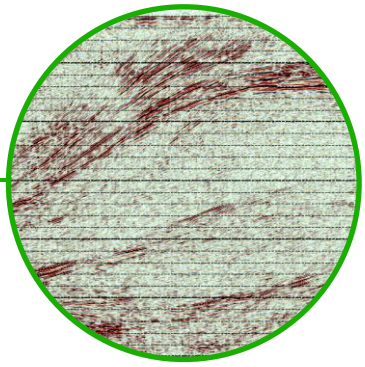
# 2019 KALGOORLIE
# EASTERN GOLDFIELDS 2D SEISMIC SURVEY



## INTERPRETATION REPORT

*Prepared for*

*Geological Survey of Western Australia*

*by*

*Velseis Processing Pty Ltd*

*Integrated Seismic Technologies*

Velseis
Integrated Seismic Technologies

| | | |
|---|---|---|
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# INTRODUCTION

This report describes the interpretation of the 2019 Kalgoorlie Eastern Goldfields 2D Seismic Survey. The survey was commissioned by the Geological Survey of Western Australia (GSWA), a division of the Department of Mines, Industry Regulation and Safety (DMIRS), and was conducted by Velseis Pty Ltd during March-April 2019 (see separate acquisition report). The data, consisting of seven Vibroseis 2D lines, totalling approximately 305 km, was processed by Velseis Processing Pty Ltd from April to July 2019 (see report #VP19-956). A preliminary, broad scale interpretation of the 2019 seismic data was completed in August 2019.

This interpretation was undertaken with input from GSWA geoscientists to correlate major features identified on the seismic data with interpreted structures from previous Geoscience Australia (GA) seismic surveys, and GSWA gravity, magnetic, and geology maps.

No borehole data were used for this interpretation.

The objective of this survey is to provide mineral explorers in the region with sub-surface information to complement data from other sources and to delineate areas that might be suitable for 3D seismic surveys for mineral exploration and targeting. This seismic interpretation represents a broad scale preliminary interpretation of the survey area.

Figure 1 illustrates the line locations using Google Earth (image taken from processing report).

Interpretation products produced for GSWA include:

**Report:** PDF file of interpretation report.

**Images:** PDF image files including:

- Scaled interpreted line sections.
- Scaled un-interpreted line sections.
- Interpreted basemap at surface.

NOTE: All line section images as well as line work interpretations have been done in time domain. Vertical scale of line section images is in Two-Way Time (milliseconds).

**Structure:** Excel spreadsheet containing structural characterisation and location data.

**Horizons:** Excel spreadsheet containing horizon characterisation and location data.

**Interpretation File:** LMKR GVERSE Geophysics interpretation project file.

These products complement the other delivered data products for the 2019 2D seismic survey:

**Processed Data:** Filtered DMO stack, filtered and unfiltered migrated stack, filtered enhanced migrated stack.

**Raw Data:** Field Data and Observer's Logs.

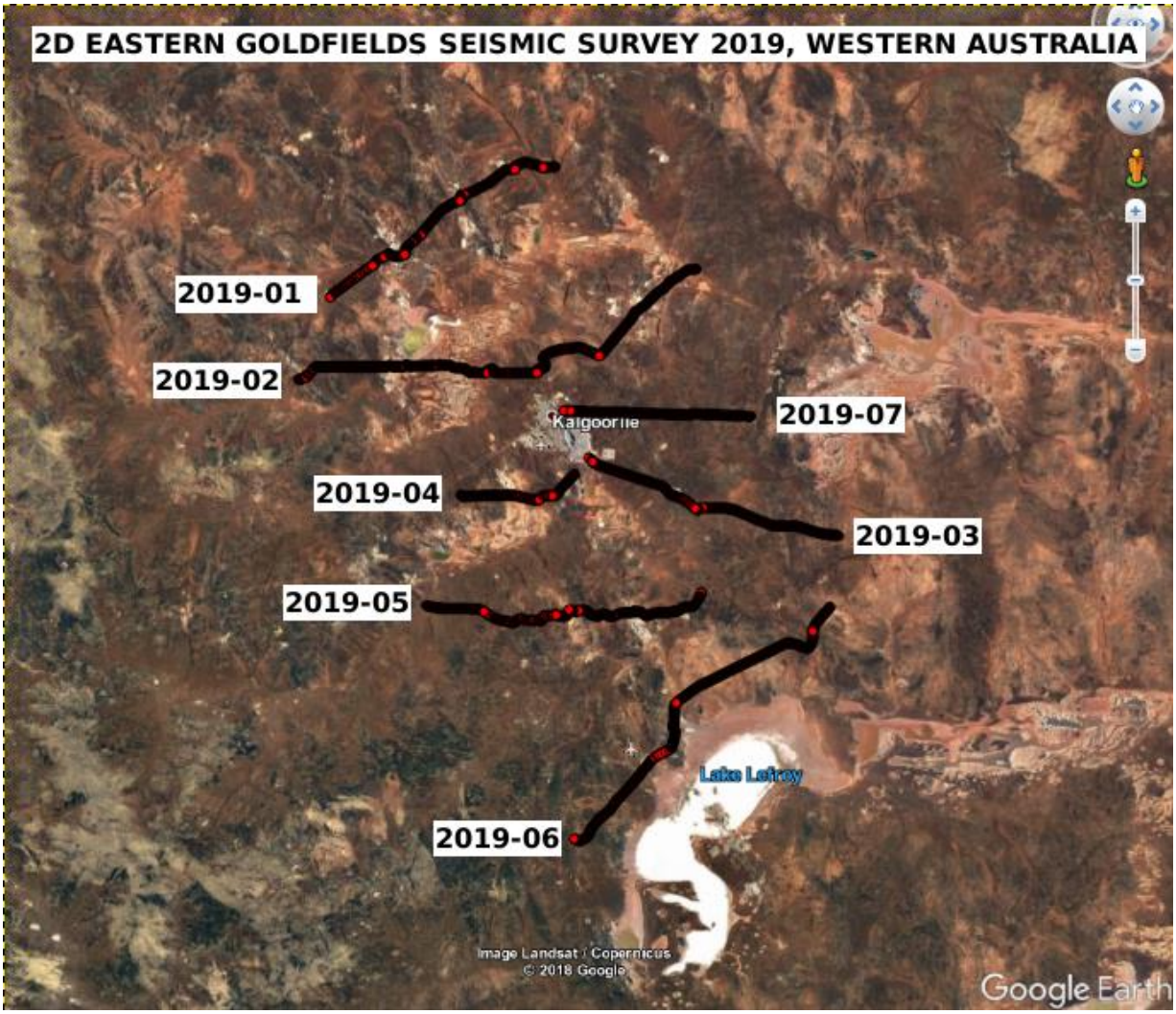



**Figure 1. 2019 Kalgoorlie Eastern Goldfields 2D seismic survey line locations.**

*Taken from Velseis Processing Pty Ltd report # VP19-956.*

# INTERPRETATION

## *Introduction*

The seismic data were interpreted by Velseis Processing Pty Ltd during July-August 2019. Interpretation was conducted on a PC using the 'GVERSE Geophysics' program by LMKR. Of the dataset versions produced during processing, it was determined that the Filtered Enhanced Migrated version provided the best image, so this is the version that was used for the interpretation.

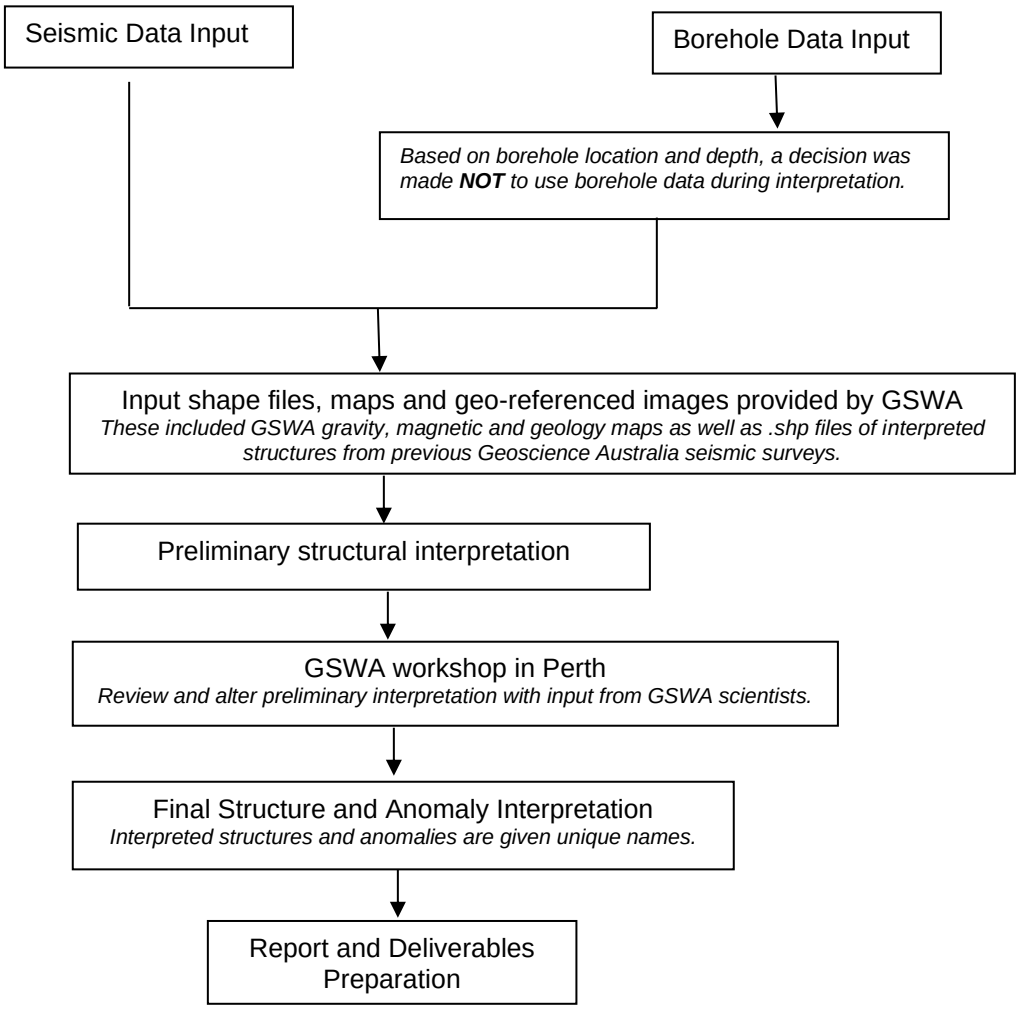
Borehole data was provided by GSWA, and this data was loaded into the interpretation software. However, all but one of these holes are located at distances of more than 500 m from the survey lines and the majority of holes were very shallow, so a decision was made not to use the borehole data during the interpretation.

The interpretation project was set up using the following Coordinate System and Interpretation Datum:
Datum: Geocentric Datum of Australia 1994 (GDA94)
System: Australian Map Grid Zone 51

Datum Elevation: 500 m
Replacement Velocity: 5000 m/s

An outline of the interpretation workflow is presented in the following section.

## *Interpretation Workflow*



### *Maps and Shape Files Provided by GSWA*

Structural interpretation has been assisted by the use of maps and shape files provided by GSWA, including gravity, magnetic and geology maps (GSWA, 2019), along with shape files of interpreted structures from previous GA seismic surveys (Goleby et al., 1993). These maps and files were used to correlate major features identified on the seismic data. Figures 2 and 3 below illustrate a selection of these maps used during the interpretation.

Figure 2 shows the gravity map superimposed with the magnetic anomaly map and the 2019 2D line locations. Figure 3 shows the geology map used along with the interpreted structures across the survey area.

