0) GOTO 920
C  CHECK FOR ESCAPE CHARACTER
      IF (CHAR .EQ. "33) GOTO 930
      NCHAR=NCHAR+1
      IF (NCHAR .GT. 512) GOTO 920
      HEADER(NCHAR)=CHAR
      GOTO 920
930   CONTINUE
C  FLUSH BUFFER
      CHAR=ITTINR()
      CHAR=ITTINR()
C  WRITE HEADER TO TAPE
      CALL MTPIO(IUNIT,2,HEADER,256,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 121
C
C  READ HEADER DESCRIPTION FROM DISK AND WRITE TO TAPE
      DO 940 I=1,8192
940   H2(I)="200
      CALL ASSIGN(3,'DL0:TPHEAD.DAT',0,'RDO')
      NCHAR=0
980   CONTINUE
      CALL GETSTR(3,BUF,80,ERR)
      IF (ERR .EQ. -1) GOTO 960
      N=LEN(BUF)
      DO 970 I=1,N
```

```
        J=NCHAR+I
        IF (J .GT. 8192) GOTO 960
        H2(J)=BUF(I)
970     CONTINUE
        NCHAR=NCHAR+N
        H2(NCHAR+1)="15
        H2(NCHAR+2)="12
        NCHAR=NCHAR+2
        GOTO 980
C   WRITE HEADER
960     CONTINUE
        CALL MTPIO(IUNIT,2,H2,4096,IERR,ISTAT)
        IF (IERR .NE. 0) GOTO 121
        CALL CLOSE(3)
C   WRITE EOF
        CALL MTPIO(IUNIT,3,HEADER,0,IERR,ISTAT)
        IF (IERR .NE. 0) GOTO 121
        NREC=NREC+1
        GOTO 20
C
C   COPY DATA FROM DISK TO TAPE
C
1000    CONTINUE
C   READ DKDAT DATA
        TYPE 1010
1010    FORMAT('$SHOT NUMBER?   ')
        READ(5,*) ISHOT
        IF (ISHOT .EQ. 0) GOTO 20
        CALL DKIN(ISHOT)
C   OPEN LOCATION FILE
        DEFINE FILE 10(1500,12,U,JREC)
        TYPE 1020
1020    FORMAT('$ENTER NAME OF LOCATION FILE  ')
        CALL ASSIGN(10,,-1,'RDO')
        READ(10'ISP) LATDS,LATMSH,ALATSS,LONDS,LONMSH,ALONSS,IELEVS
        LATSS=ALATSS
        LATMSS=1000.*(ALATSS-LATSS)
        LONSS=ALONSS
        LONMSS=1000.*(ALONSS-LONSS)
        IF (MTFEET .EQ. 1HY) IELEVS=IELEVS*3.28084+0.5
C
C   OPEN DATA FILE
1030    CONTINUE
        TYPE 1040
1040    FORMAT('$COPY A DATA FILE OR FLOPPY(Y OR N)?   ')
        READ(5,1041) ANS
1041    FORMAT(A1)
        IF (ANS .EQ. 1HY) GOTO 1050
        CALL CLOSE(10)
        GOTO 20
1050    CONTINUE
        CALL DLOPEN
C
C   TRANSFER ONE TRACE AT A TIME TO TAPE
        DO 1070 I=1,MREC
        IF (IHEAD(1,I) .EQ. -1) GOTO 1070
        I1=I
        CALL DXIN(I1,IA,IERR)
        IF (IERR .NE. -2) GOTO 1073
C
C   HARDWARE READ ERROR ON FLOPPY DATA DISK
        TYPE 1074,I
1074    FORMAT(' HARDWARE INPUT ERROR ON T.DAT FILE. DATA
      * RECORD =',I4)
        GOTO 1070
C
```

```
C   INITIALIZE DATA BUFFER IN MEMORY
1073    CONTINUE
        DO 1071 J=NSAMP+1,4096
1071    IA(J)=0
C   INITIALIZE HEADER
        DO 1080 J=1,149
1080    IH(J)=0
        DO 1090 J=300,512
1090    HEADER(J)='200
C   COMPUTE TIME OF FIRST SAMPLE
        DIST=RRDIST(I)
        TADD=ABS(DIST)/VREDUC+IHEAD(3,I)
        RKSEC=ISSEC+ISMSEC/1000.
        CALL TIME(ISDAY,ISHOUR,ISMIN,RKSEC,
     *  IPDAY,IPHOUR,IPMIN,IPSEC,IPMSEC,TADD,0.)
C   READ INSTRUMENT LOCATION
        READ(10'IHEAD(2,I)) LATD,LATM,ALATS,LOND,LONM,ALONS,IELEVR
        LATS=ALATS
        LATMS=1000.*(ALATS-LATS)
        LONS=ALONS
        LONMS=1000.*(ALONS-LONS)
        IF (MTFEET .EQ. 1HY) IELEVR=IELEVR*3.28084+0.5
C   COMPUTE AZIMUTH
        D=ADIST(ISP,IHEAD(2,I),AZIM)
C   FILL HEADER
        IH(1)=NREC                !FILE NUMBER IN TAPE
        IH(2)=IEXP                !EXPERIMENT NUMBER
        IH(3)=ISHOT               !SHOT NUMBER
        IH(4)=ISP                 !SHOT LOCATION NUMBER
        IH(5)=0                   !SHOT LOCATION SUBNUMBER
        IH(6)=IHEAD(2,I)          !RECORDER LOCATION NUMBER
        IH(7)=0                   !GEOLOGY CODE
        IH(8)=IYEAR               !YEAR OF FIRST SAMPLE
        IH(9)=IPDAY               !JULIAN DAY OF FIRST SAMPLE
        IH(10)=IPHOUR             !HOUR OF FIRST SAMPLE
        IH(11)=IPMIN              !MINUTE OF FIRST SAMPLE
        IH(12)=IPSEC              !SECOND OF FIRST SAMPLE
        IH(13)=IPMSEC             !MILLISECOND OF FIRST SAMPLE
        IH(14)=0                  !MICROSECOND OF FIRST SAMPLE
        IH(15)=IYEAR              !YEAR OF SHOT
        IH(16)=ISDAY              !MONTH OF SHOT
        IH(17)=ISHOUR             !HOUR OF SHOT
        IH(18)=ISMIN              !MINUTE OF SHOT
        IH(19)=ISSEC              !SECOND OF SHOT
        IH(20)=ISMSEC             !MILLISECOND OF SHOT
        IH(21)=0                  !MICROSECOND OF SHOT
        IH(22)=10.*VREDUC         !REDUCTION VELOCITY(TENTHS OF A KM/S)
        IH(23)=IHEAD(3,I)         !REDUCED START TIME (SEC)
        IH(24)=1000./FLOAT(NSRATE)
C                                 SAMPLING RATE IN HERTZ
        IH(25)=NSAMP              !NUMBER OF SAMPLES PER TRACE
        IH(26)=LATDS              !SHOT LATITUDE DEGREES
        IH(27)=LATMSH             !SHOT LATITUDE MINUTES
        IH(28)=LATSS              !SHOT LATITUDE SECONDS
        IH(29)=LATMSS             !SHOT LATITUDE MILLISECONDS
        IH(30)=LONDS              !SHOT LONGITUDE DEGREES
        IH(31)=LONMSH             !SHOT LONGITUDE MINUTES
        IH(32)=LONSS              !SHOT LONGITUDE SECONDS
        IH(33)=LONMSS             !SHOT LONGITUDE MILLISECONDS
        IH(34)=IELEVS             !SHOT ELEVATION IN FEET
        IH(35)=LATD               !RECORDER LATITUDE DEGREES
        IH(36)=LATM               !RECORDER LATITUDE MINUTES
        IH(37)=LATS               !RECORDER LATITUDE SECONDS
        IH(38)=LATMS              !RECORDER LATITUDE MILLISECONDS
        IH(39)=LOND               !RECORDER LONGITUBE DEGREES
        IH(40)=LONM               !RECORDER LONGITUDE MINUTES
```

```
      IH(41)=LONS               !RECORDER LONGITUDE SECONDS
      IH(42)=LONMS              !RECORDER LONGITUDE MILLISECONDS
      IH(43)=IELEVR             !RECORDER ELEVATION IN FEET
      IH(44)=DIST               !RANGE IN KILOMETERS
      IH(45)=10000.*(DIST-IH(44))
C                               RANGE IN CENTIMETERS
      IH(46)=AZIM               !AZIMUTH IN DEGREES
      IH(47)=1000.*(AZIM-IH(46))
C                               AZIMUTH IN MILLIDEGREES
      IH(48)=ISIZE              !SHOT SIZE IN POUNDS
      IH(49)=2                  !EARTHQUAKE-SHOT CODE
C                               1=EARTHQUAKE  2=SHOT
      IH(50)=IHEAD(1,I)         !RECORDER UNIT NUMBER
      IH(51)=0                  !CHANNEL NUMBER
      IH(52)=-1                 !DB ATTENUATION NUMBER
      DO 1091 J=1,100
      IF (IHEAD(1,I) .EQ. JUNIT(J)) GOTO 1092
1091  CONTINUE
      GOTO 1096
1092  IH(51)=JCHAN(J)
      IH(52)=IDB(J)
1096  CONTINUE
C
C   WRITE DATA TO TAPE
      CALL MTPIO(IUNIT,2,IH,256,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 1093
      CALL MTPIO(IUNIT,2,IA,4096,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 1093
      CALL MTPIO(IUNIT,3,IA,0,IERR,ISTAT)
      IF (IERR .EQ. 0) GOTO 1094
C   TAPE WRITE ERROR
1093  CALL CLOSE(10)
      GOTO 121
1094  CONTINUE
      TYPE 1095,I,NREC
1095  FORMAT(' DISK RECORD',I3,' WRITTEN TO TAPE FILE',I5)
      NREC=NREC+1
1070  CONTINUE
C
C   END OF ONE FLOPPY OR DISK FILE
      CALL DXCLOS
      GOTO 1030
C
C   WRITE AN END OF TAPE MARK
C
1100  CONTINUE
C   WRITE TWO EOF'S
      CALL MTPIO(IUNIT,3,IA,0,IERR,ISTAT)
      CALL MTPIO(IUNIT,3,IA,0,IERR,ISTAT)
      GOTO 20
C
C   PRINT ONE DATA FILE
C
1400  CONTINUE
      TYPE 1510
      READ(5,*) IO
      PAUSE 'START A NEW PAGE ON OUTPUT DEVICE'
      CALL MTPIO(IUNIT,1,IH,256,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 121
      WRITE(IO,1410) (IH(I),I=1,52)
1410  FORMAT(//(1H ,15I8))
      CALL MTPIO(IUNIT,1,IA,4096,IERR,ISTAT)
      IF (IERR .NE. 0) GOTO 121
      WRITE(IO,1410) IA
      CALL MTPIO(IUNIT,4,IA,0,IERR,ISTAT)
      GOTO 20
```

```
C
C   PRINT HEADER RECORDS FROM A ROSE TAPE
C
1500    CONTINUE
        TYPE 1501
1501    FORMAT('$SHORT FORM(0) OR LONG FORM(1)?   ')
        READ(5,*) IFORM
        IF (IFORM.LT.0 .OR. IFORM.GT.1) GOTO 20
        TYPE 1510
1510    FORMAT('$OUTPUT TO TERMINAL(5) OR LINE PRINTER(6)?   ')
        READ(5,*) IO
        PAUSE 'START A NEW PAGE ON OUTPUT DEVICE'
C   READ TAPE HEADER
        CALL MTPIO(IUNIT,1,HEADER,256,IERR,ISTAT)
        IF (IERR .NE. 0) GOTO 121
        CALL PRINT(HEADER)
        CALL MTPIO(IUNIT,1,H2,4096,IERR,ISTAT)
        IF (IERR .NE. 0) GOTO 121
        CALL PRINT(H2)
C   SKIP TO NEXT FILE
        CALL MTPIO(IUNIT,4,IA,0,IERR,ISTAT)
1530    CONTINUE
C   READ A FILE FROM TAPE
        CALL MTPIO(IUNIT,1,IH,256,IERR,ISTAT)
        IF (IERR .EQ. -3) GOTO 1540
        IF (IERR .NE. 0) GOTO 121
        CALL MTPIO(IUNIT,1,IA,4096,IERR,ISTAT)
        IF (IERR .NE. 0) GOTO 121
        IF (IFORM .EQ. 0) WRITE(IO,1545) IH(1),IH(2),IH(4),IH(6),
     *  IH(50),IH(44),IH(45),IH(46),IH(51),IH(52)
1545    FORMAT(1H ,15I8)
        IF (IFORM .EQ. 1) WRITE(IO,1550) (IH(I),I=1,52),(IA(J),J=1,8)
1550    FORMAT(//(1H ,15I8))
C   SKIP TO NEXT FILE
        CALL MTPIO(IUNIT,4,IA,0,IERR,ISTAT)
        GOTO 1530
1540    CONTINUE
        WRITE(IO,1570)
1570    FORMAT(//' END OF DATA MARK FOUND (TWO EOFS)')
        GOTO 20
C
C   SET FLAG TO CONVERT ELEVATIONS FROM METERS TO FEET
C
2100    CONTINUE
        TYPE 2110
2110    FORMAT('$CONVERT ELEVATIONS FROM METERS TO FEET(Y OR N)?   ')
        READ(5,2120) MTFEET
2120    FORMAT(A1)
        GOTO 20
C
        END

        SUBROUTINE DKIN(ISHOT)
C
C   DKIN READS DATA FOR ONE SHOT FROM A DKDAT DISK
C
        INTEGER ITM(700)
        REAL SSEC(30)
        EQUIVALENCE (SSEC(1),ITM(225))
C
        COMMON/DKBUF/JUNIT(100),JCHAN(100),JDB(100),ISF,JSDAY,
     *  JSHOUR,JSMIN,JSSEC,JSMSEC,IEXP,IYEAR,JSIZE
C
        DEFINE FILE 2(153,800,U,KREC)
        TYPE 10
10      FORMAT('$ENTER NAME OF DKDAT FILE  ')
```

```
        CALL ASSIGN(2,,-1,'RDO')
16      TYPE 15
15      FORMAT('$ENTER EXPERIMENT NUMBER  ')
        READ(5,*,ERR=16) IEXP
30      TYPE 20
20      FORMAT('$ENTER EXPERIMENT YEAR EG. '1981'  ')
        READ(5,*,ERR=30) IYEAR
        READ(2'1) ITM
        ISP=ITM(104+ISHOT)
        JSDAY=ITM(134+ISHOT)
        JSHOUR=ITM(164+ISHOT)
        JSMIN=ITM(194+ISHOT)
        JSSEC=SSEC(ISHOT)
        JSMSEC=1000.*(SSEC(ISHOT)-JSSEC)
        JSIZE=ITM(314+ISHOT)
        IF (JSIZE .LT. 0) JSIZE=0
        DO 40 I=1,5
        IREC=ISHOT*5-2+I
        READ(2'IREC) ITM
        DO 50 J=1,20
        IOUT=(I-1)*20+J
        JUNIT(IOUT)=0
        JCHAN(IOUT)=0
        JDB(IOUT)=-1
        KUNIT=ITM(20+J)
        IF (KUNIT.LT.1 .OR. KUNIT.GT.150) GOTO 50
        JUNIT(IOUT)=KUNIT
        KCHAN=ITM(380+J)
        IF (KCHAN.LT.1 .OR. KCHAN.GT.3) GOTO 50
        JCHAN(IOUT)=KCHAN
        KDB=ITM(640+(J-1)*3+KCHAN)
        IF (KDB.LT.0 .OR. KDB.GT.200) GOTO 50
        JDB(IOUT)=KDB
50      CONTINUE
40      CONTINUE
        CALL CLOSE(2)
        RETURN
        END
```

.¨0

```
      SUBROUTINE PLOT(X,Y,IPEN)
C
C*** PEN MOVEMENT ROUTINE
C
      COMMON/PLTDEV/IDEV
      IF ( IDEV.EQ.0 ) GOTO 10
      CALL TKPLOT(X,Y,IPEN)
      RETURN
10    CONTINUE
      CALL CPPLOT(X,Y,IPEN)
      RETURN
      END
      SUBROUTINE TKPLOT(X,Y,IC)
C
C*** PEN MOVEMENT ROUTINE FOR TEKTRONIX 4014 GRAPHIC TERMINAL
C
      COMMON/TKCOM/JCSR,MODE
      COMMON/TKPNT/JX,JY,JORX,JORY,CFAC
      DATA JX,JY,JORX,JORY,CFAC/
     *     0 ,0 ,0   ,0   ,100./
C
      IF ( IC .LT. 100 ) GOTO 500
      GOTO (101,102,103,104),IC-100
101   JORX=0
      JORY=0
      CFAC=100.
      IF ( MODE .EQ. 1 ) CFAC=400.
      GOTO 700
102   X=JORX
      Y=JORY
      RETURN
103   CFAC=100.
      IF ( MODE .EQ. 1 ) CFAC=400.
      CFAC=CFAC*X
      RETURN
104   X=FLOAT(JX)/CFAC
      Y=FLOAT(JY)/CFAC
      RETURN
500   JX=X*CFAC
      JY=Y*CFAC
      IX=JX+JORX
      IY=JY+JORY
      ICABS=IABS(IC)
      IF ( ICABS-3 ) 602,603,604
602   CALL TPLOT(IX,IY,1)
      GOTO 605
603   CALL TPLOT(IX,IY,0)
      GOTO 605
604   CALL TPLOT(IX,IY,-1)
605   CONTINUE
      IF ( IC .GT. 0 ) RETURN
      JORX=IX
      JORY=IY
700   JX=0
      JY=0
      RETURN
      END
      SUBROUTINE CROSSH(X,Y,ICHAR)
      BYTE ICHAR
      COMMON/TKPNT/JX,JY,JORX,JORY,CFAC
      CALL TKCURS(IX,IY,ICHAR)
      X=(IX-JORX)/CFAC
      Y=(IY-JORY)/CFAC
      RETURN
```

```
      END
        SUBROUTINE DEVICE(I)
C
C*** SELECT PLOT DEVICE
C***    0 - COMPLOT PEN PLOTTER (DEFAULT)
C***    1 - TEKTRONIX 4014 GRAPHICS TERMINAL
C
        COMMON/PLTDEV/IDEV
        IDEV=I
        RETURN
        END
        SUBROUTINE INITT(IP)
C
C*** INITIALIZE PLOT DEVICE
C
        COMMON/PLTDEV/IDEV
        DATA IDEV/0/
        IF ( IDEV.EQ.0 ) GOTO 10
        CALL TKINI(IP)
        RETURN
10      CONTINUE
        CALL CPINI(IP)
        RETURN
        END
        SUBROUTINE FINITT(I1,I2)
C
C*** PLOT FINALIZATION ROUTINE
C
        COMMON/PLTDEV/IDEV
        IF ( IDEV.EQ.0 ) GOTO 10
        CALL TKFIN(I1,I2)
        RETURN
10      CONTINUE
        CALL CPFIN(I1,I2)
        RETURN
        END
        SUBROUTINE TKINI(IP)
C
C*** PLOT INITIALIZATION FOR TEKTRONIX 4014 GRAPHICS TERMINAL
C
        CALL TKERS
        RETURN
        END
        SUBROUTINE TKFIN(I1,I2)
C
C*** PLOT FINALIZATION ROUTINE FOR TEKTRONIX 4014 GRAPHICS TERMINAL
C
        CALL TPLOT(I1,I2,0)
        CALL TKALPH
        RETURN
        END
        SUBROUTINE TKERS
C
C*** ERASE TEKTRONIX 4014 SCREEN
C
        INTEGER IBUF(2)
        DATA IBUF/27,12/
        CALL TKOUT(IBUF,2)
        CALL WAITM(750)
        RETURN
        END
        SUBROUTINE TKALPH
C
C*** PUT TEKTRONIX 4014 INTO ALPHANUMERIC MODE
C
```

```
      CALL TKOUT(31,1)
      RETURN
      END
      SUBROUTINE TKBELL
C
C*** RING TEKTRONIX 4014 BELL
C
      CALL TKOUT(7,1)
      RETURN
      END
      SUBROUTINE TERM(I1,I2)
C
C*** SET CHARACTERISTICS OF TEKTRONIX 4014 GRAPHICS TERMINAL
C***   I1 - DUMMY PARAMETER INCLUDED FOR COMPATIBILITY WITH PLOT-10
C***   I2 - GRID RESOLUTION TO BE USED
C***        =1024 , USES SCREEN IN 1024X1024 MODE
C***        =4096 , USES SCREEN IN 4096X4096 MODE (DEFAULT)
C
      COMMON/TKCOM/JCSR,MODE
      COMMON/TKPNT/JX,JY,JORX,JORY,CFAC
      MODE=0
      CFAC=100.
      IF ( I2.LE.1024 ) RETURN
      MODE=1
      CFAC=400.
      RETURN
      END
      SUBROUTINE TKCURS(IX,IY,ICHAR)
C
C*** ACTIVATE INTERACTIVE CROSS-HAIR CURSORS AND READ X,Y POSITION
C*** OF CROSS-HAIR WHEN USER PRESSES A CHARACTER
C***    IX - X COORDINATE OF CROSS-HAIR
C***    IY - Y COORDINATE OF CROSS-HAIR
C***    ICHAR - CHARACTER PRESSED BY USER
C*** X,Y COORDINATES WILL BE RETURNED IN RANGE 0-1023 OR 0-4095
C*** ACCORDING TO CURRENT COORDINATE ADDRESSING MODE OF TERMINAL
C
      BYTE ICHAR
      INTEGER IBUF(2),IDATA(5)
      COMMON/TKCOM/JCSR,MODE
      DATA IBUF/27,26/
      CALL TKOUT(IBUF,2)
      CALL TKINSL(IDATA,5)
      ICHAR=IAND(IDATA(1),'177)
      IX='40*IAND(IDATA(2),'37)+IAND(IDATA(3),'37)
      IY='40*IAND(IDATA(4),'37)+IAND(IDATA(5),'37)
      CALL TKOUT(29,1)
      IF ( MODE.EQ.0 ) RETURN
      IX=IX*4
      IY=IY*4
      RETURN
      END
      SUBROUTINE TPLOT(IX,IY,IPEN)
C
C*** BASIC LOW-LEVEL VECTOR DRAWING ROUTINE FOR TEKTRONIX 4014
C***   IX - X COORDINATE TO MOVE TO
C***   IY - Y COORDINATE TO MOVE TO
C***   IPEN - BEAM POSITION DURING VECTOR MOVEMENT
C***          =-1  , PLOT POINT AT (IX,IY)
C***          =0   , MOVE TO (IX,IY) WITH BEAM OFF (DARK VECTOR)
C***          =1   , MOVE TO (IX,IY) WITH BEAM ON (VISIBLE VECTOR)
C*** IX,IY SHOULD BE IN RANGE 0-1023 OR 0-4096 ACCORDING TO
C*** CURRENT ADDRESSING RANGE OF TERMINAL
C
      INTEGER IBUF(5)
      COMMON/TKCOM/JCSR,MODE
```

```
      IF ( IPEN.NE.1 ) CALL TKOUT(29,1)
      IF ( MODE.EQ.1 ) GOTO 100
      IBUF(1)='40+ISHFT(IY,-5)
      IBUF(2)='140+IAND(IY,'37)
      IBUF(3)='40+ISHFT(IX,-5)
      IBUF(4)='100+IAND(IX,'37)
      CALL TKOUT(IBUF,4)
      IF ( IPEN.EQ.-1 ) CALL TKOUT(IBUF(4),1)
      RETURN
100   CONTINUE
      IBUF(1)='40+ISHFT(IY,-7)
      IBUF(2)='140+ISHFT(IAND(IY,3),2)+IAND(IX,3)
      IBUF(3)='140+ISHFT(IAND(IY,'174),-2)
      IBUF(4)='40+ISHFT(IX,-7)
      IBUF(5)='100+ISHFT(IAND(IX,'174),-2)
      CALL TKOUT(IBUF,5)
      IF ( IPEN.EQ.-1 ) CALL TKOUT(IBUF(5),1)
      RETURN
      END
      SUBROUTINE TKOUT(IBUF,N)
C
C*** TEKTRONIX 4014 OUTPUT ROUTINE
C***  IBUF - INTEGER ARRAY OF VALUES TO OUTPUT TO TEKTRONIX 4014,
C***         ONLY BOTTOM 8 BITS OF EACH WORD ARE OUTPUT
C***  N - NUMBER OF VALUES TO OUTPUT TO TEKTRONIX 4014
C
      INTEGER IBUF(1)
      COMMON/TKCOM/JCSR,MODE
      COMMON/TKVEC/IZ,ITYPE
      DATA JCSR/'177560/,MODE/0/
      DATA IZ/0/,ITYPE/0/
C   CODE MODIFIED BY W. KOHLER 7/23/80 TO USE
C   DMA INTERFACE
C     DO 100 I=1,N
C        CALL BPUT(JCSR+6,IBUF(I))
C10      CONTINUE
C        CALL WGET(JCSR+4,ICSR)
C        IF ( IAND('200,ICSR).EQ.0 ) GOTO 10
C100     CONTINUE
      NWORD=-N
      IBAR=IADDR(IBUF(1))
      CALL IPOKE('172410,NWORD)
      CALL IPOKE('172412,IBAR)
      CALL IPOKE('172414,'27201)
      RETURN
      END
      SUBROUTINE CZAXIS(I)
C
C*** SET Z-AXIS FOR TEKTRONIX 4014 VECTORS AND ALPHANUMERICS
C***  I - Z-AXIS TYPE
C***     =0 , NORMAL VECTOR AND POINT SIZE (DEFAULT)
C***     =1 , DEFOCUSED Z-AXIS (FAT VECTORS)
C***     =2 , WRITE-THRU MODE ENABLE (NON-STORE MODE)
C
      INTEGER IBUF(2)
      COMMON/TKVEC/IZ,ITYPE
      COMMON/PLTDEV/IDEV
      DATA IBUF(1)/27/
      IF ( IDEV .EQ. 0 ) RETURN
      IZ=I
      IBUF(2)='140+IZ*8+ITYPE
      CALL TKOUT(IBUF,2)
      RETURN
      END
      SUBROUTINE VTYPE(I)
C
```

```
C*** SET VECTOR TYPE FOR TEKTRONIX 4014 VECTORS
C***     I - VECTOR TYPE
C***         =0 , NORMAL VECTORS (DEFAULT)
C***         =1 , DOTTED LINE VECTORS
C***         =2 , DOT-DASH VECTORS
C***         =3 , SHORT-DASH VECTORS
C***         =4 , LONG-DASH VECTORS
C
        INTEGER IBUF(2)
        COMMON/TKVEC/IZ,ITYPE
        DATA IBUF(1)/27/
        ITYPE=I
        IBUF(2)='140+IZ*8+ITYPE
        CALL TKOUT(IBUF,2)
        RETURN
        END
        SUBROUTINE CSIZE(I)
C
C*** SET SIZE OF TEKTRONIX 4014 HARDWARE CHARACTER GENERATOR
C***     I - CHARACTER SIZE
C***         =0 , 133 CHARACTERS BY 64 LINES (DEFAULT)
C***         =1 , 121 CHARACTERS BY 58 LINES
C***         =2 , 81 CHARACTERS BY 38 LINES
C***         =3 , 74 CHARACTERS BY 35 LINES
C
        INTEGER IBUF(2)
        DATA IBUF(1)/27/
        IBUF(2)=59-I
        CALL TKOUT(IBUF,2)
        RETURN
        END
        SUBROUTINE TKINSL(IBUF,N)
C
C    TEKTRONIX 4014 INPUT ROUTINE
C    THIS ROUTINE IS SIMILAR TO ARGOS SYSTEM ROUTINE TKIN
C    BUT USES THE RT11V03B SYSTEM SUBROUTINE LIBRARY
C
        INTEGER*2 IBUF(1)
        COMMON/TKCOM/JCSR,MODE
C    SET SPECIAL CONSOLE MODE BY SETTING BIT 12 OF THE JSW
        CALL IPOKE('44,'10000.OR.IPEEK('44))
        DO 100 I=1,N
10      CONTINUE
        ICHAR=ITTINR()
        IF (ICHAR .LT. 0) GOTO 10
        IBUF(I)=ICHAR.AND.'177
100     CONTINUE
C    SET NORMAL CONSOLE MODE BY CLEARING BIT 12 OF THE JSW
        CALL IPOKE('44,'167777.AND.IPEEK('44))
        RETURN
        END
        SUBROUTINE SYMB(XINCH,YINCH,HEIGHT,CHARS,ANGLE,NCHAR)
        COMMON /PLTDEV/ IDEV
        IF(IDEV.EQ.0)CALL SYMBH(XINCH,YINCH,HEIGHT,CHARS,ANGLE,NCHAR)
        IF(IDEV.EQ.1)CALL SYMBT(XINCH,YINCH,HEIGHT,CHARS,ANGLE,NCHAR)
        RETURN
        END
        SUBROUTINE SYMBT(X,Y,SIZE,CHAR,THETA,N)
C
C    TEKTRONIX SYMBOL ROUTINE USING THE TEK HARDWARE
C    GENERATOR AND THE DMA INTERFACE
C
        BYTE CHAR(1)
        IF (X .EQ. 999.) GOTO 30
        IF (Y .EQ. 999.) GOTO 30
        CALL TKOUT(29,1)
```

```
      CALL PLOT(X,Y,3)
30    CONTINUE
      CALL TKOUT(31,1)
      I=0
      IF (SIZE .GT. .084) I=1
      IF (SIZE .GT. .108) I=2
      IF (SIZE .GT. .138) I=3
      CALL CSIZE(I)
      DO 10 I=1,N
      IOUT=CHAR(I)
      CALL TKOUT(IOUT,1)
10    CONTINUE
      CALL CSIZE(0)
      RETURN
      END
      SUBROUTINE HCOPY
C
C   HCOPY MAKES A HARD COPY FROM THE TEK-TUBE SCREEN.
