Toward improved geological maps of northern Canada: Remote predictive mapping contributions to Operation GEM

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INTRODUCTION

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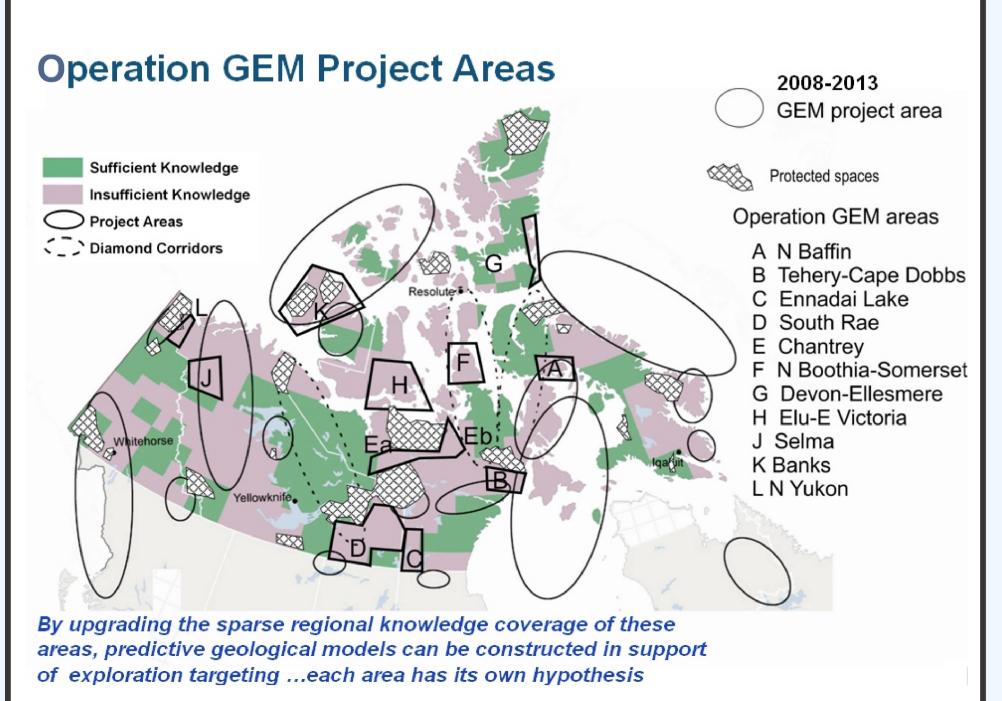
[1] Geological Survey of Canada, Ottawa
[2] Geological Survey of Canada, Pacific
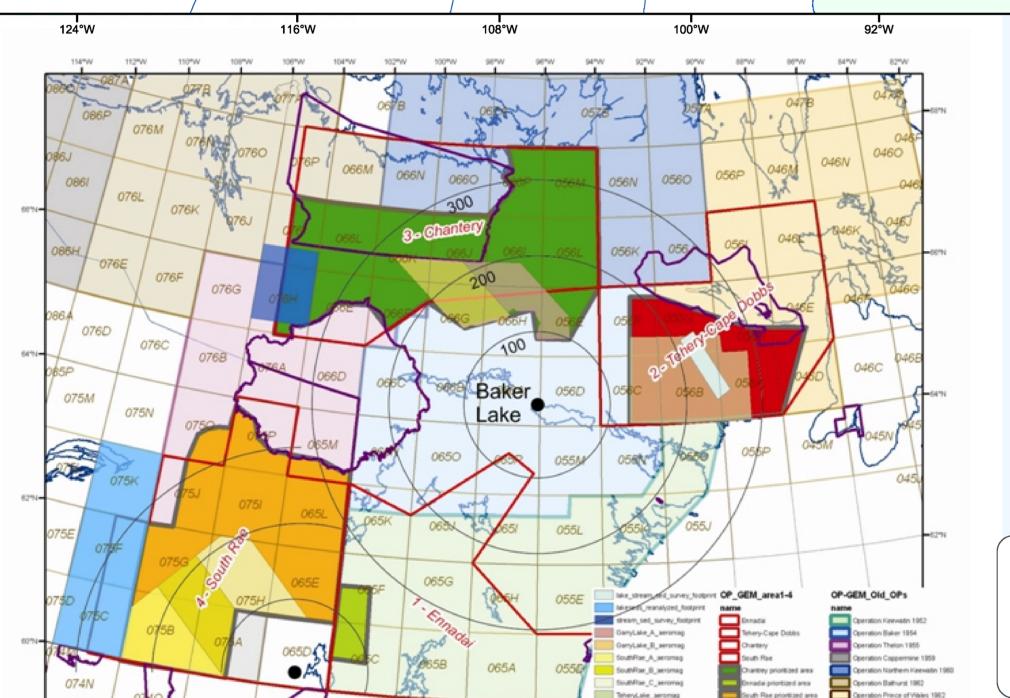[3] Geofirma Engineering, Ottawa

