



GEODESC web applications for collaborative description of geological materials – a legacy of the *JOIDES Resolution* era

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Abstract. Expedition scientists on the *JOIDES Resolution* (*JR*) during the Ocean Drilling Program (ODP), Integrated Ocean Drilling Program, and International Ocean Discovery Program (IODP) carried out visual descriptions of hundreds of kilometers of cores to characterize the sequences drilled for subsequent subsampling and analysis. The methods and tools for this collaborative process, conducted under demanding workflow conditions, evolved over the decades along with evolving technologies, user expectations, and collective experience gained. The review presented here recognizes five phases of database and user application development from 1985 to 2024, culminating in the GEODESC (GEOlogical DESCription) toolset built in 2019–2023 and deployed during the last 2 years of *JR* operations. GEODESC was designed around spreadsheet-based data capture, continuing the approach users had independently applied and explicitly requested. Likewise, the final products are well-structured spreadsheets suitable for analysis and visualization. A relational database supports collaborative work, data security, and quality control. State-of-the-art web applications provide user-friendly interfaces that can be run on all major web browsers without the need to install software, making collaborations among globally distributed team members easy. GEODESC supports geological core description of all types of Earth materials at microscopic, macroscopic, and summary scales and supports micropaleontological data capture as well. GEODESC catalogs provide ready-to-use templates and template components based on programmatic experience for efficient project template creation and an application to customize templates to meet project needs. An observable definition syntax promotes quality and consistency among hundreds of observables. GEODESC web applications require an administrator to initiate projects and create user accounts with appropriate credentials and roles. The *JOIDES Resolution* Science Operator (JRSO) originally hosted the service, and it is now maintained by the Gulf Coast Repository (GCR) and used at the GCR and beyond. If not used directly at additional organizations, the modular, feature-rich, and highly configurable GEODESC tool set and its history may serve as a reference for current and future organizations developing software for geological descriptions.

1 Introduction

Throughout the history of scientific ocean drilling (SOD) on the *Glomar Challenger* and the *JOIDES Resolution* (*JR*), visual core descriptions were a critical part of producing contiguous characterizations of the stratigraphic sections drilled. Investigators could subsequently use the abundance and variety of data collected in visual core descriptions for stratigraphic analysis in conjunction with shipboard measurements and select samples for further analyses in specialized

onshore laboratories. During ~ 37 years of *JR* operations, a total of more than 640 km of sediment and rock formations was drilled, and more than 370 km of cores was recovered and described, making the *JR* the primary and longest-operating SOD platform serving the Ocean Drilling Program (ODP), Integrated Ocean Drilling Program (IODP), and the International Ocean Discovery Program (IODP). As imperfect as these mostly shipboard descriptions were given the demanding 24/7 workflows, where real-time core recovery and description imposed observational time constraints on

the limited number of scientists on board, they were a collaborative effort by experts selected for their specific expertise, resulting in a complete record of the recovered materials. Methods and tools to capture, visualize, and archive the observations evolved episodically, taking advantage of newly available technologies. GEODESC (GEOlogical DESCRIPTIONS) is the latest toolset developed for core description and was used during the final 2 years of *JR* operations. The specific methods used on each drilling expedition are summarized in the methods sections of the ODP and IODP Proceedings. A synopsis of those methods for the description of sedimentary material can be found in the technical note by Marsaglia and Milliken (2023). Here we present a brief history of core description on the *JR* in the context of software tool developments to provide some context before summarizing the design concepts and implementation of the resulting GEODESC toolset.

2 Brief history of core description on the *JOIDES Resolution*

2.1 Early phase: call for digital databases (1985–1989)

From the earliest days of SOD, starting with the Deep Sea Drilling Project (DSDP; 1968–1983) through to ODP (1985–2003) and, for some expeditions, until the end of IODP (2024), the core description scientists began their task with handwritten notes on paper forms (Figs. 1 and 2). The handwritten notes were made on templates printed for each section at intervals of ~ 1.5 m. The templates featured a scale in centimeters from the top of the section, followed by columns for detailed observations, with the last column available for any comments. Igneous rock describers often typed the initial descriptions in a more structured fashion and added them to the template along with the handwritten notes (Fig. 2b). These initial notes were photographed and archived on microfiche until ~ 1992 and scanned and archived as PDF files after that. They are accessible online for the period ending in 2005. In more recent years, if the handwritten notes were still created, it was up to the project scientists to determine if they should be included in the published expedition Proceedings Volume.

The handwritten notes were summarized and transcribed to visual core description diagrams (VCDDs) using graphic and text production tools available during that early phase (Figs. 3 and 4). The VCDDs were published in the Proceedings and represented the final descriptive data product from each expedition. Sediment descriptions were summarized for each up to a ~ 11 m long core with the following 16 graphic columns (Fig. 3): time–rock unit; biostratigraphic zone and fossil character separately for foraminifers, nannofossils, radiolarians, diatoms, and another potential group; paleomagnetism; physical properties; chemistry; section number; meters from top of core; graphic lithology; drilling disturbance; sedimentary structures; samples taken; and lithologic de-

scription. Microscopic descriptions of sediment smear slides (typically one per core) were added to the VCDDs and included texture (percent sand, silt, and clay) and composition (percentage of microfossil groups and other significant components). Igneous rock descriptions with typically more detail were prepared for up to 1.5 m long sections cut from cores, with the following eight columns (for basalts, slightly modified for phaneritic rocks) (Fig. 4a): centimeter scale from top of section, piece number, graphic representation, orientation, shipboard studies, lithologic unit, and final wide column for detailed descriptions. The detailed descriptions were structured into paragraphs including the section ID, unit number (interpreted from compositional and textural characteristics), pieces included in the unit, curated section length, contacts, phenocrysts and groundmass in basalts or the major mineral phases in phaneritic rocks (abundance, size, shape, degree of alteration, and comments), color (of the dry rock), vesicles (abundance, distribution, size, shape, and fillings), structure, alteration (presence and characteristics of secondary minerals), veins and fractures (abundance, width, mineral fillings, orientation), and comments. Descriptions of igneous-rock thin sections were presented in separate structured forms and published following the VCDDs (Fig. 4b). They included rock name; texture; grain size; and primary mineralogy, with the current and original percentage of each phase present and their size and morphology, groundmass, secondary mineralogy, and vesicle description.

The convention of publishing VCDDs by core for sediments and by section for igneous rocks remained consistent throughout ODP and IODP because igneous rocks are recovered at slower rates than sediments, which allows for a more detailed description of their variations in texture and composition, typically higher than those in sediments. As desktop computers became more widely available in the mid-1980s, the scientific community began demanding databases with data capture client programs for more detailed and consistent data collection and accessibility. At the start of ODP, the state-of-the-art System 1032 (Computer Corporation of America) or the S1032 database run on VAX computers was introduced on the *JR*. Routine instrument data, such as from the multi-sensor core logger, were directly written to the database. Other data were later entered by staff members. Entering descriptive data into the database proved to be a much bigger and, at the time, insurmountable challenge. The only data entry user application directly populating the S1032 database during this early phase of ODP (1985–1989) was Corelog, used to collect basic coring and sample curation information. During this time, considerable effort also went into entering existing DSDP and ODP legacy data into the S1032 database. This included instrument data tables and core description text blocks extracted from the VCDDs published in the expedition Proceedings. The migration of DSDP and ODP data continued during and after this early phase for ~ 15 years, in parallel to the data capture tool developments described here, and included

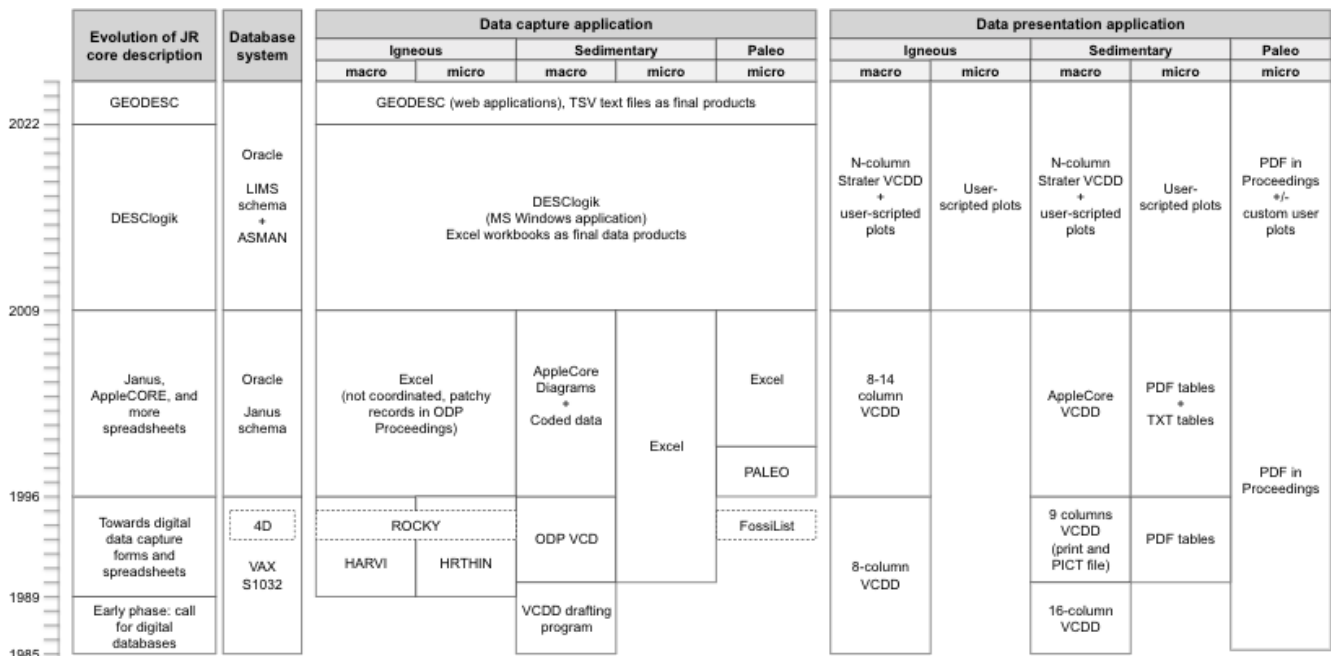


Figure 1. History of core description and biostratigraphy applications, databases, and data presentations on the *JOIDES Resolution*. Note that macro denotes macroscopic descriptions, micro denotes microscopic descriptions, and VCDD denotes visual core description diagram. Software names and abbreviations are explained in the text.