C
      BYTE ESC,ETB
      DATA ESC/'33/,ETB/'27/
      TYPE 10,ESC,ETB
10    FORMAT(1H+,2A1)
C   WAIT FOR COMPLETION OF COPY
      DO 20 I=1,7
      DO 20 J=1,2000
      A=SIN(B)
20    CONTINUE
      RETURN
      END
      SUBROUTINE ERASE
C
C   ERASE ERASES THE TEK-TUBE SCREEN
C
      BYTE ESC,FF
      DATA ESC/'33/,FF/'14/
      TYPE 10,ESC,FF
10    FORMAT(1H+,2A1)
C   WAIT FOR COMPLETION OF ERASE
      DO 20 I=1,2
      DO 20 J=1,2000
      A=SIN(B)
20    CONTINUE
      RETURN
      END
```

.^0

APPENDIX 4. Bibliography of reports, documents, and abstracts to date resulting from the seismic refraction profile.

Anonymous, 1976, USGS/DGMR Geophysical Investigations in Saudi Arabia: Seismic refraction profile - status report no. 1: U.S. Geological Survey Mission, internal report, 19 pp., 6 figs.

Blank, H. R., Healy,, J. H., Roller, J. C., Lamson, R. J., Fisher, F., McClearn, R., and Allen, S., 1979, Seismic refraction profile, Kingdom of Saudi Arabia--field operations, instrumentation and initial results: U.S. Geological Survey Saudi Arabian Mission Project Report 259, 49 pp.

Blank, H. R., Mooney, W. D., Lamson, R. J., Healy, J. H., and Gettings, M. E., in press, Crustal structure of the eastern margin of the Red Sea depression, southwest Saudi Arabia, from seismic deep-refraction observations: U.S. Geological Survey Saudi Arabian Mission Project Report, c. 25 pp.

Gettings, M. E., 1982, Heat flow measurements at the 1978 Saudi Arabia deep-seismic refraction line shot points II. Discussion and interpretation, 45 pp.

Gettings, M. E., and Showail, Abdullah, 1982, Heat flow measurements at the 1978 Saudi Arabia deep-seismic refraction line shot points I. Results of the measurements, 97 p.

Gettings, M. E., 1981, A heat flow profile across the Arabian Shield and Red Sea (abs.): EOS, American Geophysical Union Transactions, v. 62, no. 17, p. 407.

Healy, J. H., Mooney, W. D., Blank, H. R., Gettings, M. E., Lamson, R. J., and Kohler, W. M., in press, Summary report on the 1978 Saudi Arabian seismic deep-refraction profile: U.S. Geological Survey Saudi Arabian Mission Project Report, c. 50 pp.

Kohler, W. M., Lamson, R. J., and Healy, J. H., A study of P-wave attenuation in the Arabian shield using spectral ratios (abs.): EOS, America Geophysical Union Transactions, v. 60, no. 46, p. 881.

Lamson, R. J., and Blank, H. R., USGS/DGMR Geophysical Investigations in Saudi Arabia: Seismic refraction profile - status report No. 2, 15 January 1978.

Lamson, R. J., Blank, H. R., Mooney, W., and Healy, J. H., Seismic refraction observations across the oceanic-continental rift zone, southwest Saudi Arabia (abs.): EOS, American Geophysical Union Transactions, v. 60, no. 46, p. 954.

Lamson, R. J., and Leone, L. E., 1980, Saudi Arabian seismic refraction profile data set, volumes 1 and 2: U.S. Geological Survey Open-File Report, Miscellaneous Document 17.

Merghelani, H. M., and Gallathine, S. K., 1980, Microearthquakes in the Tihamat-Asir region of Saudi Arabia: Bulletin of the Seismological Society of America, v. 70, no. 6, p. 2291-2293.

Mooney, W. D., 1980, IASPEI workshop--seismic modelling of laterally varying structures (Arabian Shield to the Red Sea): EOS, American Geophysical Union Transactions, v. 61, p. 19.

APPENDIX 5. Recorder station principal fact listings.

This appendix describes the data processing methods which have evolved for storing, cataloging, and updating the information generated by such a seismic refraction experiment.

The current Master Shot List and Team-Shot Data printouts, as well as a description of the programs used to compile pertinent data on shot points, recorder locations, and seismic records, are included.

Description of data processing and format

The data reduction process begins with analog data as recorded in the field on cassette tapes. These data are digitized, stored on diskettes and magnetic tapes, and displayed in the form of plotted records, both individually and in groups. To aid in the interpretation of these plots pertinent information is organized into two groups, one containing location data and the other containing data on shots, recording instruments, and the digitized records. The "Seismic Recorder Locations" list represents the final format of the location data, and the "Master Shot List" and the "Team-Shot Data" sheets represent the other data. These two data bases are stored in the computer files M.LOC and K.DAT, respectively. Associated with each of these files are specialized computer programs for updating, editing, and interfacing with other software.

The Seismic Recorder Locations printout indicates recorder site or shot point location number, latitude, longitude, elevation, and lithology. Location numbers are assigned in the field and generally correspond to the sequence of site occupation. Latitude and longitude are entered directly or as measured distances from map reference points, which are then converted by the program into latitudes and longitudes. This information is typically entered into the computer as soon as sites are surveyed, and is corrected in the field for any changes in the actual deployment of instruments. The M.LOC file has a storage capacity for 1500 locations and can be adapted to include additional parameters. Data for one or more selected locations can be printed individually, or the entire location file can be printed in page format, as in this appendix.

The K.DAT file, on which the Master Shot List and Team-Shot Data are based, has a storage capacity for 30 shots, or 3000 seismic records (up to 100 recorders are deployed for each shot set). The Master Shot List contains data on shot locations and times and on shot holes. Shots are numbered chronologically. The calendar date, shot point location number, and shot time are entered in the field after each shot set is fired. A file-interfacing program causes latitude, longitude, elevation, and lithology to be read from M.LOC so that any given shot list printout contains the most current and complete location data available. Information about the depth and nature of the land drillholes and sea-floor shot sites, and the amount of explosives loaded appears in the columns labeled "DEPTH", "WATER", and "NOTES" on the Master Shot List.

The Saudi Arabian profile consisted of 19 shots, or 1900 seismic records. Since each of five teams deployed 20 of the 100 instruments there are five "Team-Shot Data" sheets for each shot, and each data sheet contains 20 records, one for each recorder location occupied. Data about location and recording instrument numbers for each deployment are transferred from each team's field data records to the computer and appear in the "LOC" and "UNIT" columns of the Team-Shot Data sheet. As on the Master Shot List, the computer reads latitude, longitude, and elevation from the current computer location file, M.LOC. By interfacing with the M.LOC file distance and azimuth from the shot point are also calculated automatically and appear in the "DIST" and "AZIM" columns of the printout. The timing error for each instrument is calculated by the team after each deployment and entered into the K.DAT file ("CHRON" column on the printout). When the cassette field tapes from each instrument are played back, tape footage is recorded, the record tentatively graded according to instrument performance and recording quality, and this information in turn is entered into the K.DAT data file ("CHRON", "FOOTNOTE", and "TAPE GRADE" columns). Since the tape grade does not reflect the presence or quality of an arrival, a grade of "good", for example, simply means that the instruments functioned correctly and recorded the appropriate data window. A complete list of tape grades follows.

0 - Good
1 - Tape did not run
2 - Tape ran but no signal
3 - Skipped record time
4 - Fast forward; no signal
5 - Rewound and erased
6 - Weak signal; cannot read time code; low record level
7 - Continuous calibration or periodic offsets
8 - Noise, sinusoidal
9 - Noise, spike
10 - Noise, WWVB cross-feed
11 - Noise, periodic ticks
12 - Noise, random
13 - Bad clock

14 - Off frequency, tape speed
15 - Calibration
16 - Incomplete record; recorder stopped
17 - Bad time code
18 - Tape speed way off; belt slipped
19 - Turned on too early
20 - In for repair; not deployed
21 - Geophone disconnected or shorted
22 - Wrong unit number
23 - Wrong gain settings
24 - Late start
25 - Bad geophone test (usually no signal)
26 - One or more channels missing
27 - Bad WWVB
28 - Unit damaged/vandalized
29 - Tape damaged/vandalized

During later refraction profiles the digitizing software was expanded to sample and digitize the internal instrument calibration data and write it to the K.DAT file (see "CALIBRATION" columns). The entire dataset was later redigitized to extend the record length, increase the sampling rate, and include this calibration data. Each instrument records on three data channels with variable amplitudes as shown below.

Channel	Attenuation	Amplitude of 10 Hz calibration (microvolts)
1	medium	100
2	low	1000
3	high	10

All three channels are routinely digitized to select the record of highest amplitude without significant clipping for storage on diskette. The K.DAT calibration columns indicate which channel was stored ("CH"), the amplitude of that channel's 10-Hz calibration signal ("VAL"), and the amplitude in digital counts of the calibration signal ("AMP").

After the digitized records were plotted, the quality of each record was graded, and this grade appears in the "REC GRD" column of the printout. A small number of records in which data was totally obscured due to bad time code or other instrument malfunction were deleted from the dataset (grades 8 and 9, respectively). When data was evident but somewhat obscured when plotted in standard format due to overlap or noise the record was retained, but not included on the published plot (grades 5 and 7, respectively). A complete list of the grading code used follows.

0 - Good arrival
1 - Fair arrival
2 - Poor arrival
3 - Questionable arrival
4 - No arrival
5 - Deleted from record section due to overlap
6 - No record available
7 - Deleted from record section due to noise
8 - Time code or tape speed problem - record unrecoverable
9 - Instrument problem - record deleted

Miscellaneous information regarding any phase of the data reduction process appears in the "NOTES" column of the data sheet. These notes may indicate alternate location names and/or numbers, elaboration on tape grades, or any other information about instrument or data irregularities.

The location and team-shot data bases are easily accessed and form a convenient information format for data reduction and analysis. By interfacing them with the digitizing program and with each other, they eliminate the multiple entry of data. Consequently, data entry error is significantly reduced and location or unit number errors are discovered and corrected early in the data reduction process. This data format has now become the standard for a series of seismic refraction profiles. The application of these data bases continues to expand as datasets become more complete and new analysis programs are developed.

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
1	24 16 12.2	-45 35 57.5	692	
2	23 17 28.0	-44 40 55.4	887	
3	21 56 44.3	-43 34 15.6	946	
4	20 5 12.7	-42 39 4.3	1144	
5	17 46 36.0	-42 20 47.5	179	
6	16 34 24.0	-42 3 20.6	1	
60	16 36 17.0	-42 3 39.0		
97	25 1 10.5	-45 44 49.0	652	LS
98	25 0 41.9	-45 45 45.2	655	LS
99	25 0 1.2	-45 46 33.7	659	QU
100	24 59 16.3	-45 47 13.1	660	LS
101	24 58 33.3	-45 47 49.6	667	LS
102	24 57 37.1	-45 48 42.9	664	QU
103	24 56 42.9	-45 49 24.8	668	QU
104	24 56 4.3	-45 50 5.2	673	QU
105	24 55 2.0	-45 51 15.9	678	QU
106	24 54 19.3	-45 52 3.1	681	QU
107	24 53 43.4	-45 52 38.1	686	QU
108	24 53 0.5	-45 53 18.5	682	QU
109	24 52 4.8	-45 53 42.1	681	QU
110	24 51 4.7	-45 54 8.4	679	QU
111	24 49 59.9	-45 54 29.2	683	QU
112	24 49 1.6	-45 54 26.9	681	QU
113	24 47 58.1	-45 54 13.3	677	QU
114	24 46 59.9	-45 54 15.9	671	QU
115	24 46 0.5	-45 54 25.2	670	QU
116	24 44 43.0	-45 54 2.9	665	QU
117	24 43 59.5	-45 53 29.1	663	QU
118	24 43 5.6	-45 53 46.0	670	LS
119	24 42 16.2	-45 54 8.0	657	QU
120	24 41 14.3	-45 54 40.8	652	QU
121	24 40 19.8	-45 55 12.6	648	QU
122	24 39 24.4	-45 54 45.9	639	LS
123	24 38 23.4	-45 54 25.5	678	LS
124	24 37 22.4	-45 55 4.4	701	LS
125	24 36 14.0	-45 54 44.0	686	LS
126	24 35 40.8	-45 55 0.0	677	QU
198	24 34 1.6	-45 55 27.5	692	QU
199	24 32 44.0	-45 55 10.2	749	
200	24 30 47.1	-45 56 40.6	732	
201	24 30 24.1	-45 57 22.8	728	QU
202	24 29 13.8	-45 57 54.5	771	
203	24 28 45.3	-45 57 54.0	773	
204	24 27 3.6	-45 57 3.7	732	QES
205	24 25 24.7	-45 56 58.7	757	QES
206	24 25 3.9	-45 56 39.6	741	QES
207	24 23 55.4	-45 55 21.3	706	QES
208	24 23 31.3	-45 55 9.2	689	QES
209	24 22 47.5	-45 54 0.4	684	QES
210	24 22 14.9	-45 52 53.6	682	SS

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
211	24 21 54.2	-45 52 2.3	689	SS
212	24 21 31.9	-45 51 13.0	689	
213	24 21 1.9	-45 50 1.2	687	
214	24 20 38.9	-45 49 7.7	690	
215	24 20 19.1	-45 47 54.2	687	SS
216	24 20 0.1	-45 46 55.9	686	
217	24 19 34.0	-45 45 23.7	695	SS
218	24 19 7.2	-45 43 54.6	706	
219	24 18 55.2	-45 43 9.3	717	SS
220	24 18 36.0	-45 42 30.9	722	SS
221	24 18 1.8	-45 41 13.1	731	SS
222	24 17 28.0	-45 40 6.2	747	SS
223	24 17 9.7	-45 39 29.6	721	SS
224	24 16 39.6	-45 38 33.2	714	SS
225	24 16 5.9	-45 37 33.5	707	SH
226	24 15 43.4	-45 37 2.2	699	SH
227	24 15 4.7	-45 36 11.5	703	QU
228	24 14 27.3	-45 35 26.1	716	
229	24 13 16.8	-45 33 36.2	692	
230	24 12 37.4	-45 32 35.4	695	
231	24 11 54.8	-45 31 33.3	696	
232	24 11 24.2	-45 30 31.4	699	
233	24 10 54.0	-45 29 23.0	703	
234	24 10 25.8	-45 28 18.1	708	
235	24 9 58.6	-45 27 16.4	712	
236	24 9 28.5	-45 26 11.4	717	
237	24 8 56.0	-45 25 8.5	719	
238	24 8 17.1	-45 24 15.4	726	
239	24 7 35.3	-45 23 17.1	734	
240	24 6 53.6	-45 22 17.7	744	
241	24 6 15.5	-45 21 20.7	760	
242	24 5 33.5	-45 20 24.6	771	
243	24 4 54.3	-45 19 26.9	780	
244	24 4 20.9	-45 18 26.3	802	QU
245	24 3 52.3	-45 17 6.8	825	QU
246	24 2 14.4	-45 13 57.0	840	G
247	24 0 54.1	-45 12 45.4	848	G
248	24 0 1.1	-45 11 19.6	869	G
249	23 59 32.9	-45 10 55.8	871	GR
250	23 58 53.3	-45 9 52.3	873	GR
251	23 58 26.5	-45 9 11.6	882	GR
252	23 57 32.0	-45 7 48.8	893	GR
253	23 56 59.4	-45 6 37.9	910	GR
254	23 56 3.7	-45 5 54.5	931	GR
255	23 55 27.1	-45 5 2.0	926	GR
256	23 54 45.9	-45 3 39.0	947	G
257	23 54 5.8	-45 2 57.2	949	GR
258	23 53 59.5	-45 2 10.0	950	VOL
259	23 53 1.7	-45 1 8.2	940	SC
260	23 51 43.6	-45 0 21.0	920	SC

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
261	23 50 43.7	-44 59 36.3	920	SC
262	23 49 46.9	-44 58 46.0	932	SC
263	23 48 55.0	-44 58 19.3	926	SC
264	23 47 57.4	-44 58 0.8	901	SC
265	23 46 54.1	-44 57 32.8	894	SC
266	23 45 47.7	-44 57 10.2	889	SC
267	23 44 46.3	-44 56 46.7	888	SC
268	23 43 52.3	-44 56 35.2	884	SC
269	23 42 55.9	-44 56 10.4	884	SC
270	23 42 8.3	-44 55 51.0	884	SC
271	23 41 4.4	-44 55 13.5	888	SC
272	23 40 15.8	-44 54 17.5	891	SC
273	23 39 15.3	-44 53 49.0	893	SC
274	23 38 4.3	-44 52 22.5	908	SC
275	23 37 47.5	-44 50 47.8	917	SC
276	23 37 13.3	-44 49 21.8	929	SC
277	23 36 24.0	-44 48 18.8	946	SC
278	23 36 14.4	-44 47 52.5	947	SC
279	23 35 19.2	-44 47 31.3	931	SC
280	23 34 20.8	-44 47 46.5	928	SC
281	23 34 20.2	-44 46 40.1	942	SC
282	23 34 5.3	-44 45 50.7	945	SC
283	23 33 48.2	-44 45 21.8	949	SC
284	23 33 22.0	-44 44 53.2	957	SC
285	23 33 12.9	-44 44 29.1	957	SC
286	23 32 6.6	-44 43 45.8	968	SC
287	23 31 14.7	-44 43 19.3	951	SC
288	23 30 32.8	-44 42 49.9	942	SC
289	23 29 34.8	-44 43 4.3	939	GR
290	23 28 29.7	-44 42 52.1	934	GR
291	23 27 25.9	-44 42 48.8	932	GR
292	23 26 21.4	-44 42 32.3	943	GR
293	23 25 28.7	-44 42 11.9	946	GR
294	23 24 16.7	-44 42 0.1	949	GR
295	23 23 26.9	-44 41 47.2	953	GR
296	23 22 30.6	-44 41 18.2	931	GR
297	23 21 9.6	-44 41 3.7	908	GR
298	23 20 18.9	-44 40 56.7	893	GR
299	23 19 15.5	-44 40 36.7	880	VOL
300	23 18 26.9	-44 40 20.7	886	VOL
302	23 17 7.6	-44 39 51.4	889	GR
303	23 16 22.8	-44 40 3.3	879	GR
304	23 15 54.6	-44 39 18.2	878	GR
305	23 14 45.9	-44 38 49.7	878	GR
306	23 14 10.1	-44 38 43.8	866	VOL
307	23 13 56.7	-44 37 33.1	885	GR
308	23 12 29.5	-44 35 57.1	846	VOL
309	23 11 50.8	-44 35 2.0	829	VOL
310	23 11 1.7	-44 34 19.3	810	VOL
311	23 10 11.9	-44 33 30.0	804	VOL

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
312	23 9 21.3	-44 32 41.8	796	VOL
313	23 8 32.5	-44 31 53.9	788	VOL
314	23 7 44.6	-44 31 7.5	782	VOL
315	23 6 55.9	-44 30 18.8	775	VOL
316	23 6 6.2	-44 29 29.1	768	VOL
317	23 5 23.5	-44 28 34.4	764	VOL
318	23 4 49.0	-44 27 57.1	779	VOL
319	23 3 57.6	-44 27 12.2	761	VOL
320	23 3 8.0	-44 26 26.1	765	CGL
321	23 2 18.9	-44 25 41.6	768	CGL
322	23 1 31.0	-44 24 55.4	771	CGL
323	23 0 43.7	-44 24 15.3	784	CGL
324	22 59 35.2	-44 23 40.7	801	CGL
325	22 58 28.5	-44 23 38.0	811	QU
326	22 57 41.4	-44 23 18.7	824	QU
327	22 56 43.5	-44 22 53.0	834	QU
328	22 56 4.8	-44 21 55.5	843	GR
329	22 55 23.5	-44 20 54.3	854	GR
330	22 54 4.5	-44 19 7.5	902	GR
331	22 53 39.8	-44 18 9.5	915	GR
332	22 53 20.1	-44 17 32.0	924	GR
333	22 52 52.7	-44 16 57.2	930	GR
334	22 52 10.8	-44 16 31.1	943	GR
335	22 51 37.3	-44 15 29.3	962	GR
336	22 50 39.7	-44 14 13.7	979	GR
337	22 50 4.9	-44 13 18.3	972	GR
338	22 49 20.4	-44 12 7.3	966	GR
339	22 48 51.1	-44 11 29.4	957	GR
340	22 48 9.6	-44 10 29.4	949	GR
341	22 47 25.0	-44 9 24.9	935	CGL
342	22 46 37.7	-44 8 16.6	941	CGL
343	22 46 5.4	-44 7 35.8	946	CGL
344	22 45 18.7	-44 6 15.4	990	GR
345	22 45 5.7	-44 5 36.6	996	GR
346	22 44 27.1	-44 4 31.1	976	QES
347	22 43 3.6	-44 3 38.2	944	GR
348	22 41 59.7	-44 3 9.8	953	GR
349	22 41 0.2	-44 2 54.1	951	GR
350	22 39 31.2	-44 2 46.8	952	CGL
351	22 39 22.1	-44 2 8.4	958	CGL
352	22 38 43.8	-44 1 50.4	955	VOL
353	22 38 1.0	-44 1 25.3	951	VOL
354	22 36 40.2	-44 0 37.3	967	VOL
355	22 36 15.5	-43 59 17.2	979	CGL
356	22 35 14.0	-43 58 17.1	957	QU
357	22 34 30.1	-43 57 23.9	957	CGL
358	22 33 18.2	-43 56 1.9	962	CGL
359	22 32 40.6	-43 55 23.2	961	VOL
360	22 31 57.4	-43 54 34.0	962	VOL
361	22 31 21.8	-43 53 49.7	972	CGL

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
362	22 30 32.8	-43 52 47.1	974	GR
363	22 29 38.7	-43 52 6.5	982	QU
364	22 28 59.3	-43 51 16.9	993	VOL
365	22 28 25.6	-43 50 43.3	1001	G
374	22 27 45.7	-43 49 41.0	1007	GR
375	22 27 26.5	-43 48 49.9	1020	GR
376	22 26 11.4	-43 48 4.0	1031	GR
377	22 25 7.4	-43 47 23.7	1074	GR
378	22 24 12.5	-43 47 9.3	1069	GR
379	22 23 10.8	-43 46 19.2	1063	GR
380	22 22 19.2	-43 45 49.5	1094	GR
381	22 21 21.6	-43 44 34.2	1053	GR
382	22 20 48.3	-43 43 39.5	1043	GR
383	22 20 26.6	-43 43 22.5	1038	GR
384	22 19 8.9	-43 42 42.3	1028	GR
385	22 18 56.3	-43 42 1.5	1021	GR
386	22 18 23.2	-43 41 32.0	1017	GR
387	22 17 48.6	-43 40 41.8	1008	GR
388	22 17 8.8	-43 39 45.7	998	GR
389	22 16 9.6	-43 39 31.5	995	GR
390	22 15 16.5	-43 39 0.7	993	GR
391	22 14 23.4	-43 38 54.5	999	GR
392	22 14 3.7	-43 38 48.0	996	GR
393	22 13 0.7	-43 38 41.0	983	GR
