

How to create an Ontology of Entity Types from Topographic Standards

(Focus: Topographic Eminences and Convexities)

Gaurav Sinha

(Ohio University sinhag@ohio.edu)

David Mark

(University at Buffalo dmark@buffalo.edu)

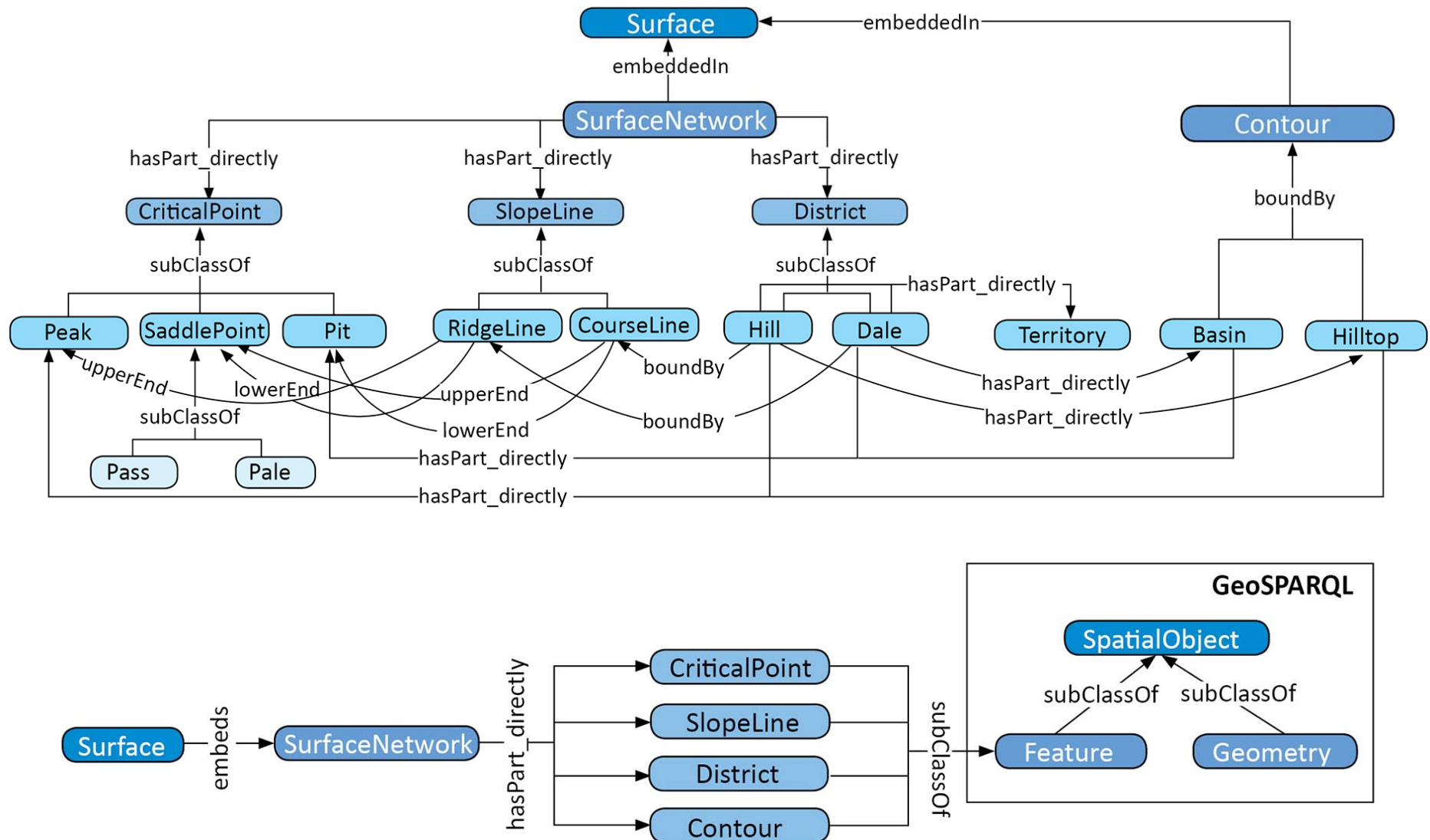
Chen-Chieh Feng

(National University of Singapore geofcc.@nus.edu.sg)

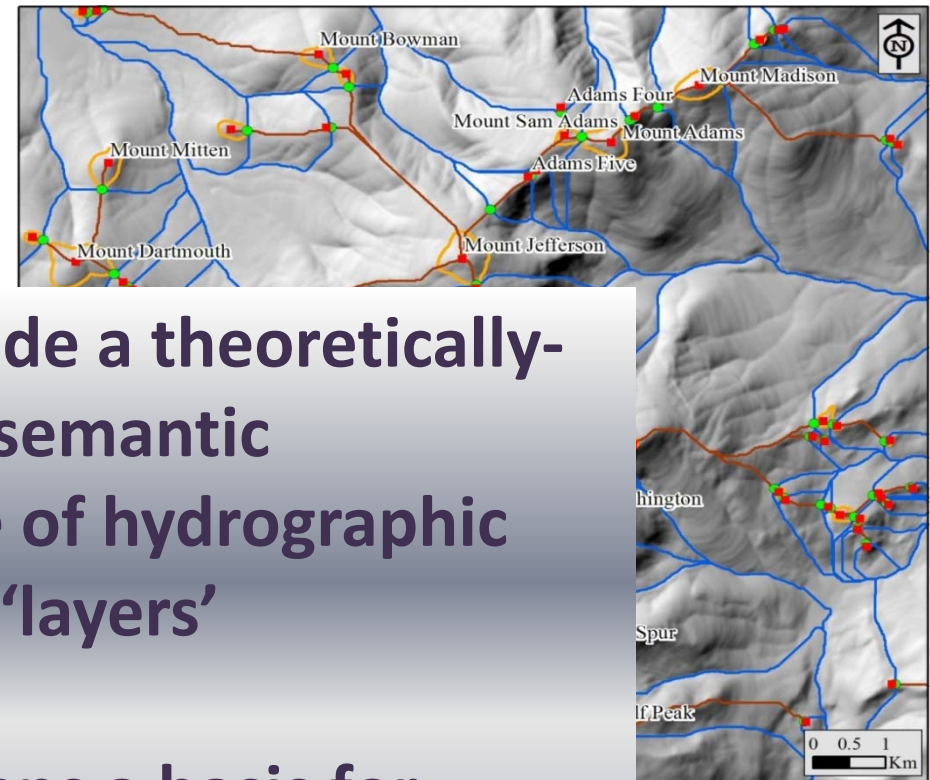
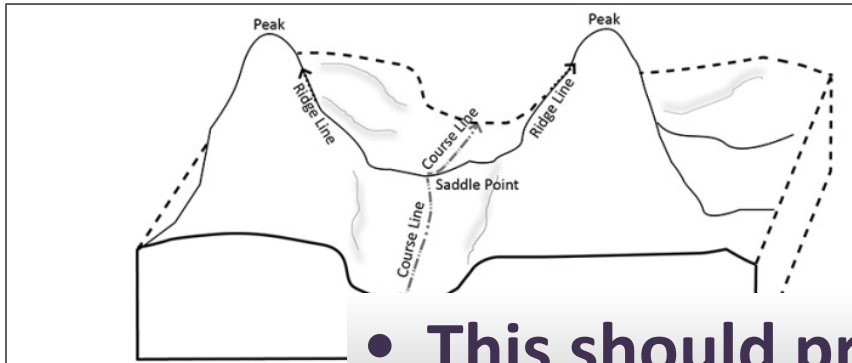
Topography ODPs Designed at GeoVocamps

- **Surface Network ODP** **November, 2012**
- **Surface Water ODP** **November, 2013**
GIScience 2014
- **Contour Map Semantics** **June, 2014**
COSIT 2015

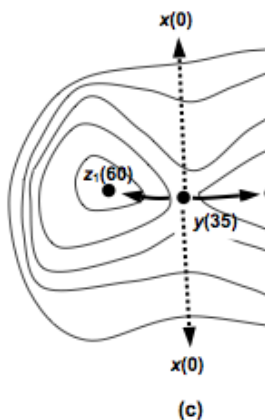
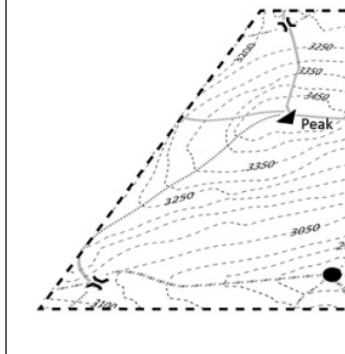
Surface Network ODP



Source: Sinha et al. (2014). Surface Network ODP. (Being revised for Semantic Web Journal).



