

AN-ADB-802

ANNUAL REPORT

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**Submitted to the U.S. Agency for International Development; Bureau for
Global Programs, Field Support and Research; Center for Economic Growth**

**INTEGRATION OF GEOPHYSICAL METHODS FOR
GROUNDWATER EXPLORATION IN TURKMENISTAN**

Principal Investigator: Dr. M. Goldman

Grantee Institution: The Geophysical Institute of Israel

Collaborator: Dr. K. Kuliev

Institution: Turkmengeology

Project Number: CA20-011

Grant Number: TA-MOU-00-CA20-011

Grant Project Officer: William H. Crane

Project Duration: May 1, 2001 – June 30, 2005

A

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The present annual report describes briefly the main activities undertaken in the framework of the project during the period from May 2003 until June 2004.

The Financial Status Report is attached in Appendix A.

I. EXECUTIVE SUMMARY

The overall aim of the project is to develop and test the methodology of the combined application of several geophysical methods for groundwater exploration and management in Turkmenistan, as well as extensive training of Turkmen geophysicists in using modern techniques of the data acquisition, processing and interpretation.

During the above-mentioned period, a large amount of geological, geophysical and hydrogeological data were prepared and analyzed. Based on this analysis, new seismic lines and electromagnetic measurements were planned and located. A relatively large number of water exploration wells located in this region provided a good basis for formulating the hydrogeological problem in the area. A number of geological and hydrogeological sections were built across the wells and locations of geophysical lines were established. The second phase of geophysical data acquisition was conducted within the Kazganchay area. Seismic reflection surveys were performed along two lines running in a general SW – NE direction (lines KA-003 and KA-004, Fig. 1). The time domain electromagnetic (TDEM) survey included 8 TDEM soundings located along the seismic lines (soundings K1 through K8, Fig. 1).

Processing and interpretation of the acquired seismic and geoelectric data were performed jointly by the Israeli and Turkmen teams at the GII and in Turkmengeology using all the geological, hydrogeological and borehole information available in the study area.

The training activities for Turkmen geophysicists took place both in the offices of the Ahal Geophysical Expedition, of the S.C. "Turkmengeology" and during the field works in the Kazganchay area of the central Kopet-Dag region.

II. SECTION I

A. Research Objectives:

The specific research objectives of the project may be defined as follows:

1. Studying the shallow subsurface in selected regions using geophysical methods in order to understand the geological structure and hydrogeological situation of the area.
2. Detecting and mapping water-saturated layers in various types of shallow aquifers (the wadi beds, alluvial fans, fractured rocks, etc.).
3. Subdividing the aquifers into separate sub-aquifers.
4. Estimating the quality of groundwater in the detected layers.

Within the framework of the project, the following geophysical techniques were applied:

- *High resolution seismic reflection method* for detailed mapping of the subsurface structure and, in particular, detecting and mapping groundwater layers and estimating their lateral extent.
- *Time domain electromagnetic (TDEM) method* for accurate determination of the fresh/saline interface within the groundwater lenses.

Combined application of the seismic and electromagnetic methods is expected to result in a reliable detection and mapping of water-saturated layers and in estimating the amount and quality of the groundwater in shallow aquifers in the Kazganchay area.

B. Research Accomplishment:

In the above-mentioned period of the project, the Turkmen partners provided the additional geological information required for planning a second phase of the

geophysical surveys in the Kazganchay area. Based on all geological, hydrogeological and borehole data, a detailed final map of the area was built (Fig. 1). The map includes locations of seismic lines and TDEM soundings, as well as basic information of all the relevant water wells drilled in the area. For each well, the depth to the water table and water mineralization (in g/l) are shown. It should be noted that the map was built in relative coordinates, since the Turkmen partners did not supply any data in absolute coordinates. On the basis of the data obtained, a number of hydrogeological cross-sections were built for the sites that were chosen as suitable for geophysical surveys. Fig. 2 represents one of such cross-sections built along line A-A' passing through six water wells (Fig. 1). The section shows location and lithological characteristics of aquifer and aquiclude units, lateral changes of thickness and lithology of various layers within the units, and indicates water table and water mineralization in the boreholes.

Analysis of the section shows that it includes the following hydrogeological units:

- The upper aquifer unit composed of upper quaternary alluvial deposits (apQ₃₋₄) consisting of sands and clays with rare thin lenses of gravels and pebbles. The total thickness of the unit varies from 2 – 3 m to 30 – 40 m.
- The main aquifer unit composed of lower to middle quaternary alluvial deposits (pQ₁₋₂) with the total thickness varying from 70 – 80 m to 160 – 180 m. In the southern part of the section (Kopet-Dag foothills), the unit is represented mainly by gravels and pebbles with inclusions of relatively thin sands and loams, whereas in the central and northern parts of the section, it is dominated by sandy loam with inclusions of gravel and clay layers.
- The aquiclude unit of poorly permeable Neogene sediments (N₂) consisting of compacted sands and clays with the total thickness of up to 280 m.

On the basis of the geological and hydrological data prepared by the Turkmen specialists, as well as of the results of the seismic survey carried out at the previous stage of the project, the following collaborative activities took place:

- analyzing the data;

- planning new geophysical surveys;
- locating the geophysical surveys in the Kazganchay area;
- training the Turkmen specialists in performing TDEM measurements;
- conducting the second stage of seismic and electromagnetic field surveys in the Kazganchay area of Turkmenistan.
- Processing and interpretation of the acquired seismic and geoelectric data at the GII and in Turkmengeology.

The geophysical field surveys included seismic and electromagnetic measurements carried out in the Kazganchay area.

Seismic survey

The seismic reflection measurements were performed along two lines running in a general SW – NE direction (lines KA-003 and KA-004, Fig. 1). The lengths of lines KA-003 and KA-004 were about 4500 m and 10000 m, respectively. The lines pass through five water wells, 460-K, 318-P, 461-K, 316-P and 317-P. The seismic field works were conducted by the Ahal Geophysical Expedition using the same equipment and parameters as at the previous stage. The seismic data acquisition took about two weeks. After completing the acquisition, the data were copied to a cartridge and transferred to the GII for processing. At the same time, the data were processed at the processing center of Turkmengeology.

At the GII processing center, the data were processed using the FOCUS processing package by Paradigm Geophysical. The main processing steps and parameters can be found in the side headers of the lines (Figs. 3 and 5).

The resulting time sections along the two lines are represented in Figs. 4 and 6. The horizontal axes on the sections represent station numbers (receiver positions), whereas the vertical axes represent two-way time of wave propagation (in seconds). Both sections show fair to good quality data making them a good basis for hydrogeological interpretation. A rough estimate of the depths to the reflected events appearing on the sections can be made on the basis of the stacking velocities obtained during the processing of the data.

Following is a brief description of the sections:

Line KA-003

This line continues the previously shot lines, KA-01 and KA-02, to the north-east direction (Fig. 1). Seismic time section along the line is represented in Fig. 3; the details of data acquisition, as well as processing steps and parameters, are specified in the side header in Fig. 4. On the section, a sequence of reflected events can be identified and traced within the time interval of 50 – 500 ms (depths of 30 – 500 m). At several locations, the continuity of the reflections is interrupted, probably by a system of faults.

Line KA-004

This line was located in approximately the same direction as lines KA-001 KA-003, at the distance of about 6 km to the west of them (Fig. 1). Fig. 5 displays seismic time section along the line, whereas Fig. 6 presents its side header containing information on acquisition and processing parameters. The section displays a sequence of almost horizontal reflections within approximately the same range of times as the previous line. The reflections appear mostly undisturbed.

At the next stage of the project, hydrogeological interpretation of the seismic sections will be performed jointly by the Israeli and Turkmen teams using all the geological, hydrogeological and borehole information available in the area.

TDEM survey

The time domain electromagnetic (TDEM) measurements included 8 soundings located along the seismic lines (soundings K1 through K8, Fig. 2). The western TDEM profile including points K1, K2, K7 and K3 ran in the vicinity of water wells 461-K, 316-P, 21 and 317-P. The eastern TDEM profile including points K8, K4, T5 and K6 was located in the vicinity of water wells 437-K, 460-K, 22 and 318-P.

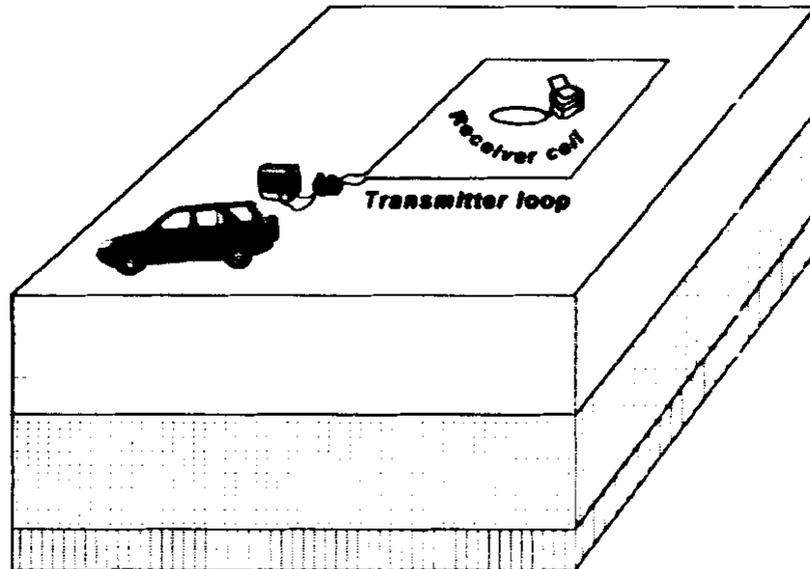
The main objective of the TDEM survey was to test the ability of the method to characterize groundwater salinity under specific hydrogeological conditions of the

area. The Geophysical Institute of Israel (GII) acquired a great experience in performing similar surveys in Israel and abroad (Cyprus, Eritrea, Jordan). As a result, the present survey in Turkmenistan ran fairly smoothly despite hard surface conditions at several sites (Picture 1).



