# Towards a Data Management Infrastructure for MARGINS: Examples from Boomerang 8 and the Virtual Research Vessel

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## Introduction

Large interdisciplinary Earth science programs such as MARGINS, RIDGE 2000 (R2K), GLOBEC, NASA's Earth Observing System, and others, are currently focusing not only new scientific insights via collaborative research and multidisciplinary studies, but on a more standardized exchange of data between individual projects, styles of data presentation and analysis, and the quality of supporting metadata. One key to developing and maintaining unified community databases for these programs lies in building and supporting a general organizational structure linking distributed databases through the web. Described here are two end-member examples of data access and management. One is a simple web site, merely linking the user to data sets for download. The other is a complex "computational environment" employing three technologies: web GIS, a computational experiment management system, and a relational database management system (RDBMS). Both projects may be of interest to MARGINS researchers and data managers.

## Boomerang 8

In 1996 the Oregon State University Department of Geosciences, in collaboration with the Scripps Institution of Oceanography, developed the Boomerang 8 online data archive at sea aboard the R/V Melville. Boomerang Leg 8 was an ODP site survey (Bloomer and Wright, 1996), and addressed a number of scientific issues concerning the origin and structure of the Tonga forearc and trench including: (1) testing the hypothesis that the forearc is comprised of an ophiolitic basement, formed in the earliest stages of subduction by high-volume, short-lived arc volcanism (Bloomer et al., 1996; Kelman, 1998); and (2) constraining the mechanisms of tectonic (subduction) erosion along the trench (e.g., Hussong and Uyeda, 1981; Hilde, 1983; Bloomer and Fisher, 1987; Wright et al., 2000), and how its effects may be distinguished from the subduction of the Louisville Ridge. As a site survey, Boomerang Leg 8 was tasked with exploratory bathymetric, sidescan, and single-channel seismic reflection surveys over proposed ODP drill sites, as well as a comprehensive dredging program. The resulting web site is very simple by today's "standards" (i.e., no advanced features such as expandable, collapsible pull-down menu interfaces, web frames, or online mapping are included), but was unusual for its time in that it was designed and coded entirely at sea, and then tarred into an archive for easy transfer to a permanent, shorebased server (Figure 1):

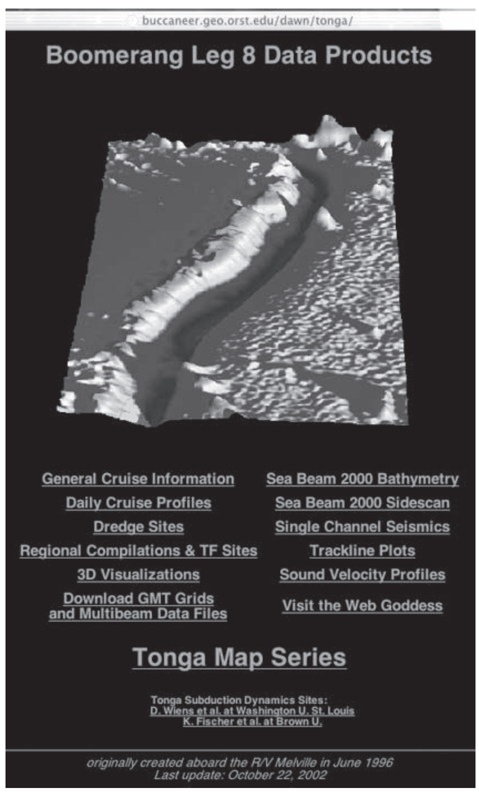


*Figure 1. Screen shot of the web portal to data products from Boomerang 8 for the Tonga forearc and trench (*http://buccaneer.geo.orst.edu/dawn/tonga/*).*

