Technical document

Spectral analysis of ATC communications

Document reference:	**BEA_sp-l120501_tec01**
Date of occurrence:	01/05/2012
Place of occurrence:	Warszawa Benowo (Poland)
Aircraft type:	Liberty XL2
Registration:	SP-AXL
Data:	Audio files labelled:

From the day of the event:
- _2012-05-01__13-52-07__Kanał_01_(...)____ .wav
- _2012-05-01__13-52-44__Kanał_01_(…)____ .wav
- _2012-05-01__13-53-28__Kanał_01_(…)____.wav
- _2012-05-01__13-53-46__Kanał_01_(…)____.wav

From the day of the flight test:
- all ATC recordings labelled_2013-05-22__xx-xx-xx__Kanał_02_(…)____.wav from 10:24:25 to 14:08:00
- audio track from video filmed into the cockpit: GOPR1009-FlightTest_Liberty XL2.WAV

Work performed:

A complete spectral analysis of all the audio and video files provided by the investigator in charge was performed at the BEA audio lab.

- **Data recorded during the flight test**

The audio track of the video file was analysed to determine the acoustic signature of the propulsion system (engine and propeller) recorded in the cockpit during the Liberty XL2 flight test. The frequencies associated with the propeller, engine and pump were present in the spectra and were used as a reference for the analysis of the recordings related to the event flight (see appendix 1).

Some ATC messages emitted during the same flight test were also selected as a reference in order to identify the relevant information caught via radio communication link. Few frequencies sometimes appeared in the spectra depending on the silence duration left by the pilot just after a speech (see appendix 2). Apart from pump sound all the acoustic signature of the propulsion system was widely covered by the pilot's voice.

- **ATC data recorded during the flight of the event**

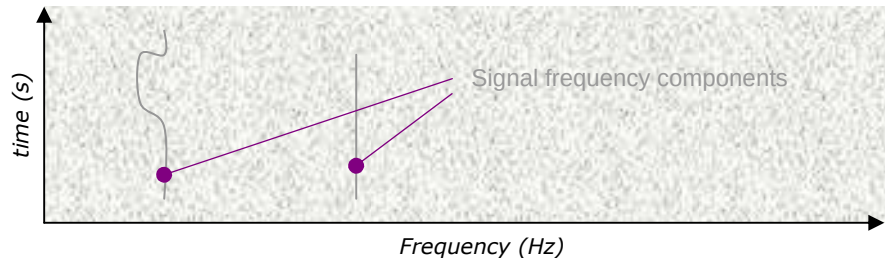
The analysis of the ATC files recorded the day of the event didn't show any information relative to either the engine or the propeller into the spectra: there was not any pause in the pilot's speech that would have allowed their detection in the background noise. Only the frequency associated to an in-flight non-permanent pump was detected on some messages (see appendix 3).

Conclusion:

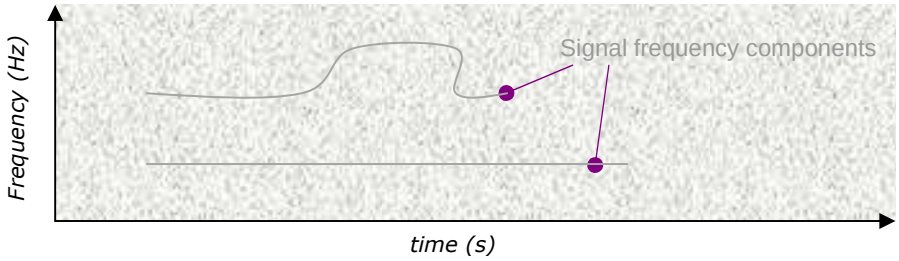
The spectral analysis of the ATC files performed with BEA audio tools didn't show any information related to the Liberty XL2 SP-AXL power plant condition the day of the event.

GLOSSARY

BR	Blade Rate / propeller blade rate in Hz
CSR	Crank Shaft Rate in Hz / Engine speed = CSR*60 **Max value = 2800 Rpm**
CR	Cylinder Rate in Hz
Rpm	Revolution per minute
Propulsion system	Engine, gear box , rotor or propeller
Power plant	Engine, gear box , rotor or propeller
N/A	Non Identified frequency
Lofargram	(LOFAR) Sound analysis pictures / frequency in X-axis and time in Y-axis



