

Developing a rich, interactive knowledge portal for GEON: extending limits of ontology with other ways of knowing

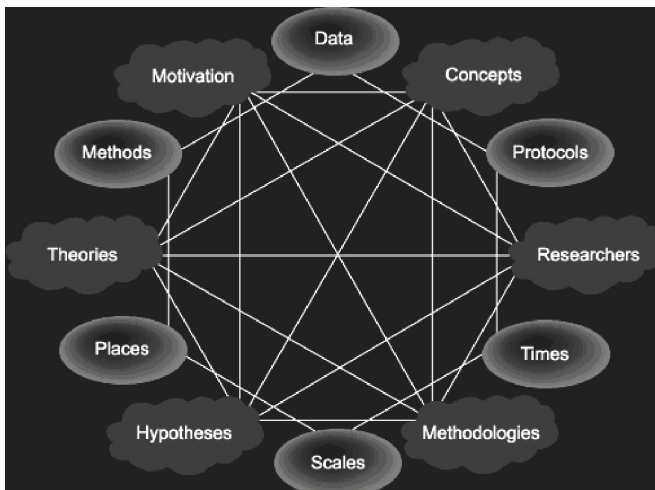
Mark Gahegan ^a, William Pike ^b, Junyan Luo, Steven Weaver ^a, and Tawan Banchuen ^a

^aGeoVISTA Center, Pennsylvania State University, University Park, PA, USA

^bPacific Northwest National Labs, Richland, WA, USA (graduated from PSU)

