APPENDIX H
BLAST VIBRATION VULNERABILITY ASSESSMENT

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EDINGLASSIE HOMESTEAD & ROUS LENCH

BLAST VIBRATION VULNERABILITY

ASSESSMENT FOR MT ARTHUR COAL

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EDINGLASSIE HOMESTEAD & ROUS LENCH

BLAST VIBRATION VULNERABILITY

SUMMARY OF FINDINGS

Monitoring of Edinglassie Homestead and a vibration–vulnerable adjacent structure under actual blast vibration loading have shown that it is safe and reasonable to allow blasting levels to be raised so that the peak particle velocity (PPV) of ground vibrations is 10 mm/s and the overpressure of air blast is 133 dBL. The monitoring and analysis also shows that this level is conservative and that the heritage–listed structures should not suffer damage at higher levels.

INTRODUCTION

THE SITE

The historical homestead of Edinglassie and the nearby Rous Lench cottage lie on the north–western side of Denman Road, approximately 7 km south west of Muswellbrook. Both groups of buildings, which have been on the same property for many years, are owned by Hunter Valley Energy Coal (HVEC) operator of the Mt Arthur Coal Complex. Both groups of buildings are listed on the NSW State Heritage Register: the listings are reproduced in Appendix A.

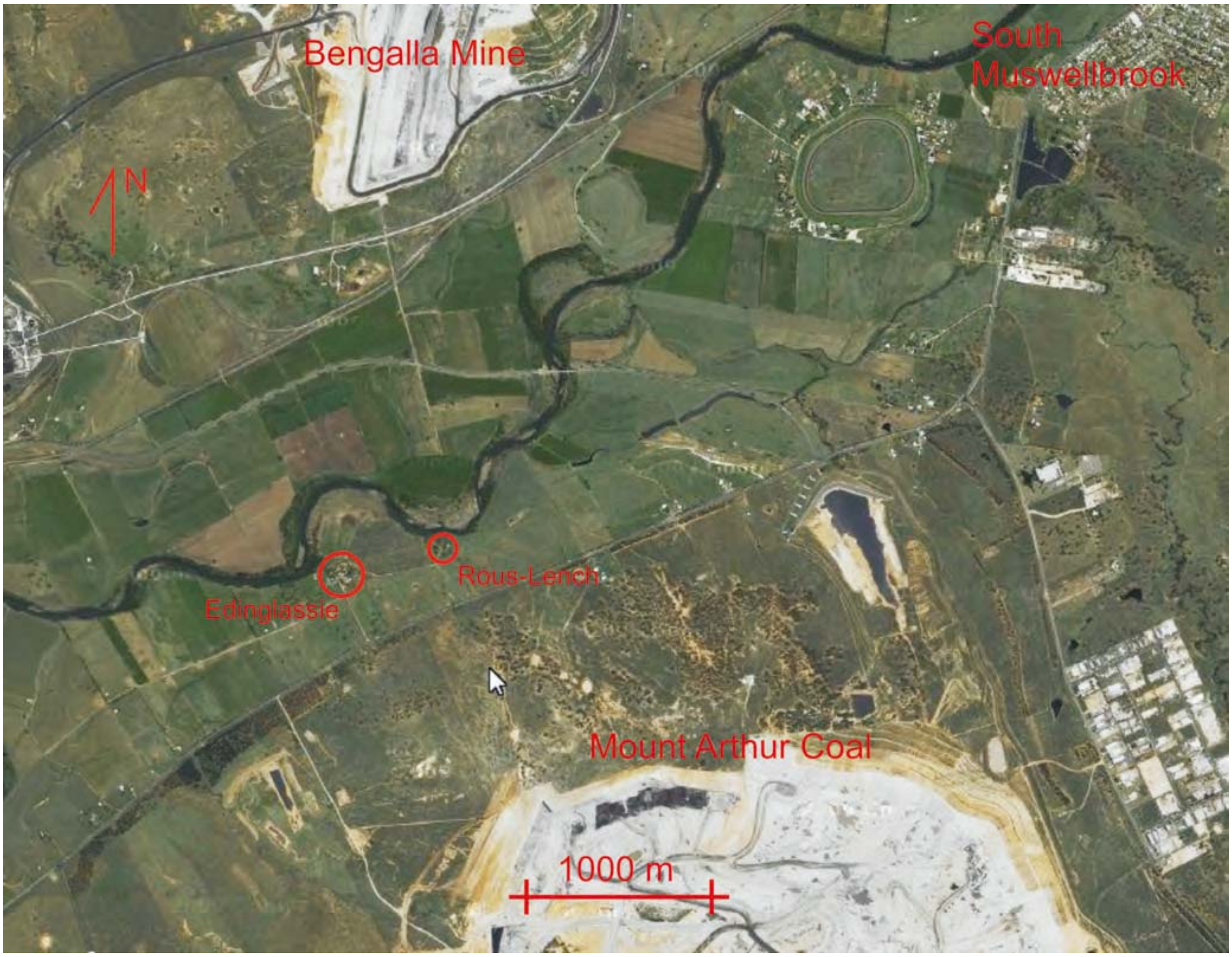

Figure 1: Site locality

Blasting for open–cut coal mining is being carried out at the Mt Arthur Coal Complex and also at the Bengalla Mine to the north. The location of the buildings is shown in Figure 1.

To date, blasting vibration limits have been determined by generic criteria not specifically related to the buildings concerned. The object of the study has been to assess the buildings by inspection, analysis and vibration monitoring to better determine the safe levels of ground vibration.

It is emphasised that the vibration levels determined as a result of this study relate to the building fabric, not to the perceptions of the occupants.

PERSONNEL

The work of engineering assessment and analysis has been carried out by Bill Jordan; the specific vibration monitoring was carried out by Allan Coyne of Datamasters Pty Ltd and the data was analysed by that firm.

MEASUREMENT UNITS

In the discussion which follows, physical units conforming to the SI system are used. The following units are particularly relevant:

- velocity, mm/s, is the principal unit used in vibration monitoring equipment in this project where the principal particle velocity (PPV) is the velocity of the vibration motion as measured by the instrument;
- acceleration, mm/s^2, can be derived from the same instrument by differentiating the data with respect to time—acceleration is relevant to the analysis as the force to which a body is subjected is equal to the acceleration multiplied by the mass of the body;
- the acceleration due to gravity (g) is approximately equal to 9.8 m/s^2—the force applied to a body by gravity is therefore 9.8 × m, where 'm' is the body's mass in kg, so a mass of 1 kg is acted on by gravity with a force of 9.8 Newtons;
- pressure and stress are measured in pascals (Pa) which is equal to the force, in Newtons, applied over an area divided by the area in m^2—stress is normally quoted in millions of pascals, or megapascals (MPa).

METHODOLOGY

BACKGROUND

Blast vibration limits

The following publications appear to form the basis for the setting of vibration limits in use at present:

- AS 2187.2—2006 (or particularly its predecessor, AS 2187.2—1979), "Explosives—Storage and use, Part 2: Use of Explosives",
- Australian and New Zealand Environment Council, "Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration", September 1990 (ANZEC 1990).

Since the existing limits were set, further publications have been issued which are relevant and likely to be considered in any future approvals, in particular "Assessing Vibration: a technical guideline, Department of Environment and Conservation NSW, February 2006 (DEC 2006).

Of particular note from all these publications is that the limits have all been based on human response to vibration, not building response. For example, the ANZEC 1990 guideline states:

The recommended criteria apply only to the minimisation of annoyance and discomfort arising from blasting.

Similarly, the more recent DEC 2006 publication states:

This guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. It does not address motion sickness, occupational vibration, blasting vibration effects or vibration-induced damage to buildings or structures.

AS 2187.2—2006 does address damage limits in the "Informative" appendix (i.e does not form part of the Standard as a "Normative" appendix does), Appendix J, but does not distinguish between normal buildings and sensitive or heritage buildings. The previous edition (1979) suggested a PPV limit of 5 mm/s for heritage buildings, but without any justification.

Overseas standards such as the United States (USBM) RI 8507, the British BS 7385–2 and German DIN 4150 have some applicable limits. One of the key features in these standards, now recognised in AS 2187.2, is that the limits are frequency dependent: In AS 2187.2—2006 the frequency dependent vibration limits from BS 7385–2 are given in Figure J4.4.2.1 and those from (USBM) RI 8507 in Figure J4.4.2.2. Whilst heritage buildings are not dealt with specifically in these standards, it is notable that the most stringent case in BS 7385–2 is for a PPV of 15 mm/s at 4 Hz, rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz; the most stringent condition in (USBM) RI 8507 has similar frequency limits but starts at a lower PPV with a "plaster" cosmetic limit of 12.7 mm/s from 2.5 Hz to 10 Hz, before rising to a PPV of 50 mm/s at 40 Hz also.

Application of limits

One key factor in all these limits is that they apply either to maintaining comfort levels for occupants or guard against even the slightest cosmetic damage in a pristine occupied building. The limits have also been set with no consideration for the vulnerability of a particular building and are therefore an envelope of a "worst case" scenario: the "worst case" would be when the vibration frequencies generated by a blast coincide with resonant frequencies in the building, leading to substantial amplification.

The application of these standards has been explored in a recent paper[1]. The work leading to that paper entailed detailed finite element structural modelling, but with limited monitoring of buildings. The vibration modelling system and analysis capability available at Edinglassie allowed an extension of that work whereby the induced vibrations of elements of the building could be directly measured. This has led to more robust results in assessing the vulnerability of the buildings.

SITE SPECIFIC CONSIDERATIONS

Monitoring equipment

The vibration effects on buildings result both from ground vibrations and air blast: the air blast occurs at some time after the ground vibration wave, depending on the distance to the blast site. The monitoring equipment measures the ground vibration by a geophone operating in three axes (longitudinal, tangential and vertical) and the air blast uses a pressure sensor to record the air overpressure. The ground vibration is recorded in velocity units (mm/s) and the air blast in pressure units (Pa): for both the sampling interval is 2 ms (milliseconds).

At Edinglassie there are two monitoring stations set up, one at the front (south–east) of the house oriented towards the Mt Arthur Coal Mine blast sites and one to the north of the house oriented towards the Bengalla Mine blast sites. Both stations are operated by the same company, Datamasters, and data from both were available for this study.

Rous Lench is located approximately 600 m to the east of Edinglassie. It has no separate monitoring station, but the distances to the blast sites are similar to those of Edinglassie and using the same ground vibration and air blast data is justifiable.

Vulnerability of structures and building elements

As noted above, the vulnerability to vibration of structures and elements of buildings is greatest when the frequency of the applied vibration is close to a resonant vibration in the structure. For typical building elements which are made from uniform materials some of the critical vibration frequencies are listed in Table 1[2].

1 Jordan, JW, Sutcliffe D and Mullard J, *Blast Vibration Effects on Historical Buildings*, Australasian Structural Engineering Conference, Melbourne, June 2008 (since revised to be published in the Australian Journal of Structural Engineering)..

2 Calculations using formulae in Young CY, Budynas RG, *Roark's formulas for stress and strain*, 7th edition, McGraw-Hill; 2002

TABLE 1				
Typical resonant frequencies of building elements				
Element	Size (L x H x t), m	Support conditions ('F' fixed, 'S' simply supported)	Fundamental frequency, Hz	Comments
Stone wall	5 x 3.5 x 0.46	3F, 1S	50	Typical 1st floor, Edinglassie
"		4F	60	Typical ground floor
"			Smaller rooms will have higher resonant wall frequencies	
Brick wall	3 x 3 x 0.23	3F, 1S	53	Typical upper floor, servants' quarters, and Rous Lench
"	3 x 3x 0.23	4F	39	Typical ground floor, servants' quarters
Glass pane	0.3 x 0.3 x 0.003	4S	164	Typical in multi-pane window
"	0.85 x 0.92 x 0.003	4S	19	Typical window pane in Edinglassie (vulnerable)
	0.85 x 1.5 x 0.003	4S	14	French window in Edinglassie

The initial assessment indicated that large floor/ceiling systems in Edinglassie would have low resonant frequencies and that the brick tank stand was of dimensions that might also result in low resonant frequencies. These elements were not suitable for simple calculation as shown in the table and structural models were used to determine their likely behaviour as set out below. In particular the ceiling above the ground floor games room was chosen as it was one of the largest in the building and had a plaster finish: many others in the building have a less vulnerable pressed metal ("Wunderlich") finish.

MEASUREMENT AND MODELLING

As a full measured drawing of the buildings was not available, an assessment was made to obtain general dimensions, then detailed measurements were obtained of those elements of the buildings and structures which the initial assessment suggested may be critical. In the case of the floor/ceiling structure in Edinglassie, the room was measured, the floor joists were measured and their timber species identified (Douglas Fir), and the type and likely materials of the ceiling and flooring measured and identified. In the case of the brick tank stand detailed measurements of the brickwork and its thicknesses were obtained and the brick type identified. Measurements were undertaken both with a steel tape and a laser rangefinder.

The structural modelling procedure is described below.

DESCRIPTION OF BUILDINGS

Edinglassie

HOMESTEAD

The Edinglassie Homestead buildings consist of:

- the two–storey stone masonry main homestead building;
- the adjacent two–storey brick masonry servants' quarters, attached to the main building by a bridge at first floor level;
- a nearby brick building, with a iron–plate rivetted water tank on top, thought to formerly have been a dairy; and
- a high brick tank stand to the east of the houses.

The above structures are all of masonry construction, the houses having timber framed corrugated sheet roofs, and are considered to be associated closely with the main building. They are all of a type vulnerable to vibration damage.

OUTBUILDINGS

There are various timber framed farm buildings, of large range in size, farther to the east of the main homestead buildings. The preliminary assessment indicated that there were no parts of these buildings vulnerable to vibration at the low levels being considered and they were not assessed further.

The buildings have been detailed in the 2007 report prepared by Parsons Brinkerhoff[3].

Rous Lench

BUILDINGS

The Rous Lench cottage is a single storey solid brick building with an adjacent brick outbuilding connected by a breezeway: the building and the nearby outbuildings are fully described in the 2007 report prepared by Parsons Brinkerhoff[4].

It was noted during a visit to Rous Lench that much of the brickwork was built using early hand–moulded sandstock bricks, possibly dating from before 1850; also, it could be readily seen where an original "lean–to rear section had been raised and a full roof covering the front and rear sections constructed. The NSW Heritage Register entry is summarised by the statement:

> *The original house was demolished and/or rebuilt when the present Edinglassie was completed in c1895.*
> *It is therefore not likely that Rous Lench is the original homestead.*

It is more likely that the building was modified c. 1895, but that the original fabric of the front rooms was largely preserved.

The adjacent brick outbuilding appears to date from earlier than the modifications to the cottage and the roof still retains much of the timber shingled covering beneath the corrugated sheeting. Unfortunately, this roof structure has been extensively damaged by termite attack to the point where it could be hazardous, particularly under high winds.

ANALYSIS AND MONITORING

Reaction to vibration of vulnerable elements

As noted above, an initial assessment of the buildings and other structures at Edinglassie and Rous Lench identified those elements which had resonant frequencies in the range expected to be generated by the blast wave, typically 5 Hz to 20 Hz. The elements were measured and their construction materials assessed; the key ones were then modelled elastically to determine their resonant frequencies using formulae for uniform elements such as window panes and detailed structural modelling using the program "Microstran" for other elements and structures. The elements chosen for detailed monitoring, each of which had resonant frequencies in the 10 Hz to 20 Hz range, were chosen as:

- the brick tank stand;
- one of the large floor/ceiling systems where the ceiling was the more vulnerable plaster (others were pressed metal); and
- window panes in the main house.

The analysis of the brick tank stand showed three modes of vibration below 20 Hz. Figure 2 shows the first mode of vibration, which is the lowest frequency for which the structure has a natural mode of vibration. This structure, and most others, also have higher modes of vibration, or higher frequencies at which the structure vibrates with a more complicated pattern. Most energy is dissipated in the first one or two vibration modes.

It should be noted that, whilst the analysis indicated 11.5 Hz as the first mode vibration frequency, the actual recorded frequency was approximately 7.5 Hz. The difference is readily explainable by considering that the weight of the water in the tanks was unknown, and not accounted for, and the Young's Modulus of the brickwork was estimated from

3 Parsons Brinkerhoff, Newcastle, *Condition Survey Report for Edinglassie, prepared for BHP Billiton – Mt Arthur Coal Pty Ltd, July 2007.*

4 Parsons Brinkerhoff, Newcastle, *Condition Survey Report for Rous–lench, Denman Rd, Bengalla, NSW, prepared for BHP Billiton – Mt Arthur Coal Pty Ltd, July 2007.*

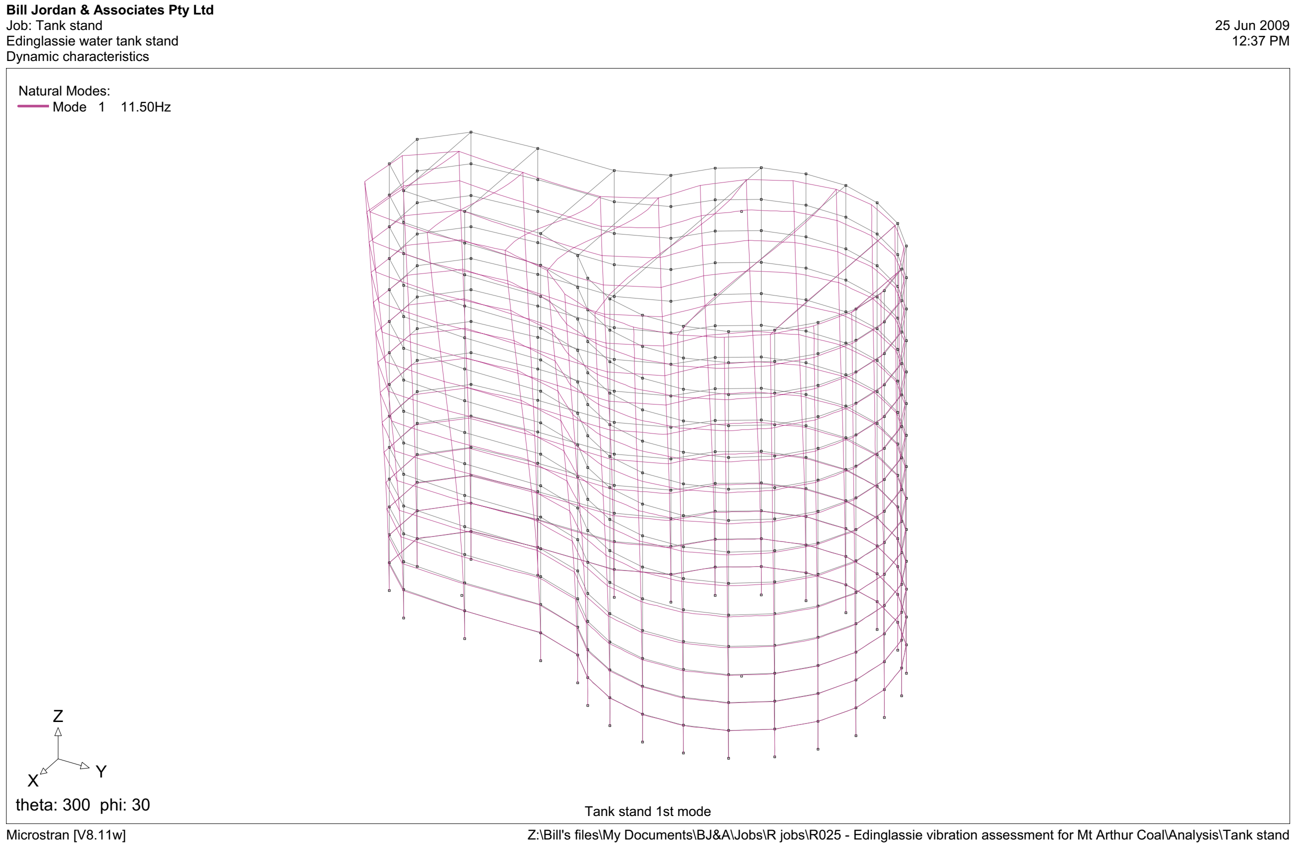

Figure 2: First mode of vibration of tank stand. This motion consists of the narrow end rocking sideways. Higher frequency modes consist of the two cylinders rocking in opposite directions to each other and the whole structure rocking parallel to its main axis.

experience: the weight of an amount of water and a change in the Young's Modulus would result in the measured and calculated frequencies agreeing. Such a calibration process could be done but is not needed for the present study.