- This should provide a theoretically-sounds basis for semantic interdependence of hydrographic and topographic 'layers'
- Also it may perhaps a basis for inferring hydrographic features from topographic information
- BUT....CAN IT?



(d)

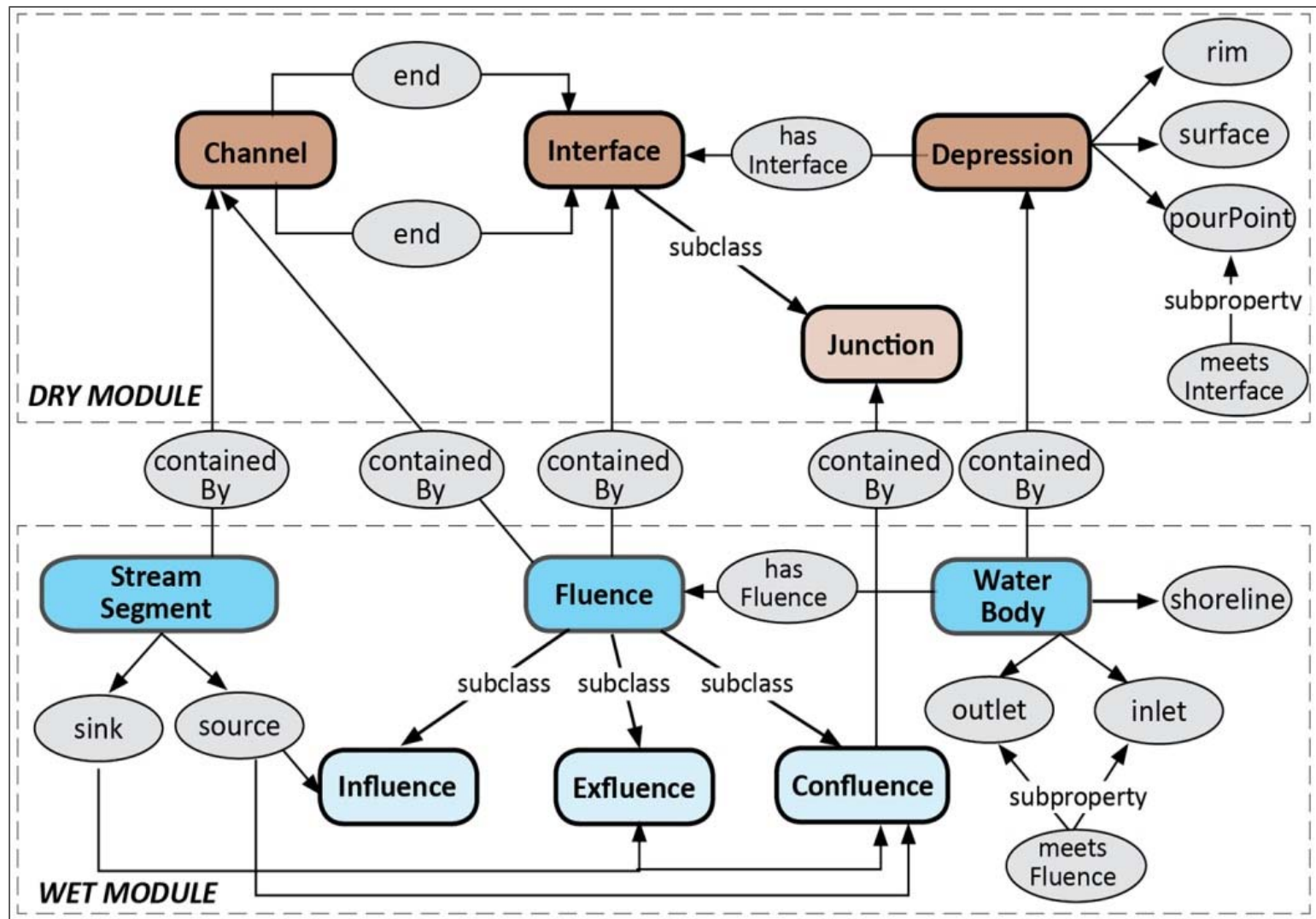
```

sn:upperEnd data:ID100029 ;
geo:hasGeometry data:Geometry200 .

data:ID900114
a
  sn:CourseLine ;
  sn:lowerEnd data:ID600114 ;
  sn:upperEnd data:ID200057 ;
  geo:hasGeometry data:Geometry54 .

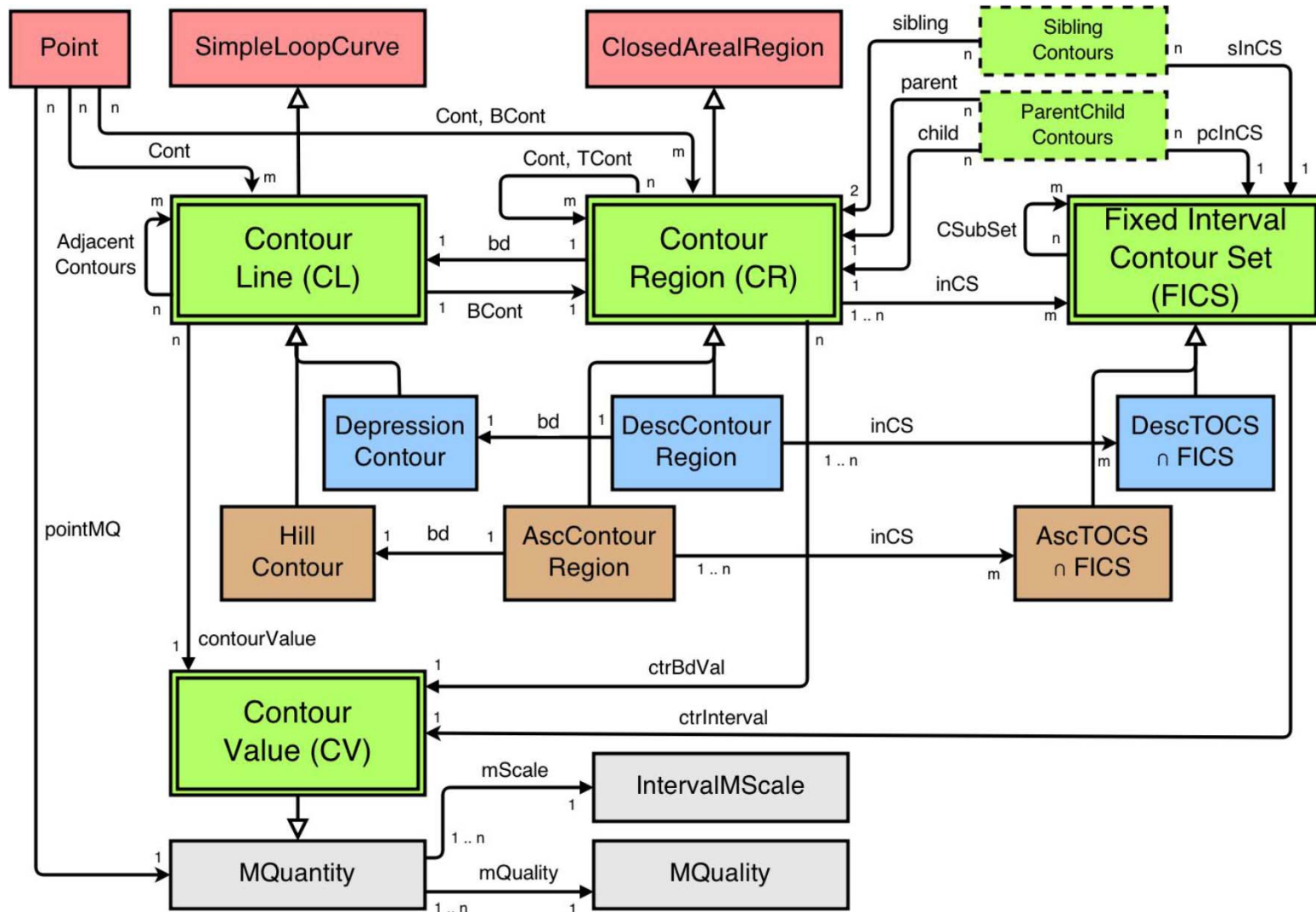
```

Surface Water ODP



Source: Sinha et al. (2014). An ODP for Surface Water Features. GIScience 2014.