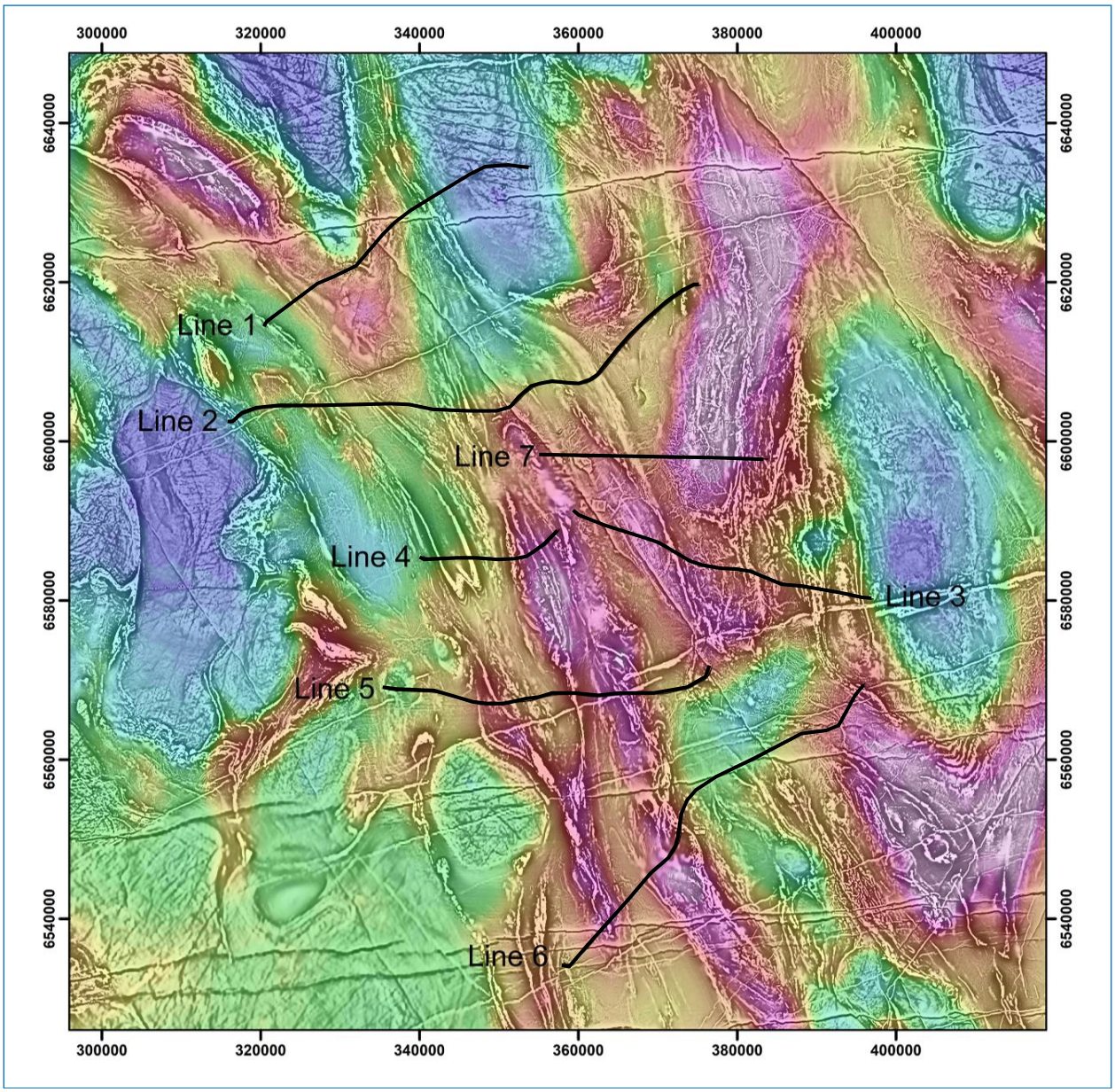



**Figure 2. Superimposed Bouguer gravity (colour) and total magnetic intensity (shading) map of the survey area.**

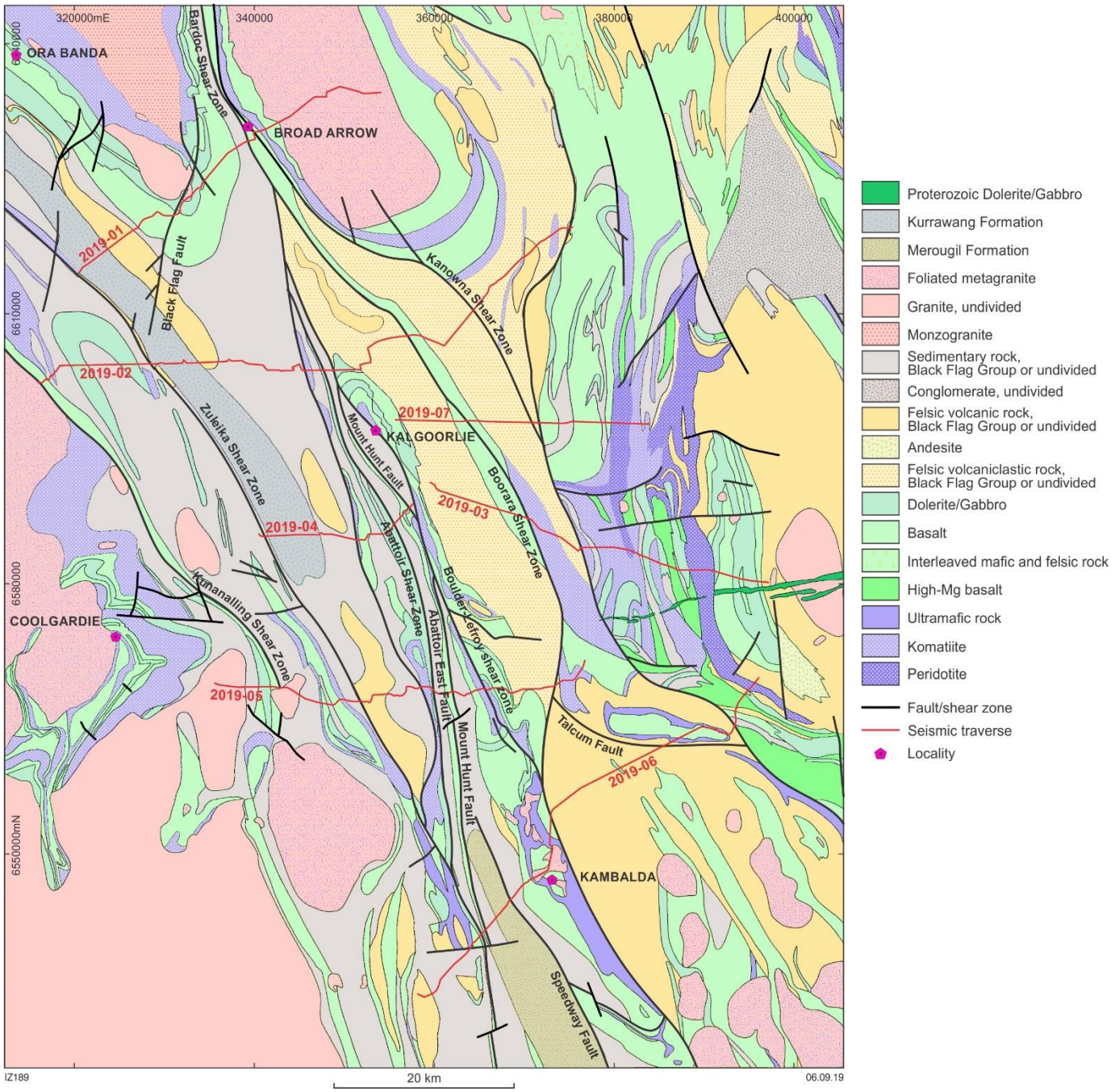



**Figure 3. 1:500,000-scale geological map of the survey area.**

### *Structural Interpretation*

This is a broad-scale, preliminary interpretation that attempts to correlate features and variations in the seismic sections with major structures — folds, faults, and shear zones — and lithological differences, such as greenstone sequences or intrusions, in the regional geology.

In the seismic data, 'structure' may be identified by a dramatic change in dip, discontinuous reflectors or sudden changes in amplitude. In some cases, fault planes and the boundaries of shear zones may be visible as reflection events.

Geological and magnetic maps show the presence of dykes and granite intrusions throughout the survey area. In seismic data, intrusions are often indicated by unreflective zones. In the interpretation sections, yellow 'fault string' lines have been used to indicate the boundaries of interpreted zones of intrusion.

Interpreted structures, anomalies (see below) and intrusion zones have been characterised by estimating their location and style as described below.

### *Structure Error Limits*

In viewing the interpretation sections, it is important to be aware of the errors associated with structure location. Given the scale and broad nature of this interpretation, it has not been possible to determine a quantitative error range. However it should be noted that errors are likely to increase with depth, in areas of decreased image quality, and also in areas of complex structure.

### *Structure Confidence*

The level of confidence in the interpreted structures is affected by data and image quality. The structures appearing on the interpretation sections have been colour coded to reflect four levels of interpretation confidence listed below in descending order of confidence:

**High Confidence Structure (F) (Fault):** Colour coded red. Characterised in the seismic data by clear, and well-defined reflections or reflection dislocations.

**Medium Confidence Structure (M):** Colour coded orange. Less well-defined 'structural' features in the seismic response.

**Low Confidence Structure (P) (Possible structure, flexure or seam roll):** Colour coded blue. Areas of reduced confidence because of poor data and image quality.

**Seismic Anomaly (A) (inferred structure):** Colour coded grey. Subtle changes in seismic character which form a trace or lineament through the data. These 'anomalies' are not likely to be vertically extensive and are not necessarily related to structure. Any structure indicated by such an anomaly is likely to be relatively small scale.

### *Structure Names*

Structure names consist of a 5 character descriptive name:

- Character 1 — level of confidence — F, M, P or A as outlined above.
- Character 2 — interpreted structural style — N, R or U for Normal, Reverse or Undefined, respectively.
- Characters 3 to 5 are a unique and sequential identifier, usually numbered in order of interpretation, and with numbering commencing with 001.

Interpreted structures which are observed to align with named structures on the geological map have been given the corresponding fault name and colour coded according to confidence level.

Interpreted intrusion zones have been labelled as either 'Intrusion' or 'Proterozoic Dyke' (abbreviated on the sections as 'Proto Dyke') followed by a numerical identifier.

### *Structure Summary*

Readers should be aware that this is a preliminary, broad-scale interpretation of the 2019 2D seismic survey data.

Structures and intrusions interpreted within the survey area have their vertical and spatial extent, and confidence level represented in excel spreadsheet format in the material provided in the deliverables package. Structures digitised on the two-way time (TWT) section are presented in the spreadsheet as individual structural sticks/strings, with each node point represented by an individual Easting, Northing and TWT.

An attempt was also made to interpret the top and base of the greenstone unit where possible. This is represented by the green horizons shown on the seismic sections. Pink horizons have been used to indicate other, undefined, interpreted unit/domain boundaries, while black horizons were used to represent formlines, indicating the general trend of the data. The Easting, Northing and TWT location data for these horizons is also included in excel spreadsheet format in the deliverables package.

A total of 121 structures were interpreted across the 2019 2D survey lines. Table 1 below summarises the confidence levels of the structures interpreted.

| Total Structures | High Confidence | Medium Confidence | Low Confidence | Anomaly |
|---|---|---|---|---|
| **121** | 0 | 10 | 64 | 47 |
| **100%** | 0% | 8% | 53% | 39% |

**Table 1. Summary of structure confidence interpreted across the survey area.**

The software used for this interpretation enabled the creation of a 3D view of the 2D line sections. This view of the survey was useful for interpolating structure between lines and insuring that interpreted structures given the same name, e.g. the Zuleika shear zone, had the same dip direction across the lines. An example of the 3D view is provided in Figures 4 and 5, which show the line sections without and with the structural interpretation, respectively.

A basemap at surface was created (Figure 6), illustrating the locations of structures and intrusions which, given their interpretation on the seismic sections, may be visible at surface. Due to the large distances between the seismic lines, any lateral interpolation of structure on this basemap should be considered as Low Confidence.

