

## APPLICATION OF OPTIMUM OFFSET SHALLOW SEISMIC REFLECTION TECHNIQUE IN THE AREA OF WEST EL FASHN, EGYPT

By

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### تطبيق تقنية المسافة القصوى للانعكاس السيزمي الضحل على المنطقة غرب الفشن - مصر

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تم تطبيق تقنية المسافة القصوى للانعكاس السيزمي الضحل على منطقة الفشن في جمهورية مصر العربية حيث إن الغرض من هذا المسح هو التعرف على مدى فعالية هذه التقنية على استمرارية التتابعات الصخرية ببيئتين موجودين بالمنطقة وبالتالي إمكانية التعرف على التراكيب الموجودة .

بعد تطبيق هذه التقنية (مع الأخذ في الاعتبار كل الاحتياطات اللازمة لتطبيقها في العمل الحقلية) تم جمع معلومات سيزمية انعكاسية على طول بروفيل طوله ٢٥٠م حيث أن المسافة بين الجيوفونات كانت ٣م . هذه المعلومات السيزمية الانعكاسية تم تسجيلها باستخدام سيزموجراف (١٢ قناة) باستخدام جيوفونات نو نبضات تذبذبية قيمتها ١٠٠ هيرتز لكل قناة وايضاً استخدام المرشح السيزموجرافي نو القيمة التذبذبية العالية (٣٠٠ هيرتز) .

تم استخدام التحليل السريع لهذه المنطقة عن طريق المسح الانكساري بواسطة عمل سابق للمؤلف في نفس المنطقة في تحويل زمن الوصول على القطاع السيزمي الانعكاسي إلى عمق . وهذا ساعد جيداً على تجميع قطاع سيزمي انعكاسي واضح على طول ٢٥٠م. هذا القطاع يظهر بوضوح الاسطح الفاصلة بين التكوينات المختلفة مثلما تم التعرف عليها من تسجيلات الآبار . إضافة إلى ذلك فإنه يمكن التعرف على بعض الاسطح على القطاع السيزمي الانعكاسي التي لا يمكن التعرف عليها من المسح الانكساري . وقد تم اللقاء الضوء على ان المعلومات الجيولوجية السيزمية وتسجيلات الآبار يمكن استخدامها معا في التعرف على تتابع ومضاهاة الأسطح الجيولوجية الموجودة تحت سطح منطقة الدراسة .

ABSTRACT

A shallow optimum offset reflection survey was performed in El Fashn area. The purpose of this survey was to determine the continuity of the subsurface boundary conditions

The optimum offset shallow seismic reflection technique was used to collect approximately 350 m of data with a geophone spacing of 3 m. The data were recorded on 12 channel engineering seismograph using signal 100 Hz geophone per channel and 300 Hz high pass filter on seismograph. Velocity analysis provided the information necessary to convert arrival time to depth estimates.

The seismic section clearly delineate the contact between the different rock units identified from the borhole data. Some boundaries, which cannot be interpreted from refraction work, are clearly recorded on the reflection section. Also, regional geologic information, seismic and borehole data are combined to indicate the continuity of the geologic contact present within the overburden beneath the study area.

I - INTRODUCTION

The recent enhancement engineering seismograph is used in groundwater prospecting, civil engineering and mapping of the overburden and bed rock interfaces. The reflection technique offer several potential advantages over refraction methods. The reflection technique are not subject to the assumption that velocity increases with depth, as are most refraction methods. The reflection technique in general require smaller sources and shorter spread lengths to map a given interface than do refraction method. From the frequency content of signal, the reflection technique has the potential of resolving deposition feature within the overburden material. Additionally, it is difficult to obtain critically refracted arrivals from several irregular bedrock refractors.

"Geo Pro" (model 8012 A) 12 Channel seismograph (Bison) is available in the geophysical Laboratory of El Minia University. It is based on a digital microprocessor computer configured to operate in the field as signal acquisition and digital processing system. It offers unparalled flexibility for applications in engineering refraction [1] and [2] and in shallow high-resolution reflection (aim of the present study).