Contour Map Semantics



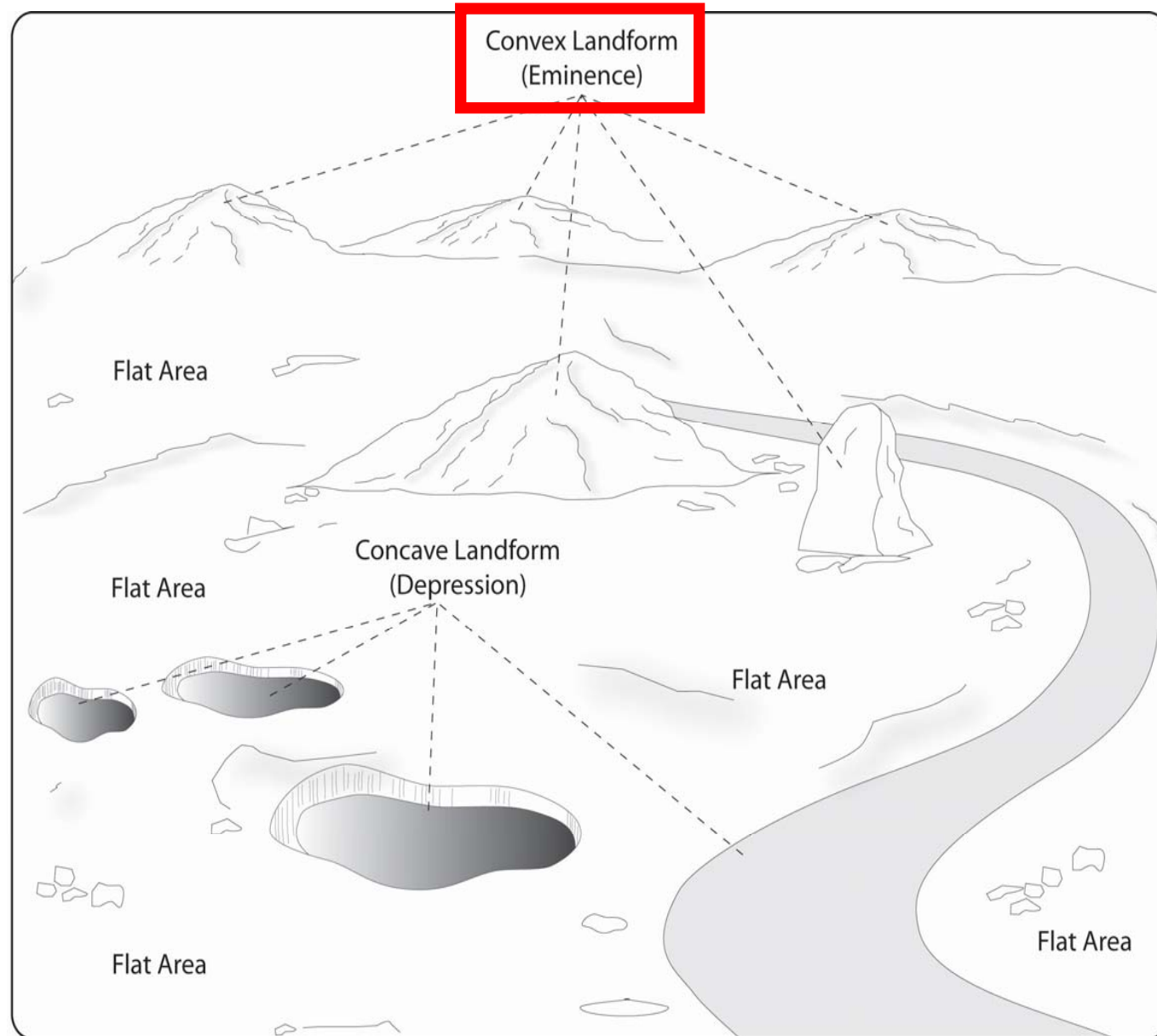
Source: Hahnmann & Urey (2015). What is a Contour Map? A Region-Based Logical Formalization of Contour Semantics. COSIT 2015.

Motivation for GeoVocampDC 2015

Topographic Categories

- What kind of topographic categories should we be using to capture people's intuitive/common sense of landforms?
 - *Note: Scientific geomorphological categories/descriptors will not align well with common sense categories and attributes because geomorphology science focuses on process and common sense is largely form/shape driven*

Topographic Eminences/Convexities



Existing Topographic Controlled Vocabularies & Taxonomies

- US: SDTS, GNIS, GeoNames
- Other national standards (*Taiwan, Russia, Australia, Indonesia, Malaysia...*)
- EnvO
- Wordnet
- Wikipedia
- OED, Merriam Webster, Dictionary.com

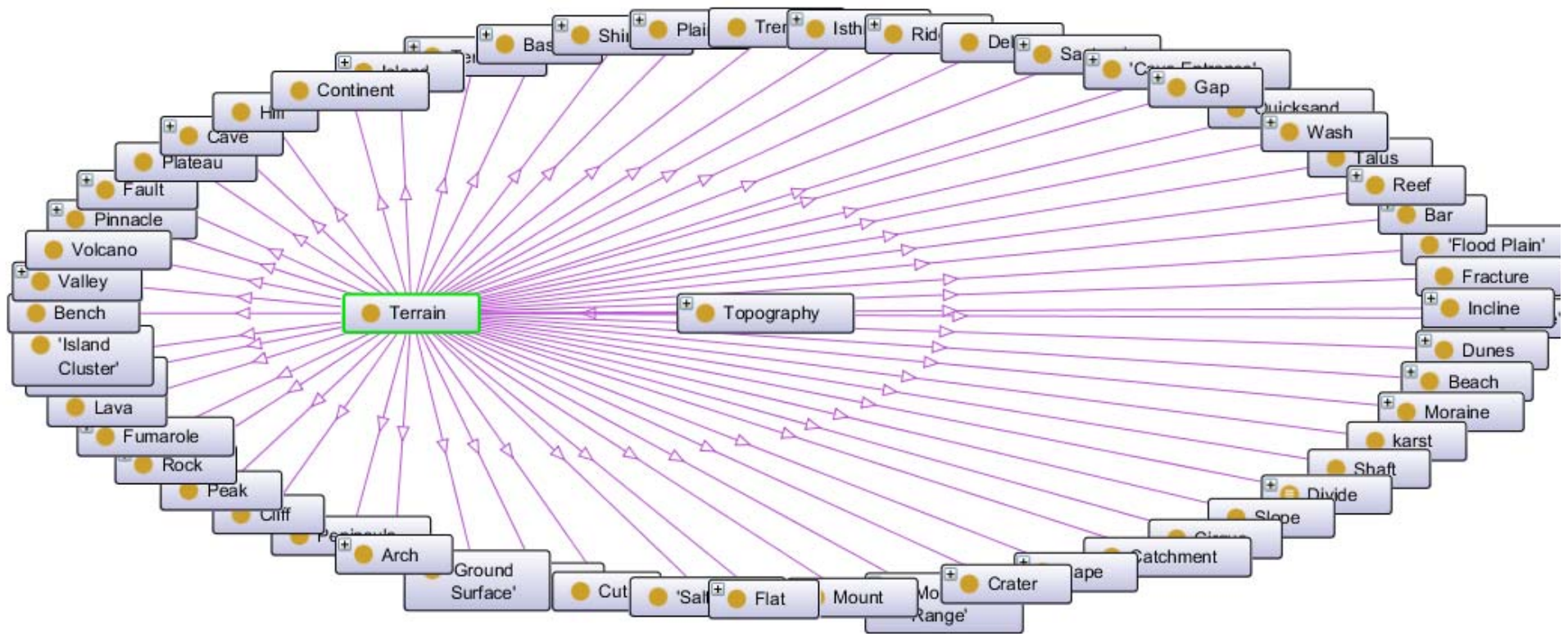
Eminence Related Types: GNIS (USA)

Feature Class	Definition	Associated Generics
Bench	area of relatively level land on the flank of an elevation such as a hill, ridge, or mountain where the slope of the land rises on one side and descends on the opposite side (level)	None
Cliff	very steep or vertical slope	bluff, crag, head, headland, nose, palisades, precipice, promontory, rim, rimrock
Pillar	vertical, standing, often spire-shaped, natural rock formation	chimney, monument, pinnacle, pohaku, rock tower
Range	chain of hills or mountains; a somewhat linear, complex mountainous or hilly area	cordillera, sierra
Ridge	elevation with a narrow, elongated crest which can be part of a hill or mountain	crest, cuesta, escarpment, hogback, lae, rim, spur
Slope	a gently inclined part of the Earth's surface	grade, pitch
Summit	prominent elevation rising above the surrounding level of the Earth's surface; does not include pillars, ridges, or ranges	ahu, berg, bald, butte, cerro, colina, cone, cumbre, dome, head, hill, horn, knob, knoll, mauna, mesa, mesita, mound, mount, mountain, peak, puu, rock, sugarloaf, table, volcano

Eminence Types: SDTS (USA)