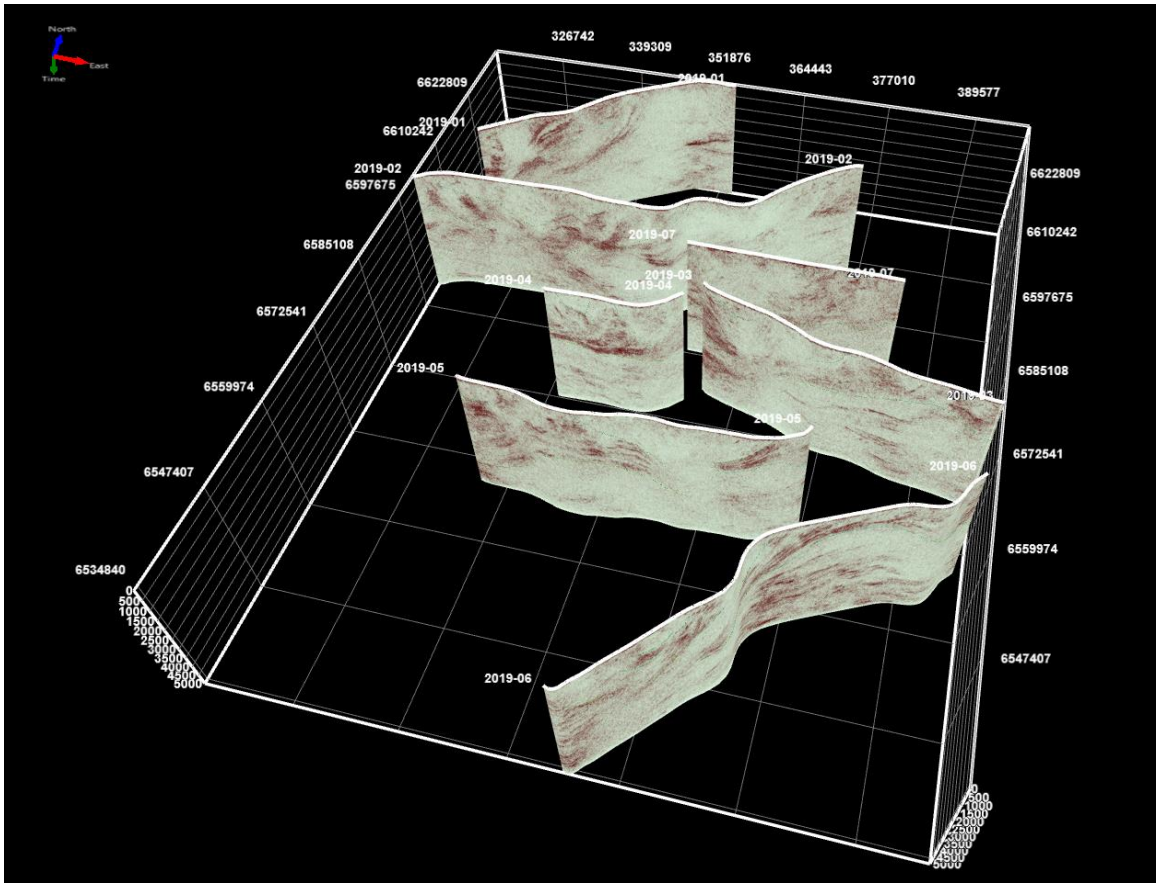



**Figure 4. 3D view of the 2019 2D seismic lines, looking north, without interpretation.**

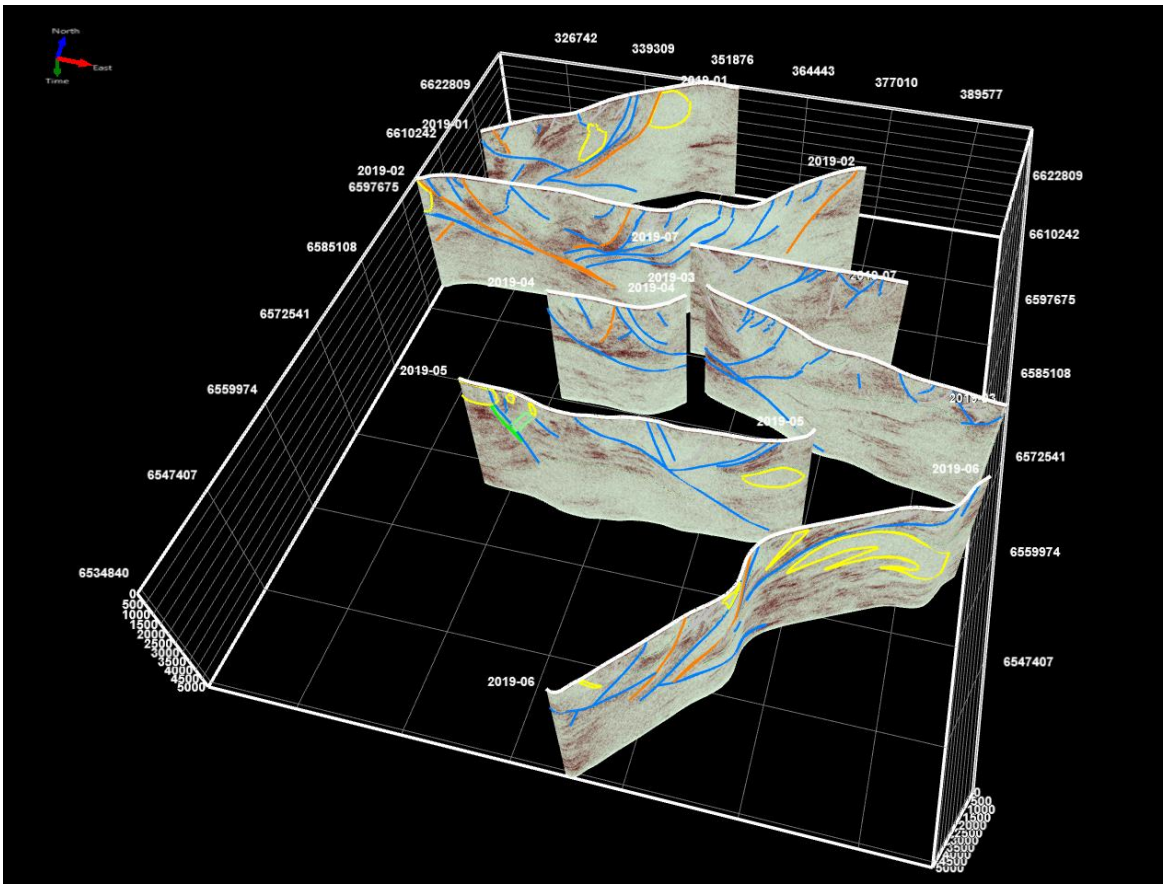



**Figure 5. 3D view of the 2019 2D seismic lines, looking north, with interpretation.**

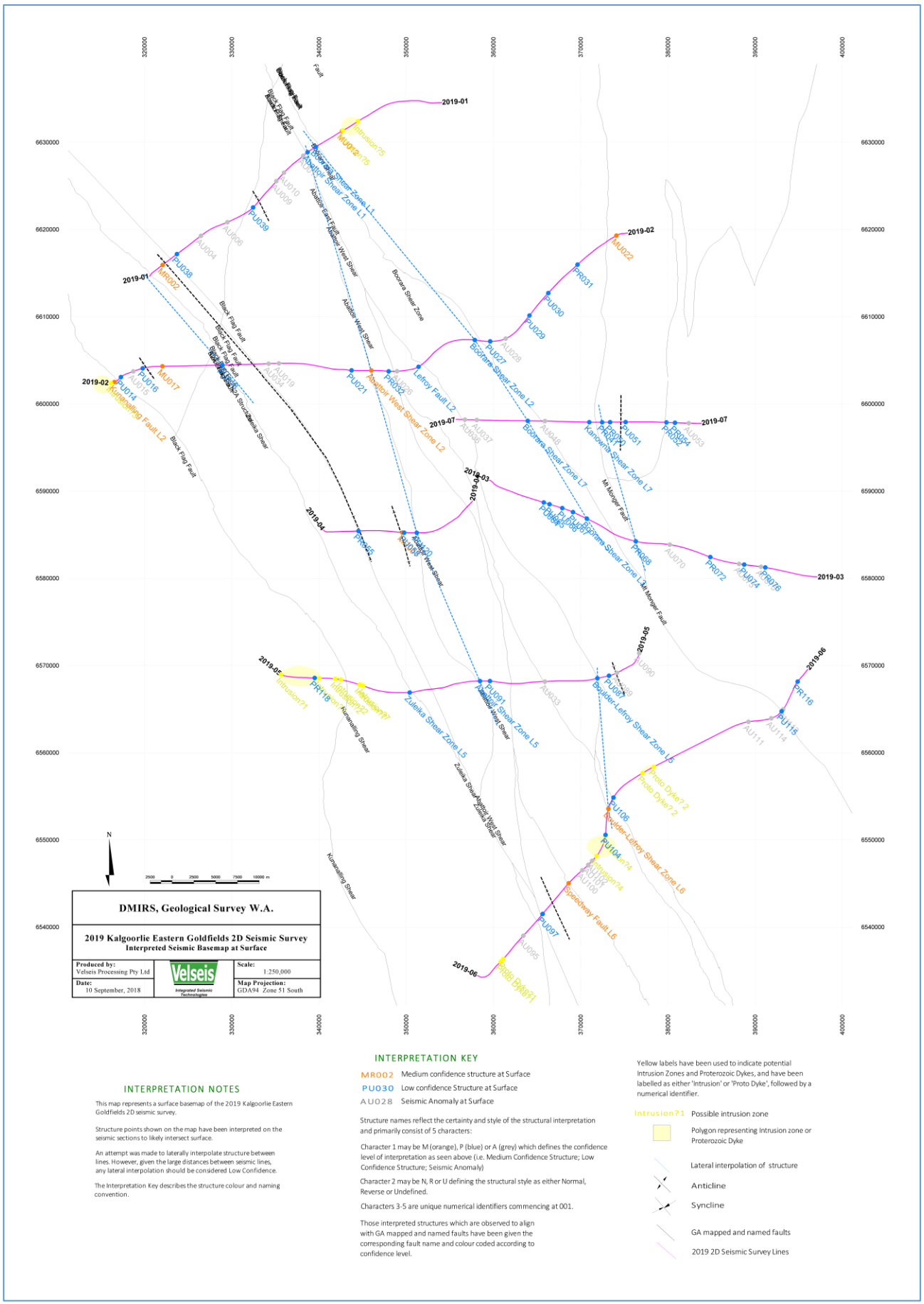



**Figure 6. Interpreted Basemap at surface.**

## *Primary Zones of Interest*

Areas of interest within the 2019 2D survey area include several shear zones, along with anti- and synclinal forms, which correspond well with structures shown on the geological maps, and interpreted from previous GA surveys. As seen in the section images below, vertically extensive structures have primarily been interpreted as listric in style.

Zones of potential granite intrusion and Proterozoic dykes have been outlined on several lines. Also, the top and base of the greenstone unit (Kambalda sequence?) have been proposed on some line sections, and have been shown with a green horizon. A pink horizon has been used to indicate other, unidentified, geological units.

These areas of interest are illustrated in Figures 7 to 13.

Line 1 (Figure 7) displays syncline and anticlinal forms, potential granite intrusions and the Bardoc shear zone.

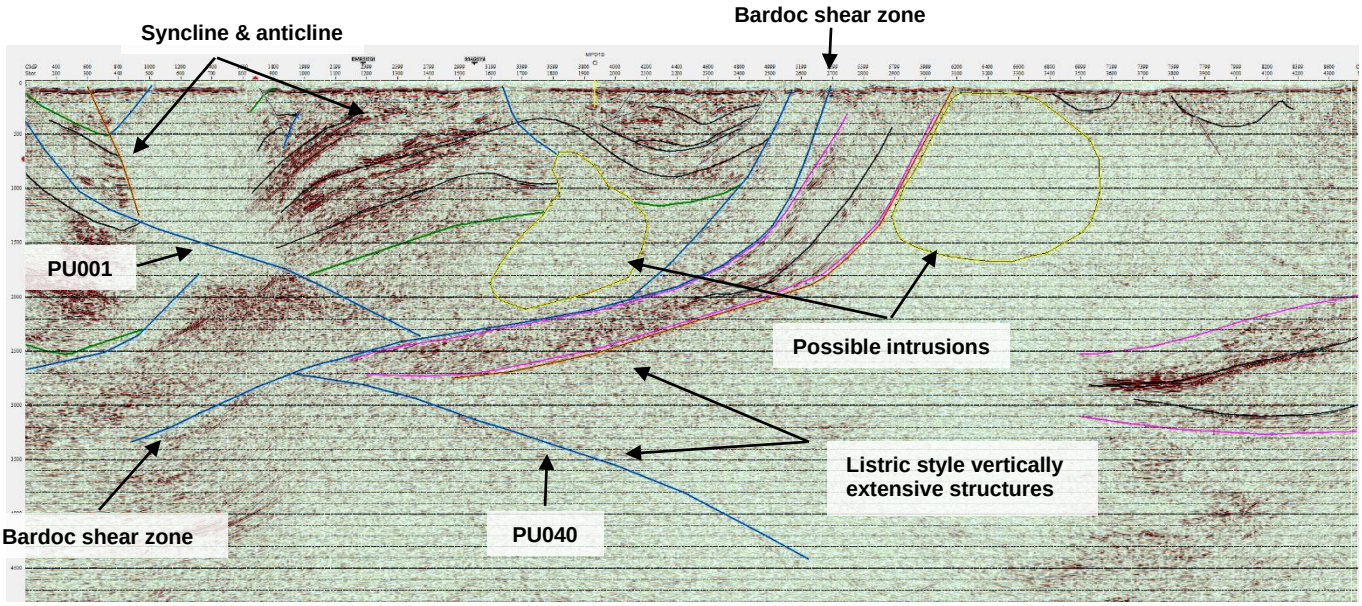



**Figure 7. Interpreted zones of interest in Line 1.**

*Structures PU001 and PU040 may represent the Zuleika shear zone, offset by the Bardoc shear zone. Line image is oriented southwest to northeast.*

2019 Line 1 is situated within 10 km of the 1991 deep seismic traverse BMR91-EG1, which has a similar orientation, and which has been interpreted and used as a representative cross section of the area in multiple papers (Figure 8). Interpreted structure and formlines on the 2019 Line 1 match well with the historical geological cross section, as seen in Figure 9.

