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DETERMINATION OF STATICS

Statik Düzeltmelerin Belirlenmesi

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ABSTRACT

The problems associated with static corrections for seismic data are as old as the hills or, in many places, as old as the glaciers. Nonetheless, despite repeated attempts over the years, statics remain as generally the most serious problem affecting seismic data acquired over varying terrain. Not so long ago computer generated residual statics using the high fold of modern CDP recording and new algorithms were thought, at least by a good few, to have laid the problem to rest. However it was not long before it was clear that only a partial solution had been found. Another great note of excitement was struck with the arrival of refraction statics algorithms on the data processing scene, again only a partial, albeit more satisfactory, solution had been found - also this technique cannot work in every situation.

So here we are in the late 1980's with a lot of fancy algorithms and computing power - still perfectly capable of drilling statics anomalies or, possibly worse, missing fields entirely.

All is fortunately not quite so bad, things have improved a long way, we can use powerful new algorithms in the processing centre, we can make a very determined stab at solving the problem; gaining greater confidence in the structural accuracy of our data. The answer, at least to my knowledge - perhaps I am missing somethings - does not lie in this or that panacea but in a logical and rational plan which seeks to use all of the modern processing tools whilst ensuring that all the data needed for them is gathered and interpreted correctly.

The statics correction problem is essentially the seismic problem in microcosm. We need to design the survey, acquire the data, process it, interpret it and possibly go back and acquire more data in areas of doubt. What this paper sets out to do is to outline a modus operandi for achieving success. It is recognised that the division of corrections into 'static' and 'dynamic' is overly simplistic and that what is really needed is a wavefield solution, however we still need the same basic information i.e. thicknesses and velocities of the near surface layers. Most operators will probably continue to talk of statics rather than near surface wavefield corrections for the next few years.

ÖZET

Kara sismik verilerinde statik düzeltmelerle ilgili sorunlar, tarih kadar eskidir. Yıllar boyu bu sorunları çözmek için gösterilen ısrarlı çabalara rağmen, statikler hâlâ, kara sismik verilerinin kalitesini ve doğruluğunu etkileyen en ciddi problem olarak kalmaya devam etmektedir. Kısa süre önce, yüksek katlamalı CDP yöntemindeki veri bolluğunu ve yeni algoritmaları kullanan bilgisayar-rezidüel statik metodları, bazıları tarafından (şimdi bulunmaları zor olsa da) soruna çözüm getirmiş olarak kabul edilmiştir. Bir diğer büyük heyecan, refraksiyon statik algoritmalarının sahneye çıkmasıyla yaşanmıştır. Yine yalnızca kısmi, fakat tatminkâr, buna rağmen evrensel olmayan bir çözüm bulunmuştur. Böylece, bugün bile bütün bilgimize ve birçok algoritma ile hesaplama gücümüze rağmen, hâlâ statik anomalilerini delme, hatta daha da kötüsü bütün bir sahayı kaçırma durumları ile karşı karşıyayız.

Fakat işler bir hayli gelişmiş olup; veri işlem merkezinde ve sahada güçlü yeni algoritmalar kullanabilir ve belirli tedbirler alındığında, mantıklı bir başarı beklentisi içinde probleme isabetli bir çözüm bulabiliriz. Bize göre en tatminkâr cevap, şu veya bu ilaçta değil, en etkili çağdaş veri işlem imkânlarını kullanarak ve gereken verilerin doğru toplandığından ve yorumlandığından emin olarak yapılacak mantıklı ve akılcı planlamadadır.

Statik düzeltme sorunu, temel olarak, mikro evrendeki sismik sorunudur. Yapılacak çalışmanın planlanması, verilerin toplanması, işlenmesi, yorumlanması ve olasılıkla geri dönülüp kuşkulu bölümlerde daha fazla veri toplanması gerekmektedir. Bu makale, bir başarıya ulaşabilme yöntemini özetlemek amacıyla yazılmıştır. Anlaşılmıştır ki, düzeltmelerin statik ve dinamik olarak ikiye ayrılması fazlasıyla basite indirgemektir ve asıl gerekli olan, olayın dalga alanı olarak çözümlenmesidir. Yine de sığ tabakaların kalınlıkları ve hızları gibi temel bilgilere ihtiyacımız vardır. Önümüzdeki birkaç yıl, çoğu operatörler, sığ dalga alanı düzeltmeleri yerine statik düzeltmelerden bahsetmeye devam edeceklerdir.

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INTRODUCTION

If 5 geophysicists were asked now to compute field statics they would give at least 6 different answers, most of these would contain common threads but would be biased towards a particular favourite method. There probably is no perfect method which will work in any area but there are a lot of techniques which can be linked together to provide the best solution for any given area. The emphasis will not be on any particular technique, but on how to plan a land survey and those peripheral activities which contribute towards arriving at a satisfactory solution to the statics problem.

The problem of near surface corrections has been around for such a long time that it is easy, if not forgivable, to believe that there is no great problem, that is was all solved years ago. Few surveys credit the problem as being worthy of the expense and effort which is usually required for satisfactory results.

Static, or near surface, corrections represent the seismic process in miniature, there is a planning phase, a data acquisition phase, a data processing phase and an interpretation phase. This last phase is sometimes overlooked, there is a tendency to believe that the statics data is in some mysterious way more absolute than our regular seismic data. Thus, in new areas statics are produced for the first line, and the next and so on as if they existed entirely in their own right, and then statics are produced for a line crossing one of those already recorded. It is not uncommon in such circumstances to find that there are wildly different near surface models and resultant static corrections for the two lines, nor should it be in the least surprising.

In order to see how we should plan ve have to investigate each phase of the statics route whilst also considering what will happen to the mainstream seismic data itself.

SURVEY DESIGN CONSIDERATIONS

What useful information do we get from our reflection survey data? What futher information do we need? How frequently do we need this? Are there specific locations at which we require such additional information? How does the processing of the reflection data affect the manner of data acquisition? What is the ultimate use of the data?

Statics will be investigated, not just as a field problem but in their entirety, as a means of solving the structural problems introduced by near surface anomalies.

Probably the first thing to consider is the actual layout of the lines. Figure 1 shows two ways of tying the ends of seismic lines. The left hard 'artist's impression' of where an interpreter requires lines has occasionally passed into reality. More often line ties are required to have a certain fold at such intersections but this does not guarantee a statics tie at this point. Surface consistent residual statics routines are not reliable beyond the last shot point and there are no reciprocal paths for refraction methods to use so these are subject to errors should there be any dip on the refractors. Line ties should thus be considered from the viewpoint of statics ties as well as fold.

One way which this is eased is by shooting through the spread until a full split is obtained rather than using a tail spread. This has several advantages, the fold of stack builds up faster, the near offset data does not tail away to the line ends and source points go to the line ends. Such an arrangement is shown in figure 2.

Stacking through the spread can not always be arranged due to permit problems and a tail spread may have to be used, in such cases some form of information is needed to tie the statics at the end of the line. Either a shot or two or an uphole or an LVL survey, at or off the line end should be arranged.

If the survey is in an area where refraction data can be used for computing statics, i.e. it is not too badly plagued by stringers or velocity inversions then care should be given to maintaining the quality of these events. This primarily means that source and receiver arrays should not be so long as to severely attenuate the first breaks. Vibroseis data has been particularly prone to the use of long arrays, both source and receiver, for attenuating the often substantial ground roll associated with this surface source.

Figure 3 shows where reflections, refractions and ground roll appear in F-K space, lengthy arrays which are essentially tight 'K filters' clobber the ground roll attenuate the higher frequency components of reflection signals and severely attenuate refraction signals. Shorter arrays are generally used these days and the health of the refracted arrivals is another good reason for using the Stack Array recently popularised by Nigel Anstey. There is something to be said for single 'phones for recording the refracted arrivals, either as well as the arrays, or in a revival of the old technique which allows switching from single to array upon detection of the first arrival. There are of course other factors affecting Vibroseis first breaks such as coupling which force control techniques can help somewhat. The data from this source is still somewhat prone to the fact that the energy has to transmit through the often very unconsolidated near surface and suffer severe attenuation and possibly scattering. Force amplitude control does occasionally result in clearer first breaks due to better penetration and it is to be hoped that there should also be further improvement with force phase control due to generating a signal more in common with that which is to be used for correlation. Mild non-linear sweeps can also improve the appearance of first break energy as in figure 4, this should preferably be accompanied by force control. Following this line of reasoning first break energy on Vibroseis data can also be improved by recording individual sweeps in the field, thus lessening the source array effect.

End of line effects on residual statics routines have been mentioned. These raise their ugly heads again in large omissions where the short offset data disappears to such an extent that large V-cuts arise in the mute zone of the data and the residual statics routines have no data to work with. Such ommissions should be filled in by some means such that the resudial statics routines have adequate data to work with. Another problem for residual statics routines is crooked lines in the presence of strong lateral cross-dip. Figure 5 shows how the data should appear on

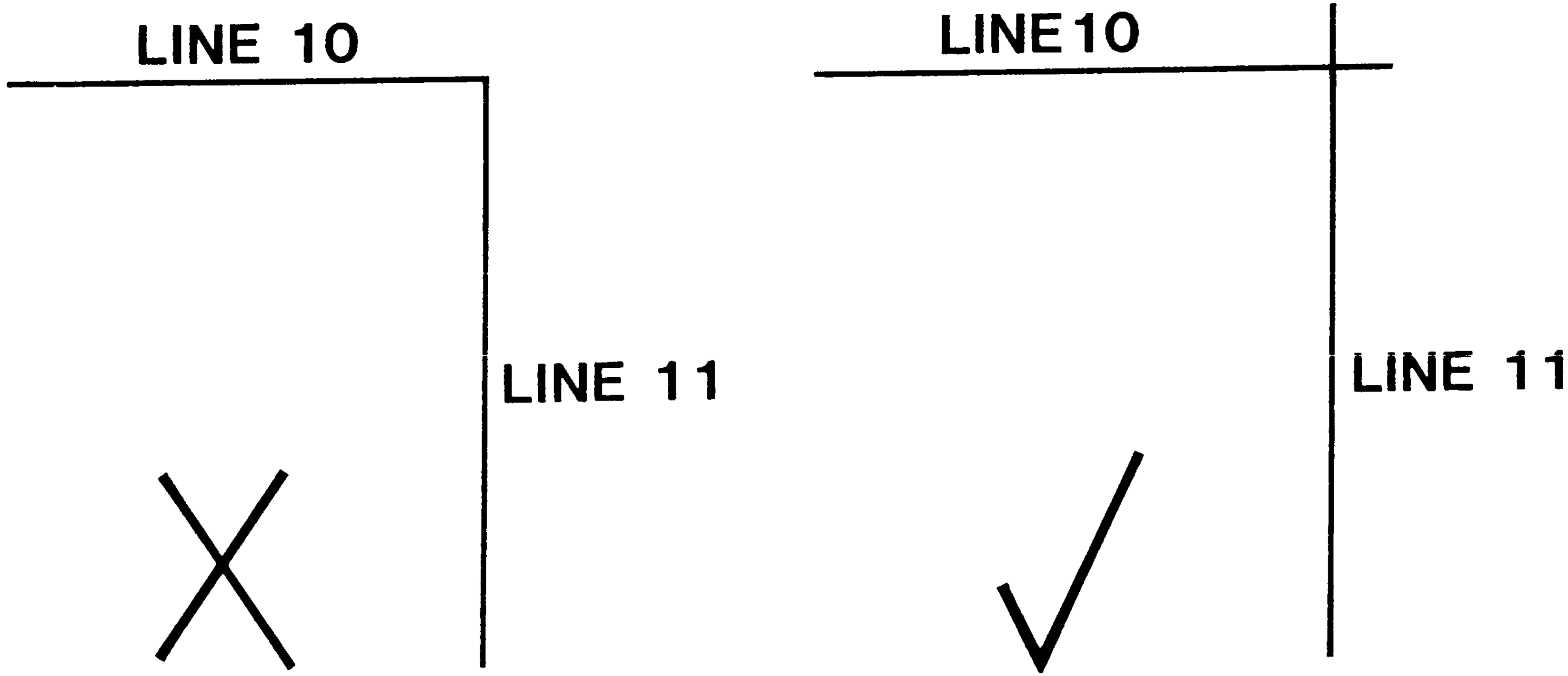


Figure 1. Statics ties require overlap.
Şekil 1. Statik bağlantıları için hatların kesiştikten sonra bir miktar devam etmesi gerekir.