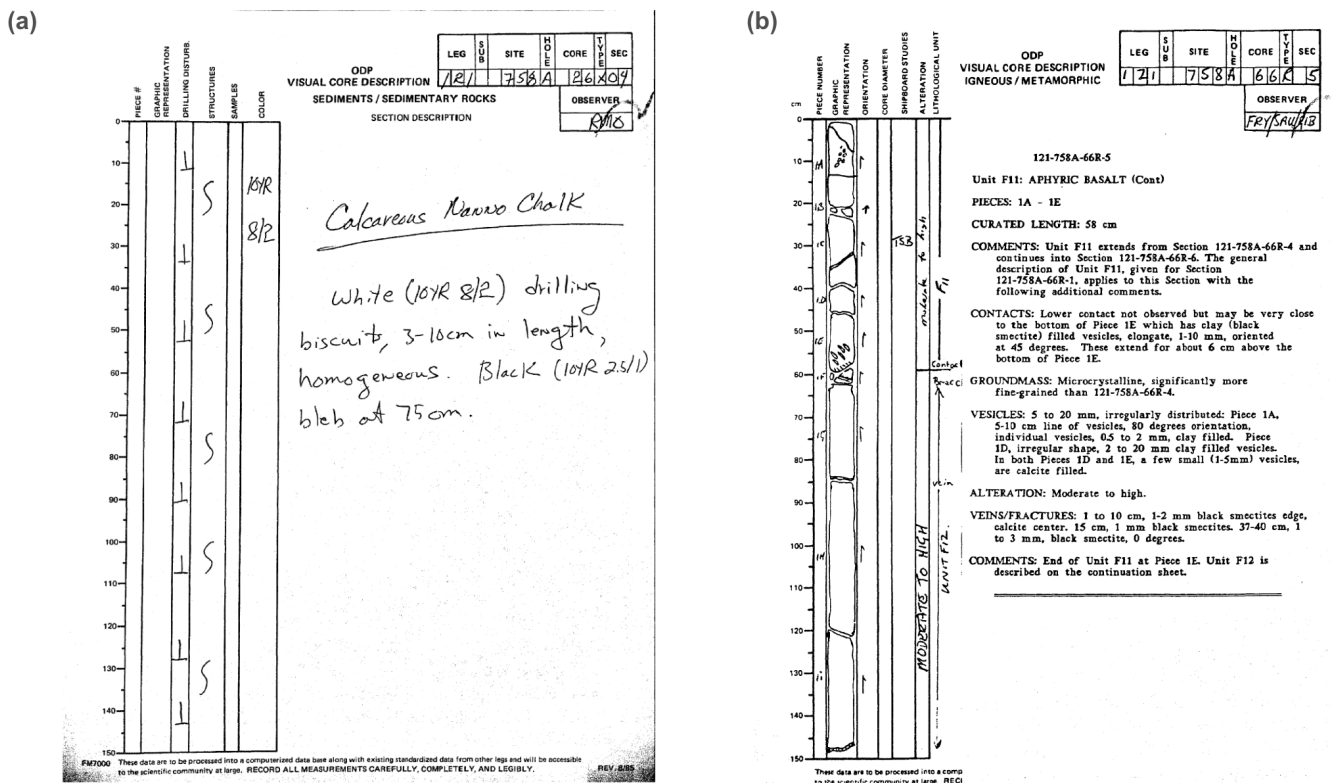
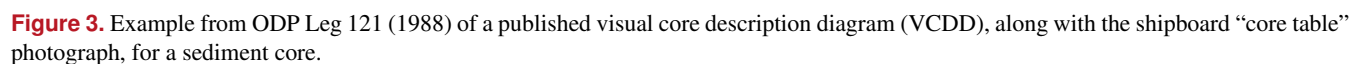


Figure 2. Examples from ODP Leg 121 (1988) of initial core description notes for (a) a sediment core section and (b) an igneous rock core section.



With the S1032 database in place and migration of legacy data underway, ODP launched projects to write client appli-

In 1989 the petrology community saw the deployment of two client applications called HARVI (for macroscopic HARDrock VISual descriptions) and HRTIN (for microscopic HardRock THIN section descriptions), which were form-based user interfaces to the S1032 database. Data entry consisted of synopses of the observers' handwritten observations into the categories defined in previous years for both macroscopic and microscopic descriptions (Fig. 4). The program provided basic data validations during data entry,

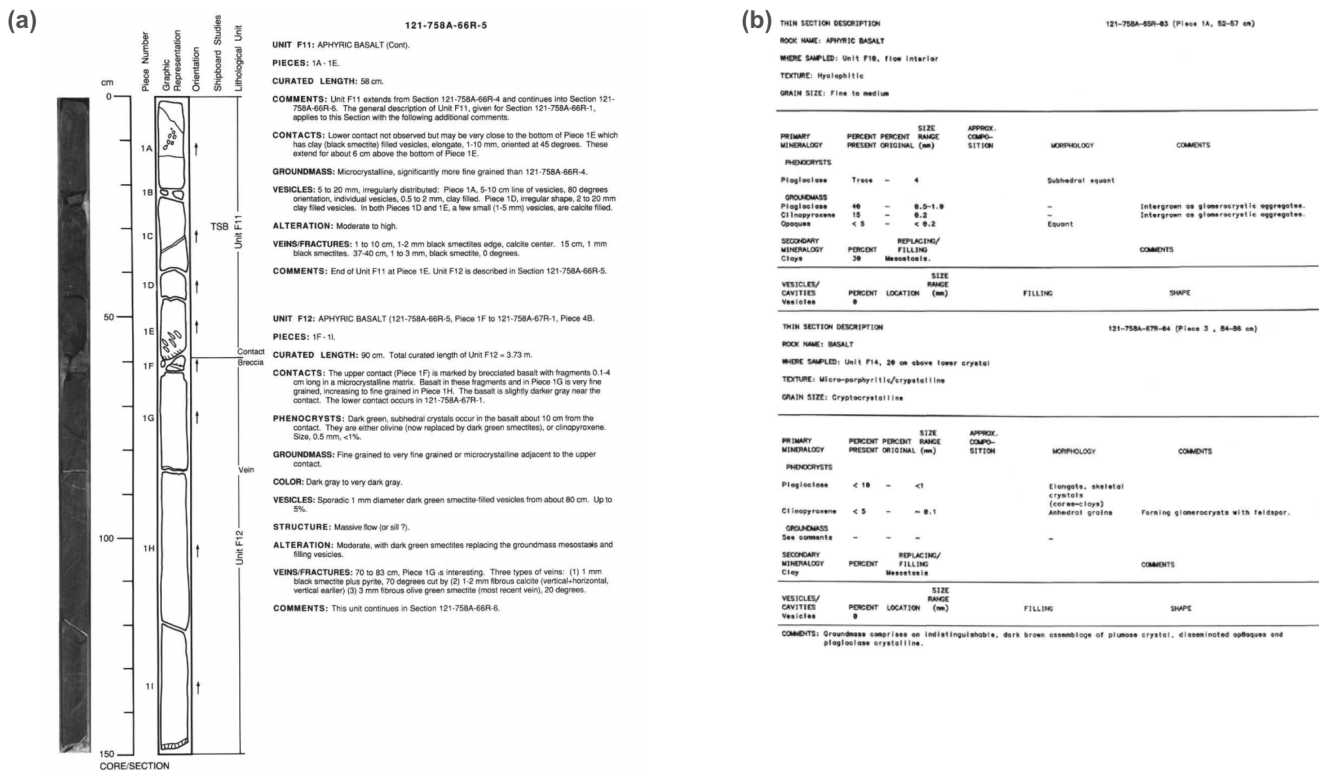


Figure 4. Example from ODP Leg 121 (1988) of (a) a published visual core description diagram (VCDD), along with a section image cropped from the shipboard “core table” photograph, for an igneous core section and (b) two published thin section description summaries.

such as the validity of sample identifiers. The programs’ output emulated the structured, multi-paragraph text blocks that users could download and place in the VCDDs, which were still generated manually using production graphic tools. The appearance of the final VCDDs did not change significantly. The HRTWIN program was used to enter modal percentages and textural descriptions of individual phases in more detail. The program outputs were regularly edited in a word processor before they were printed in the Proceedings. The HARVI and HRTWIN programs failed to achieve popularity with the scientists: the rigid data entry forms were too restrictive, and the database was not directly accessible by investigators. Furthermore, the hard-coded procedure whereby data were summarized by lithologic units defined in real time rather than the original interval-based observations became questioned by many investigators as it was only and arguably justifiable for basalt descriptions. Science parties began to use the increasingly popular Excel “log sheets” for certain observables warranting more detailed observational recordings. The ODP advisory panel (Information Handling Panel, IHP) pushed for progress with a more satisfactory program. From 1993 to 1994, ROCKY, a potential replacement for HARVI/HRTWIN, was developed based on the newly available application 4D, which allowed rapid development of entry forms and reports supported by a relational database. The development process was not successful, arguably because it

was based on the old concepts of transcribing summaries of handwritten notes into a digital form, which was perceived as restrictive and tedious.