394	22 11 42.6	-43 38 30.9	979	GR
395	22 10 32.1	-43 38 23.8	983	GR
396	22 9 28.6	-43 38 12.6	980	GR
397	22 8 22.9	-43 37 57.8	974	GR
398	22 7 17.3	-43 37 45.4	974	GR
399	22 6 15.5	-43 37 41.0	973	GR
400	22 4 51.4	-43 37 29.0	970	GR
401	22 3 36.8	-43 37 19.3	967	GR
402	22 2 42.0	-43 37 11.7	962	GR
403	22 1 42.5	-43 36 55.7	957	GR
404	22 0 24.8	-43 36 43.0	956	QU
405	21 59 29.0	-43 36 28.4	957	QU
406	21 58 7.7	-43 35 54.5	964	QU
407	21 57 39.5	-43 35 47.3	967	QU
408	21 56 41.5	-43 35 6.9	956	QU
409	21 55 39.0	-43 34 49.4	955	QU
410	21 55 3.8	-43 34 41.6	957	QU
411	21 54 5.3	-43 34 18.6	948	QU
412	21 53 8.6	-43 33 39.4	950	VOL
413	21 51 56.6	-43 33 17.3	936	VOL
414	21 51 5.5	-43 32 51.7	938	VOL
415	21 50 3.9	-43 32 23.3	928	VOL
416	21 49 0.5	-43 31 56.3	925	VOL
417	21 47 40.5	-43 30 55.1	931	VOL
418	21 46 12.6	-43 30 35.2	922	VOL
419	21 44 58.6	-43 31 38.7	914	VOL

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
420	21 43 45.1	-43 31 41.7	911	VOL
421	21 42 29.5	-43 32 18.7	908	QU
422	21 41 26.9	-43 32 45.0	907	QU
423	21 40 43.1	-43 33 10.4	905	QU
424	21 39 46.8	-43 33 41.2	896	QU
425	21 38 38.4	-43 34 17.1	906	QU
426	21 37 43.4	-43 34 30.6	902	VOL
427	21 36 39.7	-43 34 42.5	904	VOL
428	21 35 52.5	-43 34 49.7	897	VOL
429	21 35 7.5	-43 34 20.9	889	VOL
430	21 34 13.8	-43 33 47.5	882	VOL
431	21 33 24.9	-43 33 23.1	876	VOL
432	21 32 14.4	-43 32 56.5	872	VOL
433	21 30 51.2	-43 32 19.6	866	VOL
434	21 29 52.1	-43 32 9.7	857	VOL
435	21 29 5.0	-43 32 56.4	856	VOL
436	21 27 48.2	-43 31 34.6	849	VOL
437	21 26 55.9	-43 31 22.9	845	VOL
438	21 25 16.5	-43 30 41.2	842	VOL
439	21 24 21.6	-43 30 39.3	836	VOL
440	21 23 11.5	-43 30 4.9	839	QU
441	21 21 42.0	-43 29 38.2	827	QU
442	21 21 20.5	-43 30 1.1	830	QU
443	21 19 59.2	-43 29 34.0	829	QU
444	21 18 58.5	-43 29 16.6	832	QU
445	21 17 41.9	-43 28 58.1	834	QU
446	21 16 39.8	-43 28 20.1	836	QU
447	21 15 22.9	-43 27 43.0	840	QU
448	21 13 52.6	-43 27 2.7	847	QU
449	21 12 40.2	-43 26 33.1	855	QU
450	21 11 50.9	-43 26 16.1	857	QU
451	21 11 1.5	-43 25 48.8	856	QU
452	21 10 2.9	-43 25 15.7	858	QU
453	21 9 6.8	-43 24 44.2	862	QU
454	21 8 17.7	-43 24 18.5	862	QU
455	21 6 48.8	-43 23 25.7	872	QU
456	21 5 38.8	-43 22 49.7	871	QU
457	21 4 30.4	-43 22 17.3	875	QU
458	21 1 59.6	-43 20 27.0	903	
459	21 1 1.4	-43 19 37.6	889	
460	21 0 19.6	-43 18 54.4	891	QU
461	20 59 36.0	-43 18 14.6	894	QU
462	20 58 54.1	-43 17 36.8	896	QU
463	20 57 57.9	-43 16 43.8	918	QU
464	20 57 9.0	-43 16 13.8	905	QU
465	20 56 14.7	-43 15 37.3	908	QU
466	20 55 29.4	-43 15 7.7	911	QU
467	20 54 43.9	-43 14 35.7	914	QU
468	20 53 59.7	-43 14 2.9	917	QU
469	20 52 59.6	-43 13 29.6	921	QU

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
470	20 51 51.5	-43 12 49.8	926	QU
471	20 50 52.9	-43 12 9.8	931	QU
472	20 49 50.2	-43 11 28.2	935	QU
473	20 48 42.3	-43 10 50.9	940	QU
474	20 47 36.8	-43 10 18.3	944	QU
475	20 46 22.6	-43 9 40.7	949	QU
476	20 45 18.7	-43 9 7.8	953	QU
477	20 44 24.2	-43 8 34.7	957	QU
478	20 43 12.5	-43 7 59.6	958	GR
479	20 42 21.2	-43 7 30.4	966	GR
480	20 41 25.8	-43 6 52.2	973	GR
481	20 40 32.6	-43 6 17.6	981	GR
482	20 39 40.9	-43 5 43.9	992	GR
483	20 38 36.7	-43 5 16.7	994	GR
484	20 37 21.2	-43 4 49.5	993	GR
485	20 36 24.3	-43 4 29.1	994	GR
486	20 35 11.3	-43 3 50.0	998	GR
487	20 33 34.0	-43 3 1.1	1015	QU
488	20 32 38.7	-43 2 29.7	1012	QU
489	20 31 19.5	-43 1 44.8	1022	GR
490	20 30 7.3	-43 1 2.5	1010	QU
491	20 29 5.3	-43 0 43.7	1011	GR
492	20 27 59.5	-43 0 24.7	1025	SC
493	20 27 1.5	-42 59 55.8	1035	GR
494	20 25 55.3	-42 59 20.8	1057	GR
495	20 24 47.2	-42 59 1.2	1043	SC
496	20 23 40.3	-42 58 34.4	1047	GR
497	20 22 50.7	-42 58 10.1	1053	SC
498	20 21 38.7	-42 57 25.7	1059	SC
499	20 20 37.8	-42 56 51.5	1069	SC
500	20 19 35.5	-42 56 14.2	1077	SC
501	20 18 26.5	-42 55 42.4	1089	SC
502	20 17 1.8	-42 54 50.9	1097	SC
503	20 15 42.2	-42 54 8.4	1114	SC
504	20 14 18.6	-42 53 24.6	1095	GR
505	20 13 15.4	-42 52 6.5	1096	GR
506	20 12 40.8	-42 50 58.8	1090	GR
507	20 12 5.0	-42 49 50.5	1098	GR
508	20 11 32.2	-42 48 49.1	1096	GR
509	20 10 49.9	-42 47 31.1	1115	GR
510	20 10 11.3	-42 46 19.7	1119	GR
511	20 9 42.7	-42 45 13.0	1113	GR
512	20 9 4.9	-42 44 16.7	1120	GR
513	20 8 20.9	-42 43 21.4	1131	GR
514	20 7 46.9	-42 42 17.5	1134	GR
515	20 7 7.6	-42 41 28.6	1137	GR
516	20 6 25.5	-42 41 4.1	1138	GR
517	20 4 27.5	-42 40 4.5	1150	GR
518	20 2 53.8	-42 39 32.5	1152	GR
519	20 1 3.4	-42 40 1.2	1181	GR

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
520	19 59 56.3	-42 40 3.5	1170	GR
521	19 59 1.4	-42 39 54.7	1170	GR
522	19 57 58.5	-42 39 54.4	1186	GR
523	19 56 38.7	-42 39 59.6	1196	GR
524	19 55 40.9	-42 39 55.4	1216	GR
525	19 54 38.3	-42 39 46.9	1226	GR
526	19 54 0.7	-42 39 47.1	1230	GR
527	19 52 48.7	-42 39 53.9	1238	GR
528	19 51 35.7	-42 39 56.4	1241	GR
529	19 50 11.9	-42 39 54.6	1253	GR
530	19 49 10.0	-42 39 45.2	1252	GR
531	19 48 13.6	-42 39 33.7	1260	GR
532	19 47 3.3	-42 39 21.6	1263	GR
533	19 45 58.3	-42 39 12.1	1249	GR
534	19 44 6.8	-42 38 49.0	1268	SC
535	19 43 5.7	-42 38 37.7	1265	SC
536	19 41 46.7	-42 38 34.8	1287	SC
537	19 40 35.7	-42 38 45.0	1306	SC
538	19 39 38.0	-42 38 27.0	1332	SC
539	19 38 56.2	-42 38 23.2	1331	SC
540	19 38 10.3	-42 38 43.6	1355	SC
541	19 37 9.8	-42 38 54.1	1366	SC
542	19 36 41.5	-42 38 38.5	1365	SC
543	19 36 10.9	-42 38 35.4	1384	SC
544	19 35 16.2	-42 38 27.1	1393	SC
545	19 34 59.0	-42 38 58.9	1411	SC
546	19 33 59.8	-42 39 24.8	1412	SC
547	19 33 30.8	-42 39 32.1	1434	SC
548	19 32 47.1	-42 40 12.5	1423	SC
549	19 32 12.1	-42 40 46.2	1434	GR
550	19 31 8.0	-42 40 50.6	1443	GR
551	19 30 26.8	-42 40 25.1	1470	VOL
552	19 29 46.0	-42 39 40.8	1483	SC
553	19 28 28.3	-42 39 31.5	1514	SC
554	19 27 21.2	-42 39 48.7	1530	GR
555	19 26 38.0	-42 39 56.8	1561	
556	19 25 36.7	-42 40 25.4	1563	
557	19 24 25.2	-42 40 29.8	1587	
558	19 23 44.4	-42 41 6.8	1574	GR
559	19 22 20.4	-42 41 18.3	1583	GR
560	19 21 4.4	-42 41 35.5	1557	SC
561	19 20 1.7	-42 42 47.9	1537	GR
562	19 18 5.7	-42 42 35.5	1568	GR
563	19 16 48.1	-42 42 49.5	1559	GR
564	19 15 36.4	-42 43 4.6	1569	GR
565	19 14 20.8	-42 43 42.9	1546	GR
566	19 13 25.6	-42 44 37.3	1567	VOL
567	19 11 56.7	-42 44 21.4	1594	VOL
568	19 10 41.9	-42 43 43.8	1625	VOL
569	19 9 47.8	-42 43 25.4	1641	VOL

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
570	19 9 1.3	-42 42 46.7	1689	VOL
571	19 8 18.5	-42 43 31.5	1644	GR
572	19 7 29.4	-42 43 18.9	1636	GR
573	19 5 45.5	-42 43 22.9	1665	GR
574	19 4 32.9	-42 43 32.8	1663	GR
575	19 3 3.8	-42 43 57.1	1657	GR
576	19 1 40.1	-42 44 14.4	1703	VOL
577	19 0 51.7	-42 44 31.6	1698	VOL
578	19 0 32.1	-42 43 19.9	1705	VOL
579	18 59 22.8	-42 43 35.1	1720	VOL
580	18 58 45.7	-42 43 17.7	1729	VOL
581	18 57 11.5	-42 43 22.5	1745	GR
582	18 55 9.7	-42 43 5.5	1795	GR
583	18 53 36.4	-42 43 47.0	1837	GR
584	18 52 29.1	-42 45 0.2	1804	GR
585	18 51 10.6	-42 45 20.7	1799	GR
586	18 50 29.1	-42 45 53.6	1814	GR
587	18 49 40.0	-42 46 9.9	1811	GR
588	18 48 30.1	-42 46 52.8	1812	GR
589	18 47 6.9	-42 47 29.3	1811	GR
590	18 45 34.1	-42 47 48.9	1807	GR
591	18 44 14.7	-42 47 58.3	1795	VOL
592	18 43 38.7	-42 47 39.3	1821	GR
593	18 42 18.4	-42 47 13.0	1830	GR
594	18 42 6.2	-42 45 49.8	1862	VOL
595	18 40 46.0	-42 45 52.1	1849	VOL
596	18 39 32.3	-42 45 6.9	1819	VOL
597	18 38 17.4	-42 44 3.5	1835	G
598	18 37 24.4	-42 42 55.6	1856	GR
599	18 37 22.2	-42 41 34.0	1831	GR
600	18 36 25.1	-42 40 41.8	1853	GR
601	18 35 28.7	-42 40 6.1	1855	GR
602	18 34 28.5	-42 39 43.2	1886	GR
603	18 33 33.0	-42 39 20.8	1903	G
604	18 33 34.5	-42 38 6.4	1910	G
605	18 33 33.1	-42 36 43.4	1945	G
606	18 33 10.1	-42 35 59.8	1951	G
607	18 32 26.0	-42 35 8.3	1983	G
608	18 31 24.1	-42 35 14.7	2039	VOL
609	18 29 54.8	-42 35 37.2	2000	VOL
610	18 28 56.6	-42 35 49.5	1997	VOL
611	18 28 24.7	-42 35 46.9	2000	VOL
612	18 27 54.9	-42 35 26.1	2026	VOL
613	18 27 10.4	-42 35 14.8	2029	VOL
614	18 25 59.0	-42 34 58.6	2003	VOL
615	18 24 50.1	-42 35 23.4	1985	VOL
616	18 24 0.6	-42 34 6.4	2050	VOL
617	18 22 53.0	-42 33 57.3	2063	VOL
618	18 21 20.4	-42 33 38.0	2087	VOL
619	18 20 24.5	-42 33 27.9	2076	VOL

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
620	18 19 19.0	-42 33 15.9	2122	VOL
621	18 18 12.6	-42 33 9.0	2109	VOL
622	18 16 50.3	-42 33 9.1	2135	GR
623	18 14 56.7	-42 32 31.9	2067	VOL
624	18 12 30.3	-42 32 2.0	2280	VOL
626	17 49 8.9	-42 21 56.4	229	SC
627	17 47 56.0	-42 20 52.0	207	SC
697	17 45 39.2	-42 20 29.4	152	SC
698	17 44 28.8	-42 19 54.0	131	SC
699	17 43 59.4	-42 18 39.9	116	VOL
700	17 43 27.0	-42 17 42.1	93	VOL
701	17 42 50.3	-42 16 32.5	72	SH
800	17 41 33.8	-42 17 37.9	136	VOL
801	17 40 21.1	-42 17 41.7	68	SH
802	17 39 4.4	-42 17 46.7	59	SH
803	17 37 32.3	-42 17 53.3	45	QU
804	17 35 52.1	-42 17 55.8	32	QU
805	17 33 49.7	-42 18 1.6	22	QU
806	17 33 33.4	-42 24 5.4	61	SH
807	17 32 2.6	-42 24 9.9	52	SH
808	17 30 32.1	-42 24 12.1	43	QU
809	17 28 6.3	-42 24 19.2	40	QU
810	17 26 40.3	-42 24 21.1	36	QU
811	17 24 16.5	-42 24 32.2	34	QU
812	17 22 21.6	-42 24 26.7	31	QU
813	17 20 5.2	-42 24 29.4	31	QU
888	17 18 2.1	-42 23 13.3	4	QU
889	17 15 54.3	-42 22 25.8	3	QU
890	17 14 1.1	-42 22 2.1	2	QU
891	17 12 14.2	-42 20 18.7	3	QU
892	17 10 25.4	-42 21 8.7	2	QU
893	17 9 11.1	-42 21 36.6	2	QU
894	17 8 22.2	-42 21 53.6	2	QU
895	17 6 37.3	-42 21 41.7	2	QU
896	17 5 55.1	-42 21 42.6	1	QU
897	17 4 9.2	-42 21 54.4	1	QU
898	17 2 49.1	-42 22 24.2	1	QU
899	17 1 54.0	-42 22 22.0	1	QU
900	17 1 4.0	-42 21 52.0	1	QU
905	16 53 45.0	-42 17 29.0	1	QU
906	16 52 43.0	-42 17 45.0	1	QU
907	16 51 29.0	-42 17 32.0	1	QU
908	16 44 38.0	-42 13 14.0	1	QU
909	16 44 14.0	-42 12 19.0	1	QU
910	16 43 25.0	-42 11 50.0	1	QU
911	16 43 1.0	-42 10 50.0	5	QU
912	16 42 5.0	-42 10 29.0	10	QU
913	16 41 18.0	-42 10 19.0	10	QU
914	16 39 23.0	-42 10 8.0	14	QU
915	16 38 6.0	-42 9 42.0	15	QU

U.S. GEOLOGICAL SURVEY SEISMIC REFRACTION PROFILE

SAUDI ARABIA - 1978

SEISMIC RECORDER LOCATIONS

LOCATION NUMBER	LATITUDE (DEG,MIN,SEC)	LONGITUDE (DEG,MIN,SEC)	ELEV	GEOLOGY
916	16 37 1.0	-42 9 36.0	17	QU
917	16 36 1.0	-42 9 18.0	5	QU
925	16 34 24.0	-42 3 30.0	1	QU
926	16 33 0.0	-42 2 47.0	1	QU
927	16 32 19.0	-42 1 59.0	1	QU
928	16 28 43.0	-41 57 4.0	1	QU
929	16 25 41.0	-41 53 30.0	1	QU
930	16 25 24.0	-41 52 34.0	1	QU
950	24 13 49.5	-45 34 29.6	690	QU
953	22 54 31.3	-44 19 50.7	888	GR
954	21 3 33.7	-43 21 31.7	877	GR
955	18 11 15.3	-42 31 46.3	2276	GR
956	18 9 19.6	-42 29 54.0	2013	GR
957	18 8 1.9	-42 29 47.0	1968	GR
958	18 5 37.1	-42 28 45.7	1621	GR
959	18 5 20.9	-42 28 1.5	1567	GR
960	18 4 6.5	-42 26 55.8	1740	GR
961	18 2 18.6	-42 24 6.2	1109	GR
962	18 0 28.1	-42 22 33.4	659	GR
963	17 58 22.5	-42 22 8.1	658	GR
964	17 56 5.7	-42 21 26.6	536	GR
965	17 55 19.9	-42 23 1.2	622	GR
966	17 53 54.5	-42 23 7.5	441	GR
967	17 52 5.4	-42 23 13.1	412	GR
968	17 50 28.5	-42 21 40.5	480	GR
970	21 15 19.3	-43 27 59.2	840	QU
971	21 8 52.5	-43 24 52.6	863	QU
972	21 6 35.2	-43 23 31.6	872	QU
1401	17 49 32.0	-42 17 26.0		
1402	17 50 38.0	-42 22 34.0		
1403	17 45 8.0	-42 21 8.0		
1404	17 43 29.0	-42 20 52.0		
1405	17 42 7.0	-42 18 0.0		
1406	17 43 13.0	-42 9 43.0		
1407	17 42 7.0	-42 5 26.0		
1408	17 34 57.0	-42 18 0.0		
1409	17 37 43.0	-42 28 17.0		
1410	17 29 27.0	-42 42 0.0		
1411	17 25 52.0	-42 44 0.0		
1412	17 24 46.0	-42 37 26.0		
1413	17 20 38.0	-42 37 26.0		
1414	17 3 35.0	-43 1 25.0		
1415	17 2 45.0	-42 57 10.0		
1416	16 58 54.0	-42 56 2.0		
1417	16 56 42.0	-42 52 5.0		

MASTER SHOT LIST

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)

SHOT	DATE	SHOT POINT	LATITUDE	LONGITUDE	ELEV	SHOT TIME	DEPTH TOP	DEPTH BOT	SIZE (LBS)	WATER	
1	FEB 3	1	24 16 12.2	-45 35 57.5	692	34 1 0 0.012			1799		2 60-M HOLES
2	FEB 3	2	23 17 28.0	-44 40 55.4	887	34 1 45 0.650			2910		4 60-M HOLES
3	FEB 6	1	24 16 12.2	-45 35 57.5	692	37 1 0 0.012			7518		6 60-M HOLES
4	FEB 6	2	23 17 28.0	-44 40 55.4	887	37 1 15 2.456			3007		3 60-M HOLES
5	FEB 9	1	24 16 12.2	-45 35 57.5	692	40 1 0 0.012			9722		7 60-M HOLES
6	FEB 9	2	23 17 28.0	-44 40 55.4	887	40 1 45 0.876			4508		5 REDRILL HOLES
7	FEB 9	6	16 34 24.0	-42 3 20.6	1	40 4 0 0.042			5009		SEA SHOT; 200 FT
8	FEB 13	2	23 17 28.0	-44 40 55.4	887	44 1 0 0.011			10523		5 REDRILL HOLES
9	FEB 13	3	21 56 44.3	-43 34 15.6	946	44 1 15 0.015			2205		3 60-M HOLES
10	FEB 13	4	20 5 12.7	-42 39 4.3	1144	44 1 30 0.015			5811		7 60-M HOLES
11	FEB 16	1	24 16 12.2	-45 35 57.5	692	47 1 0 0.012			11023		6 REDRILL HOLES
12	FEB 16	3	21 56 44.3	-43 34 15.6	946	47 1 15 0.010			18838		6 60-M HOLES & REDRILLS
13	FEB 16	4	20 5 12.7	-42 39 4.3	1144	47 1 30 0.015			3007		3 60-M HOLES
14	FEB 16	6	16 34 24.0	-42 3 20.6	1	47 4 0 0.057			5009		SEA SHOT; 200 FT
15	FEB 20	5	17 46 36.0	-42 20 47.5	179	51 1 0 0.013			8818		2 60-M HOLES
16	FEB 20	6	16 34 24.0	-42 3 20.6	1	51 4 0 0.037			5009		SEA SHOT; 200 FT
17	FEB 22	5	17 46 36.0	-42 20 47.5	179	53 1 15 0.014			3208		5 60-M HOLES
18	FEB 22	4	20 5 12.7	-42 39 4.3	1144	53 4 30 0.013			12225		11 SHALLOW-PATTERN HOLES
19	FEB 22	6	16 34 24.0	-42 3 20.6	1	53 5 0 0.030			5009		SEA SHOT; 200 FT

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 1   TEAM 1
SHOT POINT 1
SHOT TIME: 34: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	97	84.664	10.2	87		5	47	0	0		3	36	18	0
2	98	84.090	11.4	53		61	-12	23	9			36	18	0
3	99	83.141	12.5	26		112	-5	0	0		3	36	18	0
4	100	82.034	13.4	108		157	-18	0	0		3	36	18	0
5	101	80.991	14.4	125		--	-23	1	6			36	18	0
6	102	79.426	15.7	128		199	11	6/17	9			36	18	0
7	103	78.157	16.9	65		240	-393	0	0		2	36	18	0
8	104	77.364	18.0	115		276	10	0	0		3	36	18	0
9	105	76.196	19.8	28		310	7	0	0		3	36	18	0
10	106	75.428	21.1	143		343	24	0	0		3	36	18	0
11	107	74.766	22.1	33		377	-15	0	0		2	36	18	0
12	108	73.987	23.3	79		407	8	0	0		3	36	18	0
13	109	72.688	24.3	24		435	4	0	0		2	36	18	0
14	110	71.323	25.5	10		5	56	0	0		3	36	18	0
15	111	69.792	26.6	90		61	-11	0	0		3	36	18	0
16	112	68.165	27.3	34		110	-14	0	0		3	36	18	0
17	113	66.254	27.7	98		156	81	7	9			36	18	0
18	114	64.712	28.5	66		199	-3	0/15	0		2	36	18	0
19	115	63.242	29.5			--	--	20	6			36	18	0
20	116	60.862	30.1	3		239	-18	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 1   TEAM 2
SHOT POINT 1
SHOT TIME: 34: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	117	59.227	30.0	105		5	--	0	0		3	36	18	0
2	118	58.043	31.2	132		61	--	0	1		2	36	18	0
3	119	57.081	32.5	92		109	--	21	9			36	18	0
4	120	56.002	34.4	74		149	--	0	0		2	36	18	0
5	121	55.151	36.1	64		189	37	0	1		2	36	18	0
6	122	53.336	36.6	101		226	--	0	0		2	36	18	0
7	123	51.489	37.3	52		260	16	0	0		2	36	18	0
8	124	50.702	39.6	32		--	--	1	6			36	18	0
9	125	48.725	40.6	137		295	18	0	0		2	36	18	0
10	126	48.254	41.8	45		--	--	1	6			36	18	0
11	198	46.573	45.1	55		--	--	1	6			36	18	0
12	199	44.564	46.8	38		326	--	0	0		2	36	18	0
13	200	44.177	52.5	44		355	--	0	5		2	36	18	0
14	201	44.708	54.1	82		--	--	20	6			36	18	0
15	202	44.225	57.1	62		--	--	1	6			36	18	0
16	203	43.742	58.0	23		384	--	0	1		2	36	18	0
17	204	40.930	60.7	120		--	--	1	6			36	18	0
18	205	39.407	64.5	25		413	21	0	1		2	36	18	0
19	206	38.646	65.0	142		--	--	1	6			36	18	0
20	207	35.770	66.5	78		440	--	10	9			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 1 TEAM 3
SHOT POINT 1
SHOT TIME: 34: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	208	35.169	67.4	49		5	-4	0	0		2	36	18	0
2	209	32.863	68.3	58		78	-7	0	0		2	36	18	0
3	210	30.747	68.7	122		144	8	0	0		2	36	18	0
4	211	29.167	68.9	68		198	24	15	9			36	18	0
5	212	27.624	69.1	83		250	-5	15	9			36	18	0
6	213	25.405	69.5	77		296	22	0	0		2	36	18	0
7	214	23.745	69.8	89		339	15	0	0		2	36	18	0
8	215	21.590	69.4	96		379	2	0	0		2	36	18	0
9	216	19.847	69.3	133		406	-10	0	0		2	36	18	0
10	217	17.132	68.8	107		443	-7	0	0		1	36	18	0
11	218	14.493	68.2	110		5	3	0	0		1	36	18	0
12	219	13.169	67.6	112		--	3	1	6			42	18	0
13	220	11.945	68.3	119		77	-3	0	0		1	42	18	0
14	221	9.519	69.3	121		139	15	0	0		1	48	18	0
15	222	7.394	71.6	103		194	-9	0	0		1	48	18	0
16	223	6.239	73.5	19		244	49	0	0		1	56	18	0
17	224	4.474	79.1	30		290	-9	0	0		1	62	18	0
18	225	2.716	94.1	31		333	2	0	0		1	68	18	0
19	226	2.031	115.9	39		373	-8	0	0		1	76	18	0
20	227	2.114	169.2	75		412	-7	0	0		1	56	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 1   TEAM 4
SHOT POINT 1
SHOT TIME: 34: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	228	3.348	195.3	60		5	-12	0	0		1	68	18	0
2	229	6.709	216.4	35		61	-19	0	0		1	56	18	0
3	230	8.728	220.8	106		110	-11	0	0		1	48	18	0
4	231	10.875	223.3	48		--	10	1	6			42	18	0
5	232	12.774	226.1	139		154	-12	0	0		1	42	18	0
6	233	14.823	228.7	100		195	-10	21	9			36	18	0
7	234	16.781	230.6	138	UNIT 130	233	-22	0/22	0		1	36	18	0
8	235	18.663	232.0	85		270	30	0	0		1	36	18	0
9	236	20.683	233.1	113		304	-1001	13	9			36	18	0
10	237	22.704	233.8	18		337	-16	0	0		2	36	18	0
11	238	24.621	233.6	70		368	-13	0/18	0		1	36	18	0
12	239	26.709	233.5	129		397	8	0	0		2	36	18	0
13	240	28.821	233.4	136		426	50	0	0		2	36	18	0
14	241	30.812	233.4	51		454	7	0	0		1	36	18	0
15	242	32.855	233.3	93		5	-17	7	9			36	18	0
16	243	34.882	233.3	22		--	-19	3/24	6			36	18	0
17	244	36.869	233.6	124		61	8	0	0		2	36	18	0
18	245	39.204	234.5	40		111	5	0	0		2	36	18	0
19	246	45.321	235.3	17		156	19	0	0		2	36	18	0
20	247	48.400	234.3	131		197	-28	0/18	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 1 TEAM 5
SHOT POINT 1
SHOT TIME: 34: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	248	51.320	234.4	145		--	-11	0	0		2	36	18	0
2	249	52.374	234.1	99		--	1	7	9			36	18	0
3	250	54.542	234.1	94		--	28	3/24	6			36	18	0
4	251	55.959	234.1	88		--	-22	0	0		2	36	18	0
5	252	58.839	234.1	97		--	-32	0/15	0		2	36	12	0
6	253	61.051	234.5	146		--	28	0	0		2	36	18	0
7	254	63.050	233.9	104		--	-27	7	9			36	18	0
8	255	64.914	233.8	118		--	34	0	0		3	36	18	6
9	256	67.555	234.1	69		--	5	8/26	6			36	18	0
10	257	69.239	233.9	76		--	77	0	0		2	36	18	0
11	258	70.432	234.4	56		--	7	0	0		2	36	18	0
12	259	72.892	234.1	73		--	-23	2	6			36	18	0
13	260	75.393	233.2	72		--	4	0	0		2	36	18	0
14	261	77.518	232.7	71		--	-87	0/17	9			36	18	0
15	262	79.709	232.3	63		--	-33	0	0		3	36	18	0
16	263	81.329	231.7	12		--	-16	0	0		3	36	18	0
17	264	82.853	231.0	14		--	-28	0	0		2	36	18	0
18	265	84.710	230.3	15		--	-17	2	6			36	18	0
19	266	86.525	229.5	36		--	-25	0	0		2	36	18	0
20	267	88.271	228.9	43		--	0	3/24	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 2   TEAM 1
SHOT POINT 2
SHOT TIME: 34: 1:45: 0.650

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	97	220.469	29.5	87		5	47	0	2		3	36	18	0
2	98	220.485	30.0	53		105	-12	0	5		3	36	18	0
3	99	220.084	30.4	26		163	-5	0	1		3	36	18	0
4	100	219.454	30.9	108		214	-18	0	2		3	36	18	0
5	101	218.848	31.3	125		--	-23	1	6			36	18	0
6	102	218.152	31.9	128		265	11	25	9			36	18	0
7	103	217.361	32.4	65		309	-393	0	1		3	36	18	0
8	104	216.968	32.8	115		350	10	0	1		3	36	18	0
9	105	216.444	33.5	28		389	7	0	1		3	36	18	0
10	106	216.083	34.0	143		425	24	0/21	9			36	18	0
11	107	215.720	34.4	33		5	-15	0	1		2	36	18	0
12	108	215.275	34.8	79		75	8	0	1		3	36	18	0
13	109	214.248	35.2	24		136	4	0	2		3	36	18	0
14	110	213.165	35.7	10		--	56	3/16	6			36	18	0
15	111	211.891	36.1	90		189	-11	0	1		3	36	18	0
16	112	210.403	36.4	34		239	-14	0	1		3	36	18	0
17	113	208.599	36.6	98		284	81	0	2		3	36	18	0
