Asthenospheric Flow Around the Paraná Basin Cratonic Nucleus Measured with SKS splitting

B. Melo[1] and M. Assumpção[1]

[1] Institute of Astronomy, Geophysics and Meteorological Sciences, University of São Paulo. brunamelo@usp.br

XXVIII Reunión Científica de la Asociación Argentina de Geofísicos y Geodestas

1.ABSTRACT

Anisotropy within and beneath continental lithosphere is often studied with a technique called shear wave splitting. The wave is split into two shear waves, polarized in the fast and slow directions and accumulates a delay time along with their paths. To measure the effect of splitting we use a Matlab-based environment called SplitRacer, presented by Reiss and Rumpker, 2017. The shear wave splitting analyses is based on the minimum transverse energy method by Silver and Chan, 1991. A compilation of previous fast directions in South America, together with new results from stations from the Brazilian Seismograph Network (RSBR) are presented. In general, in the stable part of South America, most fast directions are oriented roughly parallel to the absolute plate motion, however, in the southern part of the Paraná Basin, the fast directions suggest that the observed anisotropies have a contribution from asthenospheric flow deflected by a deeper lithospheric root.

2.INTRODUTION

Previous studies of S-wave splitting concentrated in the Andes and in SE Brazil. We added new measurements near the Pantanal, eastern Chaco and western part of the Paraná basins to better understand the anisotropy properties of the upper mantle in S. America and investigate the lithospheric evolution of these basins.

2.2 Shear Wave Splitting

When a core-refracted S-wave travels through an anisotropic media, it is split into two orthogonal components with different velocities.

► The direction of the fast component gives us the direction of anisotropy Φ;

► The time difference δt is related to the extent and strength of the anisotropic layer.

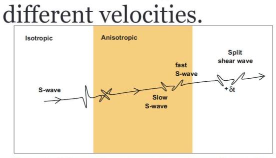


Figure 1: When a shear wave passes through an anisotropic layer it is split in two orthogonal directions with different velocities (A Wüstefeld et al, 2008).

2.3 Continental Anisotropy

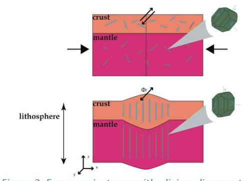


Figure 2: Frozen anisotropy with olivine alignment.

Two main hypotheses explain the origin of continental anisotropy: i) Crystallographic preferred orientation of minerals due to strain correlated with surface geological features from present and past orogenic activity "frozen anisotropy" (Savage, 1999);

ii) alignment of olivine a-axis in the direction of shear through dislocation creep induced by mantle flow or APM.

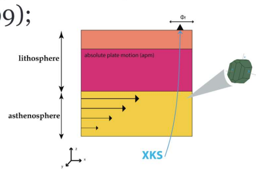
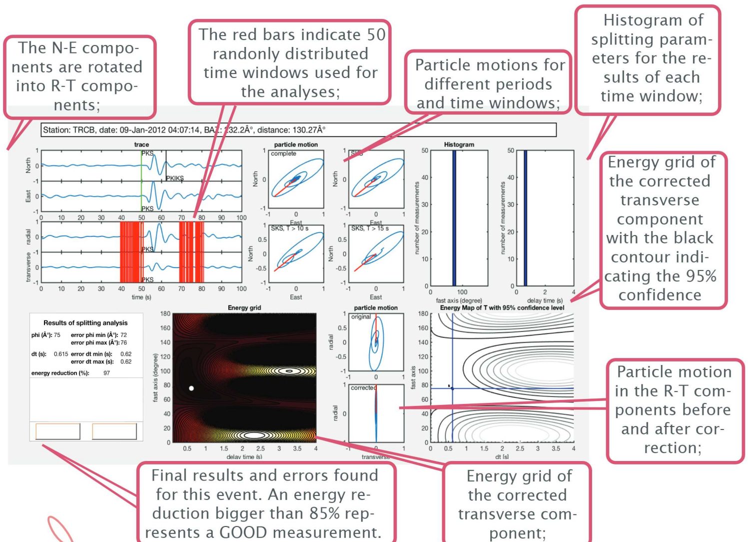