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A major component of the Operation GEM project involves the integration of legacy field data with predictions of bedrock structure and lithology, which are made from a variety of geoscience data sets including geophysical (regional and high-resolution magnetics and gamma ray), and remotely sensed data. During Operation GEM, archival materials dating from the 1950s-1960s helicopter reconnaissance operations were geo-located and re-analyzed for magnetic susceptibility, composition and in some cases, zircon geochronology (data mining) to enhance the bedrock database. This information contributed to pre-field interpretations that were then tested through targeted field visits in 2012.

This poster summarizes the Remote Predictive Mapping (PRM) protocols developed during GEM and their application in producing predictive maps for a large portion of the Churchill Province west of Hudson Bay. Predictive maps for the Tehery, Chantrey and South Rae transect areas illustrate how the maps were constructed and demonstrate how they can be interpreted. They are used to guide fieldwork as well as improve the next generation of geological maps of northern Canada.
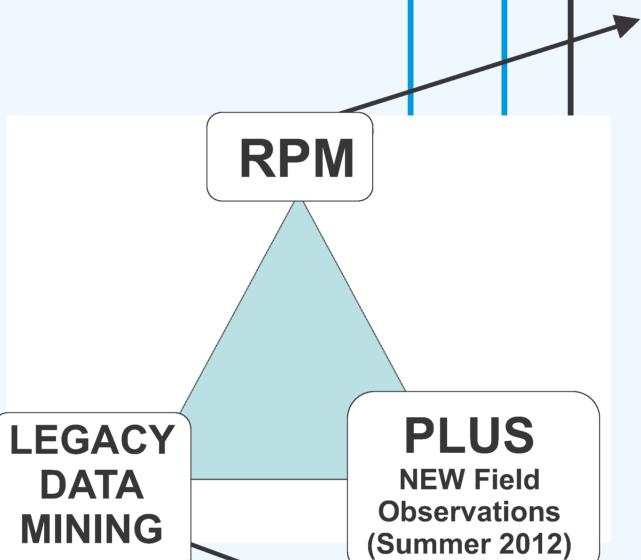
Operation GEM - Summary