18	114	207.207	37.0	66		326	-3	0	2		3	36	18	0
19	115	205.904	37.3			--	--	20	6			36	18	0
20	116	203.625	37.6	3		367	-18	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 2   TEAM 2
SHOT POINT 2
SHOT TIME: 34: 1:45: 0.650

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	117	201.982	37.6	105		5	--	15	9			36	18	0
2	118	200.959	38.0	132		77	--	0	1		3	36	18	0
3	119	200.145	38.4	92		140	--	0/21	9			36	18	0
4	120	199.230	39.0	74		194	--	0	2		3	36	18	0
5	121	198.494	39.5	64		244	37	0/17	2		3	36	18	0
6	122	196.700	39.6	101		290	--	0/17	2		3	36	18	0
7	123	194.884	39.9	52		334	16	0	2		3	36	18	0
8	124	194.152	40.5	32		--	--	1	6			36	18	0
9	125	192.178	40.7	137		374	18	0	2		3	36	18	0
10	126	191.698	41.0	45		--	--	1	6			36	18	0
11	198	189.917	41.8	55		--	--	1	6			36	18	0
12	199	187.812	42.2	38		413	--	0	2		3	36	18	0
13	200	186.901	43.5	44		450	--	0	2		3	36	18	0
14	201	187.210	43.9	82		--	--	20	6			36	18	0
15	202	186.281	44.6	62		--	--	1	6			36	18	0
16	203	185.645	44.8	23		5	--	0	2		3	36	18	0
17	204	182.427	45.2	120		--	--	1	6			36	18	0
18	205	180.190	45.8	25		77	21	0	2		2	36	18	0
19	206	179.356	45.9	142		--	--	1	6			36	18	0
20	207	176.301	45.9	78		140	--	8	9			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 2   TEAM 3
SHOT POINT 2
SHOT TIME: 34: 1:45: 0.650

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	208	175.542	46.0	49		5	-4	0	1		2	36	18	0
2	209	173.208	45.8	58		78	-7	0	1		3	36	18	0
3	210	171.162	45.6	122		144	8	0	2		3	36	18	0
4	211	169.681	45.4	68		198	24	7	8			36	18	0
5	212	168.210	45.3	83		250	-5	0/21	9			36	18	0
6	213	166.123	45.0	77		296	22	0	1		2	36	18	0
7	214	164.557	44.8	89		339	15	0	2		3	36	18	0
8	215	162.667	44.4	96		379	2	0	2		2	36	18	0
9	216	161.101	44.2	133		406	-10	0	2		3	36	18	0
10	217	158.719	43.7	107		443	-7	0	1		3	36	18	0
11	218	156.392	43.2	110		5	3	0	1		2	36	18	0
12	219	155.248	43.0	112		--	3	1	6			42	18	0
13	220	154.079	42.8	119		77	-3	0	0		3	42	18	0
14	221	151.818	42.5	121		139	15	0	1		2	48	18	0
15	222	149.778	42.2	103		194	-9	0	0		2	48	18	0
16	223	148.666	42.1	19		244	49	0	0		2	56	18	0
17	224	146.914	41.9	30		290	-9	0	0		2	62	18	0
18	225	145.017	41.6	31		333	2	0	2		2	68	18	0
19	226	143.912	41.6	39		373	-8	0	5		2	76	18	0
20	227	142.071	41.4	75		412	-7	0	1		2	76	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 2 TEAM 4
SHOT POINT 2
SHOT TIME: 34: 1:45: 0.650

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	228	140.358	41.4	60		5	-12	13	9			62	18	0
2	229	136.681	41.0	35		77	-19	0	3		2	56	18	0
3	230	134.640	40.8	106		139	-11	0	1		2	48	18	0
4	231	132.501	40.6	48		--	10	1	6			42	18	0
5	232	130.651	40.3	139		194	-12	0	1		2	42	18	0
6	233	128.697	39.9	100		244	-10	15	9			36	18	0
7	234	126.859	39.5	138	UNIT 130	290	-22	0/22	0		2	36	18	0
8	235	125.108	39.1	85		334	30	0	0		2	36	18	0
9	236	123.234	38.7	113		--	-1001	0	1		2	36	18	0
10	237	121.345	38.3	18		--	-16	0	0		2	36	18	0
11	238	119.475	38.1	70		--	-13	0	1		2	36	18	0
12	239	117.446	37.9	129		--	8	0	1		2	36	18	0
13	240	115.402	37.6	136		--	50	0	2		2	36	18	0
14	241	113.491	37.3	51		--	7	0	1		1	36	18	0
15	242	111.501	37.1	93		--	-17	0/ 7	9			36	18	0
16	243	109.556	36.8	22		--	-19	3	6			36	18	0
17	244	107.709	36.4	124		--	8	0	2		2	36	18	0
18	245	105.676	35.7	40		--	5	0	1		2	36	18	0
19	246	100.134	34.2	17		--	19	0	2		3	36	18	0
20	247	96.948	34.0	131		--	-28	0	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 2 TEAM 5
SHOT POINT 2
SHOT TIME: 34: 1:45: 0.650

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	248	94.244	33.4	145		--	-11	0	2		2	36	18	0
2	249	93.147	33.3	99		--	1	0/ 7	9			36	18	0
3	250	91.146	32.8	94		--	28	3/ 4	6			36	18	0
4	251	89.829	32.4	88		--	-22	0	1		2	36	18	0
5	252	87.161	31.7	97		--	-32	0	1		2	36	18	0
6	253	85.263	30.9	146		--	28	0	1		2	36	18	0
7	254	83.158	30.8	104		--	-27	0/ 7	9			36	18	0
8	255	81.430	30.3	118		--	34	0	2		2	36	18	0
9	256	78.957	29.3	69		--	5	17	8			36	18	0
10	257	77.302	29.0	76		--	77	0	2		2	36	18	0
11	258	76.492	28.2	56		--	7	0	2		2	36	18	0
12	259	74.101	27.7	73		--	-23	17/21	9			36	18	0
13	260	71.354	27.6	72		--	4	0	1		2	36	18	0
14	261	69.132	27.4	71		--	-87	0	0		2	36	18	0
15	262	66.930	27.0	63		--	-33	0	1		2	36	18	0
16	263	65.161	27.0	12		--	-16	0	0		2	36	18	0
17	264	63.347	27.3	14		--	-28	0	0		2	36	18	0
18	265	61.253	27.5	15		--	-17	17/21	9			36	18	0
19	266	59.147	27.9	36		--	-25	0	0		2	36	18	0
20	267	57.170	28.2	43		--	0	3/24	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 3 TEAM 1
SHOT POINT 1
SHOT TIME: 37: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	268	89.624	228.2	115		--	13	0	0		2	36	18	0
2	269	91.316	227.7	28		--	-15	2	6			36	18	0
3	270	92.718	227.3	3		--	-18	0	0		2	36	18	0
4	271	94.843	226.8	143		--	34	0	0		2	36	18	0
5	272	97.027	226.8	34		--	-13	0	0		2	36	18	0
6	273	98.900	226.3	66		--	-14	3	6			36	18	0
7	274	102.184	226.4	108		--	7	0	0		2	36	18	0
8	275	104.485	227.2	53		--	-12	0	0		2	36	18	0
9	276	106.987	227.7	98		--	18	0	0		2	36	18	0
10	277	109.331	227.7	90		--	-12	1	6			36	18	0
11	278	110.079	227.9			--	--	21	9			36	18	0
12	279	111.677	227.4	65		--	-223	0/ 6	0		3	36	18	0
13	280	112.600	226.6	87		--	72	0	0		2	36	18	0
14	281	113.979	227.3	10		--	67	0	0		2	36	18	0
15	282	115.317	227.6	33		--	-18	0	0		2	36	18	0
16	283	116.275	227.6	79		--	9	0	0		2	36	18	0
17	284	117.420	227.6	26		--	-2	0	0		2	36	18	0
18	285	118.110	227.7	125		--	-27	2	6			36	18	0
19	286	120.403	227.4	128		--	47	7	9			36	18	0
20	287	122.045	227.1	24		--	9	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 3   TEAM 2
SHOT POINT 1
SHOT TIME: 37: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	288	123.539	226.9	132		--	-14	6/24	8			36	18	0
2	289	124.484	226.2	105		--	--	28	6			36	18	0
3	290	126.138	225.7	78		--	8	0	0		2	36	18	0
4	291	127.595	225.1	92		--	-22	0	0		2	36	18	0
5	292	129.346	224.6	62		--	-13	0	1		2	36	18	0
6	293	130.918	224.3	52		--	-28	0	0		2	36	-18	0
7	294	132.755	223.7	64		--	55	0	0		2	36	18	0
8	295	134.128	223.4	44		--	2	0	0		2	36	18	0
9	296	135.960	223.1	55		--	10	0	0		2	36	18	0
10	297	138.084	222.5	38		--	-5	0/17	0		2	36	18	0
11	298	139.380	222.2	101		--	-15	28	6			36	18	0
12	299	141.221	221.8	82		--	-21	0	1		2	36	18	0
13	300	142.648	221.5	142		--	19	0	1		2	36	18	0
14	302	145.041	221.2	25		--	40	0	1		2	36	18	0
15	303	145.872	220.7			--	--	0/17	6			36	18	0
16	304	147.366	220.9	74		--	-18	0	2		2	36	18	0
17	305	149.506	220.6	137		--	30	0	1		2	36	18	0
18	307	152.073	220.8	45		--	2	0	1		2	36	18	0
19	308	155.888	220.9	23		--	84	0/ 9	1		2	36	12	0
20	309	157.814	221.1	120		--	-18	25	9			36	18	0

DATA FOR ONE TEAM-SHOT
EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 3   TEAM 3
SHOT POINT 1
SHOT TIME: 37: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	310	159.756	221.0	49		--	--	0	0		2	36	18	0
2	311	161.834	221.1	68		--	--	0	1		2	36	18	0
3	312	163.910	221.1	75		--	--	0	1		2	36	18	0
4	313	165.943	221.1	112		--	--	0	1		2	36	18	0
5	314	167.923	221.1	39		--	--	0	1		2	36	18	0
6	315	169.964	221.1	119		--	--	0	0		2	36	18	0
7	316	172.049	221.1	30		--	--	0	0		3	36	18	0
8	317	174.064	221.2	96		--	--	0	0		3	36	18	0
9	318	175.563	221.3	89		--	--	0/ 7	5		3	36	18	0
10	319	177.596	221.2	77		--	--	0	1		2	36	18	0
11	320	179.615	221.2	58		--	--	0/ 7	9			36	18	0
12	321	181.588	221.2	103		--	--	0/ 8	1		2	36	18	0
13	322	183.566	221.2	122		--	--	0	0		2	36	18	0
14	323	185.415	221.2	31		--	--	0/ 9	1		3	36	18	0
15	324	187.663	221.0	19		--	--	3/24	6			36	18	0
16	325	189.281	220.6	83		--	--	0	0		2	36	18	0
17	326	190.747	220.5	110		--	--	0	0		2	36	18	0
18	327	192.586	220.3	107		--	--	0/15	0		2	36	18	0
19	328	194.552	220.4	121		--	--	0/ 9	0		2	36	18	0
20	329	196.650	220.6	133		--	--	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 3   TEAM 4
SHOT POINT 1
SHOT TIME: 37: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	330	200.477	220.8	17		--	45	0	1		3	36	18	0
2	331	202.128	221.0	22		--	-45	3	6			36	18	0
3	332	203.284	221.1	48		--	26	0	1		3	36	18	0
4	333	204.572	221.2	60		--	-32	0/ 7	1		3	36	18	0
5	334	206.036	221.1	131		--	-66	0	1		3	36	18	0
6	335	207.969	221.3	70		--	-32	0	1		3	36	18	0
7	336	210.720	221.4	100		--	-28	0	4		3	36	18	0
8	337	212.567	221.5	136		--	159	0	0		3	36	18	0
9	338	214.930	221.7	18		--	-4	0	0		3	36	18	0
10	339	216.324	221.7	106		--	-26	0	0		3	36	18	0
11	340	218.415	221.8	124		--	-2	0	0		3	36	18	0
12	341	220.663	221.9	138	UNIT 130	--	-57	0/22	0		3	36	18	0
13	342	223.047	222.1	40		--	11	0	0		2	36	12	0
14	343	224.562	222.1	129		--	33	0	1		3	36	18	0
15	344	227.165	222.3	113		--	16	0	1		3	36	18	0
16	345	228.202	222.4	35		--	-45	7/15	9			36	18	0
17	346	230.336	222.6	85		--	61	0	0		3	36	18	0
18	347	233.262	222.4	139		--	-28	0	0		3	36	18	0
19	348	235.271	222.3	51		--	5	0	1		3	36	18	0
20	349	236.942	222.0	93		--	-38	0/15	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 3 TEAM 5
SHOT POINT 1
SHOT TIME: 37: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	350	239.139	221.6	94		--	--	0/ 9	0		3	36	18	0
2	351	240.075	221.8	97		--	--	0/15	1		3	36	18	0
3	352	241.301	221.7	88		--	--	0	0		3	36	18	0
4	353	242.768	221.6	14		--	--	0	1		3	36	18	0
5	354	245.549	221.5	76		--	--	0	1		3	36	18	0
6	355	247.624	221.7	104		--	--	0	4		3	36	18	0
7	356	250.182	221.8	99		--	--	7/15	9			36	18	0
8	357	252.203	221.8	63		--	--	0	0		3	36	18	0
9	358	255.415	221.9	71		--	--	0	1		3	36	18	0
10	359	257.016	221.9	56		--	--	0	2		3	36	18	0
11	360	258.946	221.9	72		--	--	0	3		3	36	18	0
12	361	260.606	222.0	118		--	--	7	9			36	18	0
13	362	262.923	222.0	73		--	--	0	0		3	36	18	0
14	363	264.944	222.0	12		--	--	0	0		3	36	18	0
15	364	266.793	222.0	43		--	--	0	0		3	36	18	0
16	365	268.206	222.0	15		--	--	20	6			36	18	0
17	374	270.310	222.1	145		--	--	0	0		3	36	18	0
18	375	271.721	222.3	69		--	--	20	6			36	18	0
19	376	274.325	222.2	36		--	--	0	0		3	36	18	0
20	377	276.566	222.1	146		--	--	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 4 TEAM 1
SHOT POINT 2
SHOT TIME: 37: 1:15: 2.456

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	268	55.553	28.7	115		--	13	0	0		2	36	18	0
2	269	53.696	28.9	28		--	-15	2	6			36	18	0
3	270	52.148	29.2	3		--	-18	0	0		2	36	18	0
4	271	49.914	29.2	143		--	34	0	0		2	36	18	0
5	272	47.836	28.4	34		--	-13	0	2		2	36	18	0
6	273	45.817	28.6	66		--	-14	6/15	9			36	18	0
7	274	42.739	27.1	108		--	7	0	0		2	36	18	0
8	275	41.110	24.1	53		--	-12	0	0		2	36	18	0
9	276	39.171	21.5	98		--	18	0	1		2	36	18	0
10	277	37.142	19.8	90		--	-12	1	6			36	18	0
11	278	36.617	18.9			--	--	20	6			36	18	0
12	279	34.814	18.8	65		--	-223	0/ 6	0		1	36	18	0
13	280	33.270	20.5	87		--	72	0	0		1	36	18	0
14	281	32.637	17.4	10		--	67	0	0		2	36	18	0
15	282	31.803	15.3	33		--	-18	0	0		1	36	18	0
16	283	31.086	14.1	79		--	9	0	0		2	36	18	0
17	284	30.112	13.0	26		--	-2	0	0		2	36	18	0
18	285	29.694	11.8	125		--	-27	2	6			36	18	0
19	286	27.455	10.2	128		--	47	0	2			36	18	0
20	287	25.757	9.1	24		--	9	0	1			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 4   TEAM 2
SHOT POINT 2
SHOT TIME: 37: 1:15: 2.456

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	288	24.359	7.7	132		--	-14	0	0		2	36	18	0
2	289	22.655	9.3	105		--	--	28	6			36	18	0
3	290	20.622	9.2	78		--	8	0	0		2	36	18	0
4	291	18.673	9.9	92		--	-22	0	0		1	36	18	0
5	292	16.635	9.5	62		--	-13	0	0		1	36	18	0
6	293	14.944	8.4	52		--	-28	0	0		1	36	18	0
7	294	12.706	8.3	64		--	55	0	0		1	42	18	0
8	295	11.137	7.6	44		--	2	0	0		1	42	18	0
9	296	9.331	4.0	55		--	10	0	0		1	48	18	0
10	297	6.819	2.0	38		--	-5	0/17	0		1	56	18	0
11	298	5.255	0.4	101		--	-15	28	6			56	18	0
12	299	3.348	350.9	82		--	-21	0	0		1	62	18	0
13	300	2.061	331.5	142		--	19	0	0		1	62	18	0
14	302	1.923	250.9	25		--	40	0	0		1	76	18	0
15	303	2.493	216.4			--	--	20	6		2	68	18	0
16	304	3.986	223.8	74		--	-18	0	0		1	62	18	0
17	305	6.134	215.6	137		--	30	0	0		1	56	18	0
18	307	8.680	221.5	45		--	2	0	0		1	48	18	0
19	308	12.498	222.7	23		--	84	0/ 9	0		2	42	18	0
20	309	14.440	224.1	120		--	-18	12	9			36	18	0

DATA FOR ONE TEAM-SHOT
EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 4 TEAM 3
SHOT POINT 2
SHOT TIME: 37: 1:15: 2.456

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	310	16.372	223.5	49		--	-14	0	0		1	36	18	0
2	311	18.448	223.3	68		--	22	0	0		1	36	18	0
3	312	20.520	223.1	75		--	-12	0	0		1	36	18	0
4	313	22.550	223.1	112		--	-2	0	0		1	36	18	0
5	314	24.527	223.0	39		--	-11	0	0		1	36	18	0
6	315	26.566	222.9	119		--	-6	0	0		1	36	18	0
7	316	28.649	222.9	30		--	-18	0	0		1	36	18	0
8	317	30.673	223.4	96		--	-17	0/17	0		1	36	18	0
9	318	32.173	223.5	89		--	11	0	0		1	36	18	0
10	319	34.199	223.2	77		--	-19	0	0		2	36	18	0
11	320	36.212	223.1	58		--	-31	15	9			36	18	0
12	321	38.180	222.9	103		--	-17	0	0		2	36	18	0
13	322	40.155	222.8	122		--	4	0/16	0		2	36	18	0
14	323	41.997	222.6	31		--	-8	0/17	1		2	36	18	0
15	324	44.223	221.7	19		--	48	0	1		2	36	18	0
16	325	45.825	220.1	83		--	-15	3/16	6			36	18	0
17	326	47.290	219.5	110		--	5	0	0		2	36	18	0
18	327	49.133	218.8	107		--	-16	0	2		3	36	18	0
19	328	51.089	219.4	121		--	9	0/ 9	1		2	36	18	0
20	329	53.181	220.0	133		--	-19	0	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 4 TEAM 4
SHOT POINT 2
SHOT TIME: 37: 1:15: 2.456

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	330	57.005	220.8	17		--	45	0	1		2	36	18	0
2	331	58.663	221.5	22		--	-45	0	0		2	36	18	0
3	332	59.825	221.9	48		--	26	0	0		2	36	18	0
4	333	61.116	222.0	60		--	-32	0	3		3	36	18	0
5	334	62.571	221.8	131		--	-66	0	0		2	36	18	0
6	335	64.516	222.3	70		--	-32	0	0		2	36	18	0
7	336	67.276	222.7	100		--	-28	12	9			36	18	0
8	337	69.135	223.0	136		--	159	0	0		2	36	18	0
9	338	71.517	223.5	18		--	-4	0	2		3	36	18	0
10	339	72.916	223.6	106		--	-26	0	1		2	36	18	0
11	340	75.022	223.9	124		--	-2	17	1		2	36	18	0
12	341	77.285	224.1	138	UNIT 130	--	-57	22	1		2	36	18	0
13	342	79.687	224.4	40		--	11	17	1		2	36	18	0
14	343	81.309	224.5	129		--	33	0	1		2	36	18	0
15	344	83.944	224.9	113		--	16	0	2		2	36	18	0
16	345	85.009	225.3	35		--	-45	7/17	9			36	18	0
17	346	87.171	225.6	85		--	61	0	1		2	36	18	0
18	347	90.061	225.1	139		--	-28	0	2		2	36	18	0
19	348	92.035	224.6	51		--	5	0	1		2	36	18	0
20	349	93.668	224.0	93		--	-38	0	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 4 TEAM 5
SHOT POINT 2
SHOT TIME: 37: 1:15: 2.456

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	350	95.812	222.9	94		--	--	0	1		2	36	18	0
2	351	96.765	223.3	97		--	--	0	1		2	36	18	0
3	352	97.979	223.1	88		--	--	0	1		2	36	18	0
4	353	99.438	222.8	14		--	--	0	1		2	36	18	0
5	354	102.204	222.5	76		--	--	0	0		2	36	18	0
6	355	104.307	223.1	104		--	--	0	2		2	36	18	0
7	356	106.866	223.1	99		--	--	7	9			36	18	0
8	357	108.892	223.2	63		--	--	0	0		2	36	18	0
9	358	112.111	223.3	71		--	--	0	0		2	36	18	0
10	359	113.713	223.3	56		--	--	0	0		2	36	18	0
11	360	115.647	223.3	72		--	--	0	0		2	36	18	0
12	361	117.312	223.4	118		--	--	0	2		2	36	18	0
13	362	119.638	223.5	73		--	--	0	0		2	36	18	0
14	363	121.651	223.4	12		--	--	0	1		2	36	18	0
15	364	123.507	223.5	43		--	--	0	0		2	36	18	0
16	365	124.920	223.5	15		--	--	20	6			36	18	0
17	374	127.038	223.7	145		--	--	0	0		2	36	18	0
18	375	128.471	224.0	69		--	--	20	6			36	18	0
19	376	131.056	223.7	36		--	--	0	0		2	36	18	0
20	377	133.283	223.5	146		--	--	0	1		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 5 TEAM 1
SHOT POINT 1
SHOT TIME: 40: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	278.111	221.9	10		--	73	0	1		3	36	18	0
2	379	280.487	221.9	79		--	9	0	1		3	36	18	0
3	380	282.243	221.8	53		--	-13	0/23	3		2	36	18	0
4	381	284.997	221.9	34		--	-16	0	1		3	36	18	0
5	382	286.803	222.0	125		--	--	20	6			36	18	0
6	383	287.628	221.9	115		--	12	17	8			36	18	0
7	384	290.187	221.8	143		--	34	0	4		3	36	18	0
8	385	291.250	221.9	26		--	2	0	2		3	36	18	0
9	386	292.573	221.9	87		--	75	0	1		3	36	18	0
10	387	294.324	222.0	66		--	-134	0	1		3	36	18	0
11	388	296.307	222.0	24		--	8	0	1		3	36	18	0
12	389	297.947	221.9	33		--	-21	0	1		3	36	18	0
13	390	299.760	221.8	3		--	-19	0	1		3	36	18	0
14	391	301.114	221.6			--	--	20	6			36	18	0
15	392	301.693	221.6	98		--	11	0	1		3	36	18	0
16	393	303.294	221.3	108		--	-8	0	1		3	36	18	0
17	394	305.314	221.1	90		--	-11	0	1		3	36	18	0
18	395	307.102	220.8	65		--	-17	0	1		3	36	18	0
19	396	308.806	220.7	28		--	-12	0	1		3	36	18	0
20	397	310.633	220.5	128		--	12	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 5 TEAM 2
SHOT POINT 1
SHOT TIME: 40: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	312.416	220.3	44		--	3	0	0		3	36	18	0
2	399	313.965	220.1	23	1001 SAMP	--	14	0	2		3	36	18	0
3	400	316.190	219.8	55		--	9	3/24	6			36	18	0
4	401	318.154	219.6	142	1001 SAMP	--	18	0	2		3	42	18	0
5	402	319.607	219.4	120	1001 SAMP	--	-9	0	1		3	42	18	0
6	403	321.326	219.3	105		--	-14	28	6			42	18	0
7	404	323.426	219.1	78	1001 SAMP	--	6	0	2		3	48	18	0
8	405	325.037	218.9	25	1001 SAMP	--	31	0	2		3	56	18	0
9	406	327.606	218.8	74		--	-16	1	6			62	18	0
10	407	328.421	218.7	101	1001 SAMP	--	113	0	2		3	68	18	0
11	408	330.544	218.7	132	1001 SAMP	--	-6	0	1		3	76	18	0
12	409	332.372	218.6	52		--	-28	0	1		3	76	18	0
13	410	333.365	218.5	32		--	351	3	6			68	18	0
14	411	335.195	218.4	64		--	-81	0	1		3	56	18	0
15	412	337.270	218.3	45		--	3	0	1		3	56	18	0
16	413	339.417	218.2	82		--	-20	0	1		3	48	18	0
17	414	341.114	218.1	62		--	-15	0	1		3	42	18	0
18	415	343.119	218.0	137		--	17	0	1		3	42	18	0
19	416	345.144	217.9	38		--	15	0	1		3	36	18	0
20	417	348.174	217.9	92		--	-20	0/ 9	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 5 TEAM 3
SHOT POINT 1
SHOT TIME: 40: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	350.681	217.7	30		--	-20	0	1		3	36	18	0
2	419	351.412	217.3	119		--	0	3	6			36	18	0
3	420	353.184	217.0	49		--	-15	0/19	1		3	36	18	0
4	421	354.434	216.7	122		--	18	0	1		3	36	18	0
5	422	355.557	216.4	121		--	23	0/ 9	1		3	36	18	0
6	423	356.230	216.2	39		--	-10	17	8			36	18	0
7	424	357.133	215.9	133		--	-19	0	2		3	36	18	0
8	425	358.266	215.6	83		--	-33	13/19	9			36	18	0
9	426	359.436	215.4	89		--	23	0	2		3	36	18	0
10	427	360.859	215.1	112		--	-5	0	2		3	36	18	0
11	428	361.941	215.0	77		--	-30	0	2		3	36	18	0
12	429	363.556	215.0	19		--	55	0	3		3	36	18	0
13	430	365.466	214.9	31		--	-10	0	3		3	36	18	0
14	431	367.108	214.9	58		--	-20	0	3		3	36	18	0
15	432	369.341	214.8	68		--	14	0	3		3	36	18	0
16	433	372.062	214.7	103		--	-14	0	4		3	36	18	0
17	434	373.731	214.6	107		--	-43	0/15	1		3	36	18	0
18	435	374.192	214.3	75		--	-13	0	1		3	36	18	0
19	436	377.468	214.4	110		--	-34	17	8			36	18	0
20	437	378.999	214.3	96		--	-17	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 5 TEAM 4
SHOT POINT 1
SHOT TIME: 40: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	382.217	214.2	17		--	23	0	2		3	36	18	0
2	439	383.661	214.1	48		--	16	0	3		3	36	18	0
3	440	386.012	214.0	60		--	-19	0	4		3	36	18	0
4	441	388.745	213.9	100		--	-16	0	4		3	36	18	0
5	442	388.938	213.7	131		--	-41	0	5		3	36	18	0
6	443	391.467	213.6	70		--	-21	0	3		3	36	18	0
7	444	393.313	213.5	106		--	-21	9	9			36	18	0
8	445	395.588	213.4	93		--	1622	15	9			36	18	0
9	446	397.791	213.4	136		--	87	0	2		3	36	18	0
10	970	400.208	213.3	40		--	5	0	1		3	36	18	0
11	448	403.341	213.3	129		--	31	0	4		3	36	18	0
12	449	405.682	213.2	18		--	-3	0	4		3	36	18	0
13	450	407.229	213.1	35		--	-27	25	9			36	18	0