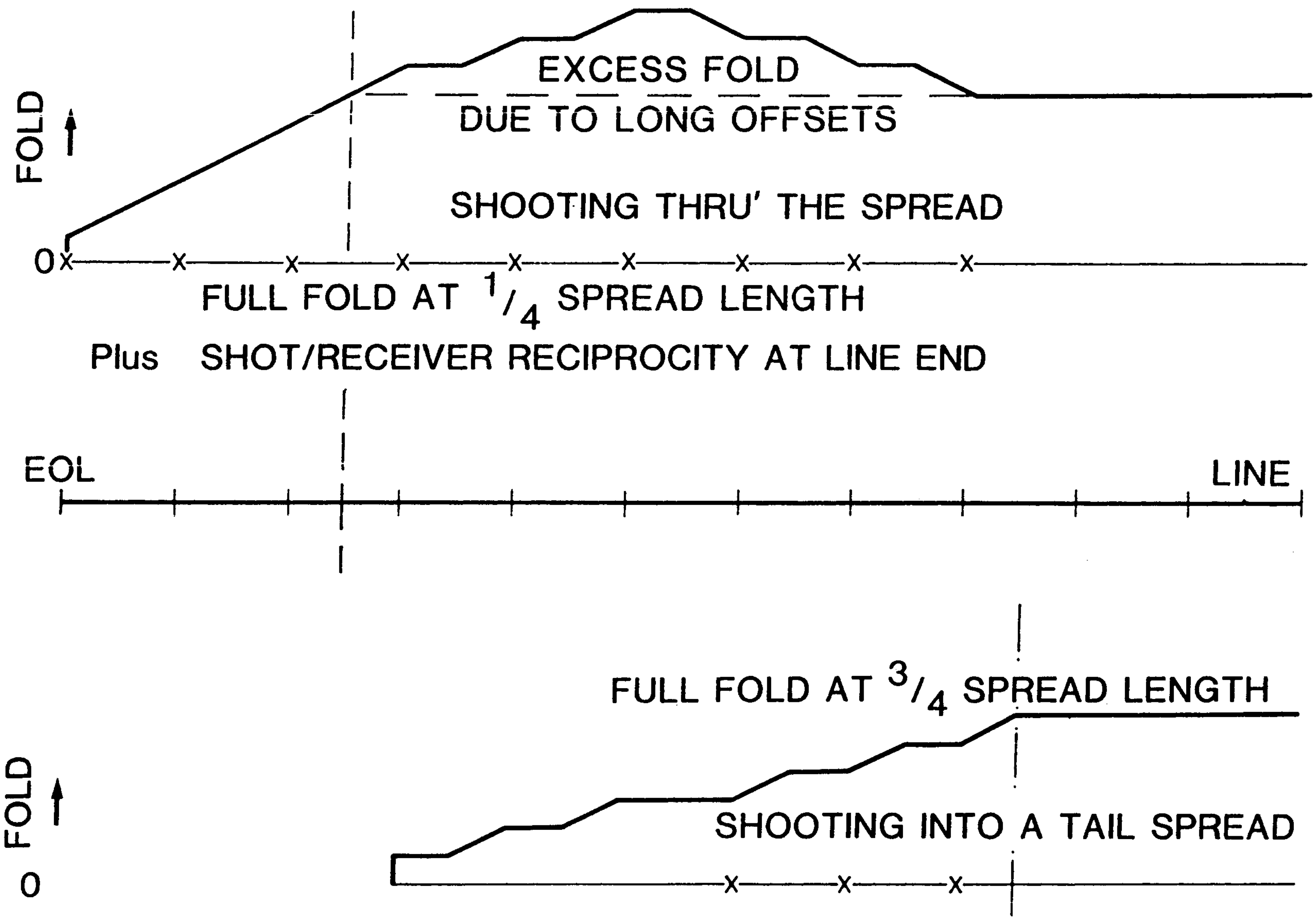


Figure 2. Alternative means of stacking on and off.
Şekil 2. Alternatif yığma şekilleri.

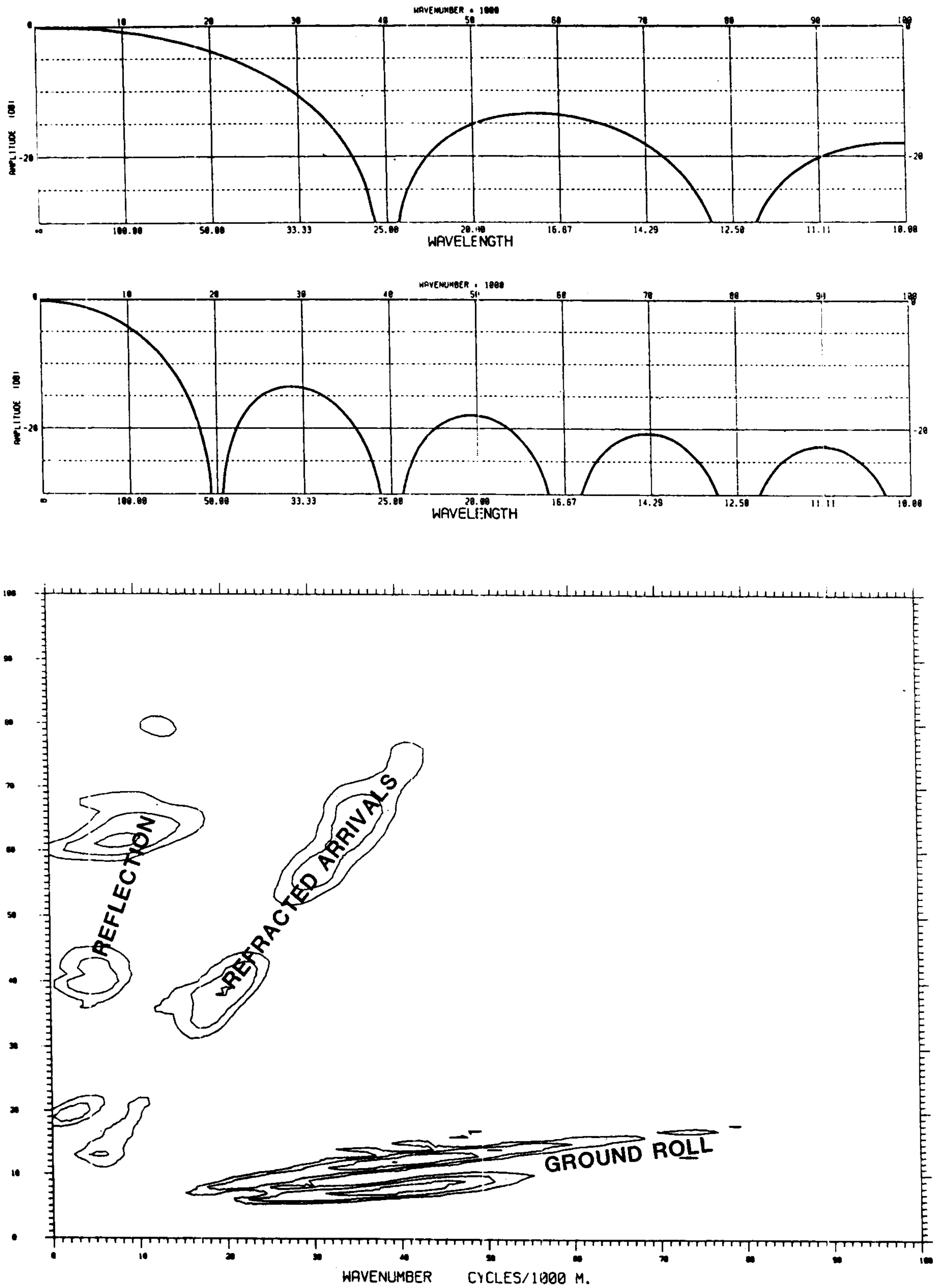


Figure 3. Spatial filtering effects in F-K space.
Şekil 3. F-K ortamında uzaysal süzgeç etkileri.

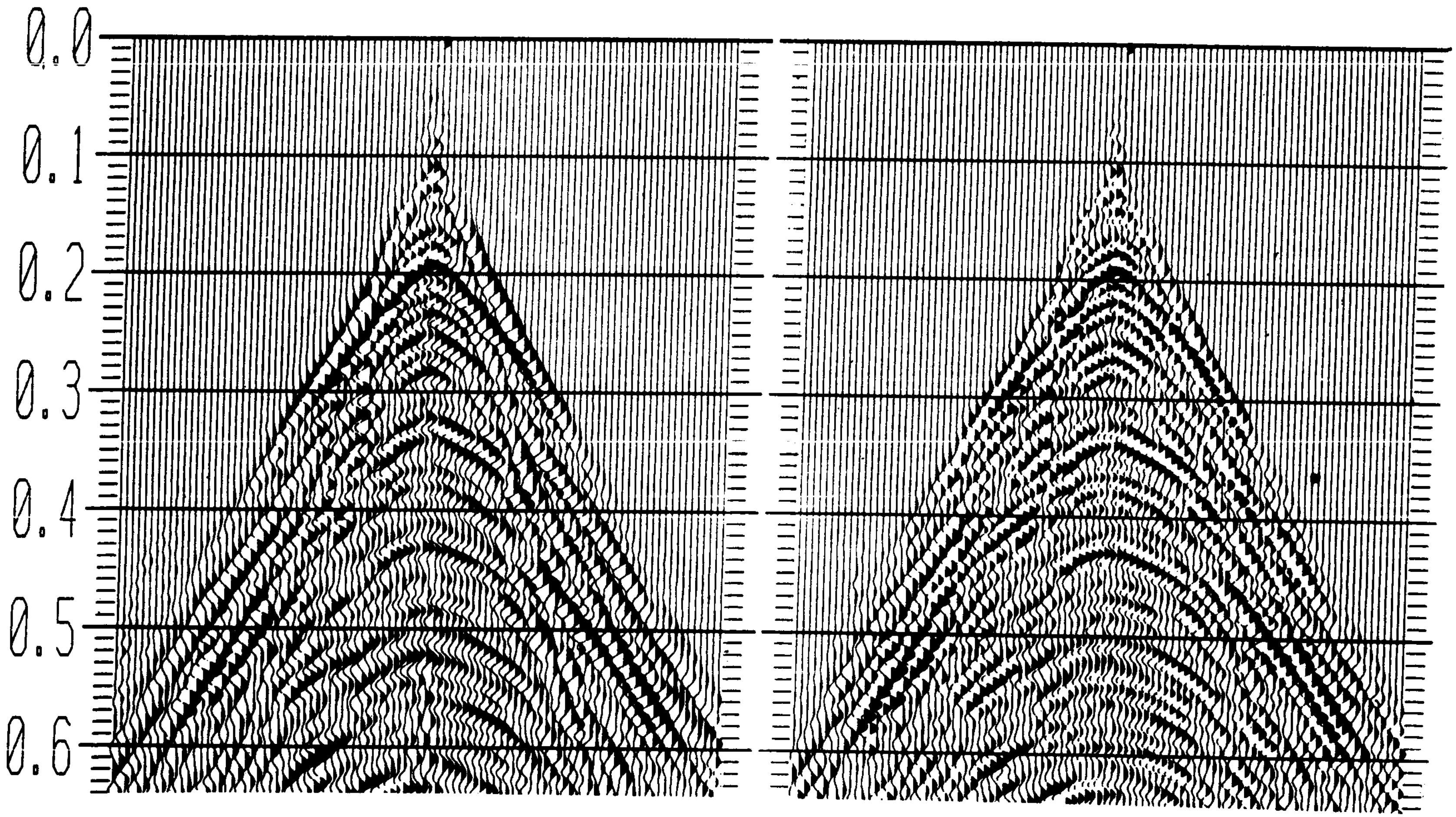


Figure 4. Linear sweep, Non-linear sweep.
Şekil 4. Doğrusal ve doğrusal olmayan sweep.

