

ASSESSMENT OF STABILITY OF GROUNDWATER CHEMICAL COMPOSITION FROM NADZIEJA SPRING

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Nadzieja Spring, artesian deep well is located in confined Jurassic carbonate fissured aquifer. The well belongs to network of wells used as an emergency water supply for urban population and is open for public use. Therefore this water should be safe for health and its chemical composition should be stable in time.

Since November 1998 Department of Hydrogeology and Geology Engineering (AGH University of Science and Technology) has led up monitoring of Nadzieja Spring water quality. Average interval between samplings was ca. two weeks. Samples were collected in accordance with guidelines applied in groundwater monitoring (Witczak & Adamczyk 1994, 1995) and the procedure of groundwater sampling described in norms of PN-EN 5667 series. Chemical analyses of 13 basic elements were performed at hydrogeochemical laboratory, which implements extensive quality assurance and analytical quality control programme (PN-EN ISO/IEC 17025).

The goal of this study was to assess the stability of chemical composition of groundwater, which is intended for human consumption. Specific methodology has been proposed for this purpose (Ciężkowski 2007). According to Polish regulations (RMZ, 2010) the composition of water is stable, when the variation range is: $\bar{x} \pm 2\sigma$.

The assessment of stability was performed for components, which influence on the hydrogeochemical type of water: HCO_3^- and Mg^{2+} . The component influences on the hydrogeochemical type of water, when its amount in [mval] is greater than 20% (RMZ, 2006). Between November 2002 and January 2007 98 samples were collected. Detailed analysis was performed for data from 2002 to 2007. To identify and reject outliers there were used box and whisker plots. Verification of data distribution was made on the base of the results from the Kołmogorow–Smirnow Test. Due to this test it was found out, that concentrations

of HCO_3^- are characterized by normal distribution. The concentrations of Mg^{2+} are characterized by bimodal distribution. Detailed statistic analysis, in addition with observations of methods used in laboratory for Mg^{2+} determination, showed that two groups of data are result of changing methodology (change ICP-OES to ICP-MS in 2004). Separately verification of both groups distribution showed, that concentrations of Mg^{2+} are characterized by normal distribution, what is request for control charts.

Control charts (Szczepańska & Kmiecik 1998, 2005) were used to assess the stability of examined components. On the basis of this analysis the following information was derived:

- the content of HCO_3^- and Mg^{2+} in water from Nadzieja Spring in Krakow is stable (most of values are in range $\bar{x} \pm 2\sigma$);
- HCO_3^- and Mg^{2+} influence on the hydrogeochemical type of water (their content in milival [mval] is greater than 20%);
- in case of long time series, analysis should be performed in different variants concerning factors responsible for changes of chemical components.

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