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# A field data based flow model for estimating the “Emergency-groundwater-supply” potential of a maar volcanoe - A study from the Gees Maar (West Eifel volcanic field, Germany)

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If a region is affected by a natural disaster (flood, earthquake, volcanic eruption, etc.) the drinking water supply for the citizens is very often affected, too. To save the water supply immediate alternative sources are needed. Results from a field study (Gees Maar, West Eifel volcanic field, Germany) show that quaternary maar volcanoes could be interesting for this because 1) maars are very common worldwide and their genesis is linked to groundwater (phreatomagmatism), 2) because of their morphological and structural features, they could serve as efficient groundwater reservoirs, 3) in contrast to the surrounding basement rocks maar structures could be separate and closed aquifers, 4) conditions of eruption products and the deposition structure can lead to a good aquifer pollution protection. The results came from geological mapping, geophysical prospection and modelling (gravity and magnetic field), hydrogeological and hydrochemical mapping, isotope groundwater investigations, and water balance calculations. To understand the hydraulic behaviour a numerical flow model was developed for calculating groundwater potentials within the crater and scenario simulations. For this purpose the FEFLOW 5.2 (WASY Ltd.) software was used.

The first step was a steady state 2D-flow model to identify hydraulic elements (boundaries, layers). Furthermore large contrasts for hydraulic parameters between crater sediment layers and surrounded rocks were assumed. In this context the model was made for testing limitations (mesh type, solver type, and stability). The result give a fast groundwater transit only within the so called “mafic and scoriaceous lapilli tuff” unit. At the northern crater margin a spring discharge was calculated which is in good conformance with field observations.

In a second step the 3D-shape of the crater and the sediment layers were constructed on the base of field data and geophysical data. The surface morphology came from a digital terrain model. In the third step a steady state 3D-flow model solution was calculated. Here the outer model boundary is given by the crater margin. Three sediment layers were inserted. For the mesh a 6-noded triangular prism type was used resulting in a good adoption on the irregular shape of the crater and layers. “Constant head” conditions were defined for two crater wells, the springs in the north, and the crater margin ranges. A “no flux” condition was defined for the outer model boundary. “Transfer” boundary conditions were used for the mapped streams to simulate influent/effluent conditions. Hydraulic parameter values follow from borehole data, lab data, geophysical modelling, and literature.

The 3D-steady state solution gives a smooth and undisturbed groundwater table in the central crater range with a gradient of 10 meters in N-S direction. But near the crater margin the gradients rise. This corresponds to the calibration well potentials. Currently, a transient 3D solution is being built, giving an answer to the following essential questions: How extensive is the reservoir? Is the water supply safe in dry/wet periods? Which pumping rates are needed? Which is the right well location? Is the aquifer safe against pollution?