- Operation GEM is designed to formulate new hypotheses for areas with little pre-existing information, through:
  - data mining and re-interpretation
  - limited new data acquisition
- Areas with previously unrecognized resource potential will be prioritized for future work
- Operation GEM knowledge is anticipated to have rapid impact on land-use decisions (East Arm park, SE NWT land claim negotiations, Nunavut Land-use Plans)
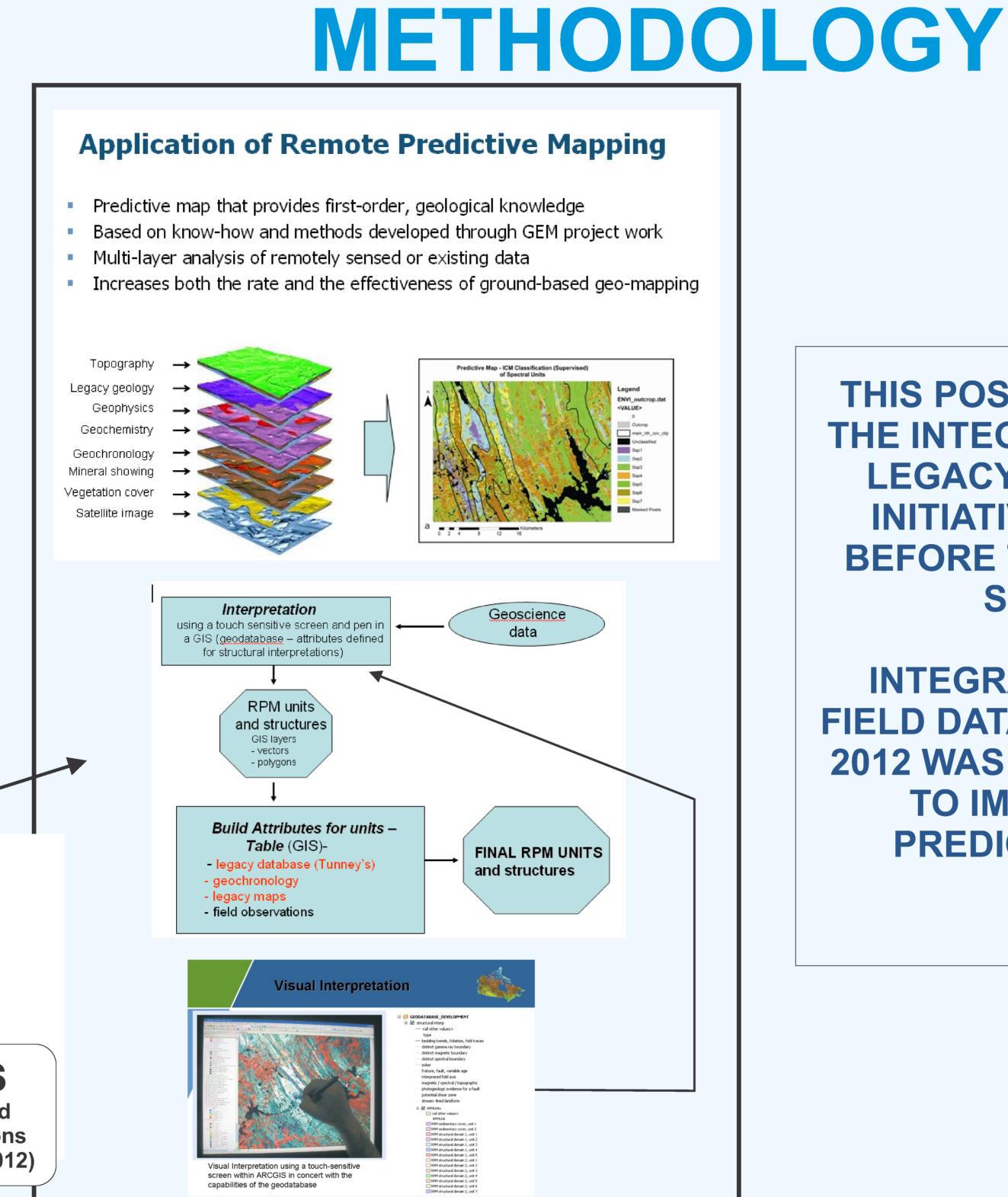- Exploration industry response to new data and ideas is likely

Operation GEM Project Areas

2008–2013 GEM project area

Operation GEM Project Areas

Sufficient Knowledge
Insufficient Knowledge
Project Areas
Diamond Corridors

Protected spaces

Operation GEM areas
A N Baffin
B Tehery-Cape Dobbs
C Ennadai Open File
D South Rae
E Chantrey
F N Boothia-Somerset
G Devon-Ellesmere
H Elu-E Victoria
J Selma
K Banks
L N Yukon

