SS reflections from conventional 3C data

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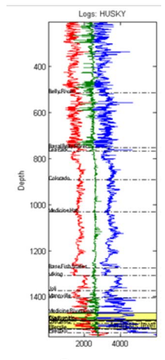
SUMMARY

This work shows an experiment with real data intended to identify the presence of pure S wave reflections (SS-waves) generated by conventional explosive sources. Just PP and PS waves are usually expected on these surveys. This work also explores its processing. The Hussard 2011 3C survey were used to this purpose. From the velocity information, it was found that the possible SS-wave arrival times concur with the highly energetic Ground Roll. Therefore noise attenuation for coherent surface waves and other events that preserves the expected SS-waves was required. After that, probable SS-events were identified. An experiment for the statics correction was carried out, and finally stacked sections were obtained for both the radial and transversal data, using statics interpolated from the receiver and a velocity analysis. The resulting SS stacked section is promising.

- **INTRODUCTION**
- It has been shown theoretically and by experiments that S waves can be generated by conventional explosive sources.
- However SS reflections have been hardly identified in real multicomponent seismic data.
- This is an experiment with real data intended to identify the presence of pure S wave reflections (SS-waves), using the horizontal components of the Hussard 2011 3C.

- **FIELD DATA ANALYSIS AND FILTERING**

From the velocity information, the possible SS-wave arrival times arrive inside the highly energetic Ground Roll (Figure 2a). Therefore it was required noise attenuation for surface waves and other events preserving as much as possible the expected SS-waves. An example of the resulting records is shown in Figs. 2b and 2c. The radial component shows strong PS wave events. Energy with the expected arrival time of SS-waves appears easier to identify in the transversal component.

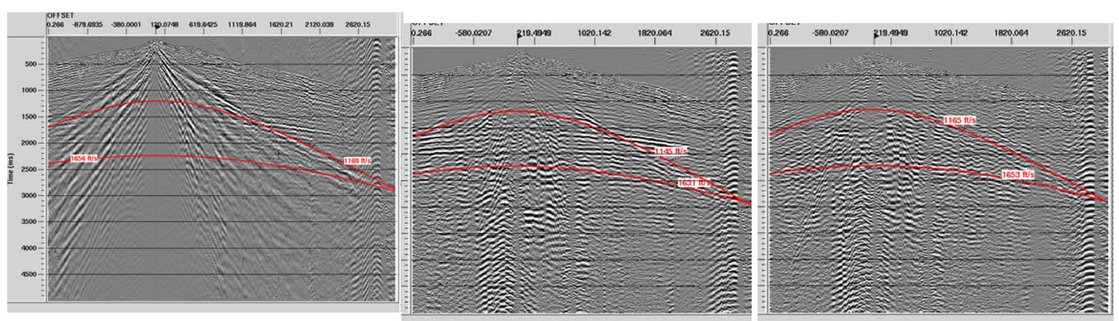


a

b

Depth m	Vp m/s	Vs m/s	t_o PP s	V_{PP} RMS m/s	t_o PS s	V_{PS} RMS m/s	t_o SS s	V_{SS} RMS m/s
30	1500	200	0.040	1500	0.170	548	0.300	200
400	2900	1500	0.291	2844	0.599	1640	0.907	1207
520	3400	1100	0.362	3094	0.743	1701	1.125	1168
750	3300	1500	0.503	3179	0.960	1845	1.416	1399
1270	3250	1500	0.803	3392	1.472	2060	2.013	1645
1450	3900	1900	0.901	3454	1.623	2111	2.217	1664
1550	4400	2200	0.949	3585	1.694	2155	2.310	1745

