Mineral Prospectivity Modeller

MPM project goals and implementation

Maarit Middleton

3.5.2018
Exploration potential mapping / Mineral prospectivity mapping

- Aim is to delineate areas favorable for mineral exploration
- Traditionally based on expert opinions on potential areas for a certain deposit type
- Digital maps allow quantitative analysis of data and numerical modelling for mineral prospectivity mapping → exploration data requires GIS based data-analysis and spatial data mining techniques
Prospectivity mapping methodology

1. Selection of the relevant data based on the exploration model
2. Generation of evidential layers
3. Spatial analysis
4. Validation

Dynamic loop and iteration
Methods of spatial modelling for prospectivity mapping

1. Empirical approach (data driven)
   - known mineral occurrences as ‘training points’ are used for examining spatial relationships between known occurrences and spatial data
   - suitable for mature ’brown fields’ exploration terrains with abundant data available
   - supervised classification: e.g. neural networks, weights of evidence, logistic regression
   - unsupervised classification: SOM

2. Conceptual approach (knowledge driven)
   - re-formulation of knowledge about deposit formation into set of criteria
   - expert knowledge necessary
   - suitable for ’green fields’ exploration terrains with limited number of deposits available for statistical assessment
   - e.g. Fuzzy logic, Expert weights of evidence
History of Spatial Data Modeller SDM

• an open source code originally developed by USGS (Gary Raines) and GSC (Graeme Bonham-Carter)
• SDM updated and maintained by University of Campinas (UNICAMP), São Paulo, Brazil (Carlos Roberto de Souza Filho): http://www.ige.unicamp.br/sdm/
Goals of Mineral Prospectivity Modeller (MPM) project

1. Investigate conceptual fuzzy logic model optimization by using receiver operating characteristics (ROC)-validation

2. Build a new mineral prospectivity mapping toolbox in a most commonly used GIS software, ArcGIS Desktop, with enhanced workflows

3. Implement the desktop tools for conceptual modeling as an open and free web-based geoprocessing service for promoting northern Finland as an exploration region

4. Demonstrate the tools in practice by using a case study
Tasks in the MPM project

Task 1. Project management

Task 2. Mineral prospectivity modeling toolbox in ArcGIS

Task 3. Online MPM tools

Task 4. Prospectivity mapping case study and testing
Funding

Business Finland /ERDF 450 000 € (90%)
Other funding: 58 000 € (10%)

Second Institute of Oceanography, SOA

Sakumpu Exploration Oy
S2R Resources
Agnico Eagle Finland
De Beers Group of Companies
Kenex
NEW Boliden
GTK
## Budget and resources

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<thead>
<tr>
<th>Position</th>
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<th>2017</th>
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<tr>
<td>Project manager</td>
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<tr>
<td>Systems specialist</td>
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### Salary total

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<td><strong>Total</strong></td>
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<td>55 370</td>
<td><strong>110 740</strong></td>
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<td>General expenses</td>
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<td>103 542</td>
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<td>Travel</td>
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<tr>
<td>Other</td>
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<td><strong>Total</strong></td>
<td>254 000</td>
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### Person months

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<tr>
<td>Task 2: ArcSDM</td>
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<td>Task 3: online tool</td>
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<td>Task 4: case study</td>
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Original schedule

Schedule after 0.5 y applied extension
Project team at GTK

Project management and geoscientists in Rovaniemi
- Vesa Nykänen, Research Professor, Geoinformatics
- Maarit Middleton, Senior Scientist
- Tero Niiranen, Senior Scientist
- Ilkka Lahti, Geophysicist
- Merja Janhila, Geologist

GIS and system specialists in Kuopio and Espoo
- Tero Rönkkö, Systems Specialist
- Janne Kallunki, Systems Analyst
- Juha Strengell, Systems Specialist
- Kimmo Korhonen, Geophysicist
- Johanna Torppa, Senior Scientist
- Niina Ahtonen, Head of Unit
Scientific advisory board

