

The following was presented at DMT'10
(May 16-19, 2010).

The contents are provisional and will be
superseded by a paper in the
DMT'10 Proceedings.

See also earlier Proceedings (1997-2009)

<http://ngmdb.usgs.gov/info/dmt/>



Building a surficial geology data model for mapping projects

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Natural Resources
Canada

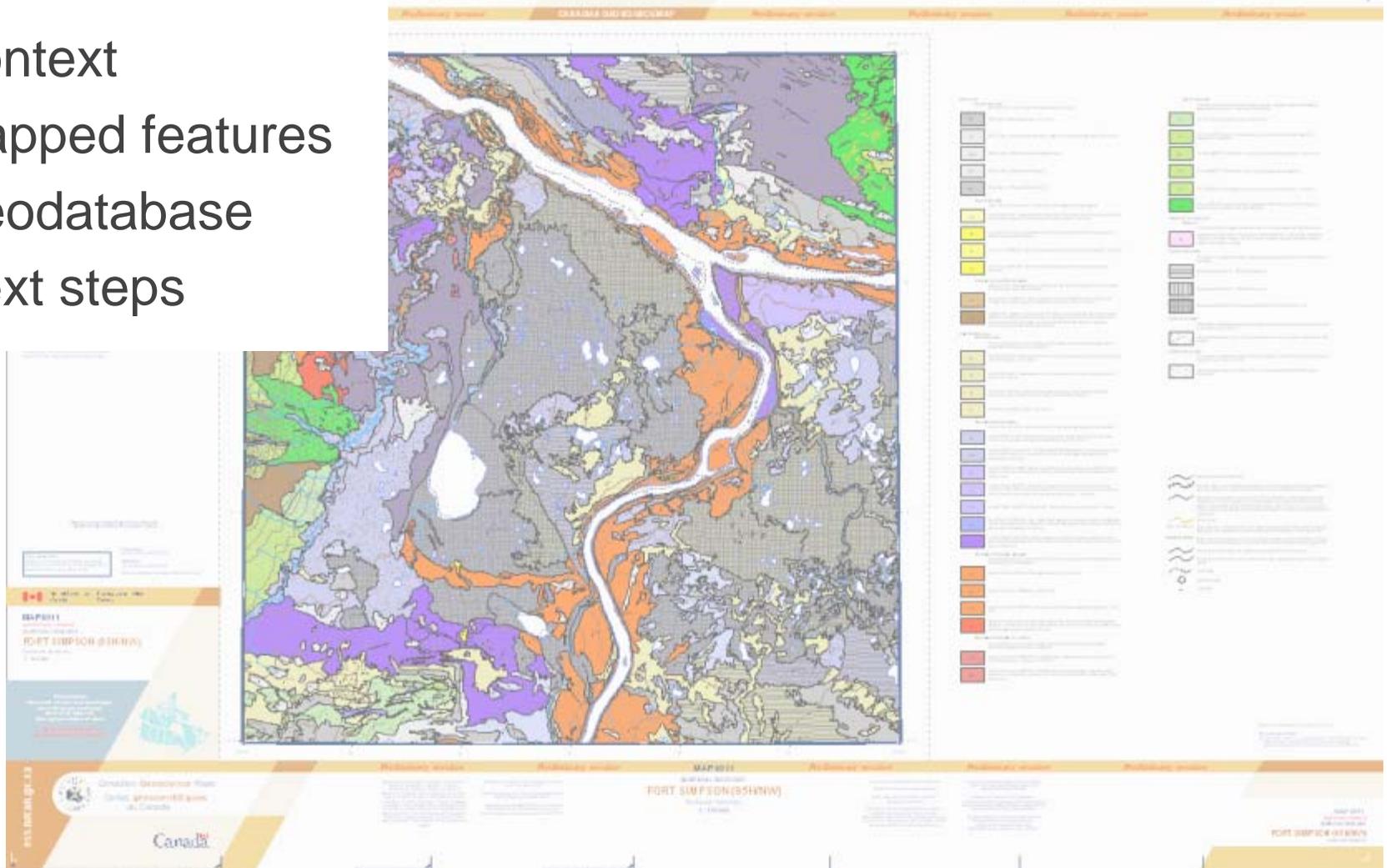
Ressources naturelles
Canada

Canada 

Outline



- Context
- Mapped features
- Geodatabase
- Next steps



Context



- Geological Map Flow Project
- Compilation, interpretation, management and dissemination of geologic map information
- Data collection → **Data management** → Data dissemination
- Surficial geology data
- Data model is implemented as an ESRI™ ArcGIS geodatabase

Mapped features



- **What is being mapped?**
- **How is it described?**
- **How is it implemented?**

Mapped features

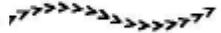
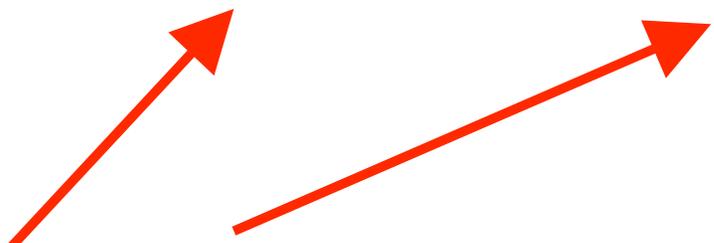


- What is being mapped?
 - Map units
 - Landforms and geomorphologic features
 - Field observations and measurements

- **How is it described?**
 - Science language, legend, symbol

- How is it implemented?
 - Data structure

Esker (direction of flow indicated)



subtype	subfeature	sense
esker ridge	none	known

Mapped features



Science language development

- Review of existing data models and mapping products
- 2 science champions
- Small working group
