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SEISMIC CONFIRMATION OF A NEW TECTONIC ELEMENT SOUTH-CENTRAL SIRT BASIN, LIBYA

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دراسة سيزمية تؤكد وجودعنصر تركيبي (تكتوني) جديد بمنطقة جنوب – وسط حوض سرت

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بينت دراسات جيولوجية سابقة وجود مرتفع (نتق) ذو اتجاه شمال غرب – جنوب شرق، يربط الحد الجنوبي لحوض سرت مع مسطح البيضاء ويفصل منخفض الحقفة عن منخفض دور العبيد وأبوتميم.

إعتمدت النتائج الجيولوجية بصورة رئيسية على المعلومات المحتصل عليها من الآبار الموجودة بالمنطقة مما حتم ضرورة التحقق ودعم هذه النتائج بأدلة جيوفيزيائية لتأكيد وجود هذا المرتفع من عدمه.

لقد تم استخدام معلومات لعدد سبع خطوط سيزمية تغطي حوالي «200» كيلومتر بالإضافة إلى معلومات لآبار واقعة على امتداد هذه الخطوط.

نتائج الدراسة السيزمية أعطت أدلة واضحة عن وجود هذا المرتفع والمحاط بفوالق ذات إتجاه شمال غرب – جنوب شرق، ويمكن إعتبار هذا المرتفع منطقة استكشافية واعدة بتجمعات نفطية.

ABSTRACT

Subsurface geologic studies brought to light an unrecognised and unreported prominent horst which is herein named "Inferred Horst". This horst trends NW–SE, links the Southern shelf with the Beda Platform and separates the Hagfa Trough from the Dor Alabid and Bu Tumayam Trough. This geologic finding relys mainly on data available from wells drilled in the area. Therefore, it is very essential to be verified and supported by geophysical evidences to confirm the presence or otherwise of this horst.

Seismic data along seven selected profiles covering nearly 200 line kilometers, were studied alongwith the completion, sonic and gamma ray logs of few wells. The study gave clear indications of the presence of MW–SE striking inferred faults bordering the Inferred Horst. It appears to be a composite tectonic unit formed by minor positive and negative blocks. The Inferred Horst is concluded to be prospective and seems to offer good locales for large accumulations of hydrocarbons.

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INTRODUCTION

The tectonic elements in the south-central Sirt basin include the Beda Platform, Hagfa Trough, Zelten Platform, Dor Alabid Trough, Bu Tumayam Trough and the Southern Shelf (N.O.C., 1983; subsequently revised in 1989 and 1990). These tectonic elements are delimited by major normal faults. The Bu Tumayan Trough is shown to join the Hagfa Trough towards the north and thus separates the Beda Platform from the Southern Shelf.

On the basis of geologic analysis, Sinha (1990) inferred the presence of a new tectonic element (*Inferred horst*) located between the Beda Platform and the Southern Shelf. Subsequently, a detailed study of subsurface data available from nearly 150 wells was carried out and, with the aid of structural, isopach and lithofacies maps for various stratigraphic units and several cross-sections, the presence of this horst (Fig. 1) was established (Sinha, 1992). According to this study, the horst links the Beda Platform with the Southern Shelf, trends NW–SE and separates the Bu Tumayam Trough from the Hagfa

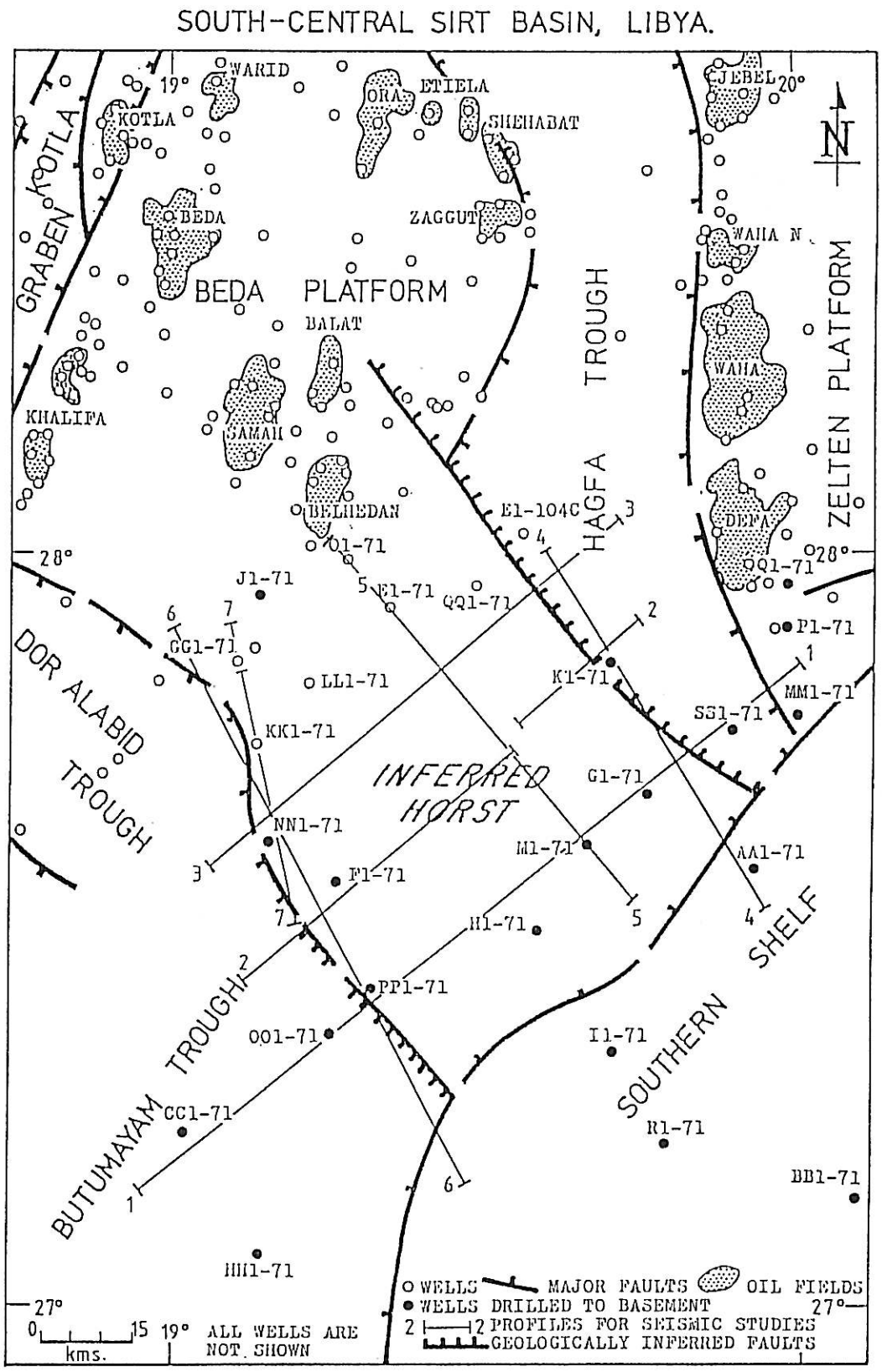

FIG. 1. Tectonic map (After Sinha, 1992).