In 1990, the sedimentology community saw the deployment of the “ODP VCD” program. Developed over 2 years for the increasingly popular Macintosh computer and operating system, the program allowed users to draw lithologic patterns and structural symbols and to type text blocks. The previous 16-column format of the VCDD was reduced to 9 columns (Fig. 5). Notably, data relating to the paleontological, paleomagnetic, geochemical, and physical properties that were previously reduced onto the VCDDs (Fig. 3) were now stored separately in their entirety in the S1032 database or organized otherwise in a file system. Starting in 1991, microscopic observations from smear slides were collected in Excel and made available as PDF files (Fig. 6). Integrating descriptive data with instrument data became a post-processing step, and scientists produced integrated graphics using commercial plotting and drafting tools. The user dissatisfaction with the ODP VCD program was primarily that no database for further interrogation or plotting was available. Furthermore, the data product was a PICT (pixel raster) file, which was converted into a MacDraw file by publication staff for further editing of the VCDD. In 1991–1993 attempts were made to create a more capable Macintosh-based custom

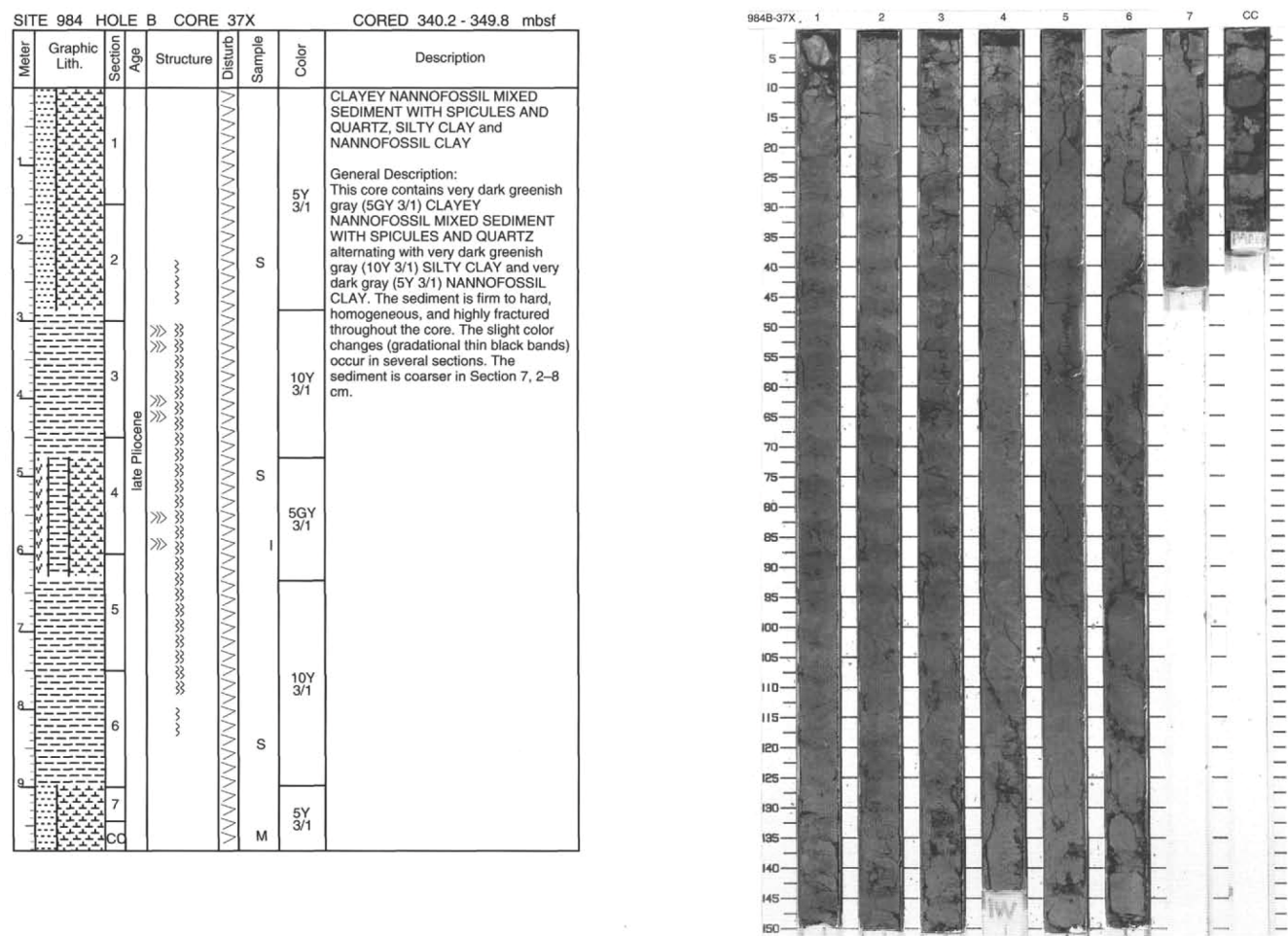


Figure 5. Example from ODP Leg 162 (1995) of a published visual core description diagram (VCDD) created using the “ODP VCD” template, along with the shipboard “core table” photograph, for a sediment core.

application; however, the “Etch-a-Sketch” program development was never completed.

The major issue during this phase of core description software developments was that the original observations still had to be summarized and transcribed into rigid forms. Emulating existing data presentation standards required that the information be summarized in text blocks next to the core image and graphic symbols. Any change or addition to observables requested by scientists led to a breakdown in workflow. Scientists started to use Excel for flexibility; however, spreadsheet tables created spontaneously by individual observers were not considered to be an acceptable data product by the IHP.

2.3 Janus, AppleCORE, and more spreadsheets (1996–2009)

In the early 1990s, it became apparent that the S1032 database system and its applications could not meet the needs of expanding data acquisition for both the number of data

types and overall data volume. Based on community advice, ODP hired a company to develop Janus, a system based on the Oracle relational database. Janus became operational on the *JR* in 1997 for the management of instrumentation data but without any program for the capture of descriptive information. Towards the end of ODP, developers attempted to create Janus database schemas for all the observables that core describers had been using so that the information could be collected and accessed in a consistent way across all future expeditions (Mithal and Becker, 2006). The draft schemas mushroomed into an unmanageable and ever-growing number of tables before data entry applications could even be addressed. Any update to the schema based on user feedback would require days or weeks of developer attention, which was not compatible with the pace and nature of the shipboard core description workflows.

In 1996, at about the same time as the Janus database becoming operational for the most common instrumented data, ODP introduced the contracted program AppleCORE for Macintosh. The program was designed for sediment de-

Figure 6. Example from ODP Leg 162 (1995) of a published PDF table of sediment smear slide descriptions originally created in Excel.

for detailed descriptions. Thin interbedded lithologies also could not be adequately entered and displayed. Thin intervals can play an outsized role in stratigraphy, and this limitation was regularly criticized. Sedimentologists began supplementing AppleCORE entries of specific observables with detailed interval logs in Excel so that the downhole trends could be statistically examined and visualized using commercial plotting tools. AppleCORE was last used in 2005 during the early phase of IODP, on the last sediment drilling during Expedition 311 and before a major renovation of the *JR*.

Also in 1996, when Janus became ready for most instrument data and sedimentologists began using AppleCORE, petrologists abandoned HARVI/HRTHIN and the failed, brief replacement ROCKY program. Science parties, with the help of ODP staff, created a modified nine-column VCDD for igneous- and metamorphic-rock descriptions using a commercial drafting program to emulate the previous VCDDs (Fig. 8). Notably, the description entities were now generally defined by changes in texture, composition, and structure rather than summarized by artificial core, section, and piece intervals or by interpreted lithologic units. However, the description intervals were still custom-formatted text blocks and not tabulated records that could be used for data analysis and visualization. Therefore, Excel was used more regularly and extensively for more detailed descriptions, where observable columns could be easily added to

Core Photo

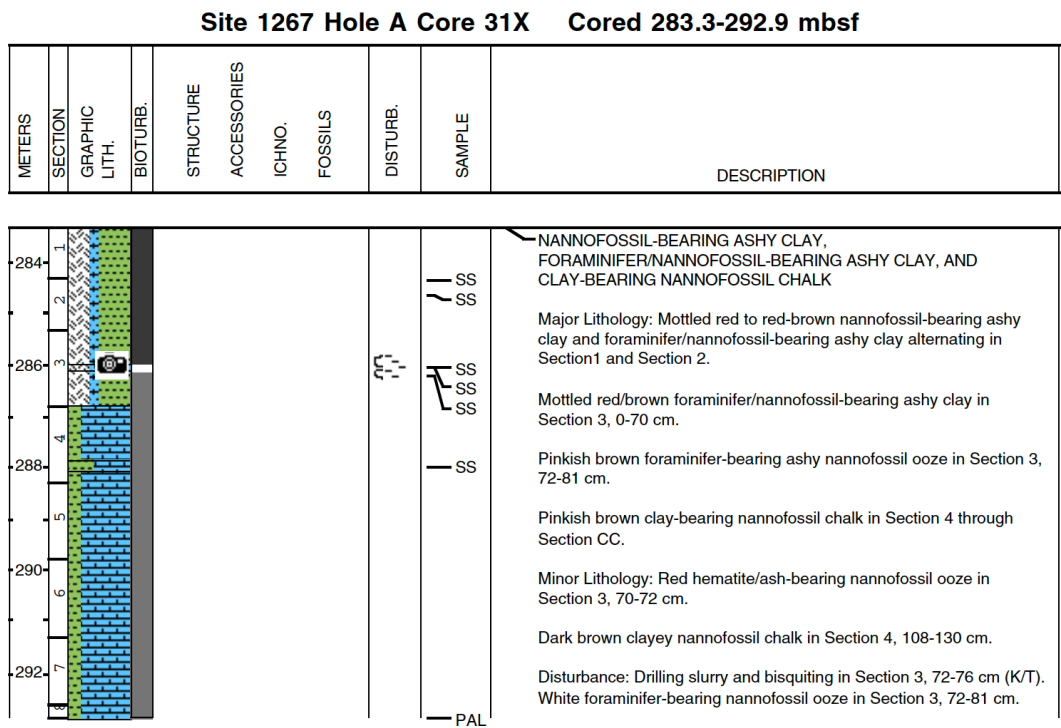


Figure 7. Example from ODP Leg 208 (2003) of a published visual core description diagram (VCDD) for a sediment core, created using the AppleCORE application.

develop new conventions for observations in metamorphic petrology and structural geology. Unfortunately, unrestricted use of Excel had its problems. With multiple scientists creating their own Excel log sheets during an expedition according to their preferences, organizational skill level, and style, redundancies and gaps in data capture were common. The spreadsheets were not compatible amongst each other in terms of basic row and column structure definition, let alone observable definitions. Many sheets used number codes for descriptive features, which created additional obstacles as the investigator would need the reference sheet to understand the data. Some sheets were linked to each other, and these links were not always persistent. Access to these spreadsheets today is not straightforward as they were not stored in a database or systematically appended in the Proceedings as supplementary material and sometimes were not included at all.