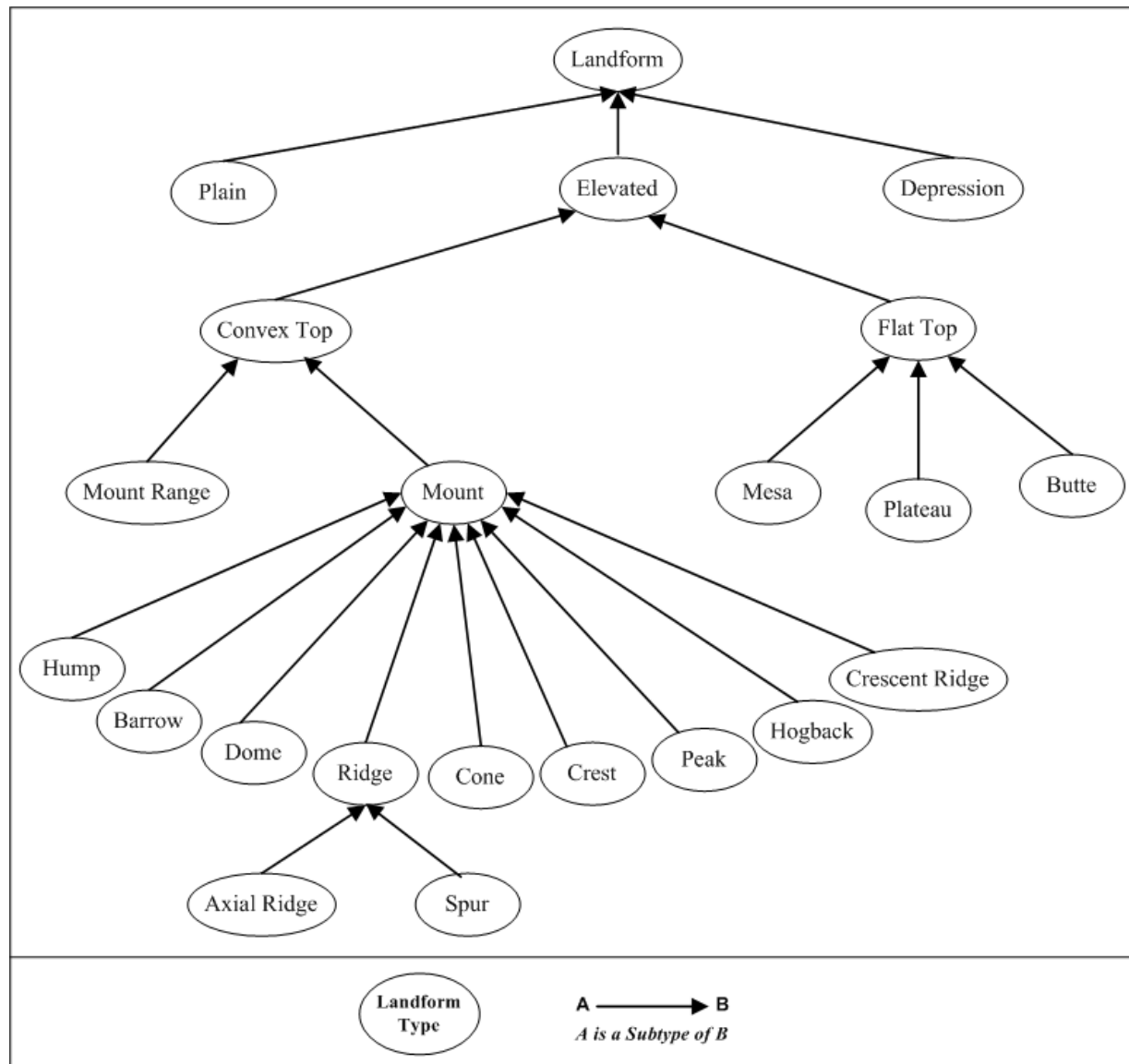
Entity Type	Definition	Included Types
Cliff	A high, steep, or overhanging face of rock.	beach scarp, bluff, ceja, crag, escarpment, ice cliff, marine cliff, palisade, precipice, scar, scarp, scaw
Mount	A mountain or hill	bald, bank, bery, cerrito, cerro, cinder cone, cuesta, dome, drumlin, foothill, hill, hillock, hummock, kame, knob, knoll, lava cone, monadnock, mound, mountain, pingo, rise, sand dune, sand hills, seaknoll, seamount, shield volcano, volcano
Mount Range	A series of connected and aligned mountains or mountain ridges	Mountain range, range, seamount chain, seamount group, seamount range
Peak	The summit of a mountain	ice peak, nunatak, seapeak, summit
Pinnacle	A tall, slender, spire-shaped rock projecting from a level or more gently sloping surface	chapeirao, coral head, crag, pillar, precipice, scar
Plateau	An elevated and comparatively level expanse of land	butte, guyot, intermontane plateau, mesa, tableknoll, tableland, tablemount
Ridge	A long and narrow upland with steep sides	arete, beach cusps, beach ridge, cerro, crest, cuesta, drumlin, esker, kame, range, sand dune, sand hills, sill, spur, volcanic dike
Ridge Line	The line separating drainage basins	None

USGS CEGIS Vocabulary



Source: CEGIS (USGS) Terrain Topographic Vocabulary. URL: <http://cegis.usgs.gov/ontology.html>

Granö's Eminence Taxonomy



Source:
Granö, 1927

WordNet

Entity



Physical Entity



Object, Physical Object

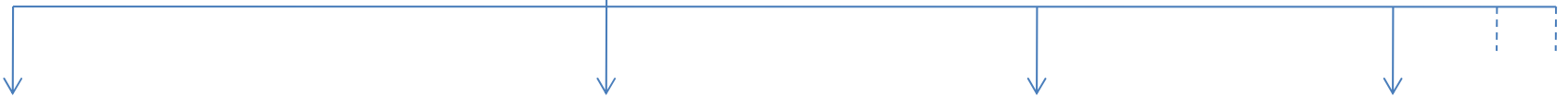


Geological Formation, Formation



NATURAL ELEVATION, ELEVATION

(HAS PART: slope, incline, side)



Highland, Upland			Hill <i>(HAS PART: hillside)</i>					Mountain, Mount <i>(HAS PART: mountain peak)</i> <i>(HAS PART: mountainside, versant)</i>				Promontory, Headland, Head, Foreland		
Down	Tableland, Plateau		Butte	Foothill	Knoll, Mound, Hillock, Hummock, Hammock			Tor	Alp	Ben	Seamount	Volcano	Mull	Point
	Mesa, Table	Terrace, Bench									Guyot			
						Anthill, Formicary	Kopje, Koppie				Mole hill			

WordNet

Entity



Physical Entity



Object, Physical Object



Geological Formation, Formation



NATURAL ELEVATION, ELEVATION

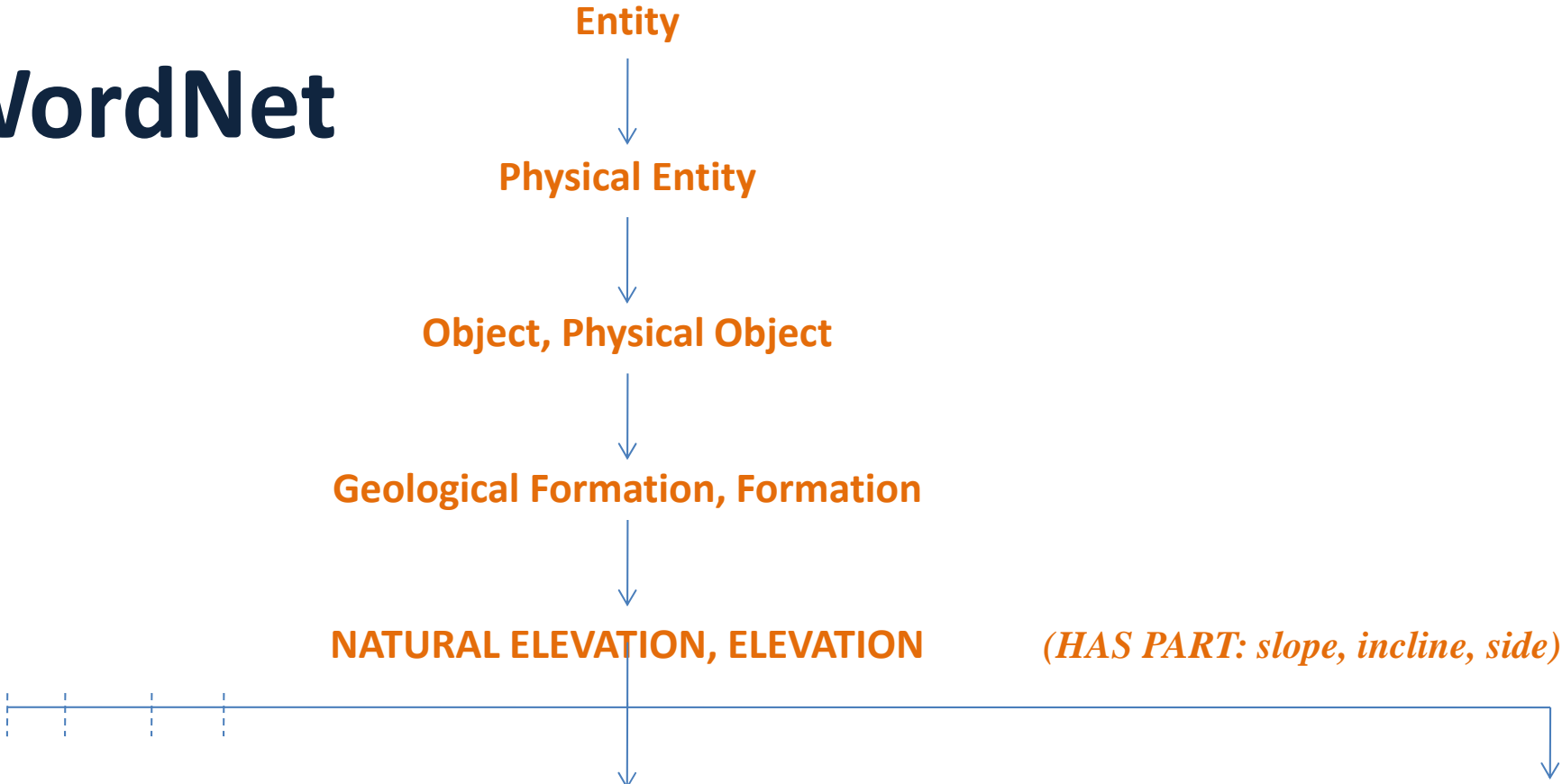
(HAS PART: slope, incline, side)