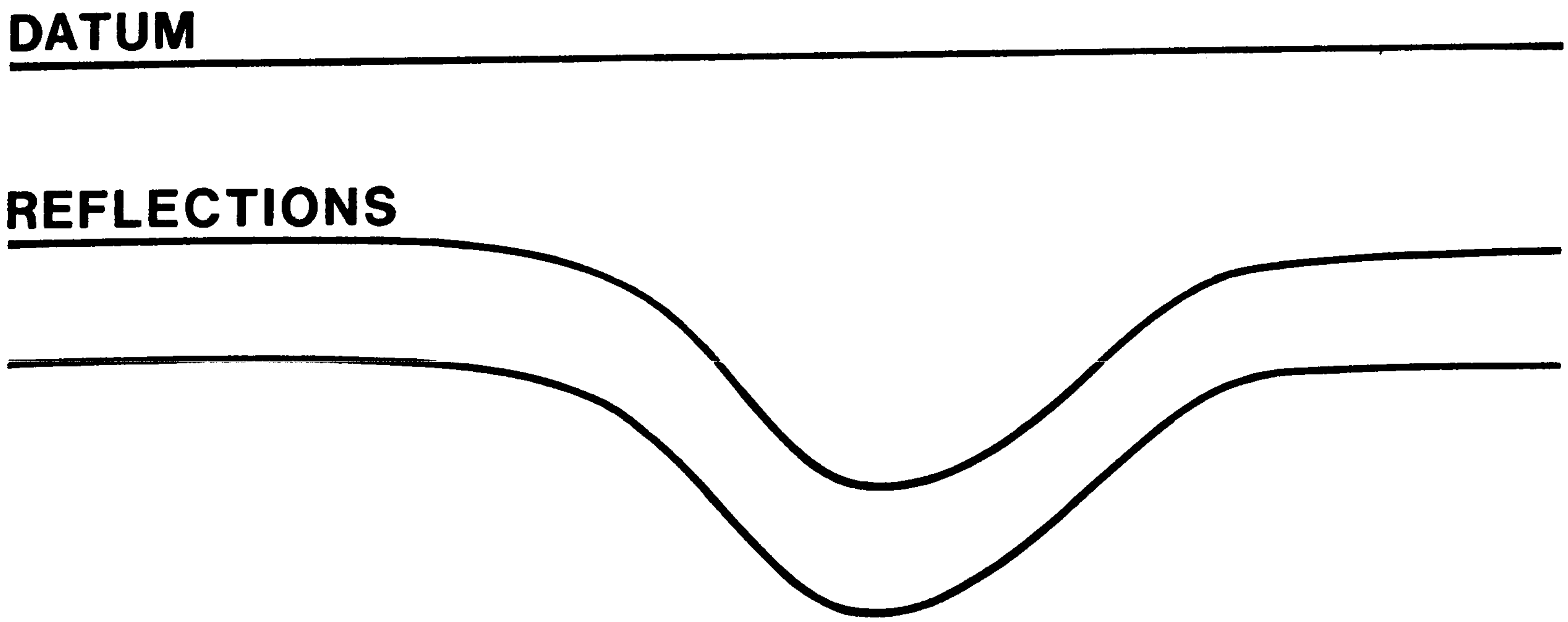


Figure 5. 'Crooked Line' section.
Şekil 5. Kırıklı hat kesiti.

a crooked line, residual statics algorithms see this as a static anomaly, whereas it is an expression of true structure along the line track. Attempting to deal with this in an automatic fashion is often hindered by poor statistics in the cross line sense, the likelihood of time variant cross dips, and probable poor data quality. From a residual statics viewpoint it is then good practice to attempt to straighten out severe bends, possibly by taking the line cross country using whatever source is appropriate.

By the above means we have ensured that residual and refraction static methods using the reflection seismic data may be used. Residual statics methods working on the reflection data can take care of short to medium wavelength static anomalies, generally up to about one spread length, provided such anomalies do not display large local variations. Refraction methods working on the first breaks from the reflection data can handle large amplitude local anomalies and long wavelength anomalies, provided these are represented in the refracted arrivals and provided there is frequent additional information to act as tie points.

What kind of additional information is required depends on the type of survey being conducted. Figure 6 shows the two basic cases, dynamite below the weathering and a source such as Vibroseis, weight drop, Hydra-Pulse etc., acting on the surface. Dynamite surveys are generally the easiest from the static correction viewpoint provided a few simple rules are followed. All shots must be detonated below the weathering, at a precisely known depth and the time for energy to travel from the shot to the surface (known as the uphole time) must be accurately recorded. Even with the best of intentions the depth of weathering may not always be known beforehand, after all we are conducting exploratory surveys. It is thus a wise precaution to drill the occasional deep hole and conduct a full uphole survey.

With surface sources we are in a worse position, we are now forced to know the velocities and thicknesses of the near surface layers and we get little help from the reflection data or the first breaks on this for several reasons; we use receiver and probably source arrays and we have long station intervals and probably also a large initial offset. It is most usual to run an LVL crew along with a surface source crew. This crew will generally also use a surface source or an extremely shallow explosive source and can provide average estimates of the weathering layer parameters at localised points. It will of course measure horizontal velocities and these may well differ from the vertical velocities we are more interested in from a static correction viewpoint. Again it is wise to perform a few upholes where possible, and to combine these with an LVL survey centred over the hole. This will enable a measure of the anisotropy to be made and give an indication of how this varies throughout the prospect area.

Where and how frequently should LVL's or upholes be sited? It is not possible to generalise but there are a few simple rules to follow for siting of LVL's. They should be sited at or near line intersections, at line ends, at any known changes in surface geology and at reasonably frequent intervals between these points. Basically the same rules apply for upholes except that permitting considerations are more crucial and fewer are needed in areas where LVL data is usable.

As to how frequent tie points need to be, some idea can be gained from figure 7 which shows a sequence of trials for a refraction statics routine on model data from a crooked line. This example shows the required frequency of tie points to give relative statics calculated from model generated first breaks on the deepest horizon more absolute meaning. The shape of the relative statics curve is correct but it is floating and needs tying periodically. Given that in this case the tie points are perfect as they are merely calculated from the model we might be justified in requiring a greater density of tie points than appears adequate here. An average density of 500m for a 25m station interval survey is about right.

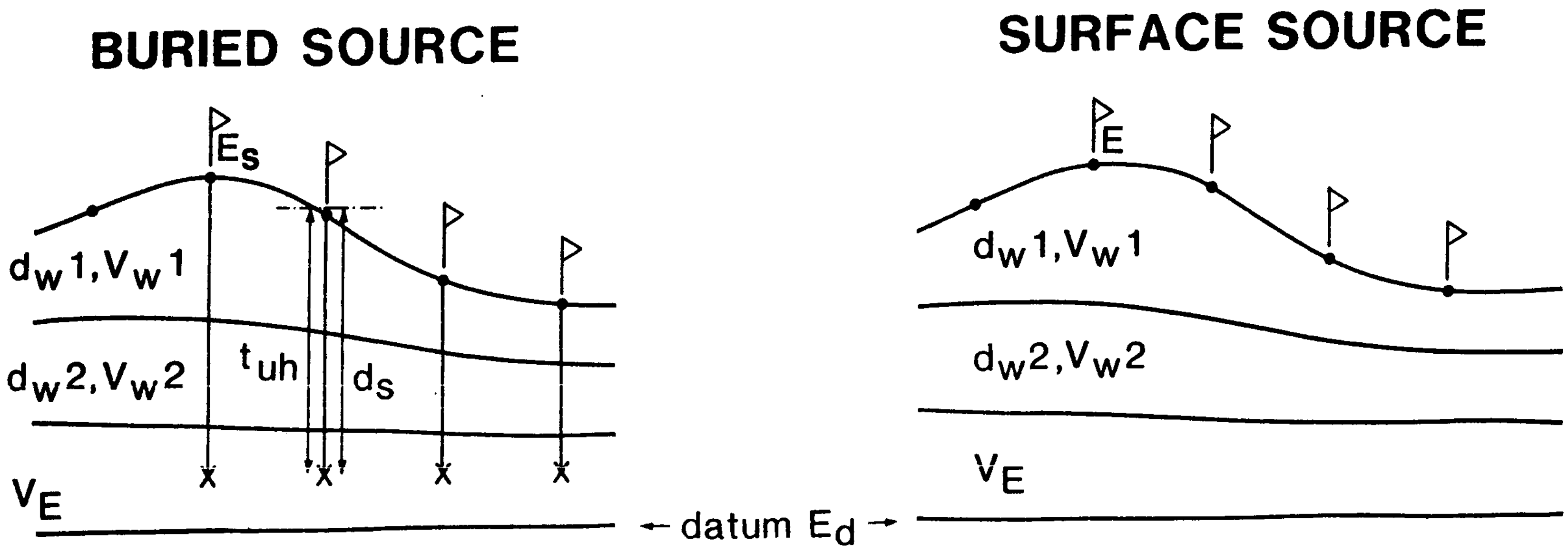
Let us now look at the actual mechanics of performing these operations.

DATA ACQUISITION CONSIDERATIONS

From the residual statics viewpoint and even more from the refraction statics viewpoint accuracy in surveying in the stations, particularly such things as offset V.P.'s is very important. For refraction statics it is also very important to know where the closest geophone to the shot is in relation to its station. Figure 8 shows the corrections which need to be applied to the basic arrival time information, two of these use the refractor velocity. If this is 2000m/s and there is a 4m error in where the end of the array is as opposed to where we think it is, then we have a time error of 2ms, representing a very substantial part of the relative static between two stations. Here again the stack array comes in handy as it is very easy to check in the field, and it should not be too difficult to arrange a reporting procedure for any stations where arrays deviate from normal. Figure 9 shows the first arrival pattern from a station bunched on one side and the resulting static profile shown dashed, knowing the error it can be corrected for; giving the static profile shown dotted.

There are rules for LVL's also, the aim is measurement of the velocities and thicknesses of all layers down to some well consolidated layer after which the velocity profile changes only gradually. This leads to conflicting requirements in that short group spacings are needed for the shallow layers but long offsets are needed for the deeper layers. This is often accommodated by having close spacings near the source points at each end of the spread which progressively increase into the centre so that a reasonable offset may be obtained. Figure 10 shows a typical layout for such a spread as well as a micro spread for soil velocity determination. When entering a new area the most important decision to make is how long an offset is needed to pick up the deep event. It is possible to measure the velocity of the deep refractor from the first breaks on the reflection data, it is then a matter of finding this velocity on the LVL spread.