- Iterative consultations with surficial geology mapping experts
- Developed for mapped features and field data collection

■ How is it described?

- Science language, symbol, legend

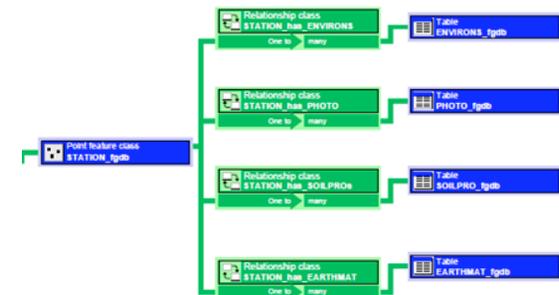
■ How is it implemented?

- Data structure

Mapped features



- What is being mapped?
 - Map units
 - Landforms and geomorphologic features
 - Field observations and measurements
- How is it described?
 - Science language, symbol, legend
- How is it implemented?
 - Data structure



Mapped features

Map units



Compilation of surficial legends (by H. Thorleifson and M. Pyne (2002))

- 1578 maps;
- Map units: 2431 different codes
- Symbols: 5423 different definitions

Mapped features

Map units



gscmap-a_1650a_e_1989_mn01.pdf - Adobe Reader

7 Deltatic Deposits: gravelly sand forms below marine limit; occurs in prodelta and fan deposits are areally much less extensive than their counterpart

LATE WISCONSINAN

6 **GLACIOMARINE DELTA/FAN** deposits: gravel to gravelly sand, and silt and clay in prodelta and fan features that grade from braided to sheeted; steep-sloped delta/fan toe are common whereas fans occur below marine limit

5a GLACIOLACUSTRINE DEPOSITS: as fans or deltas in shallow water; bedded sand, silt, clay, and silt; 10-20 m thick; deposited in short-lived lacustrine basins

5b

5c

4a,4b GLACIOFLUVIAL DEPOSITS: 2-20m thick; occurs in terraced gravel, gravelly sand, minor silt; sharp-crested and flat-topped