Can a hill not have a peak or summit?

What if a volcano has a crater and not a peak?

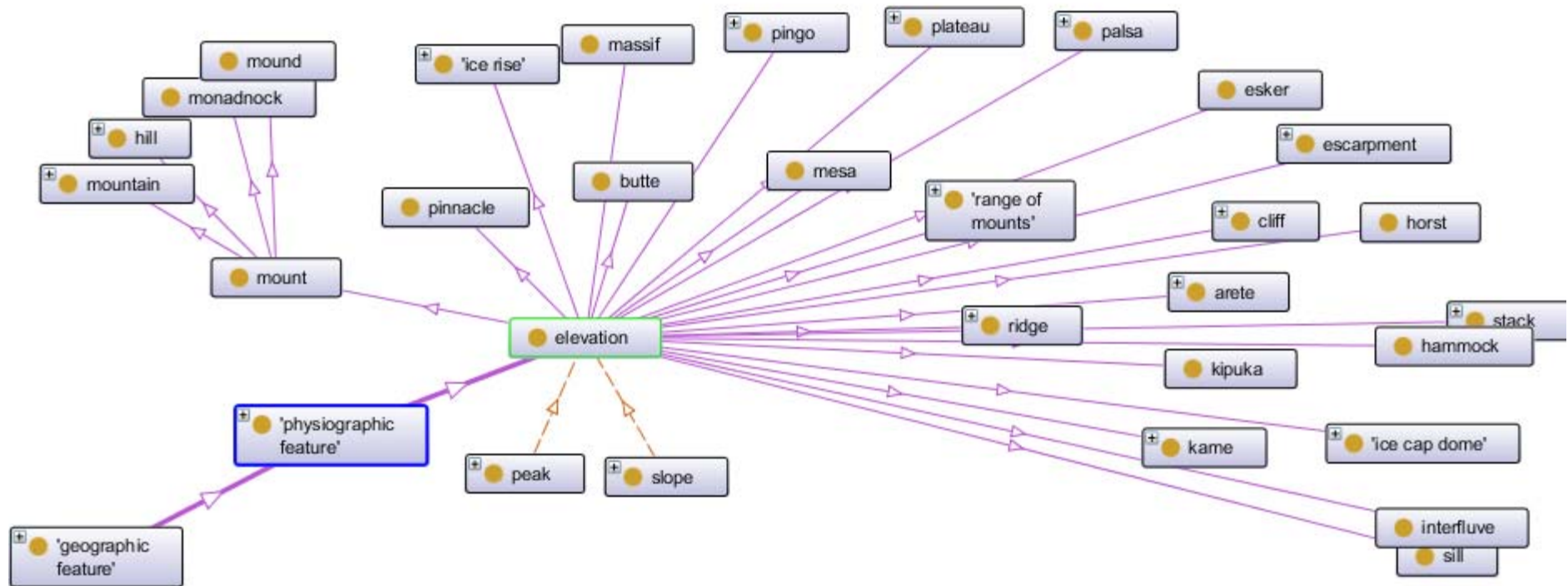
Highland, Upland		Hill <i>(HAS PART: hillside)</i>				Mountain, Mount <i>(HAS PART: mountain peak)</i> <i>(HAS PART: mountainside, versant)</i>				Promontory, Headland, Head, Foreland		
Down	Tableland, Plateau		Butte	Foothill	Knoll, Mound, Hillock, Hummock, Hammock	Tor	Alp	Ben	Seamount	Volcano	Mull	Point
	Mesa, Table	Terrace, Bench							Guyot			
				Anthill, Formicary	Kopje, Koppie	Mole hill						

WordNet

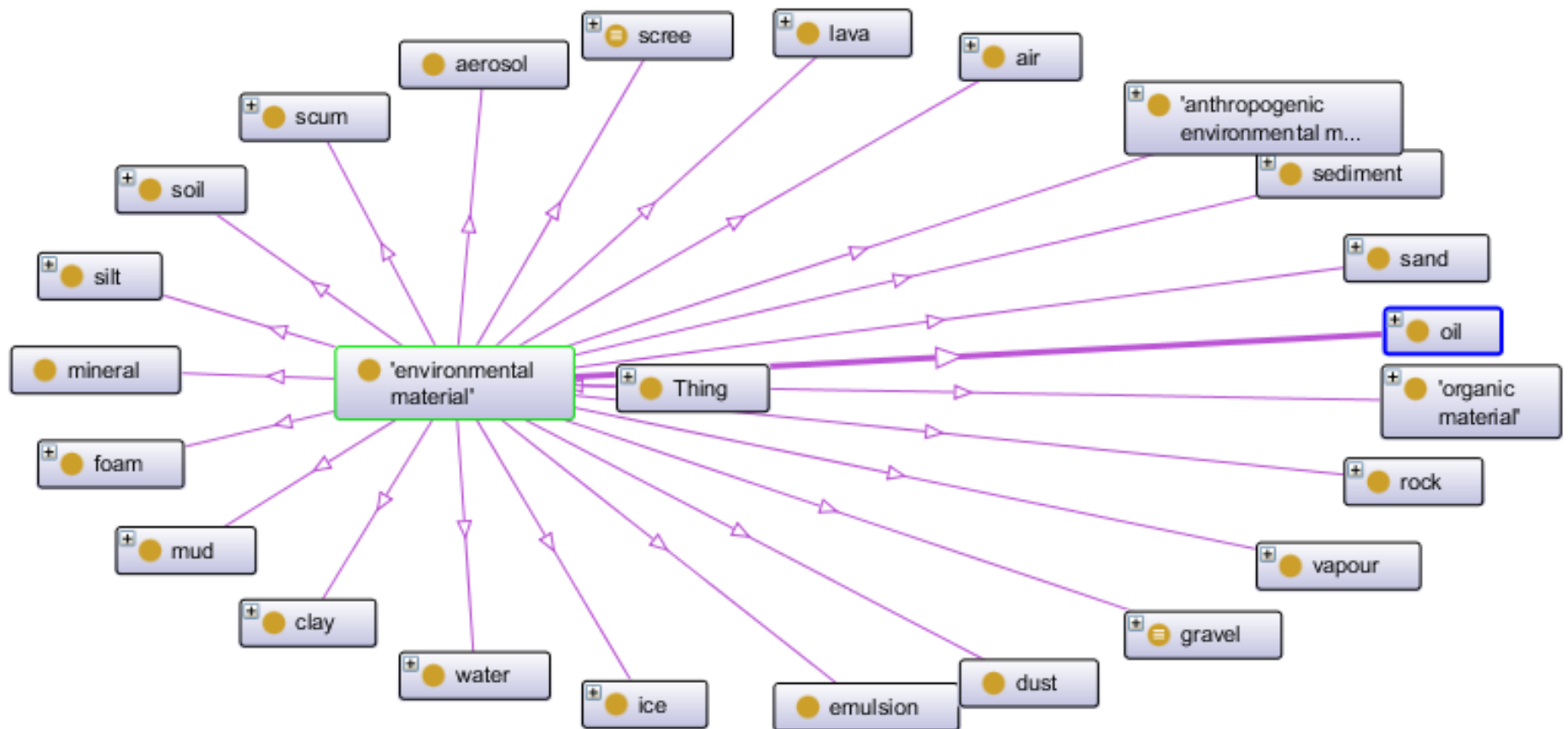


Ridge									Swell	
										
Bank		Bar	Dune, Sand Dune	Esker	Ledge, Shelf	Reef				Ripple Mark
Bluff	Sandbank	Sandbar, Sand Bar	Seif Dune		Berm	Coral Reef				
	Shoal					Atoll	Barrier Reef	Key, Cay, Florida Key		

