Mineral Prospectivity Modeller

MPM project goals and implementation

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3.5.2018

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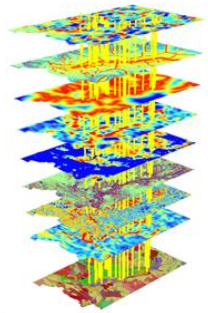
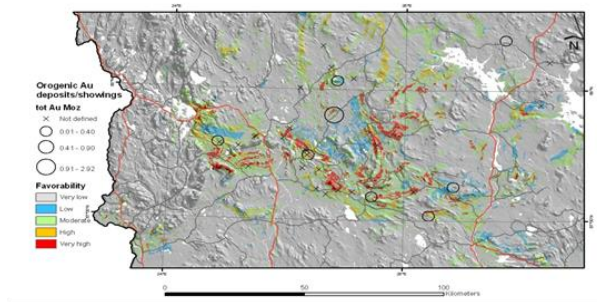
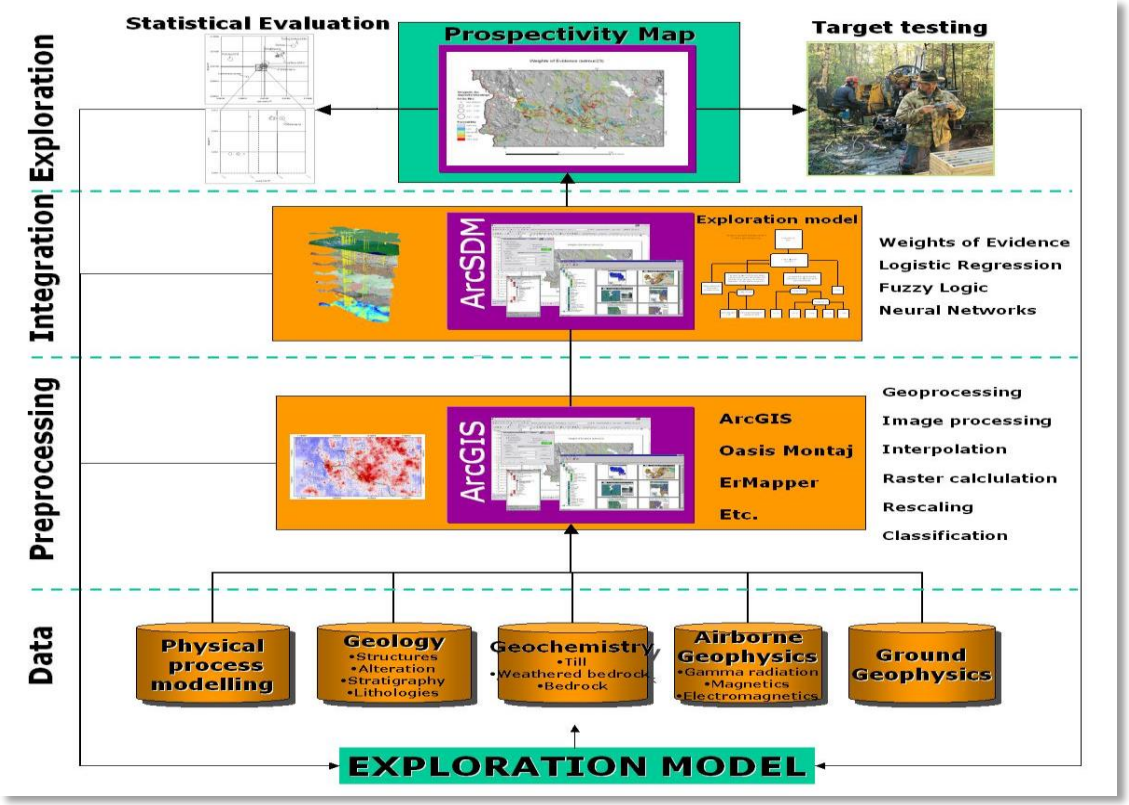
Exploration potential mapping / Mineral prospectivity mapping