The floor and ceiling above the games room in the south-eastern corner of Edinglassie were similarly modelled using measurements of the rooms and identification of the components of the floor system. This analysis showed a number of vibration modes between 10 Hz and 20 Hz.

The window vibration frequencies were calculated as in Table 1.

Generally speaking, Rous Lench does not contain vulnerable fabric, except where it has already been damaged by termite activity. Walls, ceiling and window panes are all considerably smaller than those at Edinglassie and will have resonant frequencies higher than the likely blast vibrations. The brickwork at Rous Lench, being softer than the masonry at Edinglassie, is also more able to absorb vibration energy without damage.

Monitoring

Monitoring using three separate geophone elements was carried out on Thursday 14 May 2009 (the tank stand) and Tuesday 19 May 2009 (the games room in Edinglassie). Figures 3 to 7 show the monitoring setup.

Three blast events were monitored. Using the numbering system used by Datamasters for Mt Arthur Coal monitoring, the events were MAC0NX, a blast at Bengalla Mine on 14 May 2009, MAC0NY, a blast at Mt Arthur Coal a short time later, and MAC0O0, a blast at Mt Arthur Coal on 19 May 2009. The data from the vibrations generated by the Bengalla event, MAC0NX, were were not used for further analysis relating to actions from Mt Arthur Coal events, but the spectrograms from that blast were a good indication of the resonant response of the tank stand and have been used for illustrative purposes below.

Figure 3: The three sensors were set up on top of the brickwork at the narrow end of the tank stand at a location where maximum movement was expected in the first mode vibration.

Figure 4: The recorder at the base of the tank stand had a wireless Internet link to the Datamasters headquarters.

Figure 5: A vertical sensor was set up in the middle of the floor above the games room, rigidly connected to the timber flooring with large nails (the tool box was placed to help secure it).

Figure 6: A horizontally oriented sensor was attached to the middle of a typical window pane facing the blast site.

Figure 7: The second horizontal sensor was attached to the lower pane of a french window facing eastwards.

Measurements

TANK STAND

As illustration of the results, the spectrograms in Figure 8 can be used to show the reaction to the blast of the tank stand. After consideration of the results, it was determined that the spectrograms give the best illustration of the behaviour of the structure. The top spectrogram is from the longitudinal component of the ground station at Edinglassie and shows that the majority of the blast energy in the longitudinal direction (corresponding with the P–wave) is dissipated between 2 and 3 seconds after the blast event at a frequency centred at 17.5 Hz; this produces "ringing" in the first mode of the tank stand at a frequency of 7 Hz which continues for some time after the blast wave has passed.

These spectrograms have been produced by performing progressive Fourier transforms (a mathematical process which resolves the wave recording into a series of sine waves, so allowing the frequencies to be resolved) on succeeding packets of data as the blast progresses. It is considered more relevant than the graph obtained by performing a Fourier transform over the whole wave: such a process, whilst useful, does not account for the blast being made up of a succession of small blasts over a period of time.

Other data gathered can be presented as shown in Figures 9 and 10. The acceleration data is produced by differentiating the velocity data from the instruments; the displacement data is produced by integrating the velocity data.

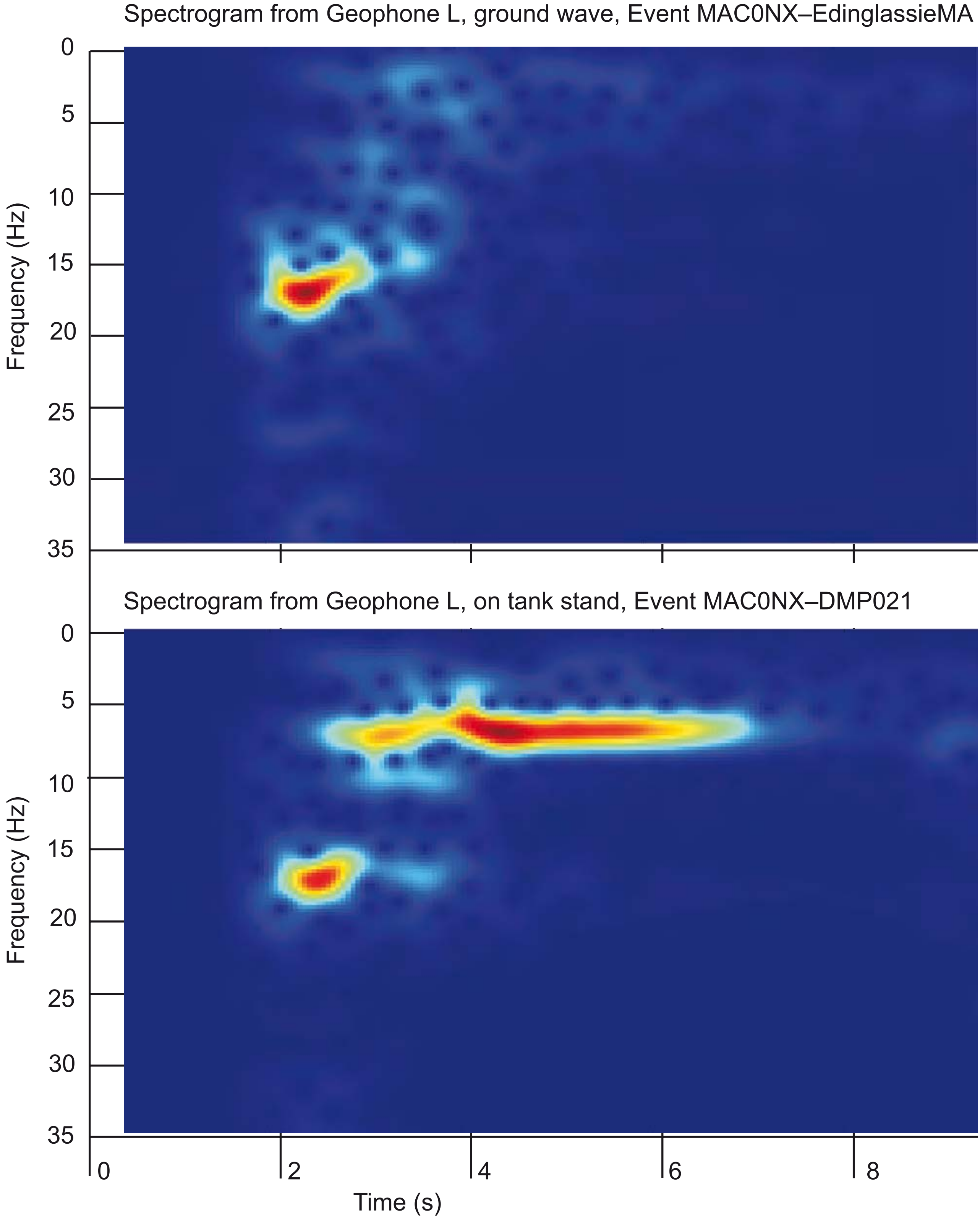

Figure 8: Spectrograms relating to the reaction of the tank stand at its first vibration mode.

VULNERABLE ELEMENTS IN EDINGLASSIE

As seen above, the three geophone elements were separated for the Edinglassie installation. In this location there was noticeable effect on the windows from air blast, and data analysis was extended for the time required to show the air blast effects.

Firstly, it is useful to look at the spectrograms recorded at the permanent station at Edinglassie, seen in Figure 11.

It can be seen that most of the energy is released in the first four seconds at frequencies up to 20 Hz. The area of very low frequency which continues beyond four seconds is particularly seen on the 'T' recording and is therefore mainly

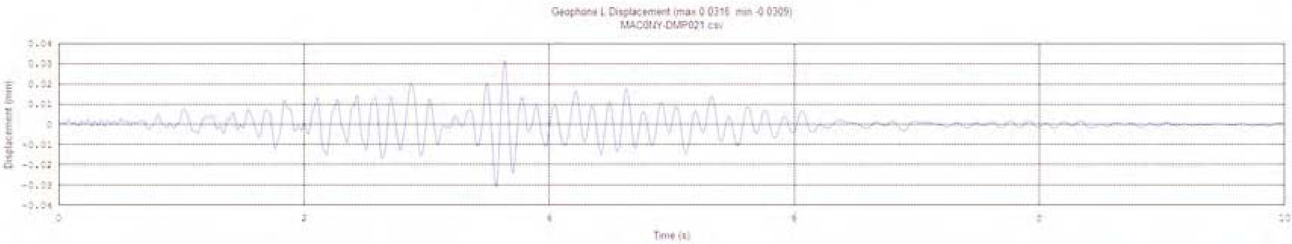

Fig 9 The waveform (PPV) for the longitudinal geophone element mounted on top of the tank stand. The "ringing" of the structure in this mode can be seen clearly and the frequency read directly by counting the number of waves per second. Such ringing did not occur on the other two geophone element recordings.

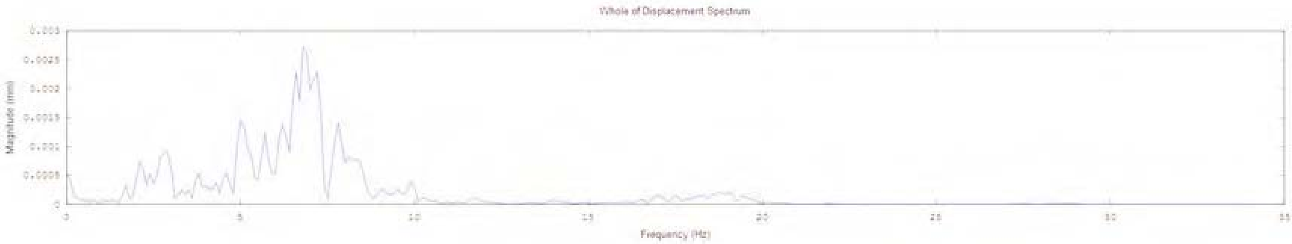

Figure 10: A Fourier transform has been performed on the displacement data (integral of velocity data) to show that the maximum vibratory movement occurs at the resonant frequency, as expected.

attributable to the 'S' wave (ground waves, such as those from earthquake and blast, can be classified into first arrival, or primary, "P–" waves and the second to arrive, secondary , "S–", waves; the P–waves are generally longitudinal and the S–waves generally transverse to the direction of the wave initiator).

The corresponding spectrograms from the recordings of the vibration of the house elements are shown in Figure 12. A description of these spectrograms is given in the captions.

The air blast recorded at the permanent station for the same blast event is shown in Figure 13. It will be noted that the overpressure is recorded in Pascals (Pa) which is readily convertible to the dBL scale.

Analysis

The data was analysed to be able to correlate the PPVs with maximum strains experienced by the structures and components and the maximum accelerations from which the applied force could be determined. As well as the work carried out by Datamasters, further analyses were done using Excel spreadsheets.

The analyses are summarised in Table 2.

Table 2

	Maxima				
Structure/element	from ground station (Edinglassie MA)		from structure (DMP021)		
	Ground PPV (mm/s)	Overpressure (Pa, dBL))	PPV (mm/s) on critical axis	Acceleration (mm/s^2)	Deflection (mm)
Tank stand	0.546	–	0.762	40	0.024
Edinglassie floor/ceiling	0.554	–	2.63	284	0.027
Edinglassie Window 1	–	4.0, 106	4.18	766	0.061
Edinglassie Window 2	–	4.0, 106	12.7	1451	0.225

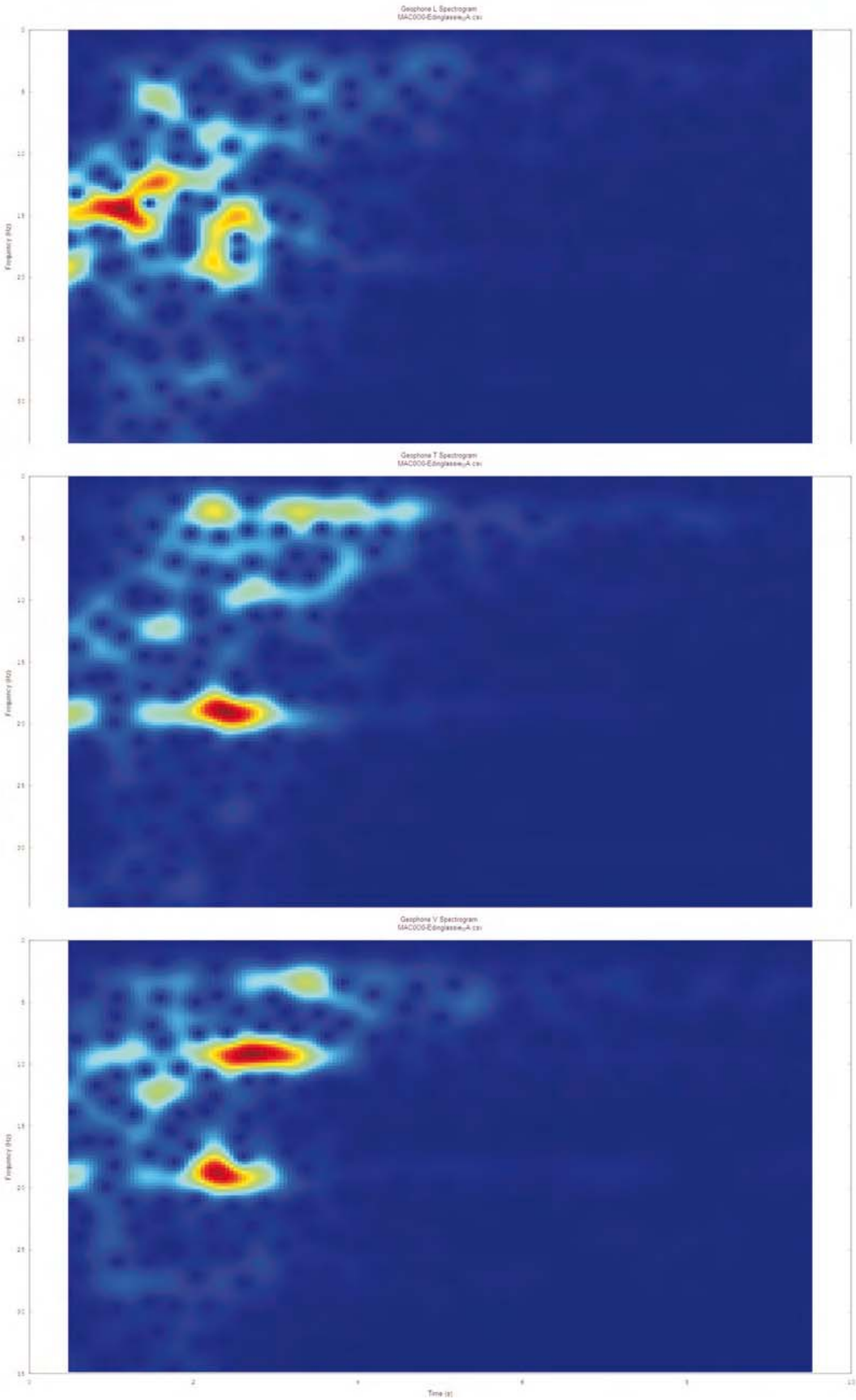

Figure 11: The three spectrograms from the main recorder at Edinglassie for the same blast (MAC0O0) for which the building elements were monitored. From top to bottom the geophone components are L, T and V.