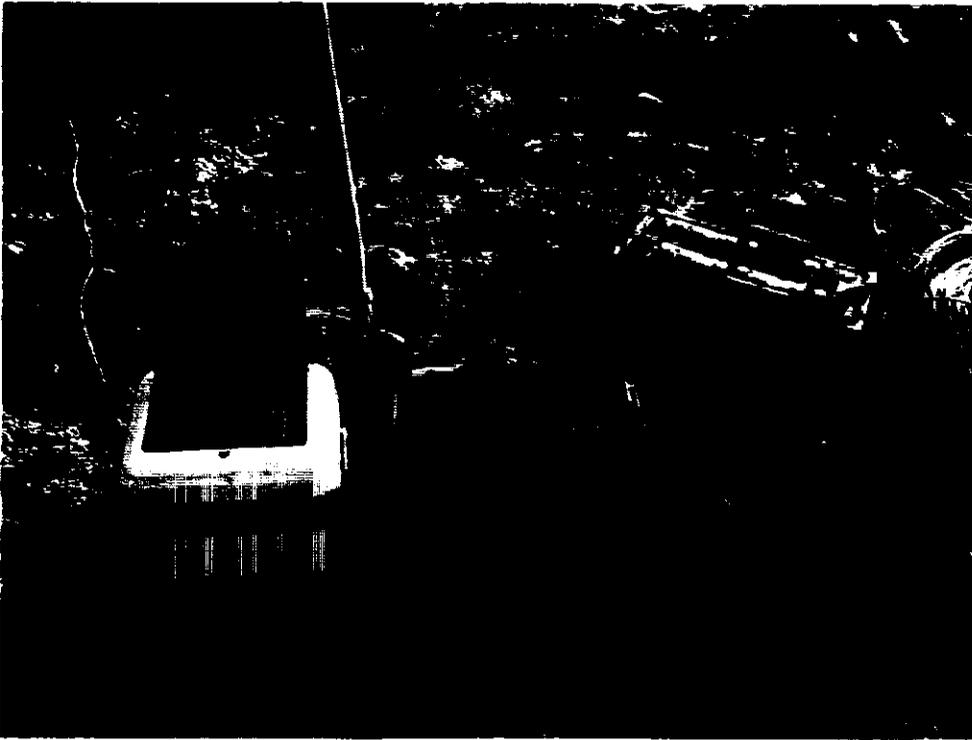
The collected data are of superior quality and preliminary analysis allows us to assume that the next stage of the project, including data processing and interpretation, will be as much successful as the acquisition stage was.

The equipment for the TDEM survey was brought from Israel. All TDEM measurements were carried out using the so-called central loop array, which is schematically shown in Picture 2

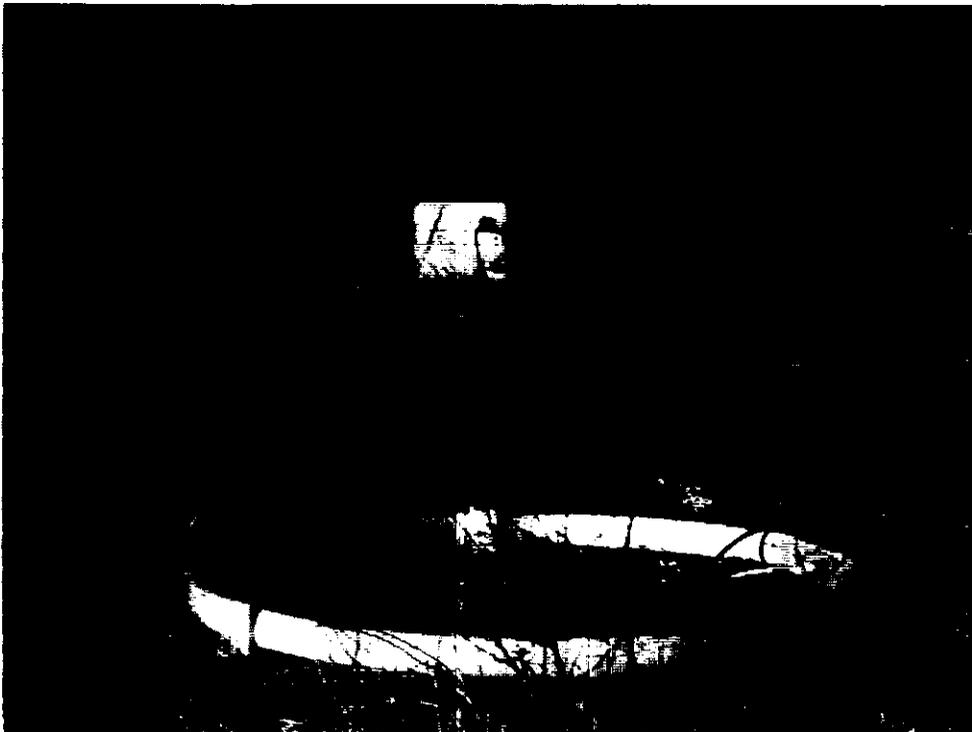


Picture 2 Schematic layout of the central loop TDEM array.

The transmitter loop size in all eight soundings was 100 by 100 m that should provide the required exploration depth between 150 to 200 m. The Geonics PROTEM-67 TDEM instrument including high power TEM67 transmitter, PROTEM digital receiver and 100m² receiver coil were used for the measurements. The power was supplied by car batteries provided by the Ahal Geophysical Expedition.



Picture 3 Protom Digital Receiver (left), TEM67 high power transmitter (center) and one of the 12V car batteries used in the TDEM survey.

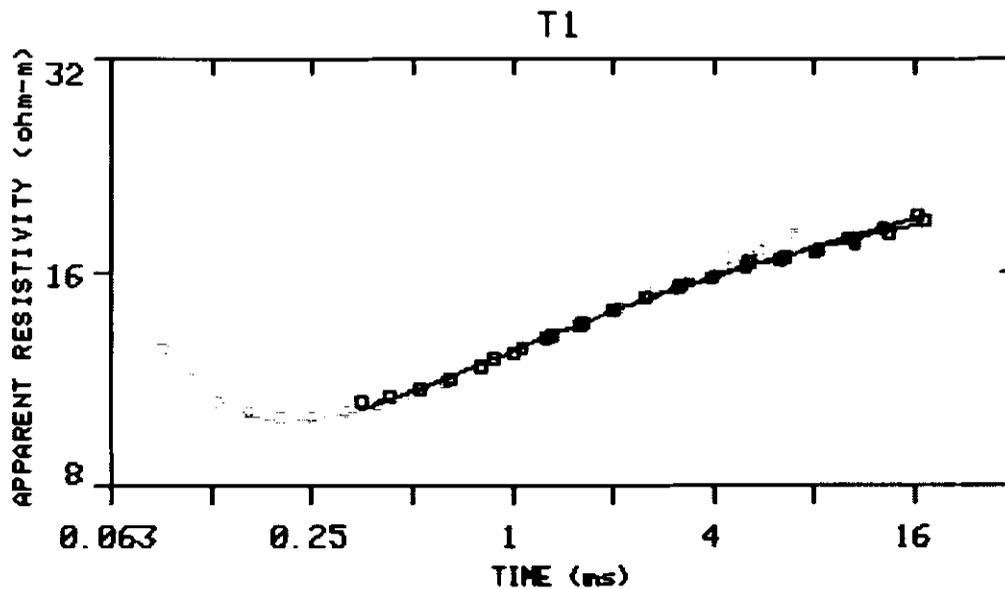


Picture 4 The Geonics 100m² receiver coil (in front) connected to Protom Digital Receiver (back).

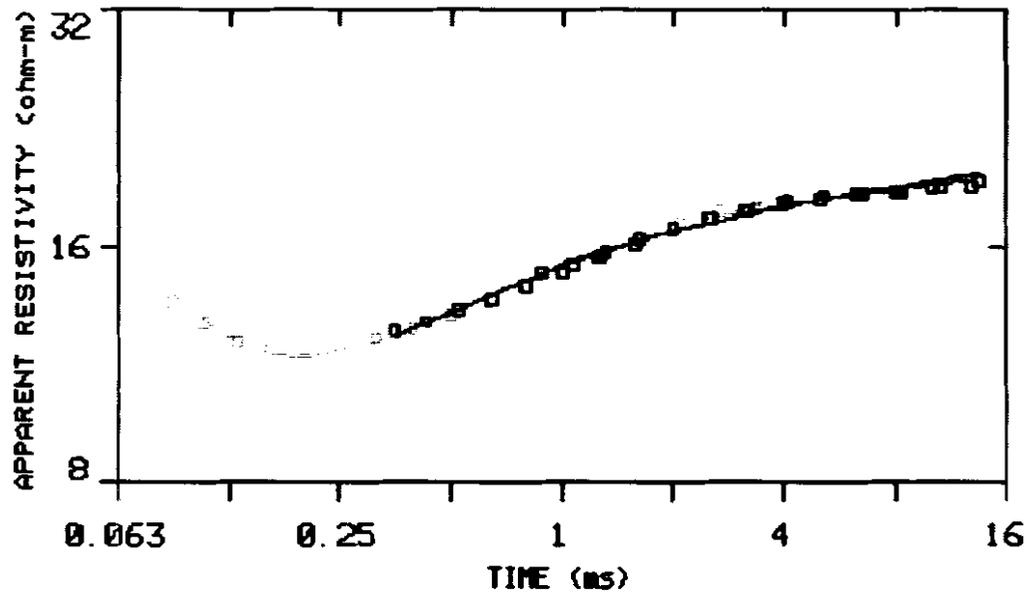
In the framework of the TDEM survey, the GII specialists conducted training of geophysicists from the Ahal Geophysical Expedition and from the State Corporation "Turkmengeologiya".

All the necessary logistical support, including surveyors, field workers, cars, cables, etc., was provided by the Ahal Geophysical Expedition.