- 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



4. Validation

3. Spatial analysis

2. Generation of evidential layers

1. Selection of the relevant data based on the exploration model

Dynamic loop and iteration

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Methods of spatial modelling for prospectivity mapping

1. Empirical approach (data driven)

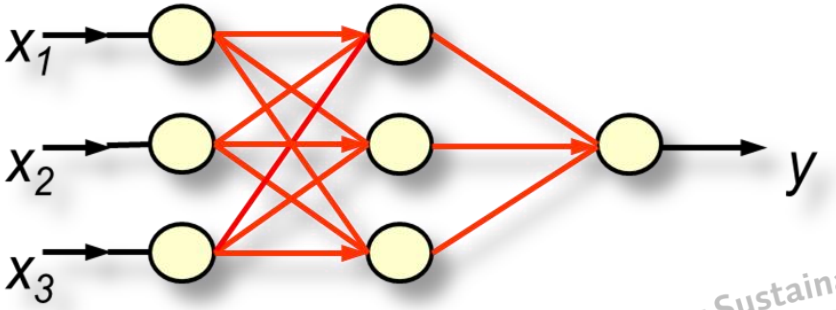
- known mineral occurrences as ‘training points’ are used for examining spatial relationships between known occurrences and spatial data
- suitable for mature ’brown fields’ exploration terrains with abundant data available
- supervised classification: e.g. neural networks, weights of evidence, logistic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

BUSINESS FINLAND

国家海洋局第二海洋研究所
Second Institute of Oceanography,SOA

AngloAmerican

Kenex
Creating opportunities in the spatial world

Sakumpu Exploration Oy

S2R S2 Resources

De Beers
Group of Companies

AGNICO EAGLE FINLAND

NEW BOLIDEN

GTK

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Budget and resources

	2016	2017
Project manager	3.5	3.5
Systems specialist	4.3	4.0
Systems analyst	4.0	4.0
Senior scientist 1	0.3	0.3
Senior scientist 2	2.0	2.0
Geophysicist 1	1.5	0.5
Geophysicist 2	1.0	1.0
Research Professor	2.0	2.0
	18.1	17.3

Salary total	**79 100**	**79 100**	**158 200**	70.0 %
Personnel side expenses	55 370	55 370	**110 740**	77.0 %
General expenses	103 542	103 542	**207 084**	
Travel	16 807	16 807	**29000**	
Subcontracting, rents	1 000	1 000	**2000**	
Other	500	500	**976**	
Total	**254 000**	**254 000**	**508 000**	

	Person months
Task 1: Management	4
Task 2: ArcSDM	10.4
Task 3: online tool	11.5
Task 4: case study	8.5
Total	**34.4**

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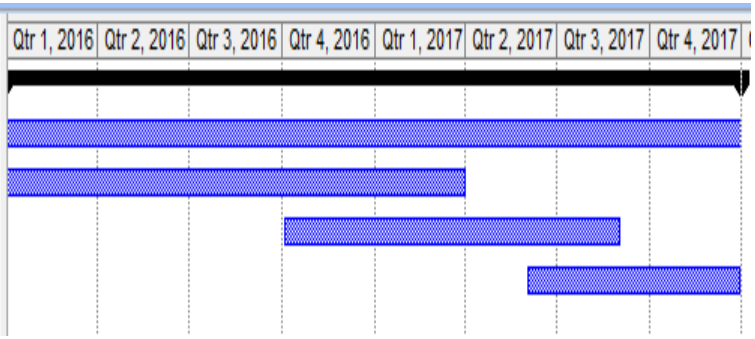
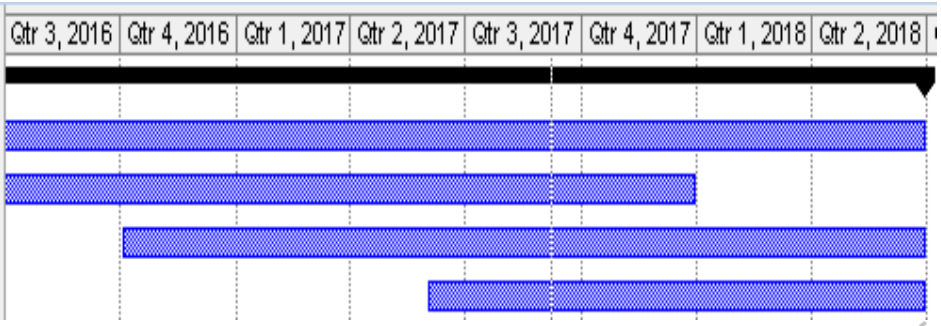
Original schedule

