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A Method for Horizon Calibration of Seismic Exploration Data of Baicheng West Area

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ABSTRACT

Considering the drastic variations in the surface elevation of the piedmont region in the Bai Cheng West Area, there is no reference point within the Reference Ground Line (RG line) of the starting point of the synthetic seismic records in the process of calibration of the horizon. Through the analysis of the process and properties of the production of the RG line, in the processing of seismic data, it is indicated that the position of the synthetic data of seismic records is not located at the beginning of the RG line. Rather, it must be at the time point of the seismic profile at the elevation of a datum position of the static value of less than the datum plane. Both the RG line and the elevation static correction value line can easily be seen by computerizing the calculated value of the elevation static correction of the datum plane relating to the seismic section and plotting it on the seismic section. To achieve a good calibration with the synthetic seismogram, it is possible to set the starting point of the synthetic seismogram on the elevation static correction value line that is situated at the place of the Common Mid-Point (CMP). In the current paper, a systematic overview of methods and safety procedures for establishing the seismic interpretation work area and horizon calibration in seismic interpretation has been reviewed, which will form an effective guide towards seismic interpretation under the complicated surface conditions in the Bai Cheng west region.

Keywords: Seismic Profile; Datum Plane; Surface Elevation; Elevation Correction Value; RG Line; Synthetic Seismic Records; Horizon Calibration

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1. Introduction

The exploration and development of coalbed methane (CBM) is increasingly becoming dependent on the linking of well information with seismic interpretation, especially in structurally complex fields where coal seams change rapidly in depth, thickness, and continuity [1]. At the Baicheng West Coalbed Methane Exploration Area in Xinjiang, China, there is a particularly intractable problem with such integration: the correct horizon (stratigraphic) calibration between synthetic seismograms obtained at wells and seismic reflection events under conditions of extreme topography and strong near-surface interactions [2]. The Baicheng West is a piedmont part of the Tianshan Mountains, where the surface elevations vary by more than 1,000 m and surface conditions are extremely changeable along seismic profiles. In this type of terrain, despite static corrections that are made by seismic processing, features visible to the interpreter on a presented seismic section may be misleading, and common calibration routines may lead to poor ties, ambiguous marker recognition, and multiple structural interpretations [3–5].

The principal coal-layers in the region are found in the Jurassic strata. Basin-margin faults affect structural deformation, making the coal-bearing strata relatively shallow in the north and deeper in the south, and banded in their distribution and dipping at relatively steep angles, often within the range of 40° to 65°. Horizon calibration is especially relevant under these conditions: well-to-seismic links are required not only to map the structure of the coal seam, but further tasks such as fault tracing, depth correction, and location of favourable areas to develop CBM are required. However, topography and the near-surface low-velocity zone have a strong influence on the seismic wavefield in mountainous or piedmont environments, and there are travel-time distortions that need to be removed in the processing. To eliminate these effects, the use of static corrections creates a transformation of the recorded data to a selected reference datum, to enhance reflection continuity, and maintain the originality of structural morphology on the resulting seismic profile. But the practical challenge of interpreters is not the notion of the static correction per se, but in the knowledge of what reference surface the shown seismic section really pertains to, and thus where the synthetic seismogram must start when carrying out horizon calibration [6–8].

The practical extension of this to horizon calibration is simply that since the synthetic seismogram is created based on well logging sonic velocity and density along the borehole, and because the top of the synthetic record is physically located at the surface at the datum, the effect of the surface elevation upon the datum of the synthetic record needs to be taken into account, rather than an artificially smoothed CMP reference surface, which can be embedded in the seismic volume [9]. This is written down explicitly in the attached document: on a migrated profile on which both the RG line and the static elevation correction line are overlaid, the RG line is identical to the smoothed out curve representing surface elevation below the reference plane, whereas the static elevation correction line is identical to the real surface elevation line below the reference plane [10]. Thus, in carrying out stratigraphic calibration with synthetic seismic records, the top of the synthetic needs to be located at the top of the static refraction line at the CMP point, which results in successful stratigraphic calibration of the major coal seams, but it is evident that it is impossible to do so in the given case by relocating the top of the synthetic to the RG line. Although this distinction is crucial, most interpretation workflows promote the vice versa error. The RG surface is stored in the seismic data volume of many processed seismic results—particularly in 2D data—and the RG line appeared on displayed profiles, but the default does not include the line depicting the static elevation correction. When an interpreter does not understand the details of processing and assumes that the RG line represents the surface, calibration to align the synthetic seismogram top and the RG line will introduce systematic bias into the calibration, and will cause the wrong horizon ties. This occurs frequently in such regions as the Baicheng West, where the distance between RG and the elevation correction line is great because of dramatic relief. Moreover, due to a mismatch even after aligning the synthetic start, it is possible to have a mismatch since well logging acoustic velocity reflects formation-scale velocities, not the same as the effective imaging velocity in time-domain seismic data; in that case, it may still be necessary to fine-tune target or marker layers. This makes clear the necessity of an interpretation workflow that is physically based on proper reference surfaces and operationally definite in terms of parameter values (datum plane, filling velocity, coordinate system, wellhead elevation) in defining the interpretation work area [11–13].