By upgrading the sparse regional knowledge coverage of these areas, predictive geological models can be constructed in support of exploration targeting ...each area has its own hypothesis

GEM Mapping Areas

Chantrey
Tehery
South Rae
Ennadai

North of 60° Structural Compilation

This map shows a compilation of geologic structures including form lines, faults and lineaments. This is being done using a "heads-up" interpretation process with a touch-sensitive screen and pen in ArcGIS. The attributes (legend) have been pre-defined in a geodatabase. The interpreter just clicks on the attribute and interprets the various geoscience data (magnetics, LANDSAT, DEM) directly on the touch screen. This work is being performed by P. Behnia (under contract to GeoFirma) and J. Harris. Within the next year, the entire area north of 60 degrees will be complete.

Legend

interpreted_structures
- rall other values=
- form line interpreted antiform
- fold axis interpreted antiform
- fold axis interpreted synform
- form line bended dem

structures
- dyke lineant dem
- dyke lineant mag
- dyke mag
- dyke lineant dem norm-norm
- fault lineant dem strike-slip
- fault lineant dem thrust
- fault lineant dem unknown
- fault lineant mag
- fault mag strike-slip
- fault mag thrust
- fault mag thrust
- form line form line bended
- form line form line interp
- form line landsat dem
- lineament landsat dem
- lineament mag
- shear_zone interpreted
- shear_zone mag
- unknown

METHODOLOGY

Application of Remote Predictive Mapping

- Predictive map that provides first-order, geological knowledge
- Based on know-how and methods developed through GEM project work
- Multi-layer analysis of remotely sensed or existing data
- Increases both the rate and the effectiveness of ground-based geo-mapping

Topography
Legacy geology
Geophysics
Geochemistry
Geochronology
Mineral showings
Vegetation cover
Satellite image

Interpretation
using a touch sensitive screen and pen in GIS (geodatabase – attributes defined for structural interpretations)

Geoscience data

RPM units and structures
GIS layers
- vectors
- polygons

Build Attributes for units –
Table (GIS):
- legacy database (Tunney's)
- geochronology
- legacy maps
- field observations

FINAL RPM UNITS and structures

Visual Interpretation
Visual Interpretation using a touch-sensitive screen within ARCGIS in concert with the capacities of the geodatabase.

RPM

LEGACY DATA MINING

PLUS
NEW Field Observations (Summer 2012)