Sonagram	(SONA) Sound analysis pictures / time in X-axis and frequency in Y-axis

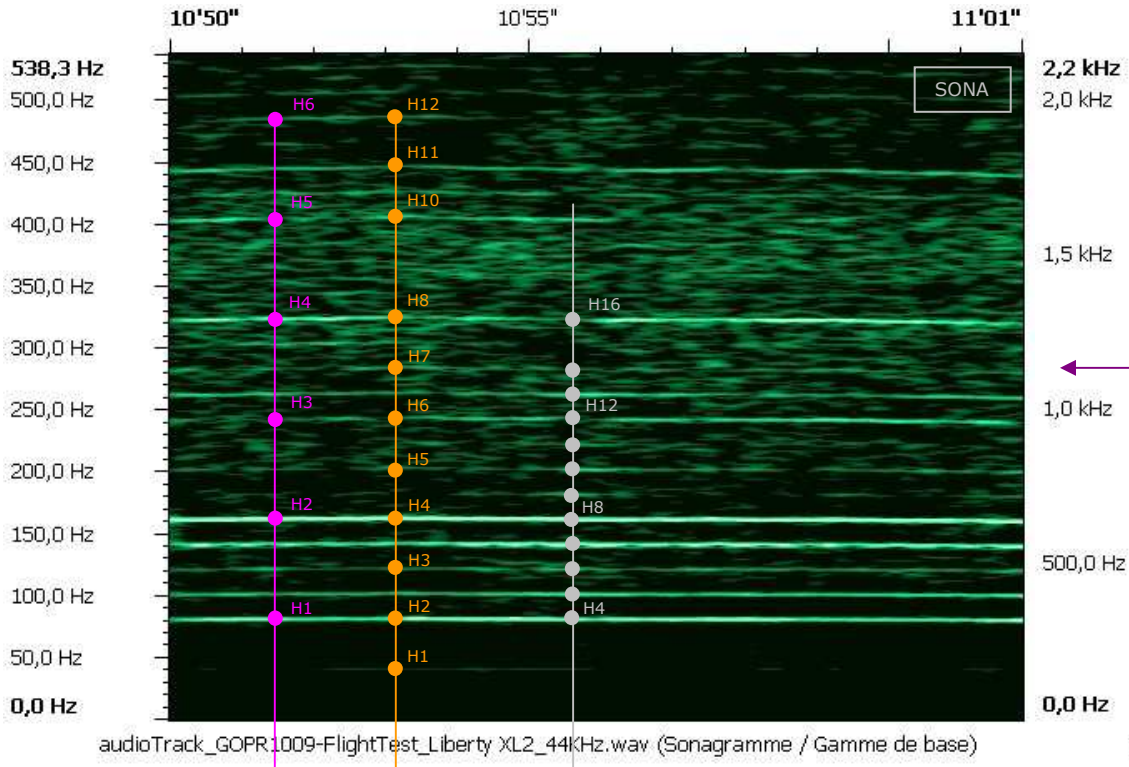


Appendix 1 - Liberty XL 2 flight test - Video / soundtrack Liberty XL2 acoustic signature

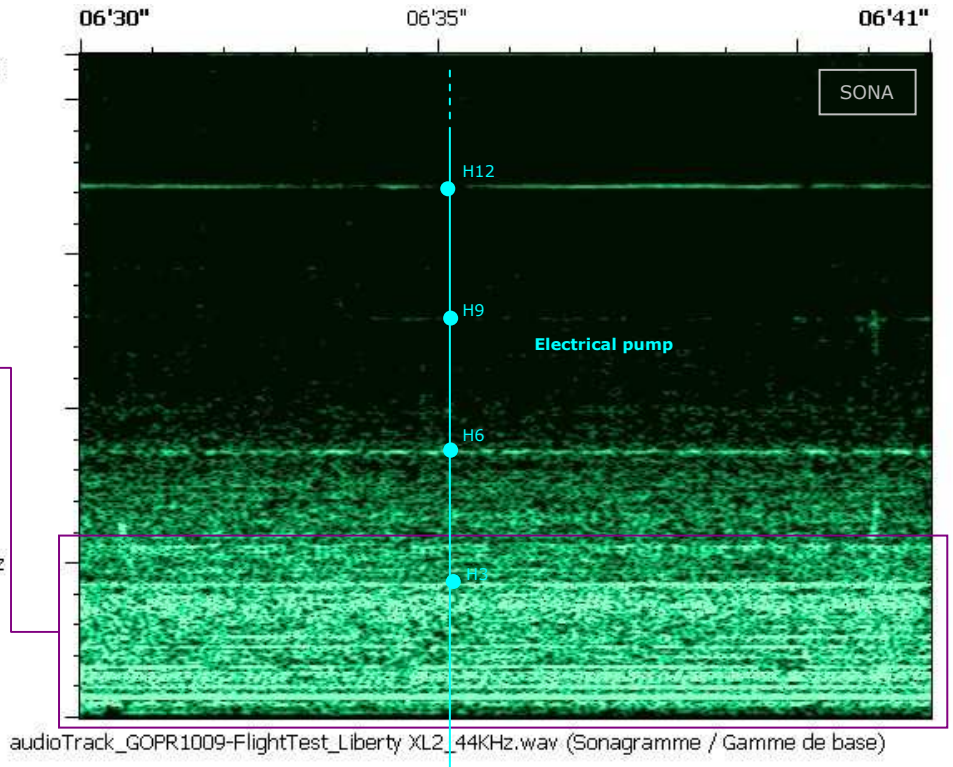
There were two main frequency bandwidths useful to display the spectral components of the XL2 propulsion system:

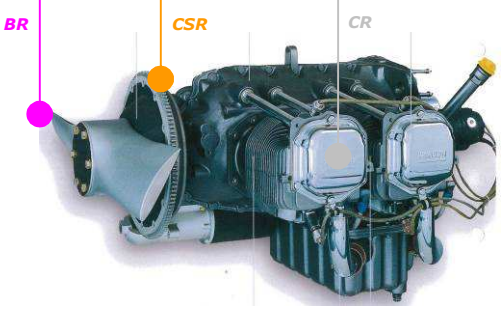
- 0 to 500 Hz for the propeller and engine
- 0 to 2200 Hz for an electrical pump (non-permanent)