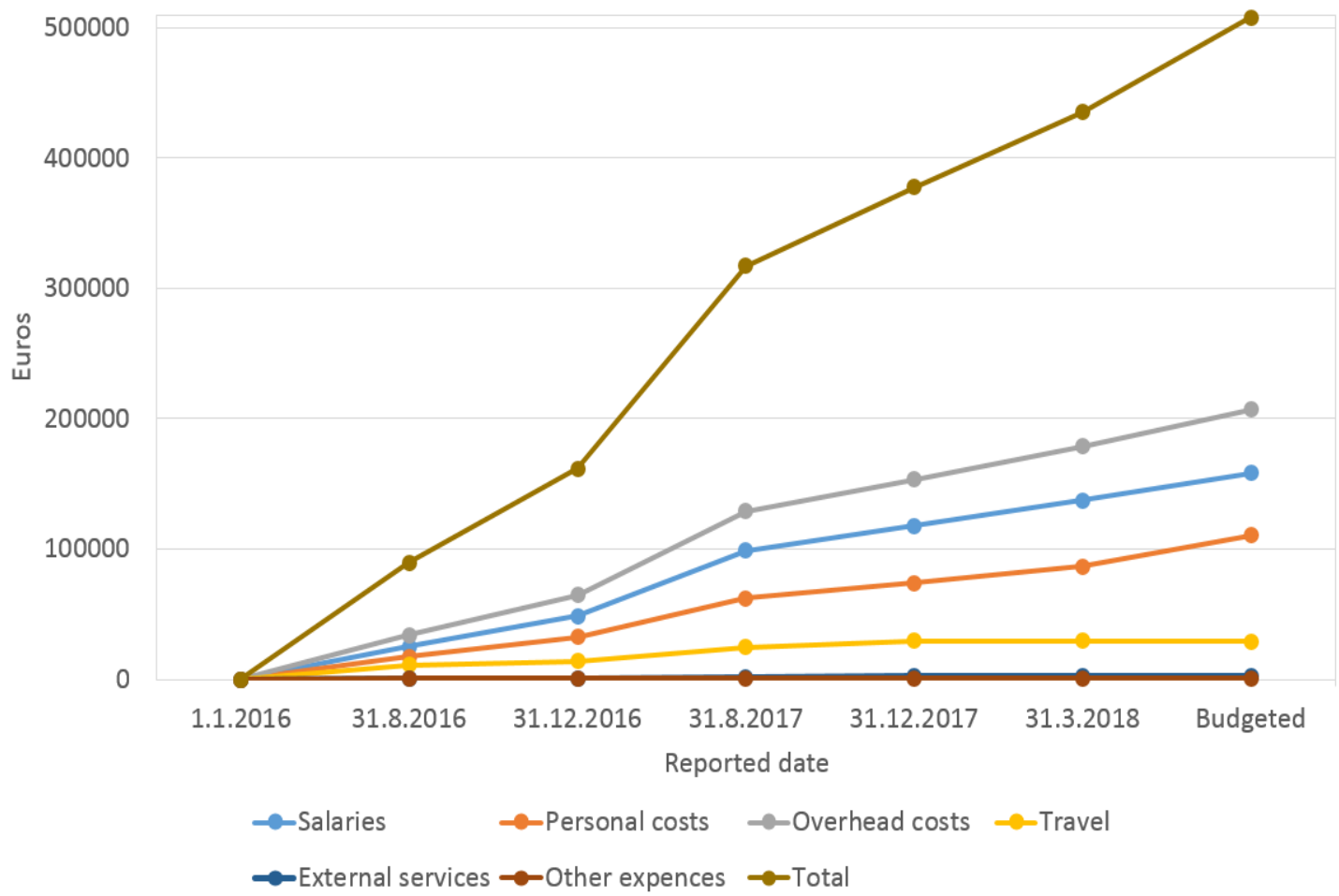
Task Name	Duration	Start	Finish	Pre
MPM	**521 days?**	**Fri 1.1.16**	**Sun 31.12.17**	
Task 1: Coordination and management	521 days?	Fri 1.1.16	Sun 31.12.17	
Task 2: MPM toolbox	326 days?	Fri 1.1.16	Fri 31.3.17	
Task 3: On-line MPM tools	240 days?	Mon 3.10.16	Fri 1.9.17	
Task 4: Case study and testing	152 days?	Thu 1.6.17	Fri 29.12.17	