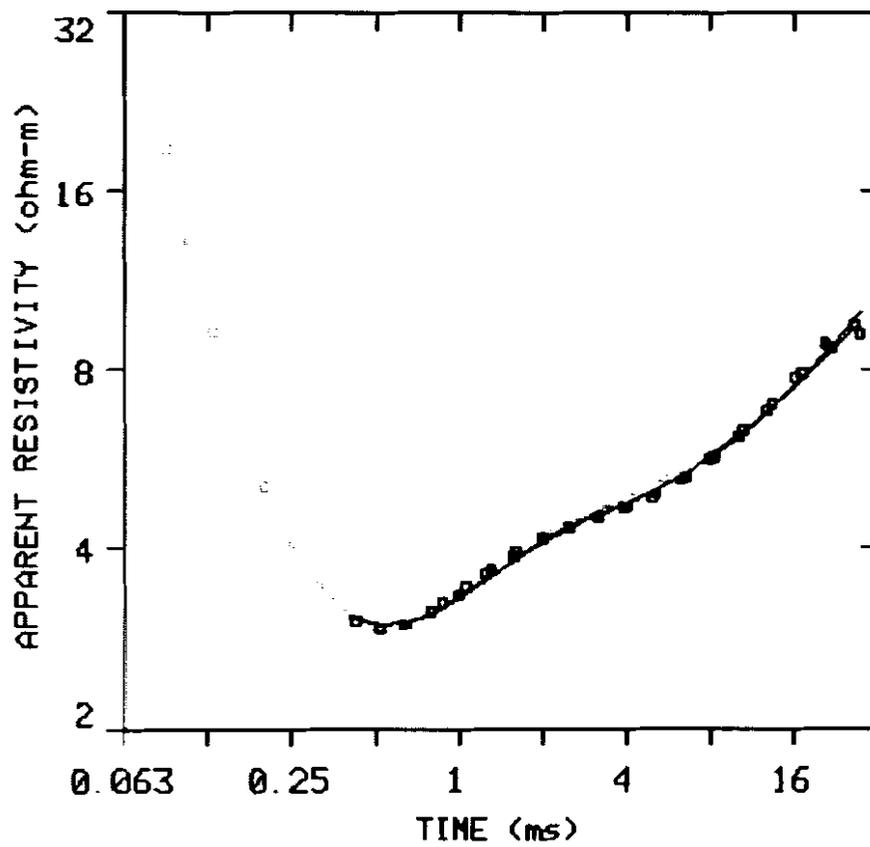
The processing and preliminary analysis of the TDEM data were carried out using the TEMIX-XL processing and interpretation package by Interpex Ltd., Golden Co, USA. All the processed data are shown in Picture 5 in the form of late stage apparent resistivities versus time graphs.



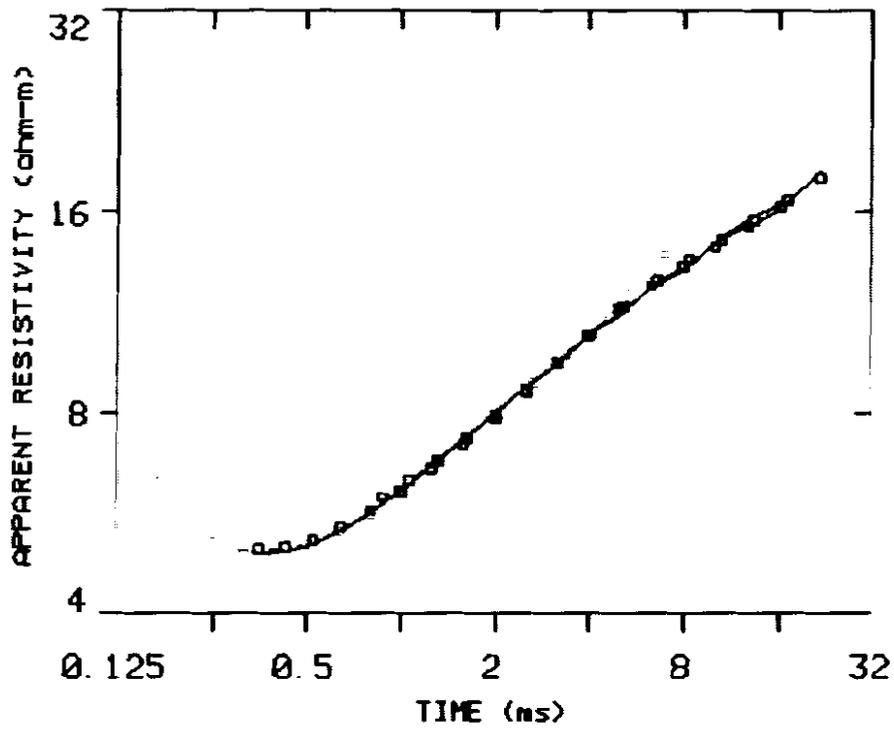
T2



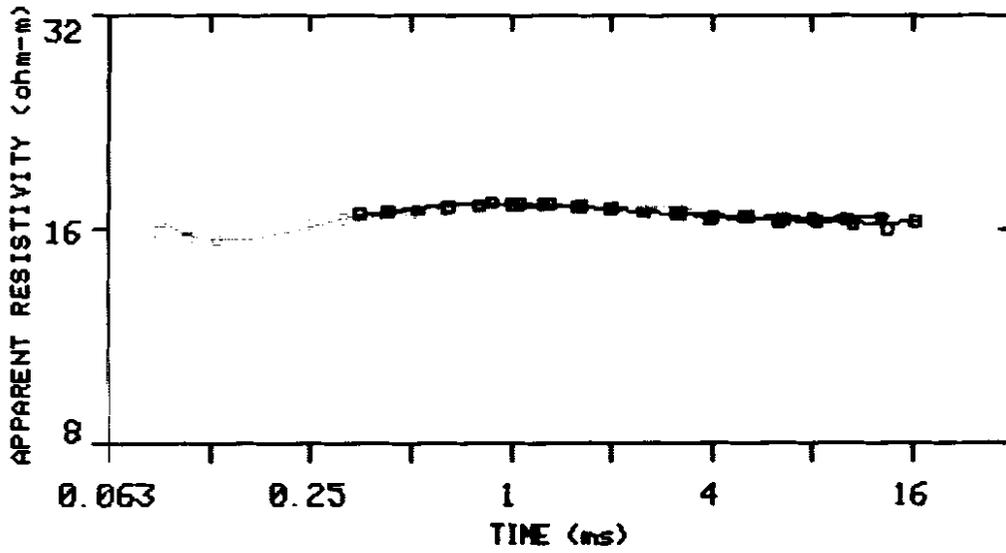
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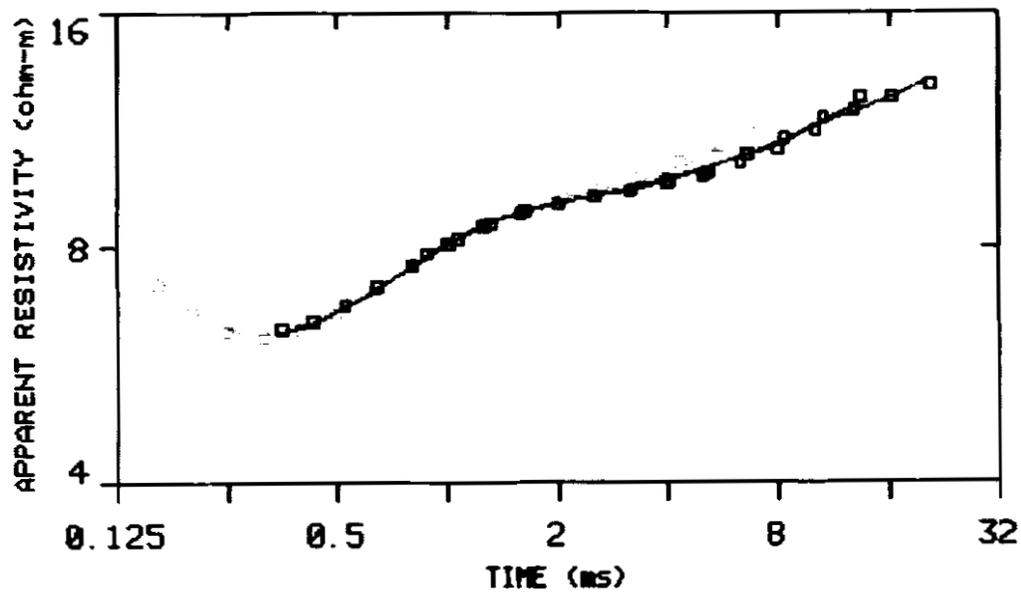
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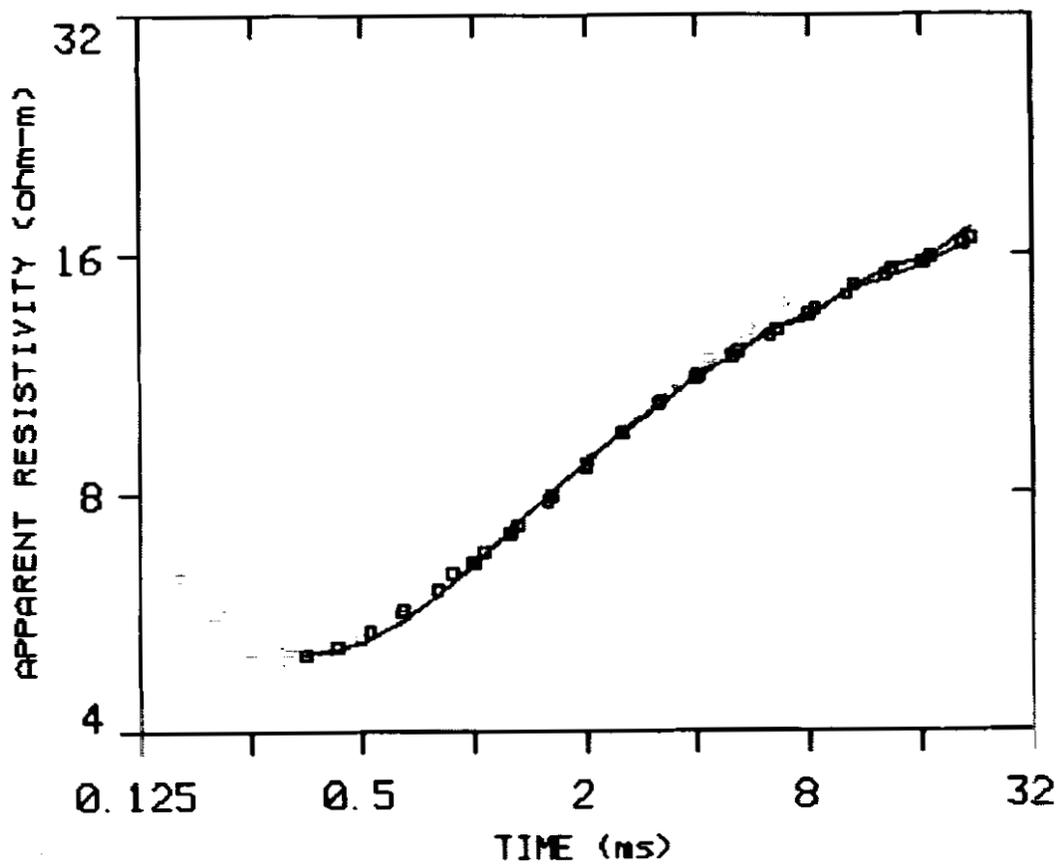
T5