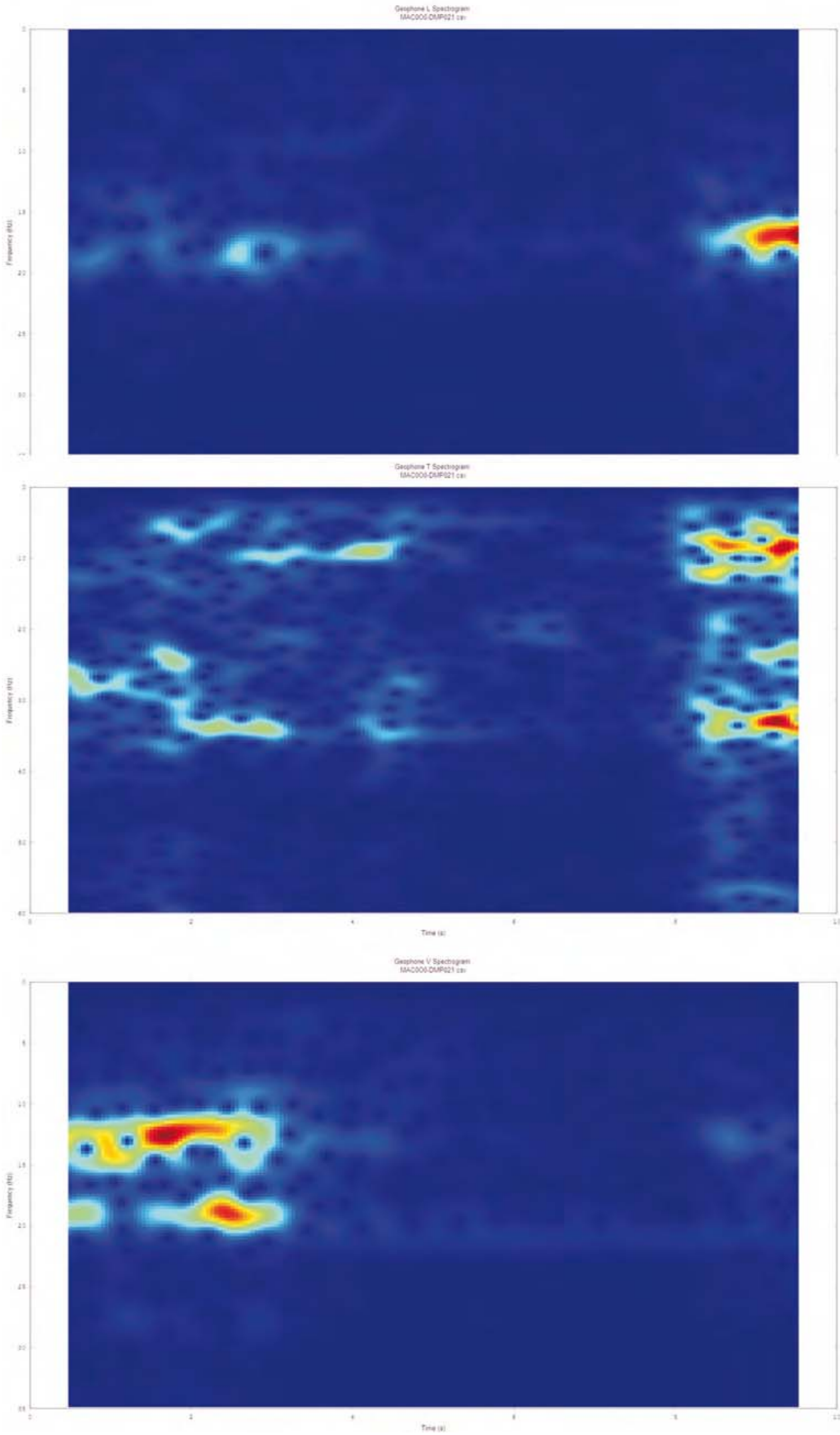

Figure 12: Spectrograms for the vibration of the building elements, from top to bottom Window 1 (typical sash window pane), Window 2 (large pane of french window) and floor. Window 1 is principally affected by the air blast at >8 seconds with a resonant frequency around 18 Hz (c.f. Table 1); Window 2 is again mainly affected by the air blast with two resonant modes reflecting a more complex behaviour than considered in the simple formula used for Table 1. The floor is affected by the ground wave and has two resonances, centred on 13 Hz and 19 Hz, which is in line with predictions.

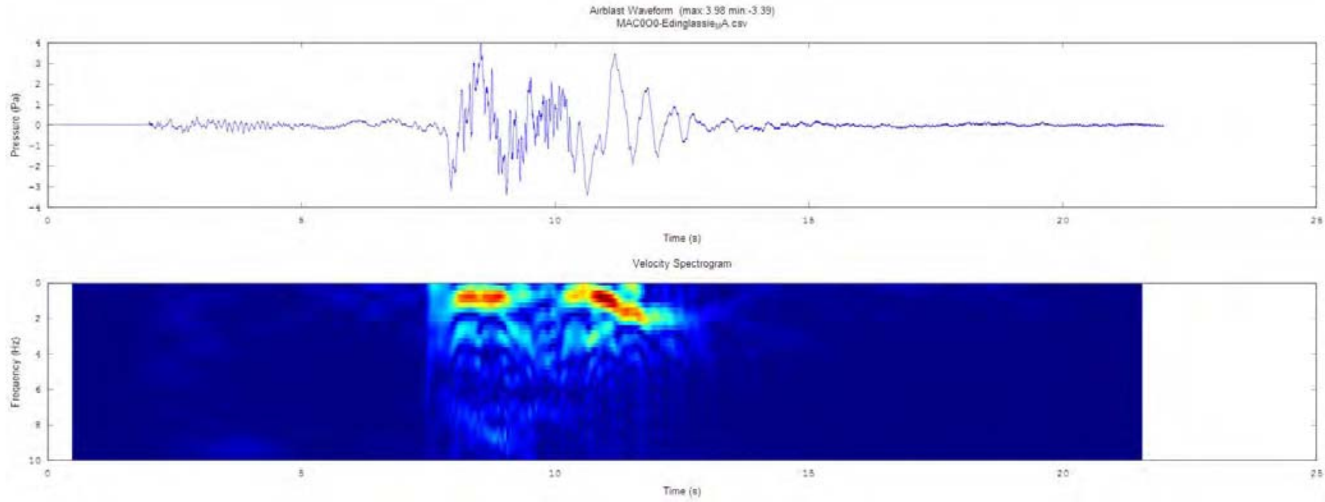

Figure 13: Pressure wave recording and spectrogram of air blast from event MAC0O0. It can be seen that the maximum overpressure is 4 Pa (equivalent to 106 dBL) and that most of the energy is dissipated below 2 Hz; this means that, in effect, the windows are not being acted on by a vibrational force from air blast as their natural frequencies are considerably higher than the applied actions

Whilst the two blasts for which the data has been obtained are considerably lower in intensity than the intended future blasts, in accordance with structural principles the results can be scaled linearly providing the structural reaction stays within elastic limits. The stresses involved are low enough, even with fragile masonry, for this to be the case.

It should be noted that, in the case of the windows, the only relevant recording is that from the air blast as there was no significant reaction to the ground vibration.

Summaries of the monitoring provided by Datamasters are at Appendix B.

INTERPRETATION OF RESULTS

Basis for criteria

Criteria for the limitation of structural damage can be expressed in a number of forms, but the most useful is a form which shows the maximum strain a material can be subjected to without damage. There is little guidance in Australian Standards, so the guidance given has been used, along with published material, to arrive at a realistically conservative figure, consistent with the heritage classification of the buildings.

The Australian Standards which incorporate suggested deflection limits are *Structural design actions, Part 0: General principles* (AS/NZS 1170.0:2002, Appendix C) and those for the design of steel and concrete structures (AS 4100 and AS 3600). In these standards the most severe suggested deflection limit is span/1000, for a beam supporting masonry walls where no provision for movement has been made. AS/NZS 1170.0 also suggests a horizontal deflection limit at the top of a column of column height/500 or a mid–height deflection limit of height/500 where there are brittle finishes. Similar, but slightly less severe provisions have been found in British Standards.

The loads, and hence stress, from the actions can be compared with the materials properties and the standards applicable to them: this is especially applicable to the glass where AS 1288 (Glass in buildings) is applicable.

The other means of determining acceptable criteria are to compare the generated actions with those from normal use. In particular, the pressure generated by winds and the stress resulting from live load actions can be determined and compared with the blast–induced actions.

Brickwork in tank stand

The maximum deflection at the top of the tank stand was 0.025 mm which, when scaled up to the action from a PPV of 10 mm/s results in a deflection of 0.44 mm. The tank stand brickwork is 5.5 m high, so the relative deflection is equivalent to height/12500, which is well within the limits of any possible criterion.

Floor/ceiling system in Edinglassie

The vulnerable component of the floor/ceiling system in Edinglassie is the plaster ceiling. The actions scaled up to a ground PPV of 10 mm/s are:

- deflection = 0.49 mm, equivalent to span/11,000,
- acceleration = 5130 mm/s^2, equivalent to 0.52g.

The acceleration value indicates that the vibration action contributes a load of about half the dead weight of the floor and a small fraction (about 5%) of the likely imposed loads (calculated in accordance with AS 1170.1).

Windows

The windows under air blast action appear to be the most vulnerable elements at Edinglassie and, of these, the large french windows on the eastern side of the building, which used to open onto a first floor verandah, are most at risk from air blast. Nevertheless, at the limits proposed the risk to these windows is negligible.

The following results are applicable:

- 133 dBL is equivalent to 89 Pa;
- design wind pressure (AS 1170.2) = 600 Pa;
- maximum stress in glass at 63 Pa pressure = 5.3 MPa;
- acceptable stress in plain glass (AS 1288) = 61 MPa.

CONCLUSIONS AND RECOMMENDATION

The monitoring and analysis of the effects of blast actions on Edinglassie Homestead show that the building and adjacent structures will not be subjected to stresses or strains likely to cause damage, even when taking into consideration the fragile nature of the historical fabric.

Whilst monitoring of Rous Lench was not carried out, it is generally of a form of construction which is less vulnerable to the type of blast action proposed and is also considered to be safe from damage providing essential repairs of termite damage are carried out.

I recommend that blast vibration limits at Edinglassie and Rous Lench be accepted as:

- ground vibration PPV = 10 mm/s
- air blast overpressure = 133 dBL.

J.W. Jordan FIEAust CPEng

August 2009

APPENDIX A

NSW Heritage Register listings

Click on the BACK button of your browser to return to the previous page.

Edinglassie

Item

Name of Item: Edinglassie
Type of Item: Complex / Group
Group/Collection: Farming and Grazing
Category: Homestead Complex
Location: Lat:150.82904322 Long:-32.30318179
Primary Address: Denman Road, Muswellbrook, NSW 2333
Local Govt. Area: Muswellbrook

Property Description:

Lot/Volume Code	Lot/Volume Number	Section Number	Plan/Folio Code	Plan/Folio Number
LOT	15	-	DP	228159
LOT	141	-	DP	533001
LOT	1	-	DP	601359
LOT	1	-	DP	90622

All Addresses

Street Address	Suburb/Town	LGA	Parish	County	Type
Denman Road	Muswellbrook	Muswellbrook	Brougham	Durham	Primary

Owner/s

Organisation Name	Owner Category	Date Ownership Updated
REMOVE	General	

Statement of Significance

Primary Significance:
The Edinglassie property including the Edinglassie homestead, associated buildings and Rous Lench cottage are closely associated with the earliest European occupation of the area and collectively represent one of the earliest land grants of the initial settlement of the Hunter Valley;

The Edinglassie property demonstrates various phases of human activities such as settlement and clearing, water supply and management, sheep and cattle running, development of specialist cattle breeding activities, recreation, viticulture and horse breeding;

The Edinglassie homestead with its associated outbuildings and Rous Lench cottage are good architectural examples of their type and style;

The Edinglassie property demonstrates an excellent application of the Arcadian design approach to the siting of structures and elements in the landscape which is rare in the region;

Secondary significance:
The place is also significant because:
It is associated with George Forbes, the original grantee, who was one of the 'gentry' settlers in the early settlement of the area;

It is associated with a prominent family, the Whites, a leading pastoral dynasty, who were synonymous with the opening and development of the region;

It illustrates the degree of opulence achieved and lifestyles led by the leading pastoral families in the area;

It is associated with a significant Australian architect, John Horbury Hunt;

It is a well known landmark, and has provided a community focus over a number of generations form the turn of the 19th century;

It has extant and potential intact archaeological evidence capable of helping interpret past occupation and lifestyles of the area (Tropman & Tropman Architects, 1993, 149).

The siting of the homestead is intrinsic to its significance.
Date Significance Updated: 31 Jul 07
Note: There are incomplete details for a number of items listed in NSW. The Heritage Branch intends to develop or upgrade statements of significance and other information for these items as resources become available.

Description

Construction Years: 1880 - 1895

Physical Description: Site/Grounds
The house is approached through original iron gates and through well kept grounds containing many fine mature trees, including some Queensland species brought from other White family properties. The homestead is set back from the access road, and a substantial line of screening trees fronts the entrance. The siting of the homestead is intrinsic to its significance.

House
A 2 storey sandstone house with hipped iron roof of simplified Italianate style built in two stages c1880, and c1895, for James White. Each elevation is assymetrical about a large full height projecting bay with a continuous single storey verandah (originally 2 stories to east and south) supported on cast iron columns stamped `F. REVETT, W. MAITLAND.'

The fourteen principal rooms have a variety of pressed metal ceilings and marble and timber fireplaces whilst the fine joinery throughout is of cedar. All joinery has been sensitively restored.

Outbuildings
A timber bridge links across a large trussed roof breezeway to a 2 storey service wing containing the original kitchen. Close to the house is the fine stables group of buildings designed by Hunt in timber and built in the 1880s. Although lacking in the more exuberant details characteristic of Hunt's work, these buildings nonetheless form a coherent and impressive whole. Other buildings include a meat house, killing shed and dovecote.

Site/Grounds
The house is approached through original iron gates and through well kept grounds containing many fine mature trees, including some Queensland species brought from other White family properties.

Modifications and Dates: 2004 Power line installed across front of property, involving the removal of 3 trees: The proposal involves the removal of 3 trees. An arborist report, submitted as part of the application identifies this fabric as: 1 x yellow box, Eucalyptus melliodora, 40-45 years old, 12 meters high & 2 x Lombardy poplar (Populus nigra 'Italica), native to Italy. 10-14 years old. 5 meters high

Former Use: agriculture

History

Historical Notes:

The land on which both Edinglassie and Rous Lench are located was the original Portion 4 of the Parish of Brougham in the County of Durham. This comprised an area of 1280 acres the deed of grant for which was issued to George Forbes on 1 August 1839. Like many grants of the period the land had been occupied for many years before it was officially surveyed and the deed grant issued.

A 2 storey sandstone house with hipped iron roof of simplified Italianate style built in two stages c1880, and c1895, for James White.

Historic Themes

Australian Theme (abbrev)	New South Wales Theme	Local Theme
3. Economy - Developing local, regional and national economies	Agriculture - Activities relating to the cultivation and rearing of plant and animal species, usually for commercial purposes, can include aquaculture	Clearing land for farming -
3. Economy - Developing local, regional and national economies	Agriculture - Activities relating to the cultivation and rearing of plant and animal species, usually for commercial purposes, can include aquaculture	Growing vines and maintaining vineyards -
3. Economy - Developing local, regional and national economies	Agriculture - Activities relating to the cultivation and rearing of plant and animal species, usually for commercial purposes, can include aquaculture	Experimenting with new breeds of stock -
3. Economy - Developing local, regional and national economies	Agriculture - Activities relating to the cultivation and rearing of plant and animal species, usually for commercial purposes, can include aquaculture	Pastoralism - grazing sheep, cattle, goats or other animals -
3. Economy - Developing local, regional and national economies	Technology - Activities and processes associated with the knowledge or use of mechanical arts and applied sciences	Technologies for reticulated water supply -
4. Settlement - Building settlements, towns and cities	Accommodation - Activities associated with the provision of accommodation, and particular types of accommodation – does not include architectural styles – use the theme of Creative Endeavour for such activities.	Housing farming families -
4. Settlement - Building settlements, towns and cities	Land tenure - Activities and processes for identifying forms of ownership and occupancy of land and water, both Aboriginal and non-Aboriginal	Granting Crown lands for private farming -
8. Culture - Developing cultural institutions and ways of life	Domestic life - Activities associated with creating, maintaining, living in and working around houses and institutions.	Living in a rural homestead -
8. Culture - Developing cultural institutions and ways of life	Leisure - Activities associated with recreation and relaxation	Enjoying public parks and gardens -

Assessment Criteria

Items are assessed against the **State Heritage Register (SHR) Criteria** to determine the level of significance. Refer to the Listings below for the level of statutory protection.

Procedures /Exemptions

Section of Act	Description	Title	Comments	Action Date
57(2)	Exemption to allow work	Standard Exemptions	SCHEDULE OF STANDARD EXEMPTIONS HERITAGE ACT 1977 Notice of Order Under Section 57 (2) of the Heritage Act 1977 I, the Minister for Planning, pursuant to subsection 57 (2) of the Heritage Act 1977, on the recommendation of the Heritage Council of New South Wales, do by this Order: 1. revoke the Schedule of Exemptions to subsection 57 (1) of the Heritage Act made under subsection 57(2) and published in the Government Gazette on 22 February 2008; and 2. grant standard exemptions from subsection 57(1) of the Heritage Act 1977, described in the Schedule attached. FRANK SARTOR Minister for Planning Sydney, 11 July 2008 To view the schedule click on the Standard Exemptions for Works Requiring Heritage Council Approval link below.	Sep 5 2008

Standard Exemptions for Works Requiring Heritage Council Approval

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Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Heritage Act - State Heritage Register		00170	02 Apr 99	27	1546
Heritage Act - Permanent Conservation Order - former		00170	02 Dec 83	167	5449
Regional Environmental Plan	Hunter REP 1989		03 Nov 89	107	9350
National Trust of Australia register	Edinglassie Including gardens, curtilage and adjoi	4033	23 Jun 80		
Register of the National Estate - Interim		00134			

Study Details

Title	Year	Number	Author	Inspected by	Guidelines Used
Section 170 register	1998	42	Pacific Power		Yes

References, Internet links & Images

Type	Author	Year	Title	Internet Links
Written	Hansen Bailey	2007	Bengalla Mining Company European Heritage Management Plan	
Written	Tropman & Tropman,	1993	Edinglassie & Rous Lench - preliminary Conservation	

	Architects		Management Plan		

Note: Internet links may be to web pages, documents or images.

(Click on Thumbnail for Full Size Image and Image Details)

Data Source

The information for this entry comes from the following source:

Name:	Heritage Branch
Database Number:	5045625
File Number:	S90/05833 & HC 32464

Every effort has been made to ensure that information contained in the State Heritage Inventory is correct. If you find any errors or omissions please send your comments to the **Database Manager**.