Spectra 0 – 580 Hz



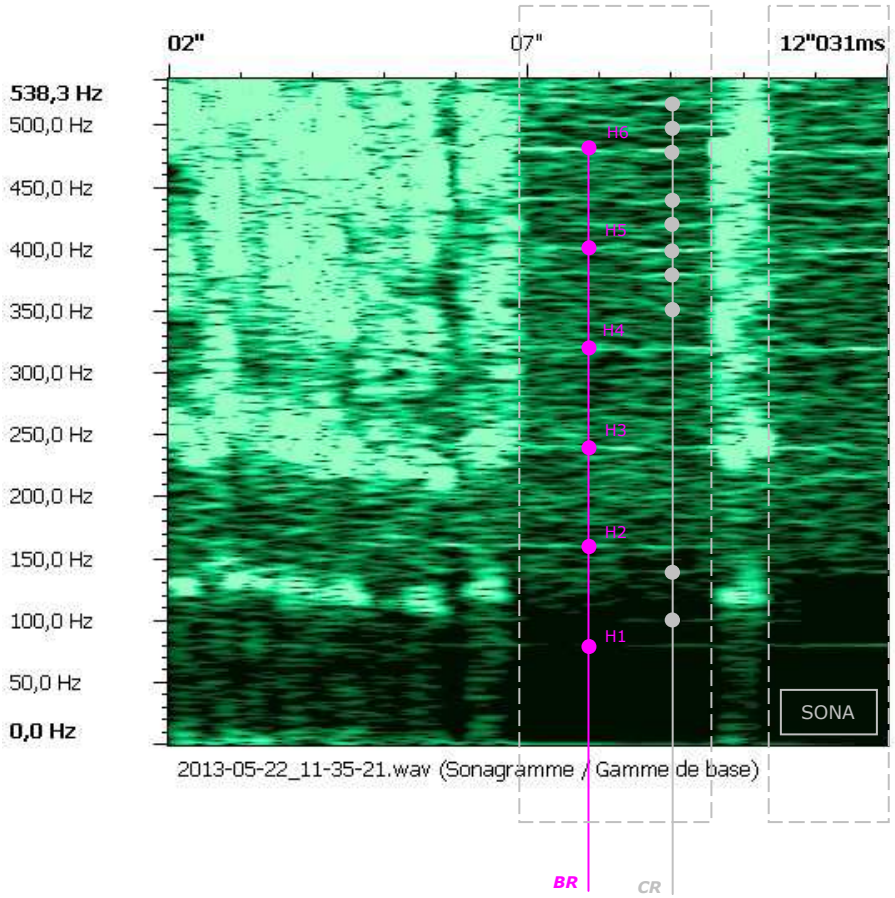
Spectra 0 – 2.2kHz



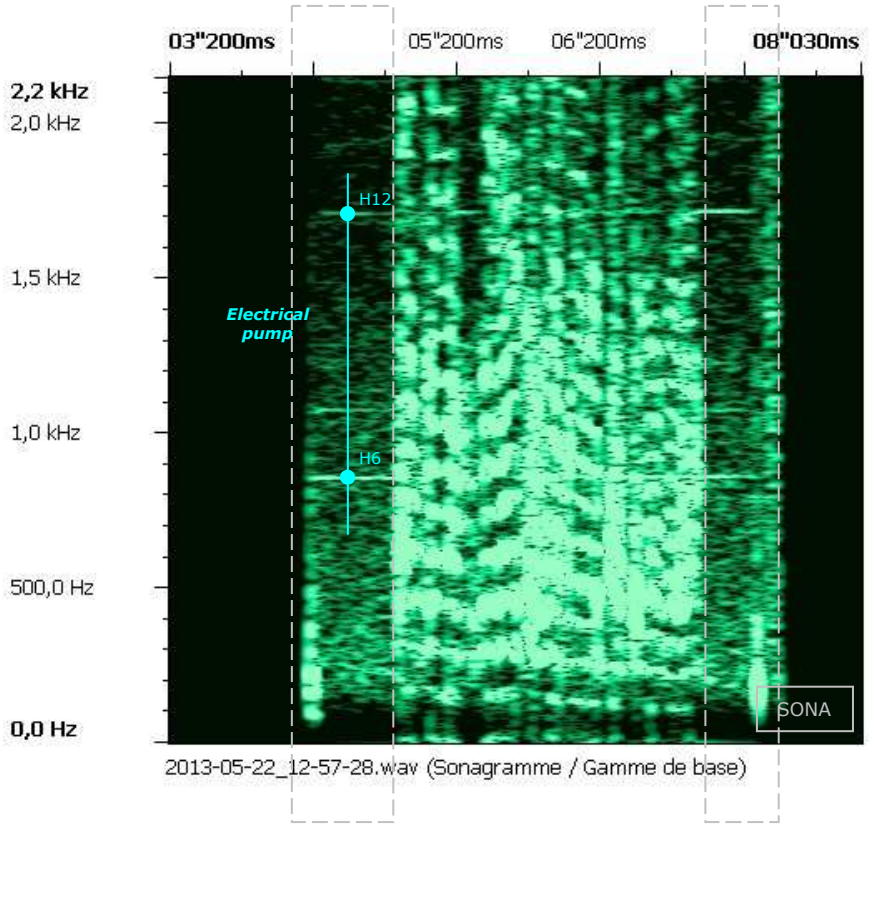


Appendix 2 - Liberty XL 2 flight test - audio / ATC Liberty XL2 acoustic signature

Silence during the speech of the pilot
(the cockpit noise rose)