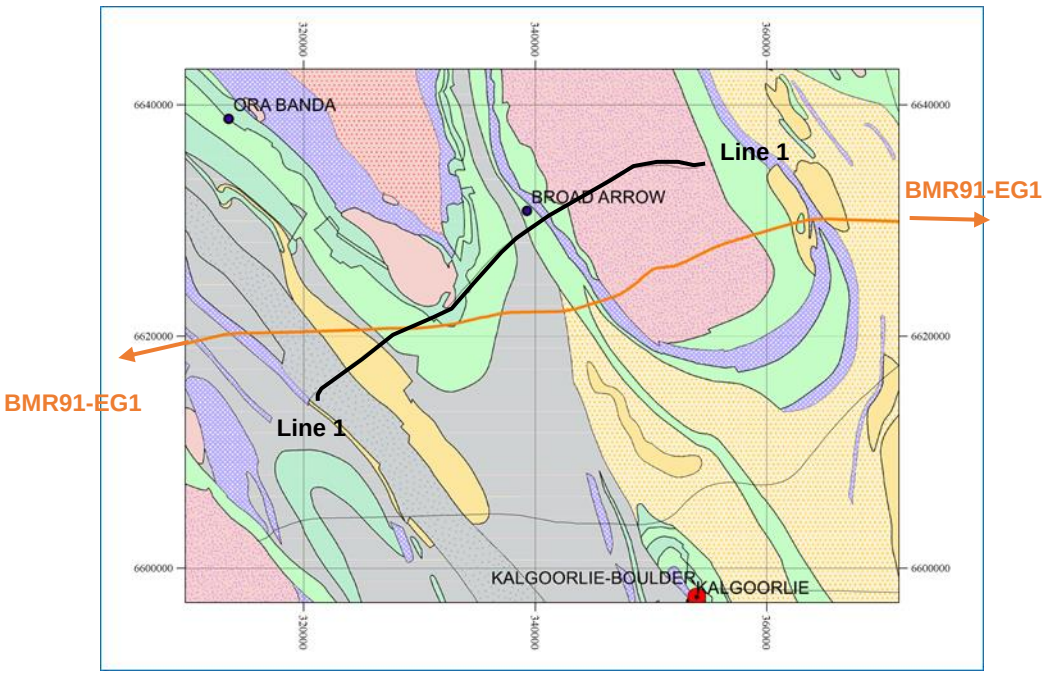



**Figure 8. Location of line 2019-01 and 1991 line BMR91-EG1.**

*Line 2019-01 is shown in black, and the central portion of BMR91-EG1 in orange.*

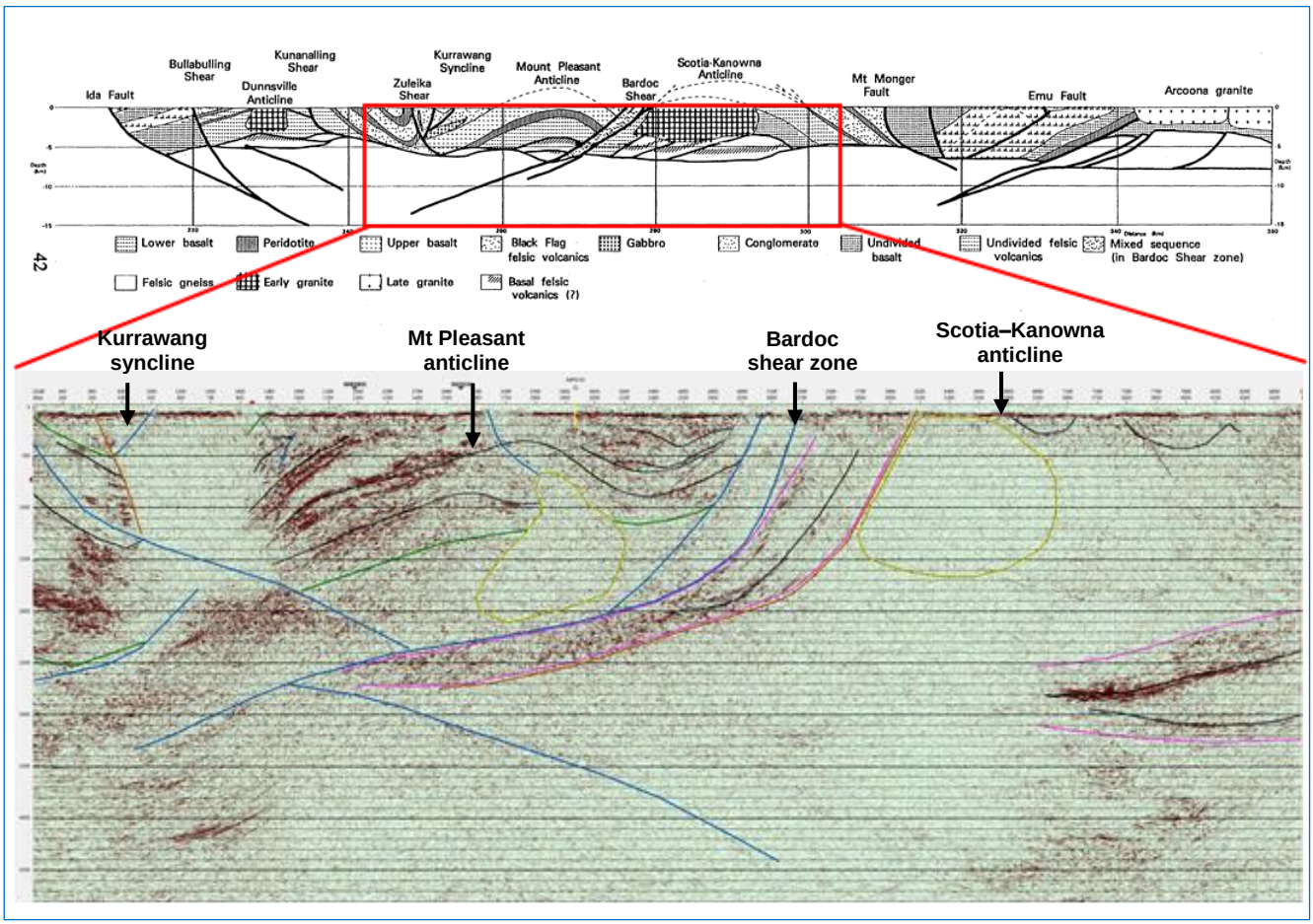



**Figure 9. 2019 Line 1 interpreted section (bottom) compared with corresponding portion of the geological cross section of line BMR91-EG1 (top).**

*Lines are oriented southwest–northeast. The cross section through the Eastern Goldfields is based on the 1991 Deep Seismic Reflection Survey (Seismic Line BMR91-EG1), from Goleby et al, 1993.*

2019 Line 4 (Figure 10) illustrates the best representation of the apparent base of the greenstone unit (Kalgoorlie Group?) visible across the 2019 survey area. The Kurrawang Syncline, which is noticeable on Line 1 above, is also evident in the west of Line 4, displaying similar characteristics to the reflections observed on Line 1.

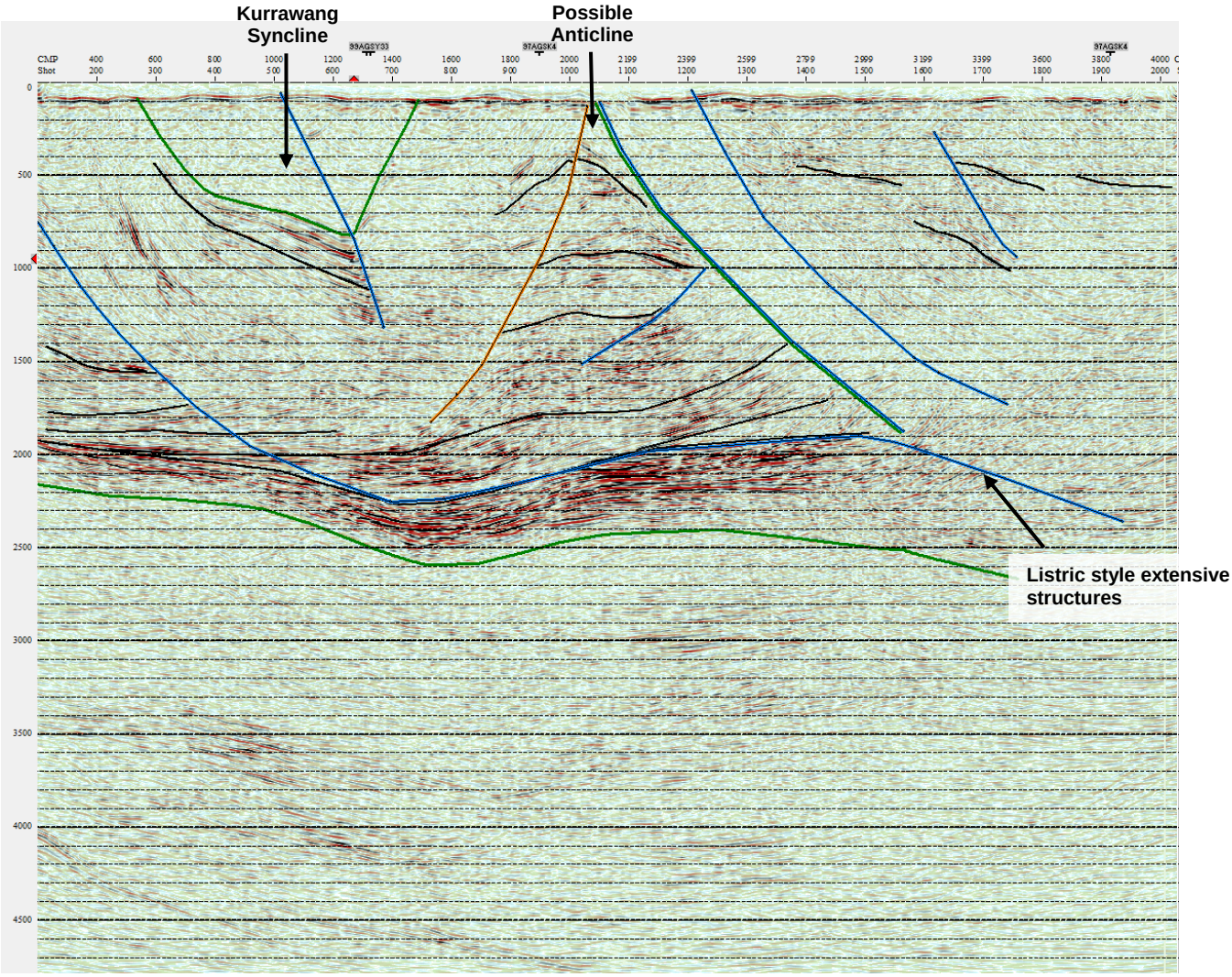



**Figure 10. 2019 Line 4 interpreted section.**

*Line is oriented west to east.*

The base of the greenstone unit is also evident on Line 5, illustrated in Figure 11. Other items of interest on this line include the Zuleika and Boulder-Lefroy shear zones, which correspond well with the structures interpreted from previous GA surveys, along with potential alteration zones. The geology and structure at the eastern end of Line 5 appears similar to that seen on the eastern half of Line 6 (Figure 12). GSWA scientists indicated that the feature at the eastern end of Line 6 represents an upright antiform imaged parallel to its axis. A possible intrusive body has been interpreted in the seismically quiet zone under this antiform on both Line 6 and 5. With the use of the magnetic anomaly maps provided, two Proterozoic dykes have been interpreted on Line 6 (Figure 13). The magnetic anomaly maps indicate the presence of a third dyke along this line, however there it is not observable in the seismic profile.