The survey is conducted in an area where information from two boreholes (A and B) are available [3], see figs. (1 and 2). A salt water aquifer is detected at a depth of 18 and 140 m., at the Wells (A) and (B), respectively. The studied area is covered with surface fine sand. Such material is characterized by seismic velocity of 400 m/s, figure [3]. The second layer (sand interclated with shale) shows a seismic velocity of 600 m/s. The medium to corse sand layer has a seismic velocity of about 2000 m/s. A velocity value of 5000 m/s represents the layers of Flint and dolomitic Limestone is detected. It should be stated here that, the refraction work cannot delienate the flinit layer from the dolomitic Limestone layer. The subject of this paper is the application of the optimum offset relection technique [4] in the area of El Fashn. The different rock units obtained from borehole data and refraction seismic are correlated with the shallow seismic reflection events.. Additionally good reflector between Flint layer and dolomitic Limestone layer is traced on seismic reflection section.

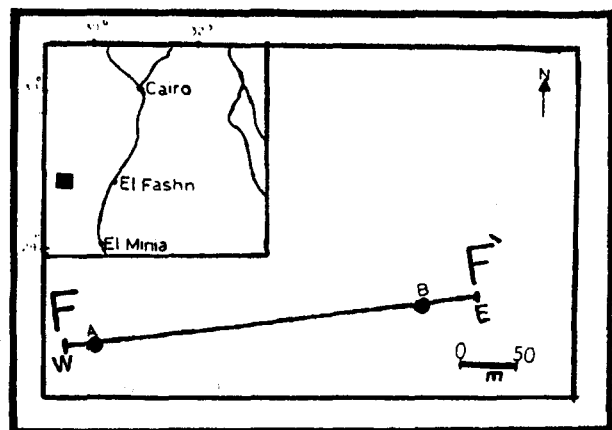


Figure 1 : The location map of the studied area. The studied reflection profile is identified by F-F and azimuthal orientation. A and B are locations of two boreholes.

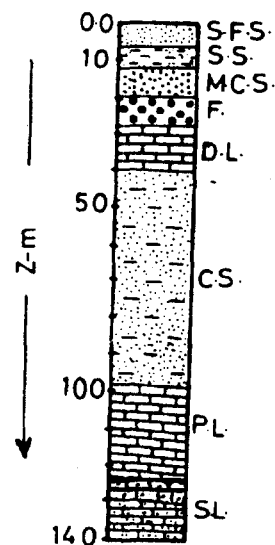


Figure 2 : Borehole data. Designations: S.F.S., surface fine sand; S.S., sand intercalated with shale; M.C.S., medium to coarse sand; F., flint; D.L., dolomitic limestone; C.S., clay intercalated with shale; P.L., pure limestone; S.L., sandy limestone. Flint, at a depth of about 18 m., represents the top of the first aquifer. Taken from the operator: El Gihad Co. for Agriculture and Land Reclamation.

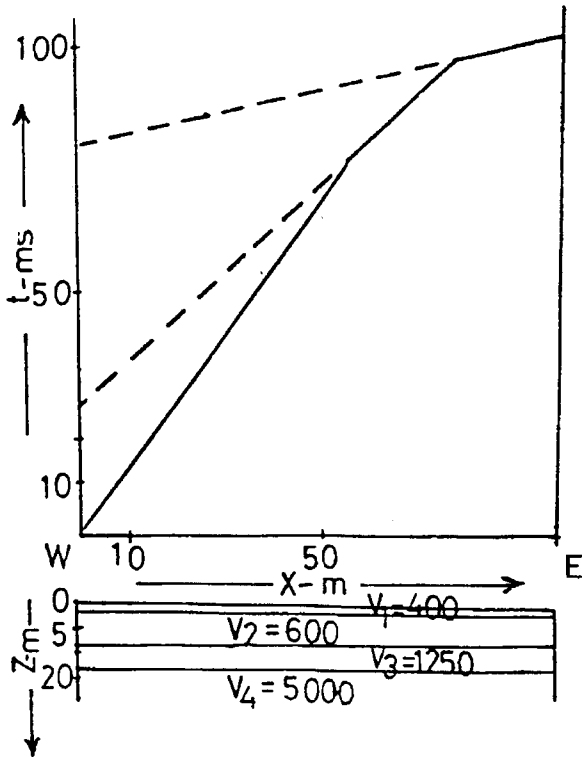


Fig. 3: Showing seismic velocity depth section for the studied area after Setto and Fattah [3].