3 HUMMOCKY MORAINIC DEPOSITS: sand, gravel, and silt; 10-50+ m thick; diamicton is usual surface sediment; hummocks and depressions

gscmap-a_1555a_e_1984_mn01.pdf - Adobe Reader

POST-LAST GLACIATION

NONGLACIAL ENVIRONMENTAL COLLUVIAL SEDIMENTS: lower slopes and valley floor; upslope weathered rock and debris; deglaciation but basal sedimentation in nonglacial intervals

7b Calcareous colluvium: slightly silty; weathered carbonates (unit 1b)

7a Granitic colluvium: muddy (unit 1a)

FLUVIAL SEDIMENTS: gravelly sand on floodplains and fans

6b Seasonally flooded sediments

6a Terraced sediments above marine limit

MARINE SEDIMENTS: gravelly sand deposited in deltaic, beach, and swale environments of postglacial regression of the postglacial sea

Beach sediments: gravel and sand and swales. (5c): Site of beach deposits older than the last glacial maximum

5c

gscmap-a_2042_e_2003_mn1.pdf - Adobe Reader

GLACIAL MARINE DEPOSITS: sand, silt, gravel, and clay deposited by the high sea

Gmd **Glacial marine delta: sand, silt, boulders, and gravel crossbedded sediments that coarsen upwards in termination of outwash trains or meltwater channels**

Gmb **Glacial marine blanket: sand, silt, minor gravel, deposited from suspension and iceberg rafting; includes regression sediments.**

GLACIOFLUVIAL DEPOSITS: gravel and sand; deposited behind, at, and in front of ice margins.

GFpt **Glaciofluvial outwash: stratified gravel and sand terraces, and fans; includes kame terraces, minor deposits, glacial lacustrine channelled deltas and marine deltas at marine limit; may include washes**

Gr **Glaciofluvial ice-contact deposits (eskers and gravel, sand, and boulders; 5-20 m thick; forming ridges)**

EARLY HOLOCENE AND WISCONSINAN

Th **TILL: clast-supported silty sand, dominantly cobble and metamorphic clasts; 0.5-20 m thick; deposited in environments of local ice caps (Meta Incognita Pt (Amadjuak Ice Divide). Minor silty till deposited on (i.e. trans-strait) and central Laurentide (i.e. down-drift)**

Mapped features

Map units



Genesis:

process and environment of deposition

C	Colluvial deposits
O	Organic deposits
E	Eolian sediments
A	Alluvial sediments
L	Lacustrine sediments
M	Marine sediments
GM	Glaciomarine sediments
GL	Glaciolacustrine sediments
GF	Glaciofluvial sediments
T	Glacial sediments
W	Weathering deposits
U	Undifferentiated deposits
R	Bedrock
H	Anthropogenic
I	Glacier - Icefield - Icecap



Category:

Morphology, stratigraphy, thickness, secondary process

Ap	Floodplain sediments
Af	Fan sediments
Ae	Estuarine sediments
At	Terraced sediments
A	Undifferentiated sediments

Legend

grain size, structure, colour, thickness (minimum and maximum), morphology, stratigraphic relationships, depositional environment and other characteristic features.

Geologic event

Neoglacial
Holocene
Pleistocene
Wisconsin(an)
Late Wisconsin(an)
Middle Wisconsin(an)
Early Wisconsin(an)
Sangamon(ian) (interglacial)
Illinoian glaciation

Mapped features

Map units



- Points – labels
- Lines – boundaries



Polygons – map units

- Feature linked annotations
- Table – map unit legend description

Mapped features

Landforms and geomorphologic features



- Compilation of surficial legends (by H. Thorleifson and M. Pyne (2002))
 - 1578 maps;
 - Map units: 2431 different codes
 - Symbols: 5423 different definitions
 - e.g. Esker - more than 50 different ways to describe the direction of flow

Geological boundary (approximate)	Map unit boundary	
Unmapped built-up area (map GSC 2055A / MGS MAP2003-7 only)		
Mine waste	features as zones	
Peat-extraction area		
Gravel pit	features as points	
Mine or bedrock quarry		
Stabilized dunes		
Abandoned channel		
Minor beach ridge	features as lines	
Wave-cut scarp		
Groundwater sapping channel		
Piping depression		
Iceberg scour		
Tunnel valley		
Esker (direction of flow indicated)		
Streamlined landform		
Glacial striae		
Crossed striae (numbers indicate relative age, 1 being the oldest)		
Small bedrock outcrop		

Mapped features

Landforms and geomorphologic features



What features (concepts) are portrayed?