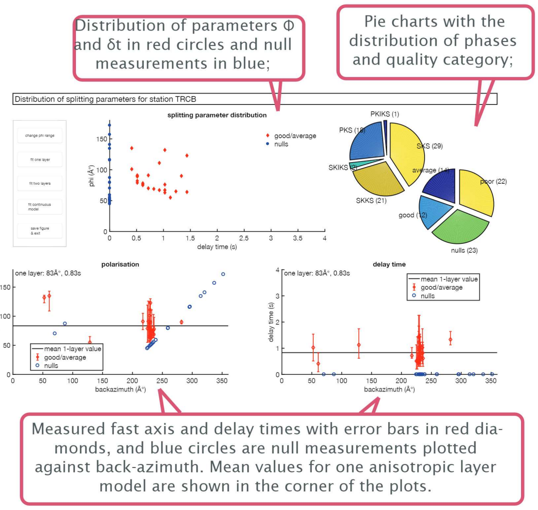
Figure 3: Alignment of olivine due to mantle flow.

3.RESULTS

We used the SplitRacer environment (Reiss and Rumpkim, 2017) minimizing the transverse energy, as in Silver and Chan (1991).



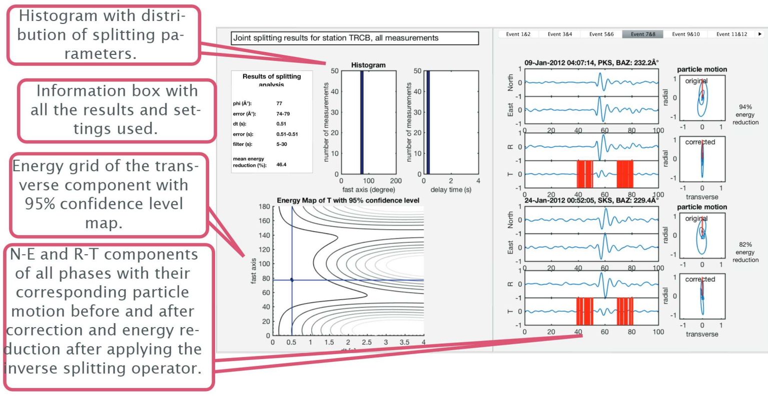
Overview of single splitting results of fast directions and delay times for the station TRCB (RSBR network):



What is a NULL measurement?

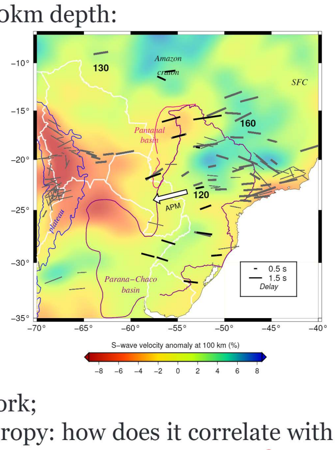
When the incoming S wave is polarized in the same direction or perpendicular to the anisotropic layer, there will be no splitting and no measurement can be made. However, NULL events are important as their back-azimuth represents either the direct or the orthogonal direction of anisotropy.

One layer joint inversion of all waveforms to find the pair of splitting parameters which best minimizes the energy on all events of the station TRCB:



Results of all stations analyzed so far compared to S-wave anomaly tomography (Assumpção et al. 2013) at 100km depth:

Bar orientations are fast anisotropy directions and lengths are delay times. Gray bars are previous results (Assumpção et al, 2011) and black bars are from this study. It is possible to see a major trend close to the HS3-NUVEL-1A model of APM. However, in the southern part of the Paraná basin, the directions suggest a contribution from asthenospheric flow deflected by a deep lithospheric root.



4.NEXT STEPS

► Analyses of stations from the XC network;

► In the case of fossil lithospheric anisotropy: how does it correlate with the lithospheric evolution of the Pantanal and Paraná-Chaco basin?

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ACKNOWLEDGEMENTS

Special thanks to Miriam Reiss for providing SplitRacer, and for being available for supporting and resolving questions about the package.

CAPES

FAPESP

Thematic Project: Pantanal-Chaco-Paraná Basins (2013/24215-6)