**http://buccaneer.geo.orst.edu/dawn/tonga/**

where it has since been used by a small community of researchers. The site contains scores bathymetric and sidescan maps, multibeam data files and grids, postscript files of selected single-channel seismic lines, dredge sampling maps, bathymetric profiles, trackline plots, sound velocity profiles, and 3-D visualizations. In a similar vein, data from the Eastern Lau Spreading Center are available via an anonymous ftp site in development at the University of Hawaii:

**ftp://iniki.soest.hawaii.edu/pub/lau**

## The Virtual Research Vessel

The Virtual Research Vessel (VRV) is a research collaborative of the University of Oregon, Oregon State University, and the Evergreen State College that is much more ambitious than the Boomerang 8 archive. VRV incorporates a web-based geographic information system (GIS) for viewing, loading, and selecting subsets of data and metadata, but also a separate relational database management system (RDBMS) and application programming interfaces (APIs) to support the coupling of numerical models. The project is fully described in Wright et al., (in press) and may be visited on the web at:

**http://oregonstate.edu/dept/vrv/**

Rather than a web site for simple access and download, VRV is a "computational environment" with the primary goal of allowing researchers to computationally link disparate data, as well as numerical simulations, so that they may actually undertake interdisciplinary experiments online. Researchers thus have the ability to explore new relations between observables collaboratively over the web, quantitatively evaluate hypotheses, and refine numerical simulations. An additional goal is the ability for researchers to build self-consistent models of complex phenomena from existing models of isolated phenomena. The prototype, a work in progress, provides a case study for the R2K community as to whether this coupling of data, maps, and models will work toward the desired goal, and includes test databases primarily from the East Pacific Rise at 9-10°N.

The web GIS in VRV is based on ESRI's ArcIMS (Internet Map Server)®, and features visual displays with the ability to incorporate diverse data sets at different resolutions and scales and to create dynamic maps (Figure 2). For example, it is possible to locate hydrothermal vent sites on maps, query or contour for variables such as water temperature or rock composition, to interact with tabular and grid-based data sets, and to simultaneously download both data and metadata for input to desktop software (e.g., ArcView, Matlab). Here logical queries can be made and spatial relationships can be seen between various layers or themes of data. This provides a rapid, "unselfish," and logical way of disseminating knowledge for rapid response to such mid-ocean ridge events as megaplumes or volcanic eruptions indicated by seismic events. In addition, images or video clips may be incorporated via a "hotlink" to locations on maps. And there exists the potential for simultaneous access to both data from a web server and local data from the client's desktop, along with the ability to dynamically edit and annotate maps.

