Volume 1

Geomathematics in Hungarian Geology

George Bárdossy[1]

[1]Hungarian Academy of Sciences (h4750bar@helka.iif.hu)

Abstract

The application of mathematical methods has a long tradition in Hungary. The main bases of geomathematics are the universities of the country, more closely the departments related to geology, such as general geology, stratigraphy, paleontology, structural geology, mineralogy, pet-rography, geochemistry, hydrogeology and applied geology. The Hungarian Geological Survey, the Geological Institute of Hungary and the Geochemical Research Laboratory of the Hungarian Academy of Sciences are institutions where geomathematical methods found broad applications. Finally, some mining and exploration companies, like the Hungarian Oil Company (MOL), the Bakony Bauxite Mining Company and others are regularly using geomathematical methods, mainly for the evaluation of exploration results, for deposit and reservoir modelling and for the estimation of resources.

Keywords: geomathematics, applications.

The application of mathematical methods has a long tradition in Hungary. The main bases of geomathematics are the universities of the country, more closely the departments related to geology, such as general geology, stratigraphy, paleontology, structural geology, mineralogy, pet-rography, geochemistry, hydrogeology and applied geology. The Hungarian Geological Survey, the Geological Institute of Hungary and the Geochemical Research Laboratory of the Hungarian Academy of Sciences are institutions where geomathematical methods found broad applications. Finally, some mining and exploration companies, like the Hungarian Oil Company (MOL), the Bakony Bauxite Mining Company and others are regularly using geomathematical methods, mainly for the evaluation of exploration results, for deposit and reservoir modelling and for the estimation of resources. In the following examples of recent geomathematical applications are listed.

Eötvös Loránd University, Department of Applied Geology, Budapest

Under the leading of Dr. J. Kovács:

- ***Time- trend analyses*** of underground water systems and sedimentary sequences

- ***multivariate statistical methods*** e.g. cluster- ,principal component-,dynamic factor analyses for the study of underground hydrogeologic systems
- ***spatial analyses*** of underground water systems e.g. autoeregression, moving averages, point- and block kriging

Directed by Dr. A. Füst:

- ***geostatistical calculations*** on different types of mineral deposits in Hungary, deposit modelling.

Szent István University, Institute of Mathematics and Informatics, Gödöllõ

Directed by Prof. Z. Varga and Dr. Z. Sebestyén:

- Statistical evaluation of different sedimentary sequences by ***bivariate and multivariate statistical methods*** and by ***geostatistics***, mainly ***variography***
- Application of the ***bootstrap method*** for the statistical evaluation of small sized samles (N=10-30)

Szent István University, Department of Biomathematics and Informatics, Budapest

Directed by Prof. J. Fodor:

- application of ***fuzzy systems*** and ***fuzzy logic*** to the ***treatment of uncertainties and errors*** in geology,e.g. quantitative phase analysis of rocks by X-ray diffractometry and thermal methods, safety assessment of radioactive waste repositories, transmissivity measurements of underground water in boreholes.

University of Szeged, Department of Mineralogy, Geochemistry and Petrography, Szeged

Under the leading of Dr. T. M. Tóth:

- modelling of fractured crystalline rocks by the methods of ***fractal geometry***.

University of Szeged, Department of Geology and Paleontology, Szeged

Under the leading of Dr. J. Geiger:

- ***3D geostatistical modelling*** of ancient fluvial dominated delta environments.
- ***Time series analysis*** of sedimentary micro-cycles based on Computer Tomograph data of hand specimens
- ***Multivariate statistical methods*** for identification of ancient sedimentary environments from grain size data and sedimentary structures
- ***Markov chain analysis*** of sedimentary sequences.

Miskolc University, Miskolc

Prof. F. Steiner:

- Detailed ***theoretical investigation of robust estimators***. Practical applications in geology and geophysics.

Hungarian Geological Survey, Budapest

- evaluation of magmatic rocks in Hungary by ***various statistical methods*** (L. Ó. Kovács and G. Kovács)
- ***application of the fuzzy set theory*** to the resource estimation of solid mineral deposits in Hungary (B. Fodor and G. Szebényi), modernization of the traditional resource estimation methods.

Geological Institute of Hungary, Budapest

- investigation of the ***background concentrations of chemical elements*** of rocks and soils in Hungary ***by statistical methods*** (I. Horváth, P. Scharek)
- ***geochemical evaluation*** of chemical data of soils in Hungary ***by statistical methods*** for agro-geological purposes (U. Fügedi)
- statistical evaluation of hydrogeological data systems, including ***time-trend analyses*** (Á. Szalkay, I. Horváth, Gy. Tóth)
- ***Statistical evaluation of micro-tectonic data***, calculation of paleo-stress (Gy. Maros, K. Palotás, L. Fodor, B. Koroknai)
- Modelling of fracture systems in rocks by methods of ***fractal-geometry***, ***detection of fault systems by statistical methods*** (Z. Unger)
- Geological ***evaluation of aerial and satellite pictures*** (Z. Unger)

Geochemical Research Laboratory of the Hungarian Academy of Sciences.Budapest

Directed by P. Árkai:

- ***statistical evaluation*** of measures of crystallinity of layer silicate minerals, ***application of fuzzy set theory*** to the evaluation of the results of quantitative mineralogical phase analyses.

Hungarian Oil Company(MOL), Szeged

Under the leading of J. Geiger:

- ***Variography***
- Numerical modelling of the properties of oil and gas reservoirs by ***indicator kriging*** and ***co-kriging, sequential Gaussian simulation, Markov-Bayes simulation, turning band simulation***.
- ***2D and 3D spatial modelling*** of reserves.
- ***parameter upscaling*** for dinamic flow-models and ***study of the volume-effect***.
- Study of the ***spatial uncertainty*** of the models.

Bakony Bauxite Mining Company,Tapolca

- Resource estimation of bauxite deposits by traditional methods and by the ***application of the fuzzy set theory***.(I. R. Szabó, G. Varga).
- Geostatistical calculations for mining-geological purposes: ***variography, point- and block kriging*** (S. Diószegi).

Finally, the author of this paper is studying the ***uncertainties and errors of geological investigations and possibilities of their evaluation by traditional stochastic and some new mathematical methods, e.g fuzy set theory, fuzzy logic, probability bounds.(Hungarian Academy of Sciences, Department of Earth Sciences)***
Applications of mathematical methods in other branches of the Earth Sciences, e.g. geography, geophysics, geodesy, mining etc.will be outlined in separate papers.Those who would like to have more informations about some of the investigations listed above, are requested to send an e-mail message to George Bárdossy (h4750bar@helka.iif.hu).