II - FIELD REQUIREMENTS FOR SHALLOW REFLECTION SURVEY

During any reflection survey, the investigator must be careful, because it needs a much requirements in the field. First of all, the used seismograph in shallow reflection work must provide high pass analog filtering options. Such a filter is very important and critical in shallow reflection survey. The success of any reflection survey depends on the detection of high frequency energy reflected from subsurface interfaces. However, the high frequencies are strongly attenuated during transmission through the earth. The high-pass analog filters on the seismograph are used to compensate in part for the low-pass characteristics of the earth [4]. Our "Geo-Pro" seismograph has high-pass analog filtering options. Also its dynamic range is of 16 bit improve the significance of the high-frequency components of the recorded signal, [5] and [6].

The second field requirement in the reflection survey is to use of high-frequency geophones. This aid in the suppression of low frequency components of seismic signals. Signals geophone with natural frequencies of 50 to 100 Hz are recommended for shallow reflection survey [4]. This means that the high frequencies geophonenes and high pass analog filters remove effectively the all low frequency component of the seismic signal and allow reflection energy with dominant frequencies of up to several hundereds herz to be recorded on an engineering seismograph. The high-frequency geophones are available. The data were filtered in the field by the use of 100 Hz geophone and a 300 Hz

high pass fileter on seismograph. During processing a digital band pass filter from 300-800 Hz was also applied.

The choice of a seismic energy source can also affect the frequency of reflected signal and hence, the resolution of the data. The source used for shallow reflection survey include sledgehammer weightdrop shotgun sources and explosion [7]. The hard sledgehammer is used in the present survey.

III - THE REFLECTION TECHNIQUE AND ACQUISITION PARAMETER

Basically, there are two field geometries that can be employed for reflection survey. The first one is the in-line offset geometry. The second one is the common depth point. Pullan and Hunter [4] suggested the optimum offset reflection technique. Figure (4) shows a schematic optimum offset section. Each trace of the final section is obtained by recording the output of single geophone separated by a given offset. The section is produced trace by trace by moving the position of the source and the recording geophone progressively down the line in equal increment Fig. (4).

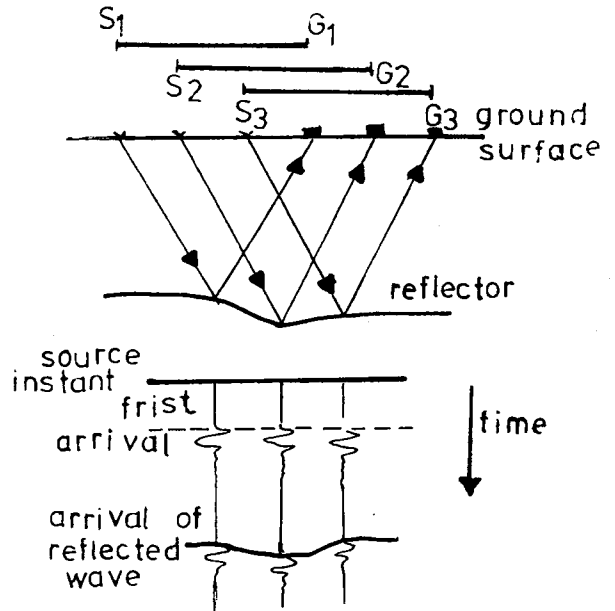


Fig. 4: The schematic optimum offset section showh at the bottom of the figure was produced by shooting first from S1 (source position) and recording the output from G1(Geophone 1), then from S2 to G2 and finally from S3 to G3.

In order to choose the optimum offset, it is necessary to record a number of test reflection records around the survey area to determine the best recording parameter. Figure (5) shows example for these test records. Several seismic events can be identified on this record. A three meter geophone interval was used. Such a distance is necessary when there is considerable topography on the target reflector or when the object of the survey is to map the subsurface in detail.