Simple analytical capabilities are available as well. Users may create or

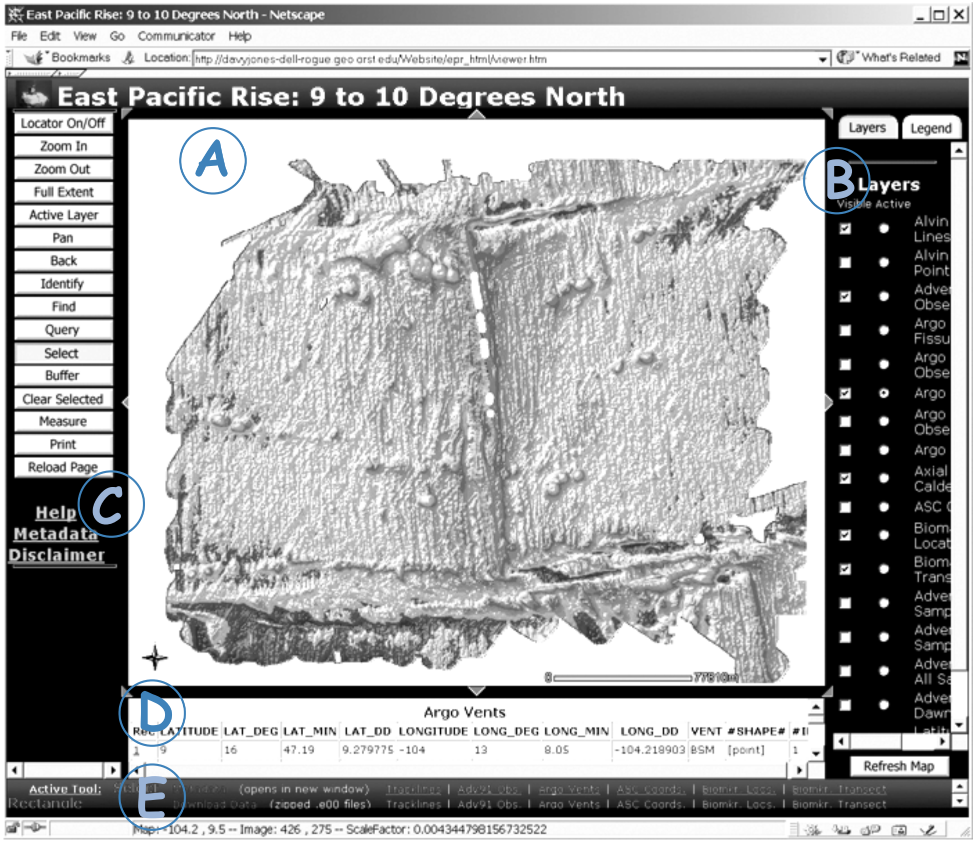


*Figure 2. Main interface of the web GIS for the Virtual Research Vessel (VRV) prototype (*http://oregonstate.edu/ dept/vrv/tools.html#gis*). Features of the interface include (A) creation and access of maps at varying scale where other data can be overlain, such as the active map layer of vent locations in yellow (B). (C) help for users, as well as all metadata open in separate windows. (D) all mapped variables are tied to a GIS database where all attributes are immediately available and can be searched and queried. Right below (D) is a bar where all metadata and data can be downloaded directly to the user's desktop in zip files. (E) as the user moves the cursor around the map, the lat/long pixel position, and scale factor of the map are displayed.*

access maps of different resolution at different scales as demonstrated in Figure 3 where the user has zoomed into large detail to map the axial summit trough at 9N with vent locations (two of which have been buffered out to a distance of 50 m) and Alvin submersible tracklines. The user may also measure distances in meters between selected points as shown by the red line measuring the distance between two critical vent sites in Figure 3. There is also interaction with tabular data to show the attributes of points, lines, and areas mapped as well as metadata for all layers that can be mapped. What can easily be added to this existing interface is the ability to contour maps at various scales for variables such as water temperature or rock composition. All data are available through this web interface as downloadable zip files.

Work in progress on the VRV prototype includes efforts to develop: 1) a virtual database to incorporate diverse data types (along with domain-specific metadata) into a global schema, allowing for web-query across different marine geology data sets, and an analogous, declarative (database-available) description of tools and models; 2) the ability to move data between the GIS and the RDBMS, along with the tools to encourage data submission to archives; 3) tools for finding and viewing archives, and translating between formats; 4) support for "computational steering" (tool