14	451	408.938	213.1	139		--	-16	0	4		3	36	18	0
15	452	410.976	213.1	124		--	-534	0	4		3	36	18	0
16	971	413.168	213.0	138		--	-32	0/22	4		3	36	18	0
17	454	414.602	213.0	113		--	10	0	3		3	36	18	0
18	972	417.999	212.9	85		--	31	0	3		3	36	18	0
19	456	420.116	213.0	51		--	7	0	3		3	36	18	0
20	457	422.401	212.9	22		--	-27	3/24	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 5 TEAM 5
SHOT POINT 1
SHOT TIME: 40: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	428.037	212.9	36		--	-35	1	6			36	18	0
2	459	430.319	213.0	63		--	-47	0	4		3	36	18	0
3	460	432.076	213.0	72		--	-13	0	5		3	36	18	0
4	461	433.828	213.0	15		--	--	20	6			36	18	0
5	462	435.505	213.1	76		--	41	0	4		3	36	18	0
6	463	437.790	213.1	97		--	-70	0	4		3	36	18	0
7	464	439.528	213.1	43		--	-2	0	4		3	36	18	0
8	465	441.507	213.1	14		--	-22	0	4		3	36	18	0
9	466	443.146	213.1	88		--	-34	1	6			36	18	0
10	467	444.827	213.1	69		--	--	20	6			36	18	0
11	468	446.488	213.1	56		--	5	1	6			36	18	0
12	469	448.571	213.1	104		--	-37	0	3		3	36	18	0
13	470	450.961	213.0	145		--	-42	0	3		3	36	18	0
14	471	453.108	213.0	94		--	29	0	3		3	36	18	0
15	472	455.386	213.0	71		--	33	1	6			36	18	0
16	473	457.736	213.0	12		--	-27	0	2		3	36	18	0
17	474	459.946	213.0	99		--	-7	25	9			36	18	0
18	475	462.464	212.9	73		--	-65	1	6			36	18	0
19	476	464.638	212.9	118		--	21	25	9			36	18	0
20	477	466.574	212.9	146		--	33	0	4		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 6 TEAM 1
SHOT POINT 2
SHOT TIME: 40: 1:45: 0.876

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	134.807	223.1	10		--	73	0	5		3	36	18	0
2	379	137.177	223.0	79		--	9	0	5		2	36	18	0
3	380	138.924	222.8	53		--	-13	0	5		2	36	18	0
4	381	141.687	223.0	34		--	-16	0	5		2	36	18	0
5	382	143.504	223.1	125		--	--	20	6			36	18	0
6	383	144.326	223.1	115		--	12	17	8			36	18	0
7	384	146.869	222.8	143		--	34	0	5		3	36	18	0
8	385	147.945	223.0	26		--	2	0	5		2	36	18	0
9	386	149.267	223.0	87		--	75	0	5		2	36	18	0
10	387	151.026	223.1	66		--	-134	0	5		3	36	18	0
11	388	153.018	223.2	24		--	8	0	5		3	36	18	0
12	389	154.636	222.9	33		--	-21	0	5		2	36	18	0
13	390	156.441	222.7	3		--	-19	0	5		2	36	18	0
14	391	157.777	222.4			--	--	20	6			36	18	0
15	392	158.352	222.3	98		--	11	0	5		3	36	18	0
16	393	159.937	221.8	108		--	-8	0	5		2	36	18	0
17	394	161.944	221.4	90		--	-11	0	5		2	36	18	0
18	395	163.725	220.9	65		--	-17	0	5		2	36	18	0
19	396	165.426	220.6	28		--	-12	0	5		2	36	18	0
20	397	167.253	220.2	128		--	12	0	5		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 6 TEAM 2
SHOT POINT 2
SHOT TIME: 40: 1:45: 0.876

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	169.039	219.9	44		--	3	28	6			36	18	0
2	399	170.594	219.5	23		--	14	28	6			36	18	0
3	400	172.831	219.0	55		--	9	28	6			36	18	0
4	401	174.810	218.6	142		--	18	28	6			42	18	0
5	402	176.276	218.3	120		--	-9	28	6			42	18	0
6	403	178.008	218.1	105		--	-14	28	6			42	18	0
7	404	180.131	217.7	78		--	6	28	6			48	18	0
8	405	181.757	217.5	25		--	31	28	6			56	18	0
9	406	184.344	217.3	74		--	-16	1	6			62	18	0
10	407	185.168	217.2	101		--	113	17	6			68	18	0
11	408	187.295	217.1	132		--	-6	28	6			76	18	0
12	409	189.143	216.9	52		--	-28	0	5		3	76	18	0
13	410	190.149	216.7	32		--	351	0	5		3	68	18	0
14	411	191.995	216.6	64		--	-81	0	5		3	56	18	0
15	412	194.074	216.5	45		--	3	0	5		3	56	18	0
16	413	196.246	216.3	82		--	-20	0	5		3	48	18	0
17	414	197.953	216.2	62		--	-15	0	5		3	42	18	0
18	415	199.973	216.1	137		--	17	0	5		3	42	18	0
19	416	202.015	215.9	38		--	15	0	5		3	36	18	0
20	417	205.047	215.9	92		--	-20	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 6 TEAM 3
SHOT POINT 2
SHOT TIME: 40: 1:45: 0.876

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	207.592	215.6	30		--	-20	0	5		3	36	18	0
2	419	208.426	214.8	119		--	0	0	1		3	36	18	0
3	420	210.254	214.5	49		--	-15	0	5		3	36	18	0
4	421	211.601	213.9	122		--	18	0	5		3	36	18	0
5	422	212.805	213.4	121		--	23	0	5		3	36	18	0
6	423	213.546	213.1	39		--	-10	17	8			36	18	0
7	424	214.539	212.6	133		--	-19	0	5		3	36	18	0
8	425	215.786	212.1	83		--	-33	21	5		3	36	18	0
9	426	217.030	211.8	89		--	23	0	5		3	36	18	0
10	427	218.535	211.4	112		--	-5	0	5		3	36	18	0
11	428	219.678	211.2	77		--	-30	0	5		3	36	18	0
12	429	221.296	211.2	19		--	55	0	1		3	36	18	0
13	430	223.211	211.2	31		--	-10	0	2		3	36	18	0
14	431	224.867	211.1	58		--	-20	7	9			36	18	0
15	432	227.133	211.0	68		--	14	0	1		3	36	18	0
16	433	229.884	210.9	103		--	-14	0	2		3	36	18	0
17	434	231.600	210.7	107		--	-43	0	5		3	36	18	0
18	435	232.186	210.3	75		--	-13	0	2		3	36	18	0
19	436	235.413	210.5	110		--	-34	3	6			36	18	0
20	437	236.982	210.3	96		--	-17	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER   6   TEAM 4
SHOT POINT   2
SHOT TIME: 40: 1:45: 0.876

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	240.239	210.2	17		--	23	0	5		3	36	18	0
2	439	241.740	210.0	48		--	16	0	3		3	36	18	0
3	440	244.110	210.0	60		--	-19	0	5		3	36	18	0
4	441	246.895	209.8	100		--	-16	0	5		3	36	18	0
5	442	247.151	209.6	131		--	-41	0	5		3	36	18	0
6	443	249.724	209.5	70		--	-21	0	1		3	36	18	0
7	444	251.606	209.4	106		--	-21	0	5		3	36	18	0
8	445	253.934	209.2	93		--	1622	15	9			36	18	0
9	446	256.141	209.2	136		--	87	0	5		3	36	18	0
10	970	258.610	209.1	40		--	5	0	5		3	36	18	0
11	448	261.741	209.1	129		--	31	0	5		3	36	18	0
12	449	264.111	209.0	18		--	-3	0	5		3	36	18	0
13	450	265.682	209.0	35		--	-27	7	9			36	18	0
14	451	267.398	208.9	139		--	-16	0	5		3	36	18	0
15	452	269.442	208.9	124		--	-534	0	5		3	36	18	0
16	971	271.672	208.8	138		--	-32	0	2		3	36	18	0
17	454	273.084	208.9	113		--	10	0	5		3	36	18	0
18	972	276.512	208.8	85		--	31	0	2		3	36	18	0
19	456	278.617	208.9	51		--	7	0	2		3	36	18	0
20	457	280.920	208.8	22		--	-27	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 6   TEAM 5
SHOT POINT 2
SHOT TIME: 40: 1:45: 0.876

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	286.532	209.0	36		--	-35	1	6			36	18	0
2	459	288.793	209.0	63		--	-47	0	2		3	36	18	0
3	460	290.522	209.1	72		--	-13	0/15	2		3	36	18	0
4	461	292.255	209.2	15		--	--	20	6			36	18	0
5	462	293.914	209.3	76		--	41	0	2		3	36	18	0
6	463	296.172	209.4	97		--	-70	0	3		3	36	18	0
7	464	297.912	209.4	43		--	-2	0	3		3	36	18	0
8	465	299.888	209.4	14		--	-22	0	3		3	36	18	0
9	466	301.527	209.4	88		--	-34	3	6			36	18	0
10	467	303.203	209.4	69		--	--	20	6			36	18	0
11	468	304.857	209.4	56		--	5	28	6			36	18	0
12	469	306.947	209.4	104		--	-37	0	5		3	36	18	0
13	470	309.342	209.4	145		--	-42	0	5		3	36	18	0
14	471	311.485	209.4	94		--	29	0	5		3	36	18	0
15	472	313.761	209.5	71		--	33	3	6			36	18	0
16	473	316.119	209.4	12		--	-27	0	2		3	36	18	0
17	474	318.343	209.4	99		--	-7	15	9			36	18	0
18	475	320.874	209.4	73		--	-65	3	6			36	18	0
19	476	323.059	209.4	118		--	21	15/16	9			36	18	0
20	477	324.997	209.4	146		--	33	0	5		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 7 TEAM 1
SHOT POINT 6
SHOT TIME: 40: 4: 0: 0.042

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	673.114	15.7	10		--	73	0	7		3	36	18	0
2	379	670.889	15.6	79		--	9	0	7		3	36	18	0
3	380	669.125	15.6	53		--	-13	0	7		3	36	18	0
4	381	666.832	15.5	34		--	-16	0	7		3	36	18	0
5	382	665.419	15.4	125		--	--	20	6			36	18	0
6	383	664.643	15.3	115		--	12	17	8			36	18	0
7	384	662.024	15.3	143		--	34	0	7		3	36	18	0
8	385	661.337	15.2	26		--	2	0	7		3	36	18	0
9	386	660.130	15.2	87		--	75	0	7		3	36	18	0
10	387	658.720	15.1	66		--	-134	0	7		3	36	18	0
11	388	657.113	14.9	24		--	8	0	7		3	36	18	0
12	389	655.242	15.0	33		--	-21	0	7		3	36	18	0
13	390	653.430	14.9	3		--	-19	0	7		3	36	18	0
14	391	651.798	14.9			--	--	20	6			36	18	0
15	392	651.164	14.9	98		--	11	0	7		3	36	18	0
16	393	649.234	15.0	108		--	-8	0	7		3	36	18	0
17	394	646.828	15.0	90		--	-11	0	7		3	36	18	0
18	395	644.674	15.0	65		--	-17	0	7		3	36	18	0
19	396	642.699	15.0	28		--	-12	0	7		3	36	18	0
20	397	640.629	15.1	128		--	12	0	7		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 7   TEAM 2
SHOT POINT 6
SHOT TIME: 40: 4: 0: 0.042

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	638.580	15.1	44		--	3	20	6			36	18	0
2	399	636.708	15.1	23		--	14	20	6			36	18	0
3	400	634.112	15.1	55		--	9	20	6			36	18	0
4	401	631.813	15.2	142		--	18	20	6			42	18	0
5	402	630.124	15.2	120		--	-9	20	6			42	18	0
6	403	628.230	15.2	105		--	-14	20	6			42	18	0
7	404	625.821	15.2	78		--	6	20	6			48	18	0
8	405	624.048	15.2	25		--	31	20	6			56	18	0
9	406	621.372	15.2	74		--	-15	1	6			62	18	0
10	407	620.474	15.2	101		--	113	20	6			68	18	0
11	408	618.441	15.1	132		--	-6	20	6			76	18	0
12	409	616.447	15.1	52		--	-28	0	7		3	76	18	0
13	410	615.341	15.1	32		--	351	0	7		3	68	18	0
14	411	613.425	15.1	64		--	-81	0	7		3	56	18	0
15	412	611.438	15.1	45		--	3	0	7		3	56	18	0
16	413	609.124	15.1	82		--	-20	0	7		3	48	18	0
17	414	607.410	15.0	62		--	-15	0	7		3	42	18	0
18	415	605.361	15.0	137		--	17	0	7		3	42	18	0
19	416	603.269	15.0	38		--	15	0	7		3	36	18	0
20	417	600.426	14.9	92		--	-20	0	7		3	36	18	0

DATA FOR ONE TEAM-SHOT
EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 7 TEAM 3
SHOT POINT 6
SHOT TIME: 40: 4: 0: 0.042

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	597.654	14.9	30		--	-20	0	9			36	18	0
2	419	595.926	15.1	119		--	0	0	9			36	18	0
3	420	593.759	15.2	49		--	-15	0	7		3	36	18	0
4	421	591.793	15.3	122		--	18	0	7		3	36	18	0
5	422	590.132	15.5	121		--	23	0/ 9	7		3	36	18	0
6	423	589.026	15.6	39		--	-10	17	8			36	18	0
7	424	587.593	15.7	133		--	-19	0	7		3	36	18	0
8	425	585.844	15.9	83		--	-33	0	7		3	36	18	0
9	426	584.320	15.9	89		--	23	0	7		3	36	18	0
10	427	582.526	16.0	112		--	-5	0	7		3	36	18	0
11	428	581.185	16.1	77		--	-30	0	7		3	36	18	0
12	429	579.619	16.1	19		--	55	0	7		3	36	18	0
13	430	577.759	16.0	31		--	-10	0	7		3	36	18	0
14	431	576.113	16.0	58		--	-20	0	7		3	36	18	0
15	432	573.806	16.0	68		--	14	0	7		3	36	18	0
16	433	571.043	15.9	103		--	-14	0	9			36	18	0
17	434	569.212	16.0	107		--	-43	0/ 7	7		3	36	18	0
18	435	568.188	16.1	75		--	-13	0	7		3	36	18	0
19	436	565.257	16.0	110		--	-34	17	8			36	18	0
20	437	563.610	16.0	96		--	-17	0	7		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1　SAUDI ARABIA, 1978　SHOTS 1-19　(1981 UPDATE)
SHOT NUMBER 7　TEAM 4
SHOT POINT 6
SHOT TIME: 40: 4: 0: 0.042

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	560.330	15.9	17		--	23	0	7		3	36	18	0
2	439	558.685	16.0	48		--	16	0/12	7		3	36	18	0
3	440	556.330	15.9	60		--	-19	0	7		3	36	18	0
4	441	553.460	15.9	100		--	-16	0	7		3	36	18	0
5	442	553.006	16.0	131		--	-41	0	7		3	36	18	0
6	443	550.376	16.0	70		--	-21	0	7		3	36	18	0
7	444	548.436	16.0	106		--	-21	15	9			36	18	0
8	445	546.016	16.0	93		--	1622	15	9			36	18	0
9	446	543.871	16.0	136		--	87	0	4		3	36	18	0
10	970	541.314	16.0	40		--	5	0	4		3	36	18	0
11	448	538.289	15.9	129		--	31	0	4		3	36	18	0
12	449	535.906	15.9	18		--	-3	0	4		3	36	18	0
13	450	534.307	15.9	35		--	-27	7	9			36	18	0
14	451	532.625	15.8	139		--	-16	0	4		3	36	18	0
15	452	530.623	15.8	124		--	-534	0	4		3	36	18	0
16	971	528.348	15.8	138	UNIT 130	--	-32	0/22	7		3	36	18	0
17	454	527.046	15.7	113		--	10	0	4		3	36	18	0
18	972	523.631	15.7	85		--	31	0	4		3	36	18	0
19	456	521.628	15.6	51		--	7	0	4		3	36	18	0
20	457	519.341	15.6	22		--	-27	0/ 3/17	8			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 7 TEAM 5
SHOT POINT 6
SHOT TIME: 40: 4: 0: 0.042

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	514.000	15.3	36		--	-35	1	6			36	18	0
2	459	511.887	15.2	63		--	-47	0	4		3	36	18	0
3	460	510.314	15.1	72		--	-13	15	9			36	18	0
4	461	508.713	15.1	15		--	--	20	6			36	18	0
5	462	507.180	15.0	76		--	41	0	4		3	36	18	0
6	463	505.107	14.9	97		--	-70	0	4		3	36	18	0
7	464	503.425	14.8	43		--	-2	0	4		3	36	18	0
8	465	501.535	14.7	14		--	-22	0	4		3	36	18	0
9	466	499.963	14.7	88		--	-34	1	6			36	18	0
10	467	498.370	14.6	69		--	--	20	6			36	18	0
11	468	496.808	14.5	56		--	5	1	6			36	18	0
12	469	494.768	14.5	104		--	-37	0	4		3	36	18	0
13	470	492.445	14.4	145		--	-42	0	4		3	36	18	0
14	471	490.404	14.3	94		--	29	0	4		3	36	18	0
15	472	488.230	14.3	71		--	33	1	6			36	18	0
16	473	485.929	14.2	12		--	-27	0	4		3	36	18	0
17	474	483.739	14.1	99		--	-7	7	9			36	18	0
18	475	481.250	14.1	73		--	-65	1	6			36	18	0
19	476	479.105	14.0	118		--	21	15	9			36	18	0
20	477	477.238	14.0	146		--	33	0	7		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 8 TEAM 1
SHOT POINT 2
SHOT TIME: 44: 1: 0: 0.011

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	134.807	223.1	143		--	33	0	0		2	36	18	0
2	379	137.177	223.0	65		--	-16	0	0		2	36	18	0
3	380	138.924	222.8	125		--	--	1	6			36	18	0
4	381	141.687	223.0	90		--	-8	0	0		2	36	18	0
5	382	143.504	223.1			--	--	20	6			36	18	0
6	383	144.326	223.1	53		--	-11	14	0		2	36	18	0
7	384	146.869	222.8	33		--	-12	0	0		2	36	18	0
8	385	147.945	223.0	79		--	5	0	1		2	36	18	0
9	386	149.267	223.0	10		--	58	0	2		2	36	18	0
10	387	151.026	223.1	26		--	-3	0	1		2	36	18	0
11	388	153.018	223.2	28		--	-16	0	1		2	36	18	0
12	389	154.636	222.9	98		--	82	0	1		2	36	18	0
13	390	156.441	222.7	87		--	63	0	0		2	36	18	0
14	391	157.777	222.4	108		--	-8	0	0		2	36	18	0
15	392	158.352	222.3	115		--	15	0	0		2	36	18	0
16	393	159.937	221.8	3		--	-13	0	0		2	36	18	0
17	394	161.944	221.4	128		--	16	0	0		2	36	18	0
18	395	163.725	220.9	34		--	-10	0	2		2	36	18	0
19	396	165.426	220.6	66		--	-94	0	0		2	36	18	0
20	397	167.253	220.2	24		--	5	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 8 TEAM 2
SHOT POINT 2
SHOT TIME: 44: 1: 0: 0.011

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	169.039	219.9	44		--	2	0			2	36	18	0
2	399	170.594	219.5	45		--	3	0			2	36	18	0
3	400	172.831	219.0	82		--	-17	0			2	36	18	0
4	401	174.810	218.6	78		--	5	0			2	42	18	0
5	402	176.276	218.3	137		--	28	0			2	42	18	0
6	403	178.008	218.1	142		--	22	1	6			42	18	0
7	404	180.131	217.7	132		--	-10	17/25			3	48	18	0
8	405	181.757	217.5	120		--	-14	0			2	56	18	0
9	406	184.344	217.3	101		--	-12	0			3	62	18	0
10	407	185.168	217.2	52		--	-16	0			2	68	18	0
11	408	187.295	217.1	105		--	0	4			2	76	18	0
12	409	189.143	216.9	32		--	-8	0			2	76	18	0
13	410	190.149	216.7	38		--	--	0			2	68	18	0
14	411	191.995	216.6	55		--	8	0			2	56	18	0
15	412	194.074	216.5	74		--	-16	0			2	56	18	0
16	413	196.246	216.3	92		--	-21	0			2	48	18	0
17	414	197.953	216.2	64		--	58	0			3	42	18	0
18	415	199.973	216.1	23		--	82	0			2	42	18	0
19	416	202.015	215.9	25		--	40	0			2	36	18	0
20	417	205.047	215.9	62		--	-8	1	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 8   TEAM 3
SHOT POINT 2
SHOT TIME: 44: 1: 0: 0.011

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	207.592	215.6	68		--	23	0	0		2	36	18	0
2	419	208.426	214.8	83		--	--	18	6			36	18	0
3	420	210.254	214.5	75		--	-8	0	1		2	36	18	0
4	421	211.601	213.9	49		--	-11	0	2		2	36	18	0
5	422	212.805	213.4	30		--	-16	0	2		2	36	18	0
6	423	213.546	213.1	103		--	-14	0	2		2	36	18	0
7	424	214.539	212.6	31		--	-2	0	2		3	36	18	0
8	425	215.786	212.1	122		--	15	0	2		3	36	18	0
9	426	217.030	211.8	119		--	-3	0	2		3	36	18	0
10	427	218.535	211.4	96		--	-14	0	2		3	36	18	0
11	428	219.678	211.2	19		--	46	0	2		2	36	18	0
12	429	221.296	211.2	39		--	--	1	6			36	18	0
13	430	223.211	211.2	121		--	32	0	5		3	36	18	0
14	431	224.867	211.1	89		--	10	0	2		3	36	18	0
15	432	227.133	211.0	77		--	25	0	5		3	36	18	0
16	433	229.884	210.9	112		--	0	1	6			36	18	0
17	434	231.600	210.7	107		--	-12	0	1		3	36	18	0
18	435	232.186	210.3	110		--	-79	17	8			36	18	0
19	436	235.413	210.5	58		--	-16	7	9			36	18	0
20	437	236.982	210.3	133		--	-16	0	5		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 8   TEAM 4
SHOT POINT 2
SHOT TIME: 44: 1: 0: 0.011

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	240.239	210.2	139		--	-14	0	3		3	36	18	0
2	439	241.740	210.0	22		--	-12	0	5		3	36	18	0
3	440	244.110	210.0	100		--	-8	0	5		3	36	18	0
4	441	246.895	209.8	93		--	-10	0	5		3	36	18	0
5	442	247.151	209.6	17		--	13	0	2		3	36	18	0
6	443	249.724	209.5	60		--	-9	0	5		3	36	18	0
7	444	251.606	209.4	106		--	-6	0	2		3	36	18	0
8	445	253.934	209.2	40		--	3	0	2		3	36	18	0
9	446	256.141	209.2	48		--	13	0	2		3	36	18	0
10	447	258.738	209.2	131		--	-20	0	2		2	36	18	0
11	448	261.741	209.1	136		--	32	0	2		3	36	18	0
12	449	264.111	209.0	70		--	-10	0	3		3	36	18	0
13	450	265.682	209.0	124		--	6	0	3		3	36	18	0
14	451	267.398	208.9	129		--	11	0	2		3	36	18	0
15	452	269.442	208.9	35		--	-8	0	2		3	36	18	0
16	453	271.399	208.9	130		--	--	1	6			36	18	0
17	454	273.084	208.9	18		--	2	0	2		3	36	18	0
18	455	276.225	208.9	113		--	5	17	9			36	18	0
19	456	278.617	208.9	85		--	13	1	6			36	18	0
20	457	280.920	208.8	51		--	385	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 8 TEAM 5
SHOT POINT 2
SHOT TIME: 44: 1: 0: 0.011

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	286.532	209.0			--	--	20	6			36	18	0
2	459	288.793	209.0			--	--	20	6			36	18	0
3	460	290.522	209.1			--	--	20	6			36	18	0
4	461	292.255	209.2			--	--	20	6			36	18	0
5	462	293.914	209.3			--	--	20	6			36	18	0
6	463	296.172	209.4			--	--	20	6			36	18	0
7	464	297.912	209.4			--	--	20	6			36	18	0
8	465	299.888	209.4			--	--	20	6			36	18	0
9	466	301.527	209.4			--	--	20	6			36	18	0
10	467	303.203	209.4			--	--	20	6			36	18	0
11	468	304.857	209.4	56		--	-5	0	3		3	36	18	0
12	469	306.947	209.4	104		--	-36	0	3		3	36	18	0
13	470	309.342	209.4	12		--	-21	0	2		3	36	18	0
14	471	311.485	209.4	69		--	23	0	2		3	36	18	0
15	472	313.761	209.5	72		--	1	15	9			36	18	0
16	473	316.119	209.4			--	--	20	6			36	18	0
17	474	318.343	209.4	76		--	100	0	2		3	36	18	0
18	475	320.874	209.4	145		--	-49	0	2		3	36	18	0
19	476	323.059	209.4	88		--	-17	2	6			36	18	0
20	477	324.997	209.4	63		--	-47	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 9 TEAM 1
SHOT POINT 3
SHOT TIME: 44: 1:15: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	55.328	23.6	143		--	33	0	0		2	36	18	0
2	379	53.017	23.0	65		--	-16	0	0		2	36	18	0
3	380	51.226	22.8	125		--	--	1	6			36	18	0
4	381	48.775	21.3	90		--	-8	0	0		1	36	18	0
5	382	47.263	20.0			--	--	20	6			36	18	0
6	383	46.469	19.7	53		--	-11	0/14	0		1	36	18	0
7	384	43.833	19.3	33		--	-12	0	0		1	36	18	0
8	385	43.089	18.1	79		--	5	0	5		1	36	18	0
9	386	41.864	17.4	10		--	58	0	0		1	36	18	0
10	387	40.432	15.9	26		--	-3	0	0		2	36	18	0
11	388	38.833	14.1	28		--	-16	0	0		2	36	18	0
12	389	36.967	14.2	98		--	82	0	0		2	36	18	0
13	390	35.172	13.4	87		--	63	0	0		1	36	18	0
14	391	33.541	13.8	108		--	-8	0	5		1	36	18	0
15	392	32.909	13.7	115		--	15	0	0		1	36	18	0
16	393	30.981	14.2	3		--	-13	0	0		1	36	18	0
17	394	28.581	14.8	128		--	16	0	0		1	36	18	0
18	395	26.436	15.6	34		--	-10	0	0		1	36	18	0
19	396	24.472	16.1	66		--	-94	0	0		1	36	18	0
20	397	22.412	16.5	24		--	5	0	0		1	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 9   TEAM 2
SHOT POINT 3
SHOT TIME: 44: 1:15: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	20.377	17.2	44		--	2	0	0		1	36	18	0
2	399	18.531	18.5	45		--	3	0	1		1	36	18	0
3	400	15.978	20.3	82		--	-17	0	0		1	36	18	0
4	401	13.737	22.6	78		--	5	0	0		1	42	18	0
5	402	12.105	24.7	137		--	28	0	0		1	42	18	0
6	403	10.257	26.6	142		--	22	1	6			42	18	0
7	404	7.993	32.0	132		--	-10	0/17/25	0		1	48	18	0
8	405	6.338	37.0	120		--	-14	0	0		1	56	18	0
9	406	3.828	47.9	101		--	-12	0	0		1	62	18	0
10	407	3.130	57.2	52		--	-16	0	0		1	68	18	0
11	408	1.475	93.4	105		--	0	4	0		1	76	18	0