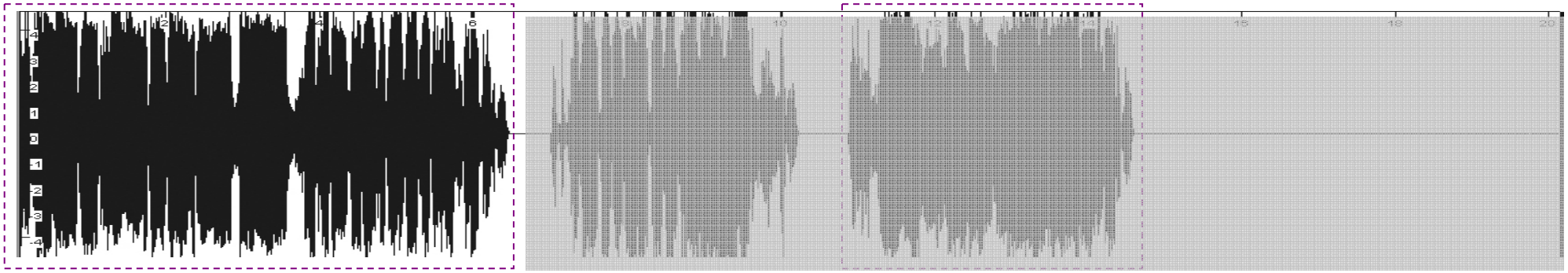


Silence during the speech of the pilot
(the cockpit noise rose)

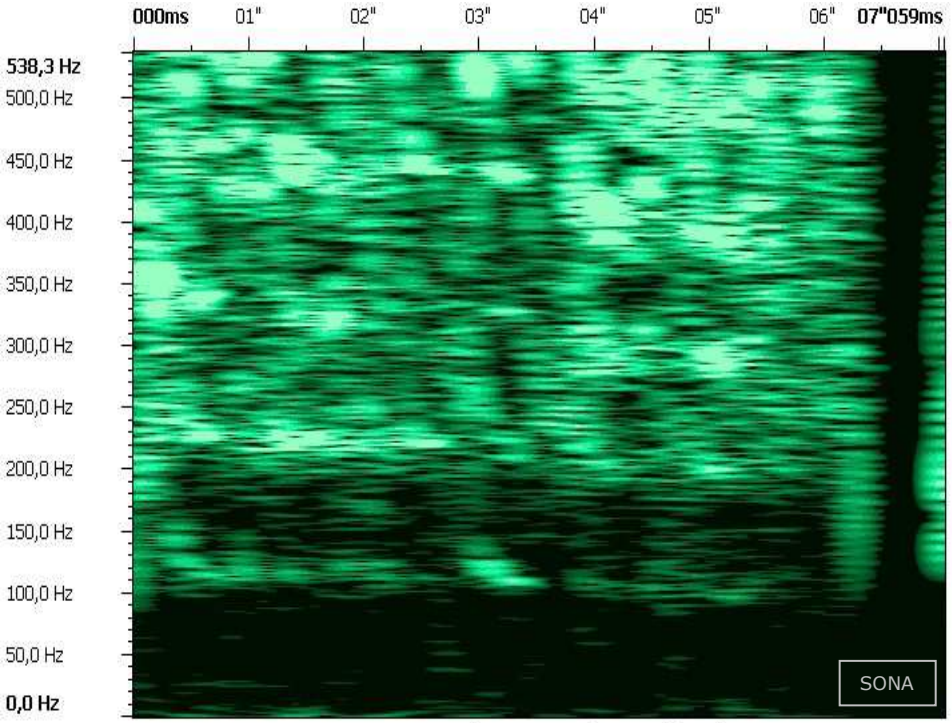


Appendix 3 - Analysis of ATC messages from the day of the event

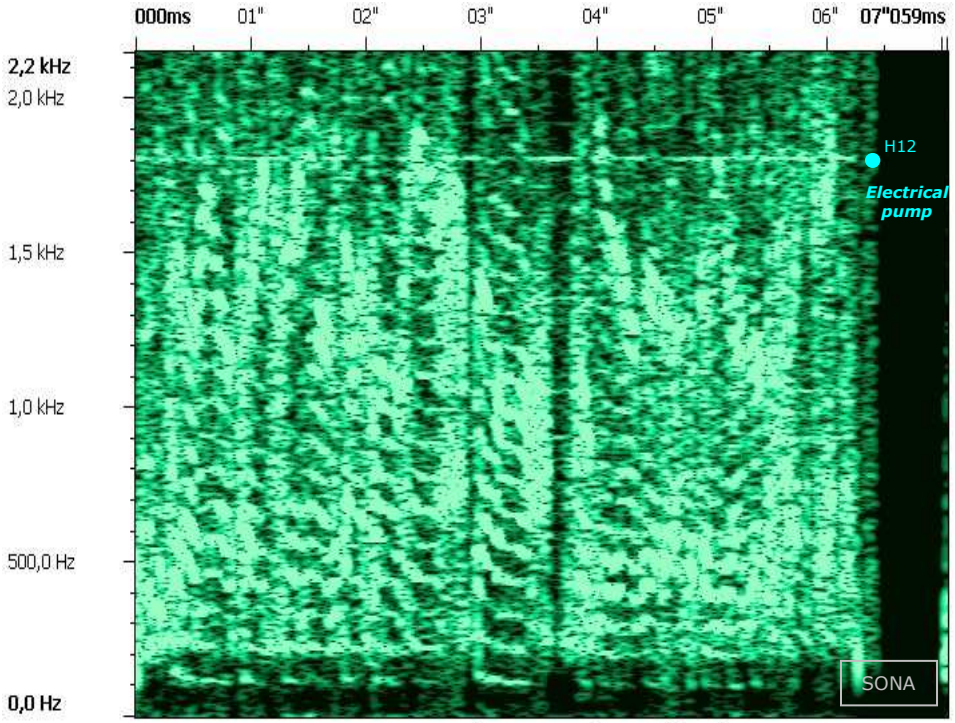
SP-AXL / ATC file *_2012-05-01__13-52-07__Kanał_01__[___nagranie___]____xxxx___0,00zł__Brak_prefiksu____.wav*



