ROV Jason Standard Data Product Deliverables

Jason is a multipurpose vehicle with a wide variety of sampling capabilities. It is equipped to collect physical materials using manipulators, an extendible front platform, biological sample boxes, water collection bottles, and water pump samplers. It can be assembled in single-body, two-body, heavy-lift, and scientific-focus configurations. It offers fiber optic and electronic interfaces for custom scientific equipment. In addition to this sampling equipment, it carries a variety of oceanographic sensors and camera systems. This document describes the standard data products from the vehicle's navigation and scientific sensors as well as products from video, still image, and bathymetric sonar systems. Please contact Matt Heintz (mheintz@whoi.edu), *Jason* manager, or Scott McCue (smccue@whoi.edu), data manager, with questions. Interested parties are also directed to the Jason page of the National Deep Submergence Facility web pages.

1. Navigation data

Primary *Jason* navigation is derived from a Doppler Velocity Log (DVL) sonar in combination with heading from a fiber-optic gyroscope (INS). While bottom-locked, DVL velocities are integrated to accurately estimate a dead reckoned position history in which errors accumulate at a rate typically below one percent of distance traveled. This dead reckoned history can be augmented with geographically referenced information from an ultra short baseline (USBL), using the ship's system or NDSF-owned systems from Sonardyne. Each new installation of a USBL system will require an in-water calibration prior to performing scientific dives: typically this takes 6-8 hours.

During a lowering operational software (*navest and navg)* displays real-time information from the georeferenced system alongside the dead reckoned history, and logs the information for later processing. After a lowering the *Jason* data processor performs a post-processing task we call "renavigation". In this task the raw sensor logs are used to recreate the dead reckoned navigation history, which is mathematically merged with a filtered history from USBL to yield an improved result (Figure 1). The result is written in several formats, suitable for use in a variety of post-processing applications. It is also used later by the data processor to add value to video, still imagery, and logged events.

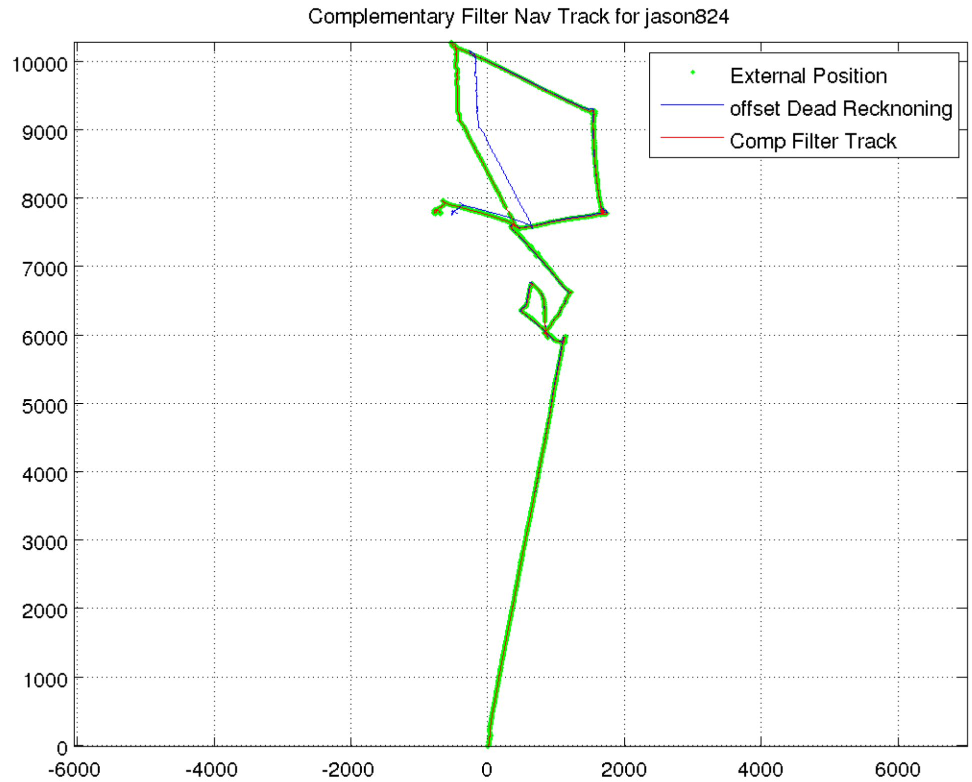


Figure 1: Comparison of real time vs renavigated track history. This example for *Jason* dive #824 was generated as part of at-sea renavigation post-processing.