Rous Lench

Item

Name of Item:	Rous Lench
Type of Item:	Complex / Group
Group/Collection:	Farming and Grazing
Category:	Homestead Complex
Location:	Lat:150.84364889 Long:-32.29787106
Primary Address:	Denman Road, Edinglassie, NSW 2333
Local Govt. Area:	Muswellbrook

Property Description:

Lot/Volume Code	Lot/Volume Number	Section Number	Plan/Folio Code	Plan/Folio Number
LOT	142	-	DP	533001

All Addresses

Street Address	Suburb/Town	LGA	Parish	County	Type
Denman Road	Edinglassie	Muswellbrook	Brougham	Durham	Primary

Owner/s

Organisation Name	Owner Category	Date Ownership Updated
REMOVE	General	

Statement of Significance

Primary Significance:
The Edinglassie property including the Edinglassie homestead, associated buildings and Rous Lench cottage are closely associated with the earliest European occupation of the area and collectively represent one of the earliest land grants of the initial settlement of the Hunter Valley;

The Edinglassie property demonstrates various phases of human activities such as settlement and clearing, water supply and management, sheep and cattle running, development of specialist cattle breeding activities, recreation, viticulture and horse breeding;

The Edinglassie homestead with its associated outbuildings and Rous Lench cottage are good architectural examples of their type and style;

The Edinglassie property demonstrates an excellent application of the Arcadian design approach to the siting of structures and elements in the landscape which is rare in the region;

Secondary significance:

The place is also significant because:
It is associated with George Forbes, the original grantee, who was one of the 'gentry' settlers in the early settlement of the area;

It is associated with a prominent family, the Whites, a leading pastoral dynasty, who were synonymous with the opening and development of the region;

It illustrates the degree of opulence achieved and lifestyles led by the leading pastoral families in the area;

It is associated with a significant Australian architect, John Horbury Hunt;

It is a well known landmark, and has provided a community focus over a number of generations form the turn of the 19th century;

It has extant and potential intact archaeological evidence capable of helping interpret past occupation and lifestyles of the area (Tropman & Tropman Architects, 1993, 149).

The siting of the homestead is intrinsic to its significance.
Date Significance Updated: 31 Jul 07
Note: There are incomplete details for a number of items listed in NSW. The Heritage Branch intends to develop or upgrade statements of significance and other information for these items as resources become available.

Description

Physical Description: The homestead is a low cottage constructed of rendered brick and corrugated iron featuring a roof ridge extended to form small gables, four panel doors, large four-pane sash windows, panelled ceilings, and gunstock stiles on French windows at the side. A photograph dating from the 1880s showing the first part of Edinglassie adjacent to an earlier hipped roof house indicates that the original house was demolished and/or rebuilt when the present Edinglassie was completed in c1895. It is therefore not likely that Rous Lench is the original homestead.

Architectural Style: Italianate.

Building Material: Sandstone, iron roof

Modifications and Dates: The original house was demolished and/or rebuilt when the present Edinglassie was completed in c1895. It is therefore not likely that Rous Lench is the original homestead.

Former Use: agriculture

History

Historical Notes: The land on which both Edinglassie and Rous Lench are located was the original Portion 4 of the Parish of Brougham in the County of Durham. This comprised an area of 1280 acres the deed of grant for which was issued to George Forbes on 1 August 1839. Like many grants of the period the land had been occupied for many years before it was officially surveyed and the deed grant issued.

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Architectural Style: Italianate.

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4. Settlement - Building settlements, towns and cities	Land tenure - Activities and processes for identifying forms of ownership and occupancy of land and water, both Aboriginal and non-Aboriginal	Granting Crown lands for private farming -

Assessment Criteria

Items are assessed against the **State Heritage Register (SHR) Criteria** to determine the level of significance. Refer to the Listings below for the level of statutory protection.

Recommendations

Management Category	Description	Date Updated
Recommended Management	Review a Conservation Management Plan (CMP)	
Recommended Management	Prepare a maintenance schedule or guidelines	

Procedures /Exemptions

Section of Act	Description	Title	Comments	Action Date
57(2)	Exemption to allow work	Standard Exemptions	SCHEDULE OF STANDARD EXEMPTIONS HERITAGE ACT 1977 Notice of Order Under Section 57 (2) of the Heritage Act 1977 I, the Minister for Planning, pursuant to subsection 57 (2) of the Heritage Act 1977, on the recommendation of the Heritage Council of New South Wales, do by this Order: 1. revoke the Schedule of Exemptions to subsection 57 (1) of the Heritage Act made under subsection 57(2) and published in the Government Gazette on 22 February 2008; and 2. grant standard exemptions from subsection 57(1) of the Heritage Act 1977, described in the Schedule attached.	Sep 5 2008

			FRANK SARTOR Minister for Planning Sydney, 11 July 2008 To view the schedule click on the Standard Exemptions for Works Requiring Heritage Council Approval link below.	

Standard Exemptions for Works Requiring Heritage Council Approval

Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Heritage Act - State Heritage Register		00211	02 Apr 99	27	1546
Heritage Act - Permanent Conservation Order - former		00211	26 Aug 83	120	3980
Regional Environmental Plan	Hunter REP 1989		03 Nov 89		
National Trust of Australia register	Edinglassie Including gardens, curtilage and adjoi	4033	23 Jun 80		

References, Internet links & Images

Type	Author	Year	Title	Internet Links
Written	Hansen Bailey	2007	Bengalla Mining Company European Heritage Management Plan	
Written	Tropman & Tropman Architects	1993	Edinglassie & Rous Lench - preliminary Conservation Management Plan	

Note: Internet links may be to web pages, documents or images.


PLAN
UNDER THE
HERITAGE ACT.
1977

(Click on Thumbnail for Full Size Image and Image Details)

Data Source

The information for this entry comes from the following source:

Name: Heritage Branch

Database Number: 5045629

File Number: S90/05440 & HC 32806

Every effort has been made to ensure that information contained in the State Heritage Inventory is correct. If you find any errors or omissions please send your comments to the **Database Manager**.

APPENDIX B

Monitoring reports and analyses from Datamasters Pty Ltd

Results for Blast MAC0O0-DMP021; Edinglassie House

The following details the geophone measurements for Mt Arthur Coal blast MAC0O0-DMP021 as measured at the Edinglassie homestead. Each geophone sensor was placed in a unique location to record a particular axis of movement rather than the usual method of a tri-axial geophone package recording all three axes at once location.

Channel T: Window 1

Channel L: Window 2

Channel V: Floor

Plots

The waveforms presented on each page are as follows:

Waveform Plots

Plot 1 - Waveform: Raw velocity waveform as detected by the geophone and recorded by the Dynamate.

Plot 2 - Spectrogram: This is a series of short Fourier transforms of the velocity waveform for a segment of 1000 milliseconds worth of samples (500 samples worth at 500 samples/sec) slid along in time to the right at 50 millisecond intervals. The Y axis is frequency and the X axis is time. The colour represents intensity where dark red is the strongest signal and dark blue the weakest. The colour map is scaled to fit between the absolute maximum and minimum for the entire transformed dataset. Each FFT has a Blackman window applied to reduce spectral leakage.

The spectrogram shows how the relative amplitudes of the frequency content varies with time through the waveform and can help determine the frequency content of the signal at any particular time.

Plot 3 – Whole of waveform Fourier transform: This plot is the Fourier transform of the entire captured signal. Each frequency bin holds the relative amplitude for each frequency's contribution for the whole waveform so shouldn't be used to measure any absolute peak amplitude. To measure absolute peak amplitudes a short FFT must be performed over the interval of interest. No window has been applied prior to the transform being performed.

Displacement Plots

Plot 1 - Waveform: This plot contains the integral of the velocity waveform to produce a displacement. The cumulative trapezoid method was used to derive this data. The result was divided by the sample rate to scale the amplitude correctly.

```
DisplacementWaveform = 1/Fs * cumtrapz(VelocityWaveform)
```

Due to ADC conversion there is an intrinsic DC offset contribution due to least significant bit noise in the ADC conversion process. This is DC error insignificant for raw waveform velocity measurements but does manifest itself in the integration as a curve or slope superimposed on the rest of the waveform resulting in the displacement plot not being centred on the zero axis.

Depending on the maximum amplitudes recorded in the waveform two approaches can be used to rid the velocity data of the DC component. The first is to compute the mean value of the total velocity waveform and subtract this mean from all values in the velocity waveform to remove the DC component prior to integration. Small amplitudes (less then 2.2mm/s) respond well to the mean subtraction method. Blasts MAC0NX and MAC0NY had small velocity waveforms and their displacement integration responded well to the subtraction of the mean.

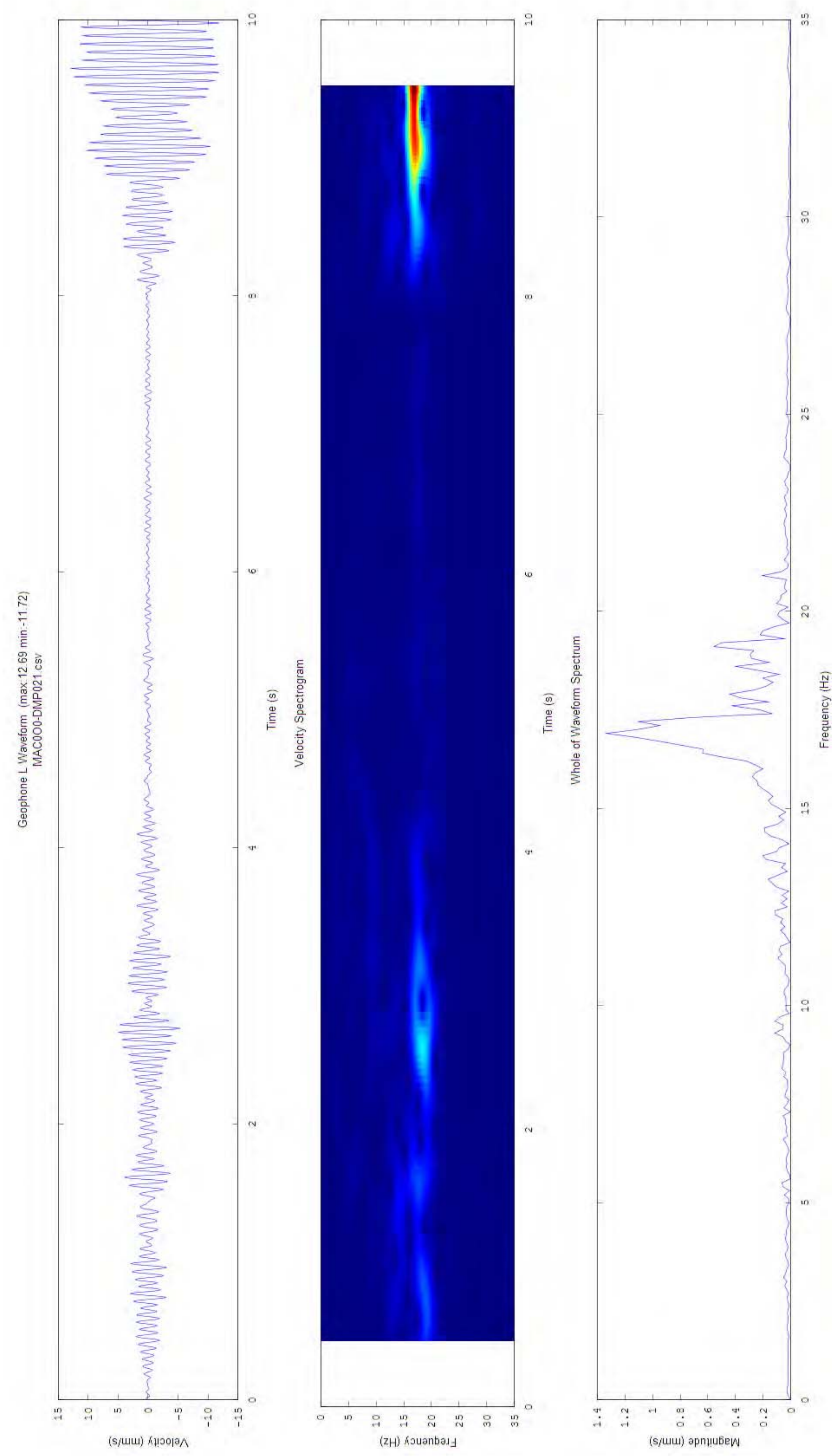
Alternatively a high pass filter can be applied to remove DC and low frequency components where the subtraction of the mean does not work effectively.

The larger magnitude velocity waveforms from MAC0O0 required a high pass filter to remove the DC component prior to integration. A filter with a -6dB corner at 1Hz effectively removes residual DC component and attenuates signals with decreasing magnitude from DC to 6Hz. From 6Hz onwards the response of the filter is flat. The magnitude and phase plot for the high pass filter used on this data set can be seen on page 12.

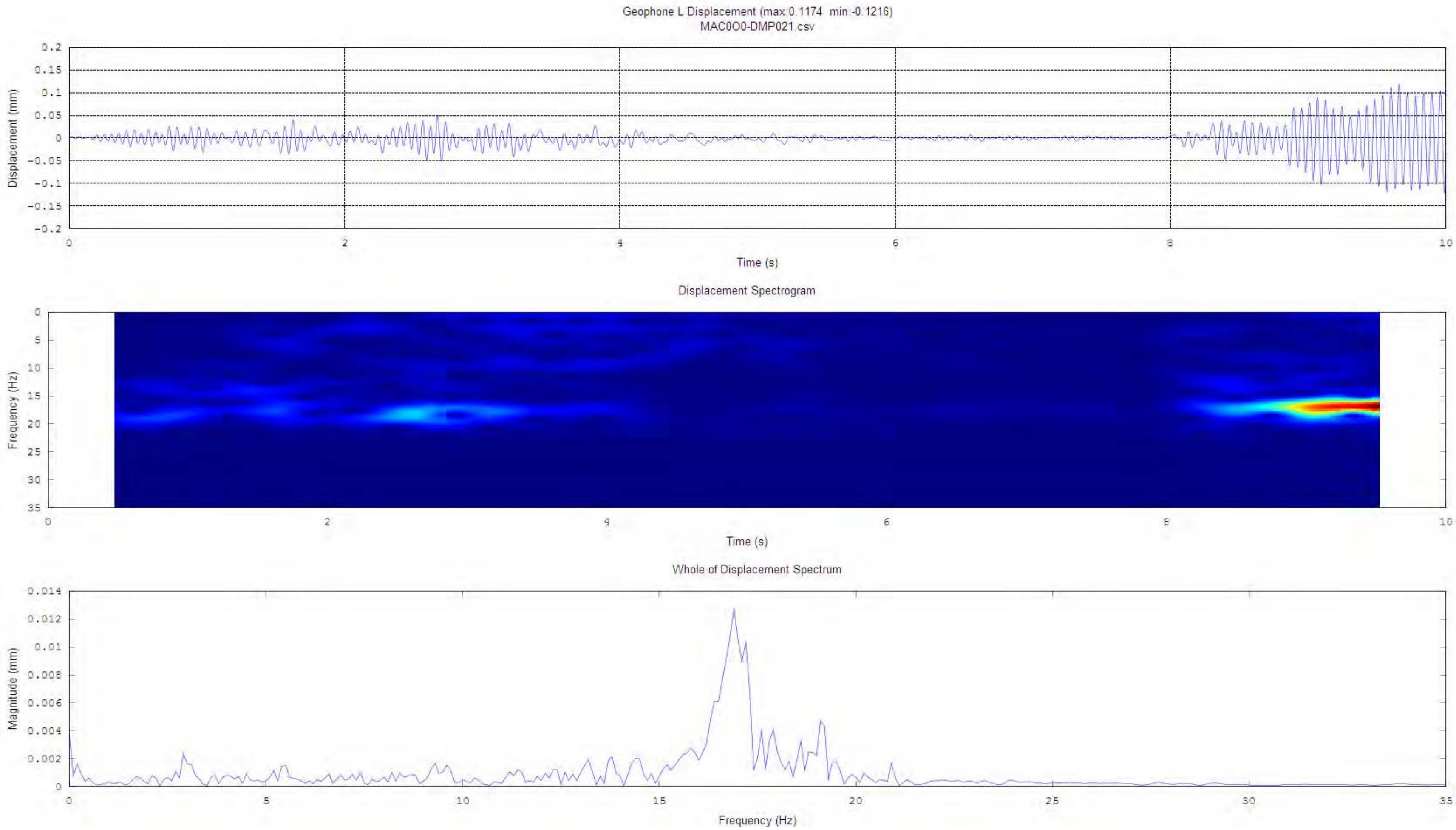
Plot 2 - Spectrogram: This is the same plot as used in the velocity waveform presentation but uses the displacement data instead.

Plot 3 – Whole of Displacement waveform Fourier transform: This is the same plot as used in the velocity waveform presentation but uses the displacement data instead.