With usually only 24 channels available it is not generally possible to meet both of the above requirements so additional shots are taken beyond the spread on each side. If possible the spread and shots should be ar-



$$\text{Shot Static} = -\left(\frac{E_s - d_s - E_d}{V_E}\right)$$

$$\text{Geophone Static} = -(\text{Shot Static} + t_{uh})$$

$$\text{Static} = -\left(\frac{E - E_d - \Sigma d_w}{V_E} + \Sigma \frac{d_w}{V_w}\right)$$

Figure 6. Static corrections.
Şekil 6. Statik düzeltmeler.

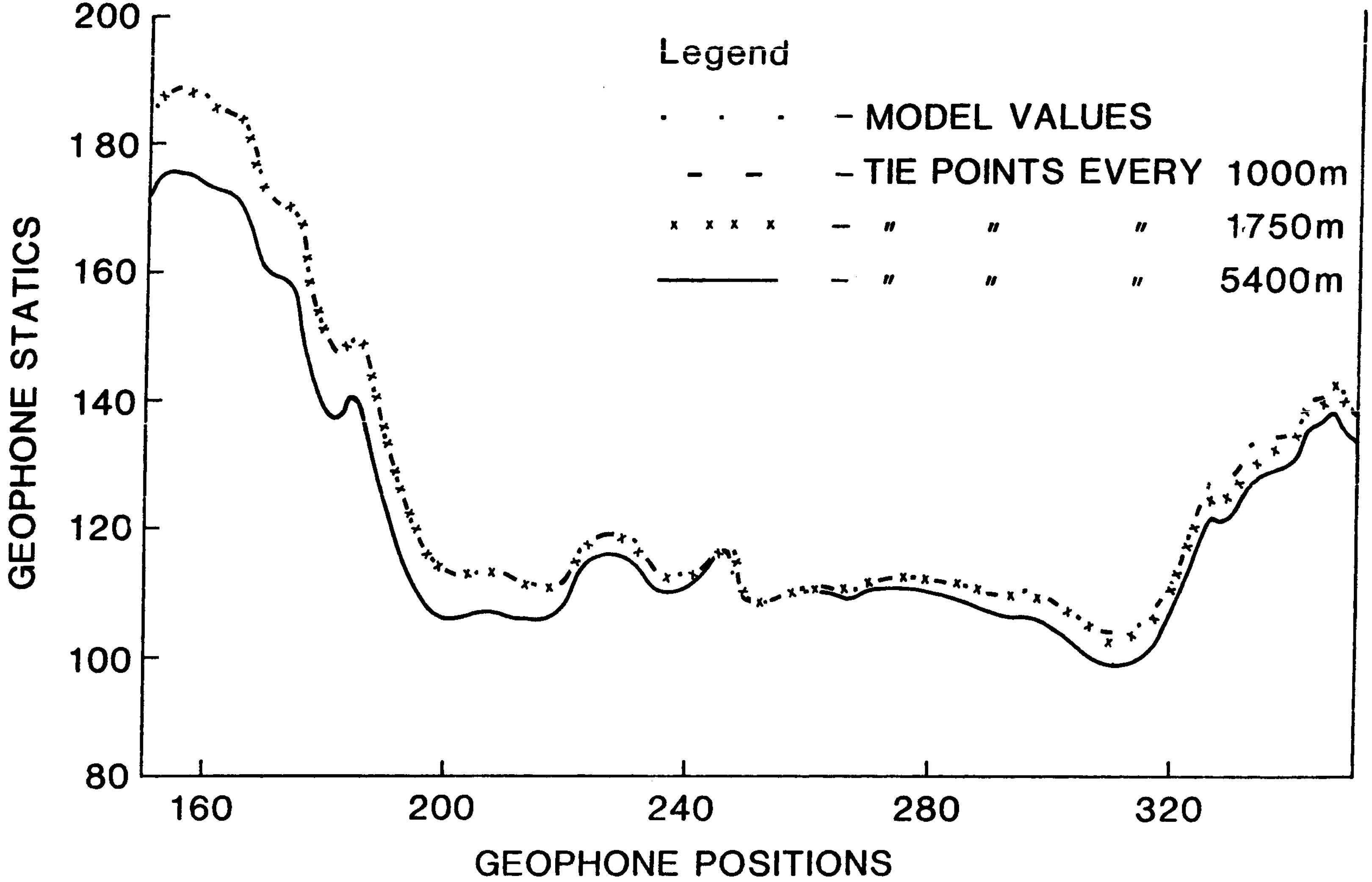


Figure 7. Tie point density.
Şekil 7. Bağlantı noktası yoğunluğu.

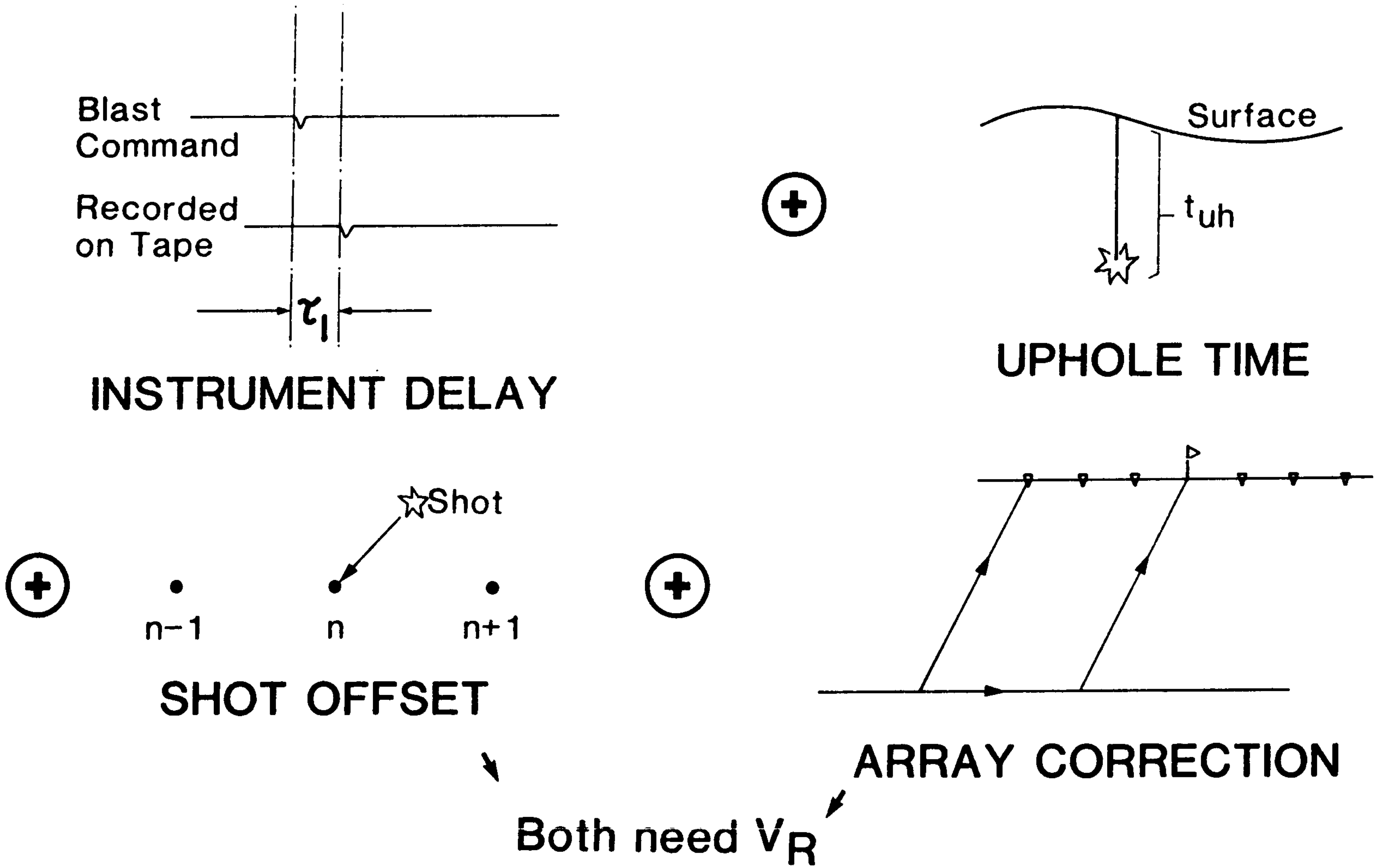


Figure 8. Correstions required for absolute times.
Şekil 8. Mutlak zaman değerleri için gerekli düzeltmeler.

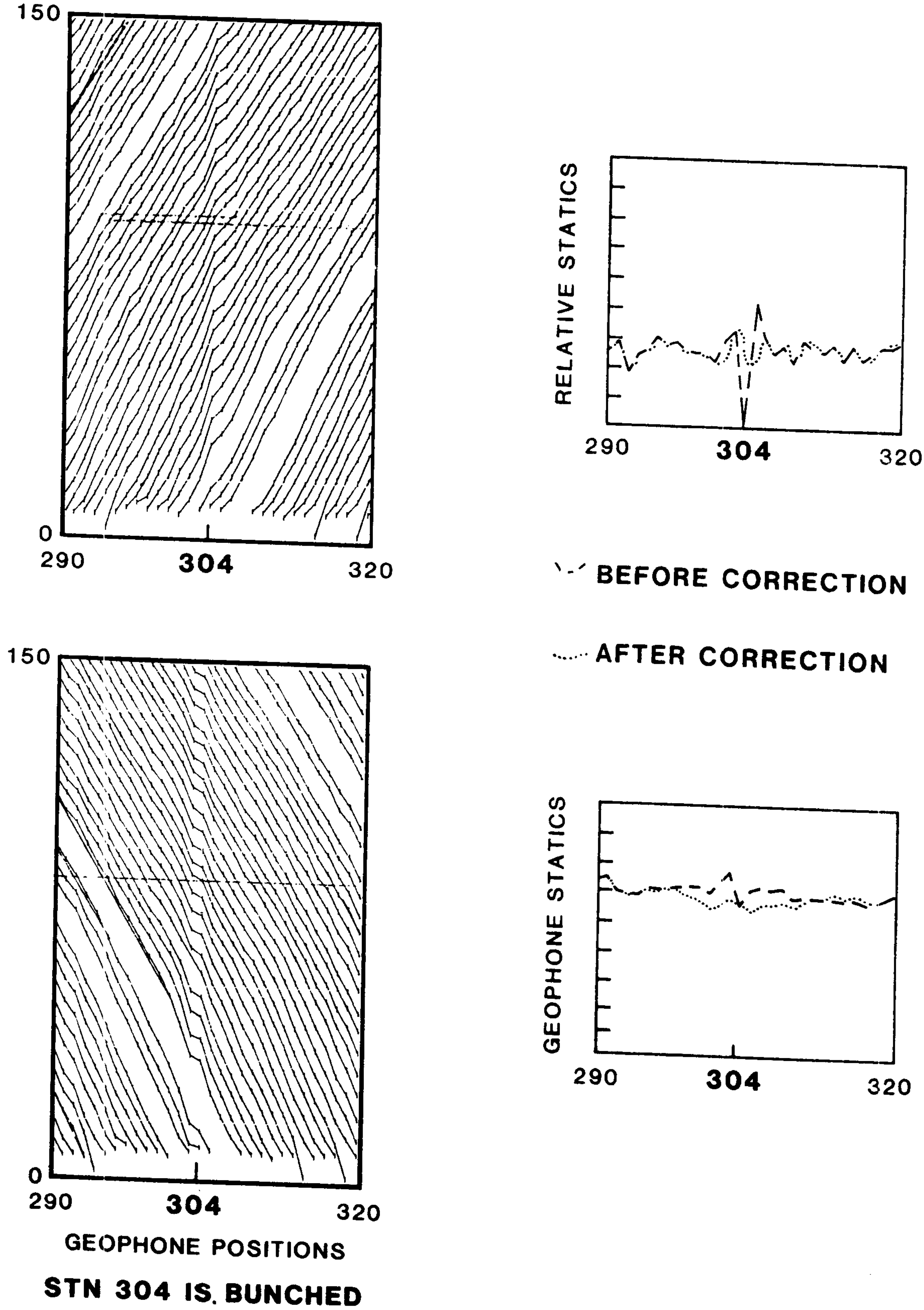


Figure 9. Effect of error in geophone position.
Şekil 9. Jeofon noktasında yapılan hatanın etkileri.