2. Motion Imagery

Jason's primary video cameras are called SciCam, PilotCam, and BrowCam. SciCam is a Sulis Z70, which produces 2160p (4K) video and can simultaneously be triggered to capture JPEG stills. PilotCam, and BrowCam are Mini-Zeus 1080i cameras. SciCam and its pan 'n' tilt are under the control of the science party watchleader. A well-proven standard configuration of light and camera placements can be modified for specific cruise or dive requirements. Please discuss your scientific needs with the *Jason* team during pre-cruise discussions.

While *Jason* is on the bottom, these three primary cameras are constantly recorded to video file on hard drive, compressed by the h.264 codec into an MPEG Transport Stream file. Recorded simultaneously are four subtitle files, each with a logical grouping of dive metadata. A fifth subtitle file is created after the dive from post-processed navigation. These are merged by the *Jason* post-processor into a Matroska container file so that the subtitles can be overlaid on the video during playback. At the time of capture video and subtitle files are named with timestamp information.

In addition, the science watchleader can direct a watchstander from the science party to make direct-to-hard drive recording of "highlights"- limited duration clips of important events. The Sulis 4K stream is directed to an UltraHD recorder, while BrowCam, PilotCam, and several utility cameras can be routed to an HD highlight recorder. The resulting clips are in the form of a computer file, compressed in real time using the *ProRes422* family of codecs. These can be played back on a computer using video player software: examples include *QuickTime* player and appropriately compiled versions of the open source software *VLCplayer*. Non-linear editing can be applied using, e.g. Apple *Final Cut* or *Adobe Premier.* The clips include time code that is synchronized to the same time reference as the sampling computers in the *Jason* system. Guidance on post-processing enhancements is offered on the NDSF web site in a white paper [2].

Because the highlights video files are captured by a manually-controlled device that applies a generic filename, a science party watchstander has the task of recording clip metadata at the time of capture. This metadata includes approximate start time, stop time, and a brief description of clip content. The *Jason* data processor will use time code imbedded in the video in combination with the watchstander's information to rename the clips to include timestamp. Clip metadata including watchstander's comments about clip content will be reported in the cruise's metadata spreadsheet.

If desired, the science watchleader can use a wireless microphone to simultaneously record an audio narrative with the video. Please alert the *Jason* team in pre-cruise meetings if you intend to do this.

3. Still Imagery

ROV *Jason* offers several systems for the capture of stills. Its primary and highest quality still image camera is the Sulis Z70, which acts as both ultraHD video camera and still capture camera. A framegrabbing system under control of the science party watchstanders captures still imagery to TIFF format from Jason's variety high definition video camera streams. The Virtualvan and Sealog dive narrative systems automatically grabs to JPEG format from *Jason's* primary cameras.

A nascent product, nonetheless one routinely provided for each dive and for each still image source, is the ppfx-format file (for "photo position file, extended"). This tabular file is produced by matching images in time with vehicle position and attitude.

Sulis Z70 Photographs

ROV Jason's Sulis is configured to take photographs under the control of the science party watch leader, by the press of a button. The resolution of the image is 5968 pixels x 3352 pixels x 8 bits. The action of taking a still does not affect the 4K video stream or any downstream products. The photos are retained in the camera on an internal card, and are offloaded once the vehicle is on deck. *Jason's* data processor renames the photograph filename using the capture timestamp.