Subtypes
cirque headwall
crevasse ridge (crevasse filling, ice fracture filling)
iceberg scour (includes iceberg pit, furrows)
kettle
moraine - major
moraine - minor
moraine, disintegration
...

Mapped features

Landforms and geomorphologic features



What geometry?

	polygons	lines	points
Subtypes			
cirque headwall		cirque headwall	
crevasse ridge (crevasse fil		crevasse ridge	
iceberg scour (includes ice			
kettle		iceberg scour - includes iceberg pit, furrows	
moraine - major			
moraine - minor	kettle		kettle
moraine, disintegration		moraine ridge - major	
...		moraine ridge - minor	
	moraine, disintegration		

Mapped features

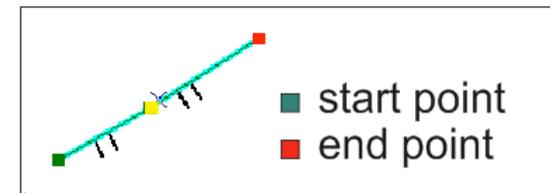
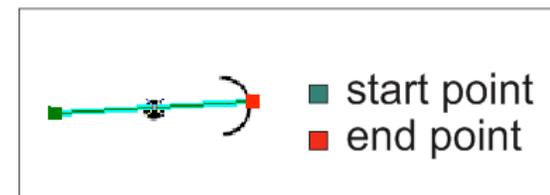
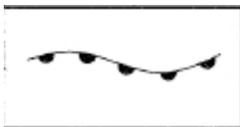
Landforms and geomorphologic features



- What is the most significant attribute? subfeatures
- What other fields do we need? and what goes in them?

subtype	subfeature	sense	notes
moraine ridge - major	lateral	known	ornamented on glacier side

- How is it symbolized?



Mapped features

Field data



<i>Geological boundary (approximate)</i>	
<i>Unmapped built-up area (map GSC 2055A / MGS MAP2003-7 only)</i>	
<i>Mine waste</i>	
<i>Peat-extraction area</i>	
<i>Gravel pit</i>	
<i>Mine or bedrock quarry</i>	
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<i>Minor beach ridge</i>	
<i>Wave-cut scarp</i>	
<i>Groundwater sapping channel</i>	
<i>Piping depression</i>	
<i>Iceberg scour</i>	
<i>Tunnel valley</i>	
<i>Esker (direction of flow indicated)</i>	
<i>Streamlined landform</i>	
<i>Glacial striae</i>	
<i>Crossed striae (numbers indicate relative age, 1 being the oldest)</i>	
<i>Small bedrock outcrop</i>	

Field observations
and measurements



Mapped features

Field data



- Field observations and measurements
 - Traverse
 - Station - Station environment
 - Photo
 - Earth material description
 - Samples
 - Paleoflow measurements
 - Structural measurements
 - Preliminary linework