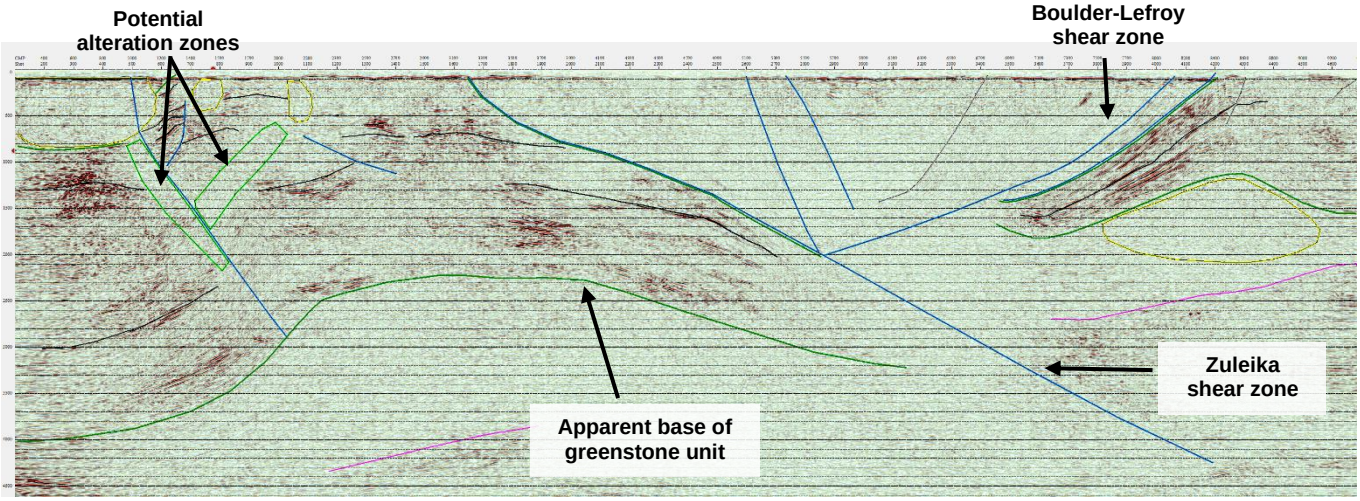



**Figure 11. 2019 Line 5 interpreted section, oriented west to east.**

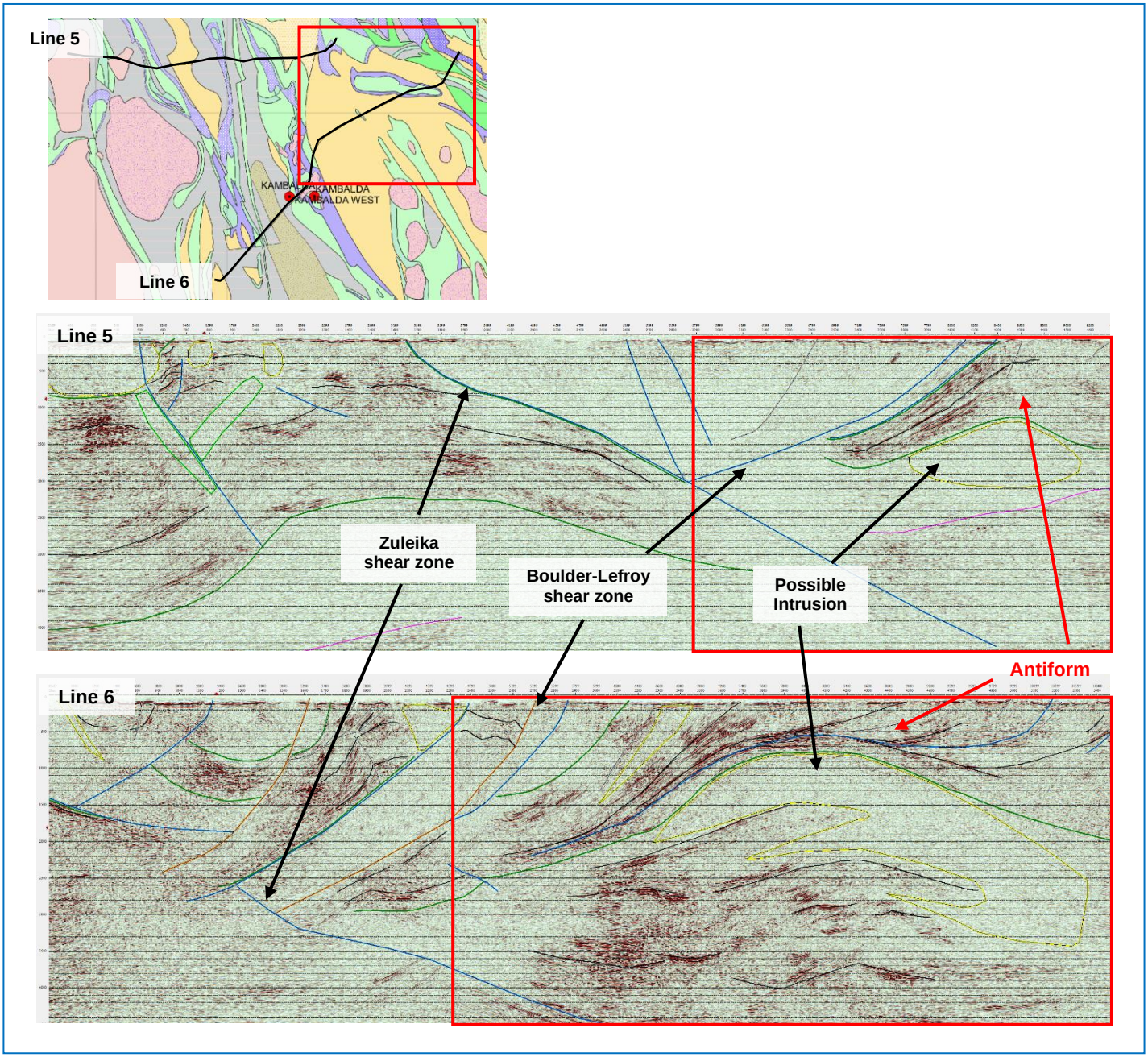



**Figure 12. 2019 Line 5 and Line 6 interpreted sections, oriented west to east.**

*The red box outlines the feature that appears to occur on both Lines 5 and 6.*

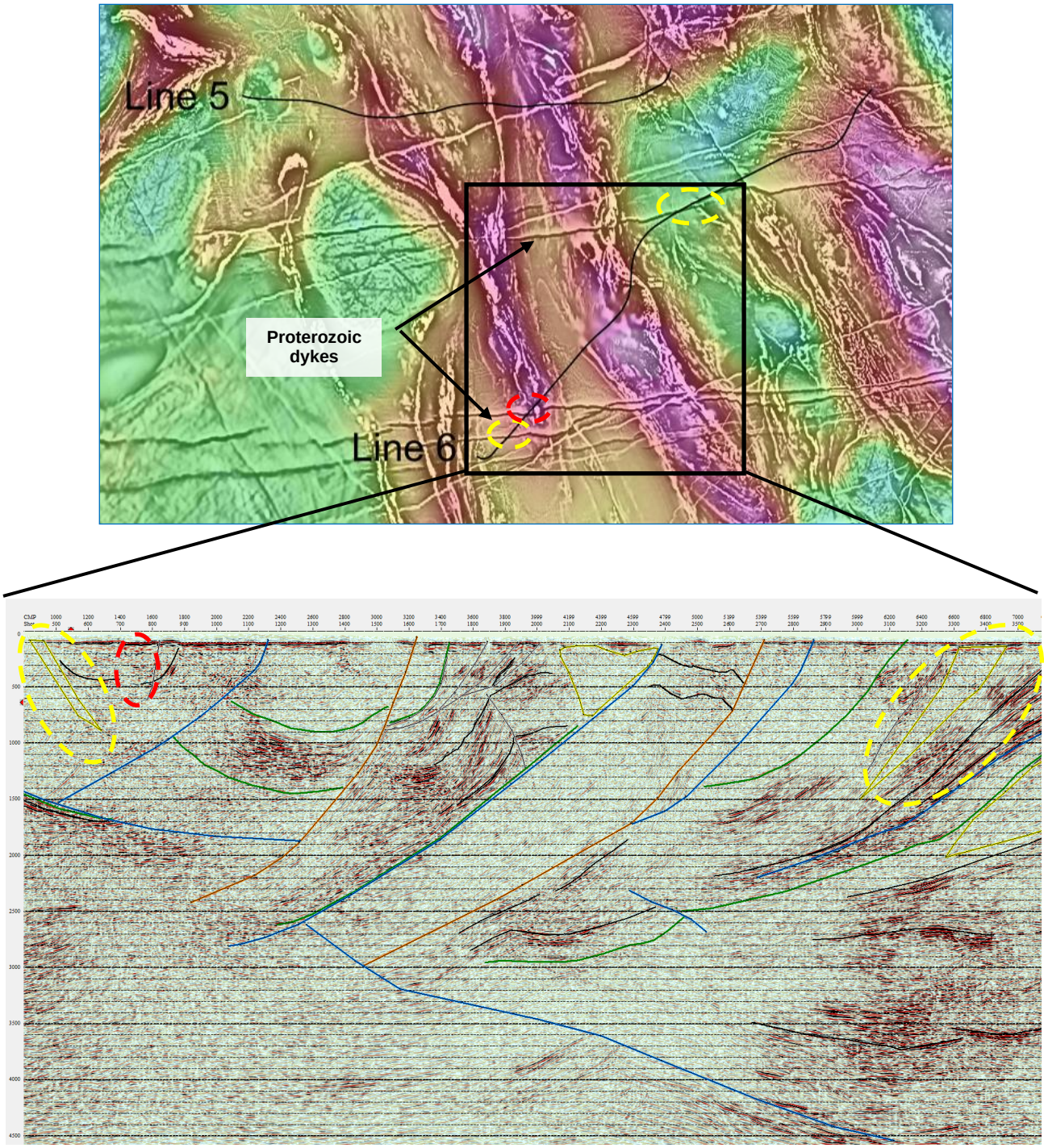



**Figure 13. GSWA superimposed gravity and magnetic anomaly maps (top), and part of Line 6 interpreted section oriented southwest–northeast.**

*Yellow ellipses represent the locations of Proterozoic dykes which are apparent on the magnetic anomaly map and are also able to be interpreted in the seismic data. The red ellipse indicates the location of a dyke apparent on the magnetic anomaly map, but not visible in the seismic section.*

## *Post-workshop commentary provided by GSWA*

(Dr Ivan Zibra)

The mainly east–west oriented seismic traverses intersect the general northerly trend of regional structures at high angles, offering favourable conditions for imagining the crustal architecture with its true across-strike geometry.

For the purpose of this preliminary interpretation, we can identify a group of four main litho-tectonic elements that are readily recognizable in both the geological map and the seismic images. These include:

i. A lower, dominantly mafic–ultramafic greenstone succession (Kalgoorlie Group) that generally produces prominent reflectors in the seismic images;

ii. An upper, dominantly felsic greenstone succession that includes the Black Flag Group and remnants of younger, unconformable sedimentary sequences. These elements are generally transparent in the seismic images.

iii. Granites and granite gneisses with intrusive contacts into the greenstones. Granites are generally transparent in the seismic images, while pervasively-foliated felsic gneisses might produce well-defined reflectors, particularly when they contain greenstone slivers;

iv. Proterozoic mafic dykes, which are discordant with respect to Archean litho-tectonic elements and may or may not produce prominent reflectors in the seismic images.

An additional ingredient (but not necessarily a litho-tectonic element) that occurs in some of the seismic images is represented by patchy, transparent or poorly-reflective areas that are generally discordant to the various domains, and can be preliminarily interpreted as zones of hydrothermal alteration. These zones might have been generated through intense fluid flow along structures and/or lithological boundaries. Examples of such potential alteration zones are the section of the Zuleika shear zone at depths shallower than c. 4 seconds at the western end of Line 1, the hanging wall of the Abattoir shear zone in Line 4, and the Zuleika shear zone in Line 5.

This preliminary interpretation suggests that most of the structures identified in map view can be consistently identified in the seismic profiles, down to a maximum depth of approximately 18 km below the currently-exposed crustal level.

Prominent reflectors, with individual thicknesses up to 2 s TWT, can be identified in all images, and help to constrain the main crustal geometry of the area. The correlation with surface and other geophysical data suggests that such reflectors image mafic–ultramafic portions of the Kalgoorlie Group. In the seismic images, these prominent reflectors define open folds that can be readily matched with the corresponding structures drawn of the geological map. Likewise, offsets and truncations of these prominent reflectors constrain the geometry of the major shear zones at depth. Other well-visible reflectors, morphologically similar to those attributed to the Kalgoorlie Group, are imaged in the deeper portions of most lines. Prominent examples of such deep reflectors are imaged at the eastern end of Line 1, in the central portion of Line 2, in the footwall of the Zuleika shear zone, and in the mid- to deep portions of Lines 4, 5 and 6. These strong reflectors may correspond to tectonically-buried portions of the Kalgoorlie Group, implying that the orogenic events produced important duplications of supracrustal units. Alternatively, they might correspond to remnants of the older greenstone stratigraphy, which is preserved in portions of the Kalgoorlie Terrane, or to other units that have not been recognized at the surface.

Most of the shear zones that, at the currently-exposed crustal level, are subvertical, show an overall listric geometry, commonly becoming shallowly-dipping below 2–3 s TWT. One of the most prominent structures in the area, the Zuleika shear zone (Figure 3), is readily identifiable along the western portion of Lines 1, 2, 4 and 6, where it is imaged as an east-dipping listric structure, representing the western boundary of the Kurrawang Formation (e.g. Figure 9). This structure can be generally traced down to the deeper portions of most seismic images. The Zuleika shear zone is locally associated—or displaced by—west-dipping, smaller-scale structures that are generally confined to the upper 2–3 seconds of the seismic images (e.g. Figure 13).

Results from these latest traverses are in substantial agreement with the larger-scale image produced earlier by Geoscience Australia, indicating that the Zuleika shear zone runs subparallel to the Ida Fault, and can be traced down to lower crustal levels. In the upper crust, the Zuleika shear zone is displaced by the west-dipping Bardoc shear zone, as imaged on line one.