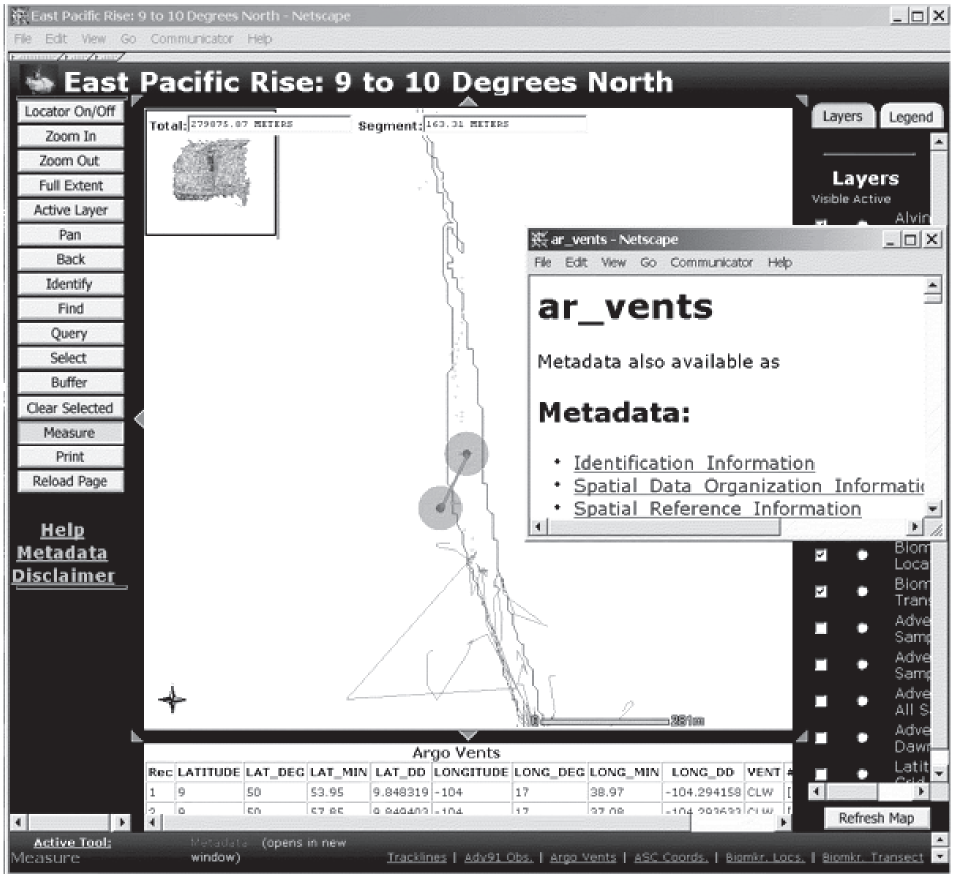


*Figure 3. Simple analytical capabilities (e.g., distance measurement, buffer generation) of the prototype web GIS for the VRV prototype as described in the text.*

composition) and model coupling (e.g., the ability to run tool composition locally, but to access input data from the web), APIs to support the coupling, especially of programs that are running, and the writing of data wrappers to publish programs; 5) support of migration paths for prototyped model coupling; and 6) export of marine geological data and data analysis to the undergraduate classroom (VRV-ET, "Educational Tool").

## Conclusion

It is hoped that the examples above will be useful to the MARGINS community in their continued development of data management infrastructure for MARGINS Focus Sites, an infrastructure that includes web portals to key data sets and metadata, maintained and updated by professionals familiar with the various data sets, and containing sufficient information to be broadly useful across all the disciplines encompassed by MARGINS scientists.

And there are several other web portals in existence, providing mid-ocean ridge data to R2K researchers, that may be also be of interest to the MARGINS community. These include results from the AHA-NEMO cruises at Woods Hole Oceanographic Institution:

http://science.whoi.edu/ahanemo2

the multibeam and petrologic data sets at Lamont-Doherty Earth Observatory:

http://ocean-ridge.ldeo.columbia.edu
http://petdb.ldeo.columbia.edu

the acoustic and photographic online archive available at University of Hawaii:

http://www.soest.hawaii.edu/HMRG/EPR/index.htm

the Scripps Institution of Oceanography's Ocean Exploration data portal:

http://sioexplorer.ucsd.edu

and the University of Washington's Endeavour GIS and Portal to Endeavour Data (PED) sites:

http://bromide.ocean.washington.edu/gis

http://bromide.ocean.washington.edu/ped

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## References

Bloomer, S. H., and Fisher R. L., Petrology and geochemistry of igneous rocks from the Tonga Trench: Implications for its Structure. J. Geology 95, 469-495, 1987.

Bloomer, S. H., and Wright, D. J., Summary of Site Survey Cruise Results, Boomerang Leg 08, in Support of Proposal 451, Ocean Drilling in the Tonga Forearc: Subduction Geodynamics, Arc Evolution, and Deformation Processes at a Non-Accretionary Convergent Margin, Ocean Drilling Program Site Survey Data Bank, Palisades, New York, 1996.