Msg 1 Msg 2



2012-05-01_13-52-07.wav (Sonagramme / Gamme de base)



2012-05-01_13-52-07.wav (Sonagramme / Gamme de base)

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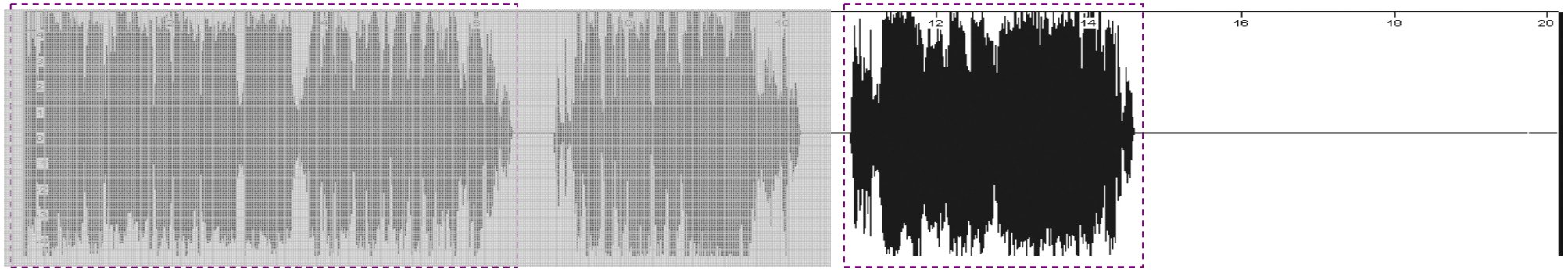

