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Continental upper mantle structure from combined data from mobile broadband networks in South America

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Introduction

Several seismic experiments using mobile broadband stations have been carried out during the past decade throughout South America. Some of these experiments deployed stations near one another, in particular in the central Andes, while being carried out with different funding at different times by different groups of seismologists. Data recorded by these nearby experiments have been combined in studies of the uppermost mantle in the central Andes (Polet et al., 2000; Yuan et al., 2000). These studies have added significantly to results based on data from the individual experiments. Van der Lee et al. (JGR, submitted, 2000) show that the combined data from the various experiments in South America form a data set that is well suited for tomographic inversion for upper mantle structure of most of the South American continent. Van der Lee et al. (2000) used this data set to derive 3-D upper mantle *S*-velocity model SA99. SA99 provides important new information on the present state of the mantle underlying the variety of geological and tectonic provinces of the continent. Results from this study and from other studies combining mobile network data show that broadband seismic data from temporary experiments can be effective beyond the goals for which each experiment was designed. Such added value of data from mobile experiments provides another argument for depositing such data for archiving and distribution at a central data center, such as the IRIS and ORFEUS data centers.

Data

The bulk of the seismograms used for the derivation of 3-D *S*-velocity model SA99, stems from five different temporary seismic experiments. This set of seismograms was augmented by seismograms from permanent GSN stations and from a permanent station, LCOC, operated by the Department of Terrestrial Magnetism (DTM) of the Carnegie Institution of Washington (CIW). Three of the five temporary experiments were carried out by DTM: BLSP92 (James et al., 1993) in south-east Brazil and in collaboration with the Instituto Astronômico e Geofísico of São Paulo, BANJO (Beck et al., 1994) in Bolivia and in collaboration with the University of Arizona, and VEN92 (Russo et al., 1996) in Venezuela and in collaboration with INTEVEP, Venezuela and the University of the West Indies, Trinidad. The BLSP95 temporary experiment (Assumpção et al., 2000) was carried out in south-east Brazil, complementing results from the BLSP92 experiment. These seismic experiments operated with STS2 sensors and RefTek data acquisition systems, using GPS timing. The fifth experiment, SEDA (Beck et al., 1994), operated in Bolivia with CMG40T sensors, producing a limited number of seismograms useful for SA99, which have been analyzed in conjunction with the longer period seismograms from the same events recorded at the BANJO stations. Figure 1 shows a map of all stations used for SA99. Van der Lee et al. (2000) selected seismograms from regional events (Fig. 1) in the magnitude range from 4.6 to 6.6 with a good signal to noise ratio, which was verified visually. A total of 611 seismograms were used to derive SA99. Of this total, 299 were recorded by BLSP92, 114 by BANJO, 42 by BLSP95, 11 by VEN92, 19 by SEDA, 114 GSN stations, and 12 by station LCOC.

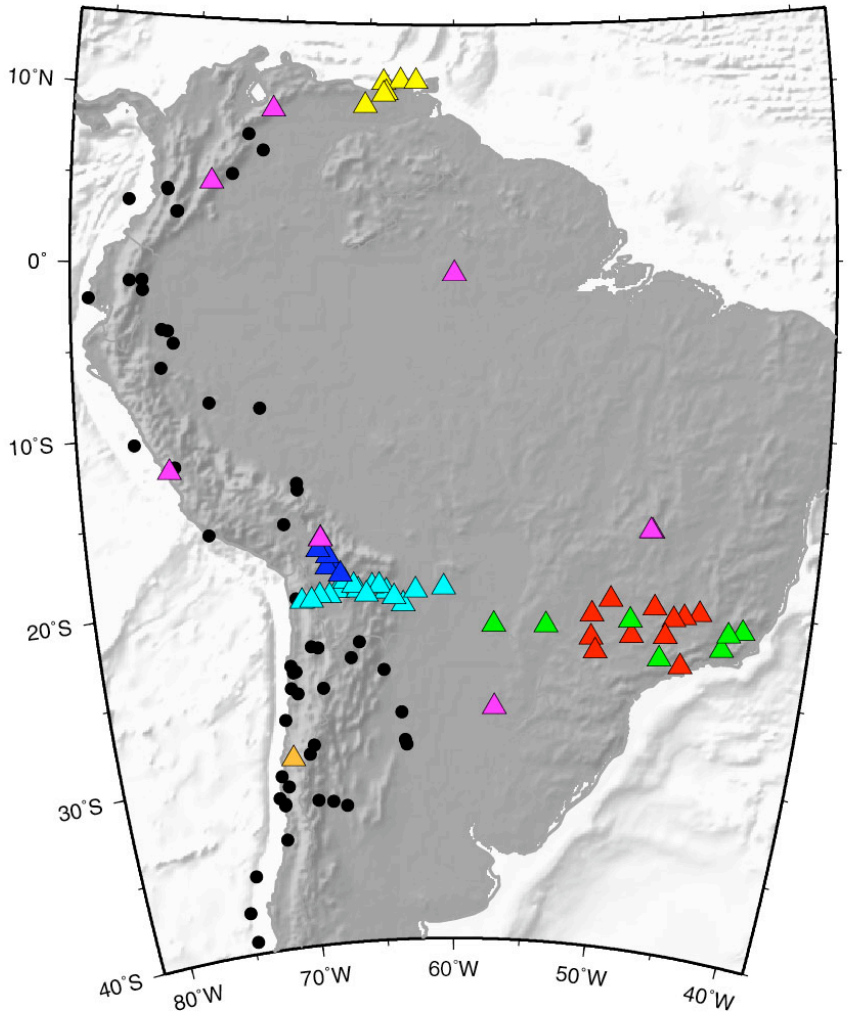

Figure 1. Map of events (black dots) and seismic stations (triangles) used for model SA99. Purple: GSN, red: BLSP92, turqoise: BANJO, green: BLSP95, yellow: VEN92, blue: SEDA, orange: LCOC.