Schedule after 0.5 y applied extension

Task Name	Start	Finish	F
MPM	**Fri 1.1.16**	**Fri 29.6.18**	
Task 1: Coordination and management	Fri 1.1.16	Fri 29.6.18	
Task 2: MPM toolbox	Fri 1.1.16	Fri 29.12.17	
Task 3: On-line MPM tools	Mon 3.10.16	Fri 29.6.18	
Task 4: Case study and testing	Thu 1.6.17	Fri 29.6.18	





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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

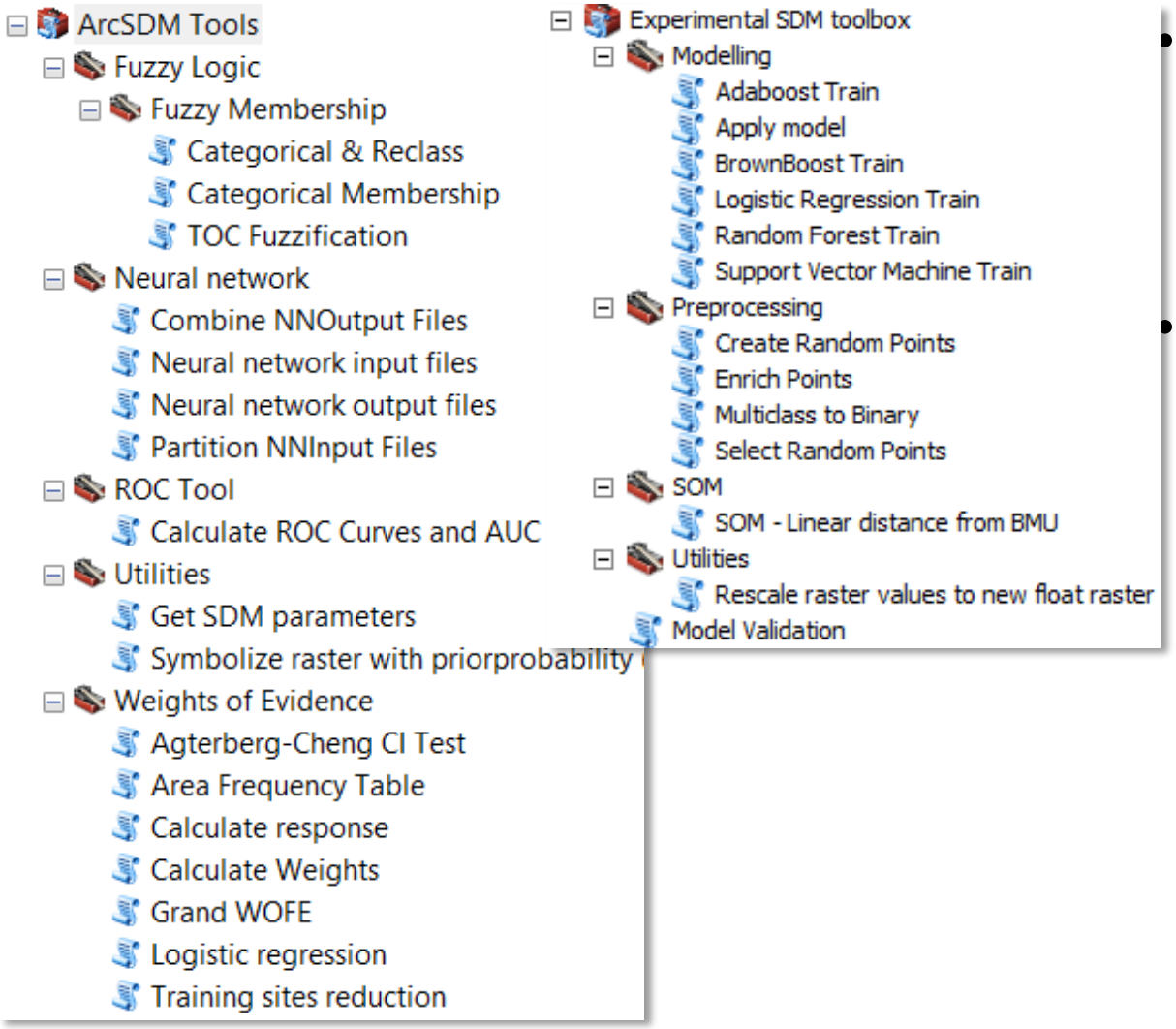
Company	Primary	Deputy
AA Sakatti Mining Oy	Jukka Jokela	Antti Mikkola
Kenex Pty Ltd	Gregor Partington	Michelle Stokes
De Beers Group Services (Pty) Ltd	Andrew Macdonald	Khaled Ali Lindsay Urban
Boliden Mineral AB	Tobias Hermansson	Joachim Albrecht
Agnico Eagle Finland Oy	Jyrki Korteniemi	Vesa Kortelainen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