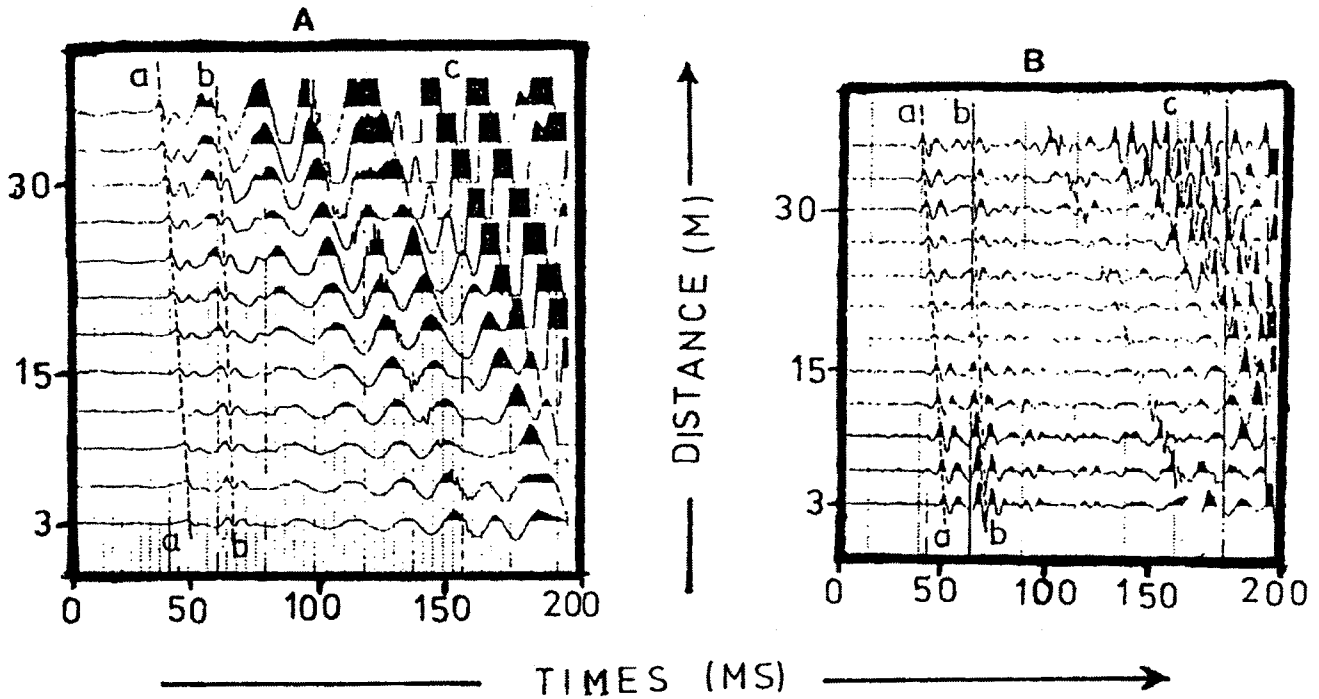


Fig. 5: A) Showing a shallow test reflection record. The relative position of the first arrivals (a), bedrock reflection (b) and ground roll (c) are identified on the figure. B) shows the same test record but filtered at 100-250 Hz. Note the pronounced improvement in the signal to noise ratio.

Figure (6) shows the time distance graph indicating the main events that are to be identified on the test records. The first arrivals on the test records are produced by energy that has been refracted from the top of the medium to coarse sand layer (i.e. from the water table, see Setto & Fattah, [2], and Figure 2). This event is plotted as a straight line on a travel time graph with slope of approximately 1250 m/s. Such a velocity value is typical for most water saturated unconsolidated material (e.g. medium to coarse sand). The ground roll (Fig. 6) is a packet of large amplitude, low frequency energy that travel along the ground surface at low velocities. The ground-roll forces a nonzero offset between source and receiver. Also the highly variable velocity structure within the overburden, particularly in the near surface material is another complication from the ground roll. However, the ground roll is reduced by use of high-frequency geophones and high pass analog filters on seismograph. From this figure the optimum offset for reflection survey can be chosen. Our next seismic section was shot with an optimum offset 21 m.