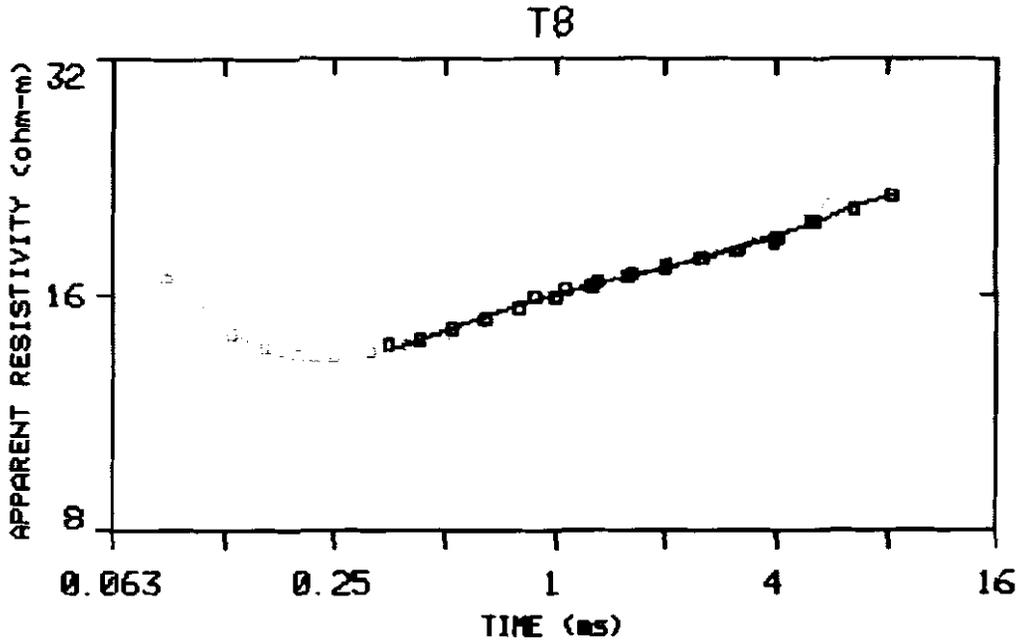


T6



T7





C. Scientific Impact of Collaboration:

During the period covered by the report, the Israeli and Turkmen partners were involved in the following activities:

- Dr. Avanesov and Dr. Kuliev undertook a number of field trips with the aim of choosing an optimal site for geophysical surveys of second stage, and also formulated several hydrogeological problems related to the fresh groundwater deposits of Kazganchay area.
- M. Bereza and I. Bayramova prepared all the new available geological and hydrogeological information from the boreholes drilled within the Kazganchay area.
- M. Gendler performed processing and interpretation of the geological and hydrogeological data, including preparation of geological cross-sections, schemes of litho-stratigraphical correlation and well location maps.

- On the basis of the results of interpretation of the geological and hydrogeological data, Dr. Shtivelman and Dr. Goldman, together with M. Gendler, established location of new seismic lines and points of geoelectric measurements.
- In November 2003, Dr. M. Goldman, M. Gendler and G. Shklyar visited Turkmenistan with the aim of carrying out a second stage of field geophysical works (TDEM survey) and of training Turkmen specialists in methods of TDEM data acquisition. During the visit, a number of working meetings took place, at which joint efforts of Israeli and Turkmen specialists for solving hydrological problems of Turkmenistan were discussed.
- The Ahal Geophysical Expedition of the S.C. "Turkmengeology" conducted the seismic field works.
- The acquired seismic and geoelectric data were processed at the GII and Turkmengeology processing center.

D. Description of Project Impact:

Until now, groundwater exploration within the Kazganchay area was conducted solely by drilling a large number of expensive wells. For this reason, several wells in the northern part of the area fell into a zone of highly mineralized groundwater and proved unsuitable for drinking and agricultural water supply. Despite this, an additional drilling of hydrogeological wells is planned in the near future. Performing joint geophysical (seismic and geoelectric) investigations prior to drilling will enable us to estimate the structure and hydrogeological characteristic of the groundwater deposits and the water quality of the aquifer in the area. Thus, locating the future drilling on the basis of the results of the geophysical works carried out in the framework of the project will reduce the number of failed wells. It should be noted that it is the first time that such joint geophysical investigations aimed at mapping fresh groundwater deposits, are carried out in Turkmenistan.

E. Strengthening of Developing Country Institutions:

A purchase of three personal computers for Turkmen specialists is planned at the third stage of the project.

Training of Turkmen specialists in methods of electromagnetic data acquisition, processing and interpretation was carried out in Turkmenistan in the offices of the Ahal geophysical expedition, as well as during the field works. Additional training of Turkmen specialists was planned to be held in Israel but, unfortunately, their visit did not take place.

F. Future Work:

At the next stage of the project, the following activities are planned:

- Interpretation of the seismic and electromagnetic data acquired and processed at the first and second stage of the project at the GII and in Turkmengeology.
- Visit of the Israeli team (Dr. V. Shtivelman, Dr. M. Goldman and M. Gendler) to Turkmenistan in order to carry out a workshop, to perform a joint interpretation and analysis of all the geological, geophysical and hydrogeological data for mapping the aquifer and estimating its properties.
- Purchase of three personal computers and for Turkmen specialists
- Preparing the final report summarizing the conducted investigations.

III. SECTION II

A. Managerial Issues:

Since the last Management Report, no managerial changes occurred.

B. Budget:

At the first and second stages of the project, three visits of Turkmen partners to Israel were planned. However, despite the persistent invitations of the Israeli side, these visits did not take place for various reasons. As the result, a sum of \$34,500 planned for the visits, remained unused. At present, it seems that there are few chances for the Turkmen partners to come to Israel in the foreseen future. However, since they are interested to go on with the joint project, they suggested that the Israeli team come to Turkmenistan instead, in order to carry out a workshop, to perform a joint interpretation and analysis of all the data and to start preparing the final report.

Taking into consideration the abovementioned problem and the past experience on this matter, their suggestion seems to be the only possibility to successfully complete the project. This will involve the following budget changes:

1. An additional 10 days visit of Israeli team (Dr. Shtivelman, Dr. Goldman and Mr. Gendler) to Turkmenistan . Since the Israeli partners have already used their travel budget, an additional budget is needed, as follows:

Tickets:	\$800 * 3	\$2,400
Allowances:	\$150 * 3 * 10 days	\$4,500
Visas, taxes, etc.	\$200 * 3	\$600
<hr/>		
Total travel budget		\$7,500

2. In order to carry out a workshop in Turkmenistan, the following equipment should be purchased:

Data projector	\$2,000
Laptop	\$1,800
Software	\$800
<hr/>	
Total equipment budget	\$4,600.

3. The above sums (\$12,100.) can be deduced from the unused travel budget (\$34,500) of the Turkmen participants of the project.

C. Special Concerns:

No special concerns arose.

D. Collaboration, Travel, Training and Publication:

In November 2003, a team of Israeli specialists visited Turkmenistan in order to transfer the technology of performing electromagnetic surveys, to provide training of the Turkmen partners and to plan and carry out the field geophysical surveys. The team included Dr. M. Goldman, M. Gendler and G. Shklyar. During the visit, the Israeli specialists held a series of meetings with local specialists regarding cooperation in groundwater exploration in Turkmenistan, performed a training of Turkmen geophysicists and carried out the geophysical surveys. The training activities took place both in the offices of the Ahal Geophysical Expedition of the S.C. "Turkmengeology" and during the field works in the Kazganchay area of the central Kopet-Dag region.

The participants from the Turkmen side included Dr. O. Atageldyev (State Minister, Chairman of the State Corporation "Turkmengeology"), Prof. K. Kuliev (Vice-Chairman of the S.C. "Turkmengeology") V. Fedin (Chief Geophysicist of the S.C. "Turkmengeology"), Prof. A. Avanesov (Chief Hydrogeologist of the Water Corporation "Senagat-Suv"), I. Bairamova (Head of the Ahal Hydrogeological Expedition) and Ch. Annageldyev (Head of the Ahal Geophysical Expedition).

APPENDIX A

FINANCIAL STATUS REPORT

APPENDIX B

LIST OF FIGURES

Map 1 General location of the study area

Fig. 1 Location of water wells and seismic lines in Kazganchay area

Fig. 2 Hydrogeological cross-section along A – A' line

Fig. 3 Seismic reflection time section along line KA-003

Fig. 4 Side header of seismic line KA-003

Fig. 5 Seismic reflection time section along line KA-004

Fig. 6 Side header of seismic line KA-004

Embassy of the United States, Tel Aviv
(Payment forms: CDR & MERC)

REQUEST FOR PAYMENT COVER PAGE

(Please submit original and one copy from each SET OF FORMS PER PARTICIPANT)

From: THE GEOPHYSICAL INSTITUTE OF ISRAEL (GII)
(Grantee Institution's Name)

Grant No.: TA-MOU-00-CA20-011

To: Mr. Boaz Ayalon
American Embassy Tel Aviv
ECON/AID Section
71 Hayarkon Street
Tel Aviv

Advance – Attached is a duly signed Form no. 3

Reimbursement – Attached is a duly signed Form no. 2
(Please select one of the above)

Period covering this request: from March 1, 2004 to May 31, 2004

Payment Information

(please provide relevant information only):

PAYMENT METHOD	<input checked="" type="checkbox"/> EFT <input type="checkbox"/> Check <input checked="" type="checkbox"/> Send to Prime Grantee <input type="checkbox"/> Send direct to Subgrantee <input type="checkbox"/> Send to Subgrantee via Prime Grantee
PAYEE NAME	THE GEOPHYSICAL INSTITUTE OF ISRAEL
STREET and NUMBER	6 HABA'AL SHEM TOV, P.O. BOX 182, INDUSTRIAL ZONE NORTH
CITY & POSTAL CODE	LOD 71100
COUNTRY	ISRAEL
BANK NAME & ADDRESS	BANK LEUMI LE ISRAEL LTD., Branch No. 651, 5 Hamashbir Street, Holon Industrial Zone, Israel
ROUTING NUMBER	026002794
ACCOUNT NUMBER	126000/28
AMOUNT \$	\$7,260.-*
SPECIAL INSTRUCTIONS	
ADDITIONAL INFORMATION	*This expenses reimbursement is for the Geophysical Institute only.

