AN IMAGE PROCESSING TECHNIQUE TO DERIVE GEOLOGICAL DISCONTINUITIES IN SOUTH AMERICA

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Abstract. The aim of this paper is to construc an image from Moho discontinuity in South America. This result can be obtained through global modeling of Rayleigh waves phase and group velocity (ROSA (1986) and SANTA ROSA (1996)). The initial 2-D inversion model was defined according to the geographic position of each block, sized 10 x 10 degrees by ROSA (1986), in the continent and in the ocean. As a result of the inversion, we obtained global group velocity, i.e. the images for the following periods: 50, 55, 60, 65, 70 e 75 seconds (see Figure 1). In the next step, 48 blocks were selected; that is, the number of blocks that cover the whole extension of South America (see Figure 2a). Global phase and group velocity inversions were made for each block, thus determining shear wave versus depth images. Finally, to determine the image of the Mohorocivic discontinuity for South America, we fixed the minimum value for shear wave velocity in 4.6 km/s and interpolated it for all blocks. The final result is the first image of the Moho discontinuity in South America (see Figure 2b). This work was supported by the Brazilian National Council for Scientific and Technological Development (CNPq).

Keywords: Image Processing, Image Modeling, Moho Discontinuity, Geology

BASIC ELEMENTS

We utilized surface Rayleigh waves group velocity curves for the period interval ranging from 20 to 98 seconds. These curves were organized according to literature data by SANTA ROSA & ROSA (1994), and SANTA ROSA (1996).

The initial model 2-D inversion was similar to the one described by JORDAN (1981); in the present study, however, we utilized blocks of 10 x 10 degrees, similarly to the model of ROSA (1986) (see Figure 2a).
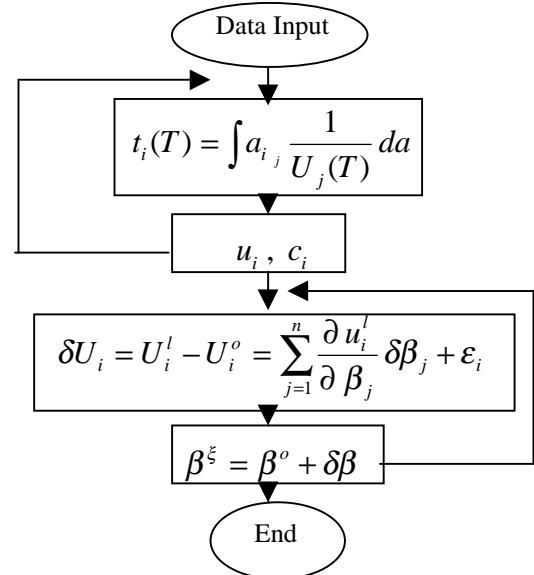
ALGORITHM DESCRIPTION

The classical surface waves radium tracing method supposed that such waves propagate around the Earth along a "great circle". Therefore, we can represent the travel time value as t_j for each studied wave path j in the first expression of the diagram below. The values of $a_{i\,j}$ represent the distances of the i-th wave path at the j-th block. t_i is the travel time of the i-th path for the T period, and $U_j(T)$ is the group velocity for the j-th block. The results are u_i and c_i, which correspond to group and phase velocity respectively adjusted. The next expression of the diagram determines the value of $\delta\beta_i$ so as to adjust the residue ε_i.

Finally, in the last expression of the diagram the shear wave velocity model is updated, by adding the increases in the shear wave velocity parameter to the to the previously defined value for the ζ-th

iteration . The process is then repeated until the residue δU_i is in the measurement errors range and that the perturbations do not suffer changes.

BLOCKS DIAGRAM

$$t_i(T) = \int a_{i\,j} \frac{1}{U_j(T)} da$$

$$u_i \, , \; c_i$$

$$\delta U_i = U_i^l - U_i^o = \sum_{j=1}^{n} \frac{\partial u_i^l}{\partial \beta_j} \delta\beta_j + \varepsilon_i$$

$$\beta^\xi = \beta^o + \delta\beta$$

Data Input — End

RESULTS

In all images (Figure 1), it is possible to notice low velocity regions - corresponding to the Andes Mountain Chain, the Amazon Basin, the East Pacific Chain – and high velocity regions - corresponding to both the Brazilian and the Guyanas Shields.

