# On SS-waves generated by conventional sources: a numerical experiment

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## SUMMARY

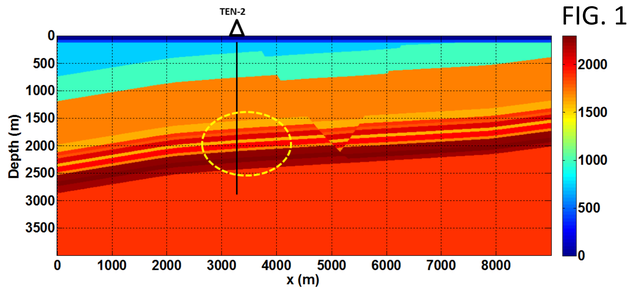
Field experiments and theoretical studies have shown that S-waves can be generated by conventional sources of energy, such as vibrators or explosives. However, they are rarely identified in conventional surface seismic data. A synthetic modeling experiment shows the presence of these events as well as the possibility of generating an image using Pre-stack Time Migration (PSTM) applied to SS reflections. It is compared with PP and PS images. The relation with real data is also considered. Research effort on this topic can be promising.

## INTRODUCTION

Theoretical models and field experiments show pure S waves generated by explosive or vertical energy sources, used for conventional seismic exploration. In this work we address SS-wave energy, through an example using a synthetic multicomponent data set. The purpose is to relate SS data with the well known PP and PS events. The tool used was pre-stack Time Migration. The results are promising, even though remarkable challenges to overcome were also identified.

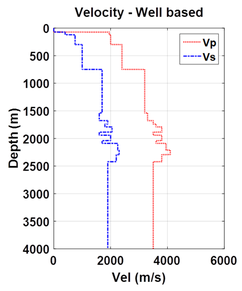
## GEOLOGICAL MODEL

FIG. 1




The geological model is roughly based on a real setting, located at the Middle Magdalena Valley Basin in Colombia. It is illustrated by the S-wave velocity model. The oval shows reflectors analyzed below with PSTM.

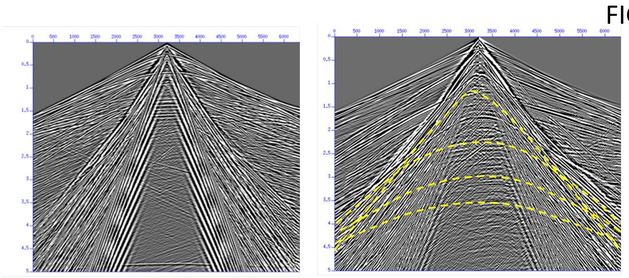
FIG. 2




The velocity profiles for P and S-waves come from well logs at this setting. This Figure shows the velocity profiles obtained after block shaping them.

## THE SYNTHETIC DATA

FIG. 3

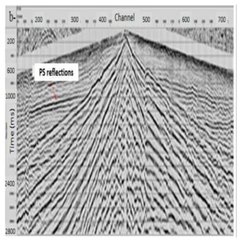


a b

The synthetic seismic data was obtained with a 2D elastic finite difference algorithm. The resulting shot gathers are illustrated here: (a) vertical component, (b) horizontal component. A rough estimate of some SS arrival times is illustrated by the yellow dashed lines.

## THE REAL DATA

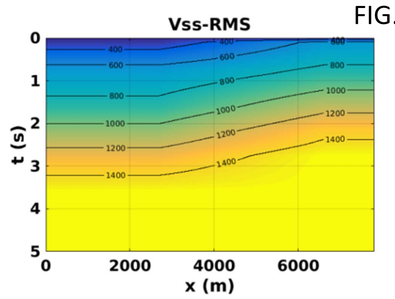
FIG. 4




An example of the real data horizontal component, taken from the thesis of Mason (2013), at that setting. Effects of coherent noise, statics, and perhaps attenuation, can be noticed.

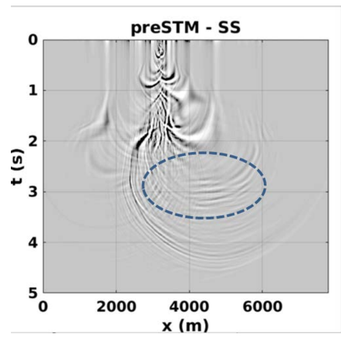
## PSTM

FIG. 5



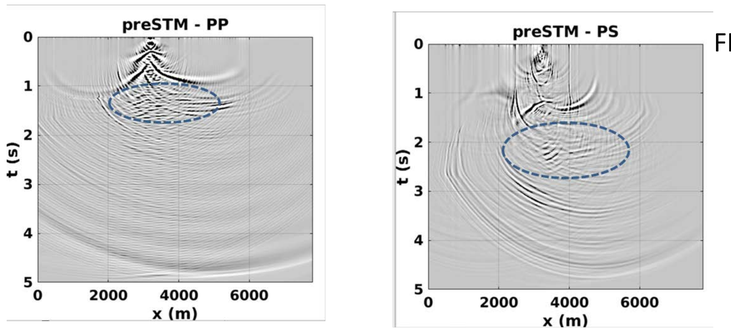

RMS velocity for SS waves used for PSTM.

FIG. 6




SS wave PSTM. The dashed oval shows the approximate location of the arrival times corresponding to the reflectors in the velocity model.

FIG. 7




a b

a) PP wave PSTM, and (b) PS wave PSTM. The dashed ovals show the approximate location of the arrival times corresponding to the reflectors in Fig.1.

## DISCUSSION

PSTM applied to SS waves appears comparable to the results of PP and PS-waves, in spite of the strong coherent noise telated to the SS events in the synthetic data. However real data exhibits additional challenges, as illustrated by Fig. 4, taken from the thesis of Mason (2012). Properties such as viscoelasticity, anisotropy and heterogeneity of the near surface can explain part of these differences, since are not considered by the FD method used for modeling (elastic and isotropic). Current progress in seismic exploration methods can provide tools to deal with these challenges. Efforts in that direction can be rewarding as a source of additional useful information from multicomponent seismic data.

## ACKNOWLEDGEMENTS

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## REFERENCES:

- Agudelo, W., Pineda, E., Gomez, R., Guerrero, J., Rojas, N., Stewart, R. R., and Coevering, N. V., 2013, Using converted-wave seismic data for lithology discrimination in a complex fluvial setting: Tenerife oil-field, Middle Magdalena Valley, Colombia: The Leading Edge, 33, 72–78.
- Guevara, S. E., 2017, PS-wave processing in complex land settings: statics correction, wave mode separation and migration. Ph.D. Thesis, University of Calgary.
- Mason, M. V., 2012, Multicomponent seismic imaging of sand reservoirs: Middle Magdalena Valley, Colombia: M.Sc. thesis, University of Houston.