EnvO



EnvO



Source: EnvO (<http://environmentontology.org>)

**How do we create an ontology from
these resources?**

Foundational Landscape Ontology

- ***ASSERTIONS***

- ***No natural kinds*** in the (inorganic) landscape domain
- A ***realist*** ontology of landforms is likely to be very ***shallow*** because of ***cultural, linguistic, and idiosyncratic*** variations in landscape perception
- ***Pluralistic*** view of landform ontology design is necessary for supporting ‘egalitarian’ information exchange on the semantic web

Foundational Landscape Ontology

- ***Commonly Experienced Landscape***



- Only ***ONE primary entity***: earth's surface
- ***secondary natural and anthropogenic entities*** (e.g., trees, roads, and buildings) physically attached to that surface
- ***observable and measurable physical characteristics*** (location, shape, size, elevation, gradient, depth, color, material);
- ***limited number of localized, observable surface “features”*** (e.g., protuberance, peak, ridgeline, fault, layer, hollow, depression, cliff, incline, slope break, edge)
- ***fundamental spatial and temporal relations*** between surface features (e.g., proximity, direction, topology, temporal overlap, composition, parthood, etc.).

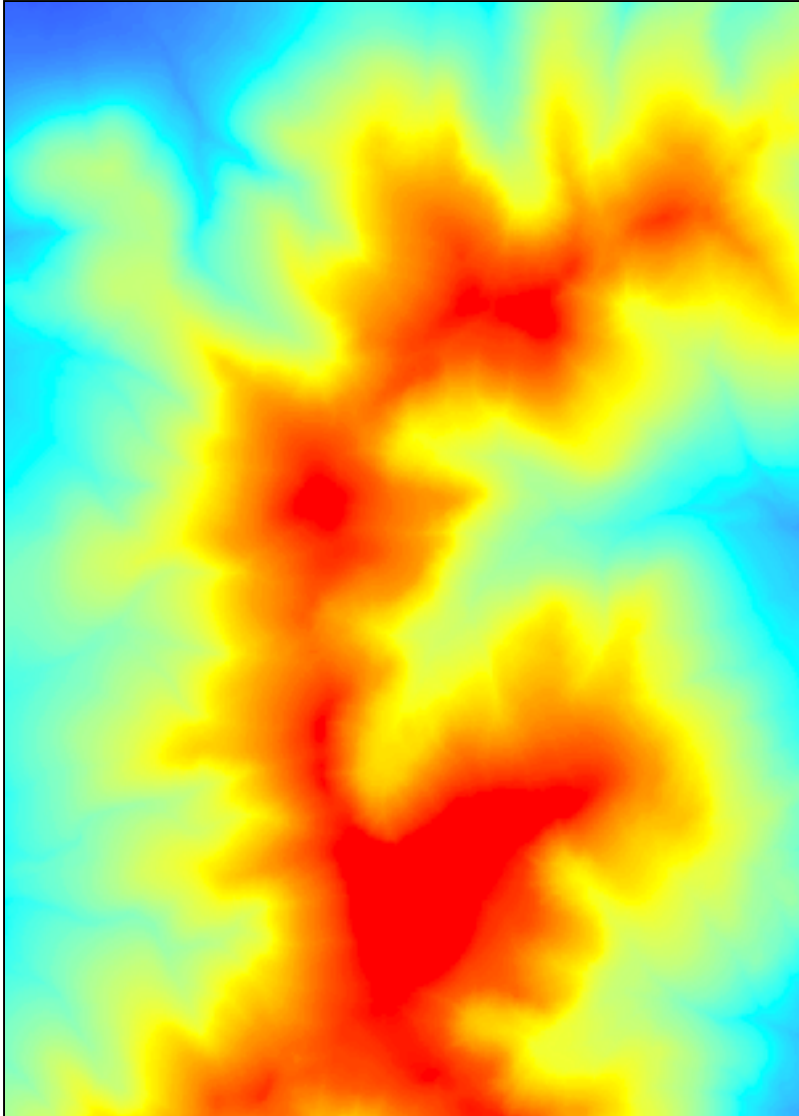
Source: Sinha & Mark (2010). *Toward a Foundational Ontology of the Landscape*. GIScience 2010.

How could we apply a terrain ontology?

Let's look at some examples from previous ODPs...

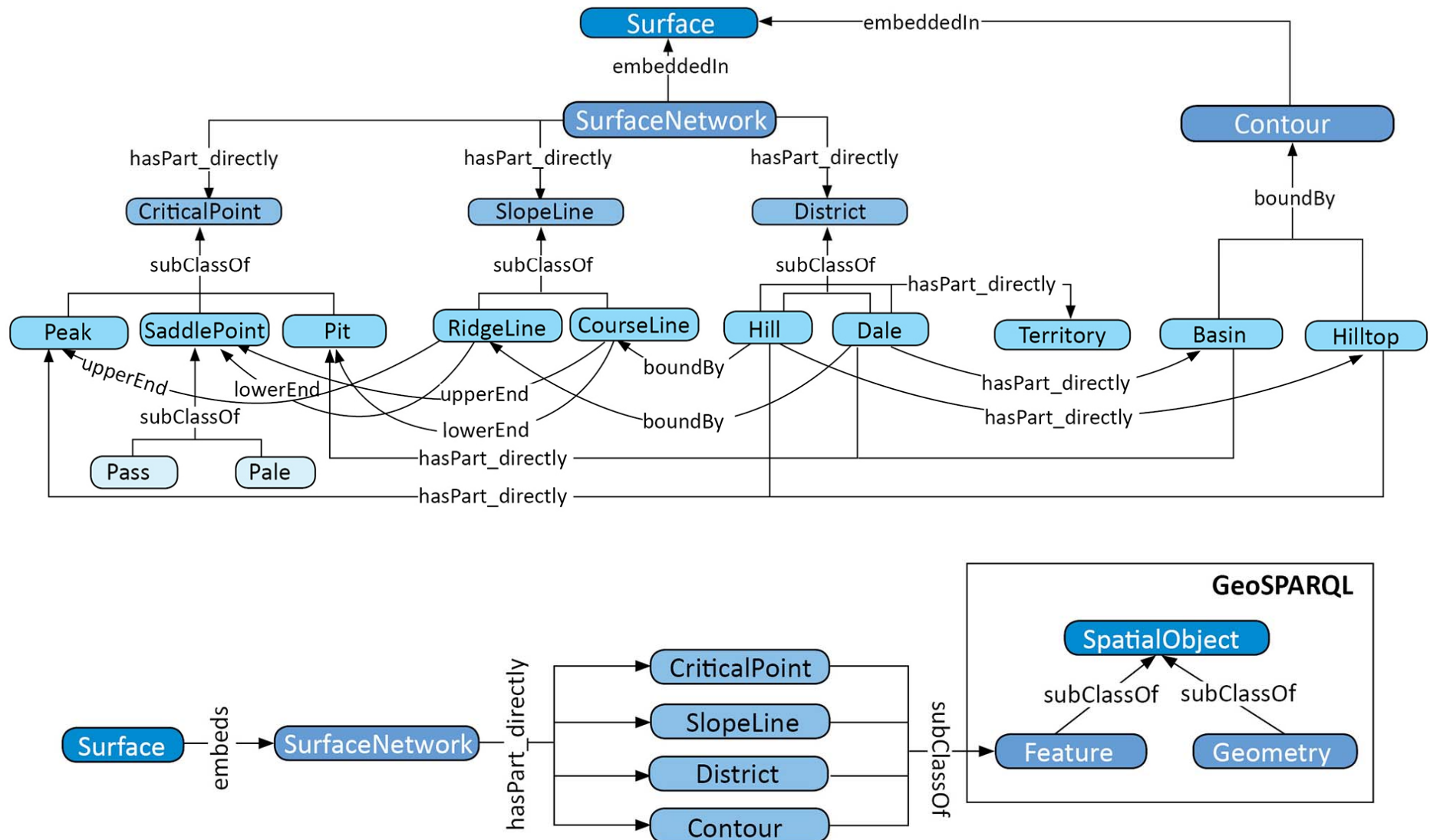
Digital Elevation Model

(Field based representation of terrain)