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)

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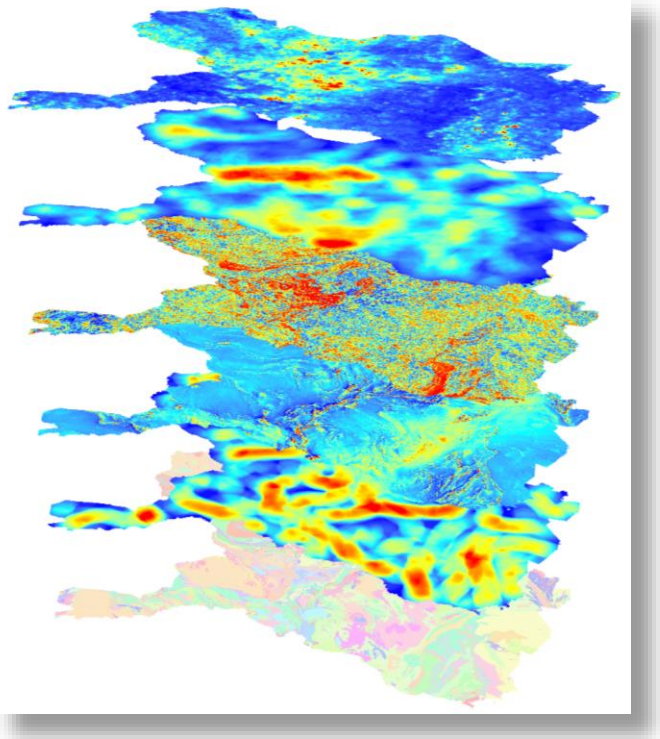
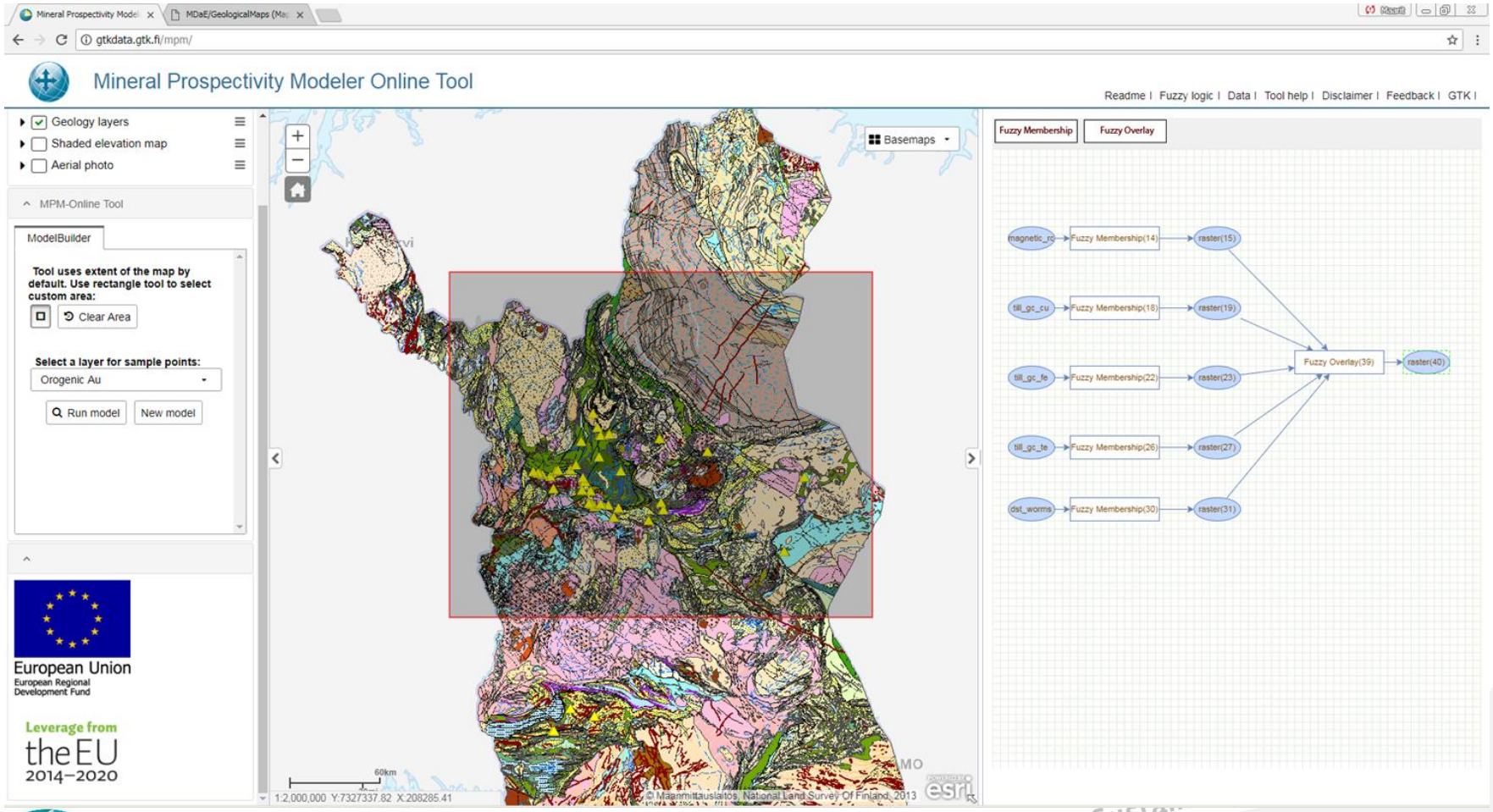
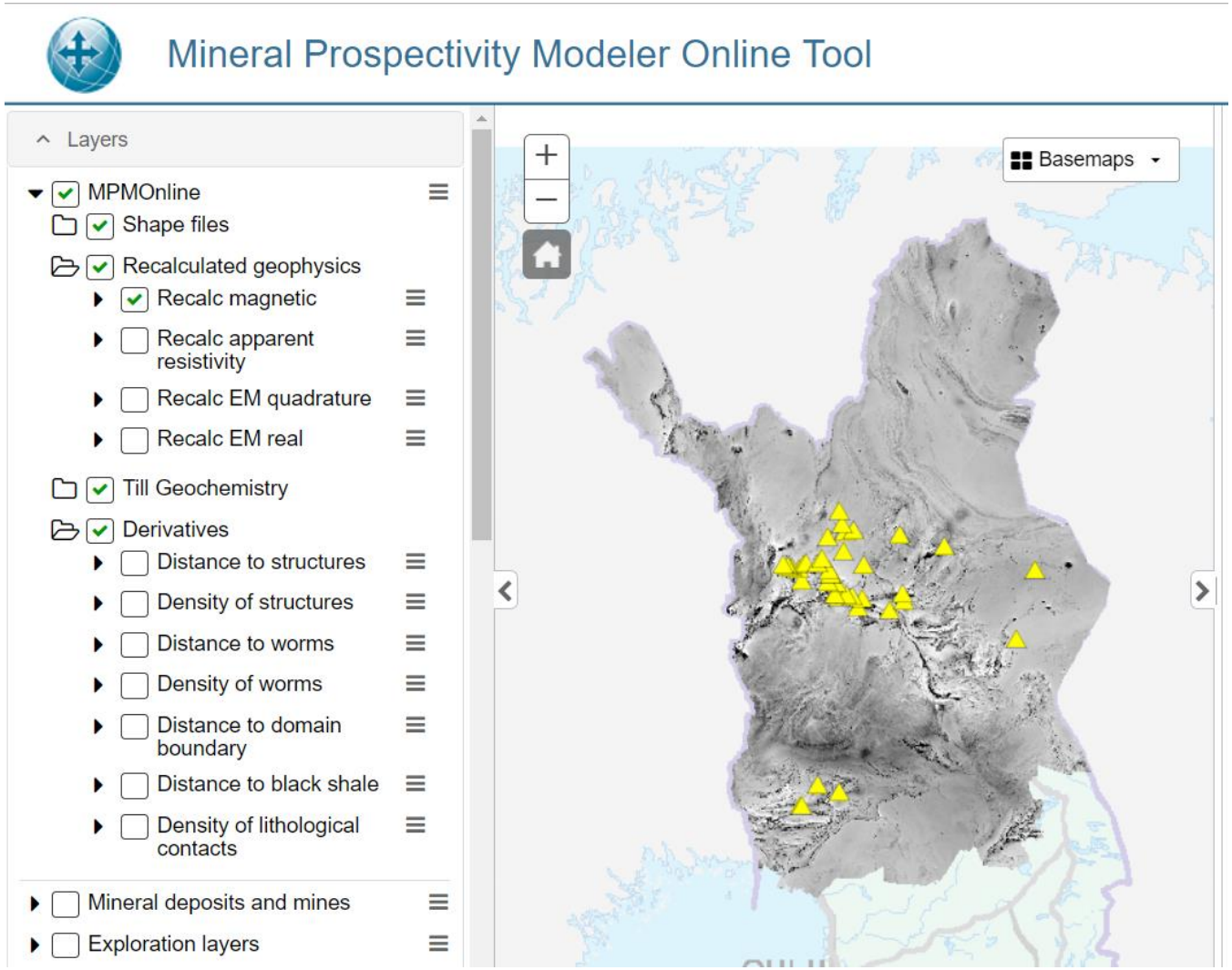
Demo dataset from northern Finland with ArcSDM5

- 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
- Download ArcSDM and the demo dataset: https://github.com/gtkfi/ArcSDM
  - Installation instructions
- MPM Online Tool: http://gtkdata.gtk.fi/mpm/
- Follow the progress at
  - Mineral prospectivity modeler

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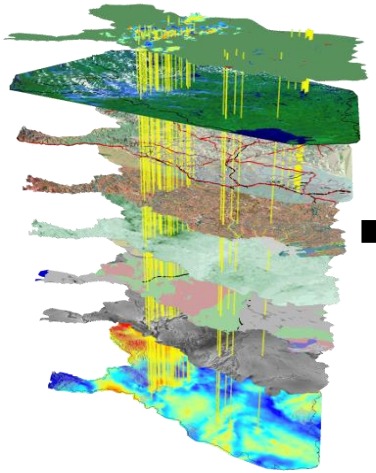

Thank you for your attention!

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