#### IV - THE SEISMIC REFLECTION SECTION

The optimum offset seismic record section shown in Fig. (7) was taken in E1 Fashn area. For its location see Fig. (1). The section is about 350 m long. The depth scale for this section was calculated from:

$$\text{Depth (m)} = \frac{[(VT)^2 - X^2]^{\frac{1}{2}}}{2} \quad \text{Slaima et al. [8]}$$

where V : The seismic velocity in (m/s)  
 T : two way traveltime in (ms)  
 and X : Optimum offset (m)

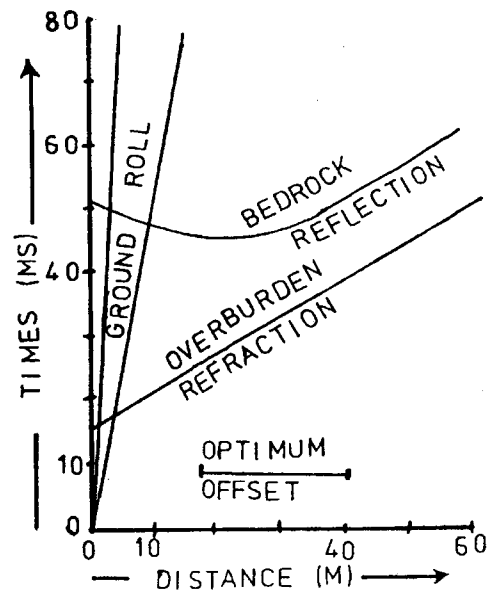


Fig. 6: Traveltime graph showing the main events observed on a multichannel shallow seismic record. The events are represented by overburden refraction, bedrock reflection and wedge shaped of ground roll. The optimum offset for final record is represented on the figure.

Information about the seismic velocity at the studied area are taken from the velocity-depth analysis, see figure (3). Such velocity values are determined from analysis of the normal and reverse refraction records using the intercept time and crossover methods (3). Lithology at the studies sit consist of surface fine sand of about 6 m thickness fig. (3). It is underlined by sand intercalated with shale. The seismic section shows a clear reflection event at depth of about 5 m implying the interface between the surface fine sand and the sand intercalated with shale. At about 14 m depth another good reflector is delineated. Such a reflector identifies the interface between the sand intercalated with shale and the medium to coarse sand layer. The top of the flint layer can be correlated with the very clear reflector at depth ranged from 20 to 22 m. The base of dolomitic Limestone can be identified by excellent reflector ranged in depth from 30 to 40 m. As mentioned previously, it was difficult to delineate the interface between the Flint layer and dolomitic Limestone layer from shallow seismic refraction interpretation. One of the very interesting results of this reflection is to overcome such problem, where the two layers are separated by a very clear reflector. (Figure 7).

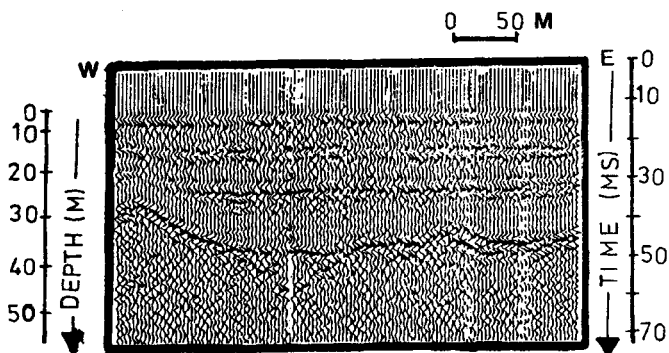


Fig. 7: showing the final optimum offset shallow reflection section from El Fshn area. The two way traveltime is converted to depth the equation of Slaine et al. (8)

## V - CONCLUSIONS

The carefully and hard use of "Geo-Pro" seismograph to apply the optimum offset shallow reflection technique led to construct a clear quality seismic section. The interpretation of this seismic section correlated well with both seismic refraction data and the geologic information obtained from the borehole data. Some interfaces, that cannot be identified from interpretation of

the seismic refraction data, are clearly recorded using the optimum offset shallow reflection technique. Finally, the reflection section provided a very important tool for evaluating the subsurface structure between drillholes.

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