Trough. It also was concluded that this horst has been intermittently active at least since the Campanian and hence is important from the view point of hydrocarbon prospects.

It was felt that the obtained geologic evidences regarding the newly discovered horst are not enough. These evidences require strong support by geophysical data. The use of seismic profiles across the study

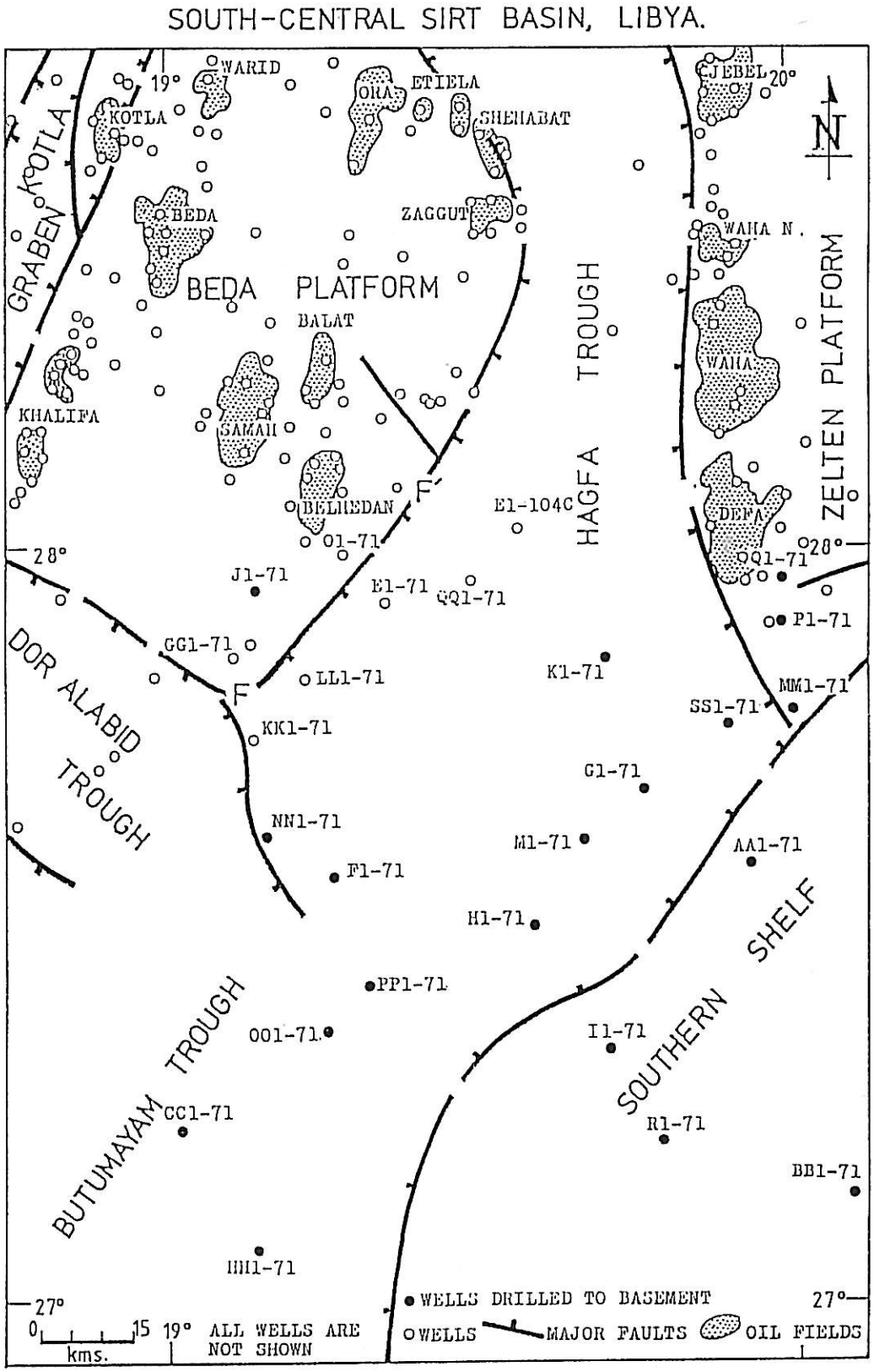

FIG. 2. Tectonic map (After National Oil Corporation, 1983).

area is very essential in order to resolve the arguments about the presence of the Inferred Horst.

A preliminary appraisal of seismic data along seven selected profiles (Fig. 1) across the *Inferred horst* was carried out mainly to confirm the presence or otherwise of this horst established by geologic studies. Profiles 1 to 3 are oriented almost NE–SW whereas, 4 to 6 are aligned approximately NW–SE. Profile 7

runs NNW–SSE. All these profiles cover the Inferred Horst and extend over parts of the adjoining tectonic elements.

WELL DATA

Completion logs of twenty five wells (AA1, BB1, CC1, E1, F1, G1, GG1, H1, HH1, I1, J1, K1, LL1, M1, MM1, NN1, O1, OO1, P1, PP1, Q1, QQ1, R1, SS1-71 and E1-104 C) were studied (Fig. 2). Nineteen of these are drilled through the entire sedimentary sequence and were bottomed in the igneous-metamorphic basement (Fig. 1). Gamma ray logs were available for only ten wells (AA1, F1, G1, GG1, H1, I1, J1, K1, OO1 and PP1-71) and these assisted in the delineation of various lithologic units. Only ten sonic logs (AA1, E1, F1, G1, GG1, I1, J1, K1, OO1, and PP1-71) could be procured and these were used for interval velocity assessments.

SEISMIC DATA

The seven profiles covering the *Inferred horst* comprise sixteen seismic lines (nos. 677, 713, 804, 805, 826, 842, 959, 970, 972, 1001, 1012, 1136, 1157, 1168, 1181 and 1189) shot by the Waha Oil Company, Libya, during 1971-1990. These, totalling approximately 200 line kms, were studied in detail. The data range from poor to good due to variations in fold coverage as well as recording and processing parameters. They however, adequately reflect the various tectonic elements of the study area. These elements are defined by normal faults. Some portions of few seismic lines need to be reprocessed for better resolution.

DESCRIPTION OF RESULTS

Profile 1

This profile is aligned NE–SW and covers the southern part of the area. It consists of 6 seismic lines 804, 842, 805, 972, 677, and 1181. Line 804 (SP's 1–240) is 24 fold stack, shot in 1975 and cover the Bu Tumayam Trough. The section shows gradual updip towards the NE. The dipping is around 100 ms in the upper part such as at 700 ms TWT and increases in the lower part of the section into around 300 ms (2000–1700 ms TWT) towards the NE.

Line 842 is an extension of line 804 shot in 1976. It consists of CMP 1–272 with wells OO1-71 and PP1-71 located along the line at CMP 66 and 152 respectively. The section shows main reflection interfaces which are characterized by their continuity and strength. These reflectors are mainly between 600 and 1700 ms TWT and could be divided into upper and lower part. The upper reflectors (600–1000 ms TWT) gradually dip towards the northeast. The lower part shows very important structural features consisting of normal faults. The reflection interfaces between CMP 1–54 and at 1700 ms TWT are nearly flat. These events are shifted upward around 75 ms TWT between CMP 54–77 and then shifted down again with slight dipping upward until CMP 126. The interval between CMP 126 and 142 shows scattered seismic energy and strong indication of the presence of a fault (Fig. 3) with a displacement of about 200 ms TWT. This fault separates the *Inferred horst* from Bu Tumayam Trough.