During the end of ODP and the transition to IODP, Excel spreadsheets had become the preferred method of data capture for core description. Spreadsheets were adopted for all microscopic descriptions and the petrologists’ macroscopic descriptions. The rigor and flexibility that spreadsheet data capture provided informed the direction the community wanted to take, which is perhaps best summarized in the recommendations by the Scientific Measurements Panel’s Hard Rock Working Group in 2002 (Allan et al. 2003, pp. 20–21):

- *Recommendation no. 10.* Continuous quantitative and semi-quantitative descriptions of specific core features, as currently collected downcore in spreadsheet format, are integral to core description and must be incorporated into the database for core log integration and analysis.
- *Recommendation no. 11.* Integrated textual descriptions of cores should be based on mappable unit boundaries and not on artificial sectional or core boundaries based upon intervals of coring.
- *Recommendation no. 12.* We recommend that common spreadsheet fields be defined, which may be incorporated into a relational database. We further recommend that common, basic templates be defined for igneous, metamorphic, structural, volcanoclastic, and sulfide lithology. Any descriptive system should allow the addition of other critical fields so as to allow leg- or project-specific descriptive logs to be created.
- *Recommendation no. 14.* Any core description package has to include the full description of thin sections, noting that it represents discontinuous data.

2.4 DESClogik (2009–2022)

During the major *JR* renovation from 2005 to 2009, all ship-board labs were upgraded, including the introduction of the

Core Photo

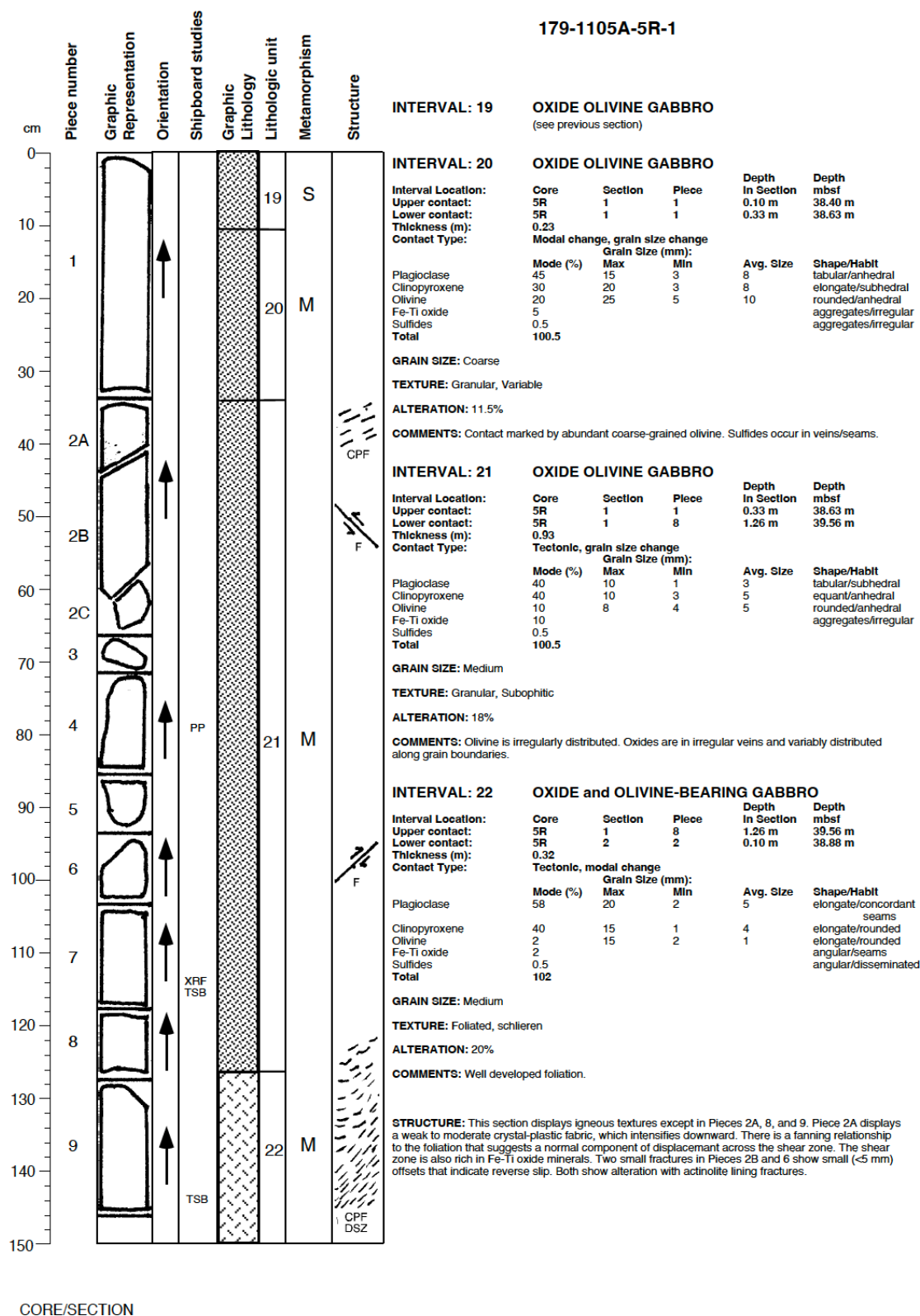


Figure 8. Example from ODP Leg 179 (1998) of a published visual core description diagram (VCDD) for an igneous core section.

new Laboratory Information Management System (LIMS). The period of refit for the *JR* was used as an opportunity to create DESClogik, a core description program using spreadsheets for the data capture interface and a relational database as a backbone, to support the description of all types of materials (sediments, igneous and metamorphic rocks, microfossils assemblages) at all scales (microscopic, macroscopic, summary). The initial ambitious ideas included a graphing module to produce geological plots from selected observables in the spreadsheets, but resources did not exist to complete such a development. Instead, the commercial geological plotting program Strater was used to produce VCDDs directly from the spreadsheets whereby user-selected observations were plotted downhole by description interval (Fig. 9). Publication staff operated Strater as visiting shipboard scientists could not be expected to master the software capabilities and workflow intricacies in a few days. Strater support by Golden Software ended around the end of *JR* operations in 2024. Strater plots as PDF diagrams and the data used to create them in Excel are available online as part of the IODP Proceedings and database. This workflow decoupled data capture from data presentation, allowing scientists to contemplate and decide which observables to plot and how to visualize them. This is a more flexible and arguably a more correct workflow compared to limiting data capture to a fixed graphic data display template. Both the data capture spreadsheet and the Strater graphic templates were customizable to meet a project's needs. The decoupled data plotting also allowed the combination of descriptive and instrument data plots in the VCDDs to become the norm, including the routine addition of digital image scans (Fig. 9).

The first rollout of DESClogik allowed each observer to create their own data capture spreadsheet, and this resulted in chaos. Best practices require that template definition be a group effort resulting in consensus by taking into account the time and expertise available, the type of material recovered, and other specific project needs. Hastily prepared templates at the beginning of an expedition could easily turn out to be less than scientifically rigorous or generally useful for analysis. With a modified version on Expedition 336 (2011), IODP representatives were in the position to provide the guidance shipboard scientists needed to implement customizations of templates and terminology.

Although continuously improved and widely accepted as a useful tool, the underlying data structure, key features, accessibility, and technology of DESClogik had unsurmountable limits. The program was based on Microsoft programming interfaces and libraries that only worked on Windows machines. Furthermore, DESClogik did not meet some important micropaleontology requirements (see Paleontology/biostratigraphy section). DESClogik did not provide a database with a normalized set of observables across all expeditions because attempts at such standardization had previously failed. Instead, the use of DESClogik generated a repository of Excel spreadsheets from Expeditions

317 through 396 that have a relatively consistent structure and are accessible online and readily available for further analysis (<https://web.iodp.tamu.edu/DESCReport/>, last access: 13 October 2026). The spreadsheets were also typically published as supplementary materials in the Proceedings of the IODP (<https://publications.iodp.org/>, last access: 13 October 2026), which are ultimately available on Zenodo (<https://zenodo.org/communities/iodp/records?q=&l=list&p=1&s=10&sort=newest>, last access: 13 October 2026). This collection of core description spreadsheets allowed more directly for the integration of descriptive and instrument data across multiple expeditions in a post-acquisition analytical process (Childress et al., 2024).

