Mapping target area of magnetite deposits by integrating aeromagnetic data and Fe_2O_3 geochemical data

JIE ZHAO[1*], WENLEI WANG[1], QIUMING CHENG[1,2,3] AND JIANGTAO LIU[1,3]

[1]Department of Earth and Space Science and Engineering, York University, Toronto, Canada, zhaojie@yorku.ca (*presenting author)
[2]Department of Geography, York University, Toronto, Canada
[3]State Key Laboratory of Geological Processes and Mineral Resource, China University of Geosciences, Wuhan and Beijing, China

Magnetite deposit is one of the most productive iron mineralization types in Eastern Tianshan mining zone, China. Previous work on exploring magnetite deposits were mainly consulting with the aeromagnetic survey data and Fe_2O_3 concentration in stream sediment geochemical data. The former is a direct physical indicator of magnetite as well as geologic bodies with extraordinary magnetism. The later is corresponding with existence of assorted iron enrichment (e.g. hematite, magnetite, iron-polymetallic mineralization, etc.). However it is difficult to identify magnetite mineralization when relying on only one of these two datasets because none of the anomalies of these two datasets can be interpreted as unique geological event. The objective of this research is to map the potential area of magnetite deposits by integrating the aeromagnetic survey data and Fe_2O_3 geochemical data with the method of Geographically Weighted Regression (GWR).

Compared to linear regression models, GWR is more realistic to explore the non-stationarity of the coefficients across an area by assigning the independent parameters for each location in space different weights [1]. In this research the singularity [2] of aeromagnetic data and singularity of Fe_2O_3 concentration are assigned as the dependent variable and independent variable, respectively, because the lower values ($\alpha < 2$) in singularity map of Fe_2O_3 and aeromagnetic data can delineate corresponding local accumulation of iron oxide and positive aeromagnetic anomalies.

The regression result of GWR is much more convincing than of the Ordinary Least Square (OLS) by examining the R-squared values. All 3 magnetite deposits in the study area are situated within high value range of coefficient map, which is consistent with the reality that both variables present lower singularity value on the areas of magnetite deposits. However, 14 out of 15 other types of iron deposits are located in the middle and lower coefficient value ranges, which is also proved by the fact that the aeromagnetic data does not present positive anomalies of magnetism around other types of iron deposits. In conclusion, the geographically non-stationary coefficient map produced by GWR can not only differentiate magnetite deposits from other types of iron mineralization, but also delineate target areas with higher potential of magnetite mineralization.

[1] Brunsdon et al. (1996) *Geographical Analysis* **28**, 281-298. [2] Cheng (2007) *Ore Geology Reviews* **32**, 314-324.

Thermodynamic and Kinetic Effect of Organic Solvent on the Nucleation of Nesquehonite

LIANG ZHAO[1*], CHEN ZHU[1], JUNFENG JI[1], JUN CHEN[1], H. HENRY TENG[1,2]

[1]School of Earth Sciences and Engineering, Nanjing University, Nanjing, PRC, zhaoliang@nju.edu.cn (* presenting author)
[2]Department of Chemistry, the George Washington University, Washington, USA

Introduction

Magnesium carbonate has a number of naturally occurring forms. Of the half dozen phases, nesquehonite is the most commonly observed near ambient conditions while various basic species appear more often at elevated (> ~ 40 °C) temperature with low pCO_2. Despite its frequent occurrence in nature, nequehonite has not attracted significant attention from scientific communities until recently due to the potential of magnesium in sequestering anthropogenic CO_2. The working principle in the approach of magnesium carbonation can be described in theory by the following reaction:

$$MgO + CO_2 = MgCO_3 \qquad (1)$$

This is a thermodynamically favored reaction not only because it is exothermic ($\Delta G = -48.31$ kJ/mol, 25 °C) but because the product is also the most stable magnesium carbonate mineral form of all. In reality, however, the formation of anhydrous $MgCO_3$ through this route proves virtually impossible at ambient environments; instead, the tri-hydrate (i.e. nesquehonite) often turns out to be the most common product. Therefore, we should study the crystallization process of nesquehonite to avoid the limit to our understanding of magnesium carbonation reaction and its application to carbon sequestration.

Results and Conclusion

Nesquehonite crystallization experiments were conducted in H_2O and water/dimethylformamide (DMF) mixture to examine solvent effect on the nucleation kinetics. Results show a reduction of nucleation induction time in the presence of DMF and a positive correlation between nucleation rate and DMF concentration. Analysis in the context of the classic nucleation theory reveals an unexpected increase in the surface energy of nesquehonite upon the solvent change, implying that kinetic factors, rather than surface energetics, is the driving force behind the resultant enhancement in nucleation rate. Further analyses suggest that kinetic acceleration under higher surface energy conditions is possible if nucleation proceeds through a cluster aggregation mechanism instead of critical nucleus formation. Fitting the Smoluchowski's coagulation theory to the experimental data seems to provide support to the operation of the non-classic nucleation mechanism as it shows that the cluster association rate is independent of the sizes of the precursors but positively correlated to the DMF concentration, consistent with the scenario of growing population of sub-critical nuclei and ensuing higher probability of cluster collision/aggregation leading to an accelerated nucleation.