Line 805 is a continuation of line 842 and consists of stations 1–316. Well M1-71 is located along the line at CMP 33. The reflectors between CMP 204 and 316 are characterized by gentle dipping of about 30 ms TWT in NE direction. The interfaces in the lower part of the section between 1200 and 1500 ms TWT and CMP 204 are shifted upward by about 100 ms TWT. This displacement is a clear indication of the presence of a normal fault. This fault is located well within the area covered by the *Inferred horst*. The reflectors between CMP 1 and 204 are nearly flat. The deeper events are characterized by strong amplitude and continuity, specially those between 1200 and 1300 ms TWT.

Line 972 shot in 1978, consists of CMP 1–196. Wells M1 and G1-71 are located at CMP 40 and 156 respectively. The reflection interfaces between 400 and 1300 ms TWT and CMP 1 and 162 are generally flat with high amplitude and continuity. They dip downwards due NE in the interval between CMP 156 and 196. The dipping is very evident in the lower part of the section between 1000 and 1700 ms TWT. It shows clear indications of the presence of several major faults (Fig. 4), especially through tracing of main reflectors in the interval between 1200 ms TWT along the section. These faults separate the *Inferred horst* from the Hagfa Trough.

The last part of profile 1 is covered by the seismic line 1181. It consists of CMP 1–615. It is shot in 1989 across the Hagfa Trough and wells G1 and SS1-71 are located at CMP 548 and 224 respectively. The section is characterized by scattering and burst of seismic energy at some interval especially in the lower part of the section such as at intervals between CMP 504–550, 450–464, 312–348 and 168–240. The reflective interfaces in the upper part of the section show strong amplitude and continuity, and a general dip due NE. The lower part shows indications of faults. These faults are evident between CMP 504–516 and 450–462 and display a throw of about 100 ms TWT. Also, there are two other faults between CMP 316–342 and 168–212 with updip shift of about 300 ms TWT and 100 ms TWT respectively. The large interval of disturbance could be a result of stacking velocity picking in faulted and fractured zone with

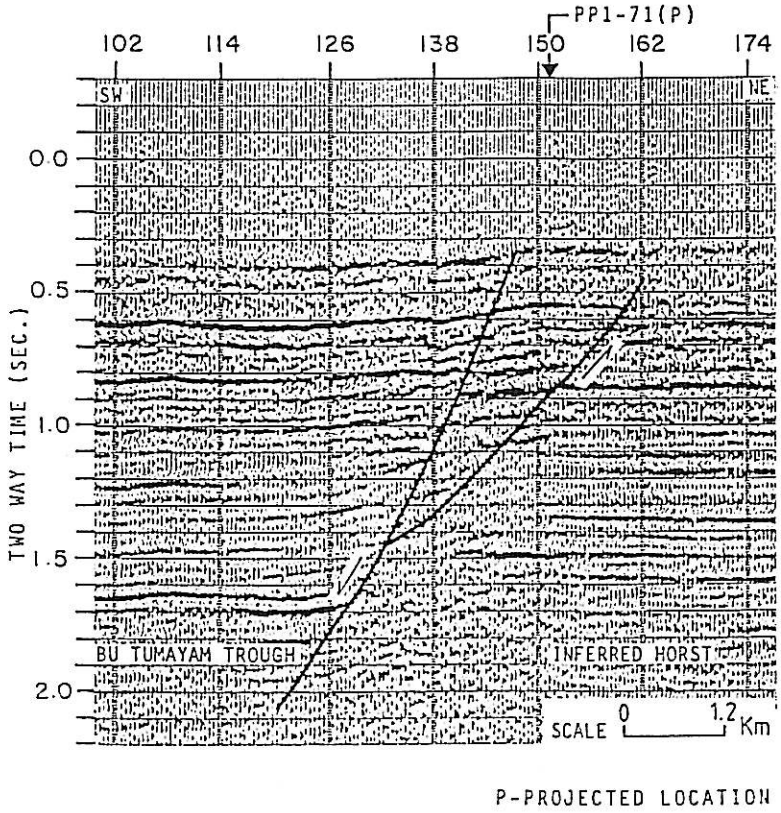

FIG. 3. Part of line 842; Profile 1-1.

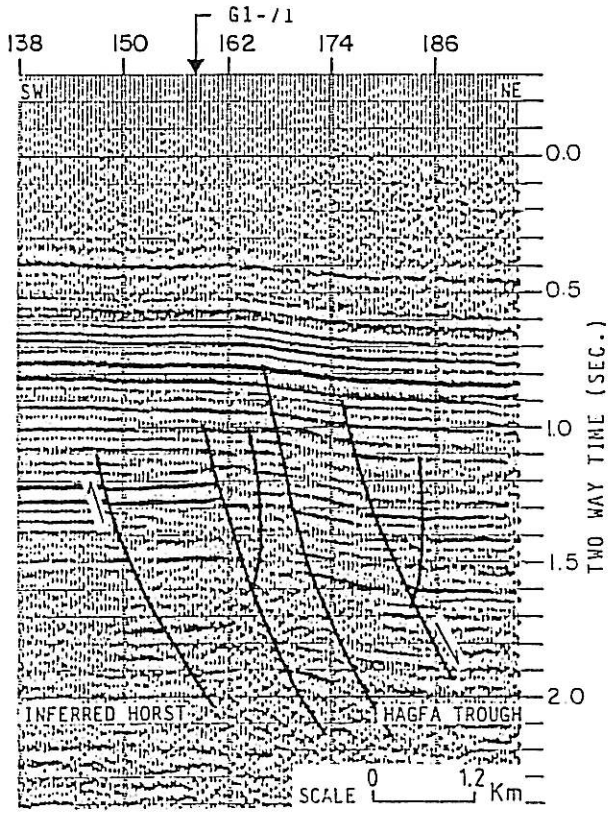

FIG. 4. Part of line 972; Profile 1-1.

low velocity which produce moving up of the reflection events that affected even the upper part of the reflection interfaces. The section shows presence of a fault dipping downward NE of well G1-71 and also another fault with an upthrown block NE of well SS1-71. These faults define the boundaries between *Inferred horst*, Hagfa Trough and Zelten Platform, (Fig. 1), respectively.

Profile 2

The profile 2, aligned NE–SW, crosses the middle part of the area and is represented by seismic lines 692 and 1001. It extends to the southern part of Hagfa and Bu Tumayam troughs. Seismic line 692 shot in 1972 represents the southwestern part of profile 2. The projected location of well F1-71 is close to CMP 176. The reflectors in the interval between CMP 1–102 show steep dips towards the SW and also indicate major step faults (Fig. 5) with a cummulative throw of about 200 ms TWT between CMP 66–102. These faults are discernible between 1500–2000 ms TWT and separate the *Inferred horst* from the Bu Tumayam Trough. The reflection interfaces in the interval between CMPs 102–238 are nearly flat with very gentle southwesterly dip. The reflectors from CMP 220 to the end of the section slightly dip towards the NE and also show evidences of step faulting (Fig. 6) in the interval between CMP 220–286 and with throw of around 100 ms TWT. The interfaces thereafter become nearly flat. These faults are located well within the area covered by the *Inferred horst*.