Detailed analysis of the generating process and the geologic importance of the RG line in seismic data processing is carried out in this paper, and the reason why establishing the starting point of the synthetic seismic record on the RG line when calibration of seismic interpretation is in progress is useless has been pointed out. It claims that the point of origin must be at the seismic profile time point of the height of the static of the reference plane below. With the incorporation of a constant elevation correction line into the Baishi 2D seismic profile and by locating the point of origin of the synthetic seismic record on the line, one can directly acquire a better calibration result, which adds more certainty and minimizes ambiguity. This is useful advice for the technical staff who are involved in interpreting seismic geology [14–16].

2. Materials and Methods

2.1. Data Sources and Study Profiles

The study of the Baixi 2D seismic migration of the Baicheng West CBM exploration area (**Figure 1**) is the basis of the study; the calibration procedure is to be discussed together with the profile of the Baixi 2D seismic migration results.

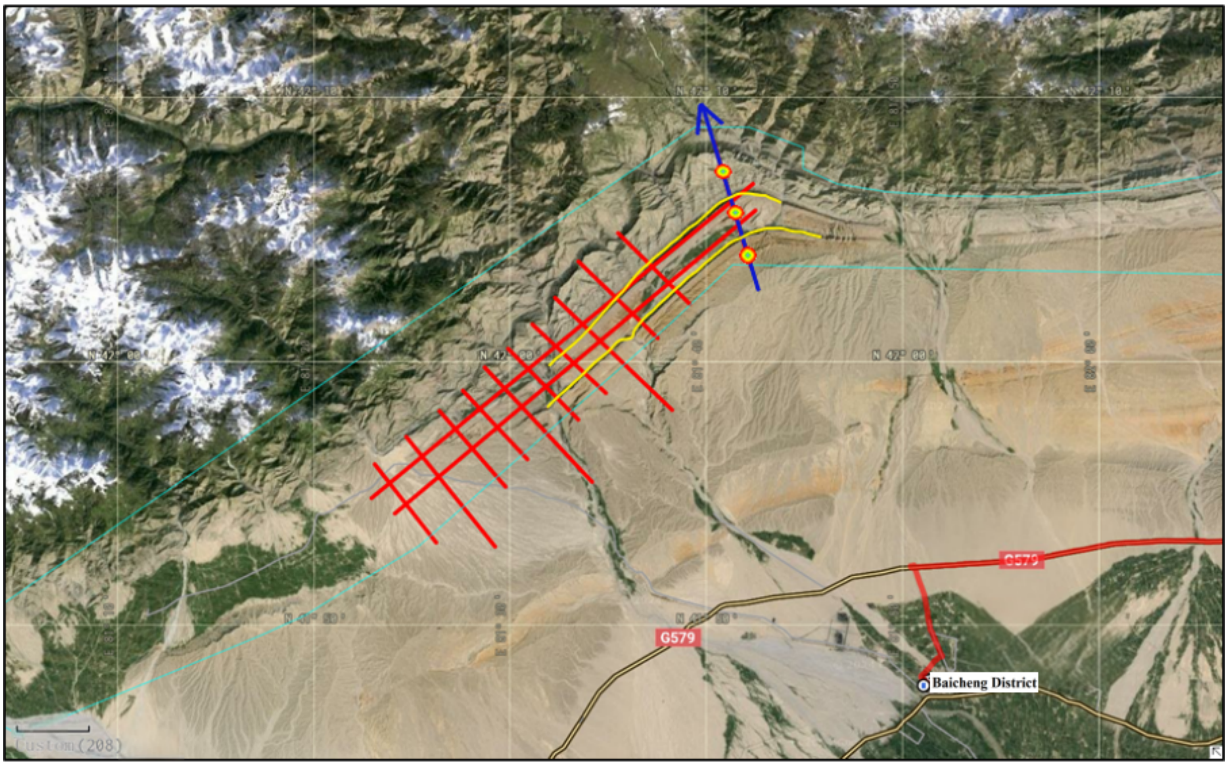


Figure 1. Surface image of Baicheng West District.

In order to construct well-to-seismic connections, it is possible to create synthetic seismic records (synthetic seismograms) using well logging sonic velocity and density, and plot them onto the migrated seismic profile to calibrate the horizons. The most important interpretational context is that the study area is extensively surface relatable. Thus, there is a significant difference in the RG line and the elevation correction line at stature, and this is depicted by the RG and elevation correction line at line X4 [17–19] (**Figures 2** and **3**).

2.2. Datum-Plane Parameters Used in Processing and Interpretation

The processing of the Baixi 2D seismic data was done with a datum (reference) plane (DP) of DP = 3,000 m and filling velocity (V_C) of V_C = 3,500 m/s. The parameters also form the core of determining the interpretation project in the commercial software, as well as determining the time shift that relates to the elevation to place the top (start) of the synthetic seismic records on the seismic profile [20].

2.3. Static Correction Framework and Calculation of Elevation Statics

Our interpretation of the fact that the RG line might not be an appropriate reference in placing synthetic seismograms is to start with the framework of the static correction as presented in the attached material. Seismic processing has two reference surfaces, one of them being the elevation horizontal reference surface, and the other is the CMP reference surface (refer to **Figure 1**). The seismic data are then corrected to the horizontal plane of reference, *DP*, after the addition of the amount of static correction calculated using the near-surface structure[21].