SIGNED: S. Ya'akov

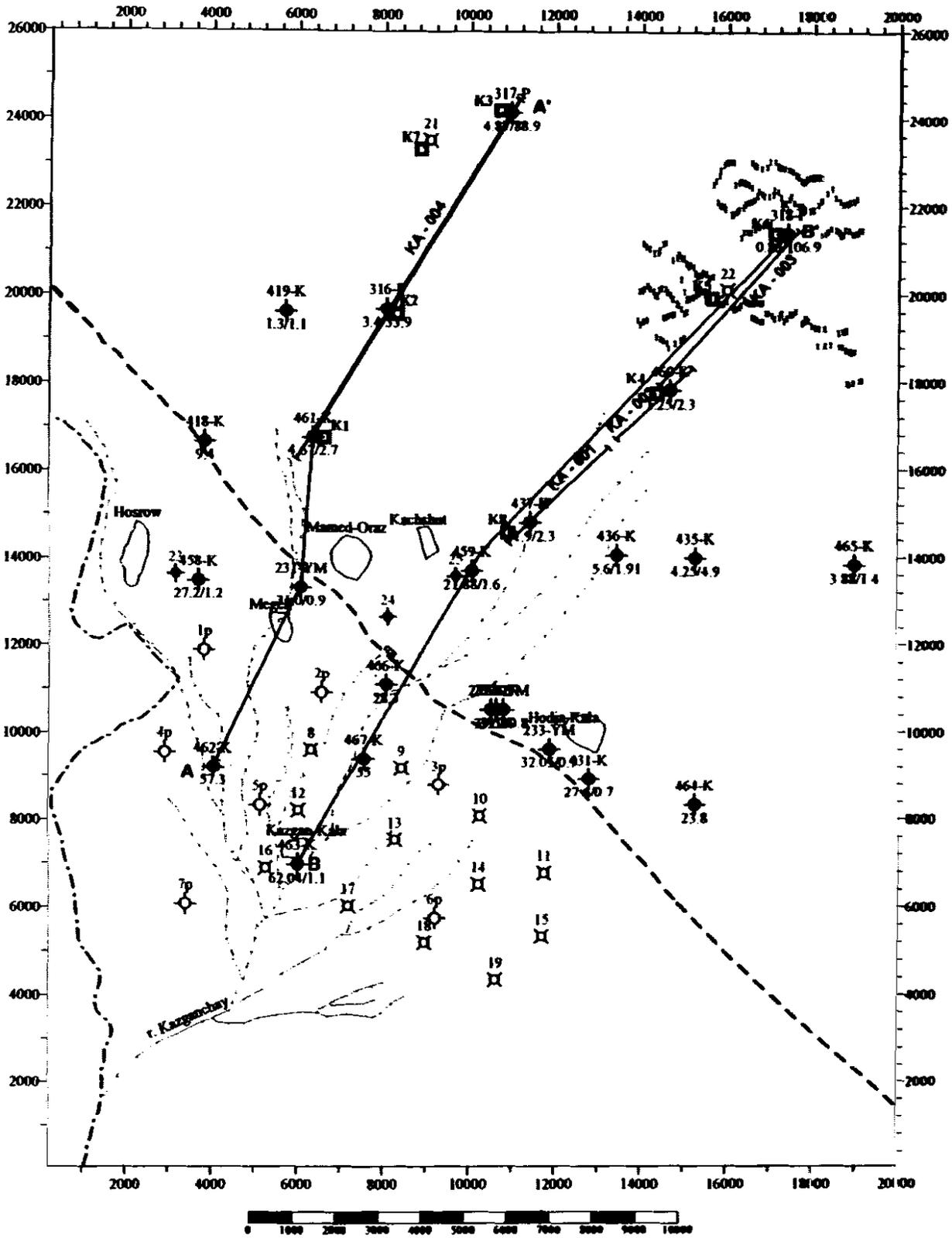
NAME: Shabtay Ya'akov

TITLE: Deputy CEO and Finance Administrator

DATE: June 21, 2004

THE GEOPHYSICAL
INSTITUTE OF ISRAEL

MAP LOCATION
(Kazganchay area, Turkmenistan)



LEGEND		
Drilled wells:		
439-K 27/8.7	- Prospecting borehole: numerator-water table; denominator-mineralization (g/l)	KA-001 - Seismic line
7p	- Projected wells: Exploratory well	- Railway
12	- Test borehole	- Karganchay river
43	- Observation borehole	- Settlement
B - B'	- Geological cross-section	- Frontier
12	- TDEM station	Mamed-Oraz - Settlement

GEOLOGICAL
(Kazganchay art)

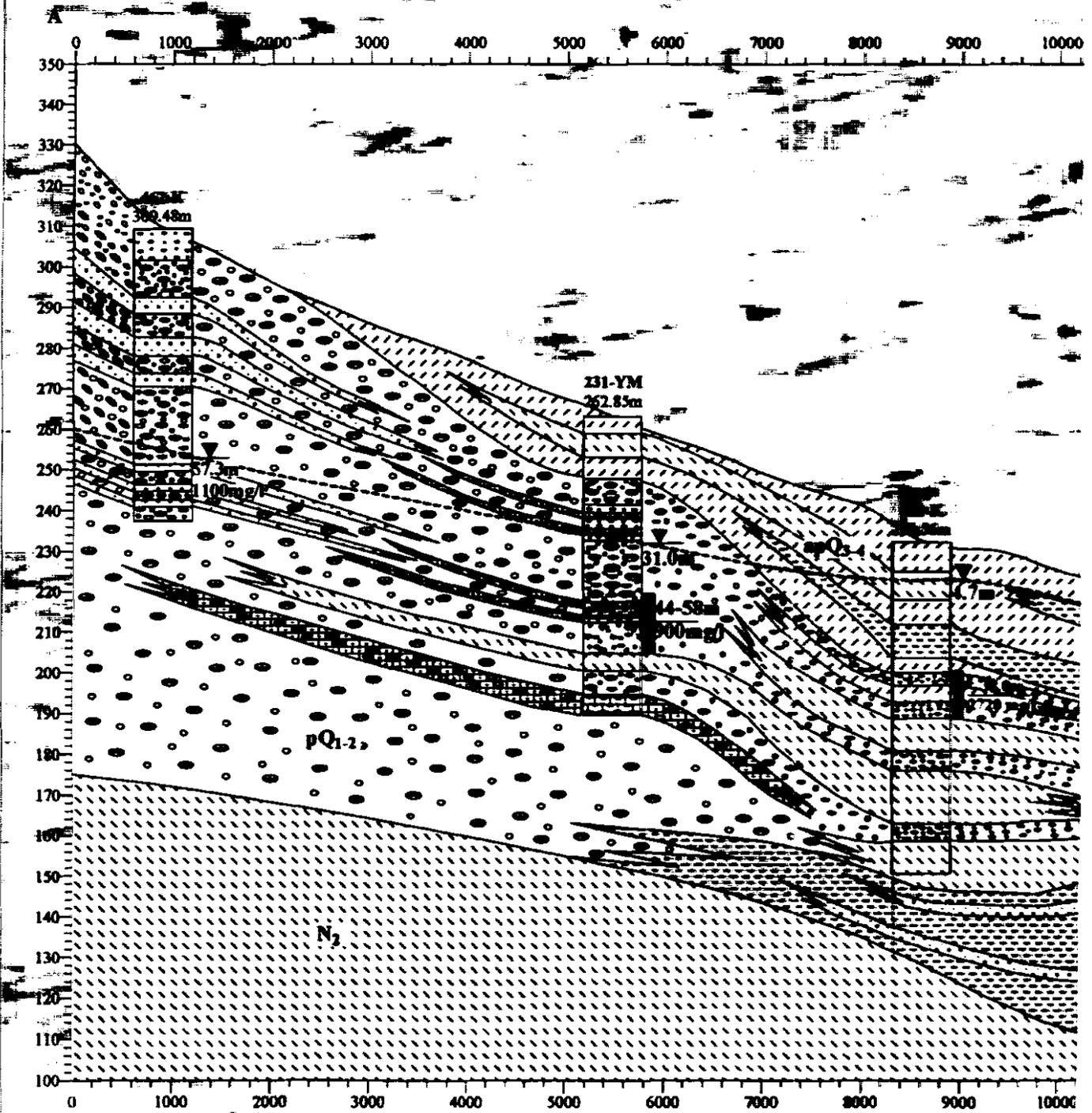
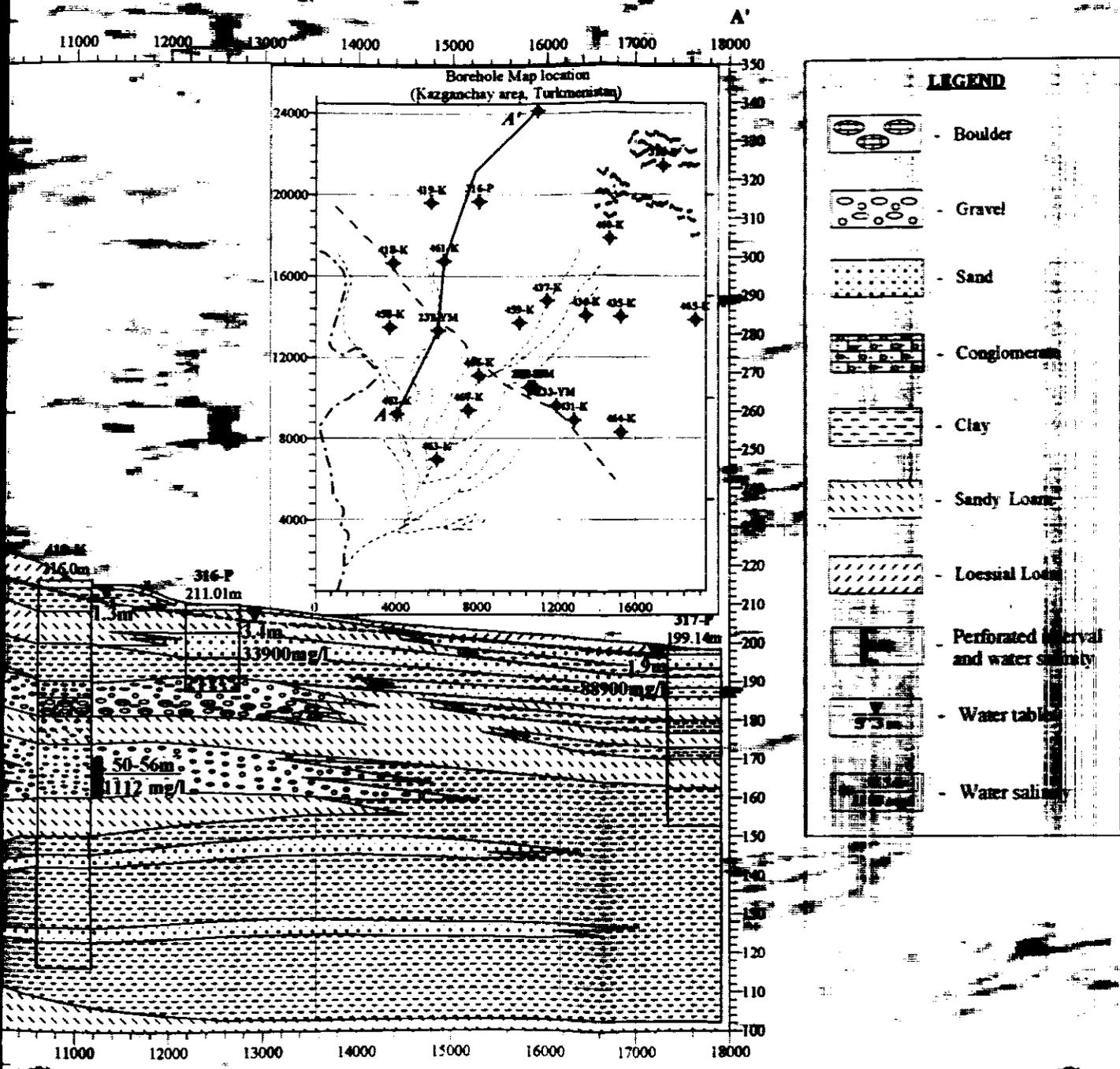