Seismic line 1001 was shot in 1979. It consists of 284 CMP and represents the northeastern part of profile 2. Well K1-71 is located very close to CMP 215. The reflection interfaces are characterized by strong amplitude and persistent continuity along the section with gentle dip towards the NE. The interval between CMPs 222–234 is denoted by presence of major faults (Fig. 7) with a throw of around 200 ms TWT towards the NE. These separate the *Inferred horst* from the Hagfa Trough. The two major faults in seismic sections 692 (Fig. 5) and 1001 (Fig. 7) clearly confirm presence of the *Inferred horst*.

Profile 3

Profile 3, represented by seismic lines 959 and 959 ext., is in the same direction as the profiles 1 and 2. Shot in 1977, it consists of CMP 1–704. It crosses the *Inferred horst* and extents into the Hagfa and Bu Tamayam troughs to the NE and SW respectively. Well NN1-71 is located at CMP 606. The main reflection interfaces in seismic section 959 cover interval between 300 and 1950 ms TWT. Most of the interfaces are characterized by high amplitude and continuity along the section. The interval between CMP 704 and 606 shows gradual updip of about 200 ms TWT toward the NE. There are indications of

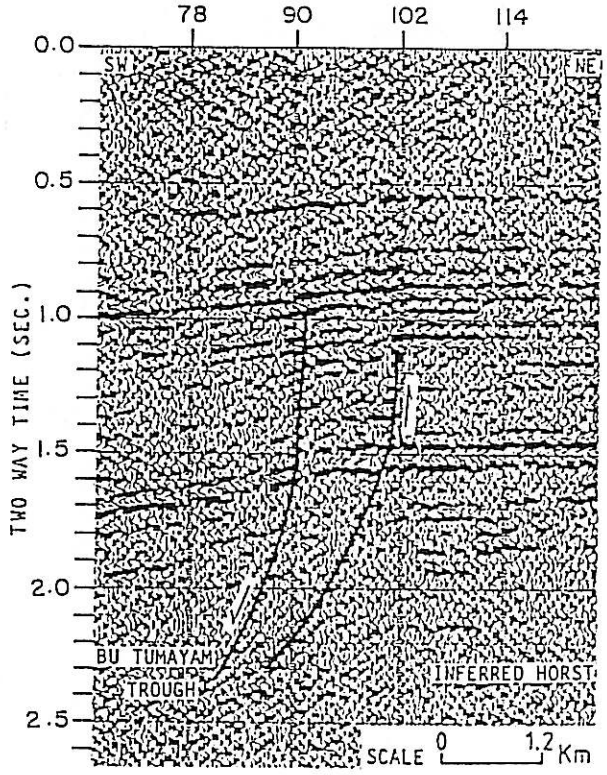

FIG. 5. Part of line 692; Profile 2-2.

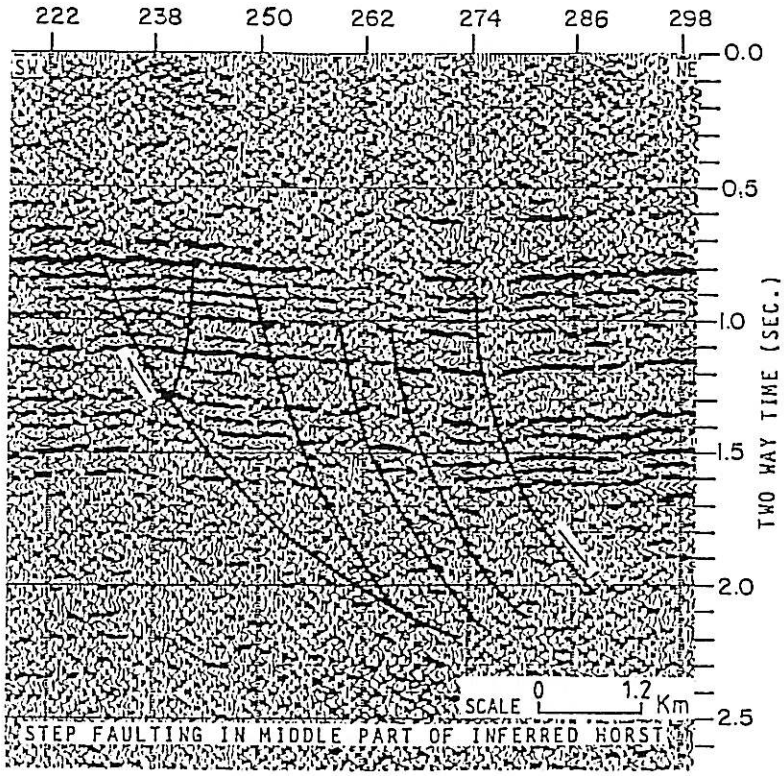

FIG. 6. Part of line 692; Profile 2-2.

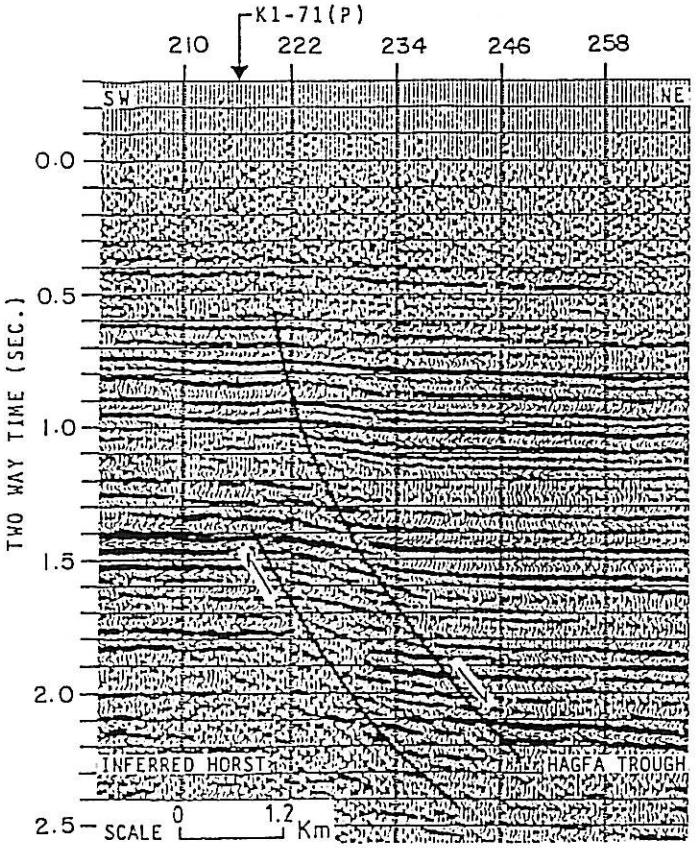

FIG. 7. Part of line 1001; Profile 2-2.

presence of normal fault (Fig. 8) around CMP 610 in the lower part of the section. The throw of the fault is not clear and the data might require reprocessing for better resolution. These faults separate the *Inferred horst* from Bu Tumayam Trough. The reflectors in the rest of the section are nearly flat.