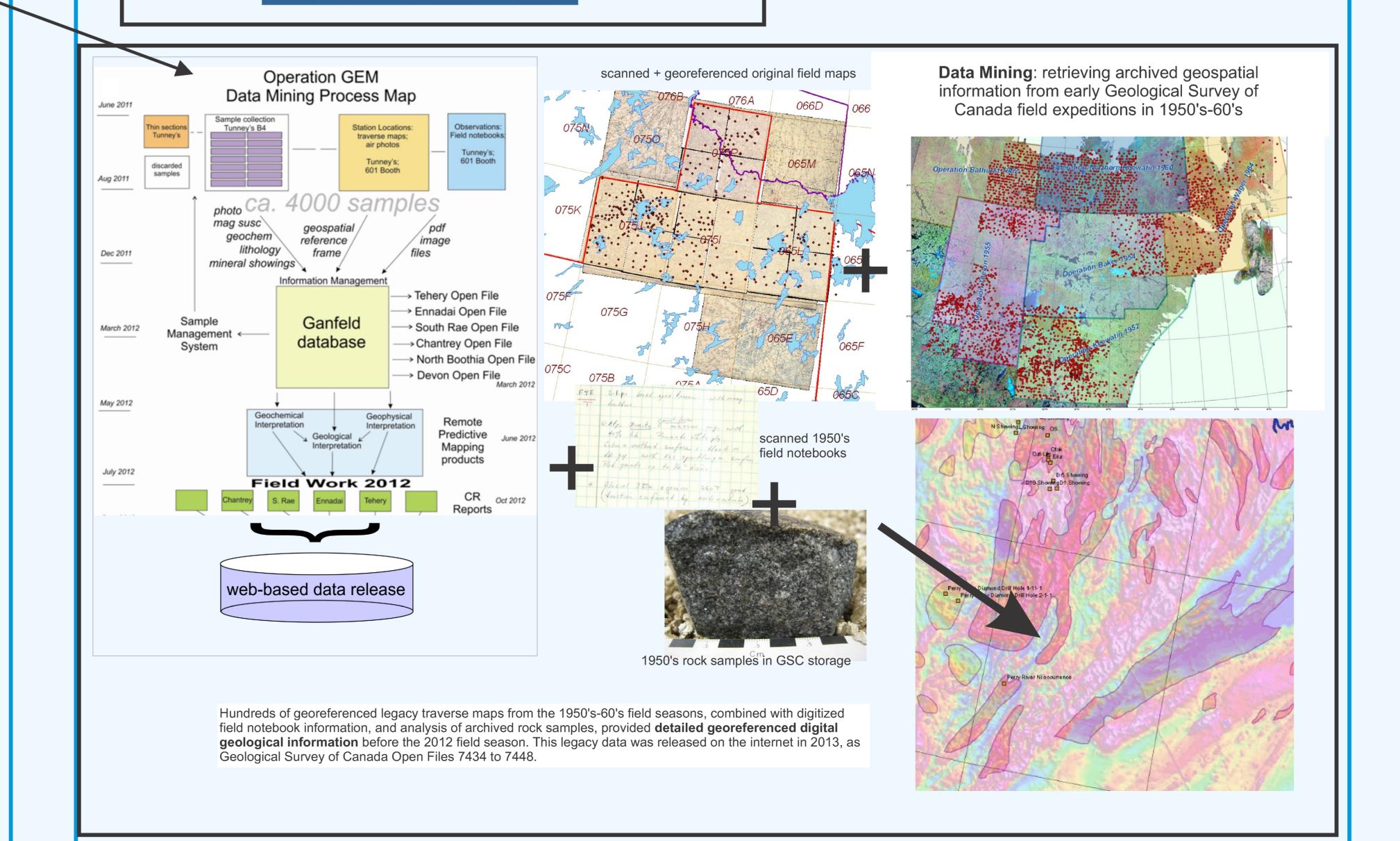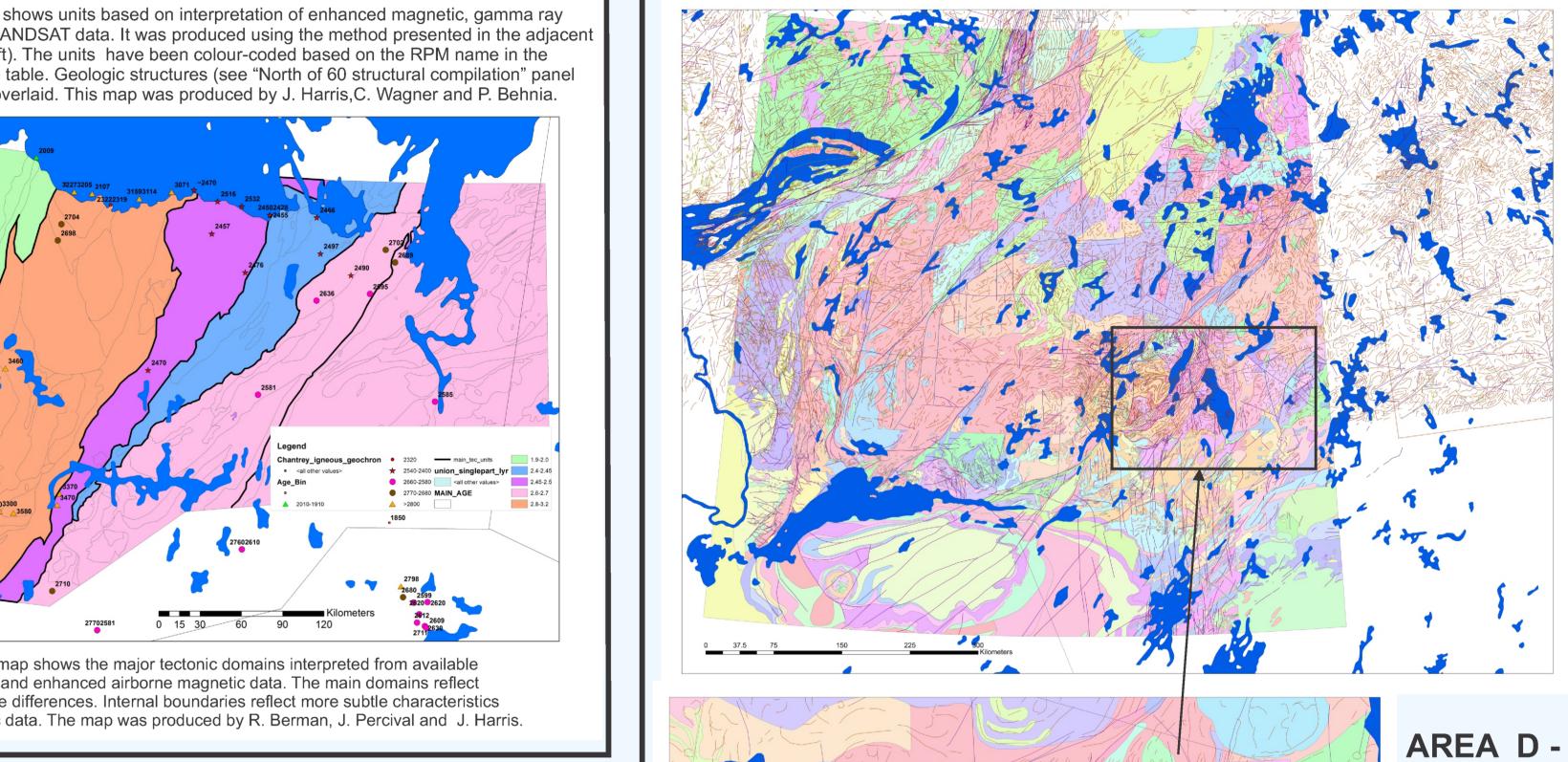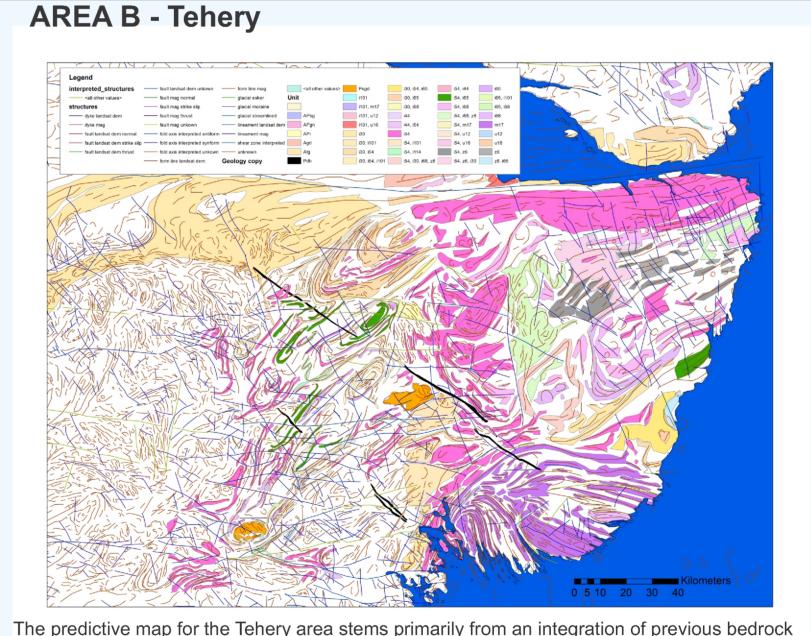**THIS POSTER PRESENTS THE INTEGRATION OF THE LEGACY DATA MINING INITIATIVE WITH RPM, BEFORE THE 2012 FIELD SEASON.**