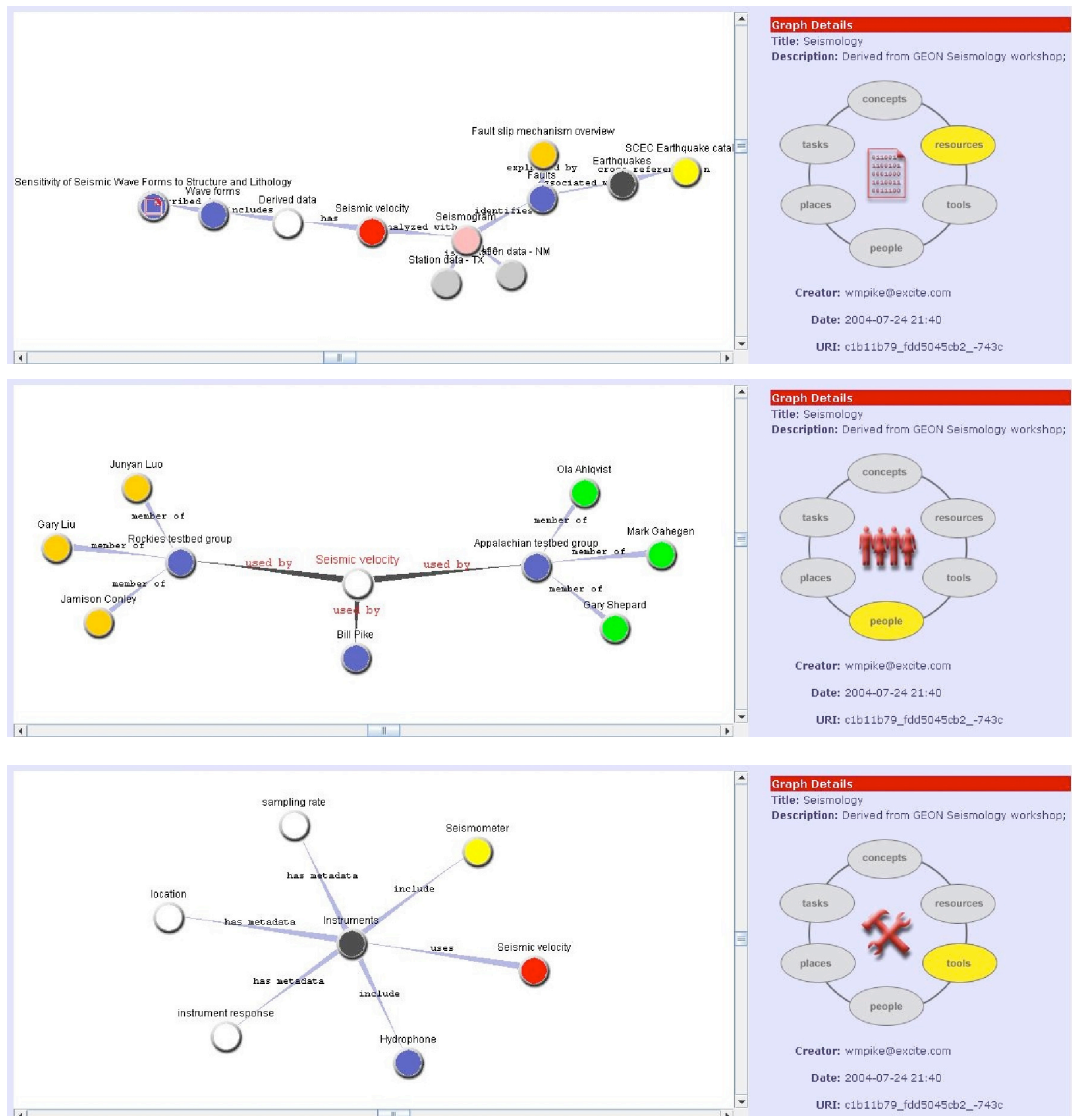
Email: mng1@psu.edu

Motivation: Ontological knowledge has already been shown to have a large potential benefit in many aspects of geoscience research, and most especially for data integration. But there are limits to ontology, and in fact much useful geoscientific knowledge is not ontological in nature, but rather procedural, epistemological and/or emergent within given *situations*. In a subject where concepts and relationships are defined as much by interactions between experiments, observations, motivations, methods, researchers, locations and time as they are by theory, the representation of meaning is in fact a multi-faceted web of interactions between these different components (theory, data, methods, tools, people and so forth). In Whitehead's terms, meaning resides in a Nexus of such interactions, where no single thread is strong enough to carry the essence of meaning by itself.



A simplified Nexus of relationships that taken together help to define geoscientific meaning

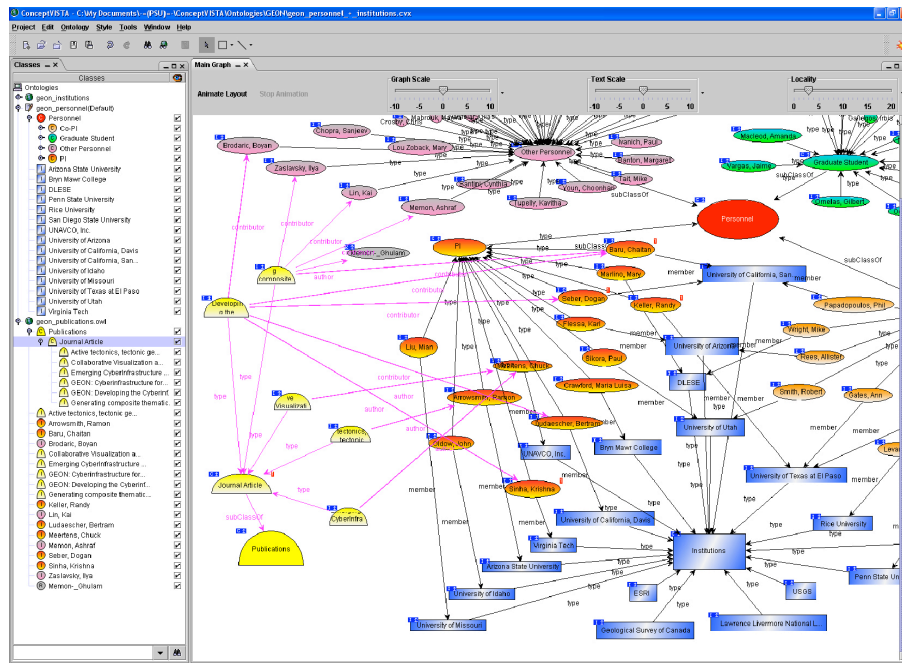
Objective: Our efforts have focused on the design and construction of a geoscientific knowledge portal based on the above Nexus, with examples drawn from interactions between researchers, tools, data, articles, and ontologies that are part of the GEON project (Geosciences Network: www.geongrid.org). Two prototype systems have been constructed: *Codex*—which offers a direct implementation of the above Nexus as a Web Portal for managing distributed knowledge, and *Concept Vista*, a visual knowledge-browsing interface to the GEON resource catalog. Both of these systems draw heavily on the above motivation to define a *Conceptual Universe* that connects together different kinds of e-resources: data, knowledge, people, methods, organizations and so forth. The systems are based on knowledge representation in RDF and OWL, allow scientists to quickly sketch out their understanding, browse connections between resources and search (both within the GEON catalogs and beyond) to locate not only useful resources but also useful knowledge, contacts, workflows and other conceptual-level artifacts that have been pre-