The other part of profile 3 is covered by seismic line 959 ext. consisting of 113 CMPs (705–818). It is a continuation of line 959 with reflection interfaces dipping towards the NE. The main feature of the section is the presence of a major normal fault (Fig. 9) in the interval between CMP 756–780. The fault is clearly shown in the lower part of the section between 1500 and 2300 ms TWT with noticeable effect on the reflectors in the upper part of the section. This could be associated with a number of step faults with a cummulative throw of about 400 ms TWT. These faults separate the *Inferred horst* from the Hagfa Trough.

Profile 4

This profile, aligned NW–SE, extends from the Southern Shelf in the southeast to a part of the Hagfa Trough and thereafter covers a part of the *Inferred horst* as well as a smaller part of the Hagfa Trough further northwest (Fig. 1). It is represented by seismic lines 1189 and 1012. Seismic line 1189, shot in 1990, consists of CMP 1–455. The reflection interfaces show good continuity and high amplitude. These reflecting horizons dip gently due NW and indicate presence of a fault around CMP 60 that separates the Southern Shelf from the Hagfa Trough. The lower part of the section shows a sudden increase in dip between CMP 370–455.

Seismic line 1012, shot in 1979, consists of CMP 1–302. The reflectors in the upper part of the section (between 400 and 1300 ms TWT) are almost horizontal and exhibit high amplitude and continuity. The lower part is characterized by a northwesterly dip, high amplitude and reasonably good continuity. Multiples are present. The trace of the *Inferred horst* bounded by the normal faults can be deciphered between CMP 174 and 78.

Profile 5

This profile, aligned NW–SE, crosses nearly the middle part of the area. It comprises seismic lines 1136, 1168, and 970. The first part is represented by

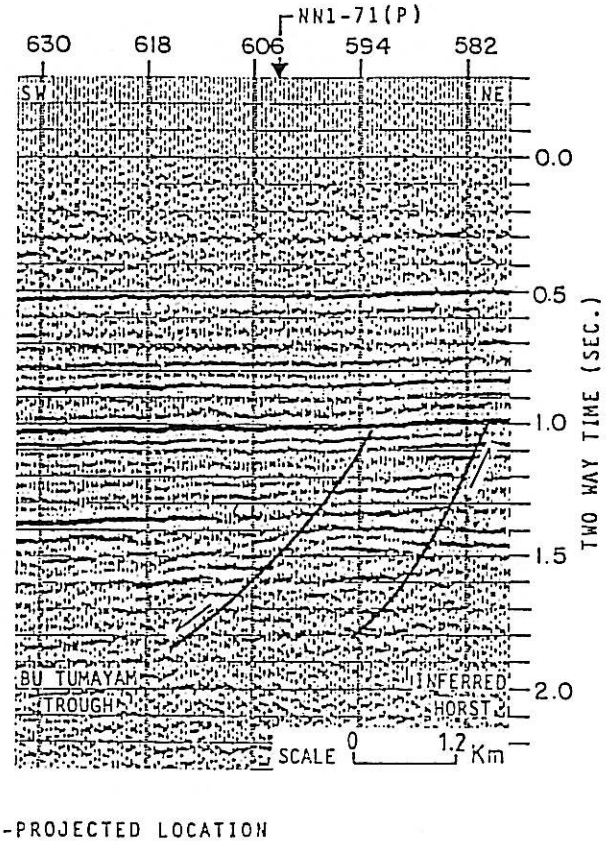

FIG. 8. Part of line 959; Profile 3-3.

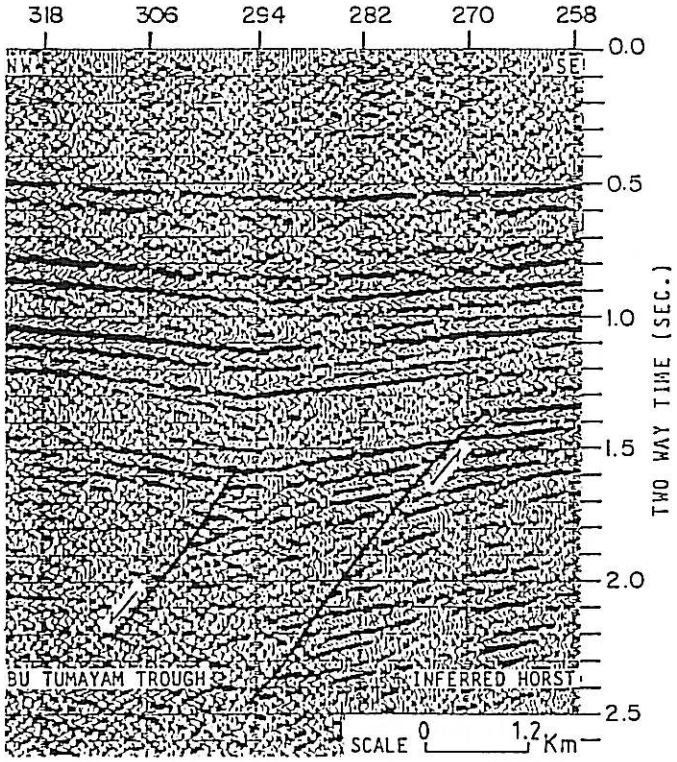

FIG. 9. Part of line 959 EXT; Profile 3-3.

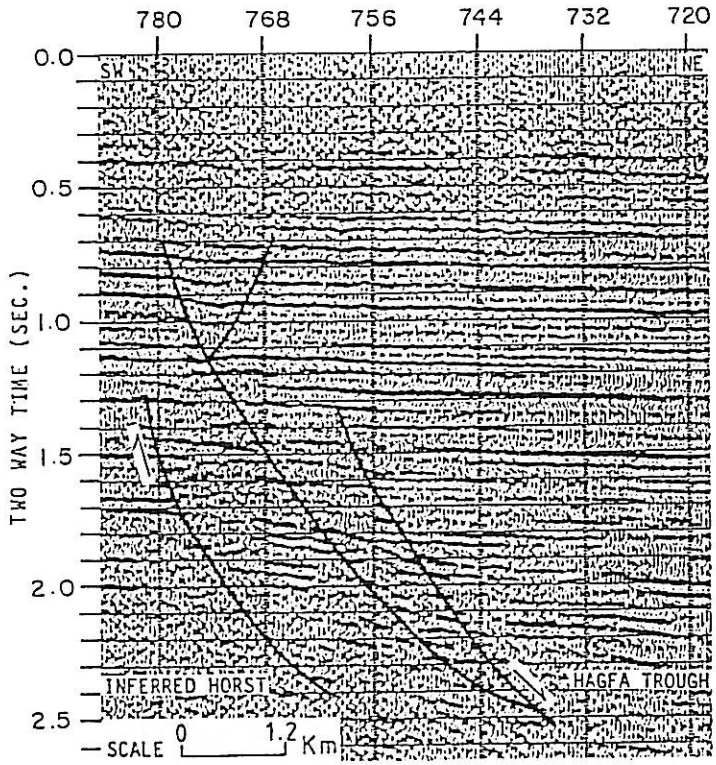

FIG. 10. Part of line 713; Profile 6-6.

seismic line 1136 shot in 1988 and consists of CMP 1–364. Wells O1 and E1-71 are located at CMP 312 and 122. The main reflection interfaces are characterized by high amplitude and continuity especially in the upper part of the section and are denoted by gentle dips towards the SE. There are no indications for the presence of any fault in the interval between CMP 120 and 360, that is between wells O1-71 and E1-71 (Fig. 11) although the tectonic maps of N.O.C. (1983; revised in 1989 and 1990) show its presence (F–F'; Fig. 2).