Fig. 2 Hydroge

CROSS-SECTION
(a, Turkmenistan)





**GEOPHYSICAL
INSTITUTE OF
ISRAEL**

AID Project TA-MOU-00-CA20-011

AREA: KAZGANCHAI; TURKMENISTAN

LINE : KA-003

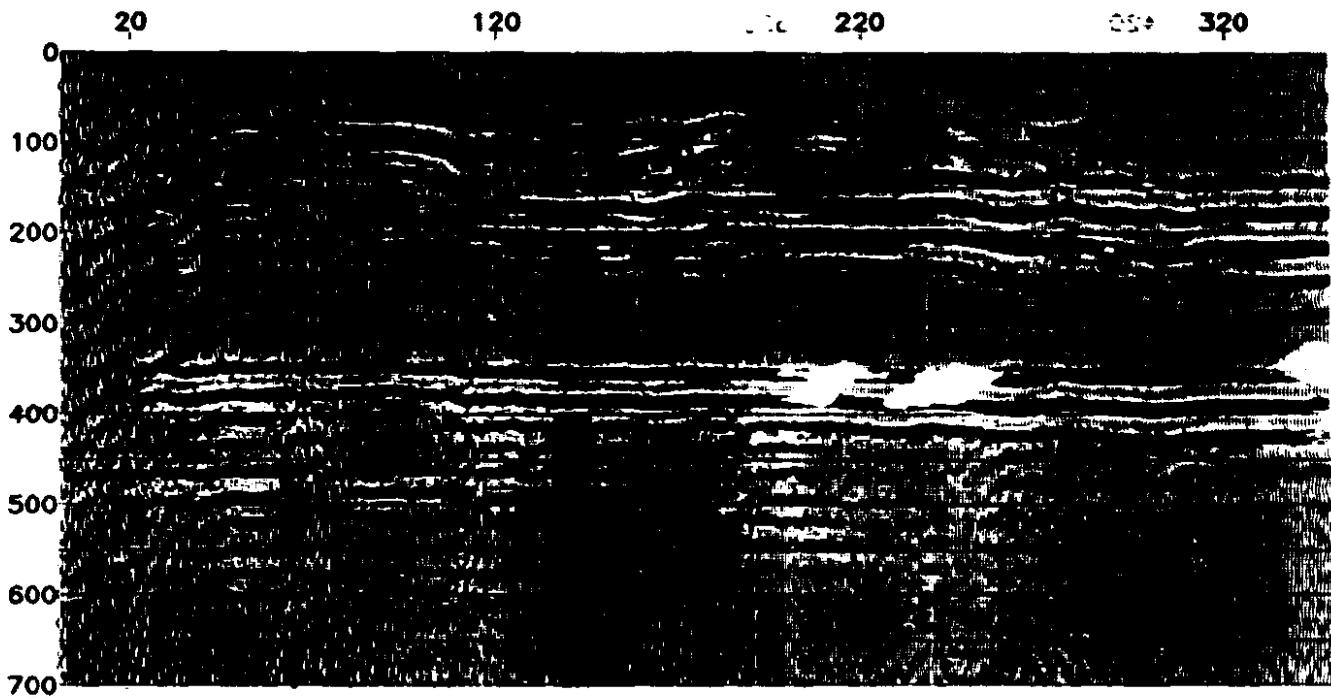
**STRUCTURAL STACK
DATUM SURFACE**

RECORDING INFORMATION		FIELD PARAMETERS	
Shot by	Geophysical Expedition of Turkmengology		
Date	November 2003		
Field System	Progress-96		
Format	SEG-X		
Record Length	2 sec		
Sample Rate	2 msec		
Lo-cut Filter	0 Hz		
Hi-cut Filter	500 Hz		
SOURCE INFORMATION			
Energy Source	GSK		
SP Interval	5 m		
RECEIVER INFORMATION			
Number of Channels	40		
Group Interval	5 m		
PROCESSING SEQUENCE			
Demultiplexation			
SEG-Y Input			
Inline Geometry Applied			
Trace Editing			
Surface Wave Noise Attenuation			
Velocity		230 m/s	
Frequency		30 Hz	
Automatic Gain Control			
AGC operator length		200 ms	
Velocity Analysis		SMB	
Normal Moveout Correction			
Stretch Mute Percentage		100	
ODP/Ensemble Stack			
F-K Filter			
Type of Filter		Power Exponent	
Power to Raise F-K space to:		1.3	
Surface Wave Noise Attenuation			
Velocity		250 m/s	
Frequency		30 Hz	
Bandpass Filter			
Type of filter specification		Ormsby bandpass	
Filter Parameters		20-25-100-150 Hz	
Automatic Gain Control			
AGC operator length		1000 ms	
G.I.I.	G.I.I. JOB	912	
	PROCESSED AT G.I.I.	JUNE 2004	
GEOPHYSICAL INSTITUTE OF ISRAEL 100, ISRAEL			
PROCESSED BY: I. GOLDBERG		QUALITY CONTROL: P. TRANTMAN	
DISPLAY PARAMETERS			
Tue Jun 1 12:47:11 2004	Static Shift = 0		
Traces/Centimeters = 41	Centimeters/Second = 12		
Bias Percent = 0	Clip Limit = 2		
Gain Set = 0.8	RMS Amplitude = 1		
Gain Constant = 800			
ADVANCE		ProMAX	

Fig. 3 Seismic reflection time section along line KA-003

COP	100	
TIME	VEL	INTV
21	1173	1321
77	1282	1535
120	1379	1793
162	1497	1370
190	1479	2399
350	1954	3125
433	2227	3352
585	2568	

COP
TIME
1
1
2
3
5



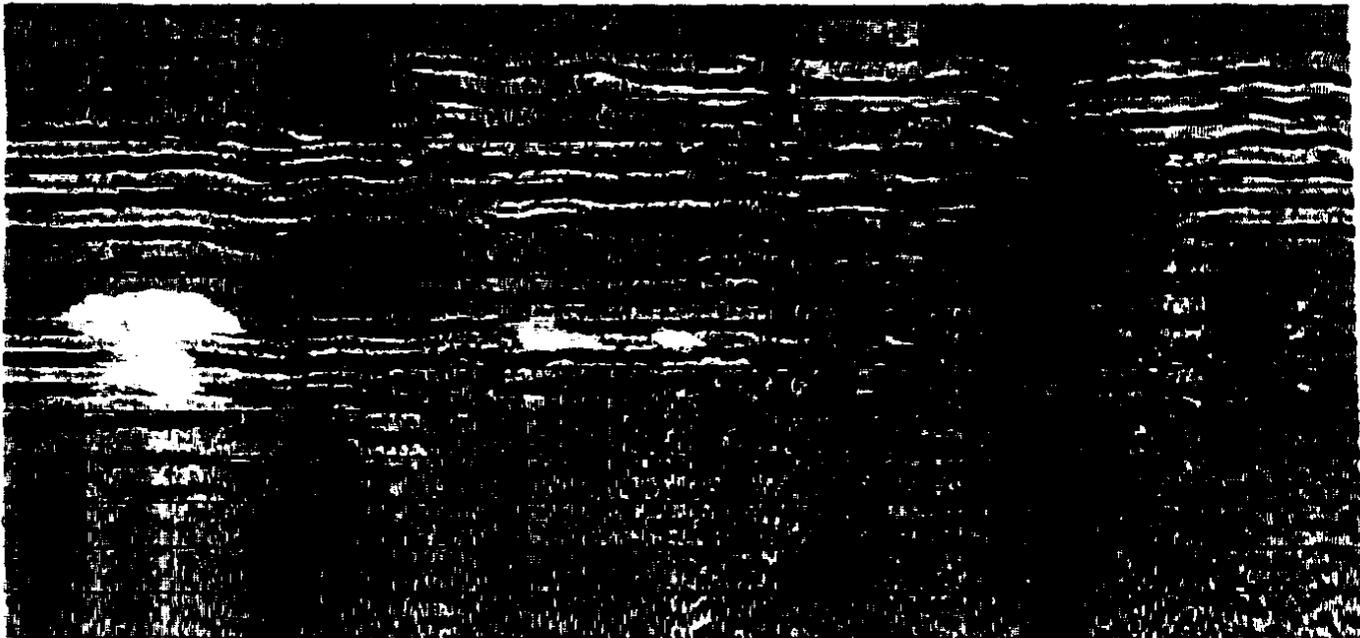
CDP TIME	800 VEL	INTV
13	1128	1254
68	1230	1281
111	1250	2352
171	1717	1606
247	1683	2026
376	1808	2684
551	2125	

