

MONTE CARLO APPROACH TO ASSESS THE UNCERTAINTY OF WIDE-ANGLE LAYERED MODELS: APLICATION TO THE SANTOS BASIN, BRAZIL

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RESUMO: The interpretation of wide angle seismic refraction models must take into account the uncertainties of the resulting models, as different modelling approaches may lead to dissimilar models with overlapping uncertainties. Model uncertainties are difficult to estimate, as the problems are generally ill-constrained and trans-dimensional (we are unable to determine the correct number of parameters that define the minimum structure discernible in the data). Uncertainty estimations must be an integral part of modelling results to avoid disparaging interpretations of the same structure imaged at opposite ends of each model's uncertainty bounds, or the exclusion of alternative hypothesis that the model is unable to undoubtedly reject. In the Santos Basin (Brazil), two parallel wide-angle refraction profiles show different crustal structures. One shows moderate crustal velocity gradient, and a clear Moho with topography. The other has an anomalous velocity zone, and no clear Moho reflections. This has large implications on the geological and geodynamical interpretation of the basin. Model uncertainties must be excluded as a source of these differences. We developed VMONTECARLO, a tool to assess model uncertainty of layered velocity models using a Monte Carlo approach and simultaneous parameter perturbation using all picked refracted and reflected arrivals. It gives insights into the acceptable geological interpretations allowed by data and model uncertainty through velocity-depth plots that provide: a) the velocity-depth profile range that is consistent with the travel times; b) the random model that provides the best fit, keeping most of the observations covered by ray-tracing; c) insight into valid models dispersion; d) main model features unequivocally required by the travel times, such as first-order versus second-order discontinuities, and velocity gradient magnitudes; e) parameter value probability distribution histograms. VMONTECARLO is seamlessly integrated into a RAYINVR-based modelling work-flow, and can be used to assess final models or sound the solution space for alternate models, and is also capable of evaluating forward models without the need for inversion, thus avoiding local minima that may trap the inversion algorithms and providing information for models still not well-parametrized. Results for the Brazilian models show that the imaged structures are indeed geologically different and are not due to different interpretations of the same features within the model uncertainty bounds. These differences highlight the strong heterogeneity of the crust in the middle of the Santos Basin, where the rift is supposed to have failed.

PALAVRAS-CHAVE: SANTOS BASIN, MODEL UNCERTAINTY, WIDE-ANGLE REFRACTION.