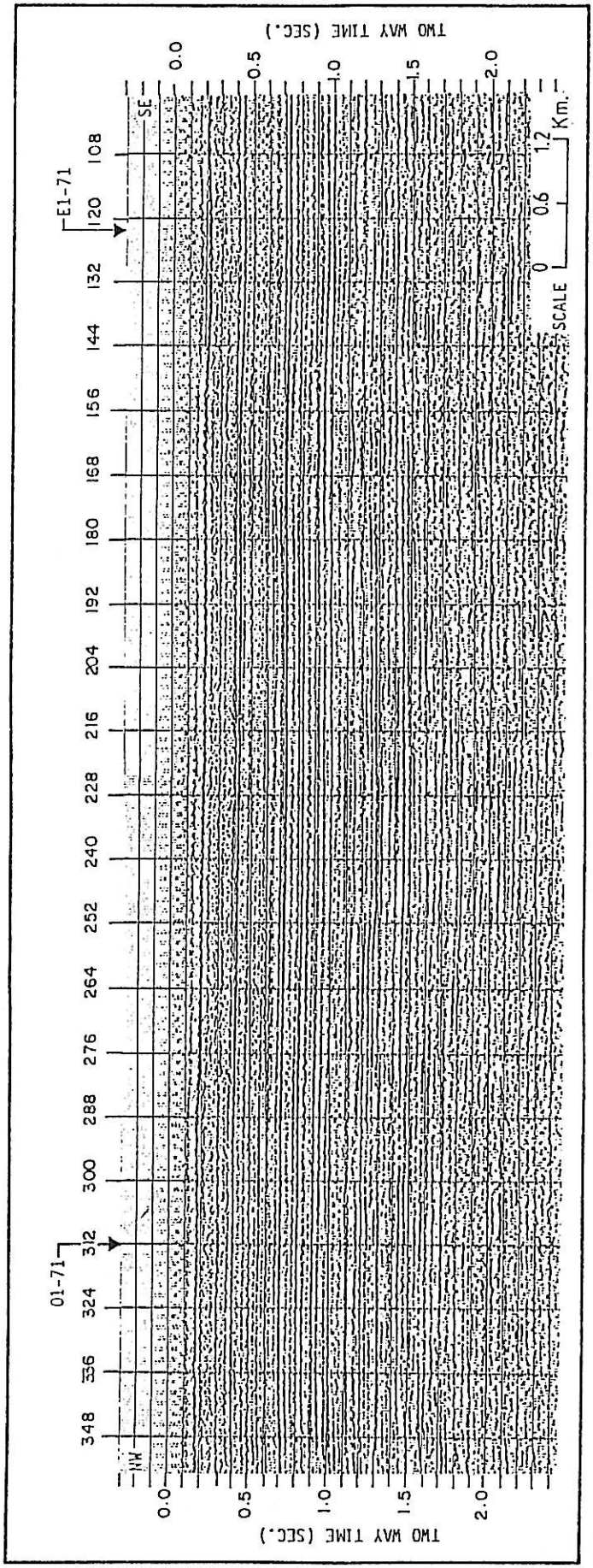

FIG. 11. Part of line 1136; Profile 5-5.

Seismic line 1168 represents the middle part of profile 5. It was shot in 1989 and consists of CMP 1–415. The reflection horizons are characterized by gentle dips towards the NW, high amplitude and continuity.

Seismic line 970, shot in 1978, consists of CMP 1–180. It is a continuation of line 1168 with well M1-71 located at CMP 103. The main reflectors, which very gently slope towards the NW in the lower part of the section, are, characterized by strong amplitude and continuity.

Profile 6

Profile 6 runs across the area in NW–SE direction and extends into the Southern Shelf and Beda Platform, (Fig. 1). It consists of seismic lines 713 and 826. These two lines are nearly in the same direction as that of the fault except in the NW part where they cross the fault. As shown in seismic section 713, the section between CMP 186 and 318 is characterized by reflectors with high amplitude and continuity especially in the upper part of the section. The lower part (between 1000–1800 ms) of this section is marked by faults (Fig. 10) as is brought out by the displacement of various reflectors. These faults seem to separate the *Inferred horst* from the Bu Tumayam Trough.

Line 826 consists of 420 CMPs 1–420 with well PP1-71 located at CMP 73. It is a continuation of seismic line 713. The reflection horizons show the same characters especially in the interval between CMPs 1–126. These reflectors then gradually dip towards the NE, between CMP 126–306. This interval represents the change from the *Inferred horst* to the Southern Shelf with possible presence of a fault at CMP 306. Another fault is indicated near CMP 246. The section between 126–234 CMP is very fuzzy and may need reprocessing. The rest of the section extends over the Southern Shelf.

Profile 7

Profile 7 consists of seismic lines 1157 (CMP 1–460) and 796 (CMP 1–400) shot in 1988 and 1974 respectively. Seismic line 1157 extends from the *Inferred horst* to Beda Platform. These lines were studied to ascertain if the southeastern part of Beda Platform is demarcated/delimited by any fault as is shown by the tectonic map of N.O.C., 1983; revised 1989 and 1990, FF'; Fig. 2. Wells GG1 and KK1-71 are located along the line at CMP 430 and 180 respectively. The main reflection interfaces are characterized by strong amplitude and continuity. The reflections between CMP 276–460 show gradual downdip towards the SSE especially in the lower part of the section. The interval between CMP 156–444 of line 1157 is characterized by nearly flat and undisturbed reflectors (Fig. 12). This seismic section does not confirm the presence of any fault which according to the tectonic maps of N.O.C. (1983; revised in 1989 and 1990) occurs between wells GG1 and KK1-71 and defines the southeastern margin of the Beda Platform (F–F'; Fig. 2).

Seismic line 796 covers the south-southeastern part of line 7 with wells KK1 and NN1-71 located at CMPs 32 and 344. The main reflection interfaces show high amplitude and continuity. These reflectors are almost flat along the entire seismic section.

DISCUSSION

The tectonic maps for the south-central part of the Sirt Basin (N.O.C., 1983; revised in 1989 and 1990) show that:

(a) the Bu Tumayam Trough continues to the north and joins the Hagfa Trough (Fig. 2),
(b) the Beda Platform is separated from the Southern Shelf by the northern parts of Bu Tumayam Trough and southern part of Hagfa Trough (Fig. 2) and,
(c) the southeastern margins of the Beda Platform is defined by a NE–SW trending normal fault (F–F'; Fig. 2).

