2.4.P04

Helium in quartz crystals and pore fluids: Equilibrium - concentration concept and helium residence times

M. GANNIBAL[1], I. TOLSTIKHIN[1], S. TARAKANOV[2], B. PEVZNER[2] AND B. LEHMANN[3]

[1] Geological Institute, KSC RAS, Apatity, Russia (mashagan@yahoo.com)
[2] Laboratory of Glass Properties, St. Petersburg, Russia (svtar@peterlink.ru)
[3] Physics Institute, University of Bern, Switzerland (lehmann@climate.unibe.ch)

Several important problems (interactions between aquifers and aquitards; identification of environments with stagnant groundwater regime as potential waste repositories; understanding and modelling of diagenesis of sedimentary rocks) require quantification of stagnant fluid migration rates. Radiogenic He appears to be a suitable tracer: because He readily migrates from rocks/minerals into related pore fluids, its inventory in a rock-fluid system not only depends on the production rate, but also on the rate of its removal by a fluid flow. This allows the He residence time in the rock-fluid system to be quantified, providing its local production.

An appropriate extraction of stagnant fluids from low-permeable rocks (especially from borehole cores) is a complicated technical problem. To avoid it we suggest a new approach giving the He-inventory without extraction and investigation of the fluid itself, but by using the relevant mineral record. Some minerals such as quartz (quartz separates from Permo-Carboniferous Formation, PCF, were studied) contain He migrated into internal volumes (IV, most probably gas vesicles) from a surrounding fluid. These IV were estimated using He as a nano-size penetrating tool, i.e., from saturation of the minerals with He under enhanced P ~ 10 to 30 atm and T ~ 300 ^{O}C. In the quartz separates IV vary from 0.017 to 0.16 % of the total volume; along with measured initial (unsaturated) He-concentrations IV give the internal He-pressures, which were found to vary in a narrow range, P = 0.45 ± 0.15 atm (1 σ) in 6 PCF samples (21 sample aliquots processed).

Estimates of He-migration rates through our samples show that in ~40,000 years the internal pressure equilibrates with He-concentration in a related pore fluid, which time is short compared with independent estimates. The above He pressure and He-solubility for temperature and salinity of the PCF aquifers give He = 0.004 ± 0.0013 cc He/cc for a virtual pore fluid, which is in full accord with the concentrations measured in the PCF aquifers, from 0.0045 to 0.0016 cc He/cc H_2O. The total He-inventory in the rock + pore fluid system and the production rates give the mean He residence time in shales of ~40 Ma, with the minimum value of ~10 Ma: pore fluids and even movable groundwaters of PCF are stagnant and diffusion is the principal mechanism of migration of species.

2.4.P05

Groundwater modeling for deep aquifers in the Yangtze Delta (south of the Yangtze River)

X.B. ZHU[1], J.C. WU[1] , S.J. YE[1] AND J.K. ZHAO[2]

[1] Department of Earth Sciences, Nanjing University, Nanjing, 210093, P. R. China (jcwu@nju.edu.cn)
[2] Geological Environmental Monitoring Station of Zhejiang, Hangzhou, 310000, China (jkzhao@mail.hz.zj.cn)

Abstract

The Yangtze Delta is an important center area for Chinese economic development, so the evaluation of the groundwater resources of this area is of great significance. In previous studies, this area was divided into subareas, according to the boundaries of the administrative districts, to evaluate their groundwater resource respectively, but the separation resulted in some artificial errors[1]. For the first time, the Yangtze Delta was considered as a whole in this paper, so such error can be avoided. The three-dimensional model which describes the characteristics of the storage and the movement of the groundwater was built according to the multilayer aquifer system with a large area and complex conditions, the parameters of the model are identified on the basis of the fine division by GMS, which is the international commonly used standard software for the numerical simulation of groundwater. Furthermore, some different exploitation alternatives of the area are evaluated. The results provide input for the building of management models of water resources in the future, and give some reasonable projections with respect to resource exploitation during projected sustainable economic development.

Conclusions

(1) The parameter fitting results show that calculated parameter values can fit the observed values of the observation holes locally. In addition, the results show that the parameters are consistent with the accumulated character of the area as a whole. All these show that the built model is reasonable and credible and can be used to predict.

(2) Results of different forecast projects for the 3-D model show that although the groundwater is exploited excessively as a whole in some subareas, some aquifers can be exploited further for the recharge of these subareas is adequate or the recent pumping quantity of these aquifers is small.

(3) A series of environmental geological disasters have appeared in the study area because of excessive exploitation of groundwater in some subareas, so it is necessary to build reasonable management model of the groundwater for sustainable use of it according to the evaluation result in the paper.

Reference

[1] Xue Yuqun, Zhu Xueyu, Wu Jichun, et.al. (1997) *Groundwater Dynamics. Beijing*: Geology Press