INTEGRATION OF THE FIELD DATA COLLECTED IN 2012 WAS THE NEXT STEP TO IMPROVE THE PREDICTIVE MAPS.

Operation GEM Data Mining Process Map

ca. 4000 samples

Ganfeld database

- Tehery Open File
- Ennadai Open File
- Chantrey Open File
- South Rae Open File
- North Boothia Open File
- Devon Open File

Remote Predictive Mapping products

Field Work 2012

web-based data release

Data Mining: retrieving archived geospatial information from early Geological Survey of Canada field expeditions in 1950's-60's

scanned + georeferenced original field maps

scanned 1950's field notebooks

1950's rock samples in GSC storage

Hundreds of georeferenced legacy traverse maps from the 1950's-60's field seasons, combined with digitized field notebook information, and analysis of archived rock samples, provided detailed georeferenced digital geological information before the 2012 field season. This legacy data was released on the internet in 2013, as Geological Survey of Canada Open Files 7434 to 7448.

RESULTS

AREA A - Chantrey

The predictive map shows units based on interpretation of enhanced magnetic, gamma ray spectrometer and LANDSAT data. It was produced using the interpretation presented in the adjacent flow chart (to the left). The units have been colour-coded based on the RPM name in the associated attribute table. Geologic structures (see "North of 60 structural compilation" panel below) have been overlaid. This map was produced by J. Harris, C. Wagner and P. Behnia.

The predictive map shows the major tectonic domains interpreted from available geochronology and enhanced airborne magnetic data. The main domains reflect pronounced age differences. Internal boundaries reflect more subtle characteristics of the magnetic data. The map was produced by R. Berman, J. Percival and J. Harris.