Contrary to the above, Sinha (1990 and 1992) on the basis of geologic studies established that:

(a) the Bu Tumayam Trough is separated from the Hagfa Trough by a horst (*Inferred horst*; Fig. 1),
(b) the Beda Platform is tectonically linked to the Southern Shelf through the *Inferred horst* (Fig. 1) and,
(c) the southeastern margins of the Beda Platform are not defined by any fault (Fig. 1).

Seismic data along seven profiles across the *Inferred horst* and marginal parts of adjoining tectonic elements (Fig. 1) was critically studied to verify the foregoing conclusions of Sinha (1990 and 1992).

Study of data along the various seismic lines comprising each of the seven profiles, as already given in the foregoing establishes presence of major normal faults. These are located towards the southwestern part of profiles 1, 2 and 3 (Figs. 3, 5 and 8). Each of these faults is marked by a southwesterly down thrown block which seems to form the Bu Tumayam Trough. The traces of these faults on profiles 1, 2 and 3 when joined together seem to form a NW–SE trending system of regionally developed normal faults. These appear to extend further NNW and thereafter to NW to join the major fault (NW–SE) already mapped by N.O.C., 1983, and which defines the southwestern margins of Beda Platform. The northwestern blocks of

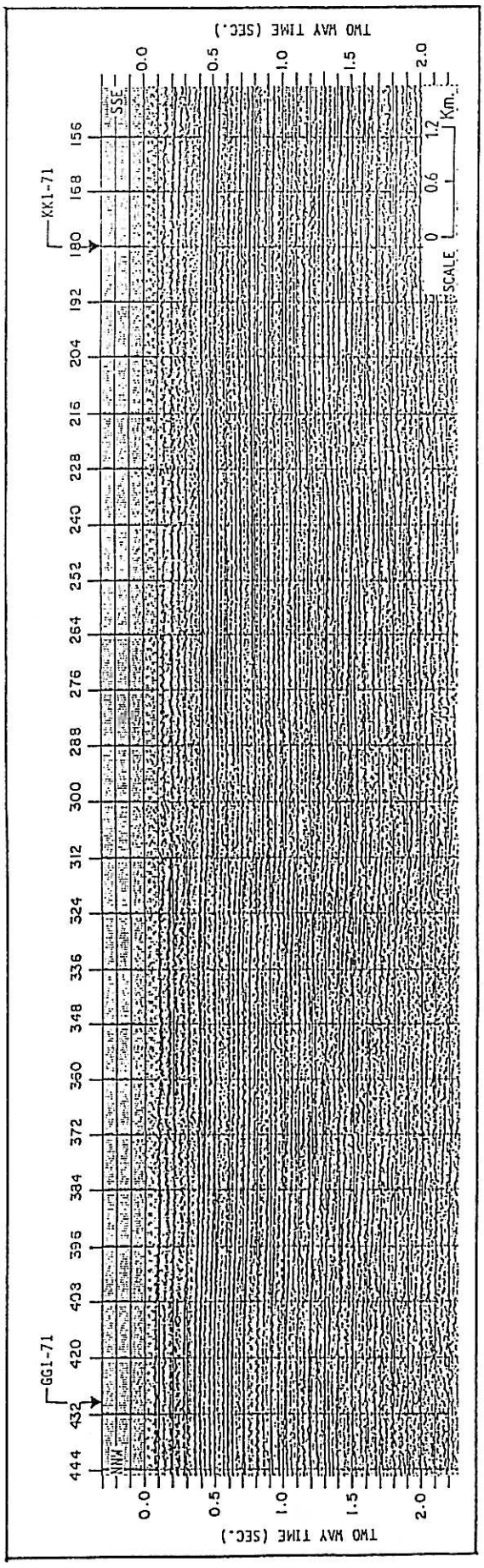

FIG. 12. Part of line 1157; Profile 7-7.

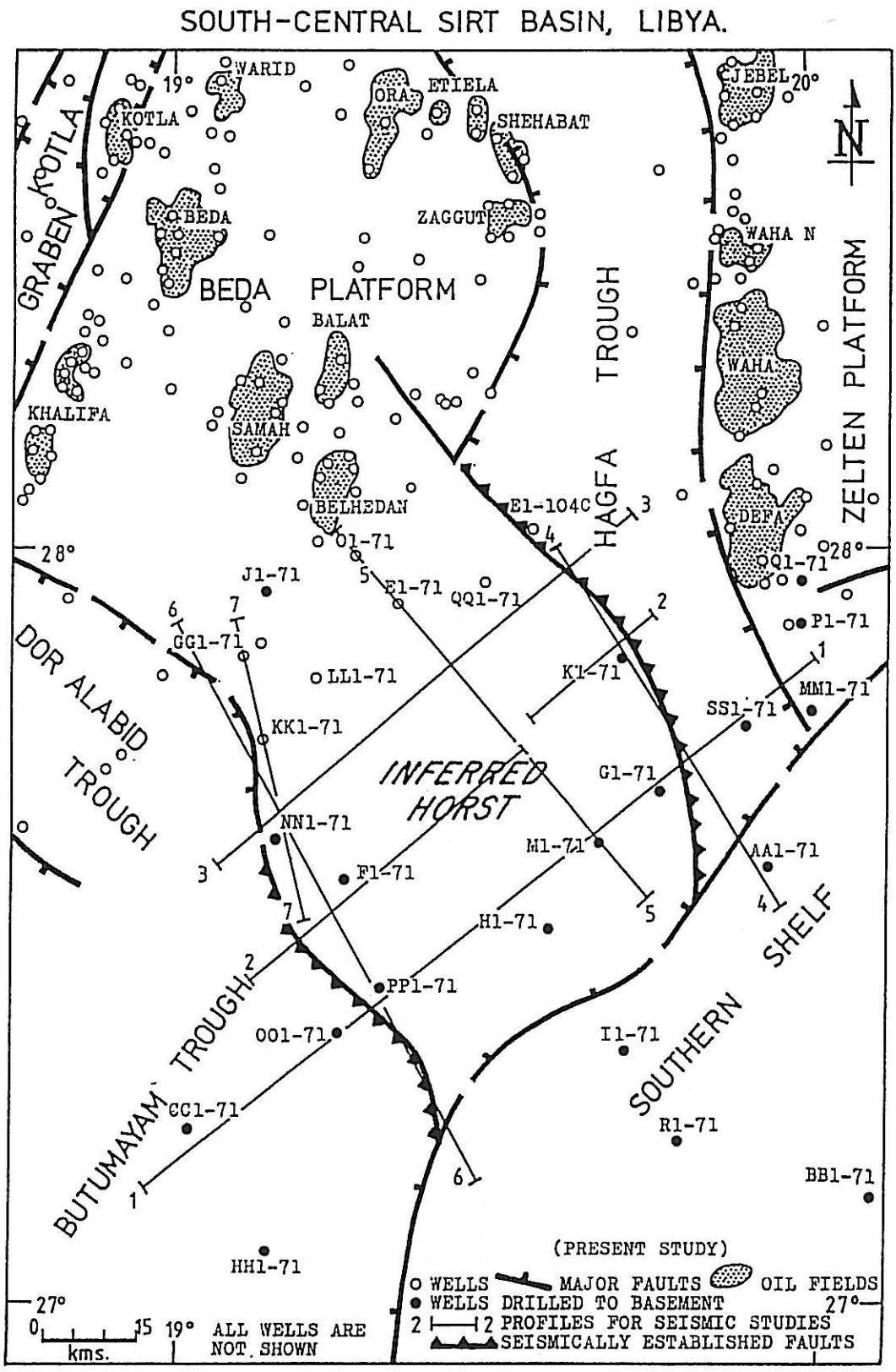

FIG. 13. Tectonic map on basis of the new seismic and geologic evidences (present study).

these faults are upthrown and together they form the *Inferred horst* (Fig. 13).