Bloomer, S. H., Wright, D. J., and Boomerang Leg 8 Shipboard Scientific Party, Geology of the Tonga Forearc: A supra-subduction zone ophiolite, Eos Trans. AGU 77, F325, 1996.

Hilde, T. W. C., Sediment subduction versus accretion around the Pacific, Tectonophysics 99, 381-397, 1983.

## MARGINS Town Meeting: The Source-to-Sink Science Plan Revisited at the AGU Fall Meeting 2002

The MARGINS Office is organizing an AGU Town Meeting to discuss the recently revised Source-to-Sink science plan and the fiscal realities of the MARGINS program with the S2S community, cognizant NSF program directors and members of the MARGINS Steering Committee.

This important Town Meeting will be held at 7.00 PM on Saturday, 7th December, 2002, in Room 104 of the Moscone Convention Center. The time and location of the Town Meeting is also posted on multiple pages at the MARGINS web site. Refreshments will be served.

## InterMARGINS seeks input for its recently revamped web site

**www.intermargins.org**

The InterMARGINS Office is always grateful to receive news of upcoming open meetings and workshops relevant to margins research worldwide.

Equally, the Office wishes to post information on its site about all recent and scheduled margins-related cruises wherever they may take place. The Office can be mailed at:

**intermargins@soc.soton.ac.uk**

## MARGINS-NSF logo use reminder

Any researcher presenting results generated by funding from the NSF-MARGINS Program is required to acknowledge this by displaying the MARGINS-NSF logo in the presentation and/or poster. The logo can be downloaded in several different file formats and resolutions from the MARGINS web site:

**http://www.ldeo.columbia.edu/margins/Logos.html**

*(Subduction Dynamics Workshop Report, continued from page 14):*

medium with viscous, elasto-plastic and brittle deformation mechanisms. An important class of current models by-passes these concerns by imposing the slab kinematics, but even with this simplified condition many difficulties remain to be solved, in particular regarding the influence of fluid flow on the dynamical properties of the wedge. Several people expressed the hope that some form of comparison between kinematic and dynamic models would be included in an eventual benchmark.

The late afternoon poster session provided another forum for the informal exchange of ideas. One observation from the poster session was that while the new temperature-dependent viscosity, thermal wedge models are similar, there are some interesting differences between models. Several of the posters presented additional details related to the computational methods. Abstracts of the posters are available at the workshop's website.

On Sunday morning, the group returned to begin the task of formalizing a set of benchmarks. The summary of the discussion was formatted into a proposed benchmark by Peter van Keken and has been uploaded onto the workshop web site. Interested persons can view the benchmark proposal and participate in the benchmark, following the instructions on the website. As results become available, they will be posted on the workshop website.

(References for Wright, continued from page 36):

Hussong, D. and Uyeda S., Tectonic Processes and the History of the Mariana Arc: A Synthesis of the Results of Deep Sea Drilling Project Leg 60, in Hussong, D. M., Uyeda, S., et al. (eds.) Initial Reports of the Deep Sea Drilling Project, 31, U.S. Govt. Printing Office, Washington D.C., 909-929, 1981.

Kelman, M., Hydrothermal Alteration of a Supra-Subduction Zone Ophiolite Analog, Tonga, Southwest Pacific, Master's Thesis, Oregon State University, Corvallis, Oregon, 1998.

Wright, D.J., Bloomer, S.H., MacLeod, C.J., Taylor, B., and Goodliffe, A.M., Bathymetry of the Tonga Trench and forearc: A map series, Marine Geophysical Researches, 21(5): 489-512, 2000.

Wright, D.J., O'Dea, E., Cushing, J.B., Cuny, J.E., and Toomey, D.R., Why Web GIS may not be enough: A case study with the Virtual Research Vessel, Marine Geodesy, 26(1-2), in press, 2002.