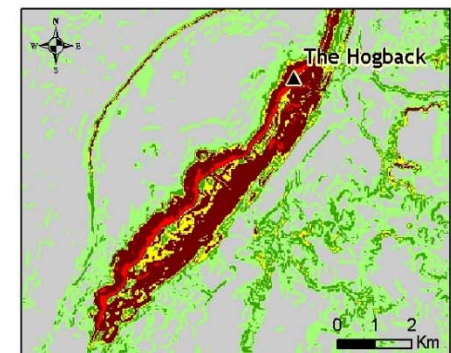
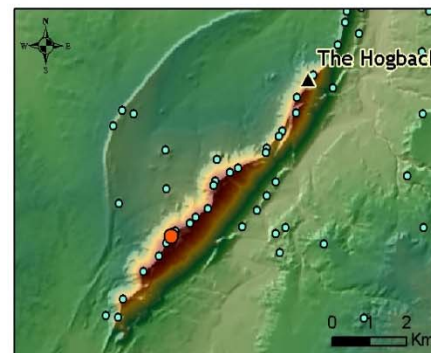
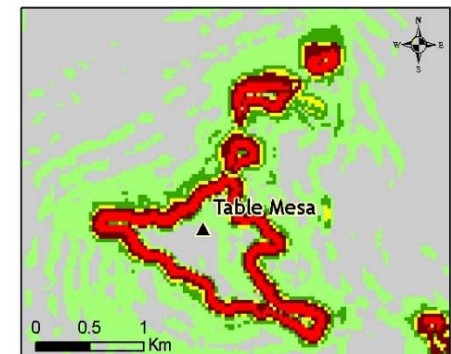
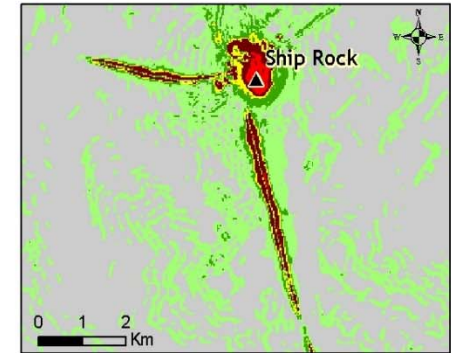
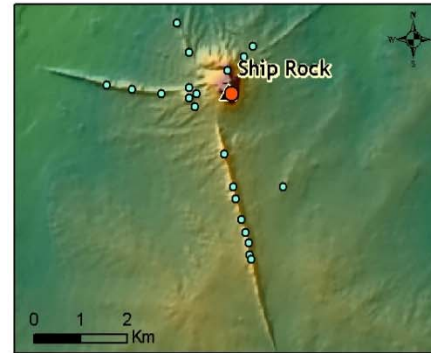
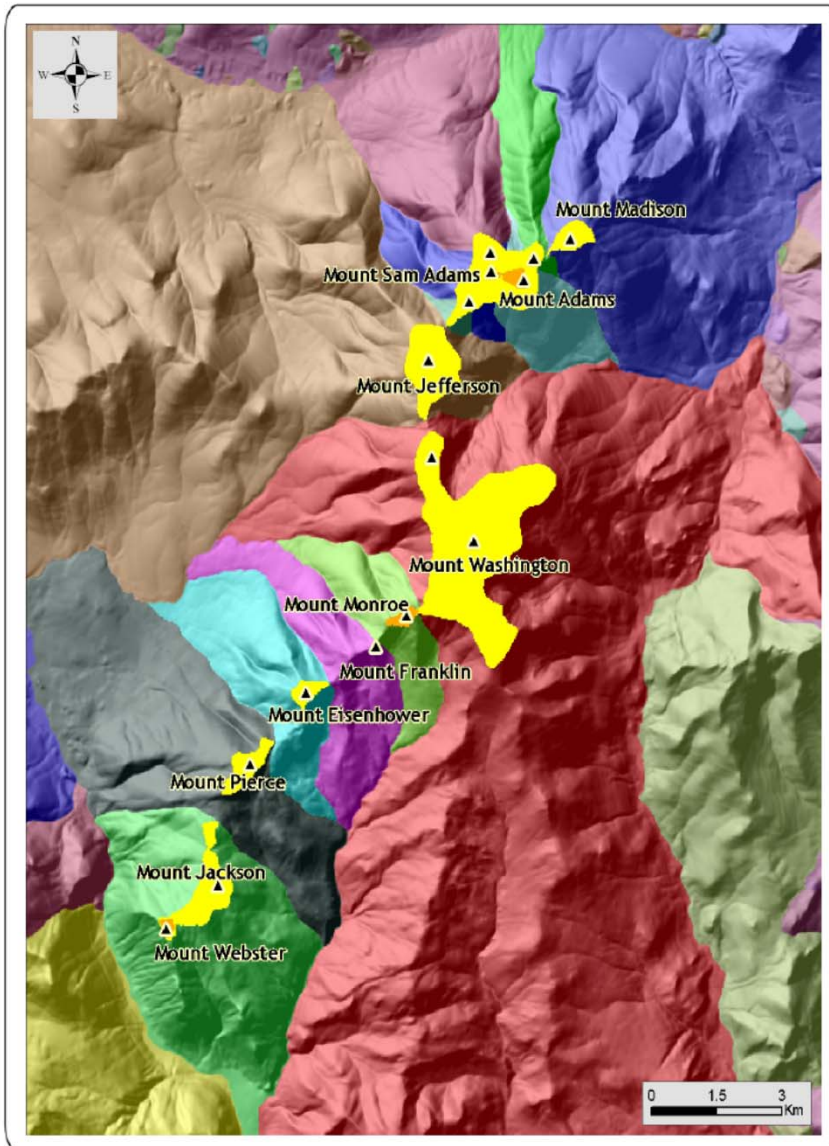
*How do we extract
qualitative objects and
describe them from
this field of elevations
that quantitatively
describe terrain?*

Surface Network ODP



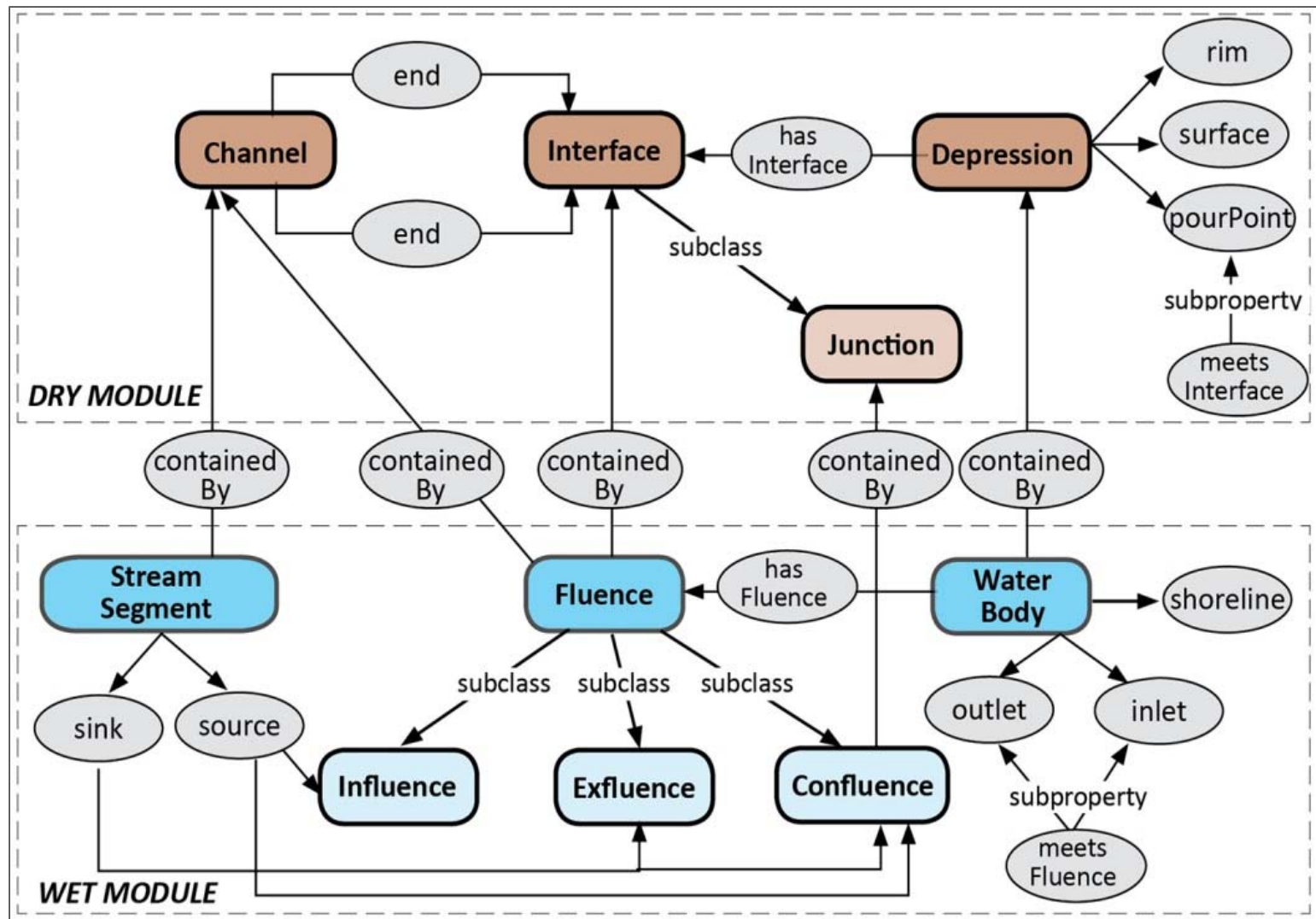
Source: Sinha et al. (2014). Surface Network ODP. (Under revision for Semantic Web Journal).