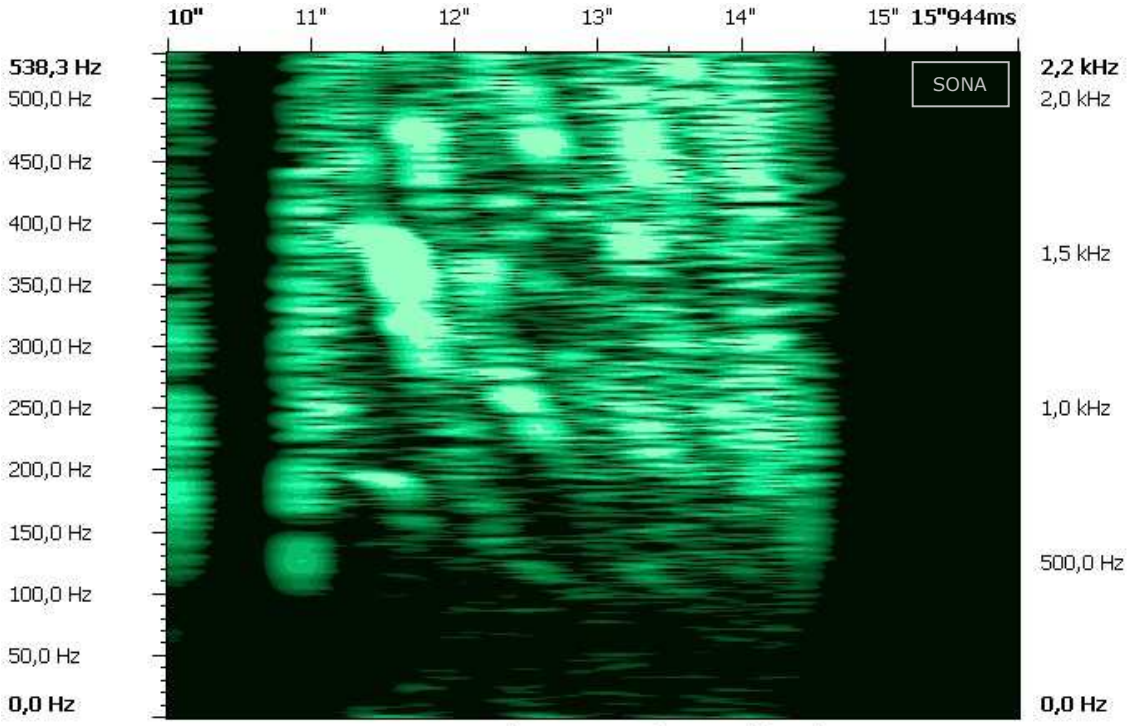

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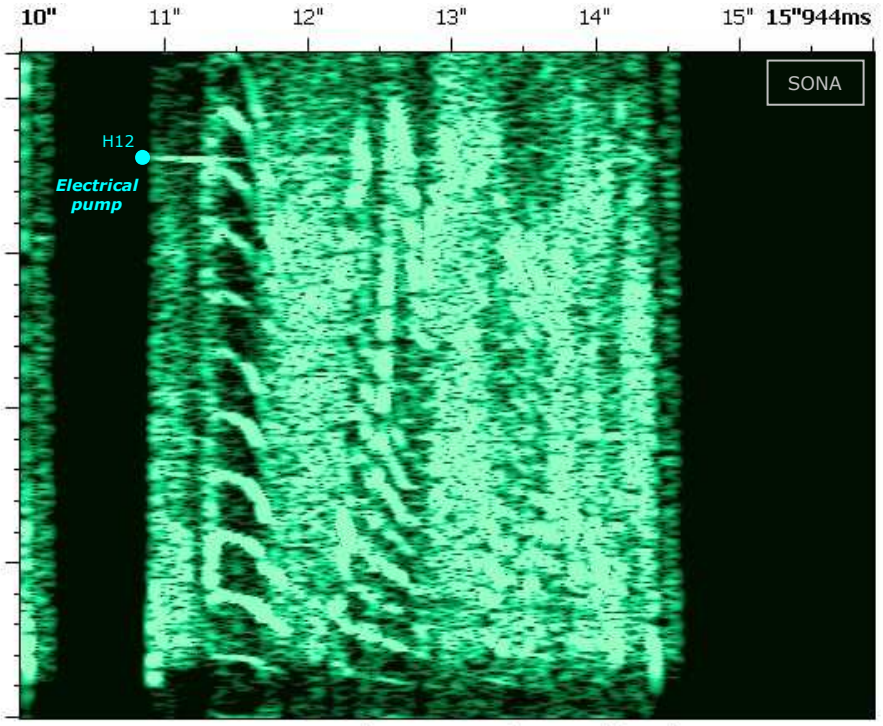

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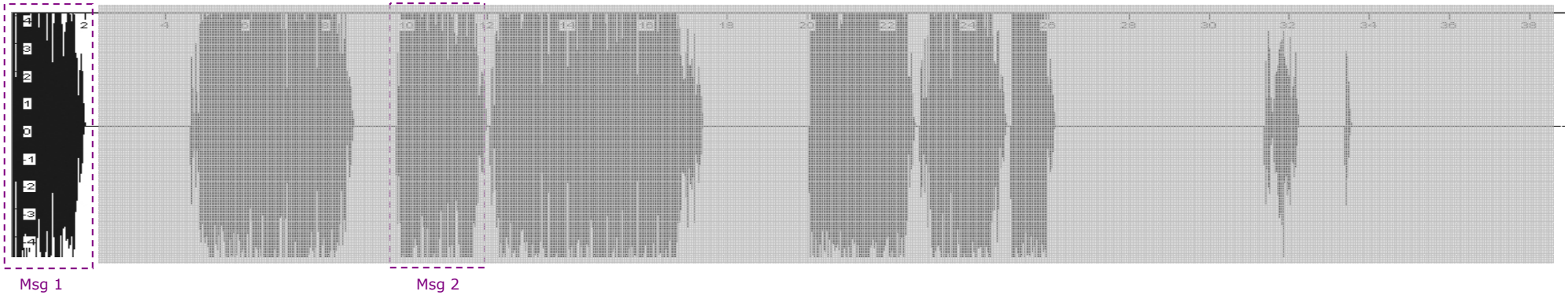

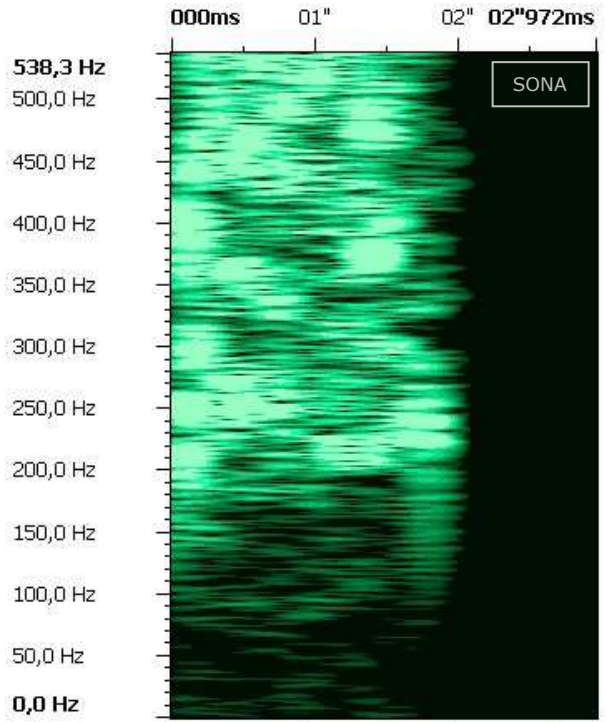

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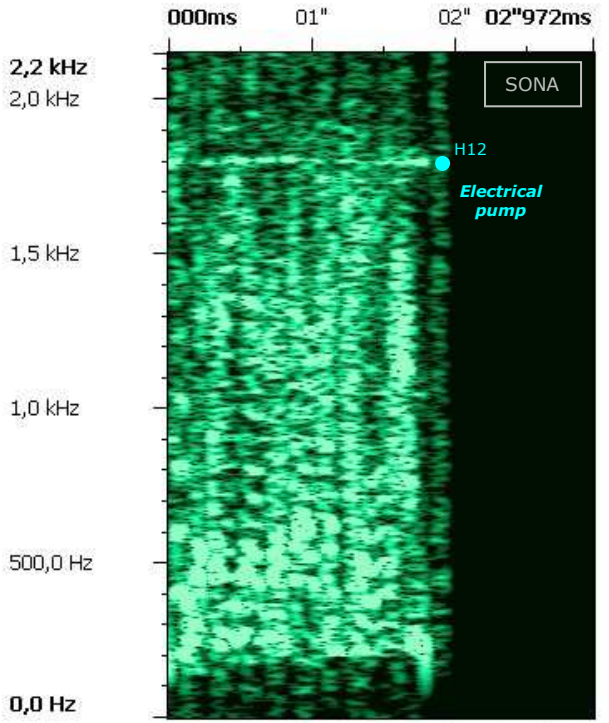