GanFeld application

Station: 10FF001

1 2 3 4

Trav 1 Date 2010-04

Elev (m) 9999

E(m) 704802.96 N(m) 5664240.6

Lat 51.0930463 Long -114.075208

Obs. Type* ground observatio

Legend Value

ok X

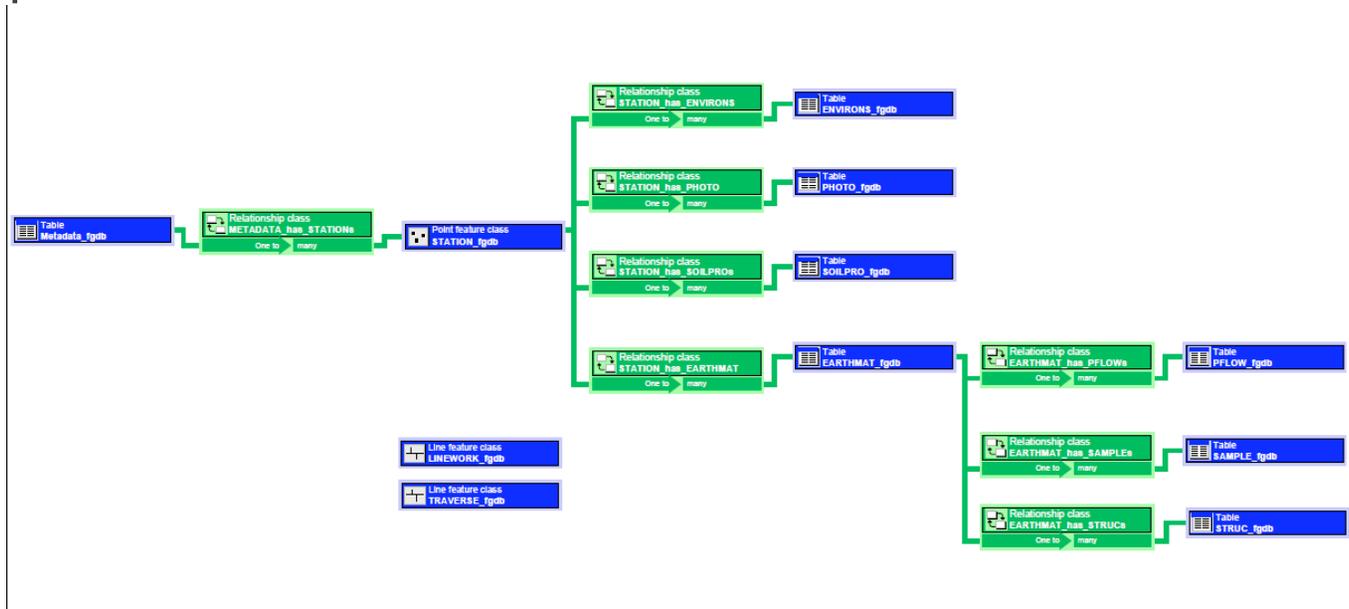
Mapped features

Field data



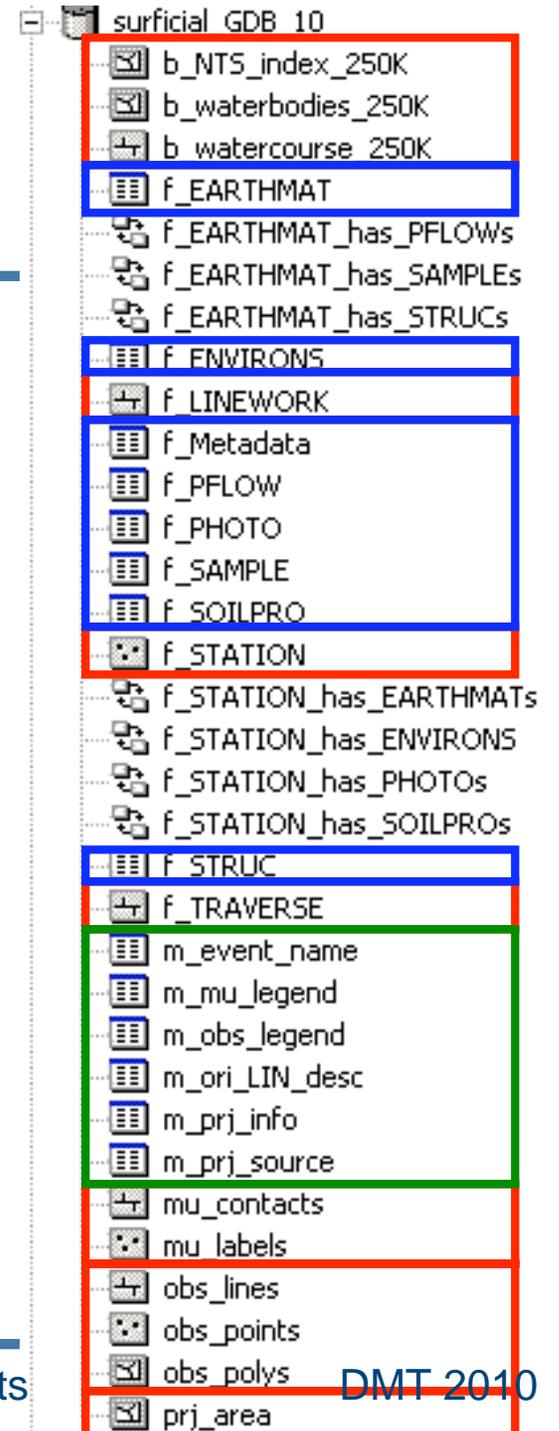
Field observations and measurements

- Points (station)
- Lines (traverse, preliminary linework)
- Tables
- Relationship classes



Geodatabase

- Mapped features
 - Feature classes
 - Data tables
- Metadata tables
- Relationship Classes
- Controls
 - Domains
 - Subtypes
 - Rules
- Tools



Geodatabase



- Mapped features
 - Feature classes
 - Data tables
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- Relationship Classes
- Controls
 - Subtypes
 - Domains
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- Tools

- Science language is maintained in a separate database
 - Unique sequential number for subtype and domain values
 - Some domains are project specific

Geodatabase



- Mapped features
 - Feature classes
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- Controls
 - **Subtypes**
 - Domains
 - Rules
- Tools

Feature Class Properties

General | XY Coordinate System | Tolerance | Resolution | Domain
Fields | Indexes | Subtypes | Relationships | Representations

Subtype Field: obs_feature

Default Subtype: ?

Subtypes:

Code	Description
465	beach crest
466	buried channel
467	buried esker ridge
468	buried subglacial outwash channel
469	cirque headwall
470	coastal accretion

Default Values and Domains:

Field Name	Default Value	Domain
obs_subfeature		subfeature_none
confidence		confidence_none
status		status_none
dep_env		dep_env_none
t_legnth		mapped_lenght_none
sense		sense none