Method

The vertical components of the selected broadband seismograms were filtered within the range from 10 to 160 s and were windowed around the time period including the arrival of a regional *S* body wave, its multiples, and the fundamental mode Rayleigh wave. In the first part of the applied method of Partitioned Waveform inversion (PWI) (Nolet, 1990) the filtered and windowed waveforms were fitted with synthetic seismograms, computed by mode summation. The linear constraints on *S*-velocity structure provided by the waveform fits were combined in an inversion for a 3-D *S*-velocity model (Van der Lee et al., 2000) using the application of Van der Lee and Nolet (1997). This model is SA99.

Results

SA99 shows a diversity in upper mantle structures that corresponds to the variety of large-scale tectonic and geologic provinces in South America, discussed in detail by Van der Lee et al. (2000). Figure 2 shows a vertical profile through SA99. The profile runs in an almost W-E direction through the center of the continent.

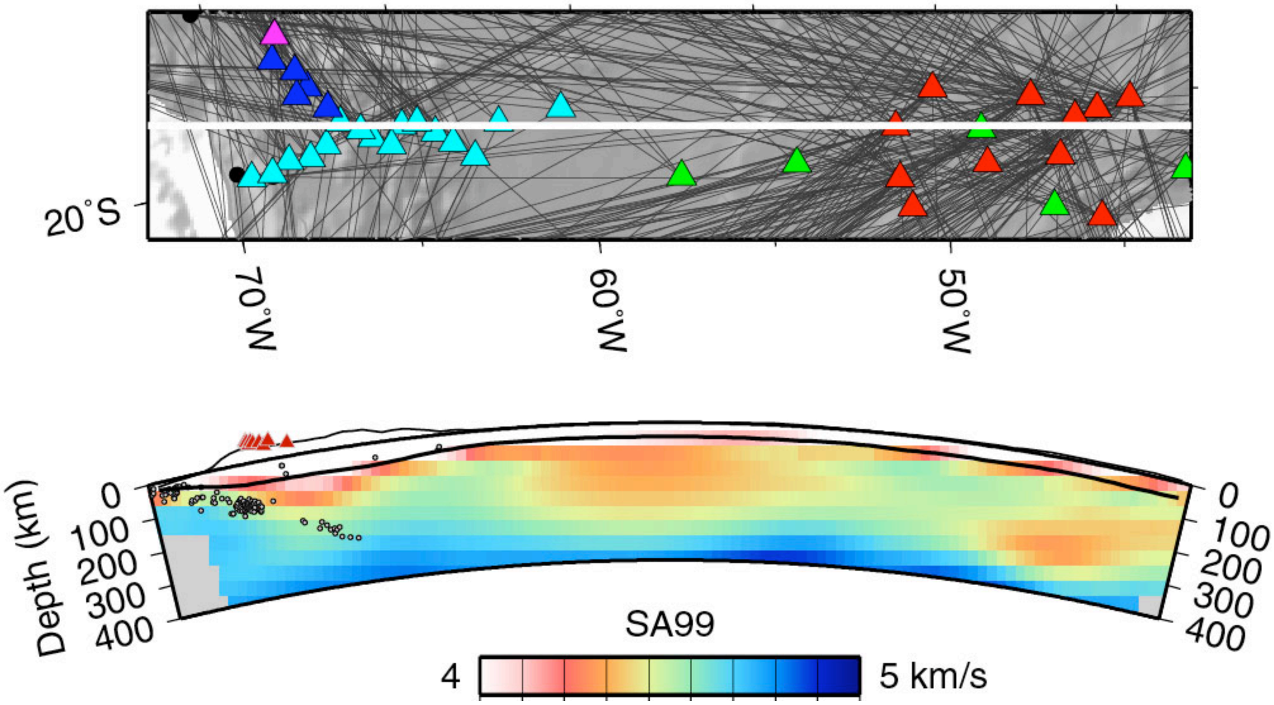

Figure 2. Cross section through 3-D *S*-velocity model SA99. Map symbols as in Fig 1. The grey dots in the profile represent hypocenters located by Engdahl et al. (1998), the small red triangles along the line of exaggerated topography represent volcanoes (James, personal communication, 1999).

On its east side the profile shows a W-dipping high-velocity feature related to the relatively cool oceanic lithosphere of the subducting Nazca plate. In the uppermost mantle the subducting Nazca plate is overlain by a mantle wedge of velocities so low as to require the presence of water and related peridotite melts to explain the low values. The center of the profile shows relatively warm mantle underlying the Chaco and Pantañal basins. The western part of the profile shows normal to relatively high velocity lithosphere in the uppermost mantle under this part of the Brazilian shield. This lithosphere in the western part of the profile is underlain by a focused region of very low velocities, possibly related to the fossil remains of an old mantle plume (VanDecar et al., 1996).

Conclusions

Seismograms from temporary deployments of mobile stations, but also data from local or regional seismic networks of a more permanent character, continue to be valuable after they served to reach the goals for which the deployments were designed. Here we show how they can be used to image upper mantle structure on a continental scale, which is merely one example of the added value of broadband seismic data that have been properly archived. Data centers, such as that of IRIS and ORFEUS, maintain open data archives in central and easily accessible sites. The completeness and value of these archives can be further improved if, on one side, the data centers advance their efforts in coordinating and facilitating data submission, and, on the other side, if network operators all push data from their networks towards the available central on-line archives long before their data "disappear" in local, off-line storage media with a limited life time.

Acknowledgements

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