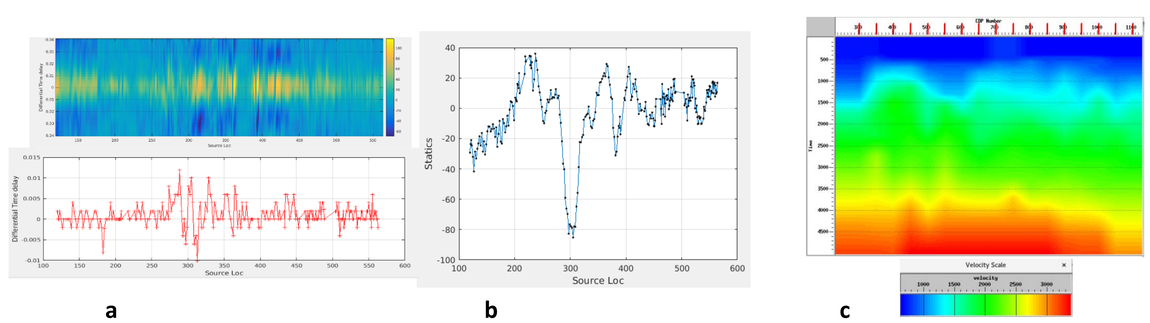
Figure1: The Sonic logs **(a)** allow to estimate the zero-offset arrival times and RMS velocities for PP, PS and SS waves, shown in the Table **(b)** above. The yellow events can be followed approximately by red lines in the shot records of Figure 2.



a b c

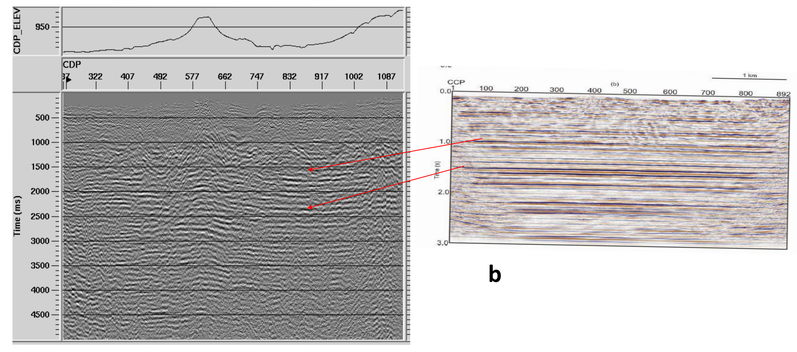
Figure2: Shot records of the horizontal components. The red lines correspond to the expected arrival times for SS reflections shown by yellow events in Fig. 1.**(a)** the radial component before noise filtering. **(b)** The radial component after noise filtering, **(c)** Transversal component after noise filtering. The transversal component was selected for the analyses, since the SS events appear easier to follow.

- **STATICS, VELOCITY ANALYSIS AND STACKING**
  - An experiment for S-wave source statics correction method included shot gather crosscorrelation (Fig. 3a), however the resut was not good enough.
  - Better result was obtained with the interpolation of the receiver statics (Fig. 3b).
  - A conventional velocity analysis was carried out on the transversal component, whose result is in Fig. 3c.
  - The stacked section of the radial component shows better image that the transversal(Fig. 4), and correlates nicely with the PS stacked section.



a b c

Figure 3: (a) An experiment for statics: above, crosscorrelation between sources; below, the resulting differential delay. **(b)** Source statics extrapolated from the PS receiver statics. **(c)** Stacking velocity model for the SS wave. Compare with the data of the Table of *Fig. 1b*.



a b

Figure 4: (a) Stacked section of the radial component, after applying the statics correction of *Fig. 3b* and the velocity model of *Fig. 3c*. **(b)** As for comparison, the PS final stack section with the same time and space scales. The red arrows show probable corresponding reflections (check arrival times in *Fig. 1b*).

- **CONCLUSIONS**
- The shots gathers, after noise attenuation, show events whose energy agree with the expected arrival time of SS waves. They are easier to identify in the transversal component.
- After source statics obtained from extrapolation of the receiver statics and a velocity analysis, the SS-wave stacked section of the radial component, shows events that correlate nicely with the PS-wave stacked section.
- The result is promising for a new technology of SS-wave applications in seismic exploration.
- There is room for research in noise attenuation and statics correction.

- **ACKNOWLEDGEMENTS**

We thanks the support of the CREWES sponsors and the CREWES staff, noticeably Kevin Hall and Kevin Bertram.

NSERC CRSNG
UNIVERSITY OF CALGARY
FACULTY OF SCIENCE
Department of Geoscience