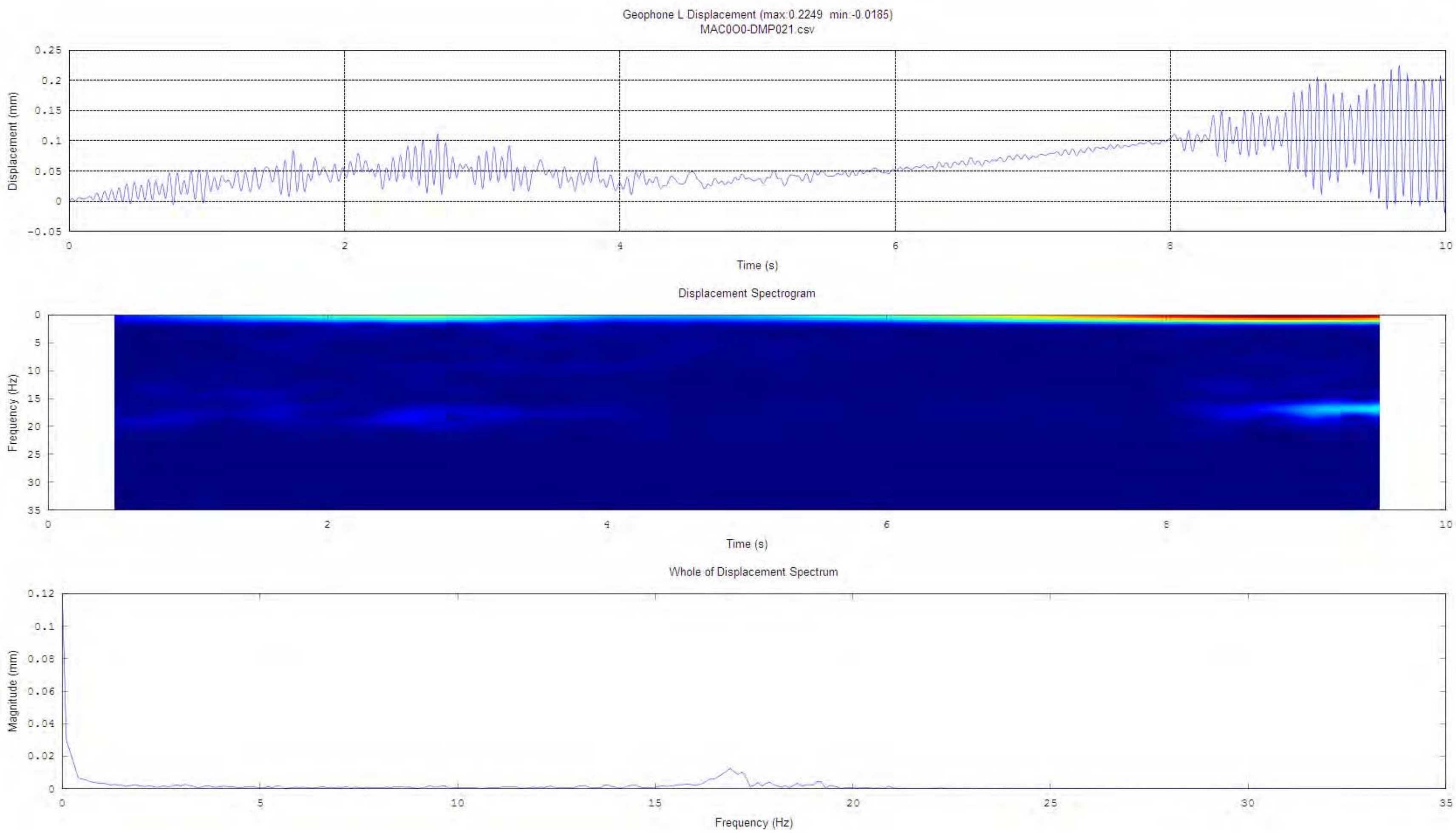
Geophone L Raw Velocity Waveform



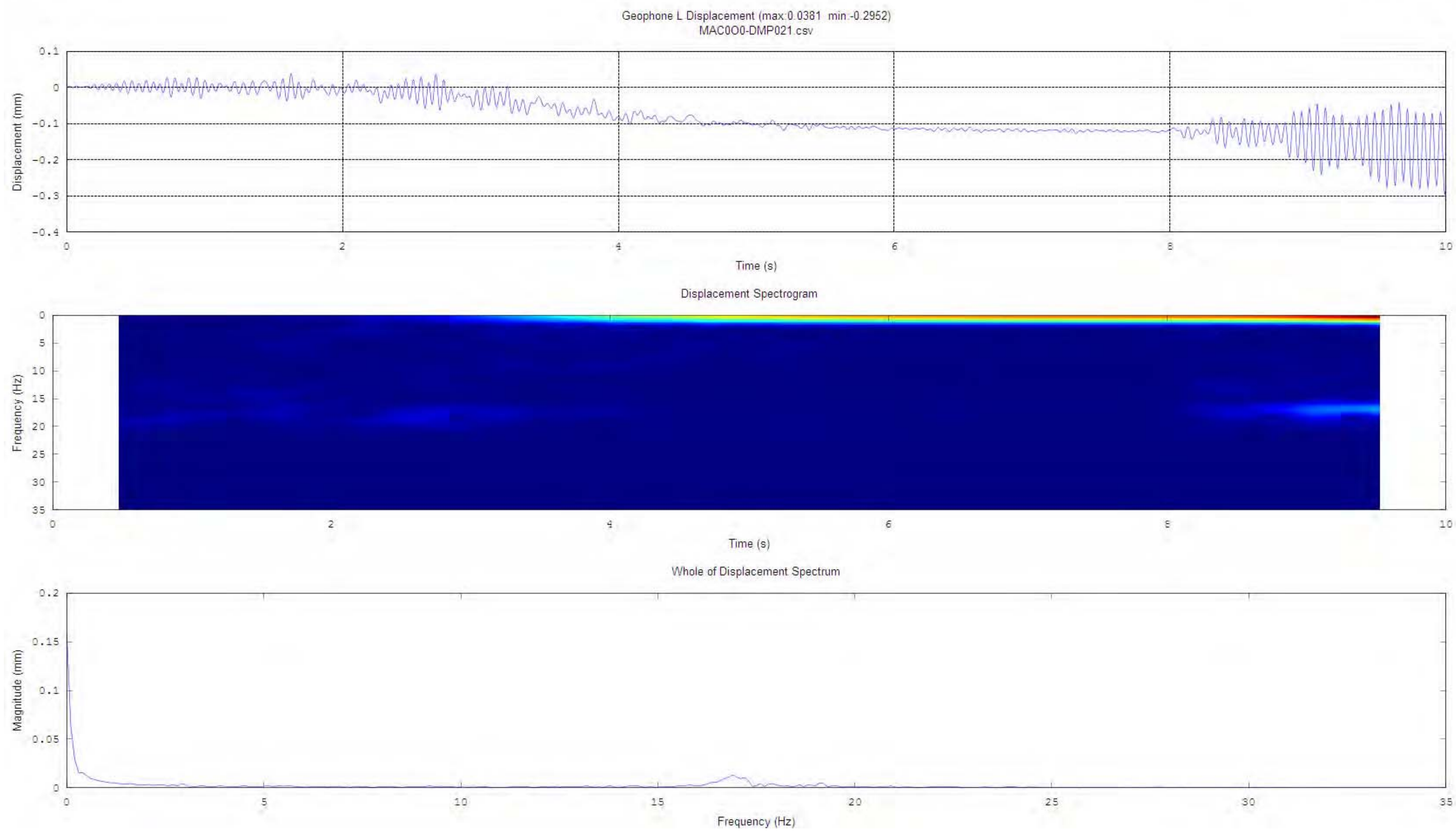
Geophone L Displacement Waveform with a high pass filter applied prior to integration.



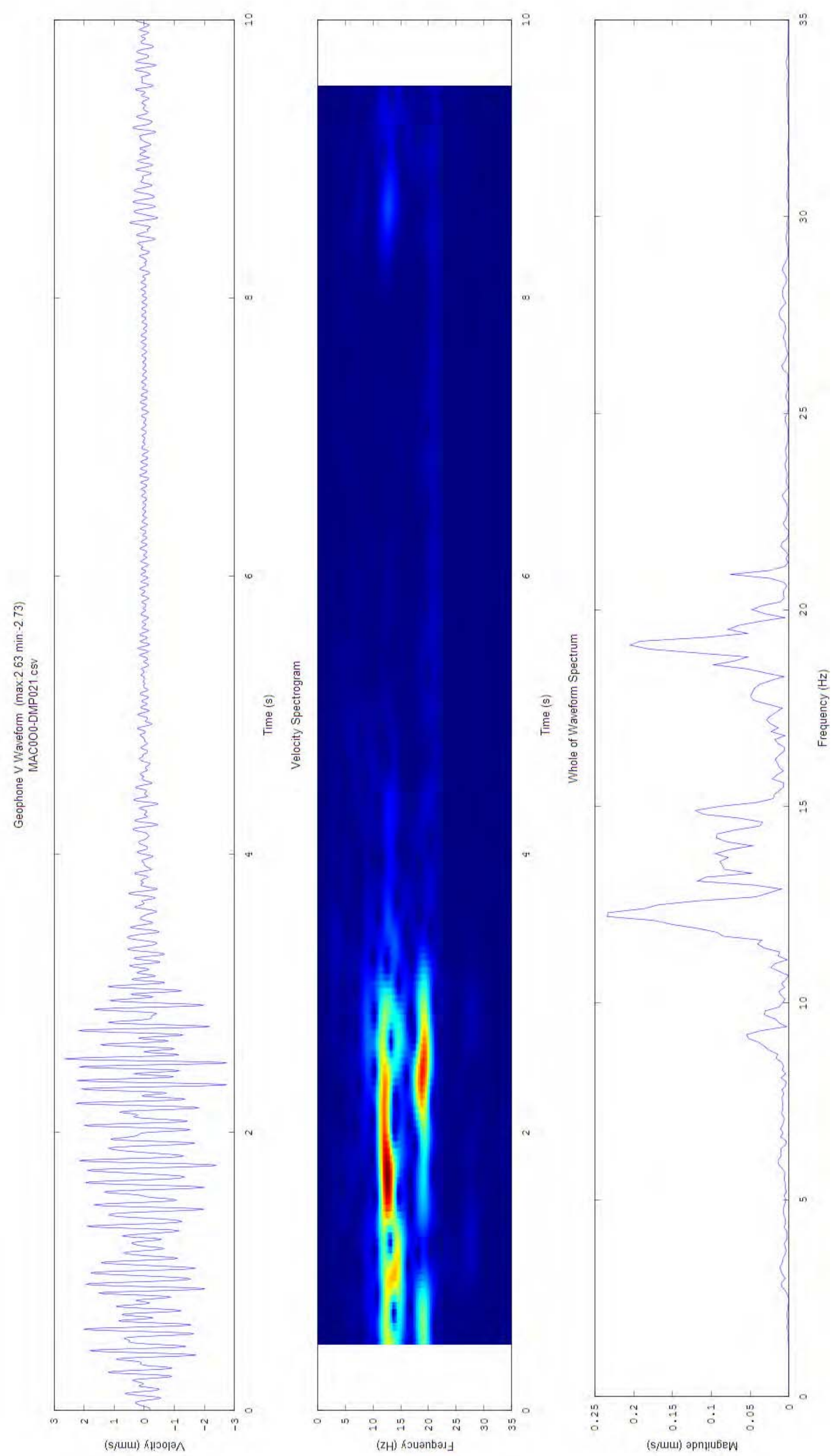
Geophone L Displacement Waveform with mean of velocity waveform subtracted prior to integration.



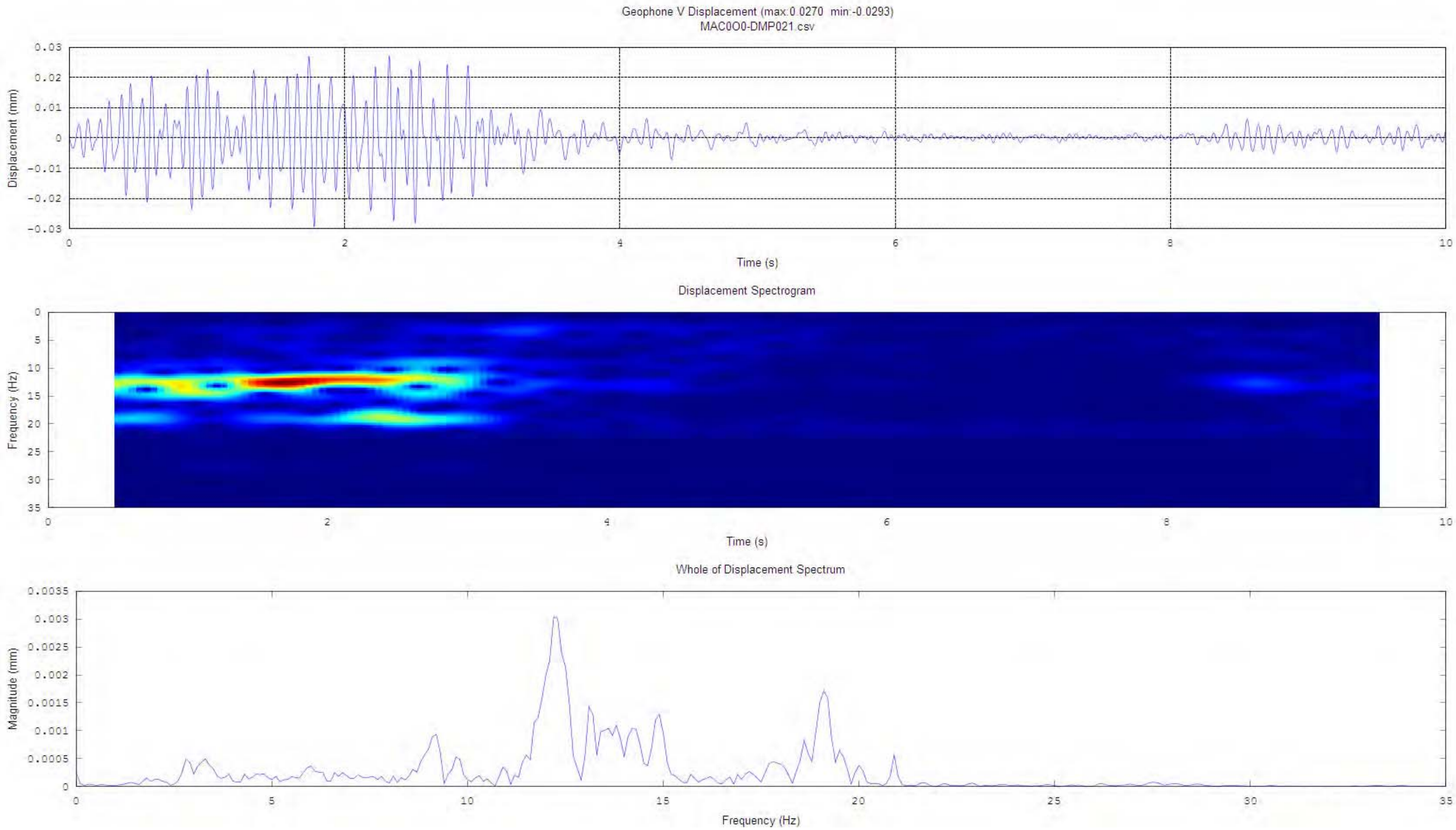
Geophone L Displacement Waveform with no pre-processing of velocity data.