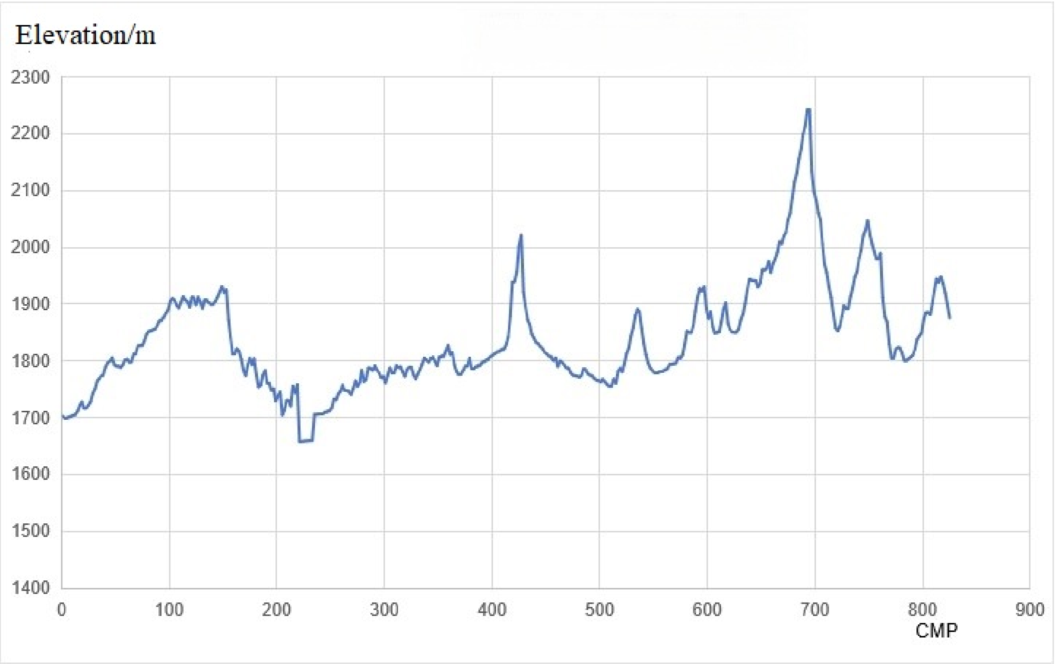


Figure 2. Map showing the surface elevation changes along line X4.

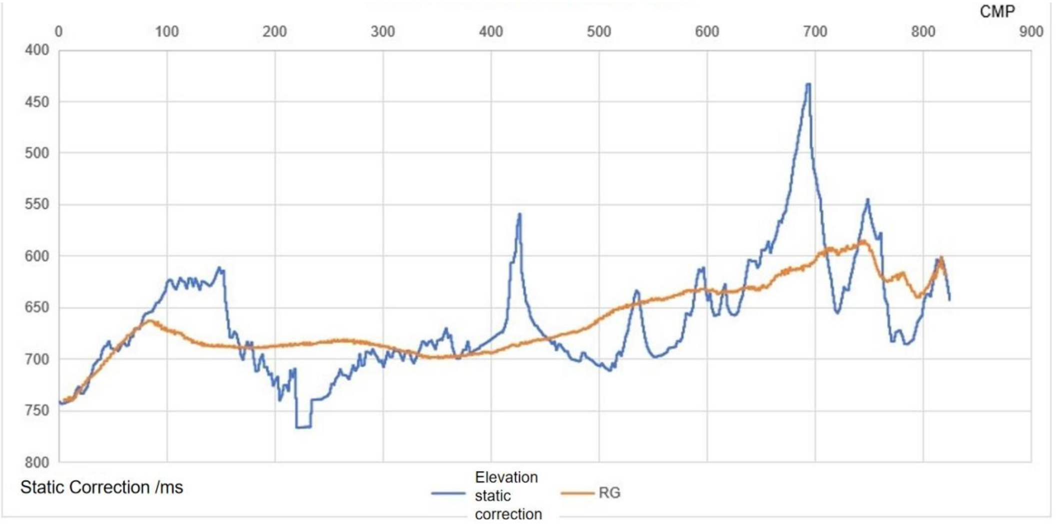


Figure 3. Curves of RG and static elevation correction for X4 line.

As shown in the schematic in **Figure 4**, the receiver (or shot point) static correction has two parts (i) the low-velocity zone stripping correction DT_0 which shifts the point off the ground surface onto the base of the low-velocity zone, and (ii) the filling correction DT_c which shifts the point off the bottom of the low-velocity zone into the datum plane *DP*.