2.5 Paleontology/biostratigraphy

The microscopic analysis of samples to identify microfossil taxa and provide geological age estimates, a fundamental task during *JR* expeditions, is in many ways quite different from the description of sedimentary and rock materials. Yet, the history of shipboard database and data capture tool developments for micropaleontology bears a significant resemblance to that of core description tools.

Near the beginning of ODP, an effort was made to synthesize DSDP biostratigraphic data, similarly to the work done for other available shipboard data. Cenozoic records were extracted from the DSDP Initial Reports (IRs), which consisted mostly of range charts prepared by the paleontologists onshore after the expedition. These records were stored in the S1032 database and then extracted into files by microfossil group and made available through the NCEI (<https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ngdc.mgg.geology:G00993>, last access: 13 October 2026). The records include sample identity and depth, microfossil group abundance, preservation, and age codes. During ODP, biostratigraphers had the opportunity to rework shipboard observations, examine additional samples, and publish the results in the Scientific Results (SR) volumes of ODP Proceedings, published 3 years after the expedition. The researchers typically used to prepare their charts, without a shared database.

Just as the petrologists had tried to seize on the availability of the 4D relational database software for non-programmers in 1993–1995, paleontologists made an attempt to develop the 4D-based program, Fossillist, to create paleontological range charts, as well as age–depth profiles, during expeditions. Like ROCKY, Fossillist never reached shipboard user acceptance. The main reason may have been that data capture in both prototypes used form-based data capture, one record at a time, rather than spreadsheets at a time when the community came to love Excel.

When the Janus database came online in 1997, the software company also developed the PALEO application with features to generate range charts, as well as age–depth diagrams. After a year of shipboard deployment, user comments

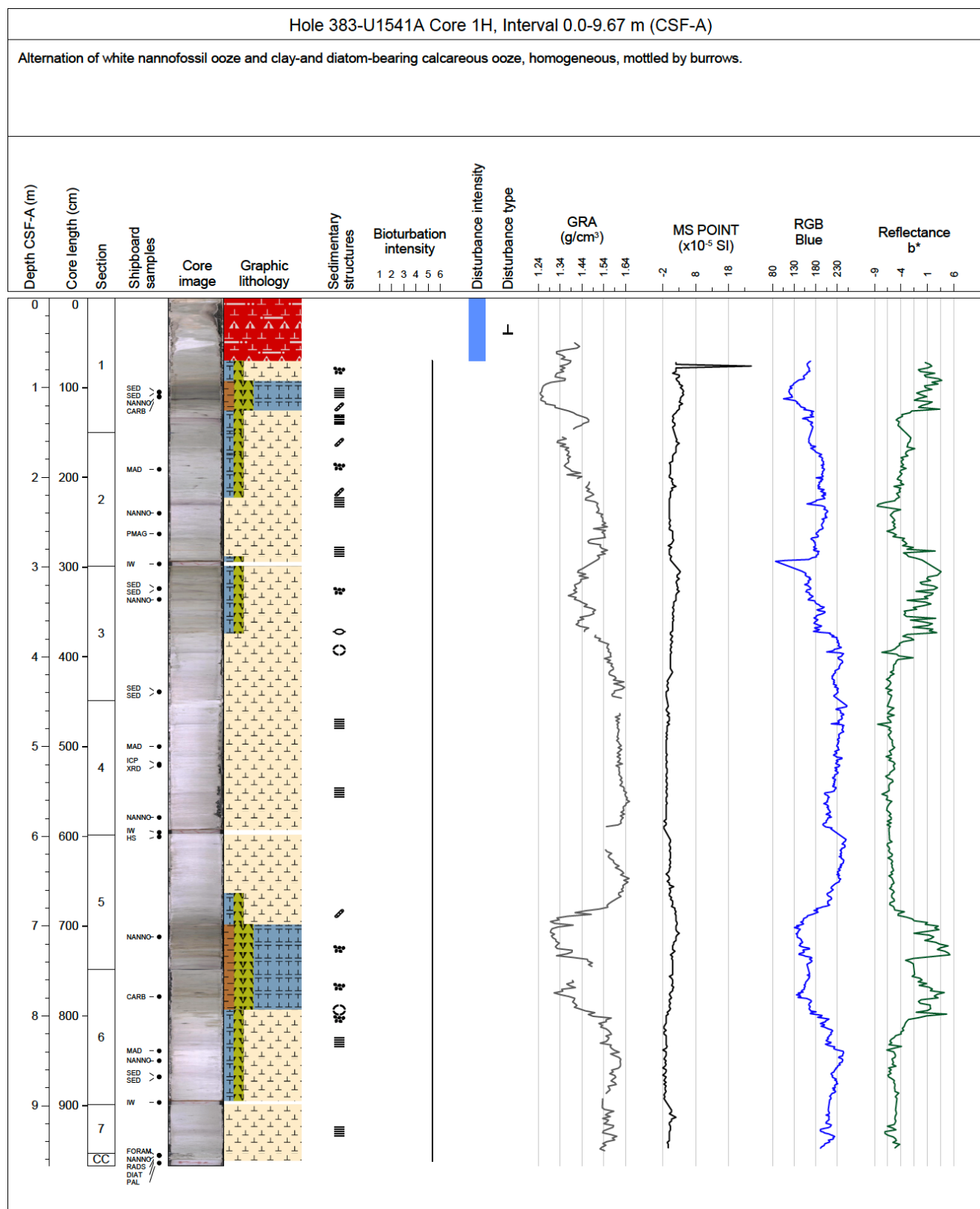


Figure 9. Example from IODP Leg 383 (2019) of a published visual core description diagram (VCDD) created with the commercial Strater (Golden Software) geological plotting program. Descriptive data acquired using the DESClogik application are plotted along with instrument data acquired with various shipboard analytical systems, including digital line scan images of each section combined into a core image.

were mostly critical of the application's complexity with regard to data entry and its unworkable slowness. Most importantly though, paleontologists were still hesitant to publish the rapid qualitative studies produced during an expedition before careful analysis and verification were possible. The consensus was that the focus should be on the basic biostratigraphic mission deliverables: render age dates, enter those into a database, and construct an age–depth plot.

During the remainder of ODP, all biostratigraphic data were collected in Excel worksheets during the expeditions, which were typically published as PDF tables in the IR of the Proceedings, and updated charts were published in the SR if researchers chose to do so. When the SR was discontinued at the end of ODP in 2003, an expectation remained that shipboard paleontologists would generate range charts during *JR* expeditions and publish them in the single Proceedings volume published 1 year after the expedition without major changes to the shipboard observations. Although the preliminary range charts were often published, many paleontologists disagreed with the publication of tentative shipboard analysis, done under serious time constraints and with the main objective of providing geological time estimates during drilling.

When DESClogik became available for core description during the early IODP, the program was also offered to micropaleontologists because it emulated the spreadsheets they had been using and would also provide them with database support. Although often used in that manner, DESClogik was not popular with paleontologists, primarily because, unlike the core describers, they frequently needed to make changes to the templates throughout the expedition, such as adding, deleting, and rearranging taxa columns. Scientists could not make these edits themselves, which resulted in a sometimes significant time lag before a technician was available to make edits to the template. During the development of GEODESC, the final stage of software evolution for the *JR* and the main topic of this article, a significant effort was made to build features specifically for paleontologists, addressing lessons learned from DESClogik and previous software. However, the fundamental issue of only having time on board for preliminary tabulation of taxa occurrences had not changed.

3 GEODESC (2022–2024 and beyond)

3.1 Overview

The fundamental objectives of the GEODESC toolset were the same as those for DESClogik: support collaborative description of all geological materials at multiple scales in a fast-paced multi-user environment, with user-configurable spreadsheet templates for specific scales and objectives. The choice of a spreadsheet interface for geological descriptions was based on decades of core description on board the *JR* by hundreds of scientists, as well as a user survey conducted at the start of the development. Geologists are accustomed

to recording observations in a spreadsheet where rows represent samples or sample intervals, the first set of columns represents the scope of an observation including sample identification, and subsequent columns represent the parameters or observables characterizing the scope of observation. New requirements and objectives for GEODESC also arose from lessons learned during decades of core description on the *JR*. The most important one was the need for the toolset to provide more effective guidance and consistency for basic descriptions, particularly in support of observers who are not necessarily specialists, paired with flexibility to ensure that the toolset never restricts a project's observation capture, particularly in projects where expert observers are extending the range of observations traditionally made. Guidance is provided in GEODESC by a set of catalogs, including completely configured starter templates, as well as lists of observable definitions, geological and general terms, and taxa, to choose from. Flexibility is provided with the Template Manager application that allows users to modify templates to meet the project's needs, with or without the use of catalog items (Fig. 10). Additional improvements over DESClogik include a user-friendly Data Capture application that handles the safe collaborative and simultaneous descriptions of cores from multiple holes and provides a feature-rich spreadsheet interface with many types of data validations. The Data Access application provides access to the descriptions by project team members who are not describers themselves but are integrating the observations with their respective tasks and data. Furthermore, GEODESC provides unprecedented support for micropaleontology. Perhaps the most impactful innovation of this most recent core description toolset used on the *JR* was to make the applications independent of computer platforms and operating systems. Through the implementation of web applications, GEODESC achieved the long-standing goal of enabling safe collaboration among core description project team members regardless of the describers' location or the time before, during, or after a field campaign or other event. The resulting toolset consists of four browser-based user applications that work seamlessly together, with each application serving a specific purpose and type of user (Fig. 10), as described in more detail below.