Seismic data from the northeastern parts of profiles 1, 2 and 3 display major normal faults (Figs. 4, 7 and 9). Each of these faults are marked by a northeasterly down thrown block and a southwesterly upthrown block. These faults when traced from profile 1 to 3, seem to form an almost NW–SE trending regional

fault system extending up to the Southern Shelf in the southeast and over the Beda Platform towards the northwest. The down thrown block corresponds to the Hagfa Trough while the upthrown block forms the *Inferred horst* (Fig. 13). Profile 4, aligned NW–SE is almost parallel to this fault. A normal fault with a northwesterly down thrown block is detected at CMP 60 of line 1189 which represents the southeastern part of profile 4. This fault seems to mark the margin of the Southern Shelf.

Seismic data from the northwestern parts of profiles 5 and 6 was studied in conjuction with data from KK1, NN1, O1 and El-71 wells (Fig. 1) with special attention to detect the presence or otherwise of the F–F′ part of the fault shown (N.O.C., 1983; revised in 1989 and 1990) to demarcate the southeastern margins of the Beda Platform (Fig. 2). The main reflectors along the seismic lines extending from wells 01 to El-71 (Fig. 11) and GG1 to KK1-71 (Fig. 12) are denoted by high amplitude and good continuity and marked by conspicuous absence of any signs of faulting. The presence of F-F′ part of the fault, hence, is not supported by seismic data even though it is shown by the tectonic maps of N.O.C. (1983; revised 1989 and 1990).

The forementioned study of seismic data appear to overwhelmingly confirm all the geologic conclusions of Sinha (1992). They confirm the presence of regionally developed *Inferred horst* in an area otherwise regarded to represent parts of two very major troughs (Bu Tamayam and Hagfa) of the Sirt Basin. The extension of Beda Platform due southeast and its linkage with the Southern Shelf through the *Inferred horst* does not seem questionable. The tectonic map prepared on the basis of seismic and geologic studies (Fig. 13), though very similar to that prepared earlier on basis of geologic evaluation (Fig. 1), brings out a better and more meaningful resolution of the faults and consequently, of the *Inferred horst*.

Normal faults with smaller throws (under 100 ms TWT) are present even within the area covered by the *Inferred horst*. These are detected on profile 1 at CMP 204 and on profile 2 between CMP 220–286 (Fig. 6). Those observed on profile 1 seem to hade due southwest while those traceable on profile 2 may hade towards the northeast. The *Inferred horst*, hence, seems to be a composite tectonic unit comprising several minor negative and positive blocks. At the present stage of study, it does not seem feasible to attempt the mapping of these faults. They, however seem to trend NW–SE. Seismic data from additional lines need to be evaluated for their precise delineation and detailing.

HYDROCARBON PROSPECTS

Oil fields are yet to be discovered in the area covered by the *Inferred horst*. Presence of oil is noted in sandstones (Late Cretaceous) met at G1-71 and in Lower Beda Formation (Palaeocene) met at NN1-71. Several giant oil accumulations are noted over the adjoining Beda Platform. Likewise, prolific oil fields are located over the nearby Zelten Platform (Fig. 13).

Sirt Shale of Campanian age is one of the principal source rocks of liquid hydrocarbons in the Sirt Basin (Hamayouni *et al.*, 1984). It is nearly 200 feet thick over the horst but it rapidly thickens to more than 1000 feet towards the northeast and southwest in the adjoining Hagfa and Bu Tumayam troughs respectively. It contains nearly 2.0 percent (average) of Type II and II–III Organic matter (Robertson International Corporation, 1979). Good clastic and carbonate reservoir rocks overlain by regionally developed shale cap rocks are present in the Early Cretaceous-Palaeocene sequence. The *Inferred horst* is concluded to have been intermittantly active since Campanian and was structurally positive during Oligocene-Miocene (Sinha, 1992) when the oil was generated, expelled and migrated from the Sirt Shale (Hamoyouni *et al.*, 1984 and El Alami *et al.*, 1989) to form giant accumulations over the adjoining Beda Platform and the nearby Zelten Platform. By the same analogy it must have also migrated over the *Inferred horst* in suitable entrapments. The hydrocarbon proclivity of the *Inferred horst*, thus, does not seem disputable. The *Inferred horst* appears to be a composite tectonic unit comprising minor positive and negative blocks. Their detailing is necessary for a more meaningful and objective evaluation of hydrocarbon prospects. Furthermore, presence of reefs especially within the Palaeocene carbonates enveloping the *Inferred horst* can not be ruled out (Sinha, 1992).

CONCLUSIONS

- The use of seismic data has contributed effectively in providing the approximity to investigate and resolve the arguments regarding the *Inferred horst*.
- Study of seismic sections covering about 200 line kms along seven selected profiles in the south-central Sirt Basin confirm the presence of the horst (*Inferred horst*) as already concluded by earlier subsurface geologic studies. This new tectonic element occupies the basinal part otherwise considered to represent major troughs.
- The *Inferred horst* links the Beda Platform with the Southern Shelf, strikes NW–SE and isolates the Bu Tumayam Trough from the Hagfa Trough. Seismic data suggest that this horst is a composite tectonic unit comprising minor positive and negative blocks delimited by normal faults of minor

throws. Alignment of the minor blocks could be NW–SE.

- The *Inferred horst* is concluded to be very prospective and seems to offer good locales for large accumulations of hydrocarbons.

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REFERENCES

El Alami, M., Rahouma, S., and Butt, A.A., 1989, Hydrocarbon Habitat in the Sirte Basin, Northern Libya, Petrol. Res. Journal, Vol. 1, p. 19–30.

Hamayouni, E.A., Amr. I.A., Riani, A.B., El Ghull, A.B. and Rahouma S.A., 1984, Source and Habitat of Oil in Libyan Basins *in* Proc. Sem. Source. and Habitat of Petroleum in the Arab Countries, Kuwait, p. 127–180.

N.O.C., 1983, (revised 1989 and 1990), Tectonic Elements of Libya, 1:1,000,000, National Oil Corporation of Libya (unpublished).

Robertson Research International, 1979. The Petroleum geochemistry of Oils and Source Rocks in the Southeast Sirte Basin, Vol. I and II, Report to Arabian Gulf Oil Co., Libya (unpublished).

Sinha, R.N., 1990, Palaeocene Palaeogeography and Hydrocarbon Prospects, Sirte Basin, Libya. Rept. National Oil. Corporation, Libya, unpublished.

Sinha, R.N., 1992, The Subsurface Palaeocene Shoal Carbonates, South-central Sirte Basin, Libya, Rept. Petroleum research Centre (unpublished).