AREA B - Tehery

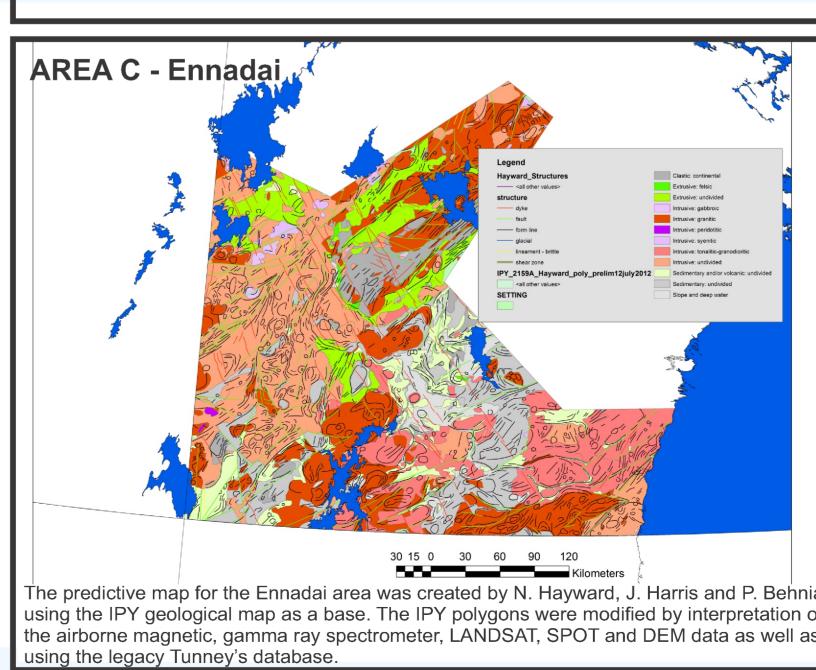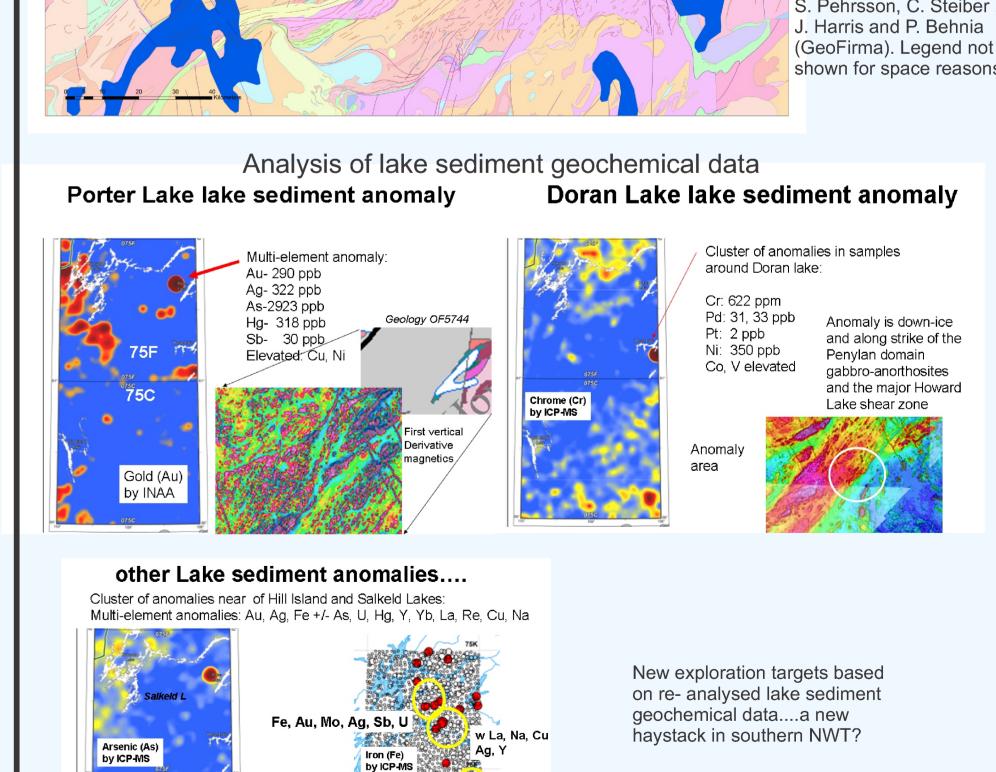The predictive map for the Tehery area stems primarily from an integration of previous bedrock compilation maps, geophysical data (regional and new, high-resolution aeromagnetic maps), and legacy archival data for the area. Combined with the form lines, the predictive map illustrates the structural complexity of this high-grade metamorphic terrain, which is dominated by Archean to Paleoproterozoic granitoid rocks with intervening supracrustal belts. The map was produced by J. Joseph, N. Wodicka, J. Harris and P. Behnia.

AREA C - Ennadai

The predictive map for the Ennadai area was created by J. Harris, J. Harris and P. Behnia using the airborne magnetic, gamma ray spectrometer, LANDSAT, SPOT and DEM data as well as using the legacy Tunney's database.

AREA D - South Rae

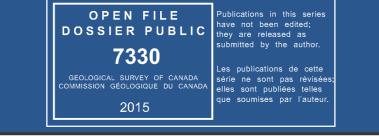The predictive map for the South Rae area was created through the integration of legacy geology maps, the legacy Tunney's database, and newly interpreted medium and high resolution magnetic, gamma ray spectrometer and LANDSAT data. The map was produced by S. Pehrsson, C. Stieber, J. Harris and P. Behnia (GeoFirma). Legend not shown for space reasons.

Analysis of lake sediment geochemical data

Porter Lake lake sediment anomaly
Doran Lake lake sediment anomaly

other Lake sediment anomalies....

New exploration targets based on re- analysed lake sediment geochemical data...a new haystack in southern NWT?