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Pareto joint inversion of 2D magnetotelluric and gravity data

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In this contribution, the first results of the "Innovative technology of petrophysical parameters estimation of geological media using joint inversion algorithms" project were described. At this stage of the development, Pareto joint inversion scheme for 2D MT and gravity data was used. Additionally, seismic data were provided to set some constrains for the inversion. Sharp Boundary Interface(SBI) approach and description model with set of polygons were used to limit the dimensionality of the solution space. The main engine was based on modified Particle Swarm Optimization(PSO). This algorithm was properly adapted to handle two or more target function at once. Additional algorithm was used to eliminate non- realistic solution proposals. Because PSO is a method of stochastic global optimization, it requires a lot of proposals to be evaluated to find a single Pareto solution and then compose a Pareto front. To optimize this stage parallel computing was used for both inversion engine and 2D MT forward solver. There are many advantages of proposed solution of joint inversion problems. First of all, Pareto scheme eliminates cumbersome rescaling of the target functions, that can highly affect the final solution. Secondly, the whole set of solution is created in one optimization run, providing a choice of the final solution. This choice can be based off qualitative data, that are usually very hard to be incorporated into the regular inversion schema. SBI parameterisation not only limits the problem of dimensionality, but also makes constraining of the solution easier. At this stage of work, decision to test the approach using MT and gravity data was made, because this combination is often used in practice. It is important to mention, that the general solution is not limited to this two methods and it is flexible enough to be used with more than two sources of data. Presented results were obtained for synthetic models, imitating real geological conditions, where interesting density distributions are relatively shallow and resistivity changes are related to deeper parts. This kind of conditions are well suited for joint inversion of MT and gravity data. In the next stage of the solution development of further code optimization and extensive tests for real data will be realized. Presented work was supported by Polish National Centre for Research and Development under the contract number POIG.01.04.00-12-279/13