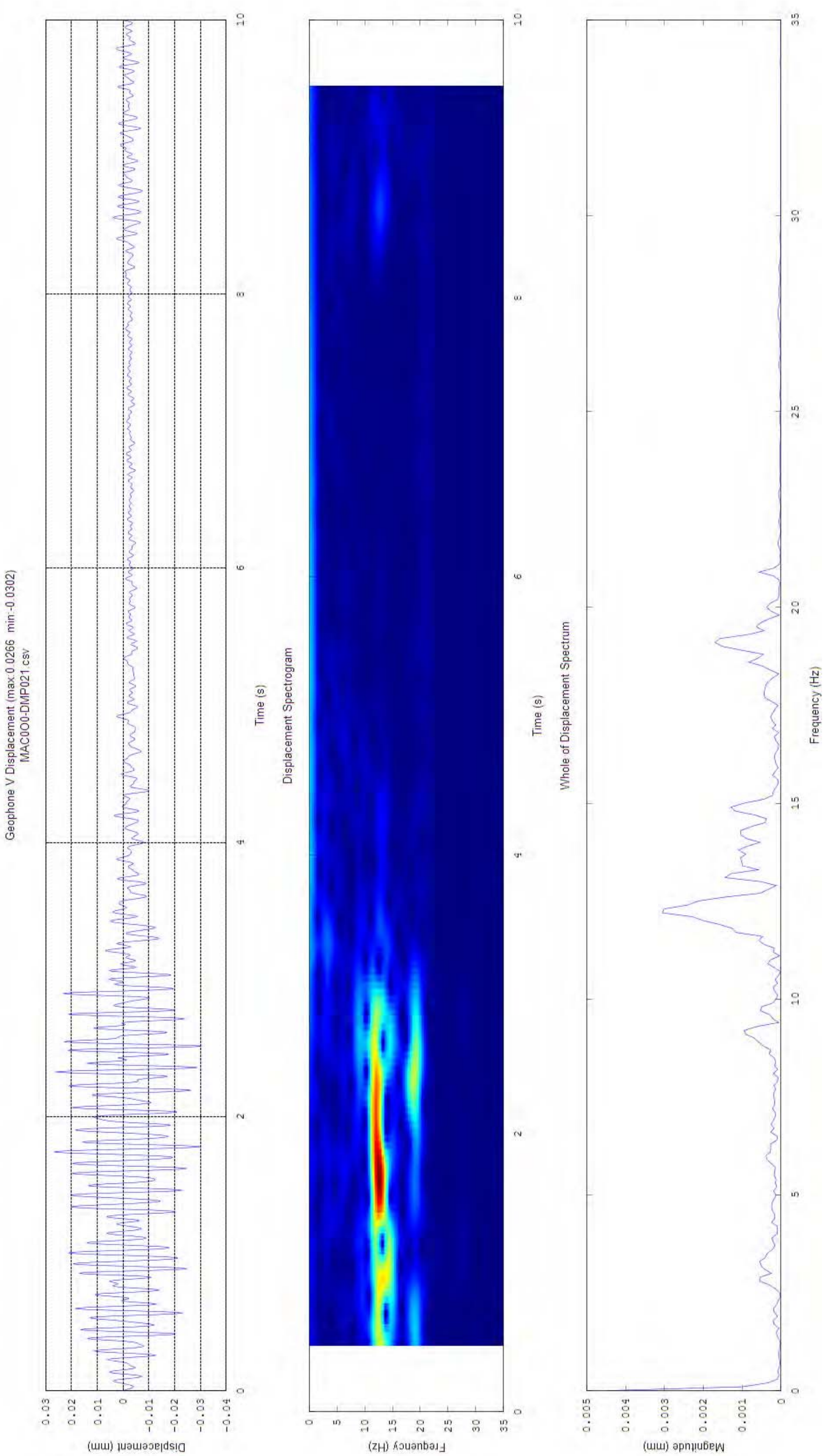
Geophone V Raw Velocity Waveform



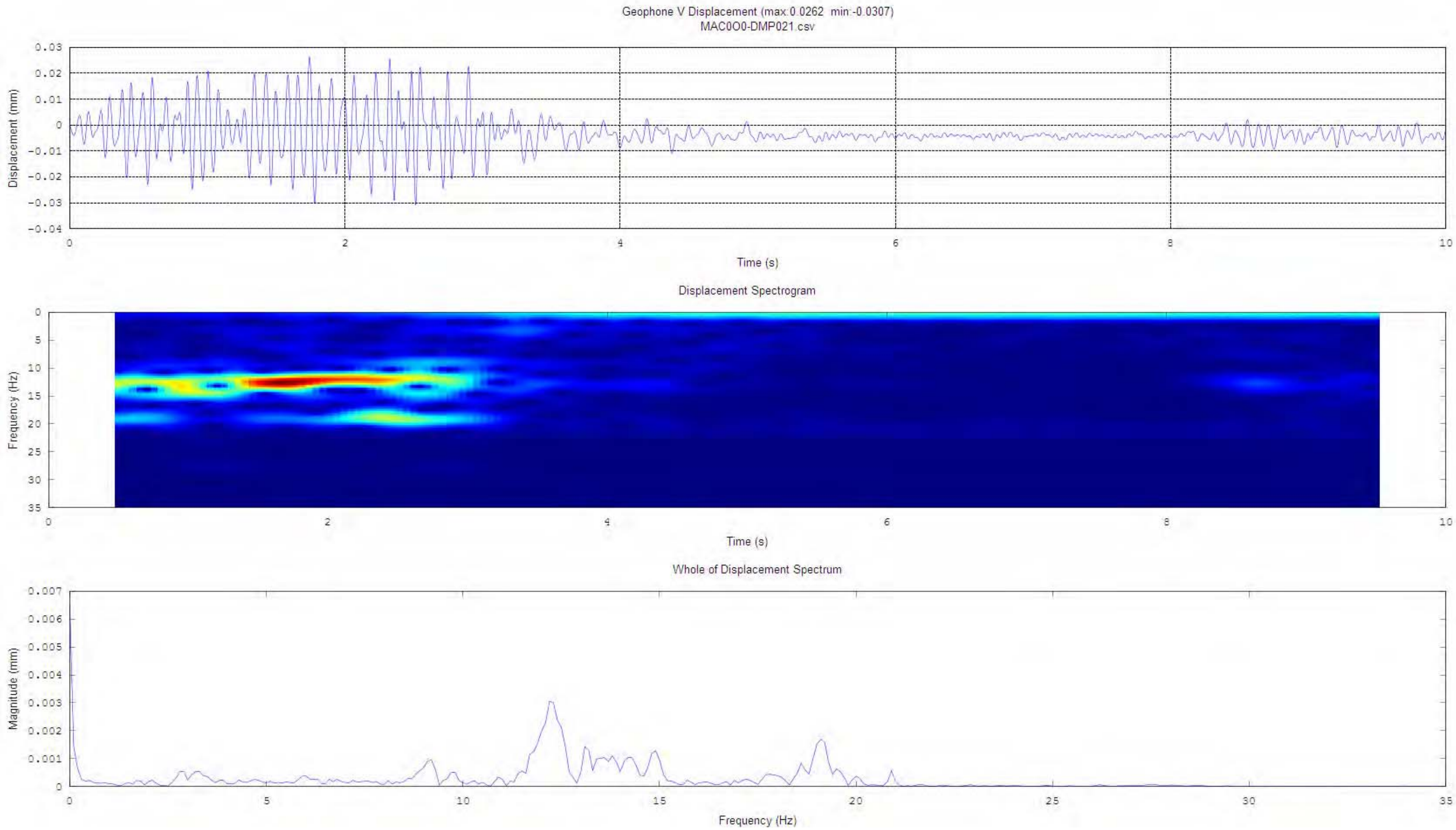
Geophone V Displacement Waveform with a high pass filter applied prior to integration.



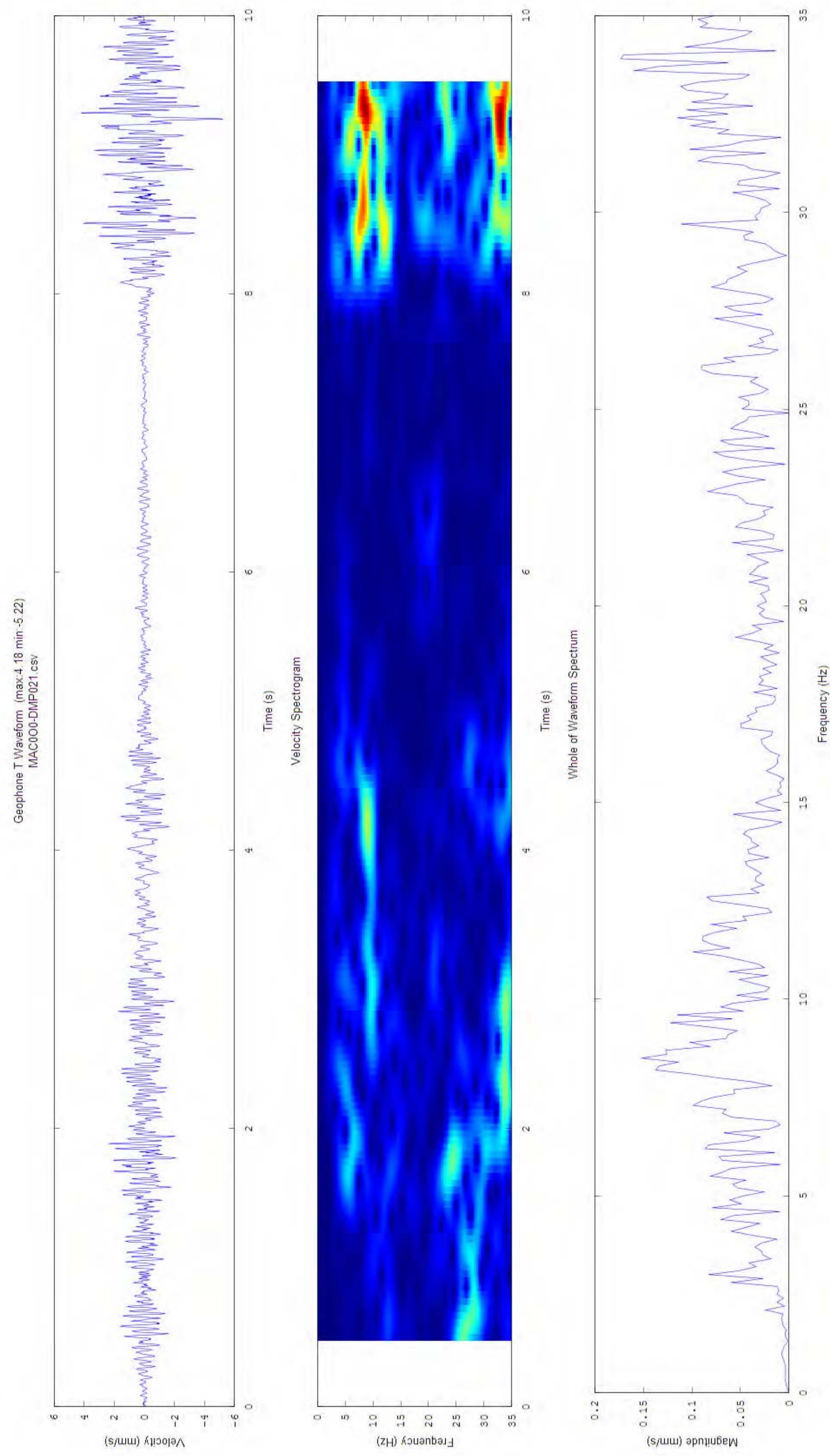
Geophone V Displacement Waveform with mean of velocity waveform subtracted prior to integration.



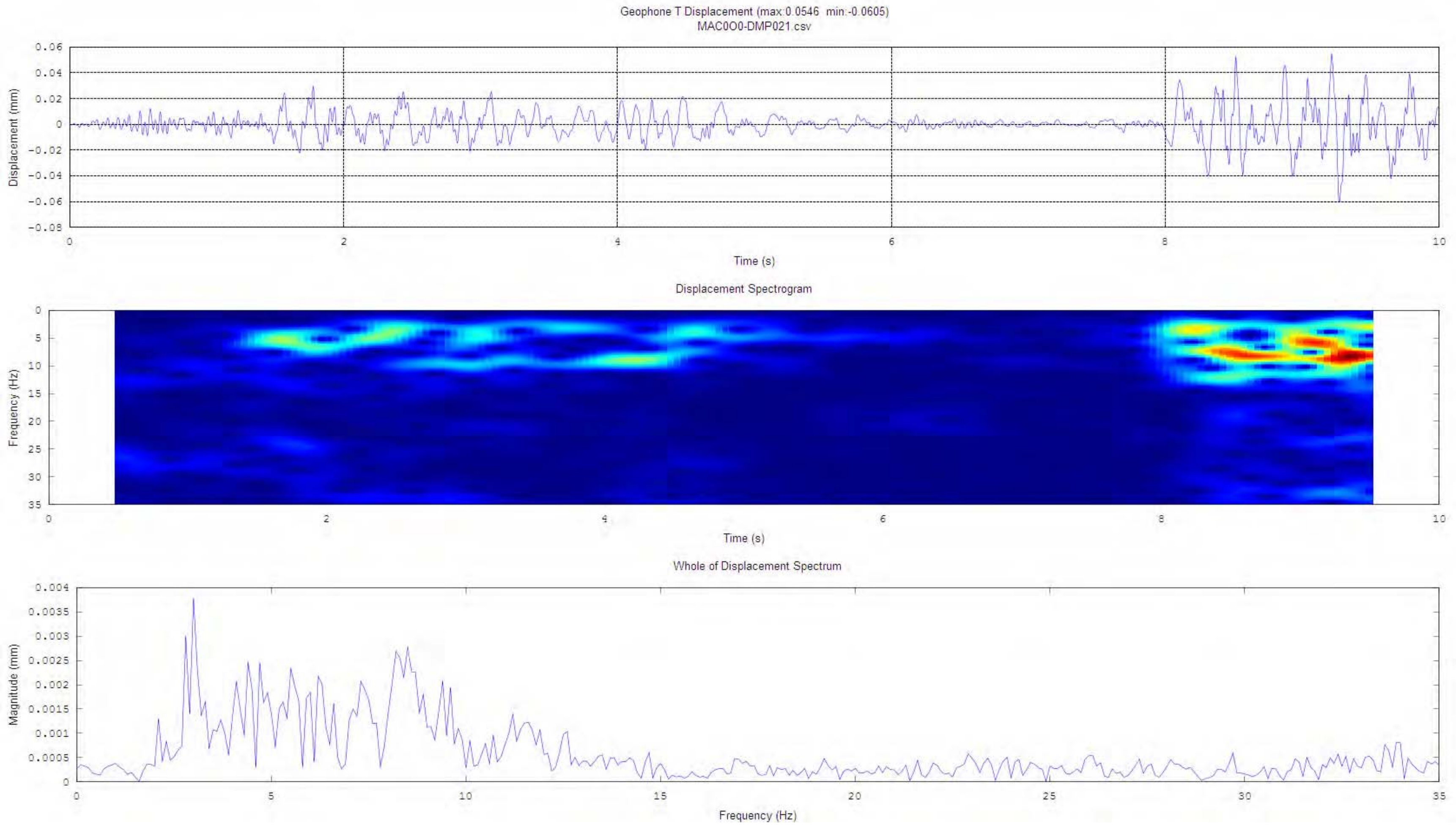
Geophone V Displacement Waveform with no pre-processing of velocity data.



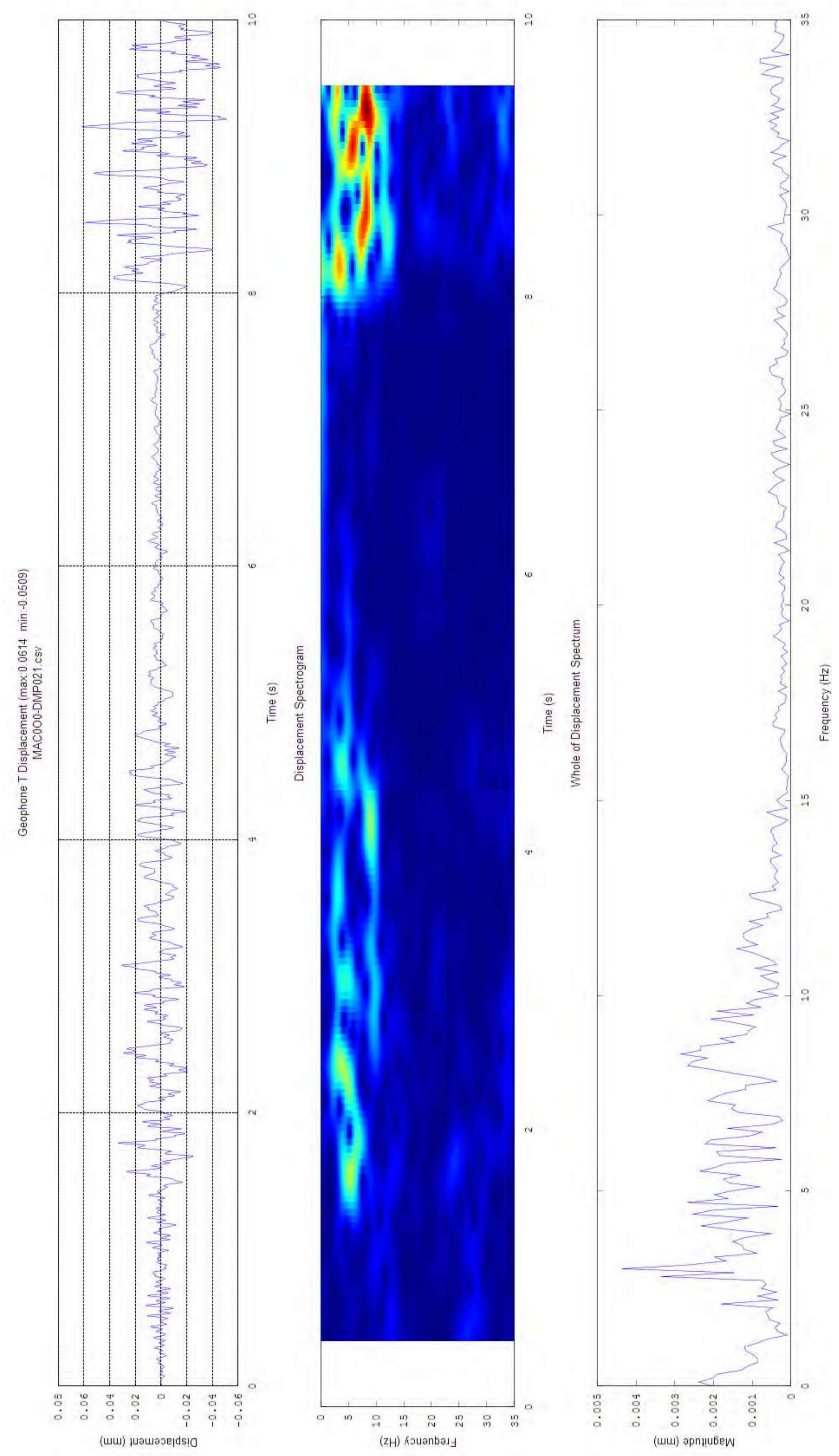
Geophone T Raw Velocity Waveform



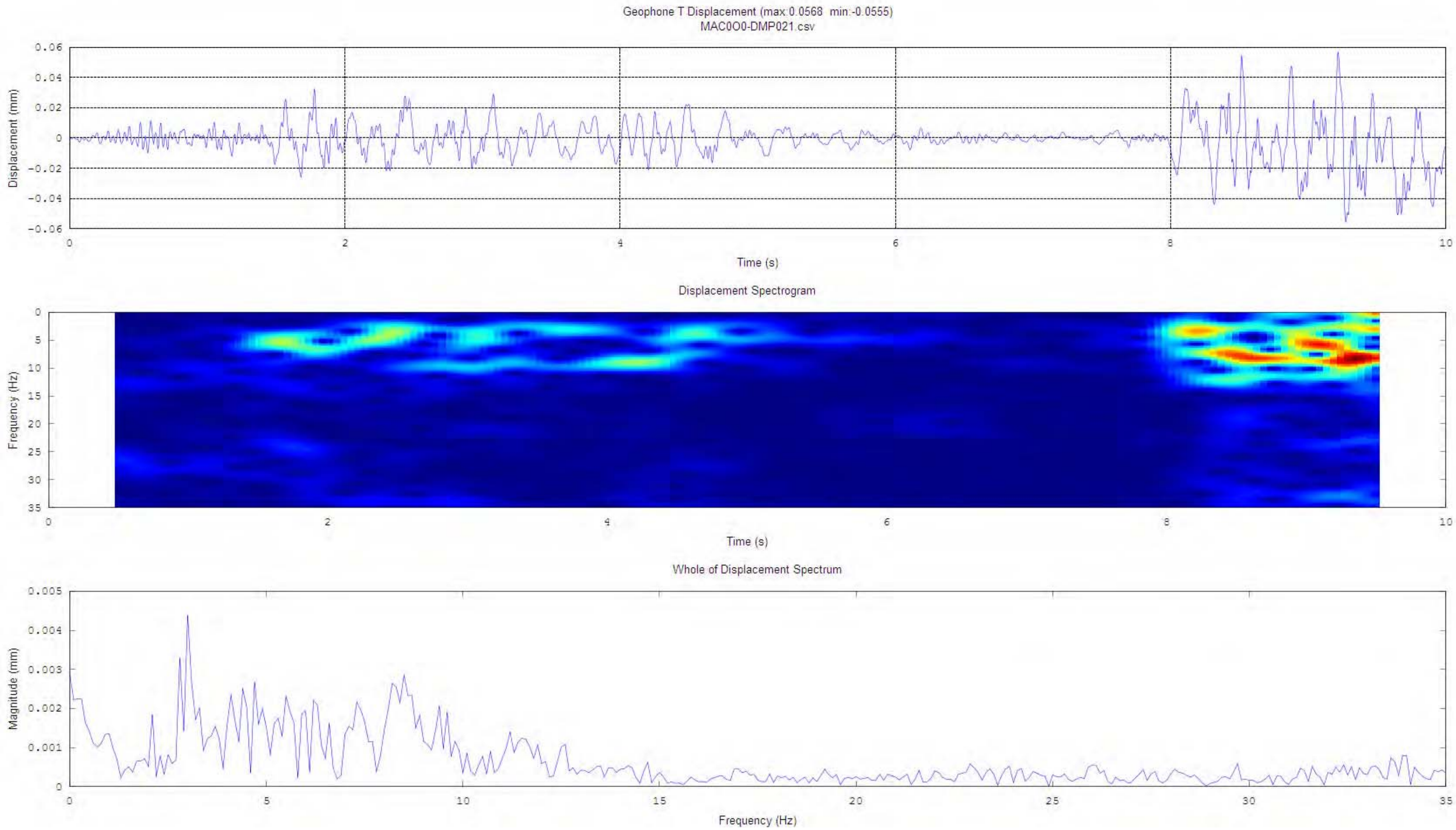
Geophone V Displacement Waveform with a high pass filter applied prior to integration.