The GEODESC replacement for DESClogik was proposed in 2016 based on the experience gained with DESClogik. Development officially began in 2019. It took until 2022 for the set of applications to be completed and deployed on the *JR*. The design and implementation took 4 years, with three team members involved for the project's entire duration and more than 20 JRSO employees from most service departments contributing to the project as designers, developers, and testers. The Angular web framework is used as a front-end throughout the applications. SpreadJS is integrated in the Angular applications for spreadsheet features. Several back-end APIs written in Java ensure connectivity. GEODESC was used on the *JR* for Expeditions 398 through 403. The limited deployment time compared to the significant develop-

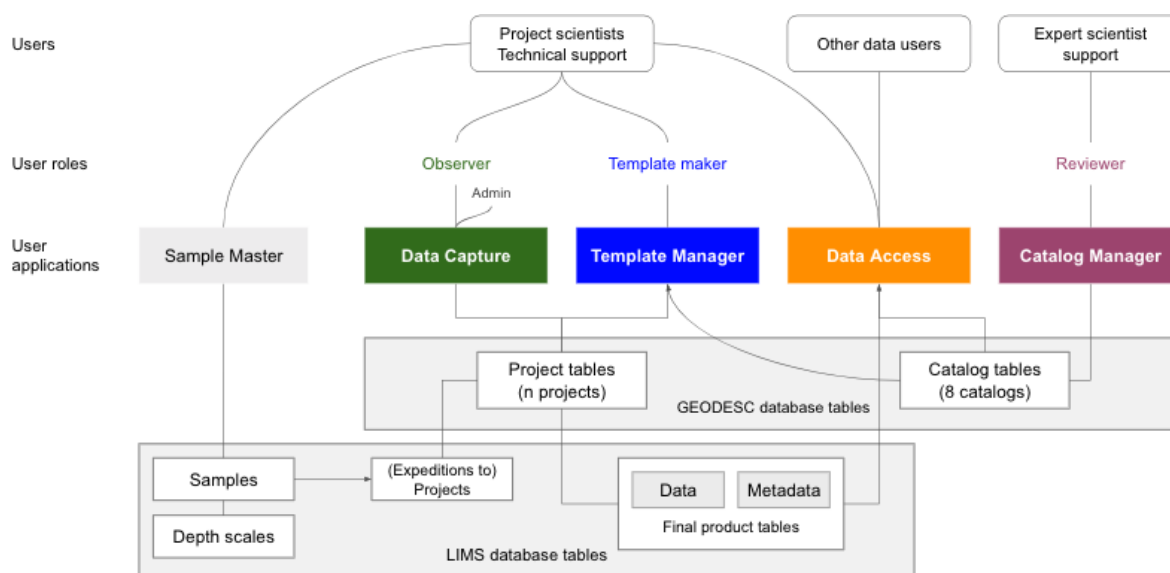


Figure 10. Overview of the GEODESC system with simplified relationships among users, user roles, applications, and databases. The GEODESC user application boxes are colored according to their application interface theme colors, and each is described in a dedicated subsection followed by a brief description of the database components (gray boxes).

ment effort was an unfortunate consequence of the earlier-than-expected termination of IODP.

3.2 The GEODESC project

A GEODESC project is a set of geological descriptions acquired by a project team using the GEODESC toolset. All GEODESC projects use the same toolset, but each project has its own database instance to ensure non-interference among projects. Each project has access to a specific set of sample records (i.e., cores, sections, thin sections, processed fossil samples). A project on the *JR* typically centered on a 2-month expedition at sea and lasted around 5 years, from operational planning to the publication of the Proceedings. Some projects required multiple sea campaigns. Some projects revisited sites investigated years earlier and acquired data on the old, as well as the new, core sample material. The cores recovered on the *JR* and their derivative samples belonged to an expedition, and the data acquired as part of one or more expeditions belonged to the project. While this ownership framework was implicit in *JR* sample and data handling, it was an explicit concept in the development of GEODESC. Some GEODESC projects consist of workshops and educational modules.

Project team members are given user accounts that allow them to work on a project. The user accounts are given one or more of three defined user roles (Fig. 10). The most restrictive project role is the “template maker”, who configures the project templates according to team consensus. For core description, only one project team member or a few project team members are needed in this role, which is typically

completed in the early phase of the project, with few subsequent modifications. The “observer role” is for description specialists recording their observations in the spreadsheets. All other project team members who have neither the template maker nor the observer role have real-time read access to the published data through the Data Access application but cannot directly edit data. This data access can be restricted to project team members during a moratorium period and ultimately becomes public based on IODP policy.

The final products of a GEODESC project are tab-separated value (TSV) files that can be analyzed and visualized. On the *JR*, graphic products were created based on these files using other existing applications. GEODESC therefore does not have its own visualization capabilities (see Development opportunities section). Two types of project files are generated: descriptive data files containing the observations and metadata files describing the templates used in recording the observations. In addition to the project files, catalog resources used in template creation are also accessible as TSV files.

3.3 Catalog manager application

3.3.1 Purpose of catalogs

GEODESC catalogs are resources used in the configuration of core description templates and include eight tables shown in Fig. 11 and described below. They are used in conjunction with the Template Manager application (next section), allowing project teams to use existing templates and to modify them to meet the project’s needs or to create entirely new templates, minimizing the burden on the project teams

by providing solutions for the more complicated aspects of spreadsheet design. The catalogs promote consistency within a project and among projects, which is critically useful for investigators analyzing data across projects.

The Catalog Manager (CM) application allows for edits and additions to the GEODESC catalogs. Catalog contents can only be edited by a GEODESC administrator who may receive suggestions from subject matter experts at any time. Any changes made in the catalogs will be immediately available to all existing projects through the Template Manager application (Fig. 11) but will not change any of the existing project template configurations or data. Likewise, changes made to project templates using the Template Manager application will not affect the catalogs. To make changes to the catalogs, the authorized user selects the catalog to be modified and proceeds through guided interfaces. The current catalog contents are publicly available through the Data Access application (<https://web.iodp.tamu.edu/DataAccess/#/catalogs>, last access: 13 October 2026).

3.3.2 Template catalog

The template catalog is a collection of ca. two dozen data capture template configurations created based on templates used on past IODP expeditions (Fig. 12). Catalog templates are essentially a collection of catalog observables (Fig. 13) and can be copied to a project's template collection for immediate use and can be modified in the Template Manager application to suit the project's needs. Templates have seven attributes, with the first three being the identifying key parameters: scale, type, and objective (Fig. 12). The scale parameter addresses the fact that spreadsheet rows may represent intervals at the micrometer to millimeter scale for microscopy, intervals at the millimeter to meter scale for macroscopic description, or summary intervals at the meter to decameter scale such as cored intervals or stratigraphic units. The selection of one of the three arguments, microscopic, macroscopic, or summary, triggers certain template configuration options based on scale. The template type parameter further identifies templates, such as "igneous petrology", which may be used at each scale but is different from the template needed for metamorphic petrology. Different templates are also needed if observations are defined by inherently different samples or description intervals, such as basic lithology defined by primary textures and compositions, alteration occurring across different lithologies, and deformational structure cutting across different lithology and/or alteration intervals. The template objective parameter is the final identity component to uniquely identify a template. When a catalog template is added to a project, the three parameters are concatenated into the template name that users will be working with in the Template Manager, Data Capture, and Data Access applications, whereby templates can be sorted and searched for by the individual parameters.

3.3.3 Observable and qualifier catalogs

The observable catalog is a collection of hundreds of observables, most of which are associated with one or more catalog templates (Fig. 13). GEODESC requires that observables are rigorously defined so that their definitions combined with the observers' data entries constitute unambiguous observations. Once created, an observable definition and the associated column header cannot be changed, but the default for attributes such as validation type, entry value choice lists, numeric constraints, and spreadsheet column display can be adjusted (Fig. 13). An observable definition syntax was introduced to guide the creation of new observables, maintain consistency among large numbers of contextually related definitions, and avoid duplication. The syntax consists of six ordered elements, which are shown across the list of existing observables (Figs. 13 and 14). Each element has a list of qualifiers in the Qualifier catalog, and the list is displayed underneath the element button when selected. Selecting qualifiers for any element filters the list of observables. If a combination of qualifiers is selected for which an observable does not exist, the user is prompted to create a new one (Fig. 14). The six syntax elements are listed here with examples of respective qualifying terms:

- *Entry type*. A mandatory word that relates to one of the four observable entry type categories, i.e., text (e.g., comments, description, interpretation), list (e.g., code, name, type), numeric (e.g., count, dimension, percent), or formula (e.g., checksum, concatenated, formula result).
- *Quantification*. An optional word that quantifies an observation (e.g., abundance, ratio, degree, intensity, thickness, volume).
- *Texture or display*. An optional word that specifies the texture or appearance of an observation (e.g., color, igneous texture, grain size, roundness, shape, opaque).
- *Source or state*. An optional word that specifies the source or state of an observation (e.g., altered, fresh, haloed, recrystallized, hydrothermal, magmatic, authigenic).
- *Composition*. An optional word that specifies the composition of an observation (e.g., biogenic, siliciclastic, plagioclase, Fe-oxide).
- *Focus*. An optional word that specifies the focus of an observation (e.g., background alteration, clasts, matrix, fabric, phenocrysts, section, displacement, lamination).