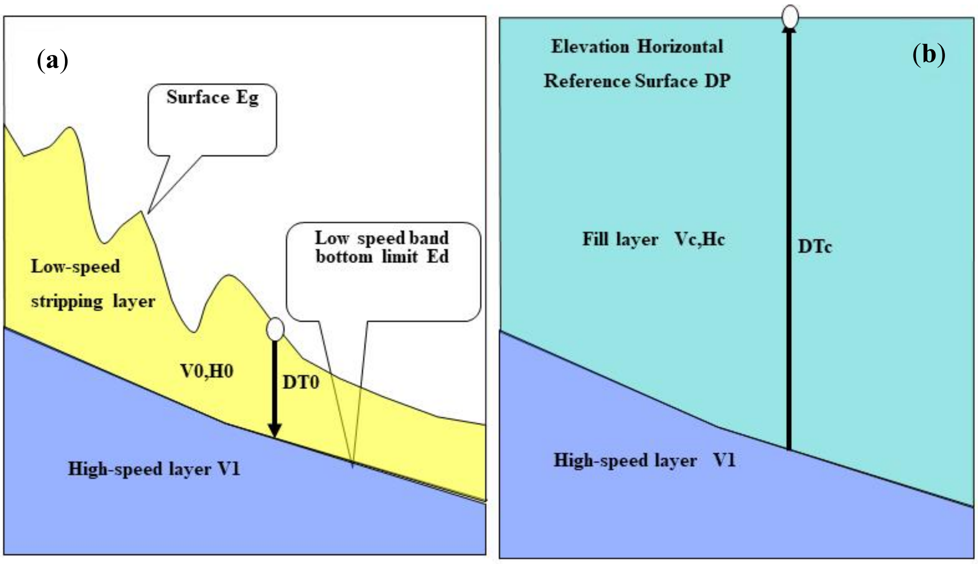


Figure 4. Diagrammatic representation of the process of calculation of the static correction: (**a**) Band reduction; (**b**) Low speed reduction. Surface correction: Reference surface correction.

The relations used are:

$$DT_0 = H_0/V_0 = (E_g - E_D)/V_0 \quad (1)$$

$$DT_C = H_C/V_C = (DP - E_d)/V_c \quad (2)$$

$$St = DT_C - DT_0 \quad (3)$$

Where E_g is surface elevation, E_d is the elevation of the low-velocity layer bottom boundary, V_0 is the low-velocity layer velocity, and V_C is filling velocity.

The correction removes the effects of surface-elevation and near-surface effects of low velocities, which allows the phase correlations to be constant and structural geometry to be represented more effectively on the seismic profile.

2.4. RG Line Generation: Two-Step Static Correction and CMP Reference Surface

The CMP reference surface is the surface that is usually plotted in 2D seismic profiles as the RG line and is defined as a time-domain reference surface produced in the two-step process of the correction of static positioning.

In this plan, the corrected statistics in a CMP gather are resolved into:

- RG: the mean value of the correction of the static (low frequency component), and
- RS (Residual Statics): the trace-by-trace difference between the average (high frequency component).

Mathematically speaking, RS correction is done on an operation-by-operation basis, when all the traces found on each CMP collectively are to be corrected to a common time reference surface (the CMP reference surface/RG surface) to enhance reflection continuity by minimizing phase-axis jitter. The stacked volume is then RG corrected and converted to the ultimate datum plane chosen at field statics calculation, and post-stack processing (e.g., migration) is then carried out. The two-step method has a practical implication in that, in the two-step method, stacking velocity is the time-domain CMP reference surface, with migration velocity being the depth-domain datum surface[22–24].

This difference has a direct effect on calibration, as the RG line on the seismic profile represents a processing-derived CMP reference surface that is an approximation of a smoothed ground-elevation surface instead of a true surface reference to wellhead-based synthetic seismograms.

2.5. Construction and Visualization of the Static Elevation Correction Line on Seismic Profiles

One of the steps in the proposed method is the calculation of the elevation static correction values (at the selected datum plane) and the clear display of the same on the migrated seismic section, such that both reference surfaces can be observed during interpretation.

The RG line and the static elevation correction line are plotted in the Baixi 2D examples on top of the migrated profile, and the relationship between the two and the differences between them can be easily compared. The given material underlines the interpretational meaning: in the seismic profile, the RG line is the same as the smooth line, which is the surface elevation below the reference plane, whereas the line of the static elevation correction is the line of the surface elevation below the reference plane [25,26].

2.6. Synthetic Seismogram Placement and Start-Time Definition

Well logging sonic velocity and density are used to produce synthetic seismic records, which are plotted on the seismic profile to be stratigraphically (horizon) calibrated. Since the physical location of the wellhead is on the ground surface, the technique locates the top (apex) of the synthetic seismic record at the static elevation correction line at the appropriate CMP location.

The beginning of the synthetic seismic record at the tracking point of a seismic profile is in the source material and is defined as calculable, based on the reference elevation DP, wellhead elevation E_g, and filling rate V_c to result in a wellhead elevation correction time DTg (Equation (3) in the attached text). Most commercial interpretation systems have, in practice, a reference surface of the seismic volume, a filling velocity, and a coordinate system in their parameterisation, needed when defining the interpretation area, and well head coordinates/elevation and well trajectory when loading well data; they then can compute and display the synthetic start time on the profile automatically once these parameters are entered [27,28].

2.7. Horizon Calibration Workflow and Quality Control

The calibration procedure used in this study consists of the following steps:

1. **Prepare interpretation project parameters** (reference surface/datum, filling velocity, coordinate system), and import well data (wellhead coordinates, elevation, well trajectory).
2. **Compute and display** the **static elevation correction line** on the relocated migrated seismic profile along with the RG line, which allows interpreters to view the distance between the CMP reference surface (RG) and the elevation correction reference.
3. **Generate synthetic seismograms**, calculate well logging sonic velocity and density, and show them on the seismic profile.
4. **Set the synthetic top** at the **static elevation correction line** at CMP position (not on the RG line) and do horizon calibration on seismic reflection phase axes.
5. **Quality control and fine-tuning**: Provided that the mismatches persist, then log-derived acoustic velocities are formation velocities and may not be equal to the imaging velocity of the time-domain seismic profile; in that case, fine-tuning of target/marker layers may be necessary to produce satisfactory calibration.