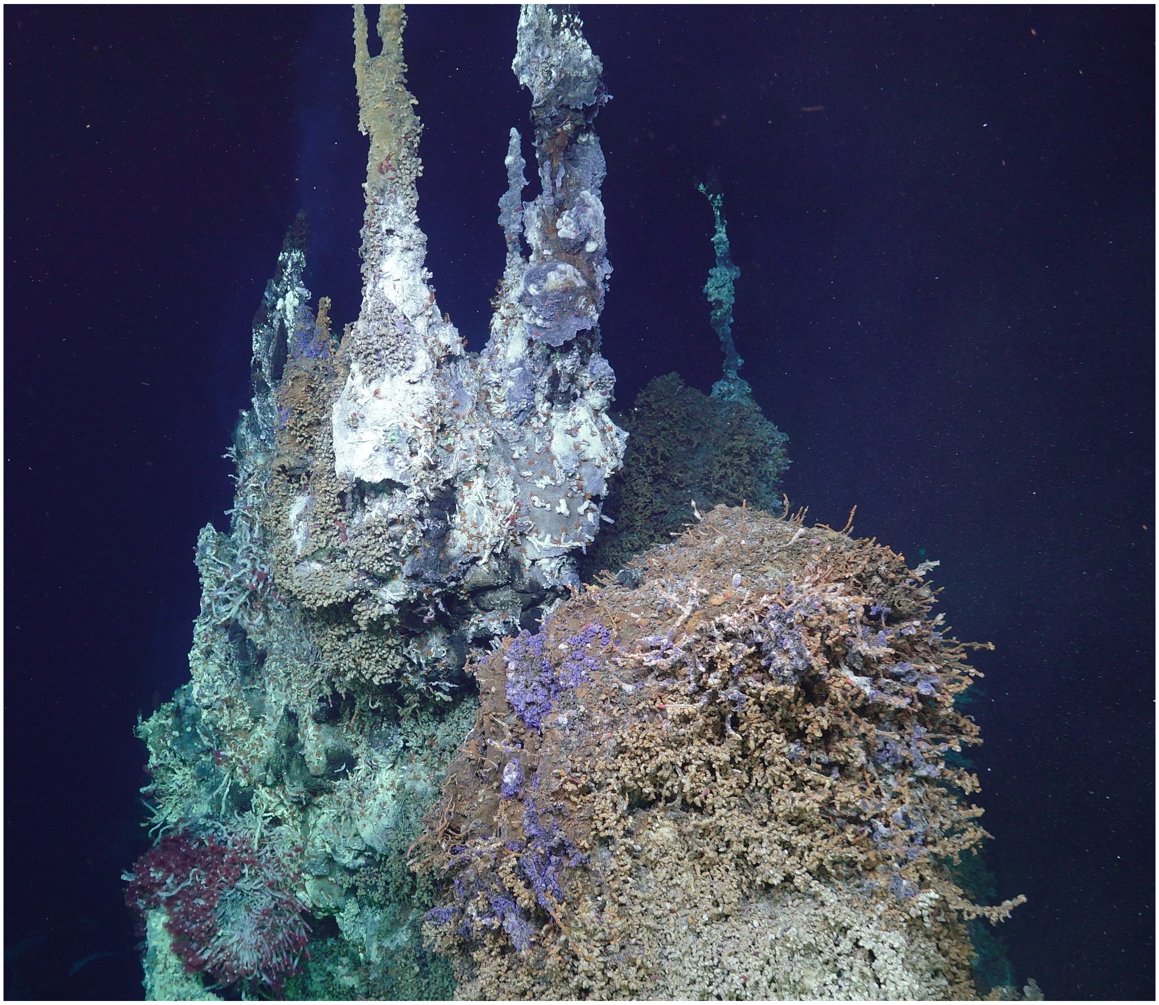


Figure 2: Example image from Jason's Sulis z70. A hydrothermal vent at the Ashes vent field, Axial Seamount, Juan deFuca Ridge, dive J2-1197. Courtesy Dr. Deborah Kelley.

Framegrabbed Stills from HD Video Streams

Using a video router at her/his station, a science watchstander will select two of the available video streams for input to the framegrabbing system. Stills from the two streams are captured simultaneously, and are named by channel and timestamp information. The footprint of the still is based on the input video, typically 1920x1080 (from 1080i video).

