Hydrogeochemical conditions in Archaean impermeable crystalline rocks (Siberian Craton)

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Lower archaean gneisses were investigated with 10 boreholes up to a depth of 700 m. The field testing was performed with systematically scaled intervals of 50 meters isolated by packers. Ground water was sampled during pumping (bailing) before recovery. All 102 water samples were analyzed by chemical methods for main ions and ICP MS and radiometry on trace elements and radioactivity.

Archaean gneisses are almost impermeable since they have very small effective porosity (average value 0.33% *in vitro*) and hydraulic conductivity (median value 8×10^{-9} m/s *in situ*). Rare thin fissures are main filtrating pathways in gneisses. All types of bedrocks are characterized by very low solubility due to prevailing stable alumosilicate minerals (feldspars, biotite, amphiboles, cordierite, sillimanite).

The main results are:

1) up to depth of 700 m all crystalline rocks contain only fresh ground waters that belong to the HCO_3 type. The TDS never exceeded 650 mg/L;

2) ground waters are mainly alkaline (average pH=8.0), their average redox potential is equal to –29 mV;

3) predominant gases found in ground waters are N_2 (average 78%), CO_2 (16%), and O_2 (6%), while hydrocarbons content is not above 0.1%;

4) ground waters in crystalline rocks are characterized by vertical zoning that depends on base levels of draining river systems (table).

Vertical Zones (base level elevation above sea level, m)	Hydraulic conducti-vity, m/s	Rock solu-bility, ppm	TDS, mg/L	Main cations
Local (>300)	$2.9\cdot10^{-8}$	637	370	Ca
Regional (300-120)	$2.1\cdot10^{-8}$	615	380	Ca >Na
Global (120-0)	$8.1\cdot10^{-9}$	595	390	Ca >Na
Deep (0- –350)	$9.3\cdot10^{-9}$	462	340	Ca >Na

Rock's permeability and solubility decrease down with depth up to global base level (sea level). At the same time TDS slightly increases that is caused by salts concentration with the depth. Rock solubility is the least below global base level therefore TDS is decreasing down to minimum values.