20

420

520

620



CDP	1700	
TIME	VEL	INTV
21	1321	1347
77	1340	1569
126	1433	1515
173	1456	2443
347	2012	3399
722	2818	

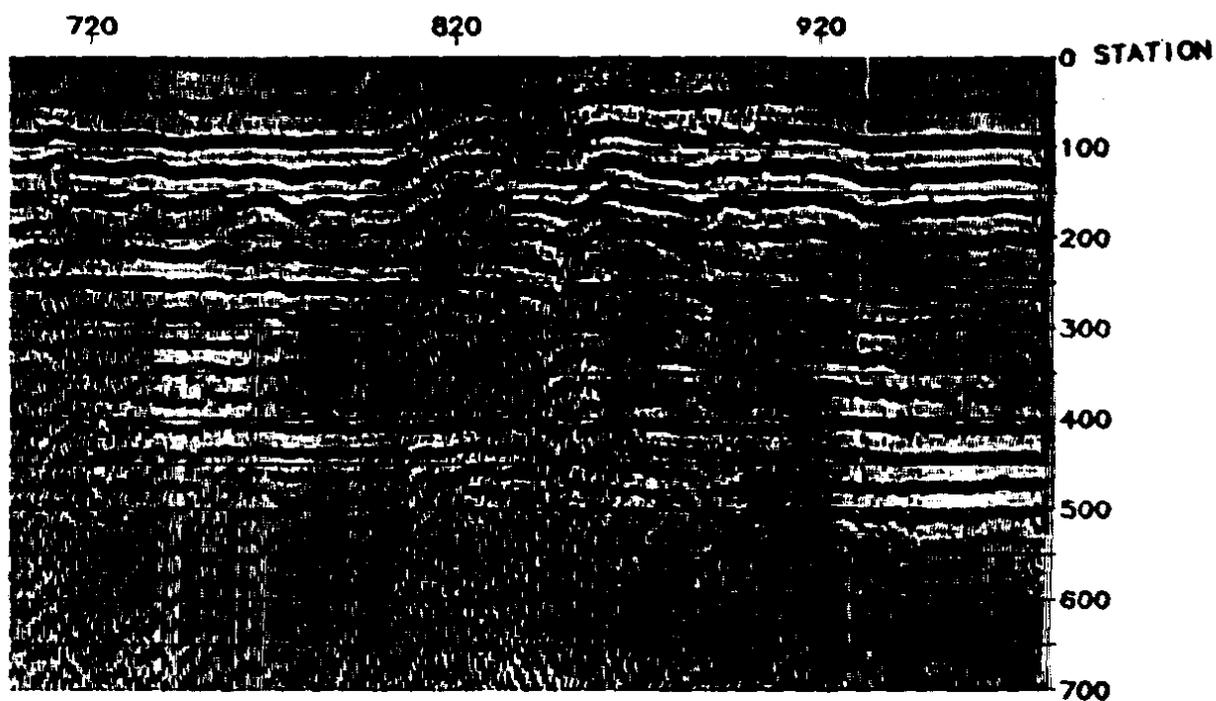


Fig. 4 Side header of seismic line KA-003



**GEOPHYSICAL
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ISRAEL**

AID Project TA-MOU-00-CA20-011

AREA: KAZGANCHAI; TURKMENISTAN

LINE : KA-004

**STRUCTURAL STACK
DATUM SURFACE**

FIELD PARAMETERS

RECORDING INFORMATION

Shot by	Geophysical Expedition of Turkmenology
Date	November 2003
Field System	Progress-96
Format	SEG-X
Record Length	2 sec
Sample Rate	2 msec
Lo-cut Filter	0 Hz
Hi-cut Filter	500 Hz

SOURCE INFORMATION

Energy Source	GSK
SP Interval	5 m

RECEIVER INFORMATION

Number of Channels	48
Group Interval	5 m

PROCESSING SEQUENCE

Demultiplexation	
SEG-Y Input	
Inline Geometry Applied	
Trace Editing	
Surface Wave Noise Attenuation	
Velocity	230 m/s
Frequency	30 Hz
Automatic Gain Control	
AGC operator length	200 ms
Velocity Analysis	SMB
Normal Moveout Correction	
Stretch Mute Percentage	100
CDP/Ensemble Stack	
F-K Filter	
Type of Filter	Power Exponent
Power to Raise F-K space to:	1.3
Surface Wave Noise Attenuation	
Velocity	230 m/s
Frequency	30 Hz
Bandpass Filter	
Type of filter specification	Ormsby bandpass
Filter Parameters	20-25-100-150 Hz
Automatic Gain Control	
AGC operator length	1000 ms

G.I.I.

G.I.I. JOB 912
PROCESSED AT G.I.I. JUNE 2004

GEOPHYSICAL INSTITUTE OF ISRAEL
100, ISRAEL

PROCESSED BY: I. GOLDBERG

QUALITY CONTROL: P. TRAHMAN

DISPLAY PARAMETERS

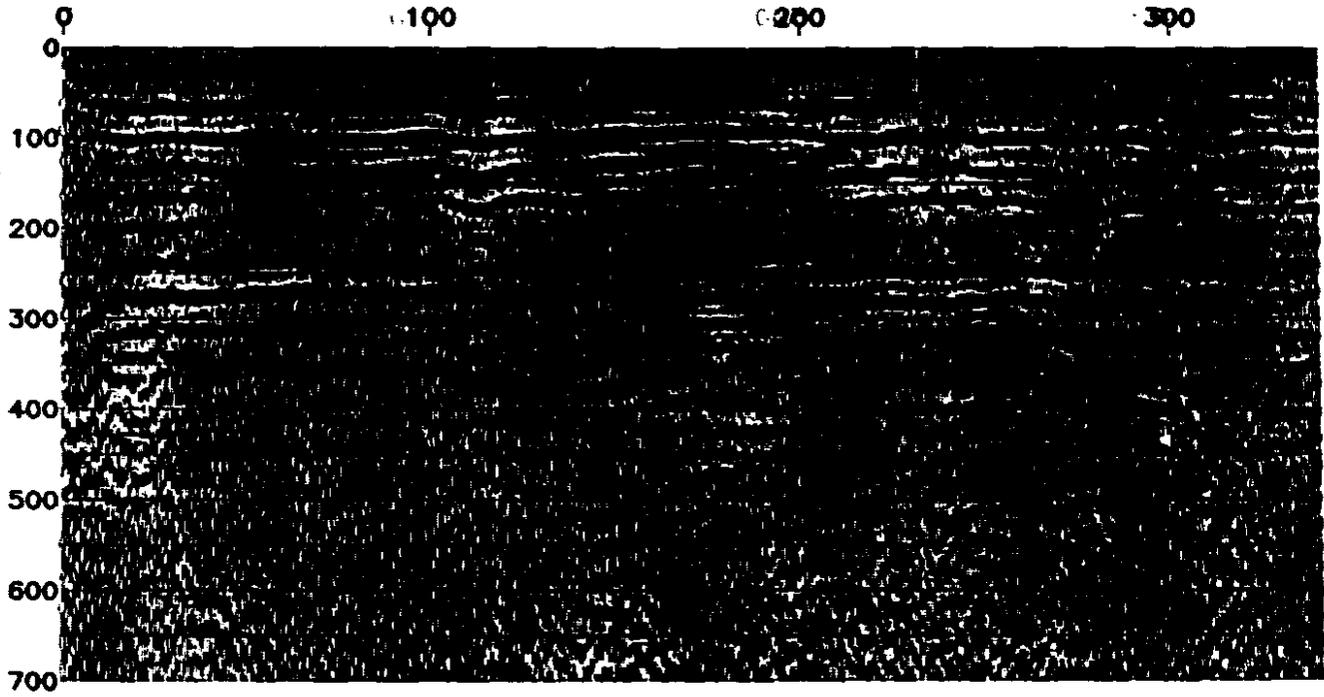
Tue Jun 1 13:00:19 2004	Static Shift = 0
Traces/Centimeters = 41	Centimeters/Second = 12
Bias Percent = 0	Clip Limit = 2
Gain Set = 0.8	RMS Amplitude = 1
Gain Constant = 800	

ADVANCE ProMAX

Fig. 5 Seismic reflection time section along line KA-004

CDP	100	
TIME	VEL	INTV
8	1445	1445
94	1445	1557
162	1493	2014
269	1717	2940
529	2397	3487
682	2681	

100
 150
 200
 250
 300
 350
 400
 450
 500
 550
 600
 650
 700
 750
 800
 850
 900
 950
 1000