Field data indicate that most of the shear zones in the area exploit lithological boundaries, highlighting the role of competency contrast in localizing deformation in upper-crustal environments. Such phenomenon introduces a degree of uncertainty in the seismic interpretation: in most cases it remains unclear to what degree the shape, thickness and other features visible in the images reflect the primary stratigraphic architecture, a tectonic overprint, or a combination of both.

# CONCLUSIONS

This preliminary interpretation of the 2019 Eastern Goldfields seismic survey has provided a broad scale analysis of the area, in an attempt to complement data from other sources and to delineate areas that might be suitable for mineral exploration. The interpretation was conducted with input from GSWA scientists and assisted by the use of maps and shape files provided by GSWA, including gravity, magnetic and geology maps, along with shape files of interpreted regional structures from previous GA seismic surveys. While borehole data was provided within the survey area, it was not suitable for this interpretation and was not used.

Many major features identified on the seismic were able to be correlated with regional structures present on the maps and data packages provided by GSWA. These features include shear zones, anticline and synclinal forms as well as intrusive bodies. An attempt was also made, where possible, to interpret the top and base of the greenstone unit (Kalgoorlie Group?) across the seismic lines.

# REFERENCES

Goleby, B.R., Rattenbury, M.S., Swager, C.P., Drummond, B.J., Williams, P.R., Sheraton, J.W., Heinrich, C.A., 1993. Archaean crustal structure from seismic reflection profiling, Eastern Goldfields, Western Australia. Australian Geological Survey Organisation, Record, 1993/15

GSWA, 2019. DMIRS data delivery system for geophysical grids and geological maps. Data download from www.dmirs.wa.gov.au/gswa and www.dmp.wa.gov.au/geoview.

Interpretation was conducted on a PC using the 'GVERSE Geophysics' program by LMKR, release 2017.2.1.

### *Acknowledgements*

The author and Velseis acknowledge the geological and interpretation input from the following GSWA staff:

| | |
|---|---|
| Lucy Brisbout | Geophysicist – Geologist |
| Klaus Gessner | Manager Lithospheric Architecture Branch |
| Sara Jakica | Senior Geologist |
| Jyotindra Sapkota | Senior Geologist |
| Ivan Zibra | Senior Geologist |

### *Disclaimer*

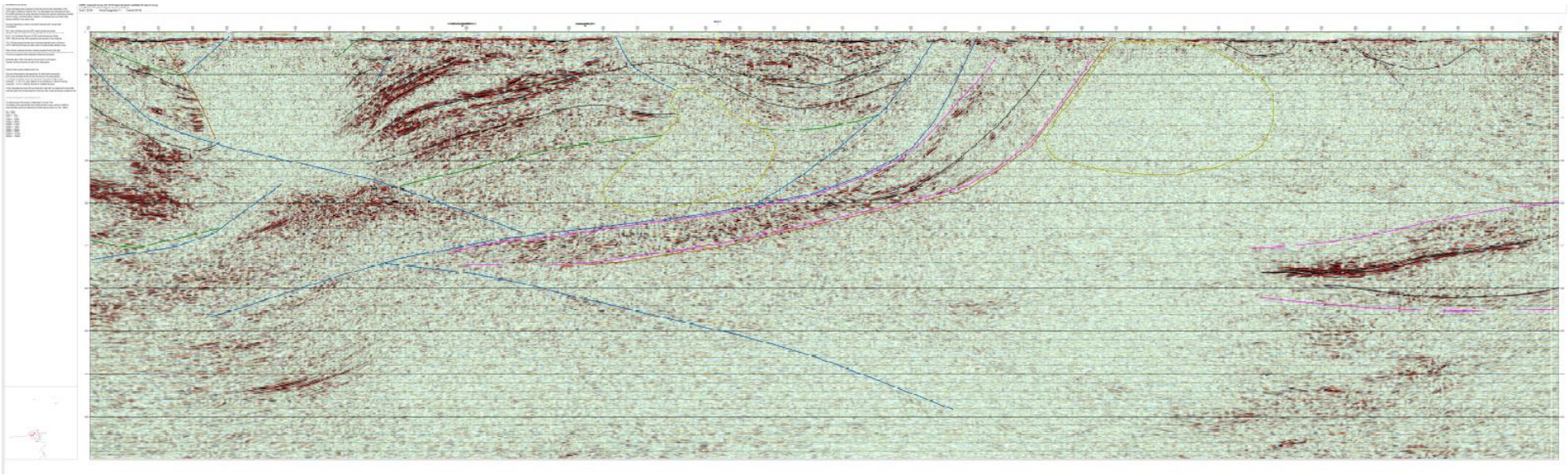
This report has been prepared in good faith and with all due care and diligence. It is based on the seismic and other geophysical data presented and referred to, in combination with the author's experience with the seismic technique, and as tempered by the geological and stratigraphic evidence presented in various forms and through discussions with client representatives.

As such, the report represents a collation of opinions, conclusions and recommendations, the majority of which remain untested at the time of preparation. In the light of these facts it must be clearly understood that Velseis Processing Pty Ltd and its proprietors and employees cannot take responsibility for any consequences arising from this report.

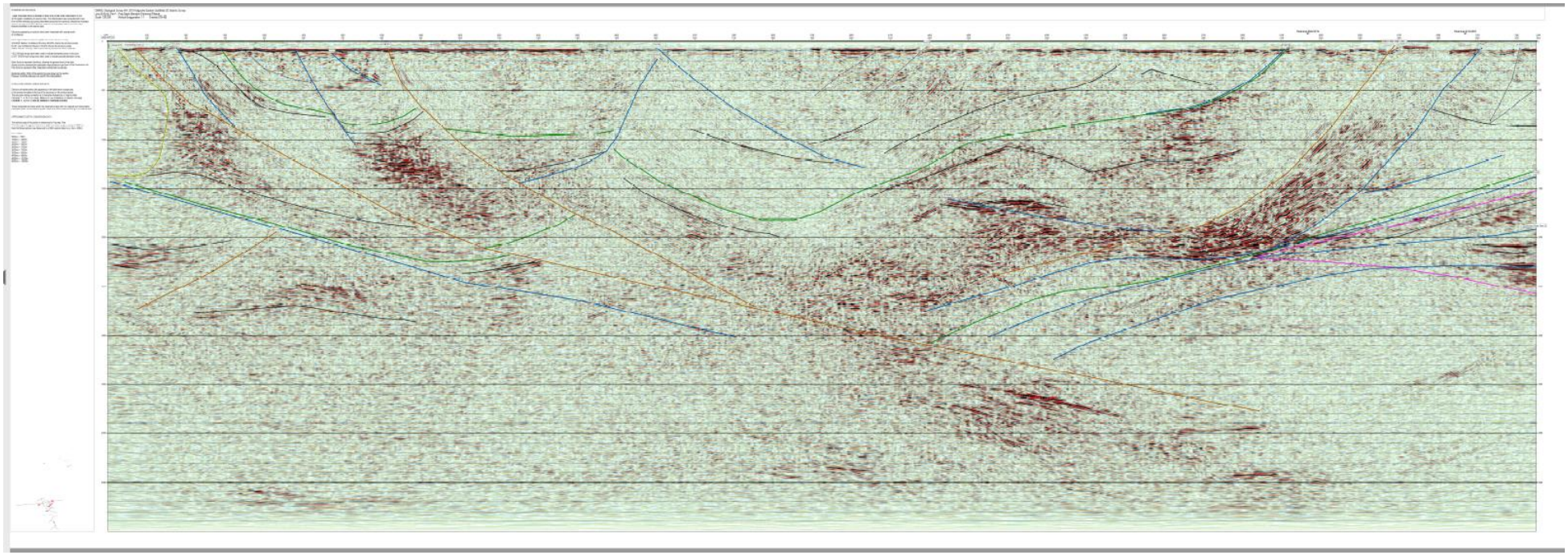
## APPENDIX A INTERPRETED SEISMIC SECTION IMAGES

High-resolution images are provided as separate pdf files accompanying this report.