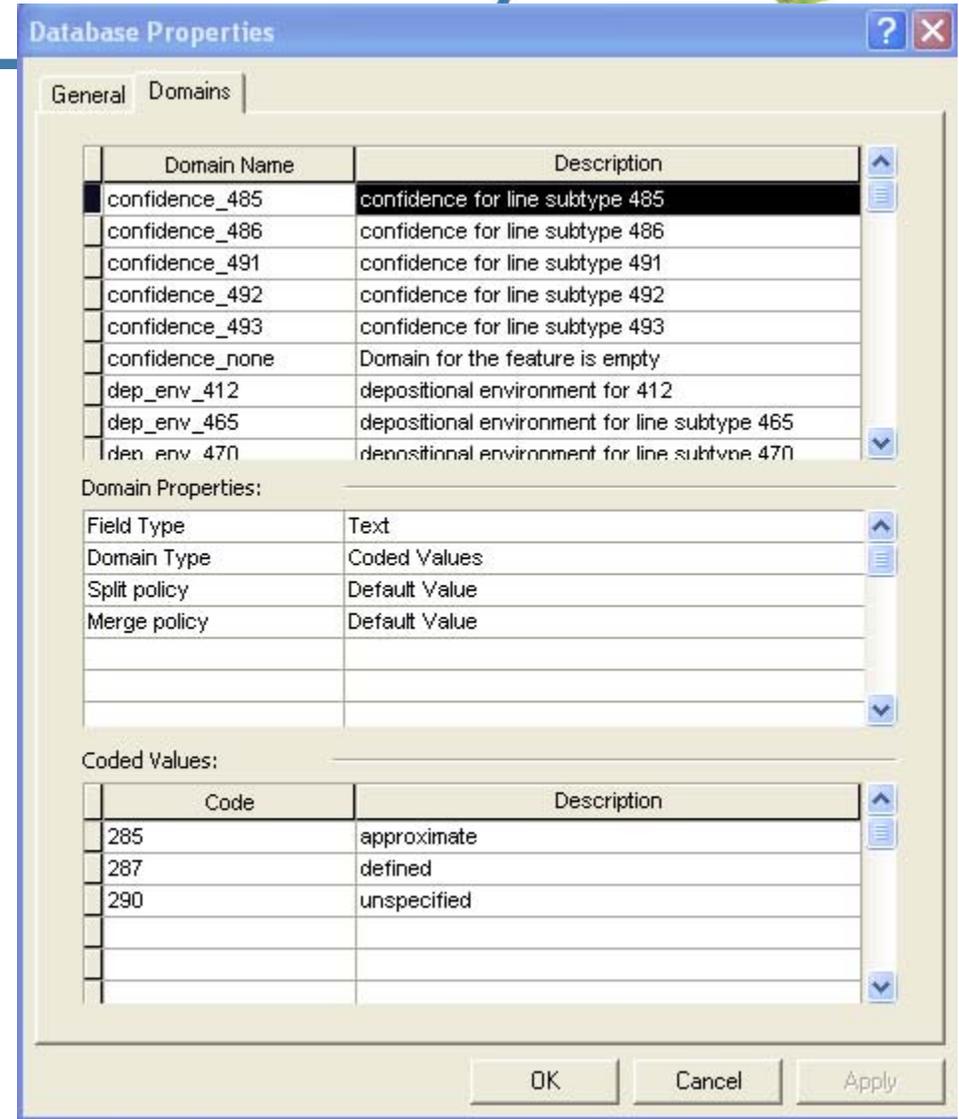
Use Defaults Domains...

OK Cancel Apply

Geodatabase



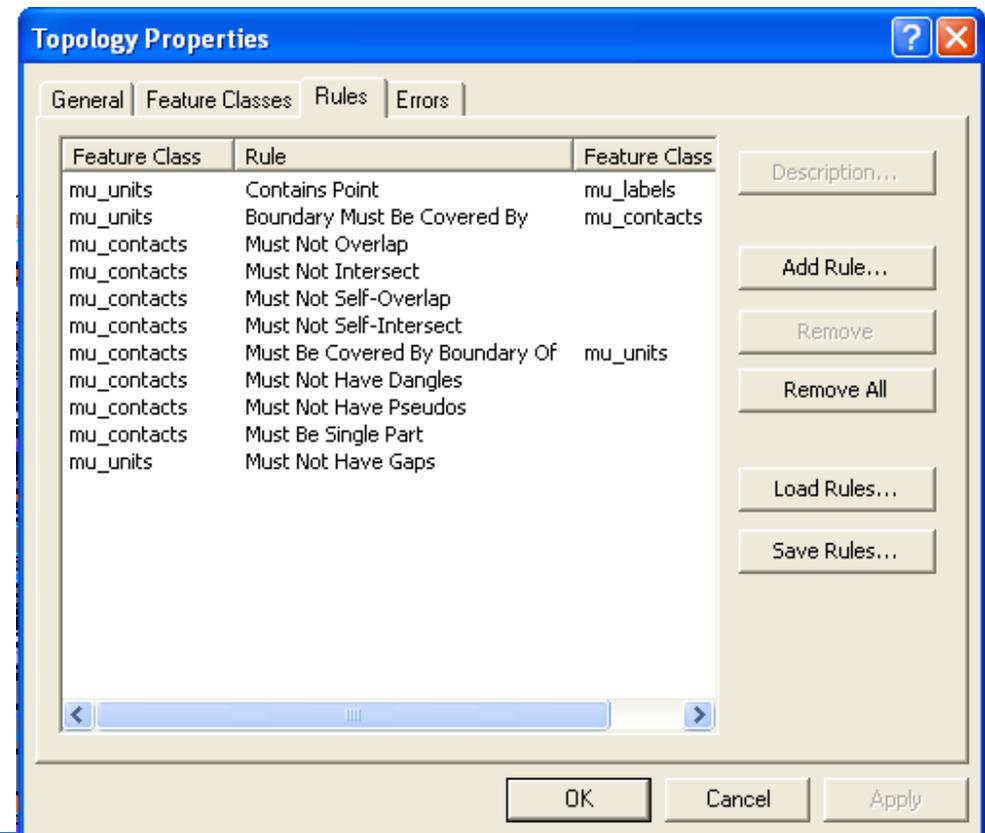
- Mapped features
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 - Data tables
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 - Subtypes
 - **Domains**
 - Rules
- Tools



