Geophysical Research Abstracts
Vol. 20, EGU2018-16906, 2018
EGU General Assembly 2018

Mathematical Geosciences Plays Indispensable Roles in Earth Science by the Digital Age

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As an interdisciplinary field merging mathematics, computer and geosciences, Mathematical Geosciences (MG) is the science of studying mathematical properties and processes of the Earth (other planets) and prediction and assessment of its resources and environments. Similar to other interdisciplinary fields such as geochemistry and geophysics, mathematical subjects such as geometry, calculus, functional analysis, morphology, probability and statistics etc. provide essential theories and methods for quantitative study of the Earth ranging from geometry and dynamics of the Earth, uncertainties of measurement, observation to prediction of earth events. In this paper many examples will be introduced to demonstrate that Mathematical Geosciences has made indispensable contributions in geosciences. Examples are ranging from the mathematical model of the Earth's shape, the mathematical model of mantle convection and models for plate motions, mathematical symmetry and symmetry operations as principles of crystallography and optical mineralogy, mathematical topological model as foundation in geographical information systems; mathematical and statistical theories provide foundation for describing distribution and correlation of elements, uncertainty and error bars in geochemistry including isotope geochemistry and geochronology such as geological time scale, mathematical model and uncertainty of prediction of climate change, probability theory and stochastic models for prediction of energy and mineral resources, geo-complexity theory such as fractal, multi-fractals, chaos and self-organized criticality for modelling and predicting singular events and extreme phenomenal issues, to information extraction such as big data mining, machine learning, geo-intelligence. I hope to demonstrate that the majority of current earth frontiers and critical earth issues we are facing in the digital age are fundamentally related to MG. A long period of incremental advances of new mathematical theories and models in conjunction with modern technologies for solving these earth science problems may lead to creative leaps of innovation