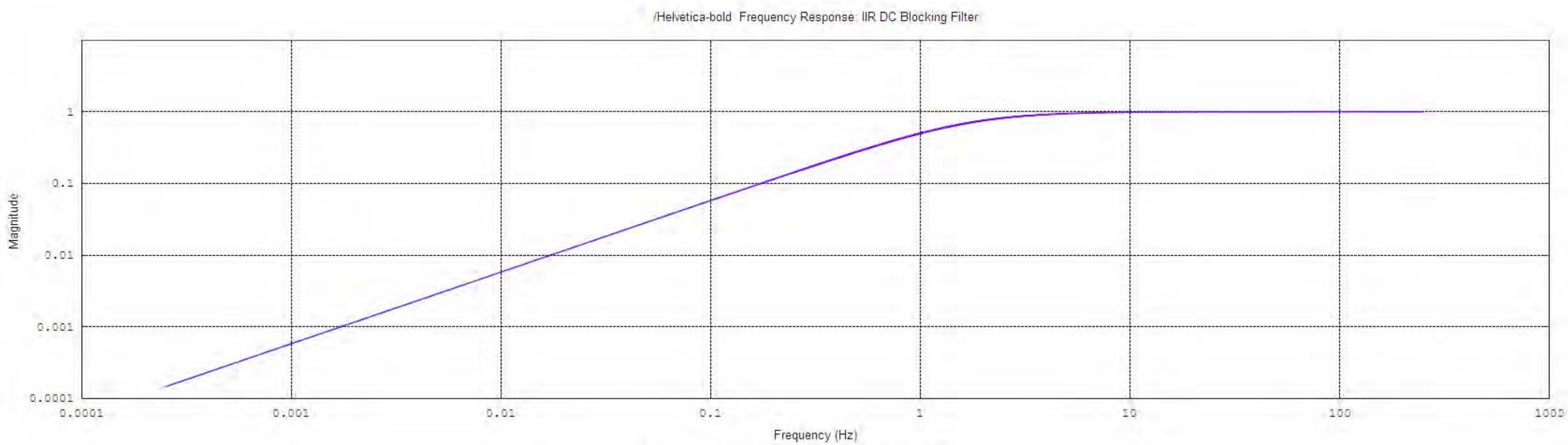
Geophone T Displacement Waveform with mean of velocity waveform subtracted prior to integration.

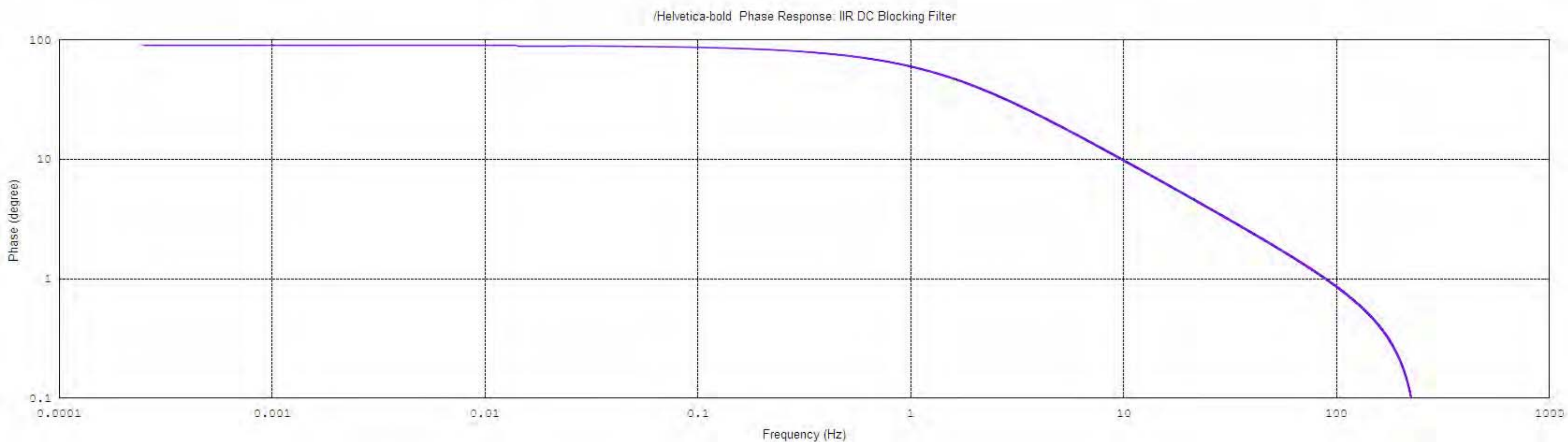


Geophone T Displacement Waveform with no pre-processing of velocity data.



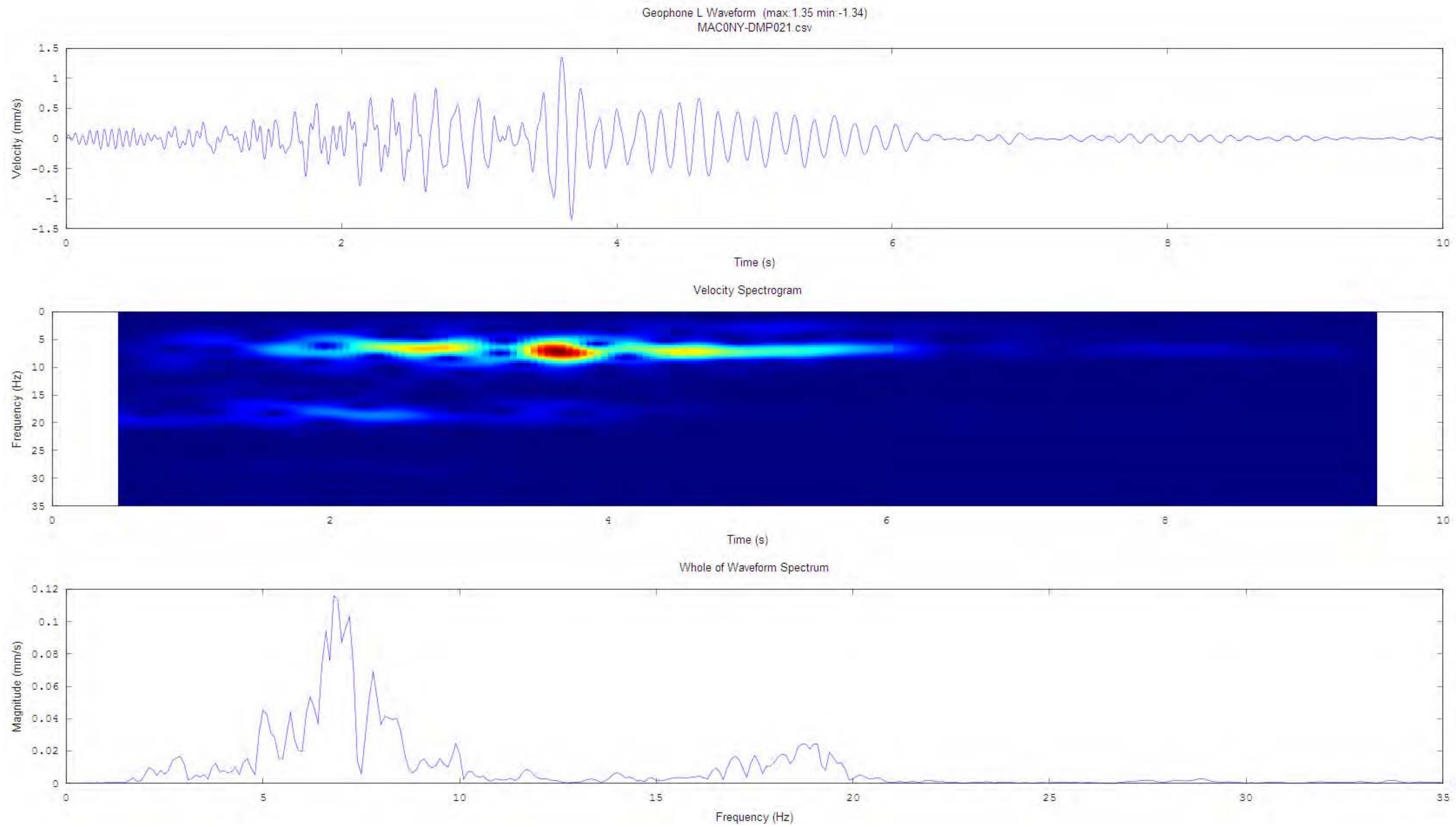
Below is the performance characteristic of high pass (DC blocking filter) as applied to the velocity waveform prior to integration. The -6dB point is at 1Hz with the response tending to be flat from about 6Hz to 7Hz. The corner frequency of 1Hz is used as it tends to effectively remove all the DC and low frequency components that can make the displacement integral not be centred around the 0mm axis (as noted by sagging on displacement waveforms that use the method of subtracting the mean).



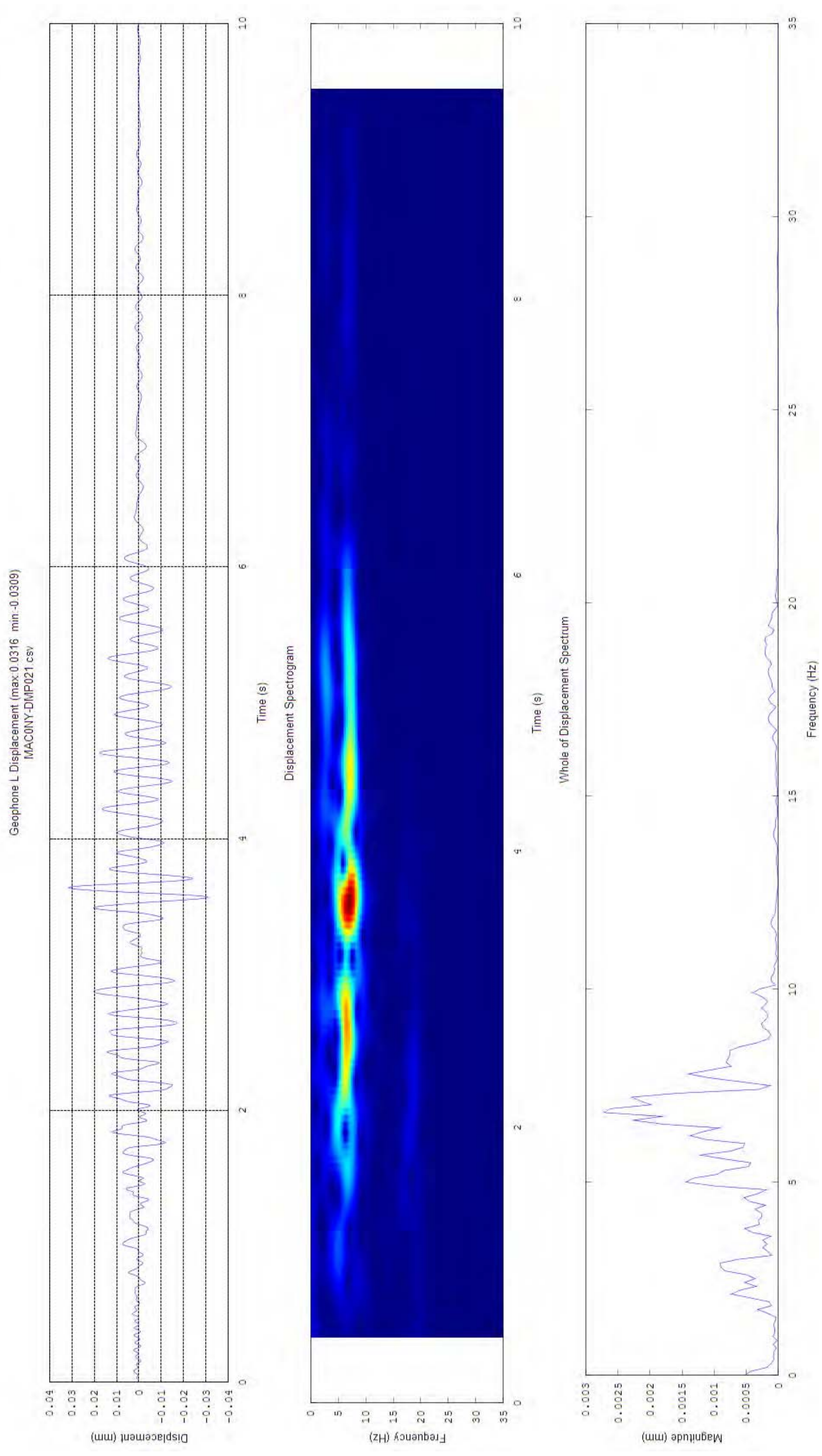


MAC0NY-DMP021; Edinglassie Water Tower

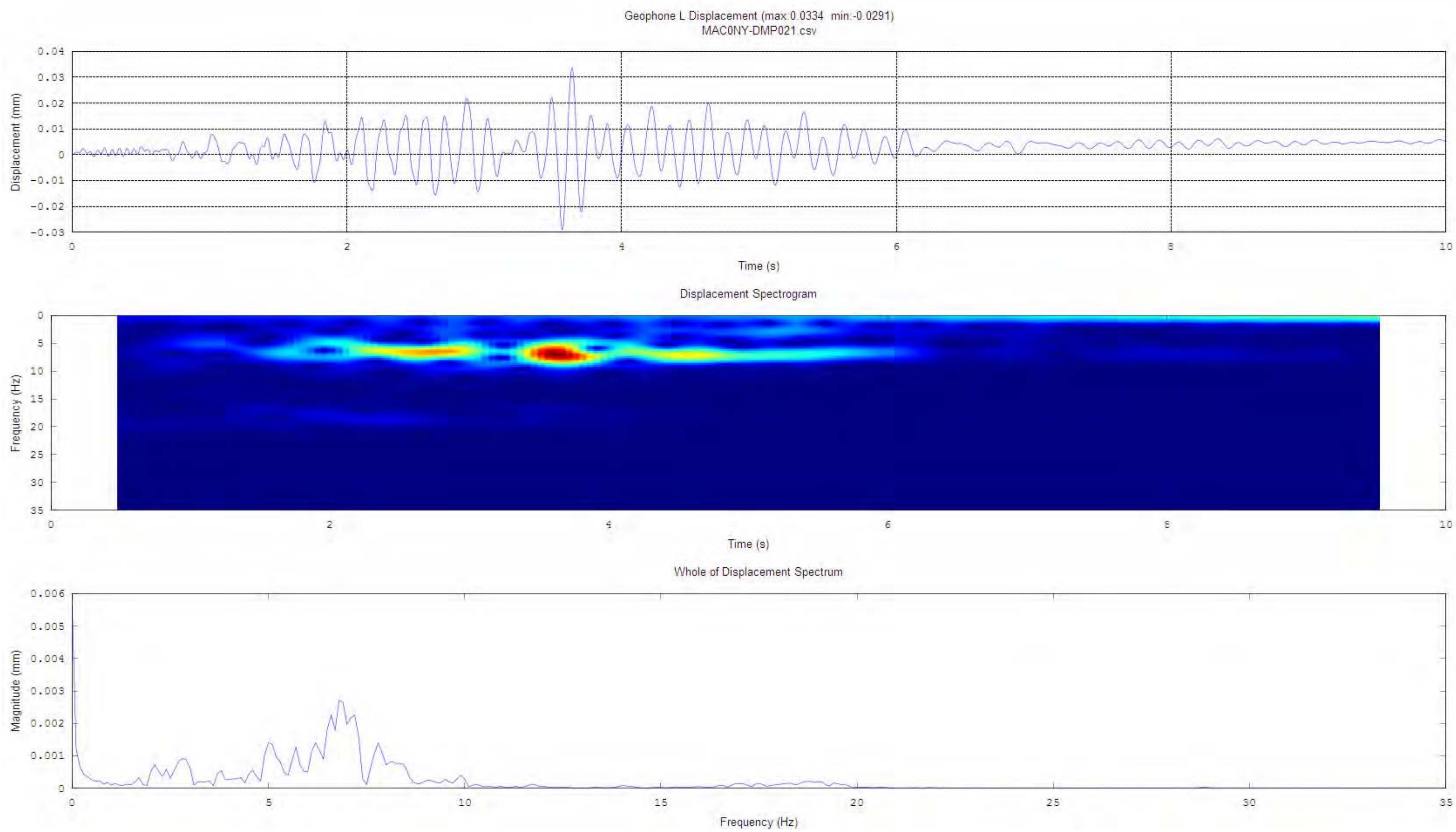
Geophone L Raw Velocity Waveform



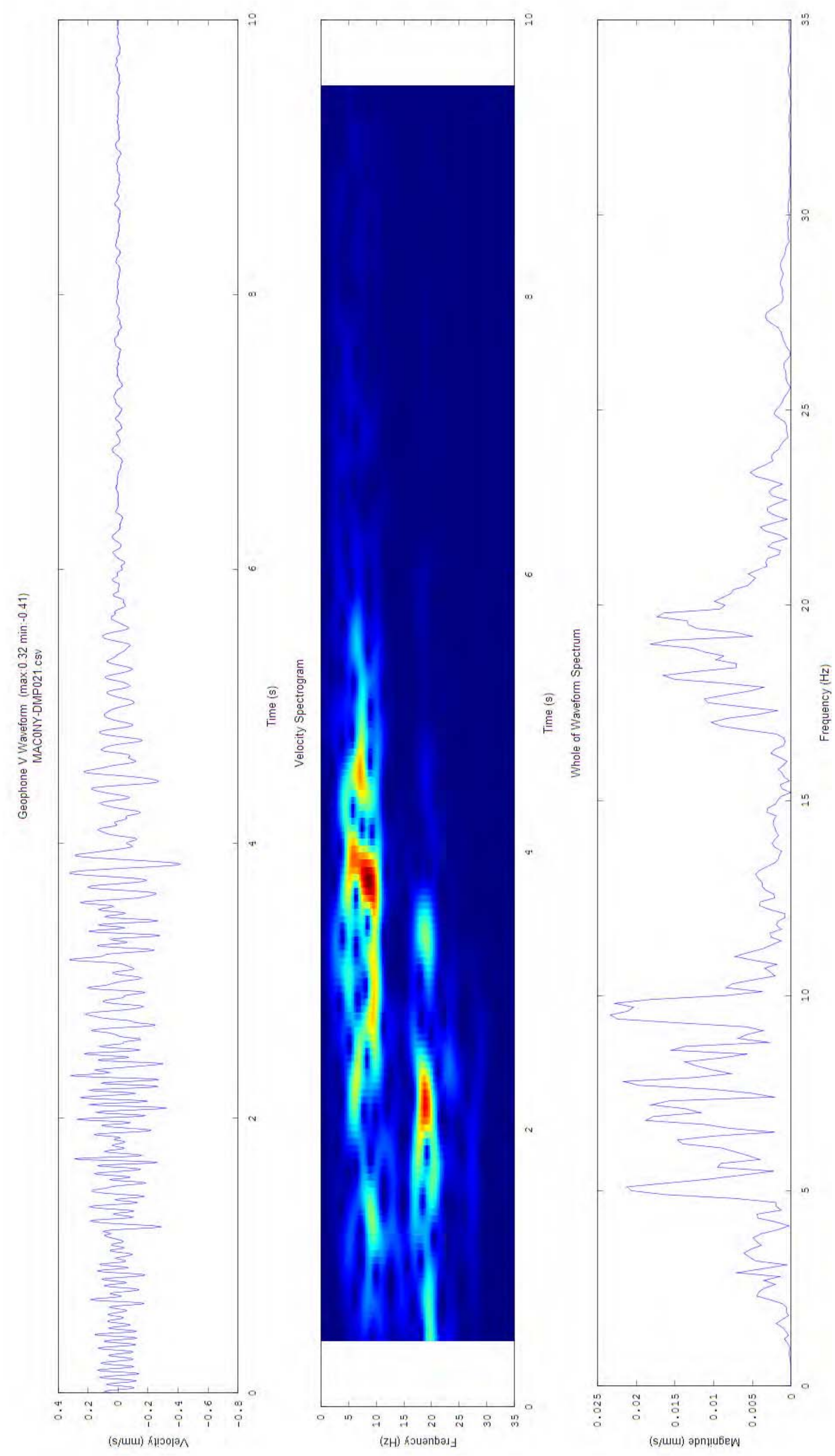
Geophone L Displacement Waveform with mean of velocity waveform subtracted prior to integration.