Three perspectives defined around the concept of seismic velocity: (top) resources used to define seismic velocity, (middle) the user community of seismic velocity, (bottom) the various tools that seismic velocity employs in its calculation. The right hand panel in each perspective shows the Nexus control as it appears in the Codex web browser. The user changes perspective by clicking on the icons around the Nexus.

served. Using these systems, geoscientific knowledge can be explored not only via ontological structure or resource catalogs, but also by social networks, citation graphs, scientific workflows, and organizations, as shown in the following two figures.

Since the Conceptual Universe of GEON is likely to be explosively large, methods for *navigation and perspective filtering* have been developed that help users to focus on aspects of knowledge that are of current interest to them in fulfilling a particular task. ConceptVista provides rich visualization capabilities and styling to help users create customized views with ease, and find the resources or knowledge they need. It also possesses elaborate search and foraging capabilities for enriching content via links to:



An example illustration of a small part of the conceptual universe of GEON displayed in the ConceptVista system. The figure shows connections between personnel, institutions and scientific publications that form part of the GEON knowledge Nexus. Users of the interface can locate resources (data, methods, articles, ontologies etc.) by navigating through this Nexus and following links.

- (i) External databases (such as the DLESE collections of Earth Science educational resources, CiteSeer—for gathering relevant articles, even Amazon—for finding books),
- (ii) Ontology conflation tools for matching and merging terms used for knowledge representation; for example matching keywords use in retrieved articles to the AGI geoscience upper level ontology adopted by GEON.
- (iii) Relevant web content (images, text, videos, sound) via an inbuilt Google search tool that generates queries from GEON semantic structures.

Articles:

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- (2) MacEachren A. M., Gahegan M. and Pike W. (2004), "Geovisualization for constructing and sharing concepts", *Proceedings of the National Academy of Science*, Vol. 101, Suppl. 1, pp. 5279-5286.
- (3) Brodaric, B., Gahegan, M., Harrap, R. (2004). The art and science of mapping: computing geological categories from field data. *Computers & Geosciences* Vol. 30, No.7, pp. 719-740.
- (4) Brodaric, B., Gahegan, M. (2006). Representing Geoscientific Knowledge in Cyberinfrastructure: challenges, approaches and implementations. In: Sinha, A.K. (Ed.), *GeoInformatics, Data to Knowledge, Geological Society of America Special Paper 397*, pp. 1-20.
- (5) Snow, D. R., Gahegan, M., Giles, C. L., Hirth, K. G., Milner, G. R. Mitra, P. and Wang, J. Z. (2006). Cybertools and Archaeology. *Science*, Vol. 311, 17 Feb, 2006, pp. 958-959.

- (6) Gahegan, M. and Pike, W. (2006). A situated representation of geographical information. *Transactions in GIS*, Vol. 10, No. 5, pp 727-749.
- (7) Guo, D. S and Gahegan, M (2006). Spatial Ordering and Encoding for Geographic Data Mining and Visualization, *Journal of Intelligent Information Systems*, Vol. 27, pp. 243-266.
- (8) Pike, W. and Gahegan, M. (to appear). Beyond Ontologies: Toward Situated Representations of Scientific Knowledge. *International Journal of Human-Computer Studies* (accepted).
- (9) Brodaric, B. and Gahegan, M. (to appear). Experiments to examine the situated nature of geoscientific concepts. *Spatial Cognition and Computation Journal* (Special Issue on Cognitive Semantics and Ontologies).
- (10) Gahegan, M., Agrawal, R. and DiBiase, D. (to appear). Ontologies of pedagogy and geoscience to facilitate sharing and reuse of educational resources. *Journal of Digital Libraries* (accepted)