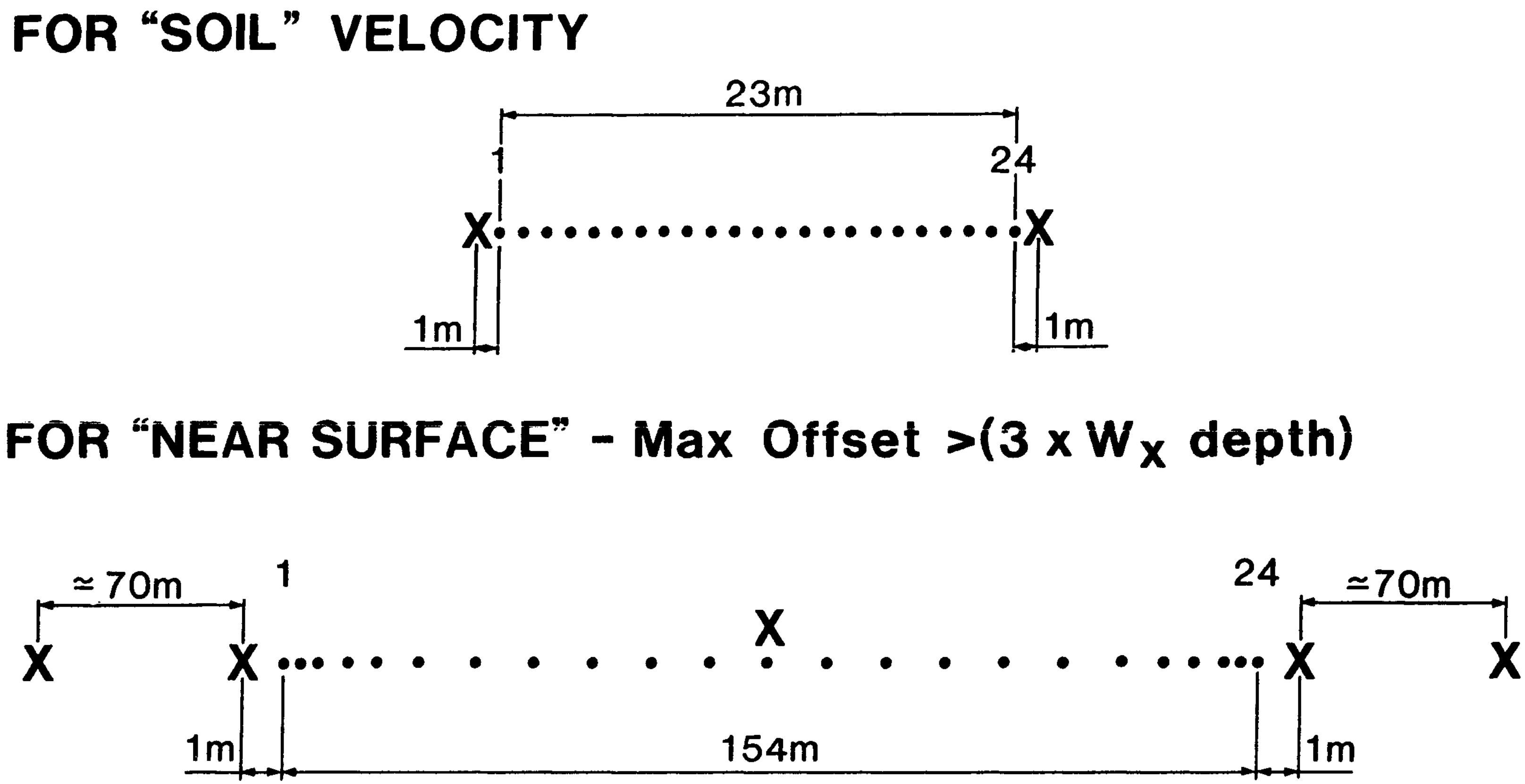


Figure 10. Example LVL spread layouts.
Şekil 10. Düşük hız tabakası serim örnekleri.

ranged such that the outer shots are extended out by about 1/2 to 3/4 of the spread length. This will allow some overlap of data and enable the velocity transition offset to be found. A fair rule of thumb for the offset required is that this should be about 3 times the depth of investigation in order to pick up refractions from it, the spread should thus be a little longer than this to eanble several picks to be made from the deep refractor.

As the dimensions used in an LVL spread are much smaller than we are normally used to for the reflection spread, great care must be taken in positioning both the source and receivers, which are all single geophones, usually with a low resonant frequency for wide bandwidth signal recording. Another source of error which can easily creep in is in timing between the shot initiation and recording, a wise precaution here is to devote one channel to some form of time break recording.

Whilst considering acquisition points, what things should be considered as regards uphole surveys? These can provide a great deal of accurate, if local information provided they are well designed and carefully executed. Figure 11 shows on the left a cheap fast procedure which produces very poor quality data. The hole has not gone through the weathering, only one detector is used and too few shots are taken too infrequently. The first rule is; make the hole deep enough to go through the weathering and far enough into the next layer to enable its velocity to be measured. Such depth information can usually be approximated from other seismic data, if not the driller can be instructed to drill some distance into a specified consolidated material, perhaps assisted by someone who can readily recognise the material from the cuttings.

We then follow the same sampling rules as used for LVL surveys; i.e. the shallower layers are sampled more finely than the deeper layers. A spread of geophones is laid on the surface in at least two opposing directions, either an expanding interval from the centre is used or a cluster of geophones is placed closely around the hole and the remainder are spaced out at about 5m. The hole is shot from the bottom up with small charges, both to avoid sealing it off (or breaking the harness, if used) and creating cavities in the ray-paths of deeper shots. Shot spacings at depth can be 10 or even 20m for a very deep hole but should progressively decrease to about 2m over the top 10m, possibily 1m over the top 5m. Again, with such fine samplings distances must be accurate both down the hole and along the surface. Also as with LVL's an accurate time break must be available and accurate recording must be used.

Using the layout described it is also possible to produce a Meissner plot which shows the wavefield as it would emanate from a shot at the top of the hole. This is useful is spotting horizontal/vertical anisotropy and in locating bands of high or low velocity. The information is only of extremely local relevance but it may help in establishing the geological model for the area.

Uphole surveys are an extension of regular uphole recording as performed on a dynamite crew. Here again the charge depth at time of detonation should be accurately known. It has been recent practice to measure the uphole locally in the shot firing system and transmit this as a time back to the recording system for recording on an auxiliary trace. Such systems are subject to a number of errors, they are primarily threshold detectors and are thus prone to anything which affects the signal level; pick up, variations in transmitted energy and/or receiver plant sensitivity, casing breaks, any extraneous noise. A better answer is to record the uphole informations in its entirety and preferably at a higher sampling rate than used by the recording system, using some form of local recorder.

Figure 12 shows an uphole signal recorded on such an instrument capable of sampling down to 1/4ms on up to 8 separate channels. A casing break is clearly visible, yet the time break can still be picked to greater than 1ms accuracy. Another phenomenon which is verified by use of this device is the effect of the drilling activity around the top of the hole. Figure 13 shows signals from 3 identical geophones simultaneously recorded at different offsets from the top of the hole. The 'phones closer to the top of the hole have the shortest travel path but the longest times, this is most likely due to the disturbance of the near surface by the drill.

It is of course possible that the hole is not perfectly vertical but this slowing down is often observed close to the hole. A recommended practice would be to use such a recorder with at least four wide band 'phones radially spaced around the hole, away from the disturbed zone,. say about 2m from the hole. As dynamite statics rely very heavily on uphole times this should become standard practice.

STATIC DATA PROCESSING AND INTERPRETATION CONSIDERATIONS

Just how much processing of statics data should be done in the field and how much should be done in the centre? This depends on many things and varies between countries, operators and contractors. As we should be concerned here with good practice, what should this be in general and how much could we deviate from this without seriously deteriorating the results? Obviously the correlation based residual statics will be performed in the processing centre, as they require the use of larger computers. It is possible to run refraction based statics routines (using the statics from the high fold available in reflection data) in the field, but it is probably best to do this in the processing centre where the effects can be checked on stacked data.

There are advantages in determining the field statics in the field. With these we are seeking to get within range of residual statics routines and provide the informatin needed for removing the long wavelength components. There are numerous occasions when a survey is well designed for what is expected but what comes out of the data provides a few surprises, it is just as well for as all that this is the case, otherwise there would be no point in the exercise anyway. In such instances it is useful to be able to be aware at the time that this is so, to be able to examine the data for any errors and possibly repeat some experiments or generate some infill data. Going back weeks or months later to plead for another couple of

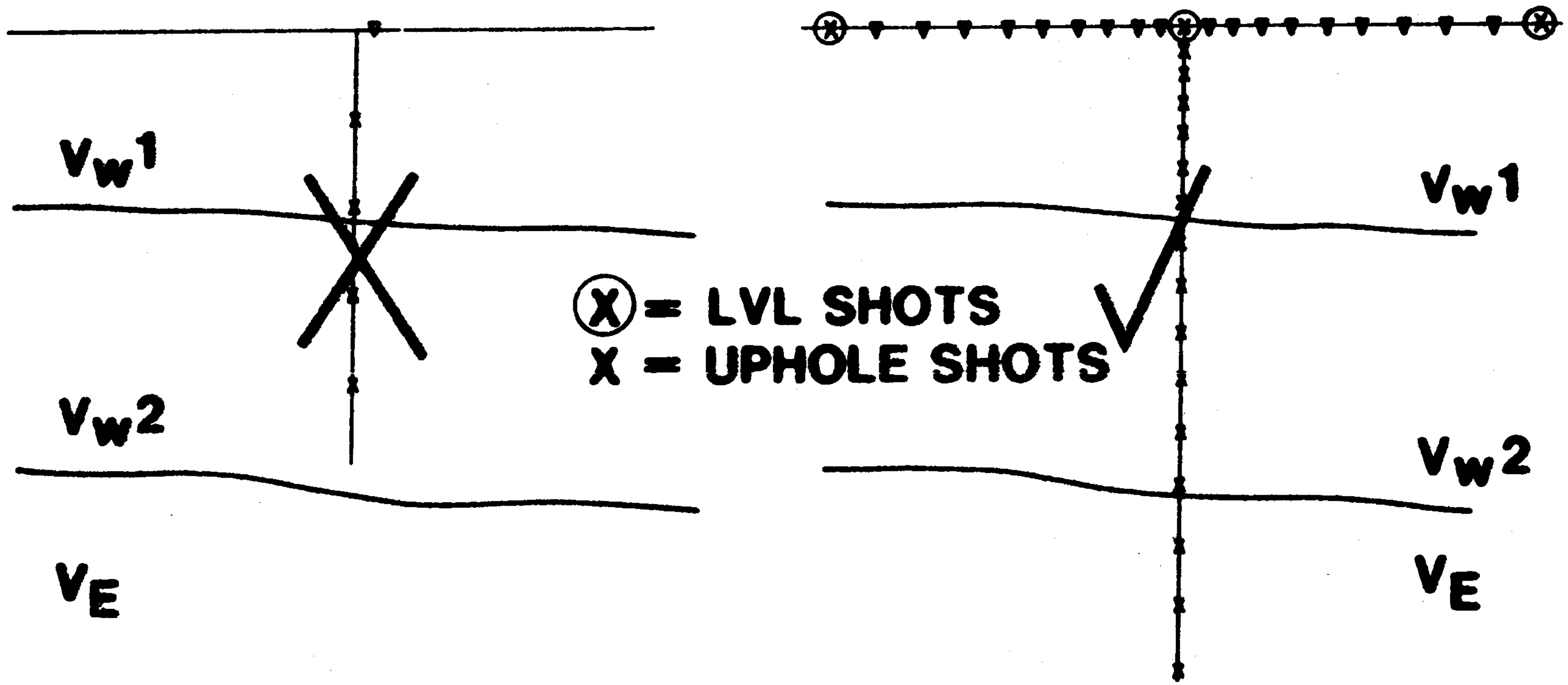


Figure 11. Uphole recording technique.
Şekil 11. Kuyu üstü zamanı kayıt yöntemi.