Identify/Delineate/Classify



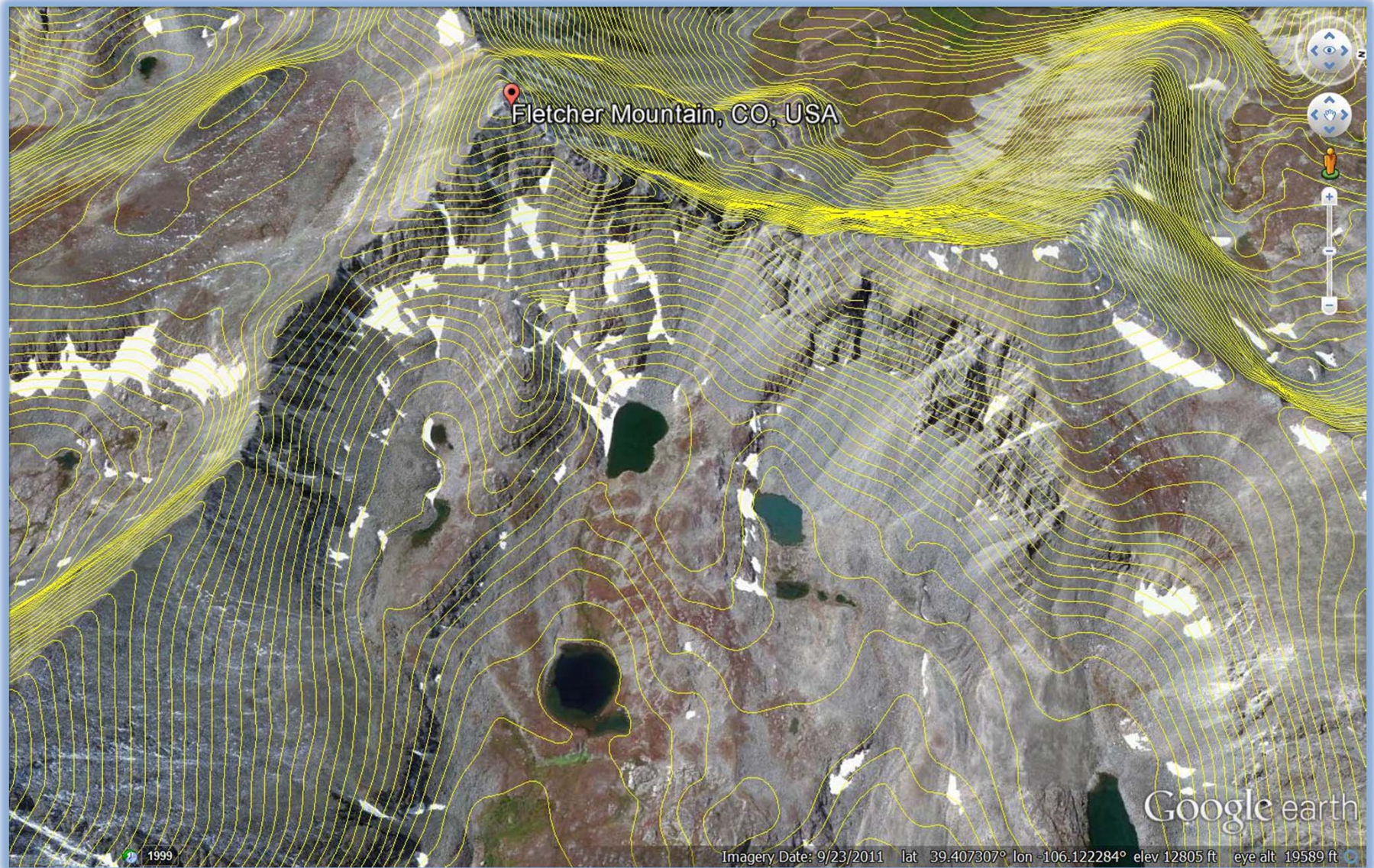
Source: Sinha (2008). *Identification, Delineation and Characterization of Topographic Emienences*. Phd Dissertation, Department of Geography, University at Buffalo,

Surface Water ODP

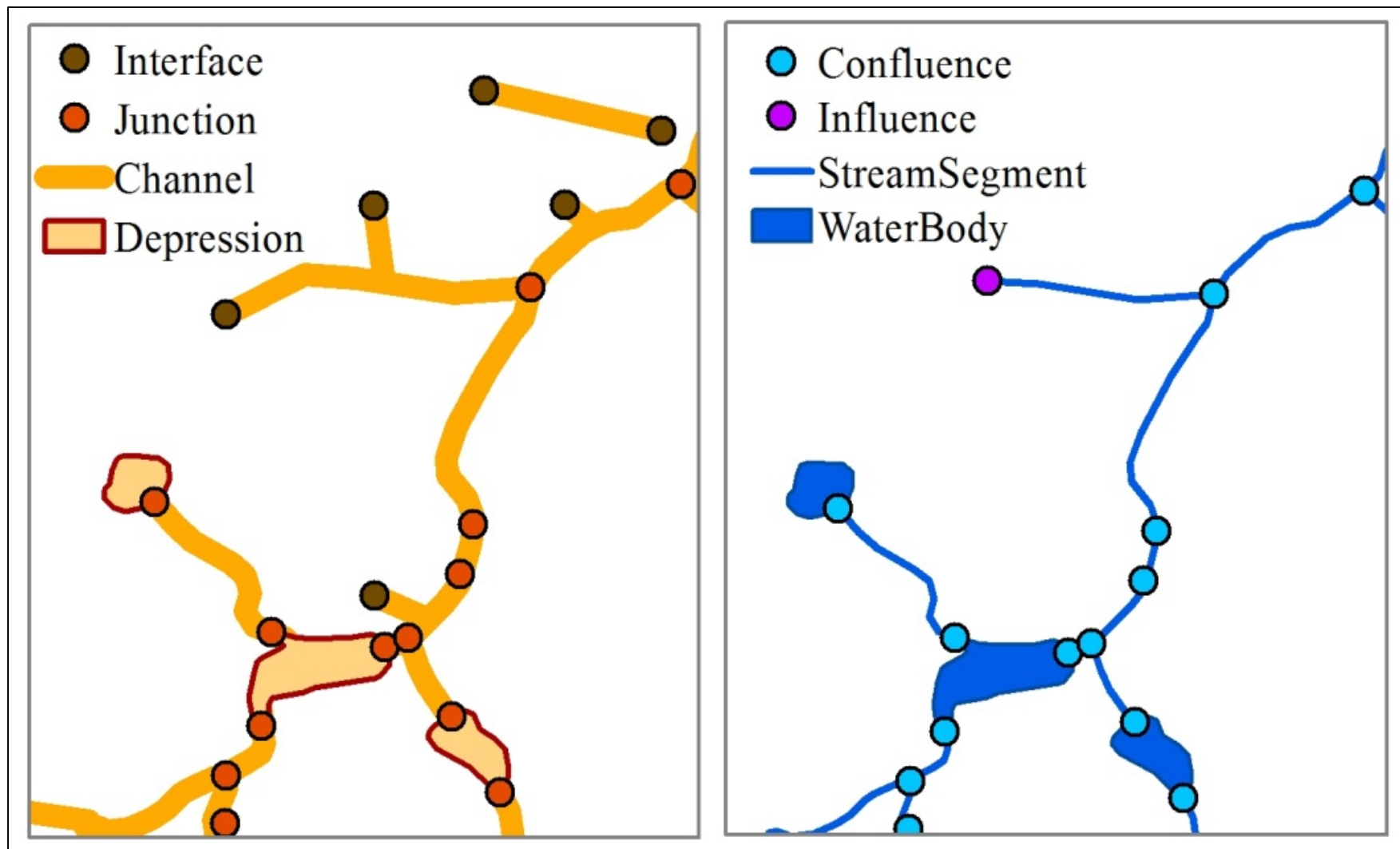


Source: Sinha et al. (2014). An Ontology Design Pattern for Surface Water Features. GIScience 2014.

Identify/Delineate/Classify



Annotating Hydrographic Features



Source: Sinha et al. (2014). *An Ontology Design Pattern for Surface Water Features*. GIScience 2014.