CDP	900	
TIME	VEL	INTV
68	1456	1553
127	1502	1813
239	1655	2320
356	1899	2906
502	2239	2833
664	2397	

TVS
 0-100
 100-200
 200-300
 300-400
 400-500
 500-600
 600-700
 700-800
 800-900
 900-1000

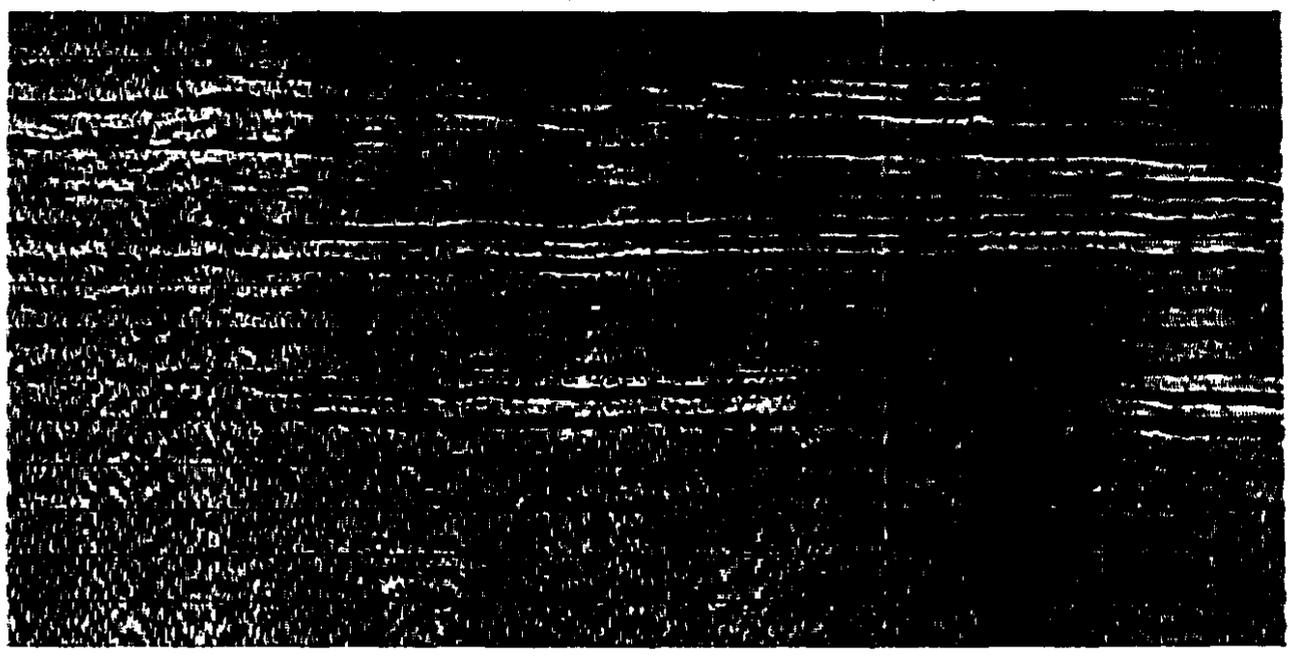
0-100
 100-200
 200-300
 300-400
 400-500
 500-600
 600-700
 700-800
 800-900
 900-1000

0-100
 100-200
 200-300
 300-400
 400-500
 500-600
 600-700
 700-800
 800-900
 900-1000

400

500

600



33a

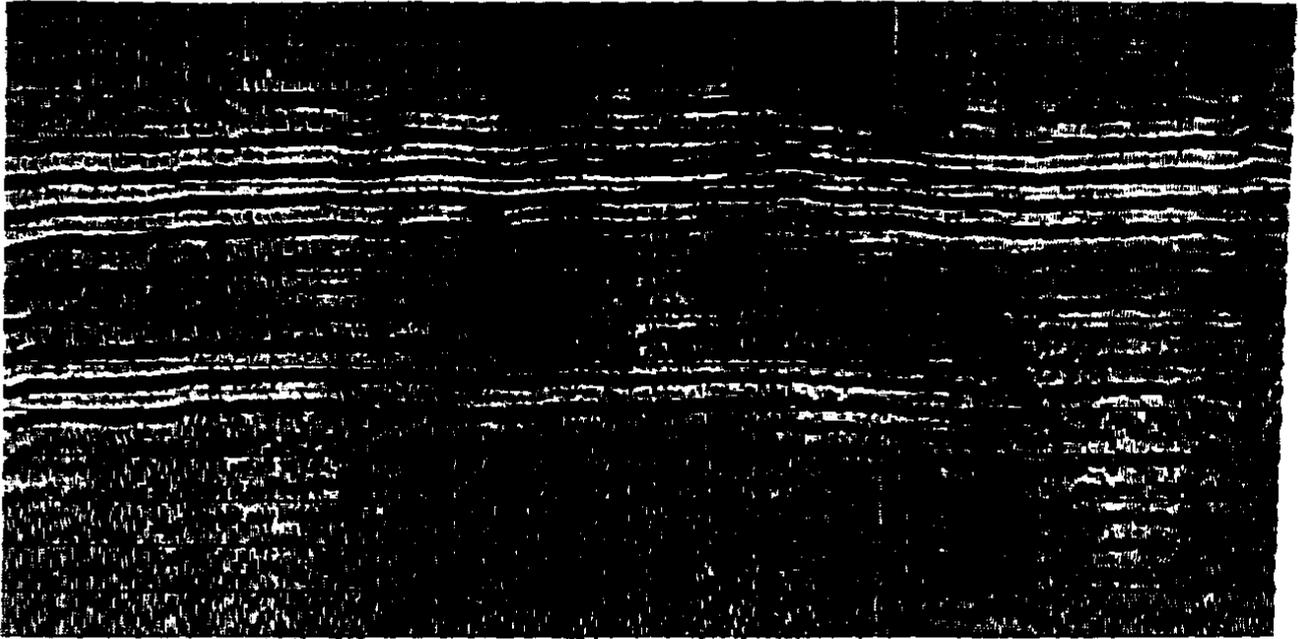
CDP	1900	
TIME	VEL	INTV
72	1524	1805
145	1672	2287
192	1842	2179
246	1921	2502
344	2103	2639
487	2273	2857
701	2465	

00

800

000900

1000



334

1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010

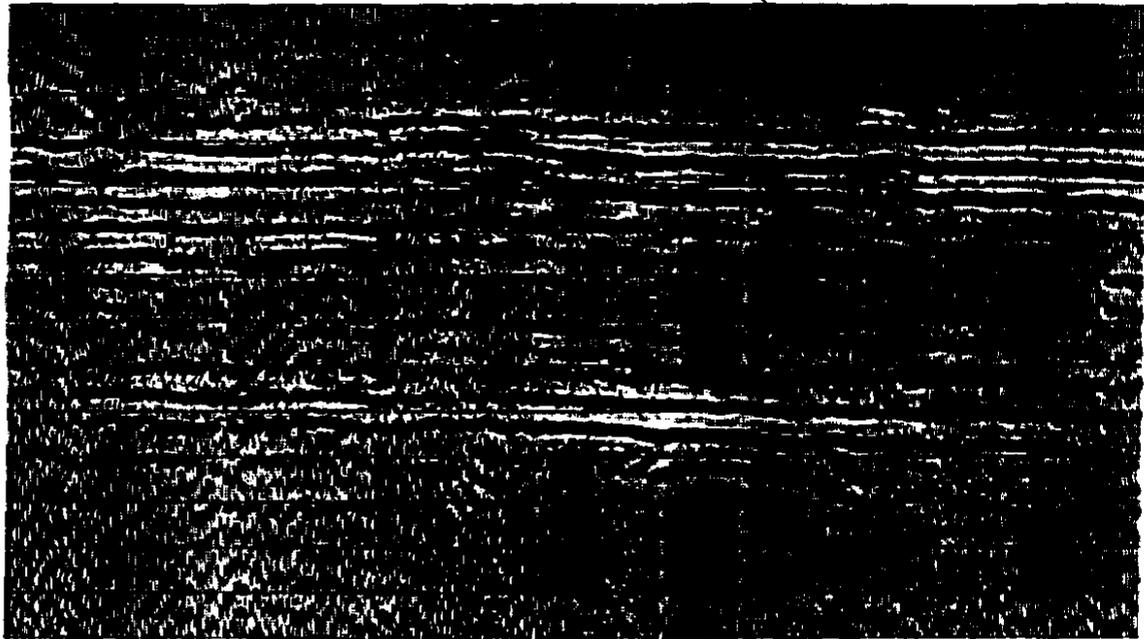
1011
1012
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1014
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1016
1017
1018
1019
1020
1021

1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032

1100

1200

1300



33c

CDP TIME	3000 VEL	INTV
48	1377	1735
185	1648	2387
239	1842	2530
355	2091	3023
543	2454	

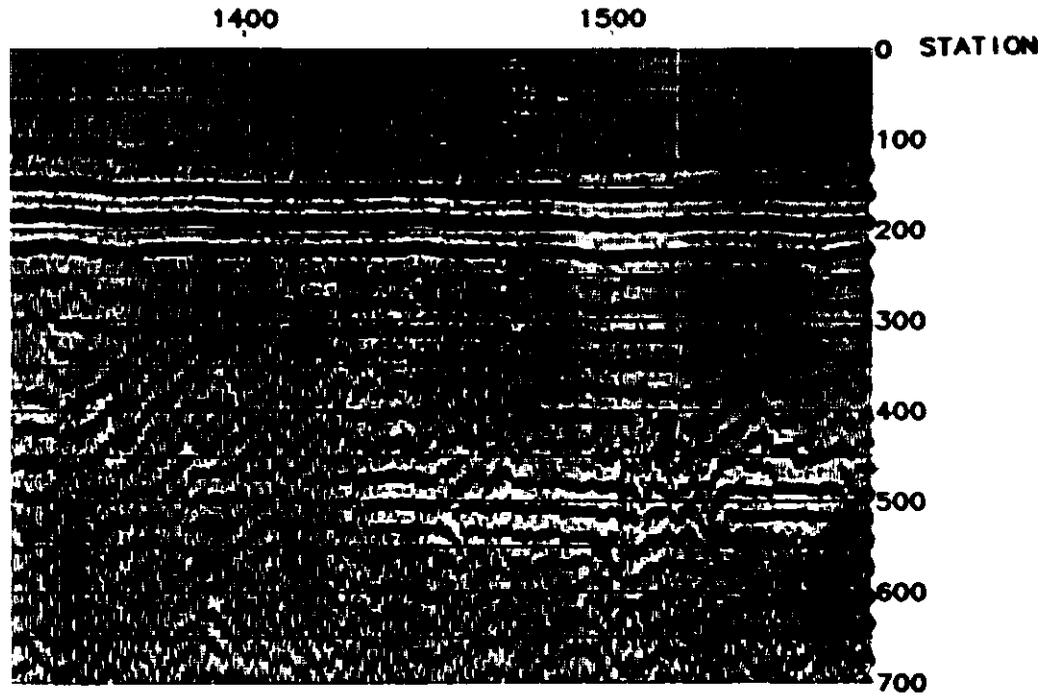


Fig. 6 Side header of seismic line KA-004