Most observables have two to four qualifiers. When creating a new observable, the user can place appropriate connecting words between the selected qualifier terms in the given order, creating a full definition that is essentially an English

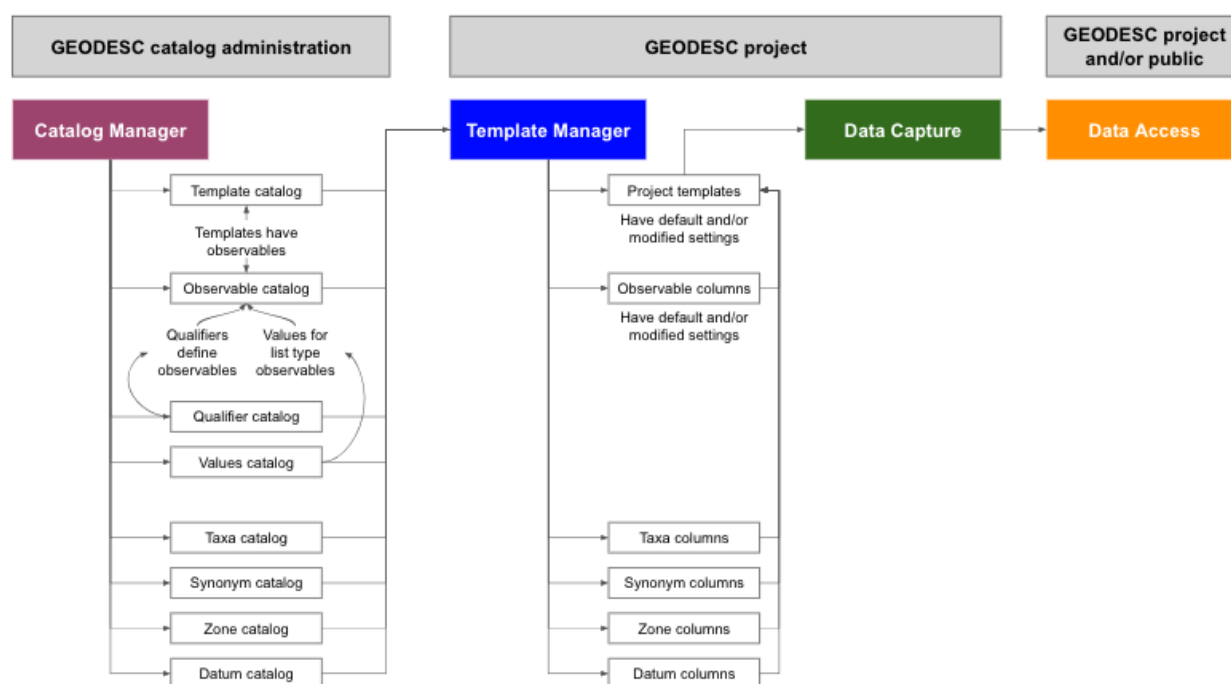


Figure 11. Diagram illustrating the relationships between the GEODESC catalogs administered using the Catalog Manager application, a GEODESC project using the catalog contents to build the project templates using the Template Manager application and acquiring the observations using the Data Capture application, and all project team members (and the public after a moratorium) accessing the data using the Data Access application.

sentence (e.g., “percent volume of altered plagioclase phenocrysts” or “name of roundness of biogenic clasts”). From this full definition, which uses complete descriptive terms without abbreviations and can therefore be of substantial length, a column header is created that strikes the balance between being uniquely descriptive but short enough to be practical as a column header, for example, by allowing abbreviations (Fig. 14). Both the full description and the column header of an observable are unique in GEODESC and cannot be changed. New observables can be created in the catalog by an administrator or by scientists in a project using the Template Manager applications if needed.

Once an observable definition is created, attributes can be defined, starting with one of the four entry types:

- text – basic text characters with no restrictions (default);
- list – a list of allowed values from which the observer selects one or multiples;
- numeric – only numbers can be entered;
- formula – computed results based on entries from other columns.

The list type has two subtypes: single-select and multi-select. The more commonly used single-select type allows for the selection of one value per cell, whereas the multi-select allows multiple values to be selected and recorded as

a comma-separated string of values in a cell. List values may be associated with ranks to sort a set of contextually related or semi-quantitative values in a choice list in the order of size, abundance, intensity, etc. Other attributes that can be set for an observable include entry controls such as the requirement to enter a value for a description interval to avoid gaps. Finally, basic display attributes can be pre-defined and will be applied in the data capture spreadsheet (Fig. 13).

3.3.4 Entry value catalog

The entry value catalog is a collection of thousands of geological and general terms used in conjunction with list type observables. The values are grouped by first-, second-, and third-order grouping terms, as well as a sort order for sets of contextually related values, to facilitate search and filtering of values (Fig. 15). Entry values have detailed descriptions and references if applicable, mostly following the American Geological Institute (Neuendorf et al., 2011; Fig. 15). Sets of allowed entry values are typically pre-configured for list type catalog observables as a default and can be modified by project teams in the Template Manager application. The sets of values are implemented as choice lists in the Data Capture application. If a suitable entry value does not exist in the catalog, users can create it for their project in the Template Manager application. As an example, the default choice list for the observable “name of shape of plagioclase phenocryst”

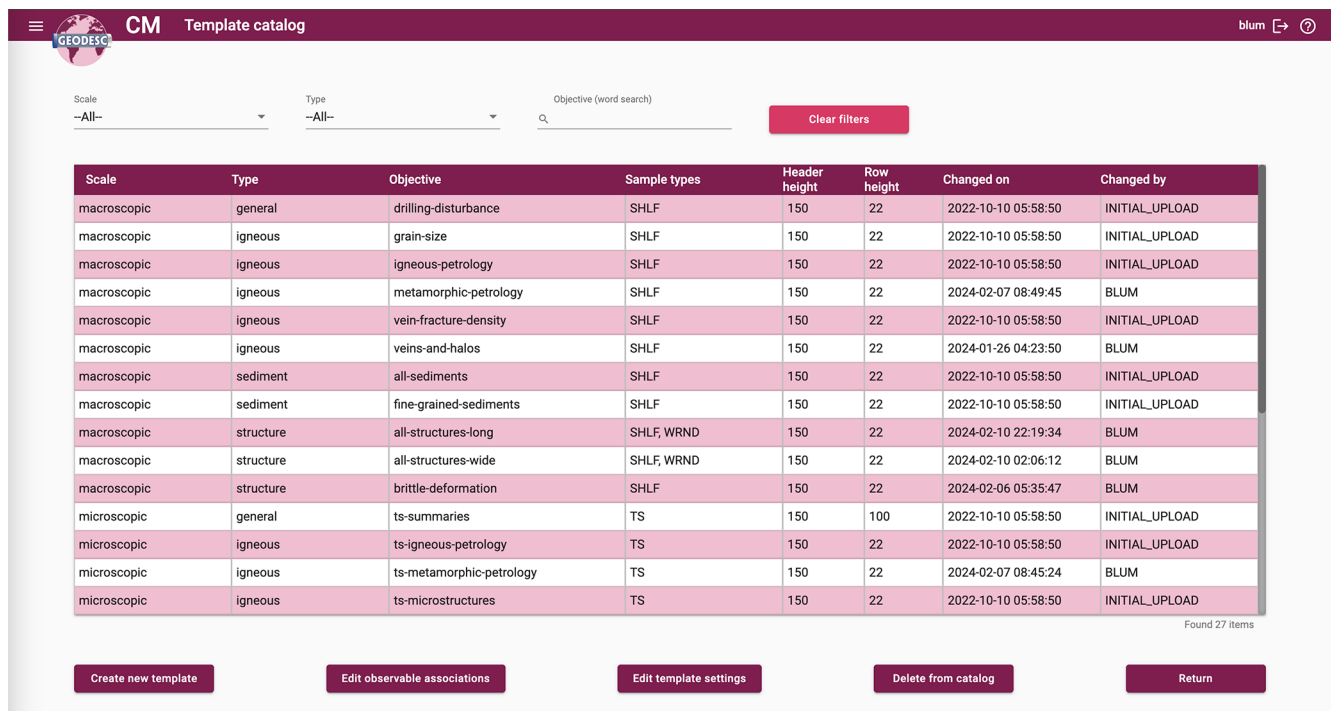


Figure 12. Example screen from the template catalog in the Catalog Manager application showing a partial list of the available catalog templates.

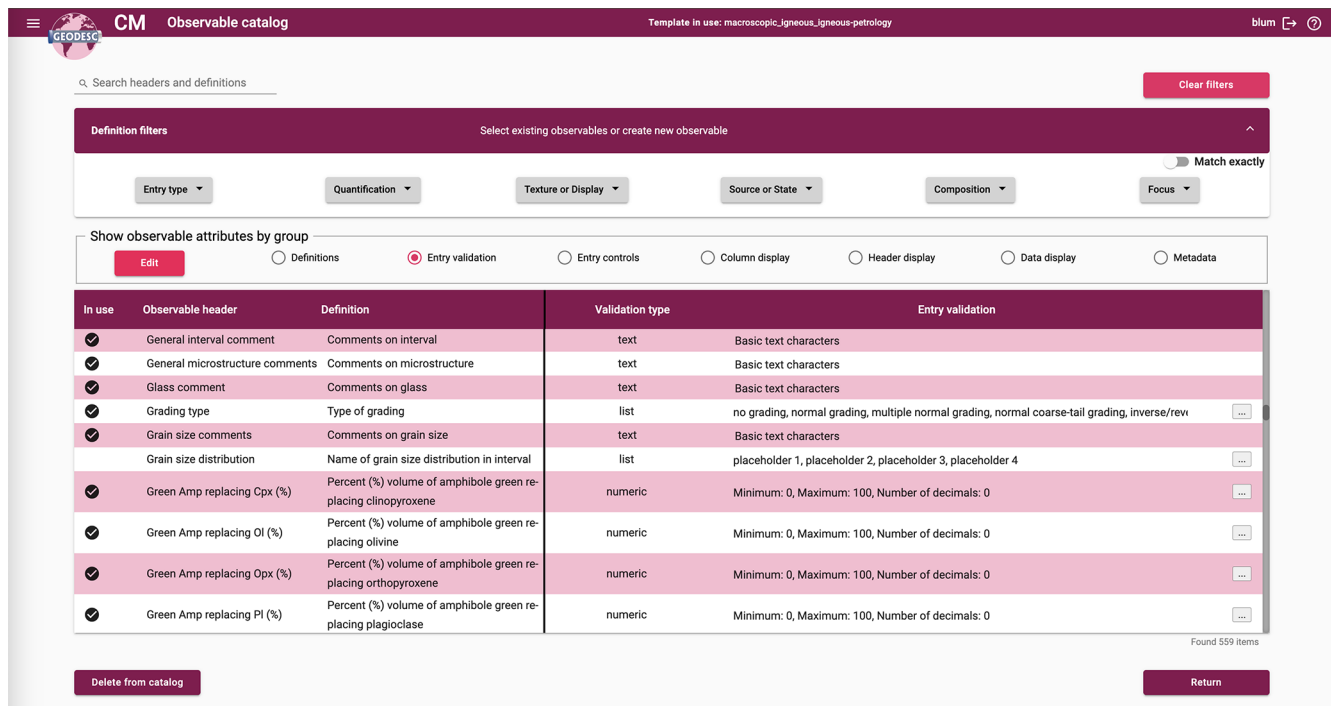


Figure 13. Example screen from the observable catalog in the Catalog Manager application showing a partial list of the available observables. The radio buttons across the top of the list change the observable attribute group display for editing.