Shot Point 0237A
No of samples is 252. Sample Rate is 0.250 ms. Gain is 8.
Window is 0 - 40 ms and -8 to +8 volts.

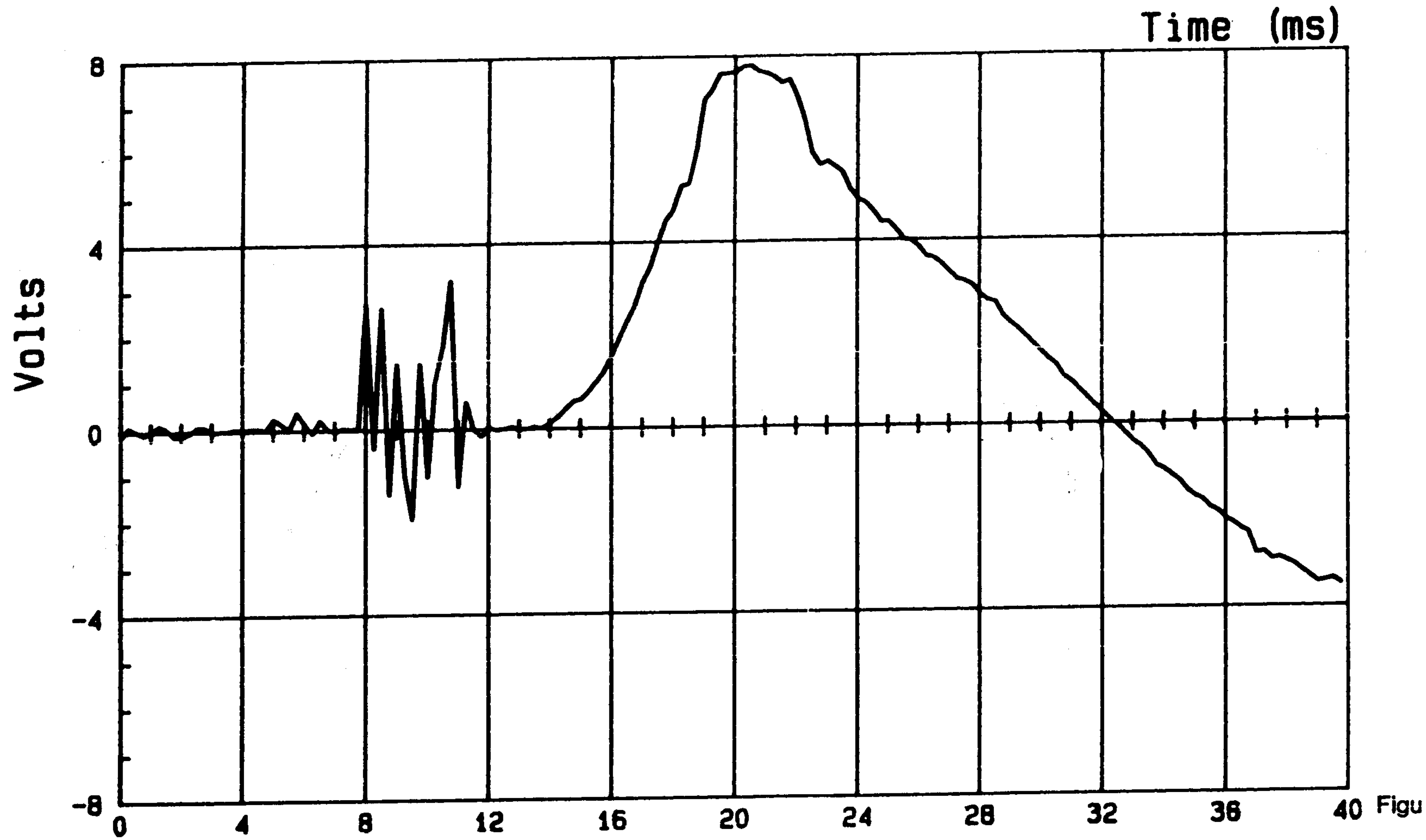


Figure 12. Shot showing casing break.
Şekil 12. Muhafaza borusundan gelen ilk kırılmalar.

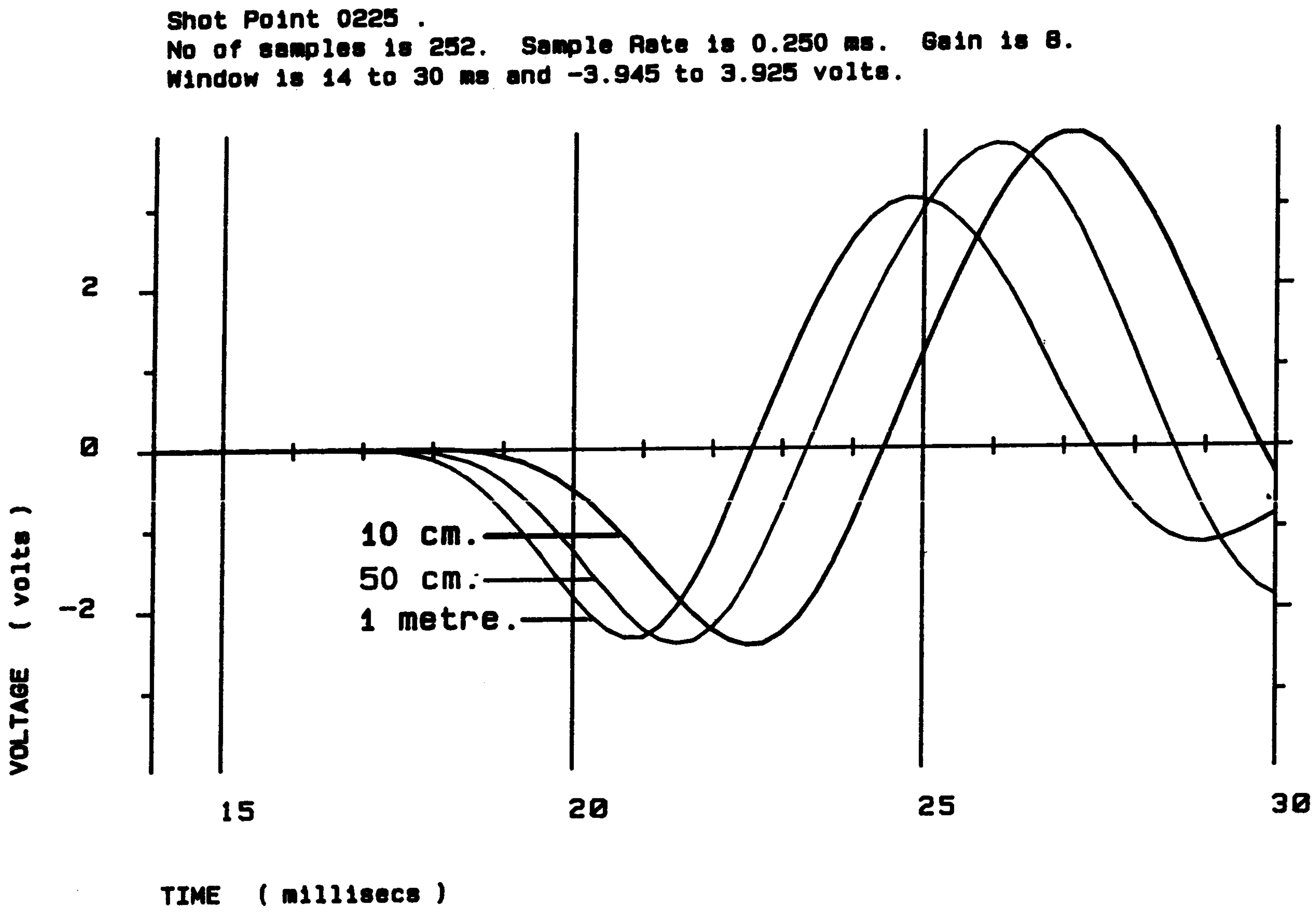


Figure 13. Different distances from shot hole.
Şekil 13. Atış kuyusundan çeşitli uzaklıklar.

uphole sites is more of an embarrassment and problem than to do it whilst the crew is there. There is another factor for computing field statics as correctly as possible on the crew; it helps to remove some of the feeling that everything can be sorted out in the processing centre.

To be able to calculate statics properly in the field a small computer is an extremely useful aid. It allows the person on the crew to put more emphasis on the processing and interpretation of the data as he is not so bogged down in the tedium of slogging though masses of calculations, drawing of graphs and documenting of results. There is not much incentive to have bright 'what if' ideas if the result means redoing four days work with no guarantee that the outcome will be any better and might have to be done again. Such a system requires access to the survey data for the lines for elevations and co-ordinates and should possess facilities for ready processing of LVL and uphole data and combining this with observations made from the first breaks on the reflection records. Figure 14 shows an LVL displayed on such a system with a colour monitor. Note the irregular spacings. Straight lines can be curve fitted through specified points to indicate the various velocity layerings, these can be fine tuned by hand and eye if some points are suspected to be in error. Velocities are indicated directly on the screen as are thicknesses of the various layers calculated from the intercepts; the harmonic means of values from each direction are used.

The processing of uphole data is not as trivial as it might at first seem. In figure 15 the processed result from a finely sampled uphole is shown as a graph. Corrections are needed to recorded times, as shown in the insert in this figure, to compensate for the slant paths taken between source and receiver. Several such results are averaged, after ignoring any wild values and the times plotted at the appropriate depths. This is the most absolute information we get other than well log data which is not usually very good so close to the surface. An LVL should be recorded to coincide with the hole and it is informative to compare the results. This comparison shows how useful the LVL data is, whether it is disturbed by shallow stringers or not, and if there is any significant vertical vs., horizontal anisotropy.

Statics can then be produced as usual on a line by line basis, but also a data base may be built up for the whole prospect area. This may well mean that the static corrections for some of the earlier lines can be improved upon as more data is acquired and a more complete geological picture is built up. As more and more data is acquired, processed and checked it can be fitted into an areal model. A 3-D interpretation of the near surface is built which is refined as each piece of fresh information is added to it. The result of such operations is a model which may be used either for simple statics calculations or more complex 'dynamic static' or wavefield solutions. A model is not needed for statics calculation but is very useful from an interpretational viewpoint and must be constructed from information external to the statics number set or the reflection data.