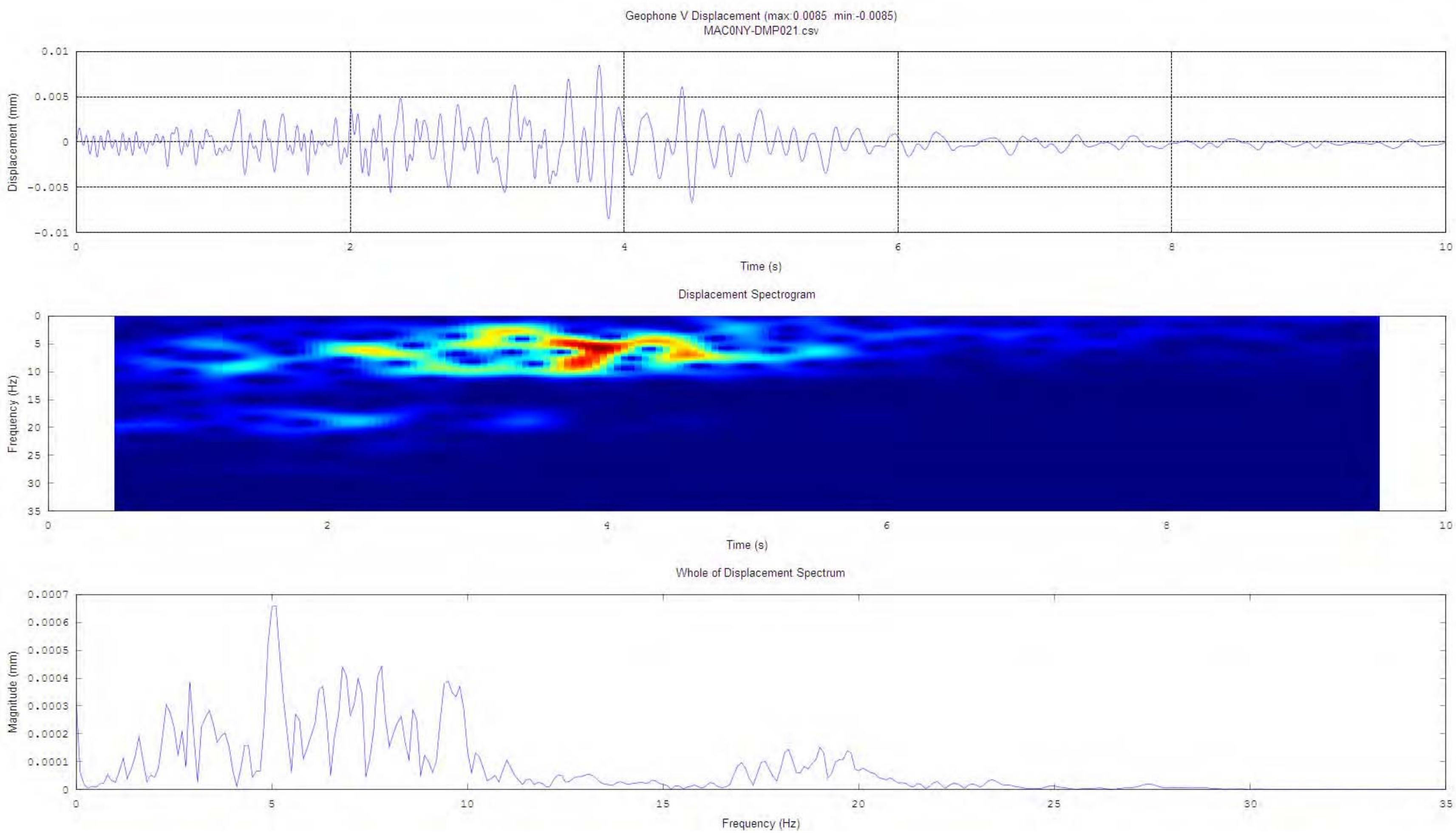
Geophone L Displacement Waveform with no pre-processing of velocity data.



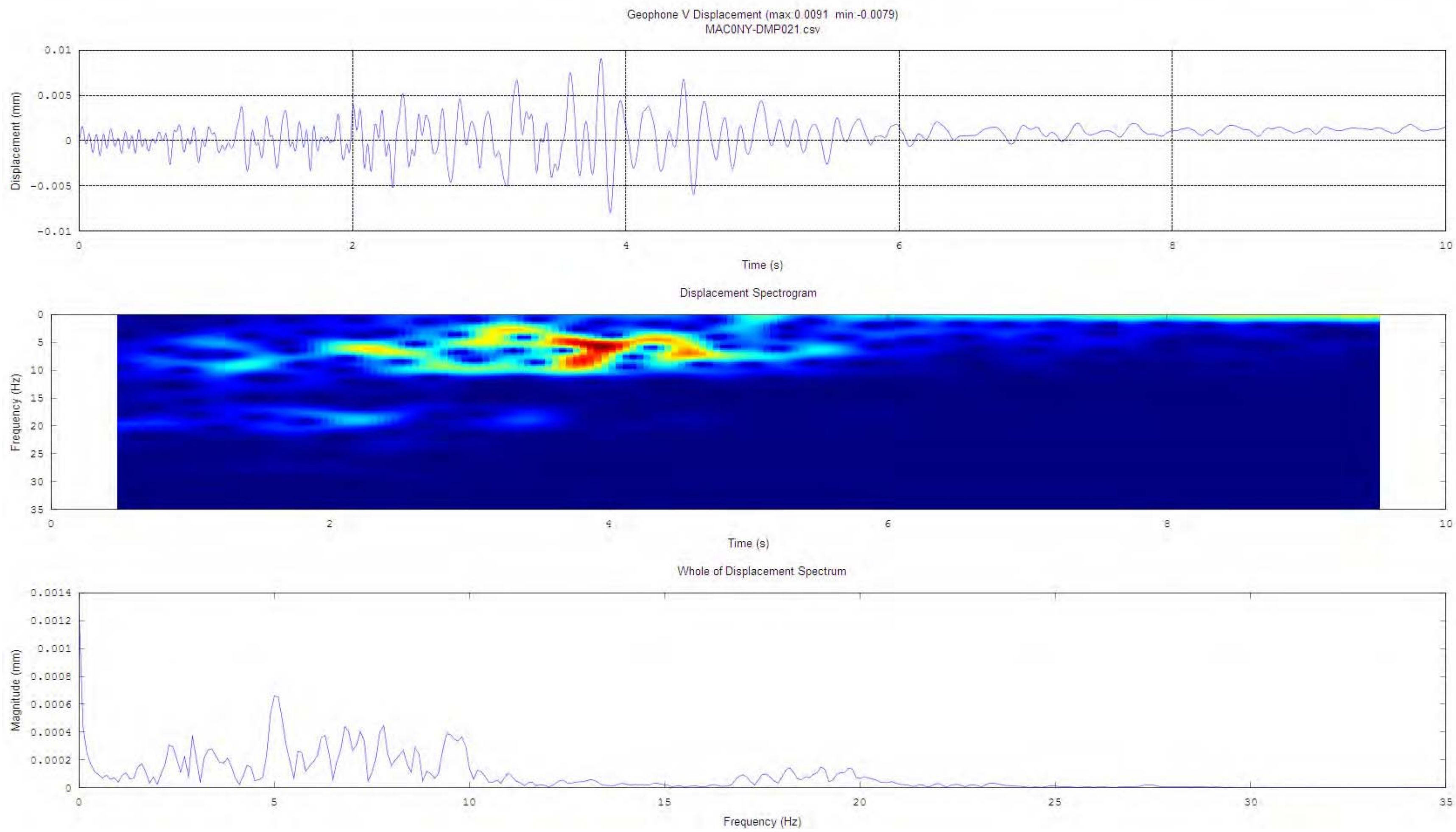
Geophone V Raw Velocity Waveform



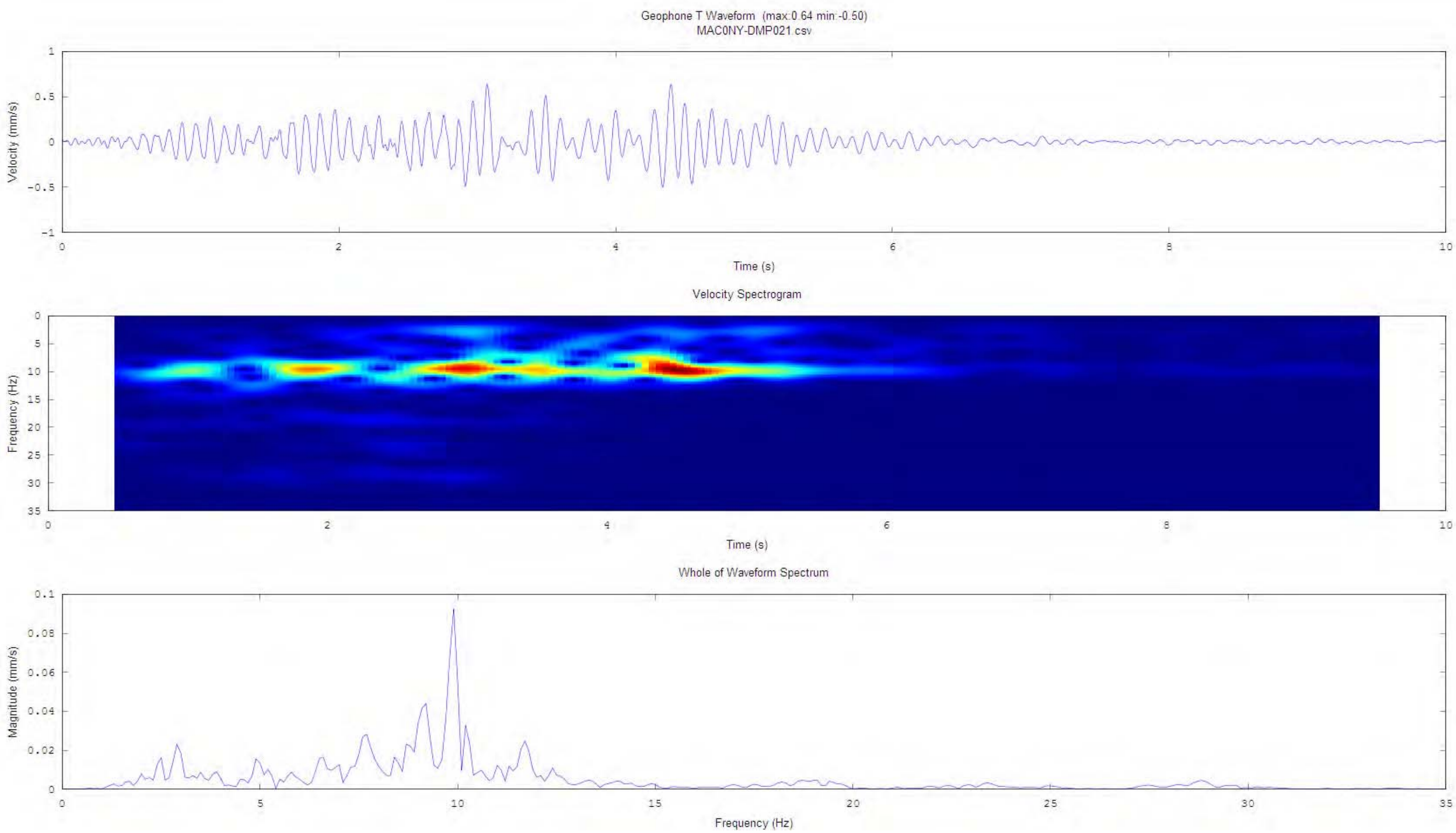
Geophone V Displacement Waveform with mean of velocity waveform subtracted prior to integration.



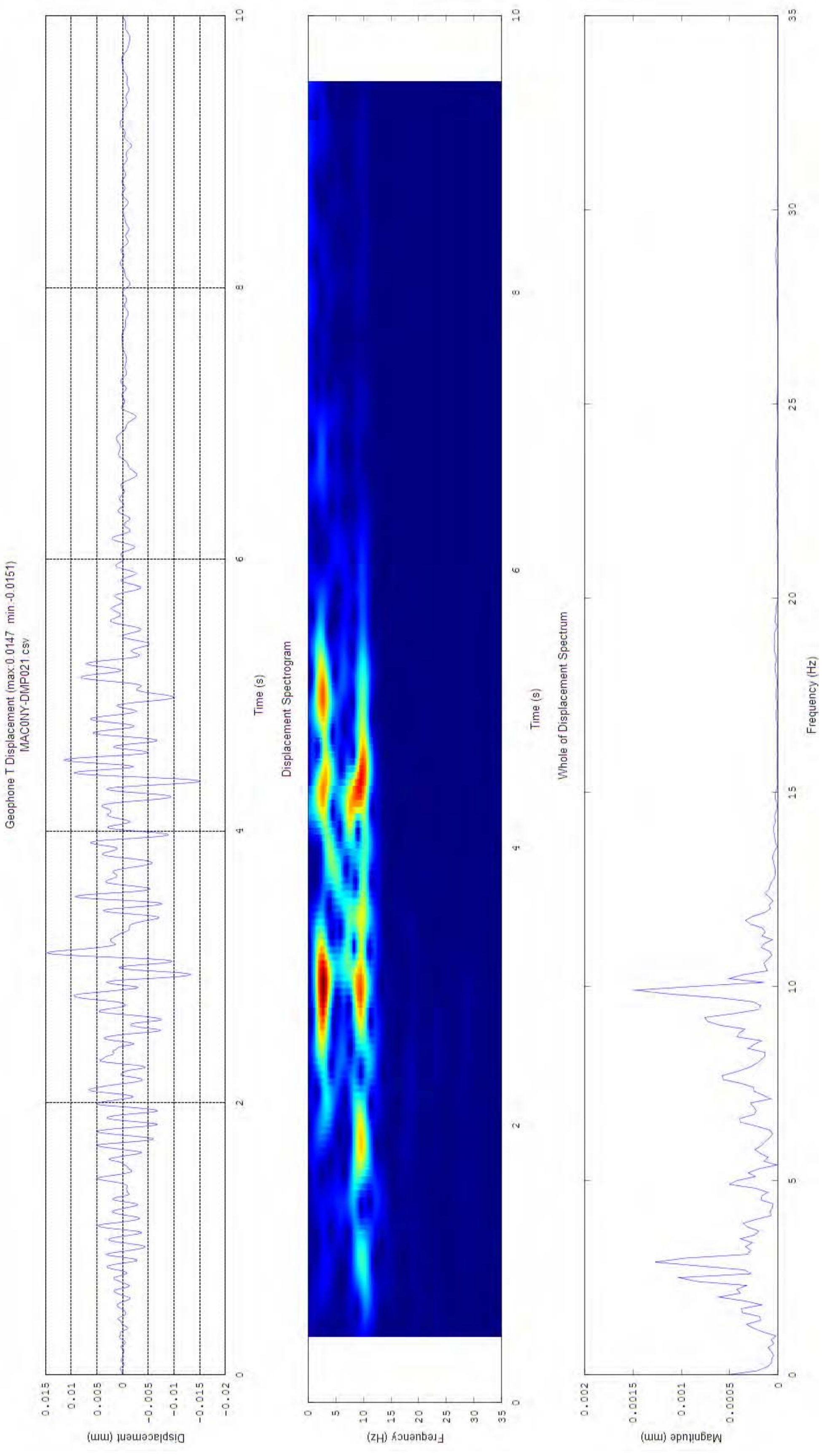
Geophone V Displacement Waveform with no pre-processing of velocity data.



Geophone T Raw Velocity Waveform



Geophone T Displacement Waveform with mean of velocity waveform subtracted prior to integration.



Geophone T Displacement Waveform with no pre-processing of velocity data.