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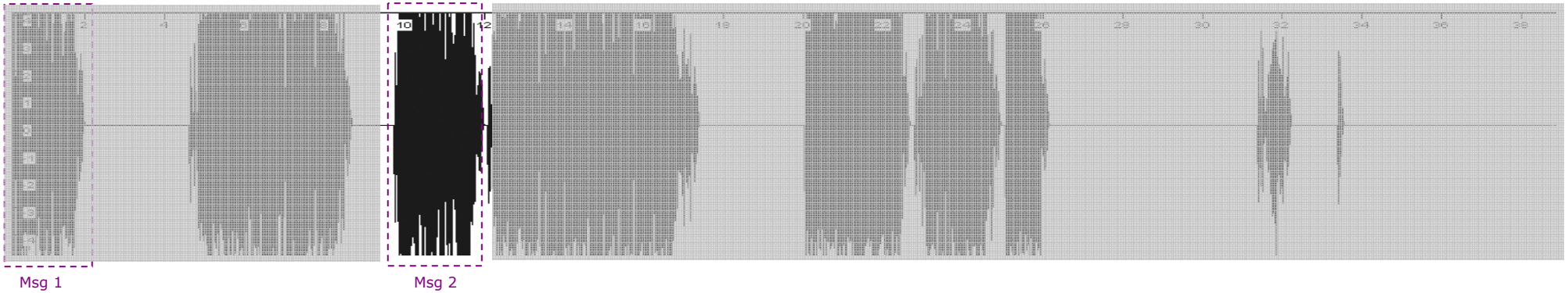

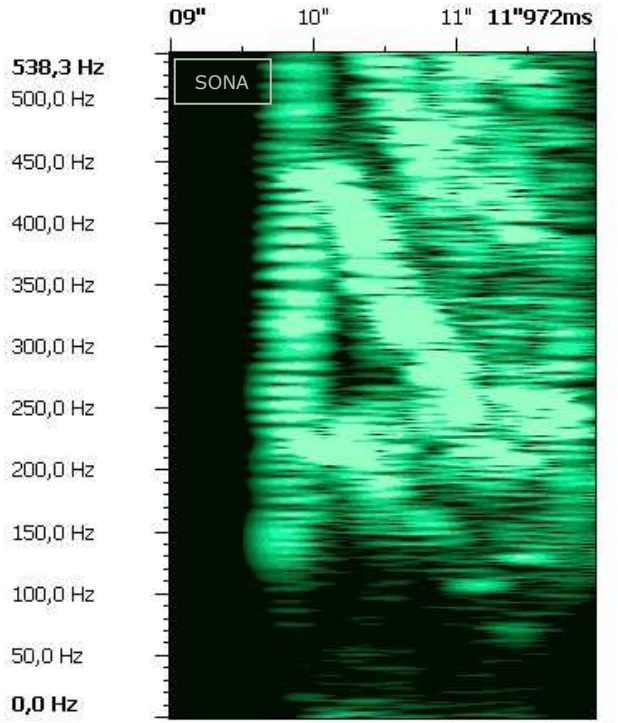

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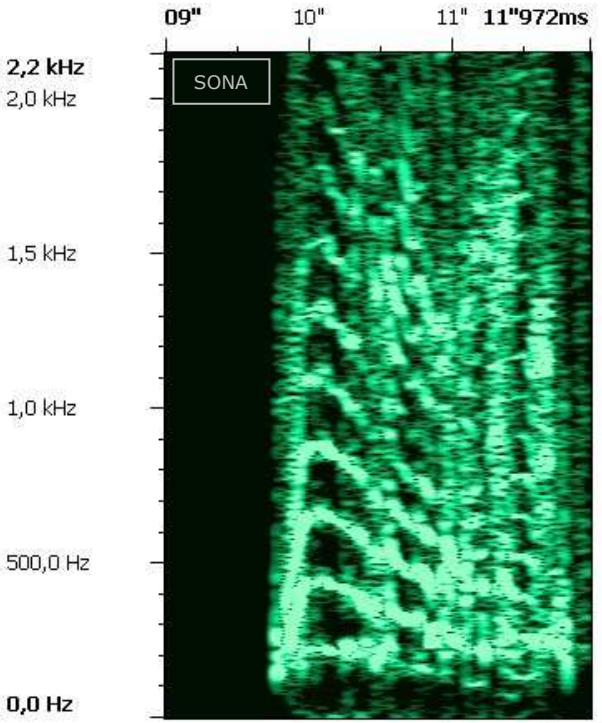