- Dr. Gary Raines, U.S. Geological Survey, University of Nevada, emeritus
- Dr. Graeme Bonham-Carter, Geological Survey of Canada, emeritus
- Prof. Carlos Roberto de Souza Filho, University of Campinas, São Paulo, Brazil
- Dr. Mark Mihalasky, U.S. Geological Survey
- Dr. Gilpin Robinson, U.S. Geological Survey
- Dr. Mark Coolbaugh, Chief Geoscientist, ATLAS Geoscience, Inc.
# Steering group

<table>
<thead>
<tr>
<th>Company</th>
<th>Primary</th>
<th>Deputy</th>
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<tr>
<td>AA Sakatti Mining Oy</td>
<td>Jukka Jokela</td>
<td>Antti Mikkola</td>
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<tr>
<td>Kenex Pty Ltd</td>
<td>Gregor Partington</td>
<td>Michelle Stokes</td>
</tr>
<tr>
<td>De Beers Group Services (Pty) Ltd</td>
<td>Andrew Macdonald</td>
<td>Khaled Ali</td>
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<tr>
<td></td>
<td></td>
<td>Lindsay Urban</td>
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<td>Boliden Mineral AB</td>
<td>Tobias Hermansson</td>
<td>Joachim Albrecht</td>
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<tr>
<td>Agnico Eagle Finland Oy</td>
<td>Jyrki Korteniemi</td>
<td>Vesa Kortelainen</td>
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<tr>
<td>The Second Institute of Oceanography, China</td>
<td>Chunhui Tao</td>
<td>Wei Cai</td>
</tr>
<tr>
<td>Geological Survey of Finland</td>
<td>Juhani Ojala</td>
<td>Jouni Vuollo</td>
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Support by ESRI Inc.

- In-kind support to the project in the form of technical guidance to help make this the best possible project.
- Best practice patterns to follow for designing and building a well integrated solution.
- Architecture review, guidance on tool and API interface design guidelines and review, or other question beyond the usual technical support or distributor’s scope.
Task 2: Spatial data modeller

• The new version of the SDM code is now called ArcSDM5
• The code is kept open source and distributed through Github: https://github.com/gtkfi/ArcSDM

• Still missing: revised tool help, learning materials
• The old SDM tools: weights-of-evidence, neural networks and logistic regression

• New tools: ROC tool, a demo version of the self-organizing maps, experimental tools (boosting, SVM, new validation tools)
Demo dataset from northern Finland with ArcSDM5

- **Till geochemistry**
  - Au, Ba, Ca, Co, Cr, Cu, Fe, K, La, Mn, Ni, P, Te, Th, V, Zn

- **Airborne geophysics**
  - magnetic, electromagnetic

- **Gravity**
  - Worms (horizontal gradient maxima)

- **Bedrock map**
  - Lithology, structures, domain boundaries, blackshales

- **Data decgraded to 500 m grid cell size because of data licensing**
Task 3: MPM Online Tool
+ the same data as in GTK’s Mineral Deposits and Exploration pages
Benefits from MPM

• Implementation in the ArcGIS Pro enables the SDM code to run the 64-bit operating systems for the first time
  – More complex larger datasets

• Github will enable easy distribution of the tool and the source code
  – anyone can contribute to the maintenance and fixing the code
Benefits from MPM

• Free and open source prospectivity modelling tool based on GTK data for regional scale prospectivity modelling in northern Finland
  → strategic planning tool for companies to select target scale prospects

• The ArcGIS modelling functionalities in a web application are demonstrated for the first time
  → application possibilities are enormous
Keep up with the tools and send us feedback

- Project web pages: [http://projects.gtk.fi/mpm](http://projects.gtk.fi/mpm)

- Download ArcSDM and the demo dataset: [https://github.com/gtkfi/ArcSDM](https://github.com/gtkfi/ArcSDM)
  - Installation instructions [YouTube](#)


- Follow the progress at [Facebook](#)
  - Mineral prospectivity modeler
Thank you for your attention!