Incorporation topography into two dimensional resistivity modeling by using finite difference technique with triangular descritization: comparison with finite element solution

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Topographic effects are commonly simulated using finite element method by means of flexible modeling mesh. In this study we focused on simulating terrain effects using finite difference technique with triangular cell. We developed a new computer program which is capable of solving Poisson's equation by using finite difference and finite element numerical solution techniques. We incorporated topography using three different approaches based on finite element method and also two different approaches based on finite difference method. In both numerical methods we assigned a high resistivity values to the rectangular blocks constituting the cells at the air earth boundary, which represent air portion of the modeling mesh. This approach simulated the topography in a stair case fashion and we showed that it can not represent the topographic effects well if one compare to the FE-distorted mesh solution. Unlike previous studies where a finite difference forward solution was used, triangular elements were formed by completing the diagonals of the rectangular cells, thereby offering flexibility in model design that is typically only available in finite element method. We compared finite element and finite difference solution results for various two dimensional resistivity models with undulating surface topographies and resistivity distributions. Comparisons of these numerical techniques show that both of the numerical solutions give similar model responses. We showed that a finite difference solution of the Poisson equation with triangular descritization allows us to simulate surface topography as well as finite element solution. This study also shows that a finite difference solution can be used as an alternative method to obtain solutions more quickly than finite element methods with almost the same accuracy.