Any given statics set can be described by an infinite number of models and modelling attempts on reflection data need some stable starting point to prevent results from being too influenced by esthetics. Figure 16 shows a contoured display of refractor velocity over an area (which may be shown in colour on the field system), including all new data plus some vetted vintage data. Many such plots can be generated, for velocity and thickness of various weathering layers, these can be interpreted both in plan view as here and also in section as shown in figure 17. As with all seismic interpretation, geological plausibility is the yardstick by which the results are measured. Other information may be included, e.g., local geological survey maps to help inassessing the verity of the data. At the end of this exercise a self consistent statics data set can be produced such as in figure 18. Appropriate datums can be used, which may be fixed or floating, the latter being useful if it is desired to keep the magnitude of the static low - a good idea in high resolution surveys.

This approach does of course mean that the final statics data set will not be ready on a line by line basis. The line by line statics will however be as good if not better than, those generally obtained and it is my contention that it is not possible to have a truly consistent set of statics until at least several loops have been investigated in an area. An areal approach also enables such things as offline LVL's and upholes to be properly incorporated, upholes are frequently up to 100 metres off the line in road surveys, and this can be too far to use their results in an absolute sense at any point on the line.

What should be done as regards processing the data if the statics picture needs to be built up over the area? Either the processing can continue as normal; with the option to reprocess using the final statics data set if these differ substantially from the original set, or processing can be taken up to brute stacks and further processes suspended until the final statics data set is ready. It might be possible to make some post stack structural statics corrections if the differences between original and final statics data sets are not large, but this is complicated by the effects that residual statics may have had on the data. Which route to take depends on budget and time constraints.

An economical exercise which might be worthwhile in some areas is the re-assessment of vintage statics data followed by re-processing, possibly after some strategically located LVL's or upholes have been completed. As processing is becoming an ever smaller element of total project cost and there are many areas with static 'problems' this would seem well worthwhile.

WIDELINE AND 3-D SURVEYS

The same general guidelines apply for wideline and 3-D surveys as for 2-D. The data should obviously be interpreted in a 3-D sense for both such survey types, surveying becomes more complex but still has the same criteria. Some source - receiver reciprocity should be attempted, this will probably be the case in 3-D but is not for some wideline configurations. It is not a good idea to have shot lines with no receivers unless there is a guarantee that all shots are detonated below the weathering. An even worse condition is all receiver lines without shots as this provides very poor control for separat-

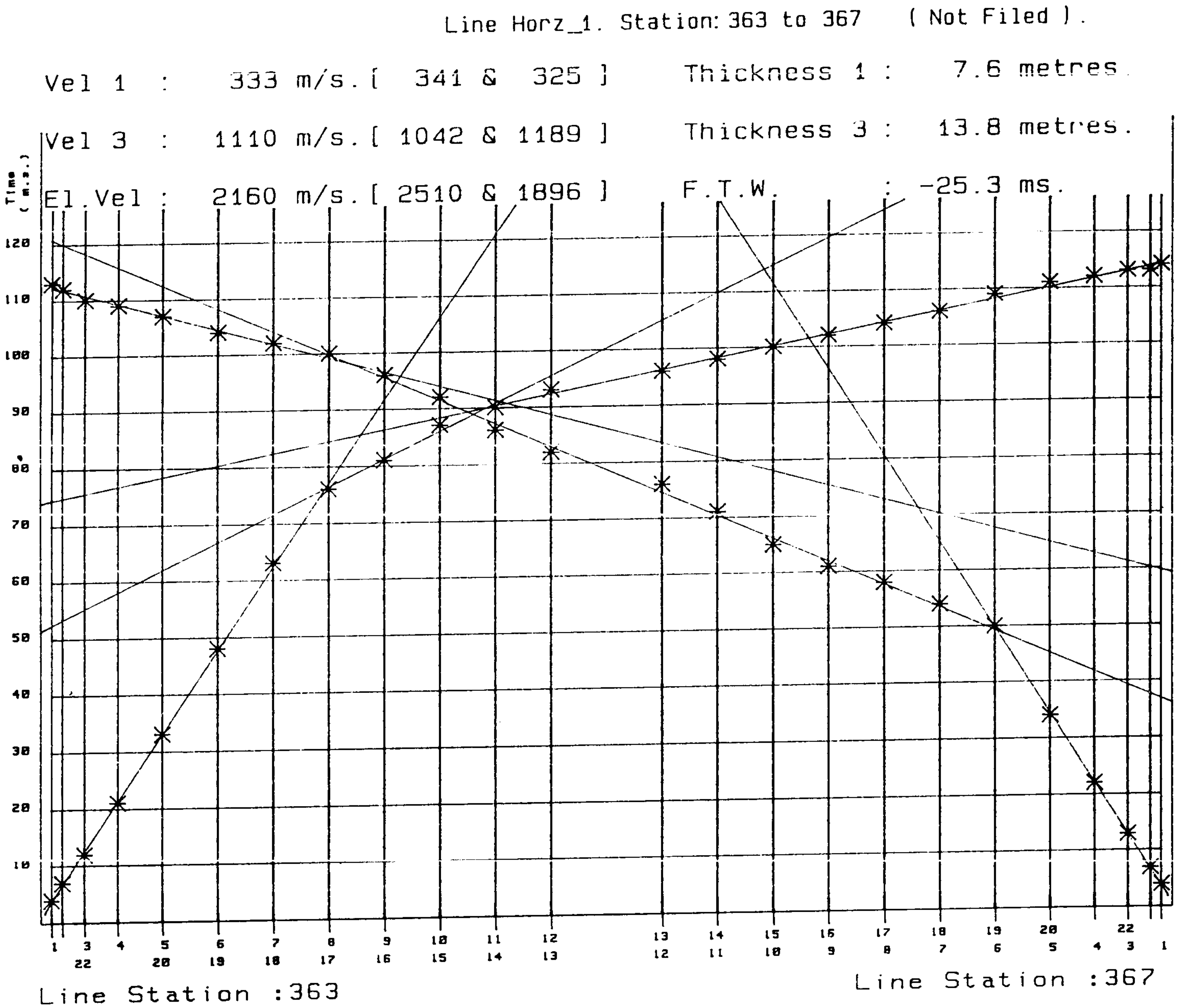


Figure 14. Low velocity layers calculation.
Şekil 14. Düşük hızlı tabakaların hesaplanması.

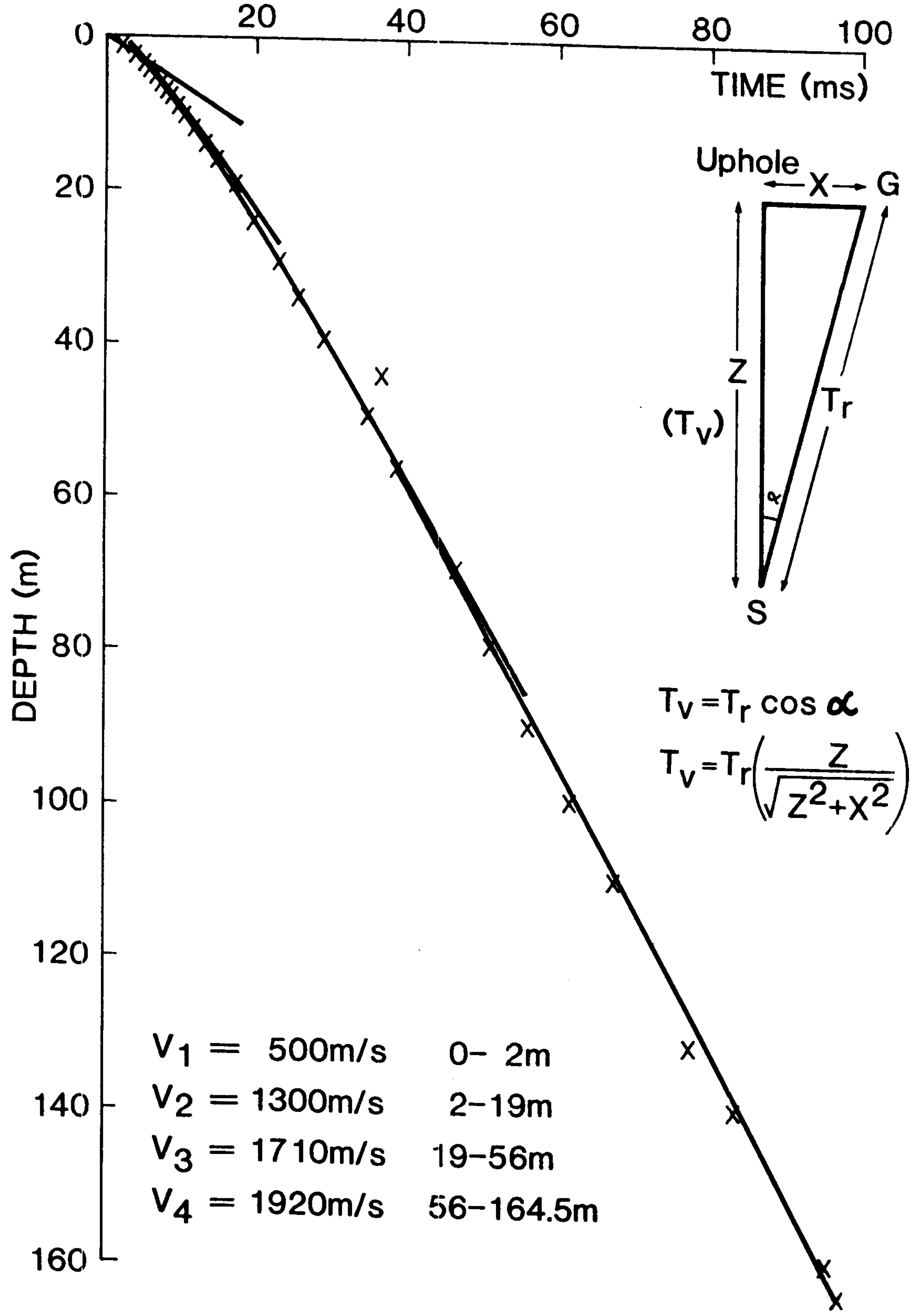


Figure 15. Results from a well acquired & processed uphole.
Şekil 15. Bir kuyu atışının işlenmiş sonuçları.