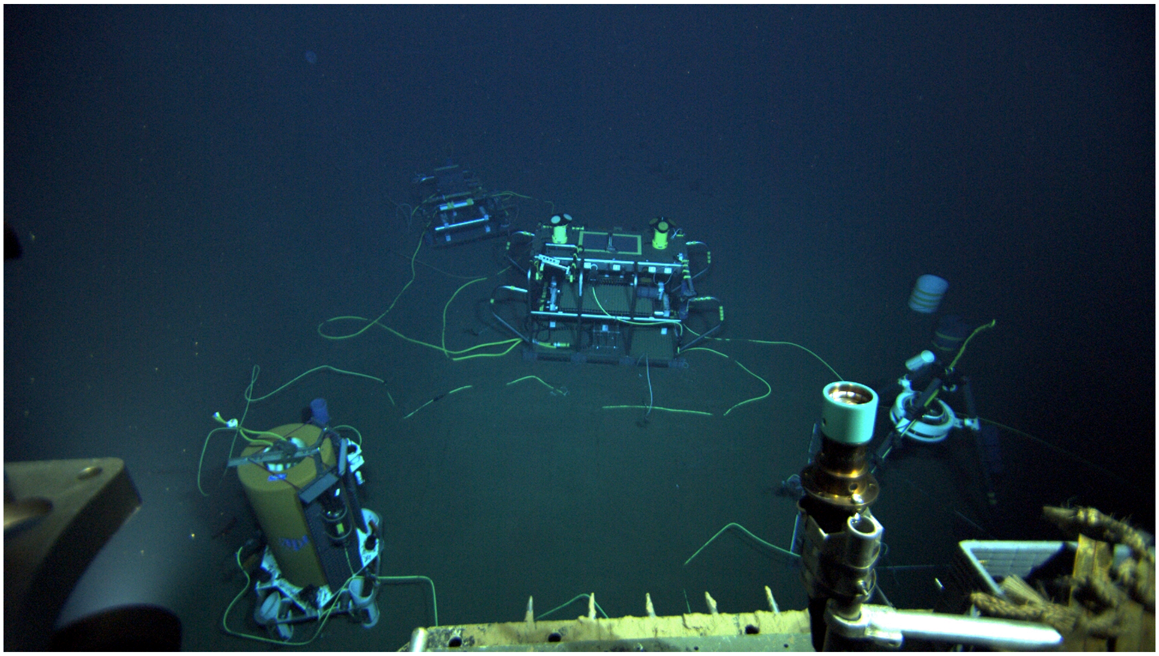


Figure 3: Still image from *Jason's* HDTV camera, J2-564, courtesy Dr. Bruce Howe, U Hawaii.

Virtual Van

Virtual Van is a real-time logging system that periodically (adjustable, typically 0.5-2 minutes) captures video framegrabs and co-registers them with vehicle navigation and other sensors. It is also equipped with an event logging system that is used to co-register observations logged during operations. During the cruise the Virtual Van interface can be accessed via a web browser running on the ship's network to monitor dive activities in real time, or review them afterwards.

At the end of a cruise an independent web site of the Virtual Van is extracted from the sampling system and placed in the data package. This content can be viewed on a personal computer without need for network access. A copy of the Virtual Van is transferred to WHOI, where it is loaded onto a web server and is made available to the community at address [*http://4dgeo.whoi.edu/jason*](http://4dgeo.whoi.edu/jason). Access to the served VirtualVan data from a cruise can be password-protected (for up to two years) if desired. Logged events and commentary can be extracted to csv-format files that can be loaded into Excel or kml-format files that will load into Google Earth (figure 6).