Figure 2b shows that such South America results are consistent with the plate tectonic known

for the region, being the greatest thickening (around 70 km) found in the Andes regions, and thickening between 30 and 40 km in the shields. Curiously, we found a great crust thickening in the central portion of the Amazon Basin and in the western portion of the Parnaíba Basin, which reaches over 40 km in these areas.

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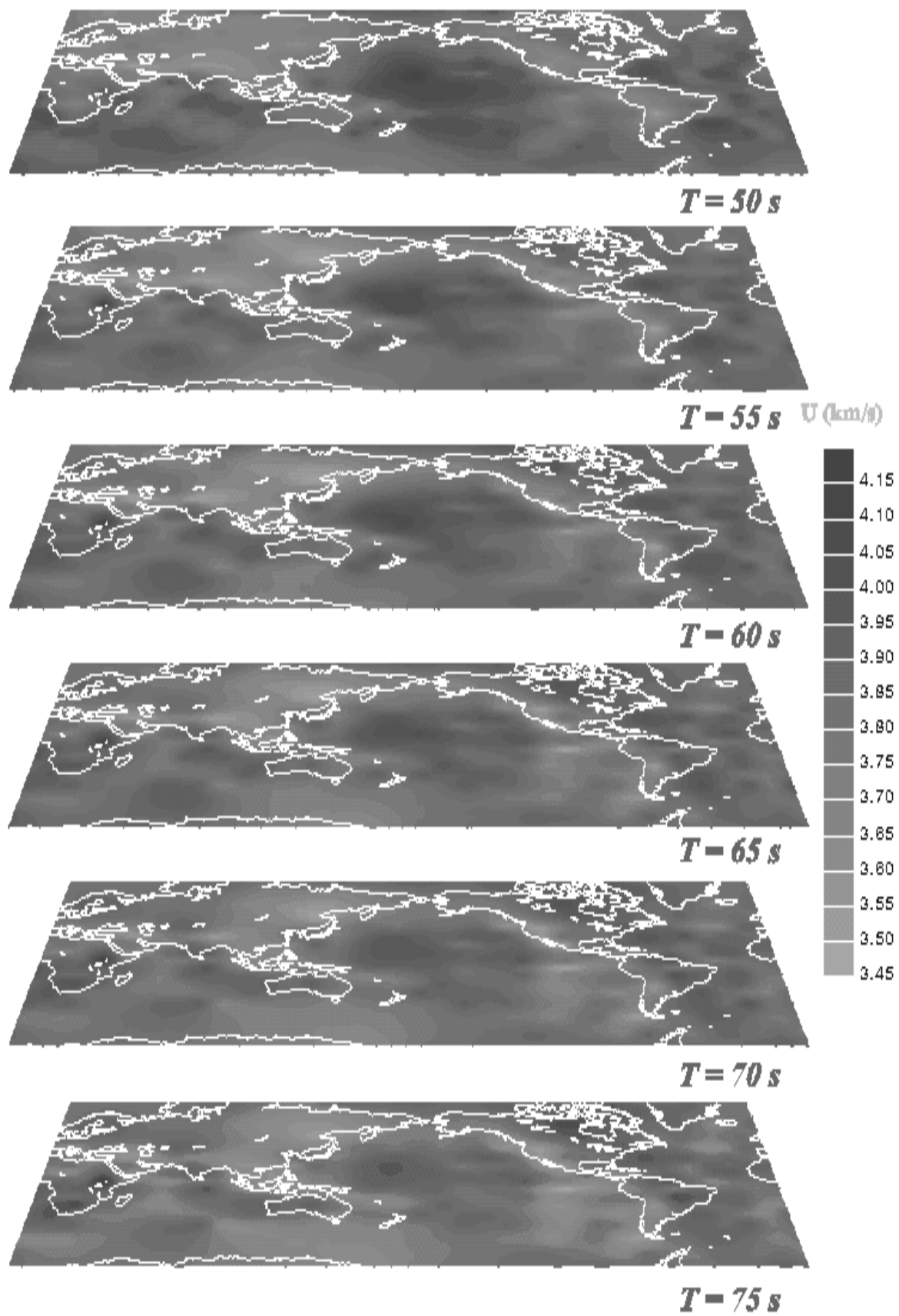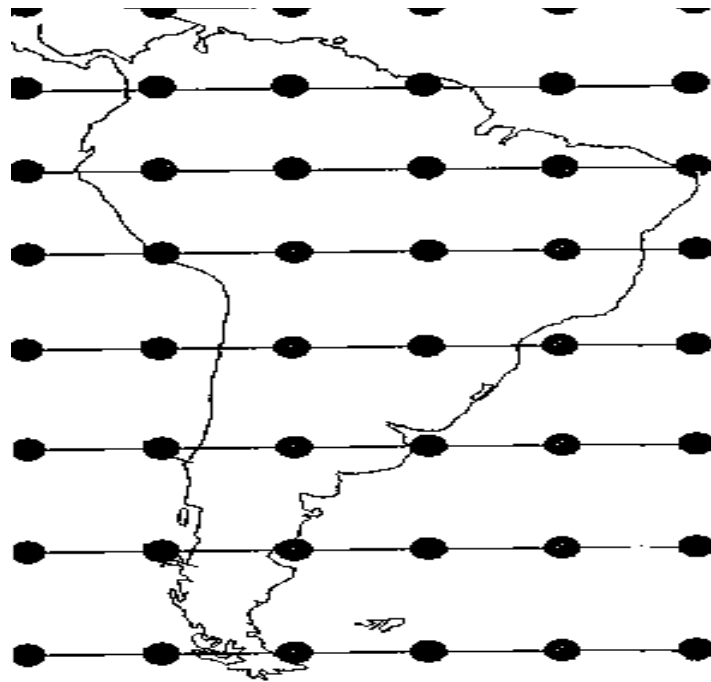
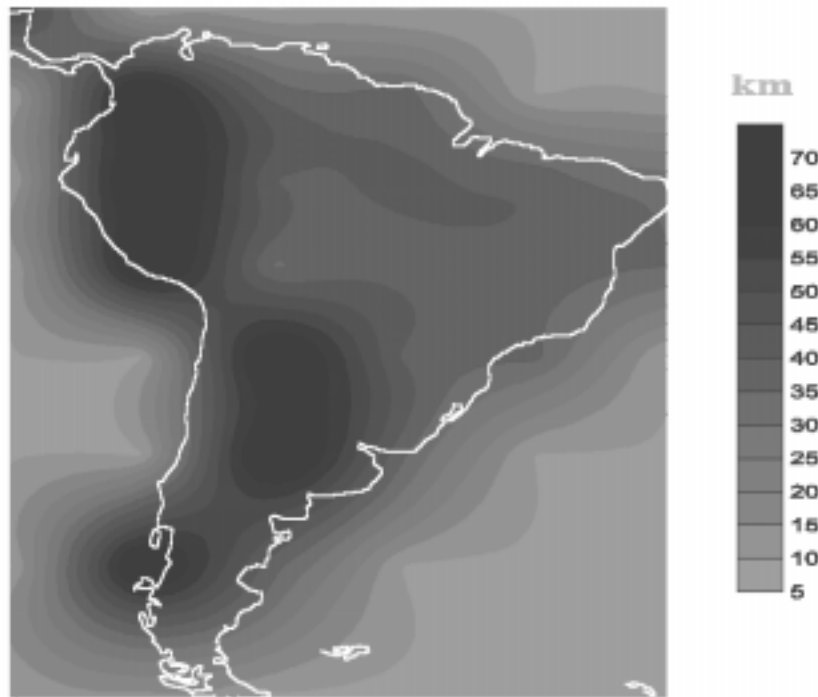Figure 1. Global images for the periods of 50 to 75 seconds

MOHO DEPTH

Figure 2 a (upper Figure). Blocks disposition.
Figure 2 b (lower Figure). Mohorocivic discontinuity image for South America.