



Withdrawal and chemical composition of mineral water spa Essentuki (Caucasus, Russia)

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The Caucasian mineral water (CMW) region is the unique spa area in the Russian Federation, known by therapeutic mineral springs. The Essentuki mineral groundwater basin (EMGW) is located in the central part of the CMW region. The study of mineral groundwater has more than 200-year history. The first documents about saline springs dated 1810 then in 1823 professor A.P.Nelyubin described 28 springs, № 4 and 17 were found the most valuable and called Essentuki-4 and Essentuki-17, famous now all over the world.

The Essentuki spa involves the unique wide variety of mineral waters having different TDS, pH, chemical, and gas composition. TDS changes from fresh (0,5-0,9 g/l) to high-salinity (10-13 g/l) and strongly depends on the chemical composition of water. According to the main anion, the chemical type of groundwater varies from HCO_3 to Cl-HCO_3 or $\text{SO}_4\text{-HCO}_3$. Based on gas content, the mineral groundwater within the Essentuki basin could be still water or high- pCO_2 sparkling water, sometimes H_2S rich aqua.

Such hydrogeological range is associated with geological and tectonic aspects of the region:

- 1) The geological feature consists of two-stage structure: basal complex and carbonate-terrigenous sedimentary cover with total thickness of 1500-1800 m, declined in the north-eastern direction. Increase in the depth of layers, removal the recharge area consequently change the chemical and gas composition.
- 2) Significant stratum of Neogene clays overlays Palaeogenic and Upper-Cretaceous sediments, conserving high-salinity groundwater. In the southern part of monocline subjacent Lower-Cretaceous aquifer appears on the surface and recharge by precipitation. Constant fresh flow causes stepwise freshening in lateral migration in north-eastern direction, forming hydrochemical inversion.
- 3) EMGW basin is located in extension structure, faults and surrounding them fractured rocks served in the past and present time as vertical channels to fluid migration between layers and from basal complex to sedimentary cover and as lateral channels to speeding migration inside aquifers.
- 4) Magmatic granitic laccolite-peaks set also in north-eastern direction, create thermal, hydrochemical and gaseous anomalies and generate CO_2 .

Groundwater pumping in the EMGW basin began in 50th years XX century from Quaternary and Upper-Cretaceous aquifers, the pumping rate reach up to 310-380 m³/d and 310-410 m³/d respectively. Withdrawal Palaeogenic mineral water began also in 50th years with small rate of 10-20 m³/d and increases in 80th years up to 35-40 m³/d. Lower-Cretaceous aquifer use joined to others in 70th years with average rate of 60-80 m³/d. In 80th years Quaternary aquifers stopped using due to bacteriological contamination. In 90th years mineral groundwater withdrawal considerably decreased, the recent times demand in mineral water spa is growing and pumping rates are rising. The groundwater levels lowered, but in some wells the phenomena is observed. The groundwater levels after pumping is higher than before, this case is explained by thermogaslift – formation the gas-cap due to high gaseous factor. The chemical and gas composition changing depends on geological conditions (occurrence of fractures, closeness of granitic laccolite-peaks, depth of aquifer, etc) and pumping rate.

Hereby Essentuki mineral groundwater basin is characterized by wide assortment of mineral and thermal water.