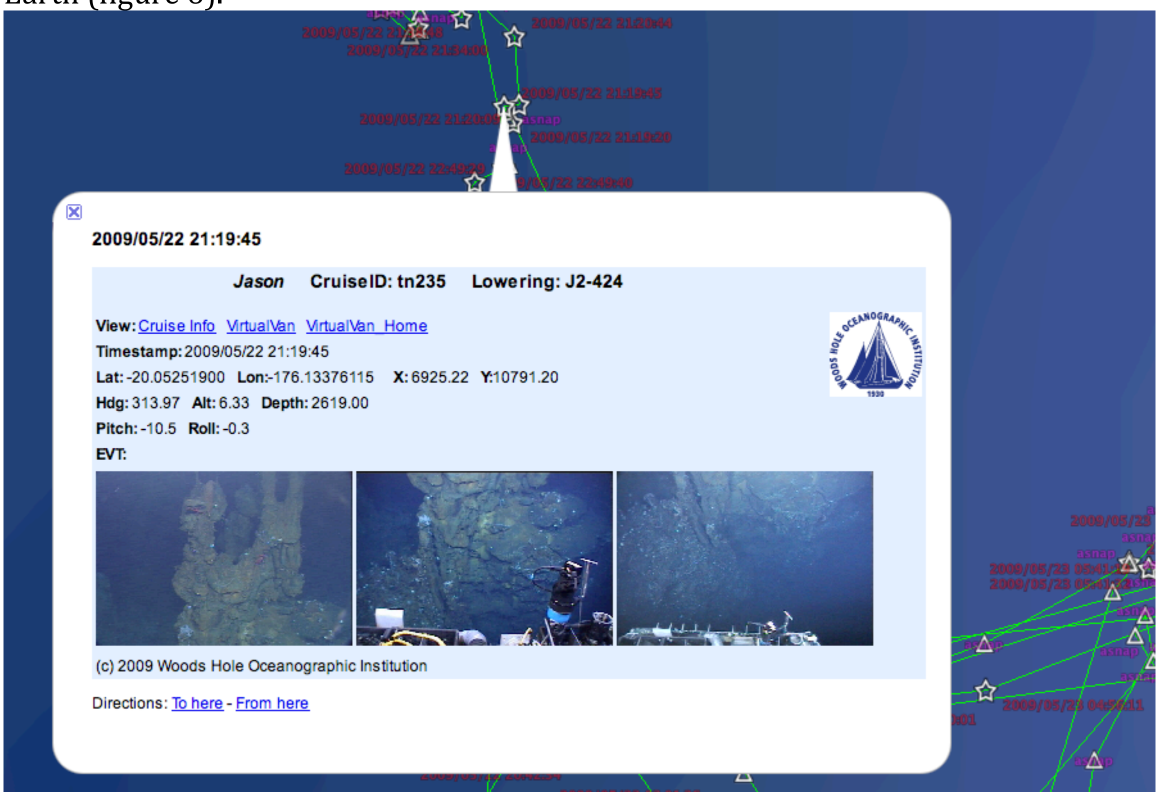
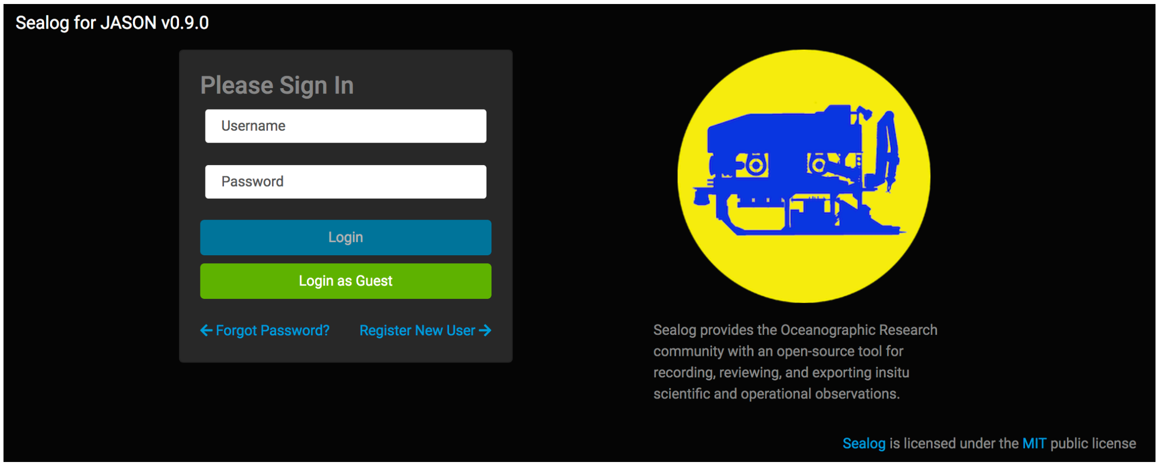


Figure 4: View of a selected autosnap event of a dive history from Virtual Van. A *kml* file of dive 424 was extracted from Virtual Van; the file was then opened using the Google Earth application.

Sealog

Sealog is an event-logging and dive narration system under development to replace Virtualvan. It has been in use simultaneously with Virtualvan since 2018 and we expect that it will become our sole dive narration system in 2020. Its function is similar to Virtualvan, with a modern front-end and back-end technology stack. Sealog is an open-sourced project (MIT license) and freely available to the community. For more information visit https://github.com/oceandatatools/sealog-server.