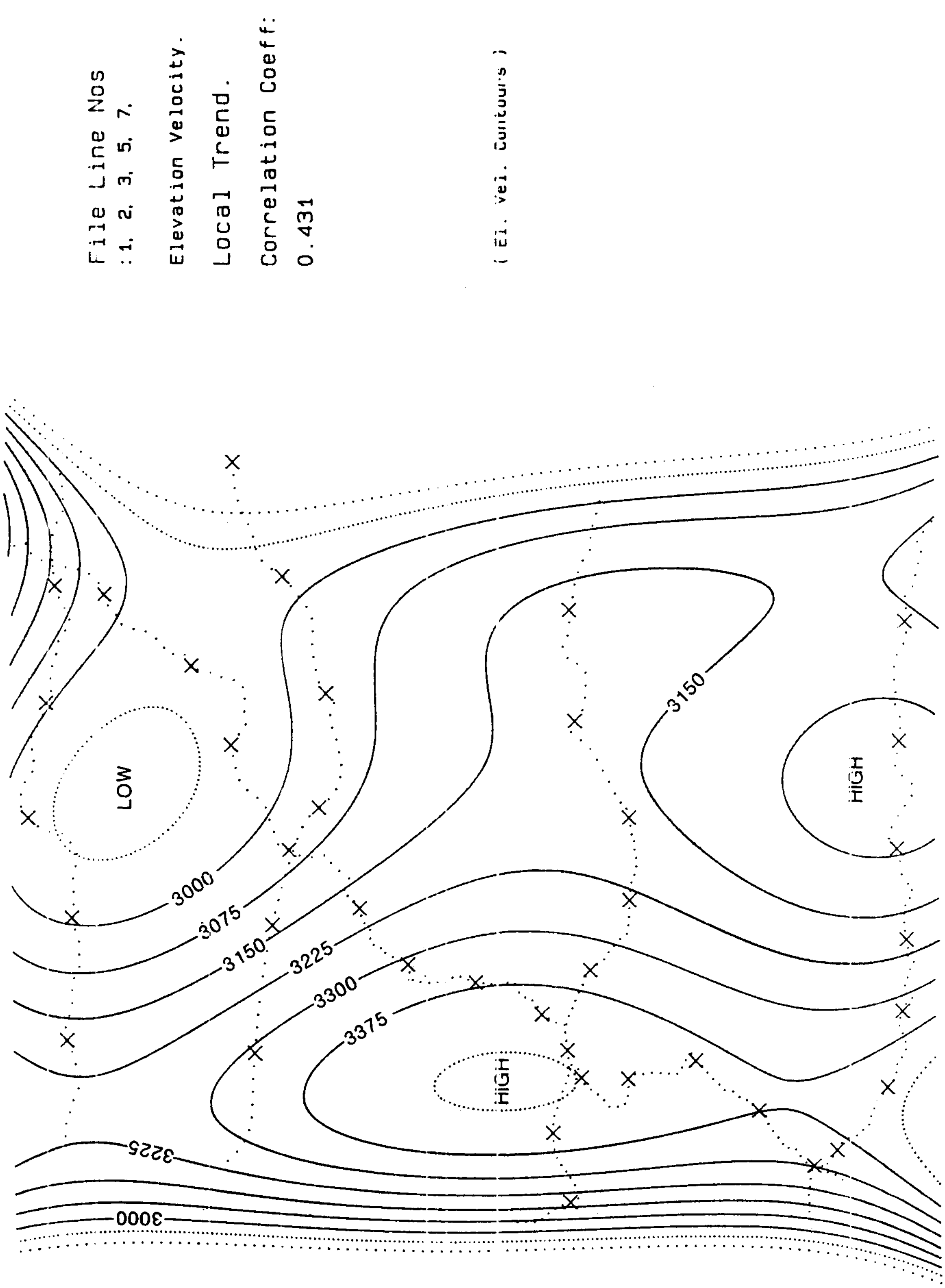


Figure 16. Statics.
Şekil 16. Statik düzeltmeler.

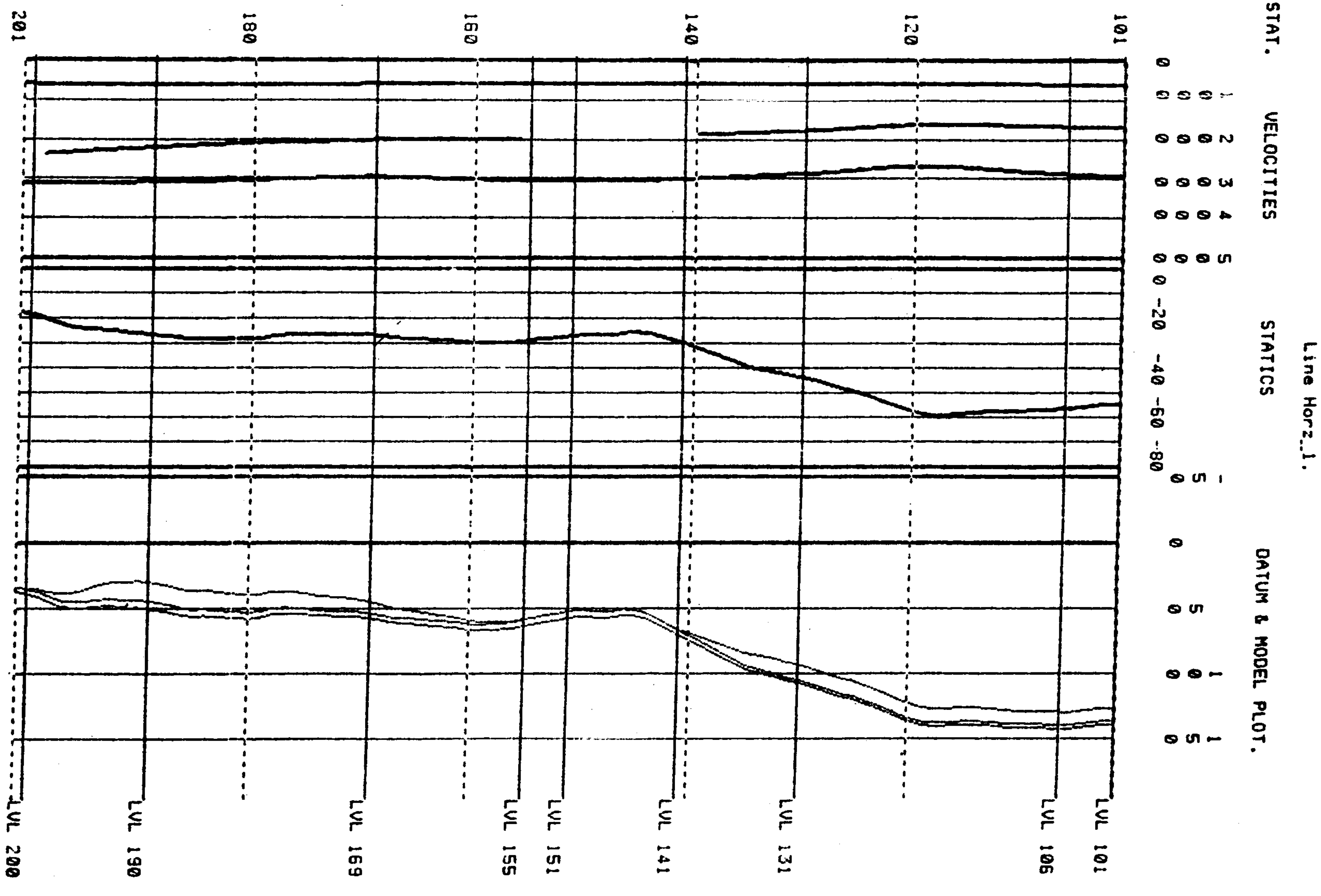


Figure 17. Cross sectional model plot.
Şekil 17. Model kesit çizimi çıktısı.

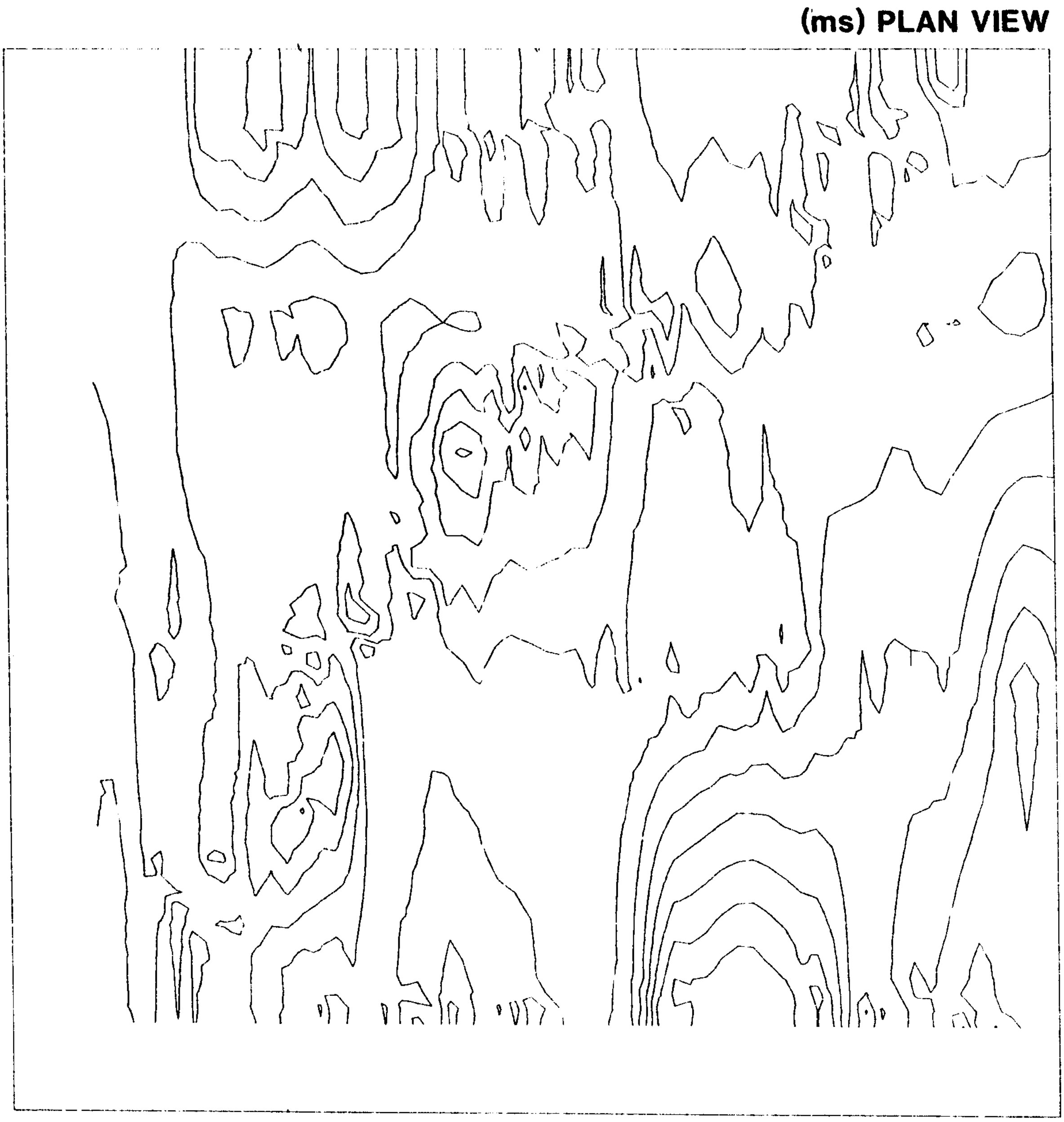


Figure 18. Statics (ms) plan wiew.
Şekil 18. Statik düzeltmeler (ms) plan görüntüsü.

ing out such things as cross dip from statics. Thus it would seem a good idea to put at least the odd shot into receiver only lines on wideline surveys, the problem is actually less in 3-D as there is more data available from surrounding areas.

CONCLUSIONS

Statics still remain as a prime potential error source in land seismic data. As a general rule insufficient attention has been paid to the problem, though there are signs that this is improving, this is probably due to the fact that it often takes a poor second place to the primary activity of acquiring and processing the reflection data, is something of a tedious slog and costs money. Many improvements in statics processing have appeared over the years, sometimes giving the impression that little attention need be paid to the problem in the field. In fact the problem of resolving the statics or near surface problem, is one for both the field crews and the processing centres, preferably with some communication between them. A lot can be done using good practice and careful attention to detail to solve the problem. The use of micro or mini computers in the field can remove a lot of the tedium from the task of computing field statics and assist in improving the analysis and interpretation of the data. Finally the best attempts possible should be made to gather, process and interpret the relevant information at the time of the survey. Failure to take the problem seriously will result in data of less than the required veracity and may lead to some very expensive wrong decisions being made at a later stage.

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REFERENCE

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