Geodatabase



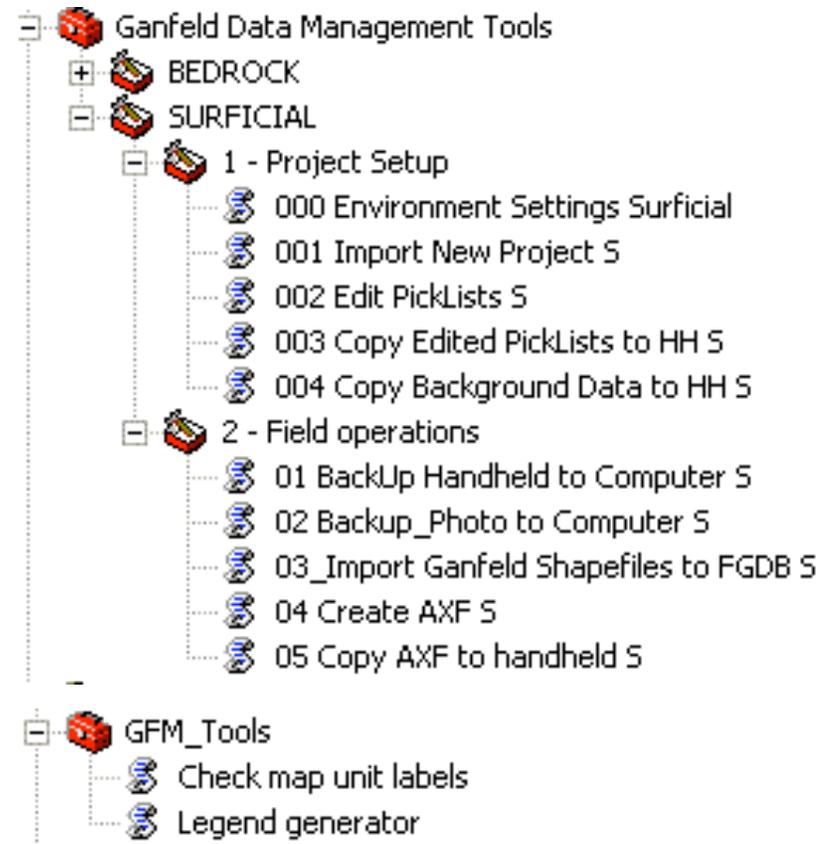
- Mapped features
 - Feature classes
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 - Subtypes
 - Domains
 - **Rules**
- Tools



Geodatabase



- Mapped features
 - Feature classes
 - Data tables
- Metadata tables
- Relationship Classes
- Controls
 - Subtypes
 - Domains
 - Rules
- Tools



Next steps



- Science language review committee
- Tools, rules (topology, tolerance)
- Publication of science language and geodatabase schema
- Cookbook and training
- Testing Science language by loading maps from:
 - A preliminary version in a personal GDB
 - Coverages
 - Compilations
- ArcSDE implementation

Participants



Science language working group

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GanFeld application and tool development team

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Questions?



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