Delivered with the cruise data package will be the logged events in a CSV table, the grabs that are co-registered with the events, and sensors data. A network-independent standalone version is not yet possible as a deliverable. After the cruise the full cruise narration will be hosted, with passworded protection if desired by the cruise PI, by a server at WHOI at *http://sealog.whoi.edu/sealog-jason.*



4. Real-time sensor data:

Jason carries a number of sensors routinely, such as a CTD, a sound velocity probe, a cabled temperature probe, a magnetometer, and an optical oxygen sensor. Others are carried when requested by the scientific investigator. Examples of occasionally used sensors are a light scattering sensor; inductively coupled, interchangeable sensors; an eH sensor (which must be borrowed from the developer by the PI); and a true altimeter. In some vehicle configurations altimetry is measured by a Doppler Velocity Log sensor. In many cases the output streams from these systems are captured as raw ASCII data as it is produced at the sensor's serial data connection, with a synchronized *Jason* system timestamp prepended to the individual records. In some cases, we provide direct serial port connection from control van to sensor package, and in these cases a control computer provided by the investigator logs sensor data directly- these data are not included in the *Jason* data package.

During a lowering these timestamped records from the suite of sensors on the vehicle are recorded to sensor-specific hourly files, collected by calendar day. After a dive these files are reorganized in the following ways:

1. Hourly files are copied so that type-by-day also exists as type-by-cruise.
2. Hourly files are copied so that type-by-day also exists as type-by-lowering.
3. Hourly files are concatenated so that type-by-hour also exists as type-by-lowering.
4. The processed .csv filetype is created by merging the raw .csv filetype, which contains solely real-time navigation information, with raw sensor types to yield a tabular presentation of real time vehicle navigation and sensor data.

5. *Navest* logs, which capture raw sensor records as well as the collection of *Jason* control system records, are copied so that they exist as by-lowering. All are hourly, and include the large native rate sensor logs.

5. Documentation

A collection of written and visual records from your cruise is included in the data package. These documents typically include:

1. Data deliverables itinerary, with a brief of the data characteristics.
2. Metadata spreadsheet, consisting of several worksheets
   - In/out water, on/off bottom times
   - Navigation local origin, on/off bottom position
   - Content of the data package
   - HD video clips metadata.
3. Daily/by-lowering updates by the *Jason* Expedition Leader.
4. Pre-dive pictures of *Jason* and sometimes *Medea*.
5. Highlights metadata, as taken by the science watchstander
6. Data format definitions
7. Logs of multibeam survey events, if applicable

6. Bathymetric data

Note: We are in the process of updating *Jason's* multibeam capabilities. Use this section as a guide, but specifics will likely differ.

Jason's Reson Seabat 7125 multibeam sonar can be used to make high resolution (512 beams, 400 kHz) bathymetry maps and has been used in a "raw" measurement mode to observe water column features such as bubble plumes. Operating at altitudes in the range of 5 to 65 meters, the Seabat 7125 will capture bathymetric swaths at widths of about three times vehicle altitude. At the normal vehicle survey forward speed of 0.25 m/s (0.5 knots), areas of approximately 0.2 km^2 per hour can be surveyed. *Jason's* Seabat 7125 has also been used while *Jason/Medea* was arranged in "tow mode", which doubled speed at the expense of tight navigational control.

During the survey a science watchstander will be expected to log events such as terrain features, line start/stop times, and vehicle heading/altitude to both *Jason's* event logs and to a text file. These event histories will be added to the cruise record to aid survey post-processors and the community.

Using utilities provided by the *MB-system* software package [2], the *Jason* data processor will merge post-processed navigation and attitude with the raw bathymetry files. He/she will then apply our automated cleaning tools, based on *MB-system*, to generate the standard bathymetry product that is delivered to the science party. The intention of this product is to confirm that the raw data was collected properly and to present a preliminary view that informs subsequent cruise planning. For more rigorous bathymetry requirements we recommend that the science party devote personnel to additional processing.

The bathymetric data generated by *Jason* is made available to the science party in the following forms:

1. Raw Reson Seabat 7125 files containing individual sounding with bathymetric, amplitude, and attitude information. Other measurements such as acoustic signal magnitude/phase and sidescan-like Reson Snippets are possible by arrangement. These files do not contain real-time navigation; instead these files are later combined with post-processed navigation. These can be re-processed by the science party as required.
2. Processed, navigated profile swaths in *MB-system* 'mb88' format. Soundings are cleaned using intrinsic options offered by *MB-system* routines, and we recommend a careful review of the edited profiles by someone with good geological insight. Examples of rigorous reprocessing not performed by the *Jason* data processor include swath alignment via matching of features, time adjustment between navigation and soundings, hand-editing the data to recover those few good soundings that our automated editors may have removed, and removal of the few remaining fliers that may remain after treatment by our automated editors.
3. Gridded (5m, sometimes 2m) data files in .grd format, which can readily be imported by the scientist into generic software such as *Generic Mapping Tools* or *Matlab*, whether at sea or for post-cruise analysis.
4. Processed map images in .eps, .ps, or .pdf formats (Figure 6) that can be used by the science party for immediate visualization of the gridded data set, further dive planning while at sea, and post-cruise report generation and publications.

