Quantifying the uncertainty of uranium interpretation measured by gamma-ray logging using Co-Gibbs sampler.

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ABSTRACT

There are several ways to measure uranium grade during the exploration drilling. The most trusted method is core sampling because it is a direct measure of the uranium grade in the lab conditions. But obtaining these core samples is very expensive. Therefore, there exist alternative cheaper methods of assessing the uranium – geophysical logging methods: prompt fission neutron (PFN) logging and gamma-ray logging. The PFN logging is also considered as a direct measurement of uranium but compared to gamma-ray logging has such shortcomings as price and hazard for people because it uses neutron emission. That is the reason why gamma-ray logging is the most widely used method of detecting and quantifying uranium from drill hole.

Gamma-ray logging is an indirect measurement, it measures the natural radioactivity of the rocks. And uranium itself has very little response to it, and it is considered that gamma-ray logging detects uranium decay elements: radium, thorium and radon. During the gamma-ray logging interpretation, a radioactivity disequilibrium coefficient is introduced, which is calculated from the relations obtained from core samples and is then averaged over the considerable areas. This causes bias in the uranium quantity assessment because this coefficient strongly influences the tonnage of uranium during reserves calculation.

There is another approach that uranium grades can be imputed in unsampled locations using its relationship with a more abundant secondary variable such as radium grades. An alternative of stochastic data imputation is applied in this study, known as “conditional co-Gibbs sampler” algorithm that able one to quantify the uncertainty over the imputed values. This technique is implemented in a real roll-front deposit located in South Kazakhstan and the results showed that the method is superior to the traditional simple averaging of uranium grades at unsampled locations.