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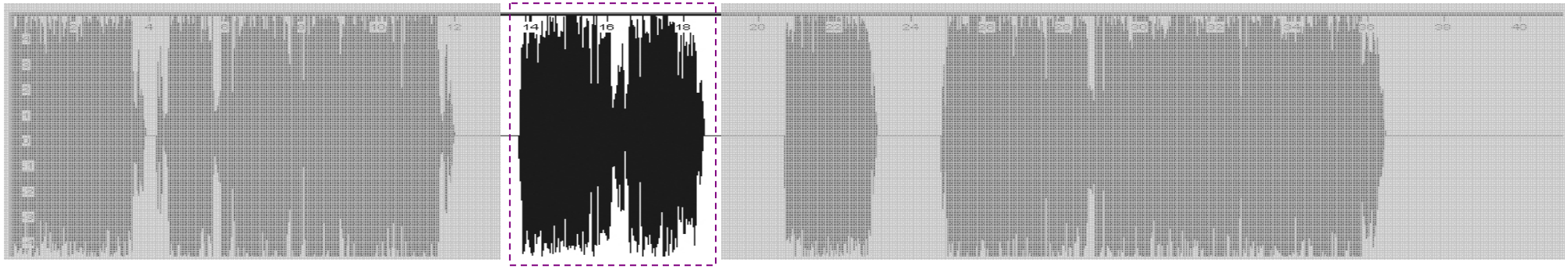
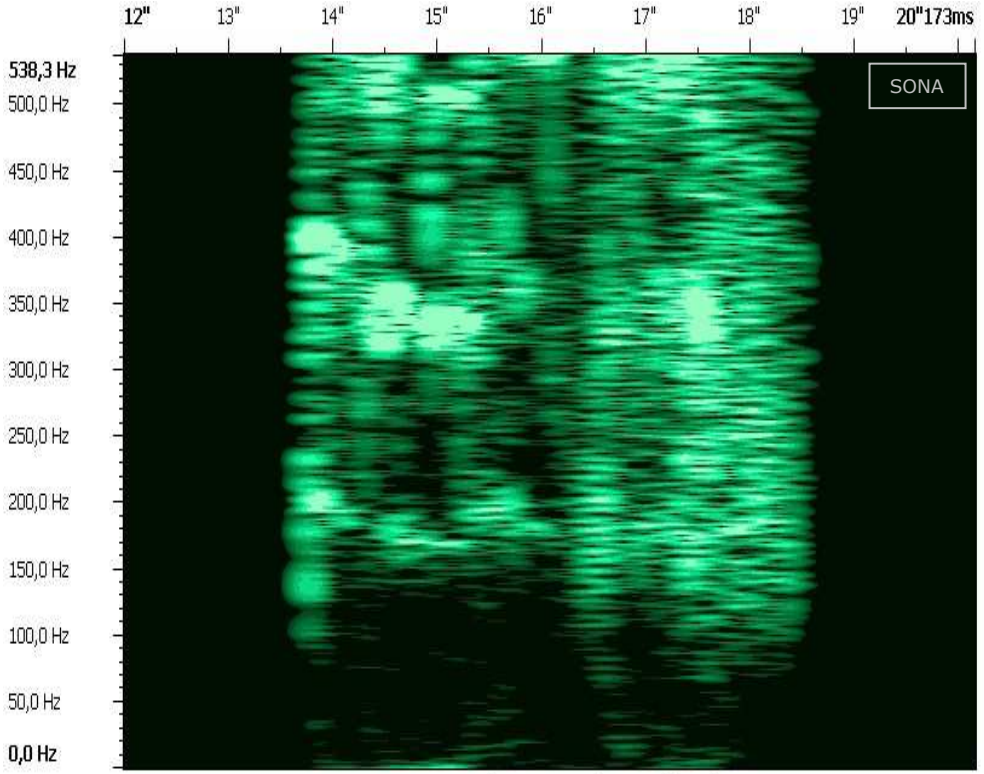


Msg 1



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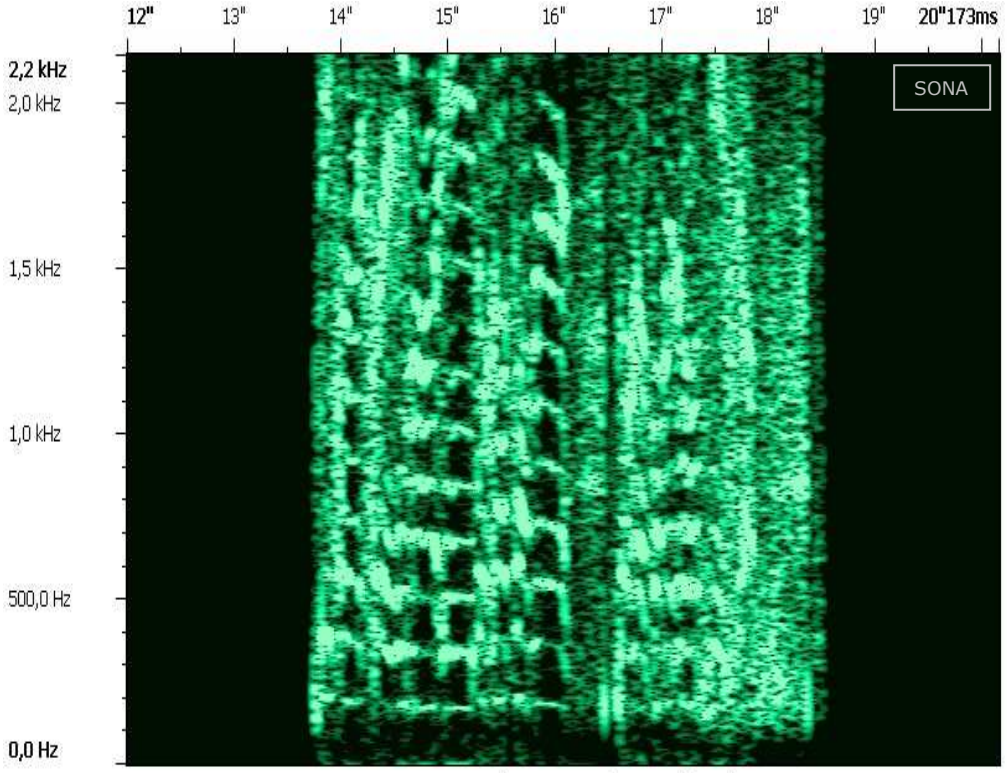

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