Because of its value and its impact on vehicle payload, the Seabat 7125 is not permanently mounted on *Jason*. As a result, this expensive system may not be carried at sea unless it is scheduled for use. If you wish to perform bathymetric surveys, please be sure to bring it up in pre-cruise discussions.

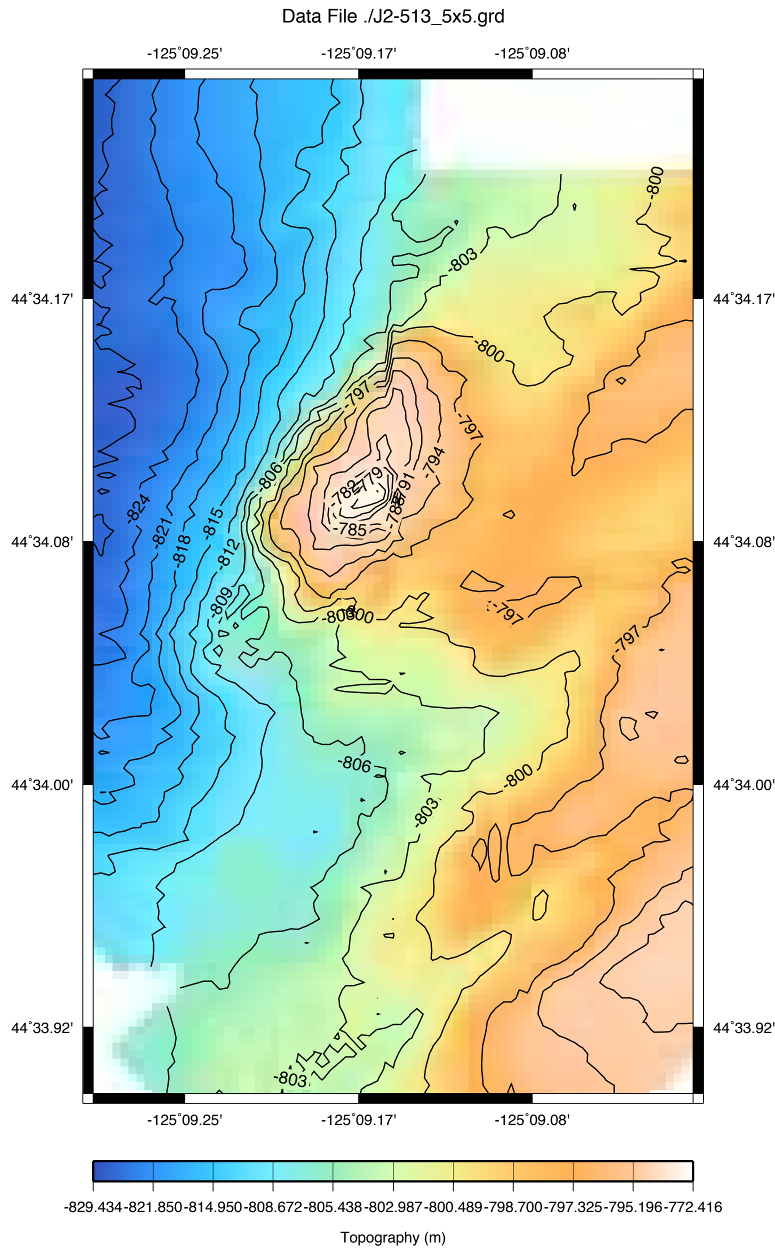


Figure 6: Bathymetric map image of "The Pinnacle" at Hydrate Ridge, Juan de Fuca , *Jason* dive 513. Gridded at 5 meter resolution, the map was generated by automated processing without the benefit of bias or lag adjustments.

References

[1] NDSF Data web site, http://www.whoi.edu/page.do?pid=8475
[2] "HD Stills and Video Enhancement Techniques for the NDSF HD Camera Using Photoshop and Final Cut", M. Morin, http://www.whoi.edu/page.do?pid=51119
[3] MB-system cookbook, mail list, web sites, http://www.mbari.org/data/mbsystem/