An applied warning is also provided: in most processing products (particularly 2D), the RG surface is represented in the seismic data volume, and thus appears on the displayed profiles, but the line of static elevation correction does not. Calibration results may be mistaken in case the interpreter mistakenly interprets that the RG line is the surface line, and aligns the synthetic top to the RG [29].

3. Results and Discussion

3.1. Surface Relief along X4 and Its Direct Effect on Time-Domain Interpretation

Figure 2 records a high variation of elevation along the X4 line in the Baicheng West CBM region. The research location is the Piedmont region; the surface elevation is between 1400 and 2,400 m (relief > 1,000 m), i.e., a highly non-flat acquisition and interpretation environment. Under these circumstances, not only is the time at a particular CMP a controlled behaviour of the subsurface structure, but time is also heavily affected by (i) the relative elevation of the source/receiver to the datum, as well as (ii) by near-surface heterogeneity in the form of the low-velocity layer (LVL). This is the reason why reference curves seen on a 2D migrated section, which appear as surfaces, are critical: when the interpreter aligns the synthetic seismograms (and thus horizons) to the incorrect reference, the error becomes systematic in the profile and may be interpreted as structural relief or other erroneous layer depth trends [30,31].

3.2. Static Correction Mechanism Clarifies What Must Be Honored during Horizon Calibration

Figure 4 gives the physical explanation of the way that elevation and LVL effects are eliminated by field statics. The workflow is a decomposition of the overall physical two-part static:

Stripping (Peeling) of the LVL:

$$DT_0 = H_0/V_0 = (E_g - E_D)/V_0$$

Filling from LVL Base to Datum:

$$DT_C = H_C/V_C = (DP - E_d)/V_c$$

Total Correction:

$$St = DT_C - DT_0$$

Most importantly, the document indicates that the definition of the static correction—receiver Correction at Shot (CS) or shot Correction Point (CP)—can be effectively described as a two-step motion in the time domain: initially, the shot/receiver must be shifted off the surface to the LVL base (to eliminate the near-surface low-velocity delay), followed by a motion of the shot/receiver through the LVL base to the datum *DP* with a filling velocity. This design removes the effect of changes in surface elevation and anisotropy of the low-velocity zone, enhancing stacking of the phases phase-critically and maintaining the originality of the morphology of structures on the seismic profile [32].

The synthetic seismograms are connected to the wellhead (surface), and these propagate downwards, so when we plot the seismic data on a migrated profile, the correct reference point at which synthetic placement should be made would be the surface elevation correction relative to the datum, not some internal processing reference to CMP processing.

3.3. Why the RG Line Exists and What It Actually Represents

The CMP reference surface on a 2D seismic profile has the graphical representation of an RG line, which is created only when a two-step static correction is made.

Operationally, two-step statics split each trace's total static into:

- **RG (low-frequency component)**: the mean static correction within a CMP gather.
- **RS (high-frequency component)**: the deviation of each channel from that mean.

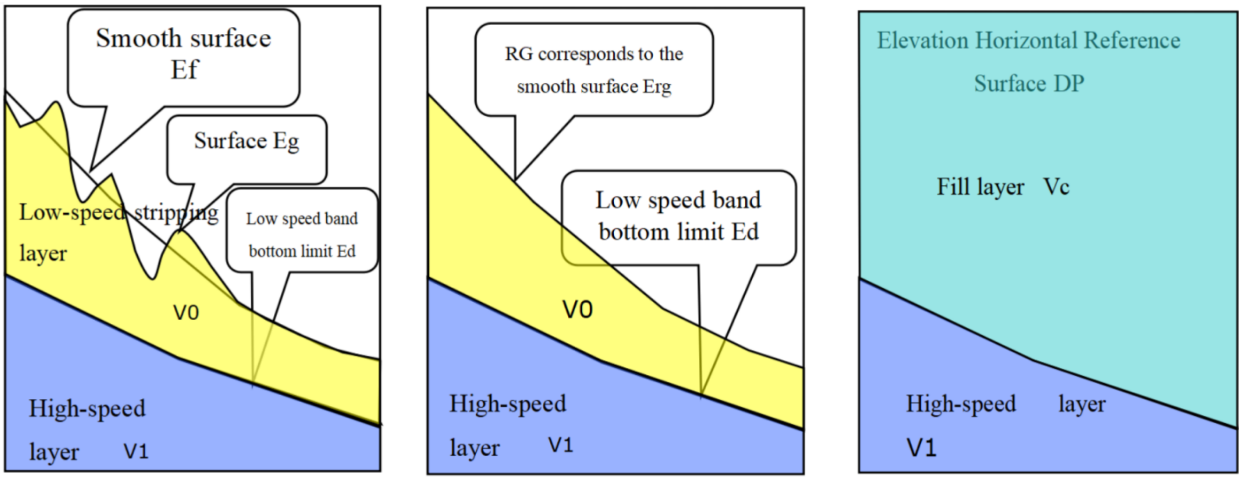
The processing logic is (and this is central to the discussion):

1. **Apply RS first** (pre-stack) in such a way that all traces in a CMP are adjusted to one time reference surface. This minimizes short-wavelength-timing scatter: "RS correction removes jitter in the phase axis of reflection, making the phase axis smoother and enhancing continuity, and since the reference is close to the surface, it does not cause (as great) changes in the original wavefield, enhancing stacking velocity estimation and stacking performance.
2. **Apply RG second** (post-stack); the stacked data is moved to the last datum *DP* utilized in the field statistics, after which migration is carried out.