12	409	2.232	154.2	32		--	-8	0	0		1	76	18	0
13	410	3.180	166.4	38		--	--	0	0		1	68	18	0
14	411	4.890	179.0	55		--	8	0	0		1	56	18	0
15	412	6.715	188.9	74		--	-16	0	1		1	56	18	0
16	413	9.007	190.7	92		--	-21	0	0		1	48	18	0
17	414	10.695	193.0	64		--	58	0	0		1	42	18	0
18	415	12.729	194.7	23		--	82	28	6			42	18	0
19	416	14.814	195.7	25		--	40	0	0		1	36	18	0
20	417	17.688	199.0	62		--	-8	1	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 9 TEAM 3
SHOT POINT 3
SHOT TIME: 44: 1:15: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	20.435	198.0	68		--	23	0	0		1	36	18	0
2	419	22.167	191.7	83		--	--	17	8			36	18	0
3	420	24.370	190.4	75		--	-8	0	0		1	36	18	0
4	421	26.502	187.3	49		--	-11	0	0		1	36	18	0
5	422	28.335	185.3	30		--	-16	0	0		1	36	18	0
6	423	29.622	183.6	103		--	-14	0	0		1	36	18	0
7	424	31.311	181.8	31		--	-2	0	0		1	36	18	0
8	425	33.399	179.9	122		--	15	0	0		1	36	18	0
9	426	35.092	179.3	119		--	-3	0	0		1	36	18	0
10	427	37.057	178.8	96		--	-14	0	0		2	36	18	0
11	428	38.512	178.5	19		--	46	0	0		2	36	18	0
12	429	39.883	179.8	39		--	--	1	6			36	18	0
13	430	41.542	181.1	121		--	32	10	9			36	18	0
14	431	43.065	182.0	89		--	10	0	0		2	36	18	0
15	432	45.267	182.9	77		--	25	10	9			36	18	0
16	433	47.885	184.0	112		--	0	1	6			36	18	0
17	434	49.717	184.2	107		--	-12	0	0		2	36	18	0
18	435	51.085	182.6	110		--	-79	17	8			36	18	0
19	436	53.594	185.0	58		--	-16	10	9			36	18	0
20	437	55.227	185.2	133		--	-16	10	9			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 9 TEAM 4
SHOT POINT 3
SHOT TIME: 44: 1:15: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	58.386	186.1	139		--	-14	0	0		2	36	18	0
2	439	60.071	185.9	22		--	-12	8	9			36	18	0
3	440	62.323	186.6	100		--	-8	12	9			36	18	0
4	441	65.149	187.0	93		--	-10	0	1		2	36	18	0
5	442	65.727	186.4	17		--	13	0	2		2	36	18	0
6	443	68.302	186.8	60		--	-9	12	9			36	18	0
7	444	70.216	187.0	106		--	-6	0	0		2	36	18	0
8	445	72.619	187.2	40		--	3	0	2		2	36	18	0
9	446	74.654	187.9	48		--	13	0	0		2	36	18	0
10	447	77.149	188.4	131		--	-20	0	0		2	36	18	0
11	448	80.398	188.9	136		--	32	0	2		3	36	18	0
12	449	82.739	189.3	70		--	-10	0	2		2	36	18	0
13	450	84.321	189.5	124		--	6	0	2		2	36	18	0
14	451	85.955	189.8	129		--	11	0	0		2	36	18	0
15	452	87.902	190.2	35		--	-8	0	1		2	36	18	0
16	453	89.770	190.6	130		--	--	1	6			36	18	0
17	454	91.398	190.9	18		--	2	0	2		2	36	18	0
18	455	94.386	191.5	113		--	5	15	9			36	18	0
19	456	96.709	191.8	85		--	13	28	6			36	18	0
20	457	98.969	192.1	51		--	385	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 9 TEAM 5
SHOT POINT 3
SHOT TIME: 44: 1:15: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	104.209	193.3			--	--	20	6			36	18	0
2	459	106.289	193.8			--	--	20	6			36	18	0
3	460	107.842	194.3			--	--	20	6			36	18	0
4	461	109.431	194.7			--	--	20	6			36	18	0
5	462	110.960	195.1			--	--	20	6			36	18	0
6	463	113.036	195.6			--	--	20	6			36	18	0
7	464	114.722	195.8			--	--	20	6			36	18	0
8	465	116.621	196.1			--	--	20	6			36	18	0
9	466	118.203	196.3			--	--	20	6			36	18	0
10	467	119.810	196.5			--	--	20	6			36	18	0
11	468	121.388	196.8	56		--	-5	0	1		2	36	18	0
12	469	123.444	197.0	104		--	-36	0	2		2	36	18	0
13	470	125.789	197.2	12		--	-21	0	1		2	36	18	0
14	471	127.859	197.4	69		--	23	0	1		2	36	18	0
15	472	130.066	197.7	72		--	1	15	9			36	18	0
16	473	132.393	197.9			--	--	20	6			36	18	0
17	474	134.604	198.0	76		--	100	0	1		2	36	18	0
18	475	137.119	198.1	145		--	-49	0	2		2	36	18	0
19	476	139.288	198.2	88		--	-17	1	6			36	18	0
20	477	141.187	198.4	63		--	-47	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 10   TEAM 1
SHOT POINT 4
SHOT TIME: 44: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	378	283.150	24.7	143		--	33	0	4		3	36	18	0
2	379	280.821	24.6	65		--	-16	0	3		3	36	18	0
3	380	279.020	24.5	125		--	--	1	6			36	18	0
4	381	276.512	24.3	90		--	-8	0	3		3	36	18	0
5	382	274.931	24.1			--	--	20	6			36	18	0
6	383	274.120	24.0	53		--	-11	14	3		2	36	18	0
7	384	271.461	24.0	33		--	-12	0	3		3	36	18	0
8	385	270.631	23.8	79		--	5	0	3		3	36	18	0
9	386	269.357	23.7	10		--	58	0	3		3	36	18	0
10	387	267.801	23.6	26		--	-3	10	9			36	18	0
11	388	266.033	23.3	28		--	-16	0	3		3	36	18	0
12	389	264.194	23.4	98		--	82	0	3		3	36	18	0
13	390	262.340	23.4	87		--	63	0	2		3	36	18	0
14	391	260.763	23.5	108		--	-8	0	5		3	36	18	0
15	392	260.133	23.5	115		--	15	0	2		3	36	18	0
16	393	258.271	23.6	3		--	-13	0	2		3	36	18	0
17	394	255.944	23.8	128		--	16	0	2		3	36	18	0
18	395	253.872	23.9	34		--	-10	0	3		3	36	18	0
19	396	251.952	24.1	66		--	-94	0	2		3	36	18	0
20	397	249.926	24.2	24		--	5	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT
EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 10   TEAM 2
SHOT POINT   4
SHOT TIME: 44: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	398	247.933	24.3	44		--	2	0	2		3	36	18	0
2	399	246.145	24.4	45		--	3	6	8			36	18	0
3	400	243.640	24.6	82		--	-17	0	1		3	36	18	0
4	401	241.429	24.8	78		--	5	0	2		3	42	18	0
5	402	239.802	24.9	137		--	28	0	2		3	42	18	0
6	403	237.943	25.0	142		--	22	1	6			42	18	0
7	404	235.617	25.2	132		--	-10	0/17/25	2		3	48	18	0
8	405	233.879	25.2	120		--	-14	0	2		3	56	18	0
9	406	231.196	25.3	101		--	-12	0	2		3	62	18	0
10	407	230.318	25.3	52		--	-16	0	2		3	68	18	0
11	408	228.204	25.3	105		--	0	4	6			76	18	0
12	409	226.245	25.4	32		--	-8	0	1		3	76	18	0
13	410	225.169	25.4	38		--	--	0	3		3	68	18	0
14	411	223.255	25.5	55		--	8	0	3		3	56	18	0
15	412	221.189	25.4	74		--	-16	0	3		3	56	18	0
16	413	218.908	25.5	92		--	-21	0	2		2	48	18	0
17	414	217.169	25.5	64		--	58	0	2		3	42	18	0
18	415	215.101	25.5	23		--	82	0	2		3	42	18	0
19	416	213.001	25.6	25		--	40	0	2		2	36	18	0
20	417	210.014	25.4	62		--	-8	1	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 10 TEAM 3
SHOT POINT 4
SHOT TIME: 44: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	418	207.317	25.6	68		--	23	0	0		3	36	18	0
2	419	206.063	26.3	83		--	--	17	8			36	18	0
3	420	204.069	26.6	75		--	-8	0	0		3	36	18	0
4	421	202.472	27.2	49		--	-11	0	0		3	36	18	0
5	422	201.103	27.7	30		--	-16	0	1		3	36	18	0
6	423	200.247	28.0	103		--	-14	0	5		2	36	18	0
7	424	199.134	28.5	31		--	-2	0	2		3	36	18	0
8	425	197.779	29.1	122		--	15	0	1*		3	36	18	0
9	426	196.487	29.4	119		--	-3	0	1		3	36	18	0
10	427	194.945	29.8	96		--	-14	15	9			36	18	0
11	428	193.786	30.0	19		--	46	0	2		2	36	18	0
12	429	192.168	30.0	39		--	--	1	6			36	18	0
13	430	190.253	30.0	121		--	32	7	9			36	18	0
14	431	188.594	30.1	89		--	10	0	0		3	36	18	0
15	432	186.325	30.2	77		--	25	12	9			36	18	0
16	433	183.571	30.3	112		--	0	1	6			36	18	0
17	434	181.855	30.5	107		--	-12	0	0		2	36	18	0
18	435	181.292	31.1	110		--	-79	17	8			36	18	0
19	436	178.051	30.9	58		--	-16	15	9			36	18	0
20	437	176.491	31.1	133		--	-16	15	9			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 10 TEAM 4
SHOT POINT 4
SHOT TIME: 44: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	438	173.245	31.2	139		--	-14	0	1		2	36	18	0
2	439	171.767	31.5	22		--	-12	15	9			36	18	0
3	440	169.406	31.6	100		--	-8	15	9			36	18	0
4	441	166.649	31.9	93		--	-10	0	1		3	36	18	0
5	442	166.436	32.2	17		--	13	0	5		3	36	18	0
6	443	163.897	32.4	60		--	-9	17	9			36	18	0
7	444	162.047	32.6	106		--	-6	0	0		2	36	18	0
8	445	159.770	32.9	40		--	3	0	0		2	36	18	0
9	446	157.566	33.0	48		--	13	0	0		2	36	18	0
10	447	154.991	33.1	131		--	-20	0	0		2	36	18	0
11	448	152.023	33.3	136		--	32	0	0		2	36	18	0
12	449	149.688	33.5	70		--	-10	0	0		2	36	18	0
13	450	148.149	33.7	124		--	6	0	2		2	36	18	0
14	451	146.443	33.8	129		--	11	0	0		2	36	18	0
15	452	144.410	33.8	35		--	-8	0	0		2	36	18	0
16	453	142.465	33.9	130		--	--	1	6			36	18	0
17	454	140.794	34.0	18		--	2	0	0		2	36	18	0
18	455	137.665	34.1	113		--	5	15	9			36	18	0
19	456	135.296	34.3	85		--	13	3	6			36	18	0
20	457	133.025	34.5	51		--	385	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 10 TEAM 5
SHOT POINT 4
SHOT TIME: 44: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	458	127.384	34.5			--	--	20	6			36	18	0
2	459	125.095	34.4			--	--	20	6			36	18	0
3	460	123.328	34.2			--	--	20	6			36	18	0
4	461	121.569	34.2			--	--	20	6			36	18	0
5	462	119.887	34.1			--	--	20	6			36	18	0
6	463	117.594	33.9			--	--	20	6			36	18	0
7	464	115.858	34.0			--	--	20	6			36	18	0
8	465	113.880	34.0			--	--	20	6			36	18	0
9	466	112.242	34.0			--	--	20	6			36	18	0
10	467	110.561	34.1			--	--	20	6			36	18	0
11	468	108.899	34.0	56		--	-5	0	0		2	36	18	0
12	469	106.822	34.2	104		--	-36	0	0		2	36	18	0
13	470	104.438	34.3	12		--	-21	0	0		2	36	18	0
14	471	102.292	34.3	69		--	23	0	0		2	36	18	0
15	472	100.015	34.4	72		--	1	15	9			36	18	0
16	473	97.675	34.6			--	--	20	6			36	18	0
17	474	95.477	34.8	76		--	100	0	0		1	36	18	0
18	475	92.975	35.0	145		--	-49	0	0		2	36	18	0
19	476	90.816	35.2	88		--	-17	1	6			36	18	0
20	477	88.887	35.4	63		--	-47	0	0		2	36	18	0

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   DATA FOR ONE TEAM-SHOT SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 11   TEAM 1
SHOT POINT   1
SHOT TIME: 47: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	478	468.987	212.8	115		--	18	0	4		3	36	18	0
2	479	470.777	212.8	87		--	68	0	4		3	36	18	0
3	480	472.815	212.8	125		--	-258	0	4		3	36	18	0
4	481	474.738	212.8	66		--	-86	0	4		3	36	18	0
5	482	476.605	212.8	24		--	7	0	4		3	36	18	0
6	483	478.704	212.8	28		--	-18	0	4		3	36	18	0
7	484	481.098	212.7	34		--	-14	0	4		3	36	18	0
8	485	482.901	212.6	143		--	32	0	4		3	36	18	0
9	486	485.411	212.6	108		--	-11	0	4		3	36	18	0
10	487	488.710	212.6	98		--	--	0	4		3	36	18	0
11	488	490.638	212.6	3		--	2	0	4		3	36	18	0
12	489	493.400	212.5	79		--	9	0	4		3	36	18	0
13	490	495.943	212.5	53		--	-13	0	4		3	36	18	0
14	491	497.855	212.4	65		--	-24	0	4		3	36	18	0
15	492	499.874	212.4	33		--	-18	0	4		3	36	18	0
16	493	501.836	212.3	26		--	-3	29	9			36	18	0
17	494	504.107	212.3	10		--	39	1	6			36	18	0
18	495	506.197	212.2	128		--	21	0/ 8	4		3	36	18	0
19	496	508.361	212.2			--	--	20	6			36	18	0
20	497	510.035	212.2	90		--	-19	0	4		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 11   TEAM 2
SHOT POINT 1
SHOT TIME: 47: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	498	512.604	212.2	44		--	5	1	6			36	18	0
2	499	514.725	212.1	55		--	13	19	6			36	18	0
3	500	516.930	212.1	52		--	-17	25	9			36	18	0
4	501	519.230	212.1	38		--	21	0	4		3	36	18	0
5	502	522.238	212.1	92		--	-18	0	4		3	36	18	0
6	503	524.979	212.1	142		--	27	0	4		3	36	18	0
7	504	527.842	212.0	23		--	96	0	4		3	36	18	0
8	505	530.691	212.1	105		--	-11	0	4		3	36	18	0
9	506	532.628	212.2	120		--	-15	0/15	4		3	36	18	0
10	507	534.606	212.4	137		--	35	0	4		3	36	18	0
11	508	536.404	212.5	64		--	92	0	4		3	36	18	0
12	509	538.708	212.6	82		--	-18	0	4		3	36	18	0
13	510	540.816	212.7	25		--	46	0	4		3	36	18	0
14	511	542.590	212.8	62		--	-9	3	6			42	18	0
15	512	544.447	212.9	101		--	-12	0	4		3	42	18	0
16	513	546.452	213.0	78		--	15	15	9			48	18	0
17	514	548.331	213.1	132		--	-9	0/26	4		3	48	18	0
18	515	550.116	213.1	74		--	-11	0	4		3	56	18	0
19	516	551.594	213.1	32		--	-4	0	4		3	62	18	0
20	517	555.599	213.1	45		--	8	2	6			76	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 11 TEAM 3
SHOT POINT 1
SHOT TIME: 47: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	558.540	213.0	110		--	-3	0	4		3	62	18	0
2	519	560.984	212.7	122		--	5	0	4		3	48	18	0
3	520	562.706	212.6	133		--	-18	0/ 6	4		3	48	18	0
4	521	564.280	212.5	119		--	-7	0	4		3	42	18	0
5	522	565.938	212.4	96		--	-15	0	4		3	42	18	0
6	523	567.956	212.3	30		--	-18	0	4		3	36	18	0
7	524	569.541	212.2	107		--	-15	0/19	4		3	36	18	0
8	525	571.320	212.1	103		--	-17	1	6			36	18	0
9	526	572.306	212.1	89		--	11	0/ 8	4		3	36	18	0
10	527	574.105	211.9	39		--	-11	0	4		3	36	18	0
11	528	575.996	211.8	121		--	28	0	7		3	36	18	0
12	529	578.242	211.7	75		--	-8	1	6			36	18	0
13	530	580.022	211.6	68		--	32	0	4		3	36	18	0
14	531	581.687	211.5	83		--	-30	0	4		3	36	18	0
15	532	583.733	211.5	31		--	0	0/12	4		3	36	18	0
16	533	585.599	211.4	49		--	-11	0	4		3	36	18	0
17	534	588.904	211.3	77		--	0	1	6			36	18	0
18	535	590.696	211.2	112		--	-4	1	6			36	18	0
19	536	592.842	211.1	58		--	-17	15	9			36	18	0
20	537	594.586	211.0	19		--	47	0	4		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 11 TEAM 4
SHOT POINT 1
SHOT TIME: 47: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	538	596.391	210.9	22		--	-56	15	9			36	18	0
2	539	597.562	210.9	60		--	-39	0	4		3	36	18	0
3	540	598.491	210.7	93		--	-48	15	9		3	36	18	0
4	541	599.955	210.6	106		--	-29	0/12	4		3	36	18	0
5	542	600.939	210.6			--	--	21	6			36	18	0
6	543	601.803	210.6	70		--	--	1	6			36	18	0
7	544	603.387	210.5	131		--	-87	0	4		3	36	18	0
8	545	603.390	210.4	136		--	148	0	7		3	36	18	0
9	546	604.605	210.3	48		--	41	18	9			36	18	0
10	547	605.282	210.2	85		--	61	1	6			36	18	0
11	548	605.877	210.1	113		--	23	0/15	4		3	36	18	0
12	549	606.341	209.9	51		--	26	0	7		3	36	18	0
13	550	608.005	209.8	129		--	42	0	4		3	36	18	0
14	551	609.478	209.8	139		--	-35	0	4		3	36	18	0
15	552	611.209	209.9	124		--	27	0	4		3	36	18	0
16	553	613.435	209.8	35		--	-55	0	4		3	36	18	0
17	554	615.003	209.7	17		--	56	15	9			36	18	0
18	555	616.057	209.6	100		--	-34	0	4		3	36	18	0
19	556	617.314	209.4	40		--	12	0	4		3	36	18	0
20	557	619.190	209.3	18		--	11	0	4		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 11 TEAM 5
SHOT POINT 1
SHOT TIME: 47: 1: 0: 0.012

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	619.781	209.2	97		--	-129	0/15	4		3	36	18	0
2	559	621.904	209.0	56		--	9	3/24	4		3	36	18	0
3	560	623.732	208.9	36		--	61	1	6			36	18	0
4	561	624.447	208.6	88		--	-64	2	6			36	18	0
5	562	627.784	208.5	15		--	-309	2	6			36	18	0
6	563	629.713	208.4	71		--	33	0/15/21	4		3	36	18	0
7	564	631.471	208.2	118		--	82	3/29	6			36	18	0
8	565	633.026	208.1	14		--	-48	0	7		3	36	18	0
9	566	633.815	207.9	63		--	-90	0	4		3	36	18	0
10	567	636.469	207.8	73		--	-68	0	4		3	36	18	0
11	568	639.025	207.8	104		--	-68	0	4		3	36	18	0
12	569	640.757	207.8	146		--	90	0	4		3	36	18	0
13	570	642.549	207.8	94		--	52	0	4		3	36	18	0
14	571	643.131	207.6	76		--	--	29	6			36	18	0
15	572	644.651	207.6	99		--	-7	0/ 8	4		3	36	18	0
16	573	647.461	207.5	145		--	-49	3	6			36	18	0
17	574	649.334	207.3	43		--	--	2	6			36	18	0
18	575	651.477	207.2	72		--	-3	8/15	9			36	18	0
19	576	653.566	207.0	12		--	-44	0/ 8	4		3	36	18	0
20	577	654.682	206.9	69		--	6	0	4		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 12 TEAM 1
SHOT POINT 3
SHOT TIME: 47: 1:15: 0.010

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	478	143.608	198.5	115		--	18	0	0		2	36	18	0
2	479	145.377	198.6	87		--	68	0	0		2	36	18	0
3	480	147.352	198.8	125		--	-258	0	5		2	36	18	0
4	481	149.229	199.0	66		--	-86	0	0		2	36	18	0
5	482	151.053	199.1	24		--	7	0	0		2	36	18	0
6	483	153.185	199.2	28		--	-18	0	0		2	36	18	0
7	484	155.647	199.2	34		--	-14	0	0		2	36	18	0
8	485	157.500	199.2	143		--	32	0	1		2	36	18	0
9	486	160.000	199.3	108		--	-11	0	1		2	36	18	0
10	487	163.303	199.4	98		--	--	0	0		2	36	18	0
11	488	165.214	199.5	3		--	2	0	0		1	30	18	0
12	489	167.951	199.6	79		--	9	0	0		2	36	18	0
13	490	170.464	199.8	53		--	-13	0	0		1	36	18	0
14	491	172.449	199.7	65		--	-24	0	0		2	36	18	0
15	492	174.551	199.7	33		--	-18	0	0		2	36	18	0
16	493	176.516	199.7	26		--	-3	29	6			36	18	0
17	494	178.781	199.8	10		--	39	1	6			36	18	0
18	495	180.955	199.8	128		--	21	0	0		2	36	18	0
19	496	183.160	199.8			--	--	20	6			36	18	0
20	497	184.839	199.8	90		--	-19	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 12 TEAM 2
SHOT POINT 3
SHOT TIME: 47: 1:15: 0.010

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	498	187.367	200.0	44		--	5	1	6			36	18	0
2	499	189.473	200.1	55		--	13	0	0		2	36	18	0
3	500	191.649	200.2	52		--	-17	0	1		2	36	18	0
4	501	193.968	200.2	38		--	21	0	0		2	36	18	0
5	502	196.935	200.4	92		--	-18	0	0		2	36	12	0
6	503	199.668	200.4	142		--	27	0	0		2	36	18	0
7	504	202.528	200.5	23		--	96	0	0		2	36	18	0
8	505	205.152	200.9	105		--	-11	0	0		2	36	18	0
9	506	206.850	201.3	120		--	-15	0	0		2	36	18	0
10	507	208.597	201.7	137		--	35	0	2		2	36	18	0
11	508	210.195	202.1	64		--	92	0	2		2	36	18	0
12	509	212.256	202.5	82		--	-18	0	2		2	36	18	0
13	510	214.148	202.9	25		--	46	0	2		2	36	18	0
14	511	215.711	203.3	62		--	-9	0	2		2	42	18	0
15	512	217.425	203.6	101		--	-12	0	2		2	42	12	0
16	513	219.309	203.8	78		--	15	0	1		2	48	18	0
17	514	221.016	204.1	132		--	-9	7/18	9			48	18	0
18	515	222.701	204.3	74		--	-11	0	2		2	56	18	0
19	516	224.178	204.4	32		--	-4	0	1		3	62	18	0
20	517	228.212	204.4	45		--	8	2	6			76	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 12 TEAM 3
SHOT POINT 3
SHOT TIME: 47: 1:15: 0.010

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	231.232	204.3	110		--	-3	0	2		2	62	18	0
2	519	234.017	203.8	122		--	5	0	2		3	48	18	0
3	520	235.892	203.6	133		--	-18	6	9			48	18	0
4	521	237.551	203.4	119		--	-7	0	2		2	42	18	0
5	522	239.344	203.3	96		--	-15	0	2		2	42	18	0
6	523	241.556	203.0	30		--	-18	0	2		2	36	18	0
7	524	243.250	202.9	107		--	-15	28	6			36	18	0
8	525	245.131	202.7	103		--	-17	1	6			36	18	0
9	526	246.201	202.6	89		--	11	0/17	1		2	36	18	0
10	527	248.187	202.4	39		--	-11	0	2		2	36	18	0
11	528	250.249	202.2	121		--	28	6	9			36	18	0
12	529	252.673	202.0	75		--	-8	1	6			36	18	0
13	530	254.550	201.9	68		--	32	0	1		2	36	18	0
14	531	256.292	201.8	83		--	-30	6	9			36	18	0
15	532	258.442	201.7	31		--	0	0	1		3	36	18	0
16	533	260.411	201.6	49		--	-11	0	1		3	36	18	0
17	534	263.863	201.5	77		--	0	1	6			36	18	0
18	535	265.742	201.4	112		--	-4	1	6			36	18	0
19	536	268.050	201.2	58		--	-17	6	9			36	18	0
20	537	269.996	201.0	19		--	47	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 12 TEAM 4
SHOT POINT 3
SHOT TIME: 47: 1:15: 0.010

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	538	271.849	200.9	22		--	-56	7	9			36	18	0
2	539	273.097	200.9	60		--	-39	0	1		3	36	18	0
3	540	274.217	200.7	93		--	-48	0	1		3	36	18	0
4	541	275.863	200.5	106		--	-29	0	2		3	36	18	0
5	542	276.839	200.5			--	--	20	6			36	.18	0
6	543	277.757	200.4	70		--	--	1	6			36	18	0
7	544	279.426	200.4	131		--	-87	0	7		3	36	18	0
8	545	279.610	200.1	136		--	148	0	1		3	36	18	0
9	546	281.076	199.9	48		--	41	6	8			36	18	0
10	547	281.851	199.8	85		--	61	1	6			36	18	0
11	548	282.734	199.5	113		--	23	0	0		3	36	18	0
12	549	283.436	199.2	51		--	26	0	2		3	36	18	0
13	550	285.267	199.0	129		--	42	0	0		3	36	18	0
14	551	286.710	199.1	139		--	-35	0	1		3	36	18	0
15	552	288.323	199.3	124		--	27	0	2		3	36	18	0
16	553	290.678	199.2	35		--	-55	0/17	2		3	36	18	0
17	554	292.479	198.9	17		--	56	0/16	2		3	36	18	0
18	555	293.669	198.8	100		--	-34	0	7		3	36	18	0
19	556	295.203	198.5	40		--	12	0	3		3	36	18	6
20	557	297.261	198.4	18		--	11	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 12 TEAM 5
SHOT POINT 3
SHOT TIME: 47: 1:15: 0.010

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	298.126	198.1	97		--	-129	0	1		3	36	18	0
2	559	300.496	197.9	56		--	9	0/24	1		3	36	18	0
3	560	302.582	197.7	36		--	61	1	6			36	18	0
4	561	303.809	197.2	88		--	-64	2	6			36	18	0
5	562	307.344	197.0	15		--	-309	2	6			36	18	0
6	563	309.521	196.8	71		--	33	0	1		3	36	18	0
7	564	311.521	196.7	118		--	82	29	8			36	18	0
8	565	313.449	196.3	14		--	-48	0	1		2	36	12	0
9	566	314.655	196.0	63		--	-90	0	2		3	36	18	0
