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Multidirectional derivation of Self-Potential / Elevation gradient (Ce) maps

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The correlation coefficient “Ce” is the ratio between the horizontal Self-Potential (SP) gradient and elevation. The Ce gradient approach appears to be promising for the qualitative interpretation of SP surveys in volcanic areas as well as in other environments (Lénat, 2007). There are two significant advantages of calculating Ce values: firstly, it was noted that a negative SP – elevation relationship is correlated with the piezometric head, or with the thickness of the unsaturated zone (Jackson and Kauahikaua,1987; Aubert et al.,1990), thus it can be used to estimate the depth of the water table; secondly, they can amplify the SP anomalies while masking any hydrogeologic gradient.

An initiative Self-Potential / Elevation gradient (Ce-gradient) calculation method proposed by Lénat (2007), calculates the gradient in four directions (N-S, E-W, NW-SE and NE-SW). Although this is an efficient method for calculating Ce gradients, it has some limitations due to the four-directional calculation. Using an array-type operator could overcome the limitations of calculations with four-directional operators. For this purpose, a computer code using an array-based operator was designed and tested both for artificial and field data. The code uses a procedure that may be named as “Swirl procedure”. Swirl procedure depends on swirling two (in this case SP-SP and DEM-DEM) images (arrays) and applying a mathematical operation to overlapped pixels during swirling. Using SP image and DEM, this operation allows calculating ΔV or Δz between two points in image array and consequently the Ce gradient map. Swirl procedure has a potential of calculating the Ce gradient precisely and with a multidirectional approach. Other than Ce-gradient maps, swirl procedure could be used effectively in wide range of calculations (e.g. ΔT calculations with Thermal satellite imagery, topographic corrections in geophysics).