The manuscript then goes on to state that, with this scheme, stacking velocity is associated with the time-domain CMP reference surface, but migration velocity is associated with the depth-domain datum; the CMP reference surface is nearly a smooth surface of the surface elevation of the Earth.

This intuitive aspect is practicalized in **Figure 5**: the stripping element (people) is highly controlled by the variation of elevation over the surface and thus inclinations to cause high-frequency impacts, whereas the filling part (comprised of a stable LVL fundamental to data utilizing a consistent filling pace) is low-frequency. Although in the case of mountainous terrain, the LVL base may not be exactly smooth, the file says this does not invalidate the key property of an RG surface as a smooth reference surface in the processing sense. RG is not a proxy of the actual surface-elevation reference ascribed to the anchor wellhead-based synthetic seismogram; it is a product derived as a result of processing that increases CMP consistency and stacking [33,34].

It is important to note that the RG reference surface has a significant and beneficial part in the seismic data processing. The RG component in the 2-step, static correction workflow is a low-frequency view of all the electrostatic corrections in each CMP gather. The method works well to minimize the time scatter of traces-to-trace and enhance continuity of the reflections by first applying the RS correction, and then making the RG surface used as a common reference in the analysis of the velocities and stacking of the traces.



(**a**) Original surface structure model. (**b**) RS-corrected surface structure model. (**c**) RG-corrected surface structure model.

Figure 5. The surface structures corresponding to the two-step static correction of the elevation horizontal datum.

Thus, the RG reference surface helps to provide a more dependable analysis of velocity, better quality stacking, and a resolved stability of seismic imaging. The problem that was addressed in this paper is not the fact that the RG surface is there, but the fact that it is being misconstrued as the true ground-surface reference when well-to-seismic calibration is done. The identification of the various functions of these reference surfaces is the key to proper seismic interpretation.

3.4. Explaining the Observed Divergence of RG and Elevation Statistics

Figure 3 shows that there are two curves along X4: (i) the RG curve, and (ii) the curve of the elevation correction at rest. In intense relief (**Figure 2**), these curves may be separated significantly. It is made clear in the introduction that the line of the static elevation correction is far different than the RG line, which is the direct cause of ambiguity in interpretation once the interpreter tries to find a point close to the RG line and place the synthetic start.

This difference is not a mistake, but that which is to be expected in two different meanings. The elevation correction curve at static is anchored on the actual wellhead/surface elevation against the datum and, as such, must maintain the spatial variability to eliminate surface-elevation effects (and LVL effects) in the time domain. The RG curve is a smoothed reference surface in the CMP domain that stems from the two-step decomposition (mean of the CMP gather statics), which is used to stabilize CMP processing and velocity analysis.

Thus, the rougher the terrain (**Figure 2**), the higher the probability of an interpreter mistakenly assuming that RG is the surface line is due to its appearance on the profile: since the line is smooth and visible on the profile, it is erroneously considered to be the surface line. The paper points out that such misinterpretation is prevalent since the RG surface is frequently included in the processing deliverables, whereas the correction line of the static elevation is normally not displayed on the 2D sections. Calibration outcome on Baixi X4: adding the missing reference resolves multi-solution interpretation.

The presentation of the methodological result of the article is applied to the Baixi 2D migrated profile (X4) by graphically depicting the RG line, as well as the static elevation correction line, on the seismic section (**Figure 6**). All the parameters of the processing are clearly mentioned: DP = 3,000 m (datum/reference plane) and V_c = 3,500 m/s (filling velocity). When these curves are presented together, they give an account of how these curves are related to the interpretation aspects. The RG line would act as a smooth line that would depict the elevation of the surface below the reference plane, whilst the static elevation correction line would be equivalent to the surface elevation line below the reference plane. The proper calibration rule can be made unambiguous with synthetic seismograms produced with the help of logs of sonic velocity and density: the top (apex) of the synthetic seismic record must be attached along the static elevation correction line, since the wellhead is at the surface[35,36].