10	567	317.423	195.9	73		--	-68	0	2		3	36	18	0
11	568	319.944	196.0	104		--	-68	0	2		3	36	18	0
12	569	321.699	196.0	146		--	90	0	2		3	36	18	0
13	570	323.386	196.1	94		--	52	0	2		3	36	18	0
14	571	324.303	195.8	76		--	--	29	8			36	18	0
15	572	325.864	195.8	99		--	-7	0	3		3	36	18	0
16	573	328.926	195.7	145		--	-49	0	2		3	36	18	0
17	574	331.012	195.5	43		--	--	2	6			36	18	0
18	575	333.483	195.3	72		--	-3	15	9			36	18	0
19	576	335.850	195.1	12		--	-44	0	3		3	36	18	0
20	577	337.167	194.9	69		--	6	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 13   TEAM 1
SHOT POINT   4
SHOT TIME: 47: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	478	86.496	35.7	115		--	18	0	1		3	36	18	0
2	479	84.717	35.8	87		--	68	0	0		3	36	18	0
3	480	82.681	35.9	125		--	-258	0	2		3	36	18	0
4	481	80.765	36.0	66		--	-86	0	1		3	36	18	0
5	482	78.720	36.1	24		--	7	0	0		3	36	18	0
6	483	76.661	36.5	28		--	-18	0	0		2	36	18	0
7	484	74.331	37.1	34		--	-14	0	2		3	36	18	0
8	485	72.582	37.5	143		--	32	0	1		3	36	18	0
9	486	70.115	37.9	108		--	-11	0	1		3	36	18	0
10	487	66.888	38.5	98		--	--	0	0		3	36	18	0
11	488	64.994	38.9	3		--	2	0	1		2	36	18	0
12	489	62.286	39.3	79		--	9	0	1		2	36	18	0
13	490	59.791	39.8	53		--	-13	0	0		2	36	18	0
14	491	57.985	40.6	65		--	-24	0	0		2	36	18	0
15	492	56.095	41.5	33		--	-18	0	0		2	36	18	0
16	493	54.210	42.1	26		--	-3	29	8			36	18	0
17	494	52.024	42.7	10		--	39	1	6			36	18	0
18	495	50.109	43.9	128		--	21	0	2		2	36	18	0
19	496	48.099	44.9			--	--	20	6			36	18	0
20	497	46.525	45.6	90		--	-19	0	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 13 TEAM 2
SHOT POINT 4
SHOT TIME: 47: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	498	44.061	46.5	44		--	5	1	6			36	18	0
2	499	42.059	47.4	55		--	13	0	0		2	36	18	0
3	500	39.973	48.4	52		--	-17	0	0		2	36	18	0
4	501	37.886	49.9	38		--	21	0	0		2	36	18	0
5	502	35.084	51.6	92		--	-18	0	0		2	36	18	0
6	503	32.616	53.6	142		--	27	0	0		2	36	18	0
7	504	30.099	56.1	23		--	96	0	0		2	36	18	0
8	505	27.134	56.8	105		--	-11	0	0		2	36	18	0
9	506	24.906	56.4	120		--	-15	0	0		2	36	18	0
10	507	22.648	56.0	137		--	35	0	0		2	36	18	0
11	508	20.606	55.5	64		--	92	0	0		2	36	18	0
12	509	18.004	54.8	82		--	-18	0	1		1	36	18	0
13	510	15.627	54.0	25		--	46	0	0		1	36	18	0
14	511	13.550	52.2	62		--	-9	0	0		1	42	18	0
15	512	11.547	51.8	101		--	-12	0	0		1	42	18	0
16	513	9.448	52.2	78		--	15	0	0		1	48	18	0
17	514	7.346	49.8	132		--	-9	0	0		1	48	18	0
18	515	5.481	49.9	74		--	-11	0	0		1	56	18	0
19	516	4.138	57.3	32		--	-4	0	1		1	62	18	0
20	517	2.233	128.5	45		--	8	2	6			76	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 13   TEAM 3
SHOT POINT 4
SHOT TIME: 47: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	4.350	169.1	110		--	-3	0	0		1	62	18	0
2	519	7.842	167.8	122		--	5	0	0		1	48	18	0
3	520	9.879	170.0	133		--	-18	6	8			48	18	0
4	521	11.510	172.7	119		--	-7	0	0		1	42	18	0
5	522	13.431	173.8	96		--	-15	0	0		1	42	18	0
6	523	15.888	174.2	30		--	-18	0	0		1	36	18	0
7	524	17.646	175.2	107		--	-15	0	0		1	36	18	0
8	525	19.547	176.4	103		--	-17	1	6			36	18	0
9	526	20.700	176.6	89		--	11	0	0		1	36	18	0
10	527	22.924	176.4	39		--	-11	0	0		1	36	18	0
11	528	25.169	176.6	121		--	28	6	8			36	18	0
12	529	27.739	177.0	75		--	-8	1	6			36	18	0
13	530	29.628	177.7	68		--	32	0	0		2	36	18	0
14	531	31.349	178.4	83		--	-30	0/ 6	0		2	36	18	0
15	532	33.504	179.1	31		--	0	0	0		2	36	18	0
16	533	35.498	179.6	49		--	-11	0	0		2	36	18	0
17	534	38.927	180.7	77		--	0	1	6			36	18	0
18	535	40.811	181.1	112		--	-4	1	6			36	18	0
19	536	43.241	181.1	58		--	-17	25	9			36	18	0
20	537	45.421	180.7	19		--	47	25	9			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 13 TEAM 4
SHOT POINT 4
SHOT TIME: 47: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	538	47.205	181.3	22		--	-56	7	9			36	18	0
2	539	48.493	181.4	60		--	-39	21	9			36	18	0
3	540	49.893	180.7	93		--	-48	0	0		2	36	18	0
4	541	51.749	180.3	106		--	-29	0	0		2	36	18	0
5	542	52.623	180.8			--	--	20	6			36	18	0
6	543	53.565	180.9	70		--	--	1	6			36	18	0
7	544	55.251	181.1	131		--	-87	0	5		2	36	18	0
8	545	55.770	180.2	136		--	148	0	1		2	36	18	0
9	546	57.593	179.4	48		--	41	6	9			36	18	0
10	547	58.489	179.2	85		--	61	1	6			36	18	0
11	548	59.859	178.1	113		--	23	0	0		2	36	18	0
12	549	60.975	177.2	51		--	26	0	0		2	36	18	0
13	550	62.949	177.2	129		--	42	3/16	0		2	36	18	0
14	551	64.181	177.9	139		--	-35	3/24	6			36	18	0
15	552	65.404	179.1	124		--	27	0	0		2	36	18	0
16	553	67.787	179.3	35		--	-55	17	0		2	36	18	0
17	554	69.857	178.9	17		--	56	0	0		2	36	18	0
18	555	71.191	178.8	100		--	-34	21	9			36	18	0
19	556	73.098	178.1	40		--	12	0	0		2	36	18	0
20	557	75.299	178.1	18		--	11	0	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 13   TEAM 5
SHOT POINT   4
SHOT TIME: 47: 1:30: 0.015

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	76.595	177.3	97		--	-129	0	1		2	36	18	0
2	559	79.192	177.2	56		--	9	16	6			36	18	0
3	560	81.913	176.9	36		--	61	1	6			36	18	0
4	561	83.984	175.5	88		--	-64	2	6			36	18	0
5	562	87.531	176.0	15		--	-309	2	6			36	18	0
6	563	89.950	175.8	71		--	33	0	1		2	36	18	0
7	564	92.193	175.6	118		--	82	3/24/29	6			36	18	0
8	565	94.609	175.1	14		--	-48	3	6			36	18	0
9	566	96.455	174.2	63		--	-90	0	1		3	36	18	0
10	567	99.143	174.6	73		--	-68	0	1		3	36	18	0
11	568	101.350	175.4	104		--	-68	0	0		3	36	18	0
12	569	102.976	175.7	146		--	90	0	1		3	36	18	0
13	570	104.330	176.4	94		--	52	0	1		3	36	18	0
14	571	105.736	175.8	76		--	--	29	6			36	18	0
15	572	107.225	176.0	99		--	-7	0	1		3	36	18	0
16	573	110.434	176.1	145		--	-49	0	0		3	36	18	0
17	574	112.691	176.0	43		--	--	2	6			36	18	0
18	575	115.487	175.7	72		--	-3	21	6			36	18	0
19	576	118.102	175.6	12		--	-44	0	1		3	36	18	0
20	577	119.632	175.4	69		--	6	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 14 TEAM 1
SHOT POINT 6
SHOT TIME: 47: 4: 0: 0.057

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	478	474.844	13.9	115		--	18	0	4		3	36	18	0
2	479	473.103	13.9	87		--	68	0	4		3	36	18	0
3	480	471.175	13.8	125		--	-258	0/12	4		3	36	18	0
4	481	469.341	13.7	66		--	-86	0	3		3	36	18	0
5	482	467.560	13.6	24		--	7	0	3		3	36	18	0
6	483	465.446	13.6	28		--	-18	0	3		3	36	18	0
7	484	462.994	13.6	34		--	-14	0	3		3	36	18	0
8	485	461.147	13.5	143		--	32	0	3		3	36	18	0
9	486	458.690	13.5	108		--	-11	0	3		3	36	18	0
10	487	455.438	13.4	98		--	--	0	3		3	36	18	0
11	488	453.566	13.3	3		--	2	0/12	3		3	36	18	0
12	489	450.888	13.2	79		--	9	0	3		3	36	18	0
13	490	448.433	13.1	53		--	-13	0	3		3	36	18	0
14	491	446.447	13.1	65		--	-24	0	3		3	36	18	0
15	492	444.340	13.1	33		--	-18	0	3		3	36	18	0
16	493	442.407	13.1	26		--	-3	29	8			36	18	0
17	494	440.187	13.0	10		--	39	1	6			36	18	0
18	495	438.008	13.0	128		--	21	0/ 8	2		3	36	18	0
19	496	435.822	12.9			--	--	20	6			36	18	0
20	497	434.171	12.9	90		--	-19	0	2		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 14 TEAM 2
SHOT POINT 6
SHOT TIME: 47: 4: 0: 0.057

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	498	431.715	12.8	44		--	5	1	6			36	18	0
2	499	429.661	12.7	55		--	13	0	1		3	36	18	0
3	500	427.546	12.6	52		--	-17	0	2		3	36	18	0
4	501	425.263	12.6	38		--	21	0	1		3	36	18	0
5	502	422.387	12.5	92		--	-18	0	1		3	36	18	0
6	503	419.720	12.4	142		--	27	0	2		3	36	18	0
7	504	416.928	12.3	23		--	96	15	9			36	18	0
8	505	414.539	12.0	105		--	-11	0	1		3	36	18	0
9	506	413.087	11.8	120		--	-15	0/15	1		3	36	18	0
10	507	411.604	11.5	137		--	35	0	2		3	36	18	0
11	508	410.258	11.3	64		--	92	15	9			36	18	0
12	509	408.534	11.0	82		--	-18	0	1		3	36	18	0
13	510	406.970	10.8	25		--	46	0	1		3	36	18	0
14	511	405.745	10.5	62		--	-9	0	2		3	42	18	0
15	512	404.301	10.3	101		--	-12	0	2		3	42	18	0
16	513	402.678	10.1	78		--	15	0	2		3	48	18	0
17	514	401.320	9.9	132		--	-9	0/15	2		3	48	18	0
18	515	399.881	9.7	74		--	-11	0	1		3	56	18	0
19	516	398.479	9.6	32		--	-4	0	2		3	62	18	0
20	517	394.597	9.5	45		--	8	2	6			76	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 14 TEAM 3
SHOT POINT 6
SHOT TIME: 47: 4: 0: 0.057

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	391.589	9.4	110		--	-3	0	2		3	62	18	0
2	519	388.367	9.6	122		--	5	0	1		3	48	18	0
3	520	386.336	9.7	133		--	-18	0/21	7		3	48	18	0
4	521	384.621	9.7	119		--	-7	0	1		3	42	18	0
5	522	382.703	9.7	96		--	-15	0	1		3	42	18	0
6	523	380.301	9.8	30		--	-18	0	1		3	36	18	0
7	524	378.521	9.9	107		--	-15	3/24/28	6			36	18	0
8	525	376.574	9.9	103		--	-17	1	6			36	18	0
9	526	375.433	9.9	89		--	11	0/18	5		3	36	18	0
10	527	373.275	10.0	39		--	-11	0	4		3	36	18	0
11	528	371.068	10.1	121		--	28	0	4		3	36	18	0
12	529	368.509	10.1	75		--	-8	1	6			36	18	0
13	530	366.580	10.1	68		--	32	0	2		3	36	18	0
14	531	364.807	10.1	83		--	-30	0	4		3	36	18	0
15	532	362.607	10.1	31		--	0	0	2		3	36	18	0
16	533	360.584	10.1	49		--	-11	0	2		3	36	18	0
17	534	357.076	10.1	77		--	0	1	6			36	18	0
18	535	355.161	10.1	112		--	-4	1	6			36	18	0
19	536	352.744	10.2	58		--	-17	0/11	9			36	18	0
20	537	350.638	10.3	19		--	47	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 14 TEAM 4
SHOT POINT 6
SHOT TIME: 47: 4: 0: 0.057

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	538	348.790	10.3	22		--	-56	7	9			36	18	0
2	539	347.500	10.3	60		--	-39	0/ 8	4		3	36	18	0
3	540	346.212	10.4	93		--	-48	0	1		3	36	18	0
4	541	344.432	10.5	106		--	-29	0	1		3	36	18	0
5	542	343.491	10.5			--	--	20	6			36	18	0
6	543	342.545	10.5	70		--	--	1	6			36	18	0
7	544	340.840	10.5	131		--	-87	0	2		3	36	18	0
8	545	340.488	10.7	136		--	148	0	5		3	36	18	0
9	546	338.834	10.9	48		--	41	18	6			36	18	0
10	547	337.992	10.9	85		--	61	1	6			36	18	0
11	548	336.895	11.2	113		--	23	0	2		3	36	18	0
12	549	336.027	11.4	51		--	26	0	1		3	36	18	0
13	550	334.113	11.5	129		--	42	0	2		3	36	18	0
14	551	332.720	11.4	139		--	-35	17/18	8			36	18	0
15	552	331.228	11.2	124		--	27	0	1		3	36	18	0
16	553	328.824	11.2	35		--	-55	17	2		3	36	18	0
17	554	326.891	11.4	17		--	56	0	2		3	36	18	0
18	555	325.629	11.5	100		--	-34	0	7		3	36	18	0
19	556	323.942	11.7	40		--	12	0	2		3	36	18	0
20	557	321.807	11.8	18		--	11	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 14 TEAM 5
SHOT POINT 6
SHOT TIME: 47: 4: 0: 0.057

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	320.798	12.0	97		--	-129	0	1		3	36	18	0
2	559	318.331	12.2	56		--	9	0	1		3	36	18	0
3	560	316.146	12.4	36		--	61	1	6			36	18	0
4	561	314.719	12.8	88		--	-64	2	6			36	18	0
5	562	311.144	12.9	15		--	-309	2	6			36	18	0
6	563	308.902	13.1	71		--	33	0/15	1		3	36	18	0
7	564	306.846	13.3	118		--	82	12/15/29	1		3	36	18	0
8	565	304.836	13.6	14		--	-48	0	1		2	36	18	0
9	566	303.557	14.0	63		--	-90	0	0		3	36	18	0
10	567	300.781	14.0	73		--	-68	0	1		3	36	18	0
11	568	298.274	13.9	104		--	-68	0	1		3	36	18	0
12	569	296.523	13.9	146		--	90	0	1		3	36	18	0
13	570	294.860	13.7	94		--	52	0	2		3	36	18	0
14	571	293.892	14.0	76		--	--	29	6			36	18	0
15	572	292.330	14.0	99		--	-7	0	2		3	36	18	0
16	573	289.246	14.2	145		--	-49	0	2		3	36	18	0
17	574	287.145	14.4	43		--	--	2	6			36	18	0
18	575	284.659	14.7	72		--	-3	0	9			36	18	0
19	576	282.289	14.9	12		--	-44	0	2		3	36	18	0
20	577	280.976	15.1	69		--	6	0	1		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 15 TEAM 1
SHOT POINT 5
SHOT TIME: 51: 1: 0: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	895	73.756	178.8	3		--	1	0	0		2	36	18	0
2	896	75.053	178.8	53		--	-10	0/ 6	1		2	36	18	0
3	897	78.316	178.6	65		--	-30	0	1		1	36	18	0
4	898	81.184	178.0	132		--	-10	6	8			36	18	0
5	899	82.883	178.1	120		--	-14	0	2		2	36	18	0
6	900	84.401	178.7	32		--	-19	6	8			36	18	0
7	905	98.114	183.4	74		--	-8	0	0		2	36	18	0
8	906	99.999	183.1	31		--	-130	0	0		2	36	18	0
9	907	102.302	183.2	105		--	-14	0	0		2	36	18	0
10	908	115.610	186.7	62		--	-15	0	1		3	36	18	0
11	909	116.544	187.4	55		--	13	3/24	6			36	18	0
12	910	118.157	187.8	26		--	3	0	1		3	36	18	0
13	911	119.140	188.6	52		--	-48	0	1		3	36	18	0
14	912	120.943	188.7	38		--	7	0	1		3	36	18	0
15	913	122.423	188.8	82		--	-54	0	1		3	36	18	0
16	914	125.983	188.7	68		--	12	0	1		3	36	18	0
17	915	128.450	188.8	44		--	10	0	1		3	42	18	0
18	916	130.462	188.8	143		--	0	0	1		3	36	18	0
19	917	132.374	188.9	142		--	14	0	2		3	48	18	0
20	925	137.255	193.0	23		--	--	1	6			64	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 15 TEAM 2
SHOT POINT 5
SHOT TIME: 51: 1: 0: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	801	12.757	205.4	137		--	9	0	0		1	42	18	0
2	802	14.869	201.0	110		--	-13	0	0		1	36	18	0
3	803	17.483	197.1	34		--	-23	0	0		1	36	18	0
4	804	20.429	194.3	64		--	58	0	0		1	36	18	0
5	805	24.060	191.7	25		--	-22	0	0		1	36	18	0
6	806	24.756	166.4	45		--	8	20	6			36	18	0
7	807	27.503	167.5	122		--	10	0	0		1	36	18	0
8	808	30.240	168.5	90		--	-23	0	0		1	36	18	0
9	809	34.679	169.6	19		--	-23	2	6			36	18	0
10	810	37.293	170.3	78		--	9	0	0		1	36	18	0
11	811	41.708	170.9	49		--	-16	0/ 6	0		1	36	18	0
12	812	45.174	171.8	30		--	-12	0	0		2	36	18	0
13	813	49.340	172.4	128		--	-22	0	0		2	36	18	0
14	888	52.862	175.3	92		--	-15	0	0		1	36	18	0
15	889	56.690	177.1	39		--	-7	0	0		2	36	18	0
16	890	60.136	177.9	108		--	-28	1	6			36	18	0
17	891	63.387	180.8	28		--	-21	3/16	6			36	18	0
18	892	66.729	179.5	24		--	3	0	0		2	36	18	0
19	893	69.025	178.8	98		--	-51	2	6			36	18	0
20	894	70.541	178.4	79		--	14	0	0		1	36	18	0

EXPERIMENT NO. 1 SAUDI ARABIA, 1978

DATA FOR ONE TEAM-SHOT
SHOTS 1-19 (1981 UPDATE)

SHOT NUMBER 15 TEAM 3
SHOT POINT 5
SHOT TIME: 51: 1: 0: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	578	142.633	16.2	106		--	1	0	0		2	36	18	0
2	579	140.704	16.6	125		--	--	1	6			36	18	0
3	580	139.462	16.6	113		--	16	0	0		2	36	18	0
4	581	136.716	17.0	100		--	2	25	9			36	18	0
5	582	132.973	17.3	89		--	22	0	0		2	36	18	0
6	583	130.596	18.1	48		--	22	0	0		2	36	18	0
7	584	129.311	19.3	10		--	58	0	0		2	36	18	0
8	585	127.230	20.0	130		--	-7	0	1		2	36	18	0
9	586	126.359	20.6	83		--	-17	0	0		2	36	18	0
10	587	125.109	21.0	133		--	-4	0	1		2	36	18	0
11	588	123.558	21.9	77		--	87	0	0		2	36	18	0
12	589	121.588	22.9	87		--	57	3/24	6			36	18	0
13	590	119.177	23.6	96		--	-2	3/24	6			36	18	0
14	591	117.048	24.3	66		--	--	20	6			36	18	0
15	592	115.806	24.2	75		--	3	0	1		2	36	18	0
16	593	113.227	24.4	112		--	-3	0	1		2	36	18	0
17	594	111.900	23.3			--	--	20	6			36	18	0
18	595	109.657	23.9	121		--	-27	0	1		2	36	18	0
19	596	107.041	23.7	58		--	-3	0	1		2	36	18	0
20	597	104.181	23.3	103		--	-3	0	1		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 15   TEAM 4
SHOT POINT 5
SHOT TIME: 51: 1: 0: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	254.710	7.5	51		--	-5	1	6			36	18	0
2	520	249.399	7.8	129		--	0	0	2		2	36	18	0
3	523	243.337	8.0	124		--	-2	24/25	9			36	18	0
4	526	238.456	8.1	85		--	27	0	1		2	36	18	0
5	529	231.490	8.4	139		--	-28	0	1		2	36	18	0
6	532	225.588	8.4	18		--	-7	0	1		2	36	18	0
7	534	220.059	8.3	70		--	--	1	6			36	18	0
8	536	215.717	8.4	60		--	-30	0	5			36	18	0
9	538	211.749	8.5	35		--	-42	0/23	3			48	36	30
10	541	207.344	8.9	22		--	-39	6	5		2	36	18	0
11	545	203.376	9.1	17		--	47	0	1		2	36	18	0
12	549	198.816	10.2	136		--	79	0	1		2	36	18	0
13	552	194.040	9.9	93		--	-38	0	0		2	36	18	0
14	555	188.407	10.3	131		--	-59	0	1		2	36	18	0
15	557	184.552	10.9	40		--	16	0	2		2	36	18	0
16	926	140.070	193.2	115		--	-88	0	1		2	64	18	0
17	927	141.630	193.7			--	--	20	6			36	18	0
18	928	150.321	196.3	101		--	-8	0	5		2	64	18	0
19	929	157.549	198.0	107		--	-14	0	5		2	36	18	0
20	930	158.563	198.5	119		--	-18	0	5		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 15 TEAM 5
SHOT POINT 5
SHOT TIME: 51: 1: 0: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	183.523	11.3	145		--	-17	0	5		2	36	18	0
2	559	181.045	11.5	72		--	-10	0	1		2	36	18	0
3	560	178.849	11.9	146		--	30	0	1		2	36	18	0
4	561	177.404	12.7	88		--	-33	1	6			36	18	0
5	562	173.828	12.8	97		--	-72	0	1		2	36	18	0
6	563	171.585	13.1	14		--	-100	0	0		2	36	18	0
7	564	169.529	13.4	69		--	-18	1	6			36	18	0
8	565	167.526	14.0	94		--	29	0	1		2	36	18	0
9	566	166.264	14.7	104		--	-39	0	0		2	36	18	0
10	567	163.491	14.8	99		--	-7	0	0		2	36	18	0
11	568	160.979	14.6	15		--	--	20	6			36	18	0
12	569	159.226	14.6	56		--	-3	0	1		2	36	18	0
13	570	157.556	14.3	43		--	--	20	6			36	18	0
14	571	156.606	14.9	12		--	-27	0	0		2	36	18	0
15	572	155.044	14.9	118		--	12	0	0		2	36	18	0
16	573	151.975	15.2	73		--	--	29	8			36	18	0
17	574	149.889	15.6	36		--	-36	0	0		2	36	18	0
18	575	147.435	16.1	76		--	39	0	0		2	36	18	0
19	576	145.096	16.6	63		--	-46	0	0		2	36	18	0
20	577	143.810	17.0	71		--	-35	0	0		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 16 TEAM 1
SHOT POINT 6
SHOT TIME: 51: 4: 0: 0.037

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	895	67.782	28.7	3		--	1	0	0		1	36	18	0
2	896	66.661	29.3	53		--	-10	0/ 6	0		1	36	18	0
3	897	64.022	31.0	65		--	-30	0	0		1	36	18	0
4	898	62.400	32.9	132		--	-10	6	8			36	18	0
5	899	60.949	33.7	120		--	-14	0	0		1	36	18	0
6	900	59.178	33.8	32		--	-19	6	8			36	18	0
7	905	43.649	35.2	74		--	-8	0	0		1	36	18	0
8	906	42.390	37.2	31		--	-130	0	0		1	36	18	0
9	907	40.359	38.7	105		--	-14	0	0		1	36	18	0
10	908	25.796	43.0	62		--	-15	0	0		1	36	18	0
11	909	24.155	41.3	55		--	13	0	0		1	36	18	0
12	910	22.460	42.2	26		--	3	0	0		1	36	18	0
13	911	20.735	40.0	52		--	-48	0	0		1	36	18	0
14	912	19.026	41.9	38		--	7	0/17	0		1	36	18	0
15	913	17.768	44.3	82		--	-54	7	9			36	18	0
16	914	15.175	52.7	68		--	12	0	0		1	36	18	0
17	915	13.205	58.9	44		--	10	0	0		1	42	18	0
18	916	12.129	66.6	143		--	0	0/17	0		1	36	18	0
19	917	11.007	74.3	142		--	14	0	0		1	48	18	0
20	925	0.279	90.0	23		--	--	1	6			64	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 16 TEAM 2
SHOT POINT 6
SHOT TIME: 51: 4: 0: 0.037

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	801	124.835	11.8	137		--	9	0	1		2	42	18	0
2	802	122.547	12.1	110		--	-13	0	1		2	36	18	0
3	803	119.809	12.5	34		--	-23	0	1		2	36	18	0
4	804	116.806	12.9	64		--	58	0	1		2	36	18	0
5	805	113.160	13.4	25		--	-22	0	1		2	36	18	0
6	806	115.623	18.6	45		--	8	20	6			36	18	0
7	807	113.014	19.2	122		--	10	0	5		1	36	18	0
8	808	110.397	19.7	90		--	-23	0	1		1	36	18	0
9	809	106.239	20.6	19		--	-23	2	6			36	18	0
10	810	103.776	21.1	78		--	9	0	1		1	36	18	0
11	811	99.766	22.2	49		--	-16	0	1		1	36	18	0
12	812	96.428	23.0	30		--	-12	0	1		1	36	18	0
13	813	92.591	24.0	128		--	-22	0/23	1		2	36	18	0
14	888	88.208	23.7	92		--	-15	0	0		1	36	18	0
15	889	84.031	23.9	39		--	-7	0	0		1	36	18	0
16	890	80.553	24.4	108		--	-28	1	6			36	18	0
17	891	76.013	23.4	28		--	-21	1	6			36	18	0
18	892	73.579	25.4	24		--	3	0	1		1	36	18	0
19	893	71.893	26.8	98		--	-51	2	6			36	18	0
20	894	70.788	27.7	79		--	14	0	2		1	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 16 TEAM 3
SHOT POINT 6
SHOT TIME: 51: 4: 0: 0.037

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	578	279.852	14.7	106		--	1	0	9			36	18	0
2	579	277.896	14.9	125		--	--	1	6			36	18	0
3	580	276.659	14.9	113		--	16	0	1		3	36	18	0
4	581	273.884	15.0	100		--	2	25	9			36	18	0
5	582	270.121	15.1	89		--	22	0	1		2	36	18	0
6	583	267.665	15.6	48		--	22	0	9			36	18	0
7	584	266.249	16.1	10		--	58	0	0		3	36	18	0
8	585	264.091	16.4	130		--	-7	0	2		3	36	18	0
9	586	263.135	16.7	83		--	-17	0	2		3	36	18	0
10	587	261.820	16.9	133		--	-4	0	2		2	36	18	0
11	588	260.127	17.3	77		--	87	0	2		2	36	18	0