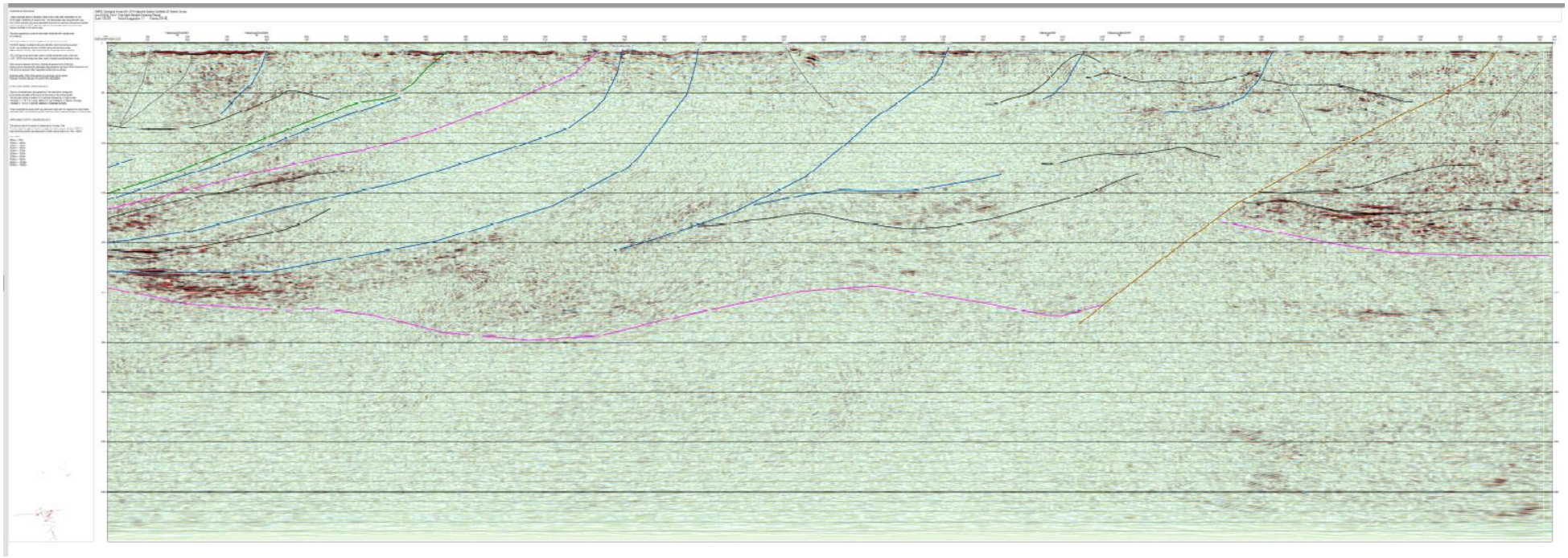
**Line 1:**



**Line 2 (west):**



**Line 2 (east):**



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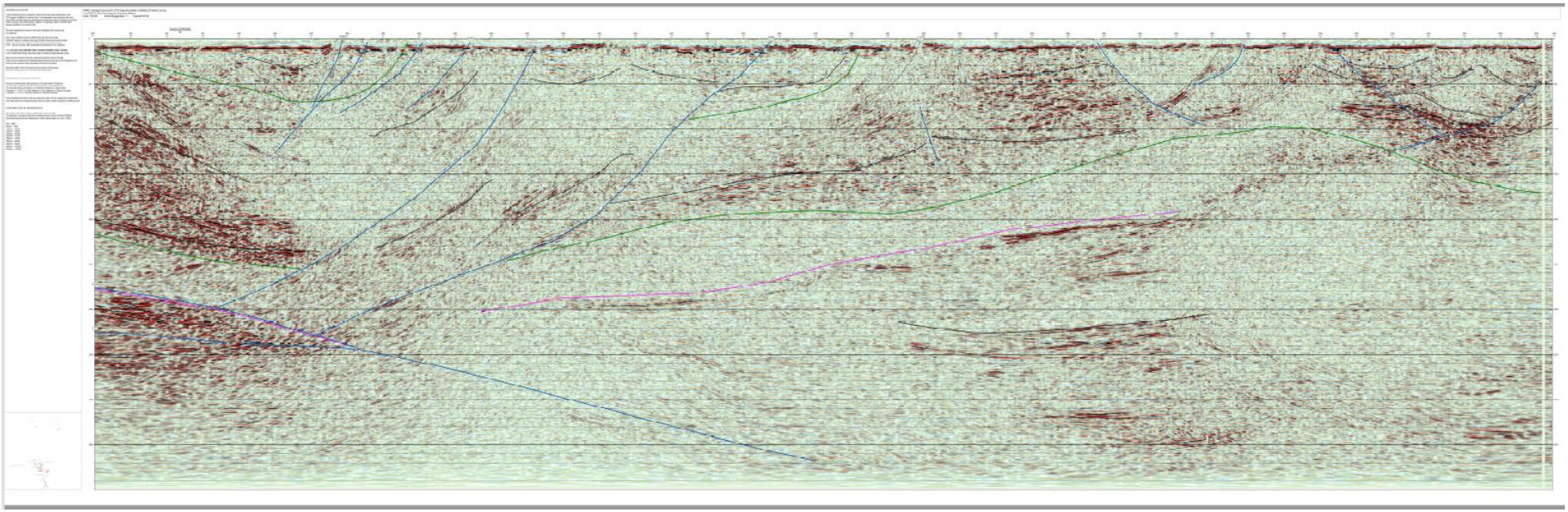
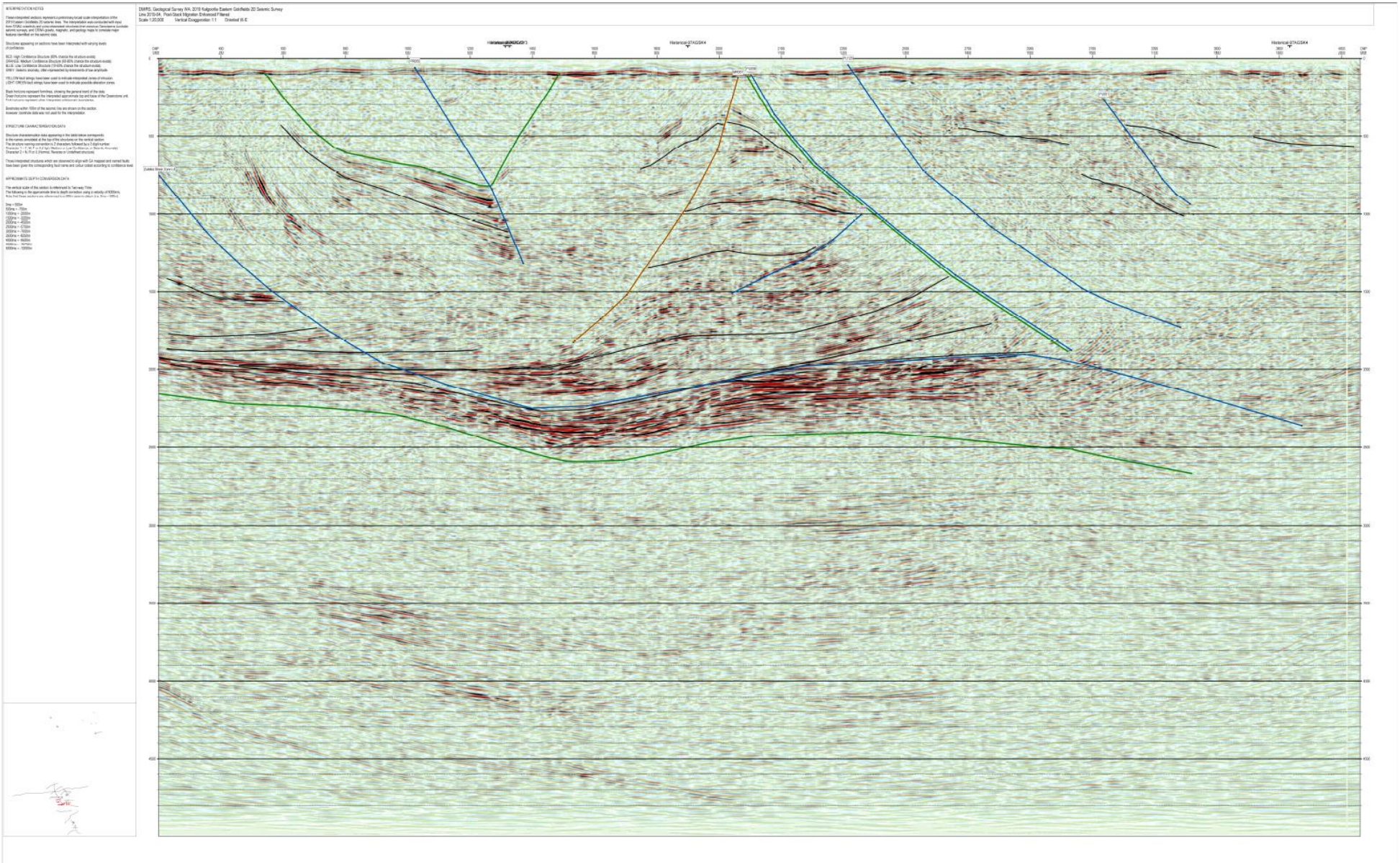
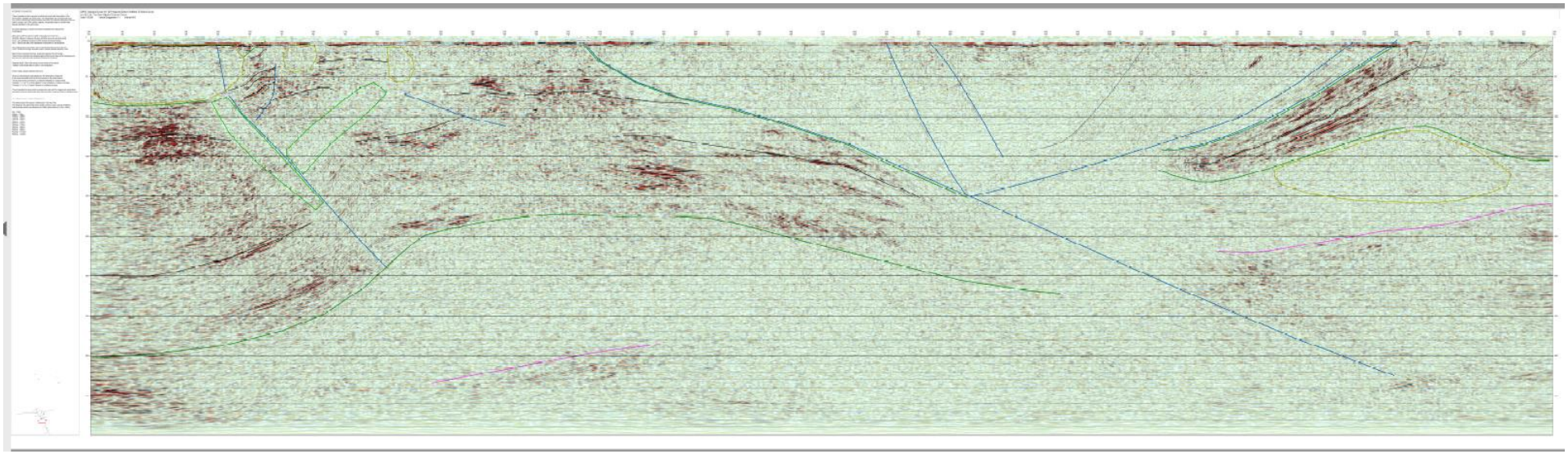


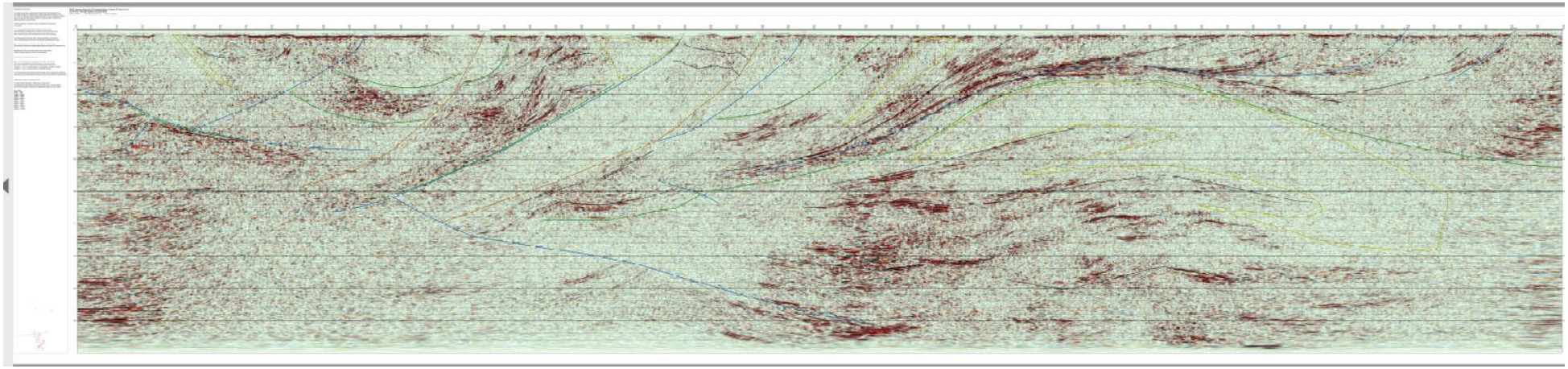
## Line 4:



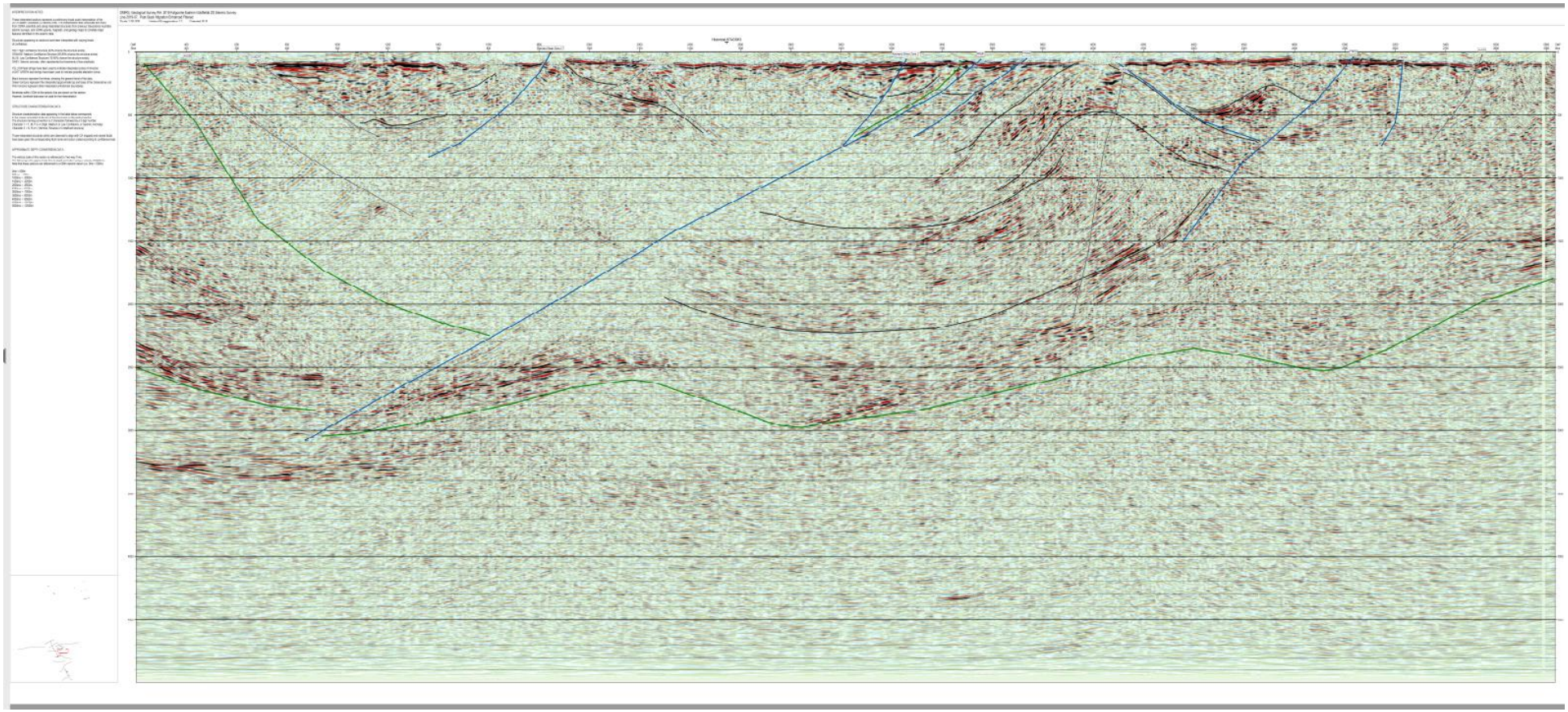
**Line 5:**



**Line 6:**



**Line 7:**



## APPENDIX B RESOLUTION OF SEISMIC INTERPRETATION

### *B.1 Vertical Resolution*

There are a number of quasi-theoretical measures of vertical resolution, which are often used to determine the vertical resolving power of P-wave seismic data.

The 'detectable limit' is defined as the minimum layer thickness required to produce an observable seismic reflection (Sheriff, 1991). This is generally taken to be of the order of $\lambda_D/30$, where $\lambda_D$ is the dominant wavelength of the P wave:

$$\lambda_D = \frac{V_{int}}{f_D}, \qquad \text{B-1}$$

$f_D$ is the dominant frequency of the seismic wave, and $V_{int}$ is the interval velocity of the geological layer being considered. The dominant frequency in a seismic record is equivalent to 1/T, where T is the time between adjacent peaks on a display of the seismic data (Figure B1). Note of course, that detection of a geological layer presupposes a sufficiently strong density and velocity contrast across the layer interfaces.