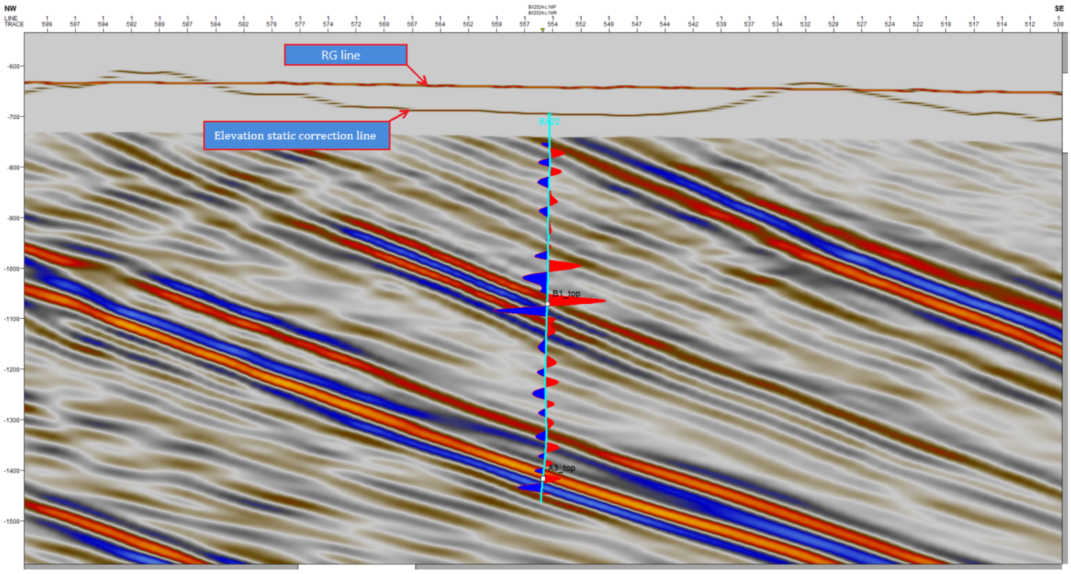


Figure 6. X4 seismic profile + static correction line.

It is seen in **Figure 6** that under this position, the two main coal seams would fit well on their respective seismic reflection phase axes, but it is evident that it is not possible to move the top of the synthetic seismic record to the RG line. This precisely is what the theory in **Figures 4** and **5** predicts. When the synthetic is pegged to RG, merely the synthetic trace is moved effectively to a processing surface, which is in the CMP domain, not limited to the wellhead elevation reference; the misfit is then allocated to all horizons. The interpreter can also attempt to correct the mismatch by adjusting the synthetic trace by hand until a marker matches, and this provides a subjective degree of freedom; therefore, the multiple interpretations problem in the introduction. In comparison, anchoring to the elevation static correction line eliminates the arbitrary shift in the vertical direction and compels the tie to obey the same datum relationship that is employed to correct the seismic data. It is also the reason why the article reports that by manually putting the static elevation correction line onto the profile and putting the synthetic starting point on the elevation correction line, one will directly get a superior calibration outcome, which, due to more certainty and less ambiguity, will yield a higher degree of confidence. Repeatability check of L1 connecting line confirms the rule is not profile-specific.

In order to show strength, the same calibration method is used in the connecting line L1 (**Figure 7**). The same effect reported by the file as record on X4, the proper tie when synthetic top compared to the static elevation correction line: this indicates the result is likely to be a general rule where there are two steps and rough topography, as opposed to a one-profile artefact. According to the manuscript, the synthetic start time is calculated based on datum elevation DP, wellhead elevation E_g and filling velocity Vc in a seismic profile (Equation (3)).

In most commercial interpretation systems, this is automatically established when the interpretation project has been configured correctly (reference surface/datum, filling velocity, coordinate system), and the well parameters have been configured correctly (wellhead coordinates, elevation, trajectory). The stratigraphic relationships are, in general, consistent with the stratigraphic relationships, and there is no ad hoc procedure of adjusting the synthetic trace by hand [37].

It also offers a helpful reality check, which is not always present in purely workflow papers, and although the reference is correct, a mismatch may still occur because the acoustic velocities as determined by log derivatives are not necessarily equal to the image velocity field as determined by the time-domain seismic section. Therefore, target/marker layer fine-tuning might yet be necessary, but only after the project parameters have been set properly; otherwise, fine-tuning will tend to correct a fault in the reference surface of the computation rather than fixing a fault in the velocity domain of the computation.

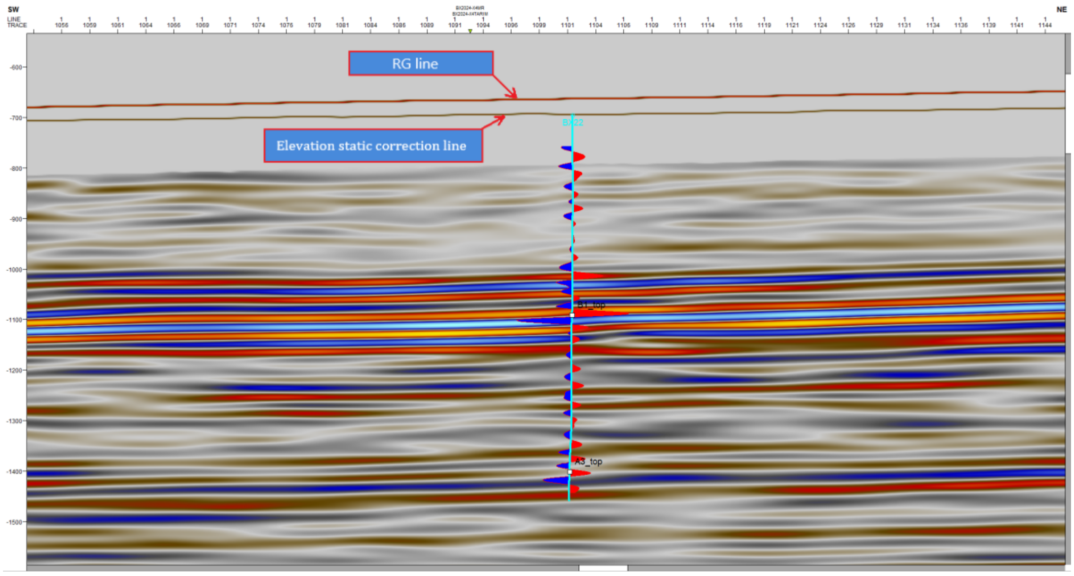


Figure 7. L1 seismic profile + static correction line.