12	589	257.998	17.7	87		--	57	0	2		3	36	18	0
13	590	255.444	18.0	96		--	-2	6	8			36	18	0
14	591	253.200	18.2	66		--	--	20	6			36	18	0
15	592	251.971	18.2	75		--	3	0	1		3	36	18	0
16	593	249.373	18.2	112		--	-3	25	9			36	18	0
17	594	248.263	17.7			--	--	20	6			36	18	0
18	595	245.927	17.9	121		--	-27	0	1		3	36	18	0
19	596	243.355	17.8	58		--	-3	0	1		3	36	18	0
20	597	240.588	17.5	103		--	-3	0	1		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 16   TEAM 4
SHOT POINT   6
SHOT TIME: 51: 4: 0: 0.037

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	518	391.589	9.4	51		--	-5	1	6			36	18	0
2	520	386.336	9.7	129		--	0	0	1		3	36	18	0
3	523	380.301	9.8	124		--	-2	0/ 9	5		3	36	18	0
4	526	375.433	9.9	85		--	27	0	1		3	36	18	0
5	529	368.509	10.1	139		--	-28	0	1		3	36	18	0
6	532	362.607	10.1	18		--	-7	0	5		3	36	18	0
7	534	357.076	10.1	70		--	--	1	6			36	18	0
8	536	352.744	10.2	60		--	-30	0	1		3	36	18	0
9	538	348.790	10.3	35		--	-42	0/23	2		3	48	36	30
10	541	344.432	10.5	22		--	-39	0	5		3	36	18	0
11	545	340.488	10.7	17		--	47	0	5		3	36	18	0
12	549	336.027	11.4	136		--	79	0	5		3	36	18	0
13	552	331.228	11.2	93		--	-38	0	5		3	36	18	0
14	555	325.629	11.5	131		--	-59	0	2		3	36	18	0
15	557	321.807	11.8	40		--	16	0	5		3	36	18	0
16	926	2.768	201.1	115		--	-88	0	0		1	64	18	0
17	927	4.541	212.2			--	--	20	6			36	18	0
18	928	15.316	226.8	101		--	-8	0	0		1	64	18	0
19	929	23.774	227.5	107		--	-14	0	0		1	36	18	0
20	930	25.363	229.1	119		--	-18	0	0		1	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 16 TEAM 5
SHOT POINT 6
SHOT TIME: 51: 4: 0: 0.037

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	558	320.798	12.0	145		--	-17	0	5		3	36	18	0
2	559	318.331	12.2	72		--	-10	0	5		3	36	18	0
3	560	316.146	12.4	146		--	30	0	2		3	36	18	0
4	561	314.719	12.8	88		--	-33	1	6			36	18	0
5	562	311.144	12.9	97		--	-72	0	1		3	36	18	0
6	563	308.902	13.1	14		--	-100	0	5		3	36	18	0
7	564	306.846	13.3	69		--	-18	1	6			36	18	0
8	565	304.836	13.6	94		--	29	0	5		3	36	18	0
9	566	303.557	14.0	104		--	-39	0	5		3	36	18	0
10	567	300.781	14.0	99		--	-7	0	5		3	36	18	0
11	568	298.274	13.9	15		--	--	20	6			36	18	0
12	569	296.523	13.9	56		--	-3	0	5		3	36	18	0
13	570	294.860	13.7	43		--	--	20	6			36	18	0
14	571	293.892	14.0	12		--	-27	0	1		3	36	18	0
15	572	292.330	14.0	118		--	12	0	5		3	36	18	0
16	573	289.246	14.2	73		--	--	29	6			36	18	0
17	574	287.145	14.4	36		--	-36	0	0		3	36	18	0
18	575	284.659	14.7	76		--	39	0	0		3	36	18	0
19	576	282.289	14.9	63		--	-46	0	5		3	36	18	0
20	577	280.976	15.1	71		--	-35	0	5		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 17 TEAM 1
SHOT POINT 5
SHOT TIME: 53: 1:15: 0.014

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	895	73.756	178.8	3		--	-6	0	5		2	36	18	0
2	896	75.053	178.8	53		--	-22	0/ 6	5		2	36	18	0
3	897	78.316	178.6	65		--	-56	0	5		1	36	18	0
4	898	81.184	178.0	132		--	-23	6	8			36	18	0
5	899	82.883	178.1	120		--	-31	0	5		2	36	18	0
6	900	84.401	178.7	32		--	-43	1	6			36	18	0
7	905	98.114	183.4	74		--	-17	11	9			36	18	0
8	906	99.999	183.1	31		--	-228	11	9			36	18	0
9	907	102.302	183.2	105		--	-27	11	9			36	18	0
10	908	115.610	186.7	62		--	-34	1	6			36	18	0
11	909	116.544	187.4	55		--	19	0	1		3	36	18	0
12	910	118.157	187.8	26		--	0	11	9			36	18	0
13	911	119.140	188.6	52		--	-98	0	5		3	36	18	0
14	912	120.943	188.7	38		--	9	6	8			36	18	0
15	913	122.423	188.8	82		--	-54	6	8			36	18	0
16	914	125.983	188.7	68		--	12	0	5		3	36	18	0
17	915	128.450	188.8	44		--	9	0	5		3	42	18	0
18	916	130.462	188.8	143		--	-15	0	5		3	36	18	0
19	917	132.374	188.9	142		--	124	0	5		3	48	18	0
20	925	137.255	193.0	23		--	98	20	6			64	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 17 TEAM 2
SHOT POINT 5
SHOT TIME: 53: 1:15: 0.014

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	801	12.757	205.4	137		--	9	0	5		1	42	18	0
2	802	14.869	201.0	110		--	-13	0	5		1	36	18	0
3	803	17.483	197.1	34		--	-23	0	5		1	36	18	0
4	804	20.429	194.3	64		--	58	0	5		1	36	18	0
5	805	24.060	191.7	25		--	-22	0	5		1	36	18	0
6	806	24.756	166.4	45		--	8	20	6			36	18	0
7	807	27.503	167.5	122		--	10	0	5		1	36	18	0
8	808	30.240	168.5	90		--	-23	1	6			36	18	0
9	809	34.679	169.6	19		--	-23	2	6			36	18	0
10	810	37.293	170.3	78		--	9	0	5		2	36	18	0
11	811	41.708	170.9	49		--	-16	6	5		2	36	18	0
12	812	45.174	171.8	30		--	-12	0	5		2	36	18	0
13	813	49.340	172.4	128		--	-22	2	6			36	18	0
14	888	52.862	175.3	92		--	-15	2	6			36	18	0
15	889	56.690	177.1	39		--	-7	0	5		2	36	18	0
16	890	60.136	177.9	108		--	-28	0	0		2	36	18	0
17	891	63.387	180.8	28		--	-21	3/16	6			36	18	0
18	892	66.729	179.5	24		--	3	0	5		2	36	18	0
19	893	69.025	178.8	98		--	-51	2	6			36	18	0
20	894	70.541	178.4	79		--	14	0	5		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 17 TEAM 3
SHOT POINT 5
SHOT TIME: 53: 1:15: 0.014

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	578	142.633	16.2	106		--	-40	0	5		2	36	18	0
2	580	139.462	16.6	113		--	-6	0	5		2	36	18	0
3	581	136.716	17.0	100		--	-39	25	9			36	18	0
4	582	132.973	17.3	89		--	12	0	5		2	36	18	0
5	583	130.596	18.1	48		--	-5	0	5		2	36	18	0
6	585	127.230	20.0	130		--	-60	0	5		2	36	18	0
7	587	125.109	21.0	133		--	-52	25	9			36	18	0
8	589	121.588	22.9	87		--	106	1	6			36	18	0
9	590	119.177	23.6	96		--	-46	17	8			36	18	0
10	592	115.806	24.2	75		--	-36	0	5		2	36	18	0
11	593	113.227	24.4	112		--	-43	2	6			36	18	0
12	595	109.657	23.9	121		--	44	0/24	5		2	36	18	0
13	597	104.181	23.3	103		--	-50	3	6			36	18	0
14	599	100.945	21.4	66		--	161	0	0		2	36	18	0
15	600	98.751	20.9	83		--	-67	0	0		2	36	18	0
16	602	94.775	20.7	58		--	-47	15	9			36	18	0
17	604	92.238	19.4	10		--	39	0	0		2	36	18	0
18	605	91.420	18.0	125		--	158	0	1		2	36	18	0
19	607	88.615	16.7	37		--	57	0	1		3	36	18	0
20	608	86.839	17.1			--	--	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 17   TEAM 4
SHOT POINT   5
SHOT TIME: 53: 1:15: 0.014

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	609	84.410	18.1	51		--	--	1	6			36	18	0
2	610	82.815	18.8	17		--	37	25	9			36	18	0
3	611	81.860	18.9	85	1001 SAMP	--	--	0	0		2	36	18	0
4	612	80.791	18.7	18	1001 SAMP	--	-2	0	0		2	36	18	0
5	613	79.068	18.8	129		--	-5	28	6			36	18	0
6	614	76.838	19.0	22	1001 SAMP	--	-25	6	0		2	36	18	0
7	615	75.086	20.1	70		--	--	1	6			36	18	0
8	616	72.895	18.8	139	1001 SAMP	--	-16	0	0		2	36	18	0
9	617	70.844	19.1	131	1001 SAMP	--	-37	0	0		2	36	18	0
10	618	67.971	19.5	93	1001 SAMP	--	-19	0	0		2	36	18	0
11	619	66.253	19.7			--	--	20	6			36	18	0
12	620	64.238	20.0	136	1001 SAMP	--	58	0	0		2	36	18	0
13	621	62.254	20.5	40		--	249	28	6			36	18	0
14	623	56.243	21.6	60		--	-16	28	6			36	18	0
15	624	51.742	22.6	35	1001 SAMP	--	-22	0	0		2	36	18	0
16	955	49.438	23.1	124	1001 SAMP	--	8	0	0		2	36	18	0
17	926	140.070	193.2	115		--	98	20	6			36	18	0
18	928	150.321	196.3	101		--	-23	20	6			36	18	0
19	929	157.549	198.0	107		--	-34	20	6			36	18	0
20	930	158.563	198.5	119		--	-48	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 17 TEAM 5
SHOT POINT 5
SHOT TIME: 53: 1:15: 0.014

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	956	44.900	21.0	145	613 H	--	96	0	0		2	36	18	0
2	957	42.601	21.9	146	614 H	--	136	0	0		2	36	18	0
3	958	37.798	21.9	94	615 H	--	125	0	0		2	36	18	0
4	959	36.866	20.3	15	616 H	--	101	0	0		2	36	18	0
5	960	34.066	18.6	76	617 H	--	143	0	0		2	36	18	0
6	961	29.564	11.4	12	618 H	--	96	0	0		1	36	18	0
7	962	25.772	6.9	36	619 H	--	86	0	0		1	36	18	0
8	963	21.851	6.2	118	620 H	--	120	0	0		1	36	18	0
9	964	17.552	3.8	56	621 H	--	107	0	1		2	36	18	0
10	965	16.581	13.7	99	622 H	--	100	25	9			36	18	0
11	966	14.099	17.0	71	623 H	--	308	0	0		1	36	18	0
12	967	10.997	23.0	88	624 H	--	89	1	6			36	18	0
13	968	7.317	12.3	63	625 H	--	84	0	0		1	36	18	0
14	626	5.120	23.4	14		--	-130	0	0		1	36	18	0
15	627	2.464	3.1	97		--	-59	0	0		1	36	18	0
16	697	1.825	196.9	69		--	-7	0	0		1	36	18	0
17	698	4.214	201.9	73		--	-5	17	8			36	18	0
18	699	6.107	218.0	104		--	-27	0	0		1	36	18	0
19	700	7.973	223.2	43		--	113	0	0		1	36	18	0
20	800	10.838	211.0	72		--	-4	0	0		1	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 18 TEAM 1
SHOT POINT 4
SHOT TIME: 53: 4:30: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	895	332.361	185.3	3		--	-6	0	3		3	36	18	0
2	896	333.657	185.3	53		--	-22	0/ 6	3		3	36	18	0
3	897	336.883	185.2	65		--	-56	0	5		3	36	18	0
4	898	339.271	185.0	132		--	-23	6	8			36	18	0
5	899	340.973	185.0	120		--	-31	25	3		3	36	18	0
6	900	342.587	185.1	32		--	-43	1	6			36	18	0
7	905	356.833	186.1	74		--	-17	0	4		3	36	18	0
8	906	358.688	186.0	31		--	-228	0	4		3	36	18	0
9	907	361.001	186.1	105		--	-27	0	4		3	36	18	0
10	908	374.471	187.0	62		--	-34	1	6			36	18	0
11	909	375.405	187.2	55		--	19	0	4		3	36	18	0
12	910	377.014	187.3	26		--	0	0	4		3	36	18	0
13	911	377.976	187.6	52		--	-98	0	4		3	36	18	0
14	912	379.772	187.7	38		--	9	6	8			36	18	0
15	913	381.250	187.7	82		--	-54	1	6			36	18	0
16	914	384.814	187.6	68		--	12	0	4		3	36	18	0
17	915	387.272	187.7	44		--	9	0	4		3	42	18	0
18	916	389.286	187.7	143		--	-15	0	4		3	36	18	0
19	917	391.193	187.7	142		--	124	0	4		3	48	18	0
20	925	395.647	189.2	23		--	98	1	6			64	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1   SAUDI ARABIA, 1978   SHOTS 1-19   (1981 UPDATE)
SHOT NUMBER 18   TEAM 2
SHOT POINT 4
SHOT TIME: 53: 4:30: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	801	271.053	188.0	137		--	9	0	2		3	42	18	0
2	802	273.380	187.9	110		--	-13	0	2		3	36	18	0
3	803	276.173	187.8	34		--	-23	0	2		3	36	18	0
4	804	279.230	187.7	64		--	58	3	6			36	18	0
5	805	282.958	187.5	25		--	-22	7	9			36	18	0
6	806	282.269	185.4	45		--	8	20	6			36	18	0
7	807	285.047	185.3	122		--	10	6	2		3	36	18	24
8	808	287.827	185.2	90		--	-23	1	6			36	18	0
9	809	292.293	185.1	19		--	-23	2	6			36	18	0
10	810	294.934	185.1	78		--	9	0	2		3	36	18	0
11	811	299.332	184.9	49		--	-16	0/ 6	2		3	36	18	0
12	812	302.880	184.9	30		--	-12	0	4		3	36	18	0
13	813	307.074	184.8	128		--	-22	2	6			36	18	0
14	888	311.053	185.2	92		--	-15	2	6			36	18	0
15	889	315.111	185.4	39		--	-7	0	4		3	36	18	0
16	890	318.657	185.4	108		--	-28	0	4		3	36	18	0
17	891	322.240	185.9	28		--	-21	3	6			36	18	0
18	892	325.438	185.6	24		--	3	0	5		3	36	18	0
19	893	327.645	185.4	98		--	-51	2	6			36	18	0
20	894	329.103	185.3	79		--	14	0	5		3	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 18 TEAM 3
SHOT POINT 4
SHOT TIME: 53: 4:30: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	578	120.087	176.4	106		--	-40	0	1		2	36	18	0
2	580	123.364	176.6	113		--	-6	0	0		3	36	18	0
3	581	126.276	176.6	100		--	-39	15	9			36	18	0
4	582	130.006	176.9	89		--	12	0	0		2	36	18	0
5	583	132.951	176.4	48		--	-5	0	1		2	36	18	0
6	585	137.636	175.4	130		--	-60	0	1		3	36	18	0
7	587	140.546	174.9	133		--	-52	15	9			36	18	0
8	589	145.471	174.2	87		--	106	1	6			36	18	0
9	590	148.382	174.1	96		--	-46	3/16	6			36	18	0
10	592	151.898	174.3	75		--	-36	0	1		3	36	18	0
11	593	154.296	174.7	112		--	-43	2	6			36	18	0
12	595	156.940	175.6	121		--	44	0	1		2	36	18	0
13	597	161.316	176.9	103		--	-50	3/28	6			36	18	0
14	599	162.844	178.5	66		--	161	0	1		2	36	18	0
15	600	164.573	179.0	83		--	-67	0	0		2	36	18	0
16	602	168.154	179.6	58		--	-47	12	9			36	18	0
17	604	169.827	180.6	10		--	39	0	0		3	36	18	0
18	605	169.912	181.4	125		--	158	0	5		3	36	18	0
19	607	172.072	182.3	37	UNIT 77	--	57	0/22	1		2	36	18	0
20	608	173.976	182.2			--	--	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 18 TEAM 4
SHOT POINT 4
SHOT TIME: 53: 4:30: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	609	176.706	182.0	51		--	--	1	6			36	18	0
2	610	178.493	181.8	17	1001 SAMP	--	37	0	0		2	36	18	0
3	611	179.478	181.8	85	1001 SAMP	--	--	0	0		2	36	18	0
4	612	180.420	182.0	18	1001 SAMP	--	-2	0	0		2	36	18	0
5	613	181.804	182.1	129		--	-5	28	6			36	18	0
6	614	184.025	182.2	22	1001 SAMP	--	-25	6	0		2	36	18	0
7	615	186.125	182.0	70		--	--	1	6			36	18	0
8	616	187.746	182.7	139	1001 SAMP	--	-16	0	0		2	36	18	0
9	617	189.842	182.7	131	1001 SAMP	--	-37	0	0		2	36	18	0
10	618	192.727	182.8	93	1001 SAMP	--	-19	0	2		2	36	18	0
11	619	194.465	182.9			--	--	20	6			36	18	0
12	620	196.504	183.0	136	1001 SAMP	--	58	0/17	2		2	36	18	0
13	621	198.562	183.0	40		--	249	28	6			36	18	0
14	623	204.662	183.2	60		--	-16	28	6			36	18	0
15	624	209.227	183.4	35	1001 SAMP	--	-22	0	2		2	36	18	0
16	955	211.567	183.5	124		--	8	20	6			36	18	0
17	926	398.410	189.3	115		--	98	20	6			36	18	0
18	928	407.951	190.5	101		--	-23	20	6			36	18	0
19	929	414.650	191.2	107		--	-34	20	6			36	18	0
20	930	415.485	191.4	119		--	-48	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 18 TEAM 5
SHOT POINT 4
SHOT TIME: 53: 4:30: 0.013

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	956	215.354	184.3	145	613 H	--	96	0	2		3	36	18	0
2	957	217.763	184.3	146	614 H	--	136	0	1		3	36	18	0
3	958	222.362	184.7	94	615 H	--	125	0	1		2	36	18	0
4	959	222.969	185.0	15	616 H	--	101	16	6			36	18	0
5	960	225.431	185.4	76	617 H	--	143	0	2		3	36	18	0
6	961	229.261	186.6	12	618 H	--	96	0	1		2	36	18	0
7	962	232.973	187.2	36	619 H	--	86	3	6			36	18	0
8	963	236.914	187.2	118	620 H	--	120	0	1		3	36	18	0
9	964	241.261	187.4	56	621 H	--	107	3/24	6			36	18	0
10	965	242.327	186.7	99	622 H	--	100	15	9			36	18	0
11	966	244.926	186.6	71	623 H	--	308	0	2		3	36	18	0
12	967	248.257	186.5	88	624 H	--	89	1	6			36	18	0
13	968	251.544	187.0	63	625 H	--	84	0	2		3	36	18	0
14	626	253.930	186.8	14		--	-130	0	2		2	36	18	0
15	627	256.393	187.2	97		--	-59	0	2		3	36	18	0
16	697	260.669	187.2	69		--	-7	0	2		3	36	18	0
17	698	262.955	187.4	73		--	-5	17	8			36	18	0
18	699	264.142	187.8	104		--	-27	0	3		3	36	18	0
19	700	265.367	188.2	43		--	113	7	9			36	18	0
20	800	268.844	188.1	72		--	-4	0/17	2		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 19 TEAM 1
SHOT POINT 6
SHOT TIME: 53: 5: 0: 0.030

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	895	67.782	28.7	3		--	-6	0	5		1	36	18	0
2	896	66.661	29.3	53		--	-22	6	5		1	36	18	0
3	897	64.022	31.0	65		--	-56	0	5		1	36	18	0
4	898	62.400	32.9	132		--	-23	6	8			36	18	0
5	899	60.949	33.7	120		--	-31	0	5		1	36	18	0
6	900	59.178	33.8	32		--	-43	1	6			36	18	0
7	905	43.649	35.2	74		--	-17	0	5		1	36	18	0
8	906	42.390	37.2	31		--	-228	0	5		1	36	18	0
9	907	40.359	38.7	105		--	-27	0	5		1	36	18	0
10	908	25.796	43.0	62		--	-34	1	6			36	18	0
11	909	24.155	41.3	55		--	19	0	5		1	36	18	0
12	910	22.460	42.2	26		--	0	0	5		1	36	18	0
13	911	20.735	40.0	52		--	-98	0	5		1	36	18	0
14	912	19.026	41.9	38		--	9	0/ 6	5		1	36	18	0
15	913	17.768	44.3	82		--	-54	1	6			36	18	0
16	914	15.175	52.7	68		--	12	0	5		1	36	18	0
17	915	13.205	58.9	44		--	9	0	5		1	42	18	0
18	916	12.129	66.6	143		--	-15	0	5		1	36	18	0
19	917	11.007	74.3	142		--	124	0	5		1	48	18	0
20	925	0.279	90.0	23		--	98	1	6			64	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 19 TEAM 2
SHOT POINT 6
SHOT TIME: 53: 5: 0: 0.030

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	801	124.835	11.8	137		--	9	0	5		3	42	18	0
2	802	122.547	12.1	110		--	-13	0	5		2	36	18	0
3	803	119.809	12.5	34		--	-23	0	5		3	36	18	0
4	804	116.806	12.9	64		--	58	3	6			36	18	0
5	805	113.160	13.4	25		--	-22	3	6.			36	18	0
6	806	115.623	18.6	45		--	8	20	6			36	18	0
7	807	113.014	19.2	122		--	10	0	5		3	36	18	0
8	808	110.397	19.7	90		--	-23	1	6			36	18	0
9	809	106.239	20.6	19		--	-23	2	6			36	18	0
10	810	103.776	21.1	78		--	9	0	5		2	36	18	0
11	811	99.766	22.2	49		--	-16	0	5		2	36	18	0
12	812	96.428	23.0	30		--	-12	0	5		2	36	18	0
13	813	92.591	24.0	128		--	-22	2	6			36	18	0
14	888	88.208	23.7	92		--	-15	2	6			36	18	0
15	889	84.031	23.9	39		--	-7	0	5		2	36	18	0
16	890	80.553	24.4	108		--	-28	0	0		2	36	18	0
17	891	76.013	23.4	28		--	-21	3	6			36	18	0
18	892	73.579	25.4	24		--	3	0	5		2	36	18	0
19	893	71.893	26.8	98		--	-51	2	6			36	18	0
20	894	70.788	27.7	79		--	14	0	5		2	36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 19 TEAM 3
SHOT POINT 6
SHOT TIME: 53: 5: 0: 0.030

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	578	279.852	14.7	106		--	-40	0	1		3	36	18	0
2	580	276.659	14.9	113		--	-6	0	5		3	36	18	0
3	581	273.884	15.0	100		--	-39	0	7		3	36	18	0
4	582	270.121	15.1	89		--	12	0	5		3	36	18	0
5	583	267.665	15.6	48		--	-5	0	2		3	36	18	0
6	585	264.091	16.4	130		--	-60	0	5		3	36	18	0
7	587	261.820	16.9	133		--	-52	0	5		3	36	18	0
8	589	257.998	17.7	87		--	106	1	6			36	18	0
9	590	255.444	18.0	96		--	-46	17	8			36	18	0
10	592	251.971	18.2	75		--	-36	0	5		3	36	18	0
11	593	249.373	18.2	112		--	-43	2	6			36	18	0
12	595	245.927	17.9	121		--	44	0	5		3	36	18	0
13	597	240.588	17.5	103		--	-50	28	6			36	18	0
14	599	237.675	16.6	66		--	161	0	2		3	36	18	0
15	600	235.551	16.4	83		--	-67	0	2		3	36	18	0
16	602	231.613	16.2	58		--	-47	0	2		3	36	18	0
17	604	229.231	15.6	10		--	39	0	2		3	36	18	0
18	605	228.546	15.0	125		--	158	0	4		3	36	18	0
19	607	225.833	14.5	77		--	57	0	1		3	36	18	0
20	608	224.029	14.7			--	--	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 19 TEAM 4
SHOT POINT 6
SHOT TIME: 53: 5: 0: 0.030

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	609	221.533	15.0	51		--	--	1	6			36	18	0
2	610	219.889	15.2	17	1001 SAMP	--	37	0	1		3	36	18	0
3	611	218.921	15.3	85	1001 SAMP	--	--	0	1		3	36	18	0
4	612	217.871	15.2	18	1001 SAMP	--	-2	0	2		3	36	18	0
5	613	216.460	15.2	129	1001 SAMP	--	-5	0	2		3	36	18	0
6	614	214.208	15.2	22	1001 SAMP	--	-25	0/ 6	1		3	36	18	0
7	615	212.349	15.6	70		--	--	1	6			36	18	0
8	616	210.276	15.1	139	1001 SAMP	--	-16	0	1		3	36	18	0
9	617	208.192	15.2	131	1001 SAMP	--	-37	0	1		3	36	18	0
10	618	205.283	15.2	93		--	-19	3	6			36	18	0
11	619	203.540	15.3			--	--	20	6			36	18	0
12	620	201.495	15.3	136		--	58	17	8			36	18	0
13	621	199.464	15.4	40		--	249	28	6			36	18	0
14	623	193.343	15.6	60		--	-16	28	6			36	18	0
15	624	188.752	15.7	35	1001 SAMP	--	-22	0	1		3	36	18	0
16	955	186.397	15.7	124		--	8	20	6			36	18	0
17	926	2.768	201.1	115		--	98	20	6			36	18	0
18	928	15.316	226.8	101		--	-23	20	6			36	18	0
19	929	23.774	227.5	107		--	-34	20	6			36	18	0
20	930	25.363	229.1	119		--	-48	20	6			36	18	0

DATA FOR ONE TEAM-SHOT

EXPERIMENT NO. 1 SAUDI ARABIA, 1978 SHOTS 1-19 (1981 UPDATE)
SHOT NUMBER 19 TEAM 5
SHOT POINT 6
SHOT TIME: 53: 5: 0: 0.030

	LOC	DIST(KM)	AZIM	UNIT	NOTES	FOOTAGE	CHRON	TAPE GRADE	REC GRD	FIRST ARRIVAL	CHAN	CH1	CH2	CH3
1	956	182.077	15.0	145	613 H	--	96	0	2		3	36	18	0
2	957	179.706	15.2	146	614 H	--	136	0	2		3	36	18	0
3	958	174.919	15.0	94	615 H	--	125	0	2		3	36	18	0
4	959	174.105	14.6	15	616 H	--	101	1	6			36	18	0
5	960	171.400	14.2	76	617 H	--	143	0/ 9	2		3	36	18	0
6	961	167.001	12.8	12	618 H	--	96	0	2		2	36	18	0
7	962	163.082	12.1	36	619 H	--	86	0	2		3	36	18	0
8	963	159.134	12.1	118	620 H	--	120	0	2		3	36	18	0
9	964	154.745	12.0	56	621 H	--	107	3	6			36	18	0
10	965	153.969	13.1	99	622 H	--	100	3/26	9			36	18	0
11	966	151.446	13.4	71	623 H	--	308	0	2		3	36	18	0
12	967	148.207	13.8	88	624 H	--	89	1	6			36	18	0
13	968	144.666	13.0	63	625 H	--	84	0	2		3	36	18	0
14	626	142.379	13.4	14		--	-130	0	2		2	36	18	0
15	627	139.757	12.9	97		--	-59	0	2		3	36	18	0
16	697	135.489	13.0	69		--	-7	0	2		3	36	18	0
17	698	133.139	12.8	73		--	-5	17	8			36	18	0
18	699	131.784	12.0	104		--	-27	0	2		3	36	18	0
19	700	130.462	11.3	43		--	113	0	1		3	36	18	0
20	800	127.012	11.6	72		--	-4	0	1		2	36	18	0