

**k.N. Toosi University of Technology**

**Faculty of Geodesy and Geomatics**

**PhD Thesis in Civil-Surveying Engineering**

**In Geodesy**

**Method of Fundamental Solution as a mathematical modeling tool of volcanic deformation field based on satellite geodesy observations**

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**Abstract**

According to geodetic research works, surface deformation in the form of uplift or subsidence in volcanic areas is either a sign of magma moving towards the opening of the volcano (inflation) or removal of the magma source (deflation). Using the new method of fundamental solutions (MFS)

in this study, a deformation field for the surface of the volcano is calculated considering the effect of topography. MFS is a numerical technique for solving boundary value problems with known partial differential equations. This technique has not been used in volcanic deformation studies so far. To test the method, the displacements calculated using the MFS were compared with that of the interferometric synthetic aperture radar observations from the previous studies in Cerro Blanco and Campi Flegrei volcanoes. These volcanoes were in the deflation mode during this period at the rate of 1.2 cm/yr and 2 cm/yr respectively. The comparisons showed root mean square errors (RMSE) in the order of 2 mm which represents a satisfactory agreement with the results of the observations, less than the RMSE of the analytical models considered.

As lava accumulates in reservoir and then comes to the surface, geometry of the source can be used to predict volcanic eruptions. In this study, using the inverse MFS and taking into account the effect of topography, the geometry of the source including shape, depth and center position of the magma tank is estimated. The displacement field calculated in the previous studies using InSAR for deflation mode of Cerro Blanco volcano was utilized in this study. It was estimated that the magma source of the volcano is a sphere with a radius of 1 km located at horizontal position of (1.001±4×10-6;-1.001±1×10-6) km and the depth of about 10 km from the summit with respect to the defined coordinate system. This finding is consistent with that of recent studies in which inversion of InSAR data was used to analyze the geometry of the magma source.The RMSE between the deformation fields of the magma source calculated in the previous studies and that of the study herein via MFS was approximately 3mm.

**Key words**: Displacement field, Method of fundamental solutions, Volcano, magma source, Meshless method, Boundary value problem