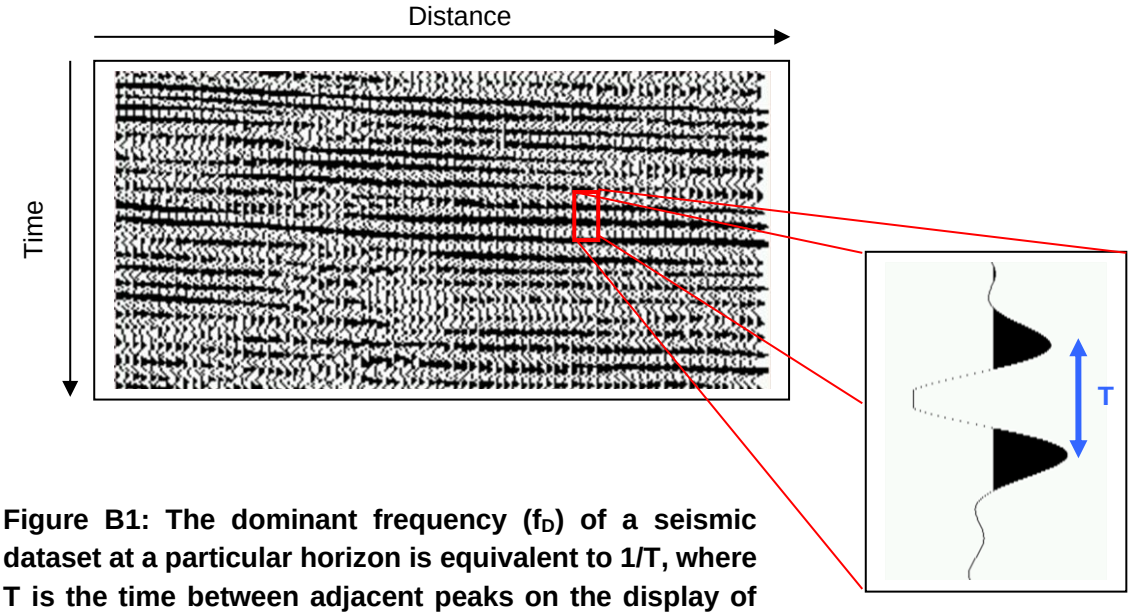



**Figure B1: The dominant frequency ($f_D$) of a seismic dataset at a particular horizon is equivalent to 1/T, where T is the time between adjacent peaks on the display of the seismic reflection event.**

The commonly used 'Rayleigh resolution limit', defined as the minimum separation of discrete seismic reflectors at which one can ascertain more than one interface is present (Sheriff, 1991), is $\lambda_D/4$. The 'Widess limit' is an alternative, and more optimistic definition, which states that two interfaces are resolvable if their separation is greater than or equal to $\lambda_D/8$ (Sheriff, 1991).

Note that these rule-of-thumb measures for P-waves are approximate, and strictly derived for resolution issues relating to layer thickness. Nevertheless, they do provide some indication of the ability of a P-wave section to resolve other geological features (e.g. faults). Obviously these resolution measurements become over-optimistic in the presence of significant noise.

### *B.2 Horizontal Resolution*

For simplicity it is generally assumed that data recorded at a receiver is reflected from a point on a seismic layer. However, in reality a circular zone of data contributes to each reflection event recorded at each receiver (Figure B2) especially for un-migrated data. This zone of reflection is called the Fresnel zone, the size of which governs the horizontal accuracy of structural information that can be acquired from seismic data. The radius of the Fresnel zone is dependent on the reflection depth, frequency content and seismic velocity.

For a P wave the radius of the Fresnel zone ($r_p$) can be approximated by:

$$r_p = ( z \lambda / 2 )^{1/2} \qquad \text{B-2}$$

where: $z$ equals the depth and; $\lambda$ is the wavelength which is given by the average P-wave velocity divided by the dominant frequency

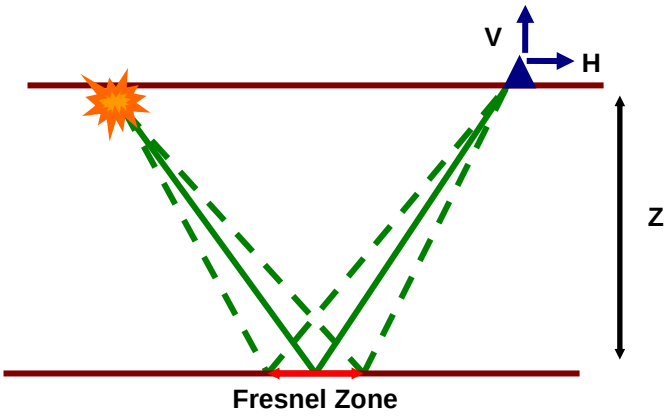



**Figure B2. The horizontal resolution of seismic data is defined by the Fresnel zone. This is the reflection region for each shot and receiver pair.**

## APPENDIX C Glossary

This glossary contains explanations of technical terms and acronyms commonly used to describe seismic processing and interpretation. More comprehensive explanations can be found in standard seismic texts and reference books (e.g. Sheriff, R.E. (1991) Encyclopaedic Dictionary of Exploration Geophysics, Society of Exploration Geophysicists, Oklahoma).

| | |
|---|---|
| 2D | two-dimensional |
| 3D | three-dimensional |
| AGC | automatic gain control; data-dependent scaling designed to normalise trace amplitude within a running time window |
| anisotropy | variation of seismic velocity depending on the direction in which it is measured; a sequence of sedimentary bedding produces polar anisotropy (where seismic velocities are symmetric about the bedding); non-horizontal fracturing and microcracks produces azimuthal anisotropy (where seismic velocities are symmetric about the axis perpendicular to the fracturing) |
| bandpass filtering | attenuation of seismic energy outside of a user-defined frequency bandwidth |
| CMP stacking | the summation of all traces within a CMP gather |
| common midpoint (CMP) gather | the set of seismic traces that share the same midpoint between their sources and receivers |
| common receiver gather (CRG) | a collection of seismic traces recorded at the same geophone (receiver) location |
| deconvolution | a process designed to restore a waveshape to the form it had before undergoing a filtering action; applied to seismic reflection data to remove the filtering effect of the earth and so improve the resolution of reflected energy |
| dominant frequency | the predominant frequency of a seismic dataset determined by measuring the time between successive peaks or troughs of the recorded seismic pulse, and taking the reciprocal |
| fold | the multiplicity of data within a CMP gather; that is, the number of traces within a CMP gather that will contribute to the summed trace at that CMP location |
| dominant wavelength | the seismic wavelength associated with the dominant frequency; for P waves, equivalent to Vp divided by the dominant frequency |
| frequency | the repetition rate of a periodic waveform, measured in ‘cycles per second’ or Hertz (Hz) |
| frequency bandwidth | range of frequencies over which the recorded seismic signal has significant power |
| f-xy deconvolution | a random-noise attenuation method typically applied to seismic data following CMP stacking; improves the signal-to-noise ratio of the final stack |
| geometric spreading | see spherical divergence |

| | |
|---|---|
| geophone | the recording device or receiver used to transform seismic energy into an electrical voltage for input into the seismic recording system; a single vertically-oriented geophone is used for conventional seismic acquisition |
| geophone array | a group of geophones arranged in a linear or areal pattern connected to a single recording channel (i.e. the ground motion recorded by each of the geophones within the array is summed to produce just one seismic recording at the particular receiver station); used to discriminate against waves with certain dominant wavelengths and boost the signal-to-noise ratio |
| geophone array length | the distance over which a geophone (receiver) array is planted about a receiver station; typically of the order of 20-30m for petroleum-scale recording and 2-5m for coal-scale seismic recording |
| groundroll | a type of seismic wave that travels along or near the surface of the ground; characterised by relatively low velocity, low frequency and high amplitude; recorded as a steeply dipping, linear event on a seismic shot record; often interferes with desired reflection events |
| instantaneous frequency attribute | the temporal rate of change of the instantaneous phase; generally has a high degree of variation that can often be related to stratigraphy |
| instantaneous phase attribute | a measure of the lateral continuity of events on a seismic section |
| magnitude spectrum | amplitude of seismic recording as a function of frequency |
| migration | a seismic inversion operation involving rearrangement of seismic data samples so that reflections are plotted at their true locations; required where laterally varying seismic velocities and dipping reflectors cause seismic energy to be recorded at relative positions different to their real physical location |
| mute | elimination of unwanted energy from seismic traces; typically used over certain time intervals to remove groundroll or noise bursts out of the final stack |
| normal moveout (NMO) | the variation of the arrival time of reflection energy with offset; NMO corrections compensate for this variation in traveltime so that reflection energy from each geological boundary is properly aligned prior to stacking; for horizontal reflectors, P-wave NMO can be described as hyperbolic |
| offset | the distance from the source point to the receiver location |
| P waves | longitudinal or compressional seismic waves; characterised by particle motion in the direction of travel; acquired using conventional (single-component) seismic acquisition surveys |
| predictive deconvolution | a method of deconvolution that takes advantage of the predictability of surface multiples; provided necessary statistical assumptions are met, predictive deconvolution will remove surface multiple energy at the same time as removing the filtering effect of the earth to produce high resolution seismic reflection events |
| receiver array | see geophone array |

| | |
|---|---|
| reflection amplitude attribute | a measure of the amplitude of seismic energy reflected from a specific geological interface; instantaneous amplitude is the amplitude recorded at the interpreted arrival time of the seismic event; RMS amplitude is the root-mean-square amplitude determined over a window of a specified length centred about the interpreted arrival time of the seismic event |
| reflection gradient attribute | a measure of the rate of variation in arrival time of a seismic event; anomalously high gradients are generally indicative of structures or rapidly varying depths of the reflector being analysed |
| residual static corrections | remnant statics associated with incomplete weathering static corrections |
| resolution | the ability to separate two features which are very close together |
| resolution limit | for discrete seismic reflectors, the minimum vertical separation so that one can ascertain that more than one interface is involved; the commonly used Rayleigh resolution limit is defined as one quarter the dominant wavelength; the Widess limit is defined as one eighth the dominant wavelength |
| S waves | transverse or shear seismic waves; characterised by particle motion perpendicular to the direction of travel; acquired using multi-component (3-C) seismic acquisition |
| seismic attribute | typically refers to some measurement extracted from seismic data beyond conventional reflection two-way time (TWT); typically presented as an auxiliary 2D surface or image; commonly used attributes include reflection amplitude, instantaneous frequency or reflection gradient (dip) (see independent entries for a description of these attributes) |
| seismic waves | sound waves that propagate through the earth |
| seismic modelling | generation of a synthetic seismic record given an earth model |
| seismic reflection | a geophysical method to image the sub-surface using artificially-generated sound waves; typically the arrival times of various seismic waves are used to map sub-surface structure |
| seismic source | an artificial device that releases energy or seismic waves into the ground; typical coal-seismic sources include small dynamite explosions, MiniSOSIE and Vibroseis |
| seismic velocity | the propagation speed of a seismic wave through a particular material |
| shot record | a collection of seismic traces recorded at a number of receivers from the release of seismic energy at a single source location |
| signal-to-noise ratio (S/N) | the ratio of desired signal to all other recorded energy (noise) in a seismic recording; may be difficult to determine in practice |
| spectral whitening | a signal processing procedure whereby all frequency components within a signal bandwidth of a seismic recording are equalised |
| spherical divergence | the decrease in seismic wave strength with distance; caused by seismic waves continually spreading out as they travel through a medium so that energy density decreases |

| | |
|---|---|
| spherical divergence correction | a scaling correction to compensate for decrease in wave strength with distance as a result of geometric spreading |
| stacking | process by which a set of seismic traces are summed |
| static corrections | corrective time shifts applied to seismic data to compensate for the effects of variations in elevation, weathering thickness, weathering velocity or reference to datum; the objective is to determine the arrival times which would have been observed if all measurements had been made on a flat plane with no weathering or low-velocity material present |
| structural interpretation | involves the mapping of geological interfaces and discontinuities (such as faults) via picking of the TWT of seismic reflection energy from target reflectors |
| trim statics | corrective time shifts applied to NMO-corrected CMP gathers prior to stacking; designed to optimally align flattened reflection events |
| TWT | two-way traveltime; refers to the time it takes for seismic energy to travel from the seismic source, down to a reflector, and back to the surface receiver |
| velocity analysis | calculation of a velocity that will accurately compensate for the effects of NMO; typically involves flattening reflection events in a CMP |
| wavelength | the distance (in metres) between two successive similar points on two adjacent cycles of a seismic wave, measured perpendicular to the wave front; often represented by the symbol $\lambda$ |