XXXVIII IAH Congress

Groundwater Quality Sustainability
Krakow, 12–17 September 2010

Extended Abstracts

Editors:
Andrzej Zuber
Jarosław Kania
Ewa Kmiecik

University of Silesia Press 2010

abstract id: **467**

topic: **3**
Aquifer management

3.1
Regional groundwater systems

Clarke contents of chemical elements in the groundwaters of the supergene zone

author(s): **Stepan L. Shvartsev**
Tomsk Division of the Institution of the Russian Academy of Sciences, the Institute of Petroleum-Gas Geology and Geophysics of the Siberian Branch of the RAS, Russia, tomsk@igng.tsc.ru

keywords: groundwater, supergene zone

For the first time, the average (clarke) contents of more than 50 chemical elements in ground waters of supergene zone were calculated by the author in 1978. During the last 30 years, new data on a great number of chemical elements were obtained by more modern methods. All this provided a basis for the calculation of more precise clarkes of chemical elements in waters. In the same way as previously, the calculation was based on the principle of latitudinal zonality of shallow ground waters. Altogether, more than 34 thousand ground water samples from 66 regions of the world were used.

According to the obtained average data, ground waters of permafrost provinces are the freshest in the world. It is natural, because permafrost rocks considerably prevent infiltration of atmospheric precipitate into not deep horizons of the supergene zone. This defines short ways of ground waters movement and, therefore, short duration of their interaction with rocks. However, groundwaters of this province have moderate acidity and extraordinary high contents of dissolved organic matter, in the composition of which fulvic acids and NH_4^+ prevail. The widespread opinion on the abundance of silica-rich waters in northern latitudes failed to be supported by concrete data, as SiO_2 contents turned out to be the lowest here.

Very fresh waters are formed in the environment of tropical and subtropical regions with the maximum intensity of water exchange. This province is characterized by the most acid water composition, high annual average temperatures, and predominance of the underground run-off over the surface run-off. The highest silica content is an important feature of waters of this province. This supports the idea that the most typical silica-saturated waters are formed not in cold northern regions, as it is thought, but in hot tropical areas.

As to the degree of mineralization, the region of mountain massifs is the next in the list. It is characterized by a very extensive water exchange and the formation of fresh waters. These waters have relatively high alkalinity related to an insufficient neutralizing effect of organic matter. Unlike all other provinces, underground waters of mountain regions contain the lowest quantifies of dissolved (C_{org}) and mineralized (CO_2) organic matter.

Ground waters of moderate climate regions are the most mineralized. They are developed on platforms, shields, and rarely in ancient fold belts. A relatively low level of water exchange leads to the formation of underground waters, which have a total mineralization of 354 mg/1 and are close to neutral waters. An increase of total salt content in waters in comparison with that of other provinces takes place mainly at the expense of hydrocarbonates of the main cations, i.e., cations obtained from the sum of mineralization products of organic matter and products of rock weathering.

The average composition of leaching ground waters can be presented by Kurlov's formula:

$$M_{0.24}\frac{HCO_3 80.7 Cl 9.4 SO_4 8.8 NO_3 1.0 F 0.3}{Ca 46.4 Mg 31.5 Na 20.3 K 1.7} pH 6.75 \quad (1)$$

i.e., these waters are moderately fresh, low-acidic, and of the hydrocarbonate calcium-magnesium composition.

Unlike leaching waters, the ground waters of continental salinization, judging by their average composition, are saline, low-alkaline, chloride-sulfate-hydrocarbonate sodium in composition and are characterized by Kurlov's formula:

$$M_{1.36}\frac{Cl37.3SO_4 32.5HCO_3 29.3NO_3 0.5F0.4}{Na56.7Ca21.7Mg19.3K2.3}pH7.50 \quad (2)$$

The average chemical composition of underground waters of the supergene zone is expressed by Kurlov's formula:

$$M_{0.47}\frac{HCO_3 48.9Cl26.7SO_4 23.4NO_3 0.6F0.3}{Na44.9Ca29.9Mg23.2K2.0}pH6.9 \quad (3)$$

i.e., these waters are moderately fresh, practically neutral, of a hydrocarbonate-chloride and sodium-calcium composition.

Each hydrogeological province is clearly distinguished by specific geochemical features of ground waters. This is confirmed by calculations of Student's criterion. It turns out that each hydrogeological province is clearly characterized by its own geochemical nature, i.e., *by its specific individuality governed by zonal factors, among which water exchange plays the most important role*.

The geochemical individuality of waters of each province is so great that it is not being lost even under the action of seasonal factors. A great number of facts suggest that seasonal variations of water compositions and water movement from to discharge areas result in limited changes in their compositions and not much affect the geochemical individuality of waters of each province.

REFERENCES

Shvartsev S.L., 1978: *Hydrogeochemistry of the hypergenesis zone*. Moscow: Nedra, 287 p. (in russian).

Shvartsev S.L., 2009: *Geochemistry of Fresh Groundwater in the Main Landscape zones of the Earth*. Geochemistry International, volume 46, number 13, pp. 1285–1389.

International Association of Hydrogeologists

AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0