Bayesian approach to tomographic imaging of rock-mass velocity heterogeneities

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Abstract

Detailed imaging of the Earth subsurface structure has both scientific and practical aspects. From a scientific point of view detailed knowledge of the Earth's structure in different scales is necessary for understanding various geodynamic, tectonic or human-induced processes. Practical aspects include such important issues as localization and describing deposits of various natural resources. Although huge progress has been made in this field, there are still a lot of intriguing questions not answered yet. One of them is the question of the relation between observed seismicity in a global, regional or local scale and the earth's structure or, in the case of induced seismicity, with the rock-mass structure. This issue is still waiting for a satisfactory analysis. In the case of local problems like, for example, those presented by mines, this very general task converts into very practical questions among which precise seismic hazard estimation and safety of mining exploitation are of the highest importance. Thus, further analysis of the possible relation between actual and future seismicity and rock-mass heterogeneity is still necessary. However, solving this task has many obstacles. One of them is the limited precision of rock-mass tomographic imaging techniques. In this paper we address this issue and argue that whenever available computational resources allow, the probabilistic (Bayesian) approach should be used. Since this inversion method introduces some additional complexity to the already

difficult seismic tomography technique, we decided to describe the basic steps of Bayesian tomographic imaging from data preparation to analysis of imaging results. The methodological considerations are illustrated by examples of imaging for four mining regions within the Rudna (Poland) copper mine.