3.5. Broader Implications for Structural Mapping and Coal Seam Modelling

The implications of the results of the paper beyond the immediate well tie consist of the larger structural-interpretation implication: interpreters should be able to understand and use various reference surfaces, and should combine the information about processing velocity with suitable reference surfaces to generate more appropriate structure maps. A stable and physically accurate time reference is a requirement in rugged-terrain CBM operations in areas such as the target coal seams are shallow in some areas and deep in others. reliable coal seam correlation across profiles, stable fault interpretation (avoiding statics-induced pseudo-faulting), and credible structural contouring for subsequent reservoir/coal seam modelling.

Overall, **Figures 2–7** all indicate that the problem of the RG line is not a display artifact: it is a reference-surface error that may carry over to horizon mis-ties, misinterpretations, and finally incorrect structural models, unless the synthetic-seismogram anchor (the static elevation correction line) is actually calculated, represented, and utilized in two-step statics datasets [38,39].

3.6. Applicability Conditions and Limitations of the Method

This horizon calibration technique is especially appropriate in seismic data sets taken in a region with a significant surface elevation gradient and significant velocity contrasts near the surface, where the variation between the RG reference surface and the elevation correction reference is large. In such a situation, systematic errors in well-to-seismic ties can be caused by the improper use of the RG line as the reference surface. Nevertheless, there are some limitations one should take into account when using the method in a more complicated situation. The first is that the method assumes that the datum parameters and the static corrections applied in the seismic processing are constrained. When the near-surface velocity model or datum parameters are inaccurate, then the calculated elevation static correction line will contain errors, and this will have an impact on the position of the synthetic seismogram.

Second, where the variation of lateral velocity is high or the structural deformation is complicated, the disparity between log-derived formation velocity and actual seismic imaging velocity can be considerable. Further calibration operations, like time-stretching of the synthetic trace or velocity model refinement, can nonetheless be necessary in any instance where the appropriate reference surface has been determined.

Third, the workflow presented in this paper is shown primarily on 2D seismic profiles. Verification again is needed to verify consistency in the implementation of the 3D seismic datasets, where processing and datum references can be defined differently, and spatial interpolation effects are important.

Lastly, the approach presupposes that data of wellhead elevation and interpretation project parameters (datum plane, filling velocity, coordinate system) are properly defined. These parameter errors can be carried into the computed synthetic start time and decrease the accuracy of calibration. Irrespective of these drawbacks, the approach offers a viable and physically coherent working procedure for horizon calibration in regions of topographically complex morphology, where misinterpretation is often caused by the misconception of reference surfaces.

4. Conclusion

The research paper contains a well-known and large-effect interpretation issue in the Baicheng West CBM seismic data: in high topographic relief, the RG line observed on most 2D migrated seismic profiles may be significantly different than the reference used for static elevation correction, and standard placement of the synthetic near RG calibration is invalid. The proposed method offers a solution to horizon calibration in rough terrain, introducing the elevation correction reference to the interpretation process clearly and effectively, and defining the meaning of processing RG, which offers a convenient and repeatable method to tackle the issue.

Synthetic seismogram positioning in start-time by reference to the real surface is not on the RG line. In two-step static correction, CMP makes use of a time-domain reference (the CMP reference surface or RG surface) to stabilize CMP gathers when performing velocity analysis and stacking; thus, the RG line on a displayed profile is a smoothed form of elevation-related reference as opposed to the elevation reference of the wellhead required to perform well-to-seismic alignment. The CMP location should be at the top of the synthetic seismogram, which should be in line with the static elevation correction line. Overlaid with both lines on the migrated profile, the static elevation correction line is the line that relates to the surface elevation relationship beneath the datum plane, which is consistent with the physical location of the wellhead and the datum-based static correction notion. With this reference, the main coal seams can be well calibrated, and in the given case, it is impossible to shift the synthetic start to RG.

The technique can be repeated over profiles and gives less interpretational ambiguity. Calibration behaviour is also claimed to be the same on the primary example (**Figure 6**, X4) as well as the connecting line example (**Figure 7**, L1), which implies the workflow is not a one-line special case but a regularity independently of reference-surface meaning. Implementation should be consistent through proper parameterization of the project. Computation Commercial interpretation systems are capable of calculating and showing a synthetic start time when the interpretation area is set up using the correct datum/reference surface, filling velocity, coordinate system, and the well data loaded containing correct wellhead coordinates/elevation and well trajectory. This enhances uniformity of stratigraphic relationships and reduces dependence on subjective manual plate-scrubbing. Mis-ties that were ruled out might be left and treated as controlled fine-tuning rather than as compensation for the reference surface. The formation velocities calculated using logging and effective seismic imaging velocities may still need limited marker-layer corrections, though they need to be made after the synthetic record has been tied to the proper elevation correction reference.

In general, it has been shown that it is the explicit declaration of the reference of the seismic section to a static elevation correction that is followed by a synthetic start anchor that is the critical measure in obtaining a good horizontal calibration of seismic in rugged topography. This enhances the trust in the further structural interpretation and assists in the creation of more sensible structural maps and depth corrections in the CBM seismic interpretation processes.

Author Contributions

All authors contributed equally to the conception, design, data collection, analysis, and writing of this study. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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