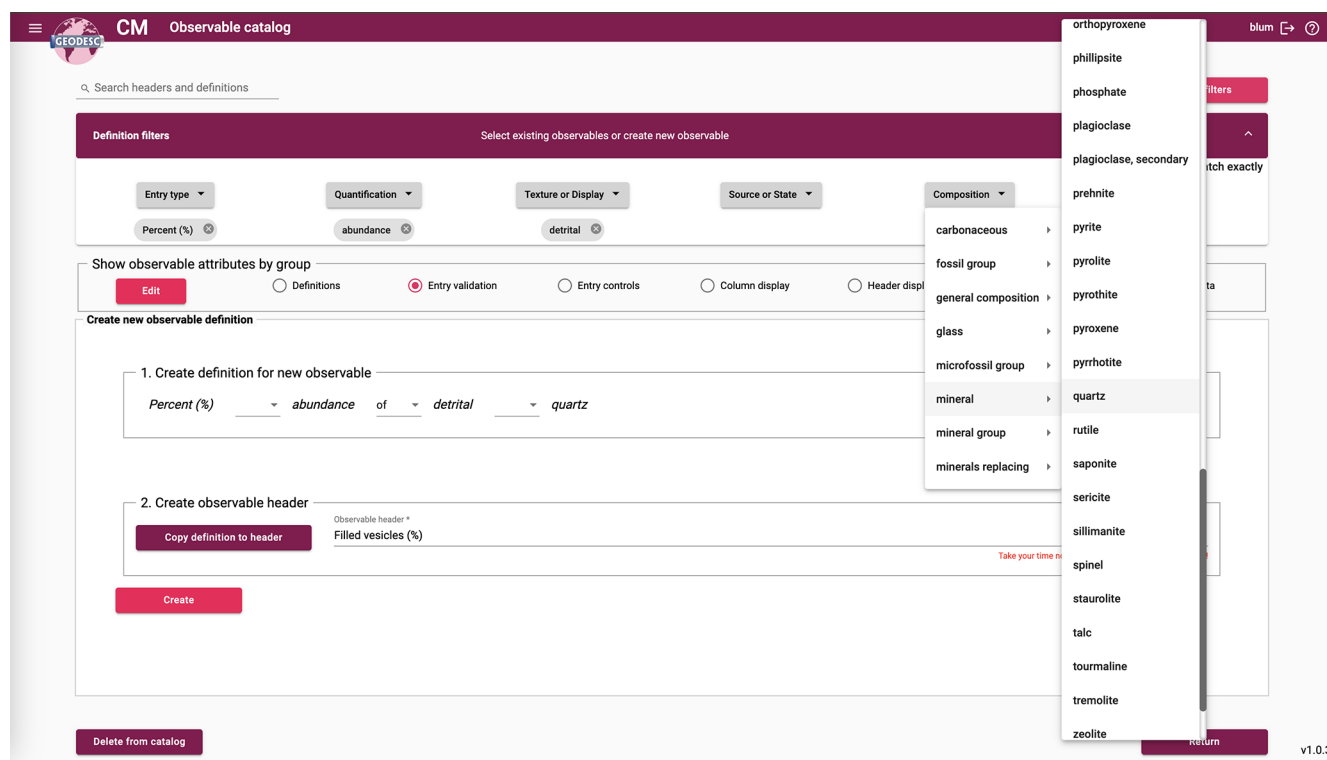


Figure 14. Example screen from the observable catalog in the Catalog Manager application showing the six observable definition syntax elements across the top. The qualifier terms selected for some of the elements act as observable filters and, in this instance, do not return any existing observables, thus triggering the definition of a new observable.

has the entry values “anhedral, subhedral, euhedral”, and the observable “name of degree of total static alteration” has the values “fresh, slight alteration, moderate alteration, high alteration, complete alteration”.

3.3.5 Micropaleontology catalogs

Four additional GEODESC catalogs are provided for the configuration of biostratigraphic data capture templates. Taxa and Synonyms catalogs are taxa name lists for any microfossil group, as provided by experts. The CM includes synonym management functions, such as allowing expert users to select a senior from the taxa catalog for a new synonym, change the senior of a synonym, and set a flag to allow or disallow use of a synonym. Zone and datum catalogs contain records based on published biozonation schemes and age-calibrated datums. Any record set selected from the catalog and added to the project template will allow observers in Data Capture to associate fossil assemblages in a sample with the appropriate zonation and/or datum.

3.4 Template Manager application

The Template Manager (TM) application is used by project team members to select pre-configured catalog templates for core description and micropaleontology (Fig. 16) and to add

them to the project’s template collection where they can be modified to suit the project’s needs (Fig. 17). For core description, templates are typically finalized early in a project, and later changes are rare, which led to the decision to make TM a separate application rather than combining it with the Data Capture application (next section), the tool used during the main data capture phase of the project. Typically, one core description scientist or a small subset of the core description scientists takes on the task of implementing team consensus-based changes to templates using the TM application.

Access to the GEODESC catalogs is a central feature of the TM application to facilitate the configuration of project templates. Pre-configured catalog observables can be added to any project template, and new observables that do not exist in the catalog can be created if needed using the same process illustrated for the observable catalog (Fig. 14). Default choice lists for list type observables can be edited by deleting values, selecting other values from the Entry Values catalog, creating new values if needed, reordering values in the choice list, and adding ranks to values (Fig. 18). Biostratigraphers can add taxa columns from multiple sources, including the existing GEODESC catalog and their personal lists. They can also add columns for multiple biozonal schemes, as well as datums with ages from multiple published timescales

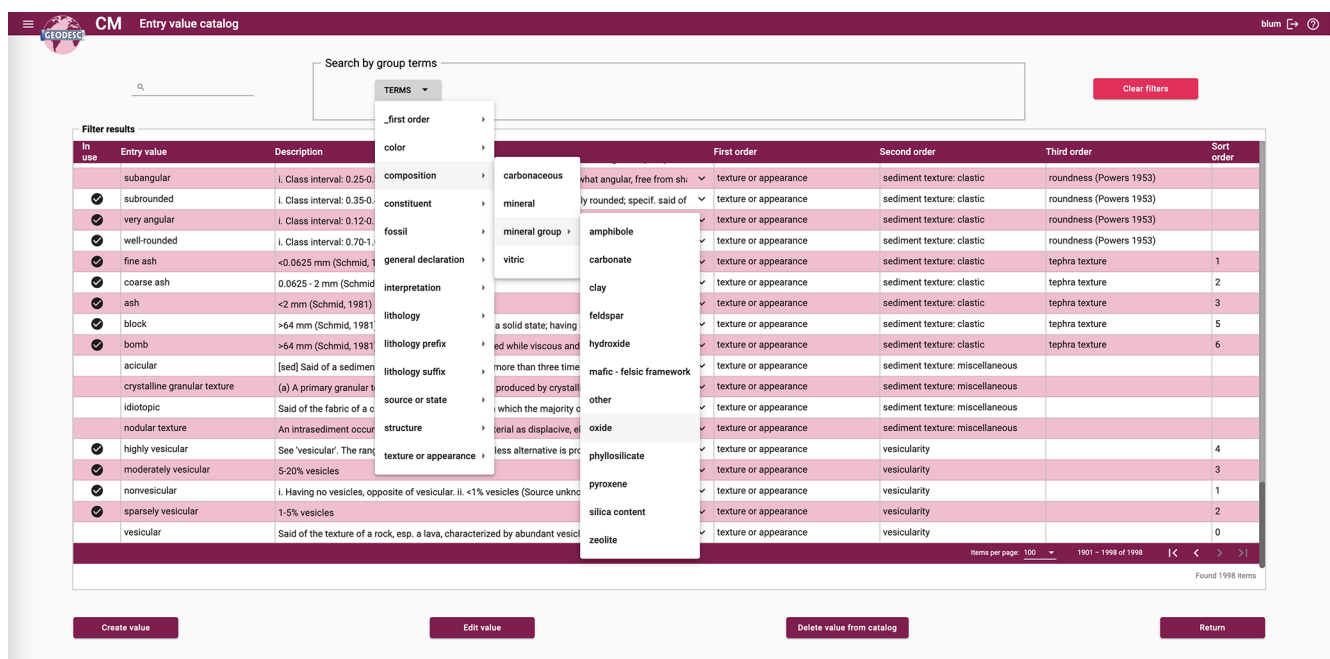


Figure 15. Example screen from the entry value catalog in the Catalog Manager application showing a partial list of the available values. The open search filter dropdown lists illustrate one way of filtering the thousands of values in a contextual way. A generic search field on the top left allows filtering for any character string.

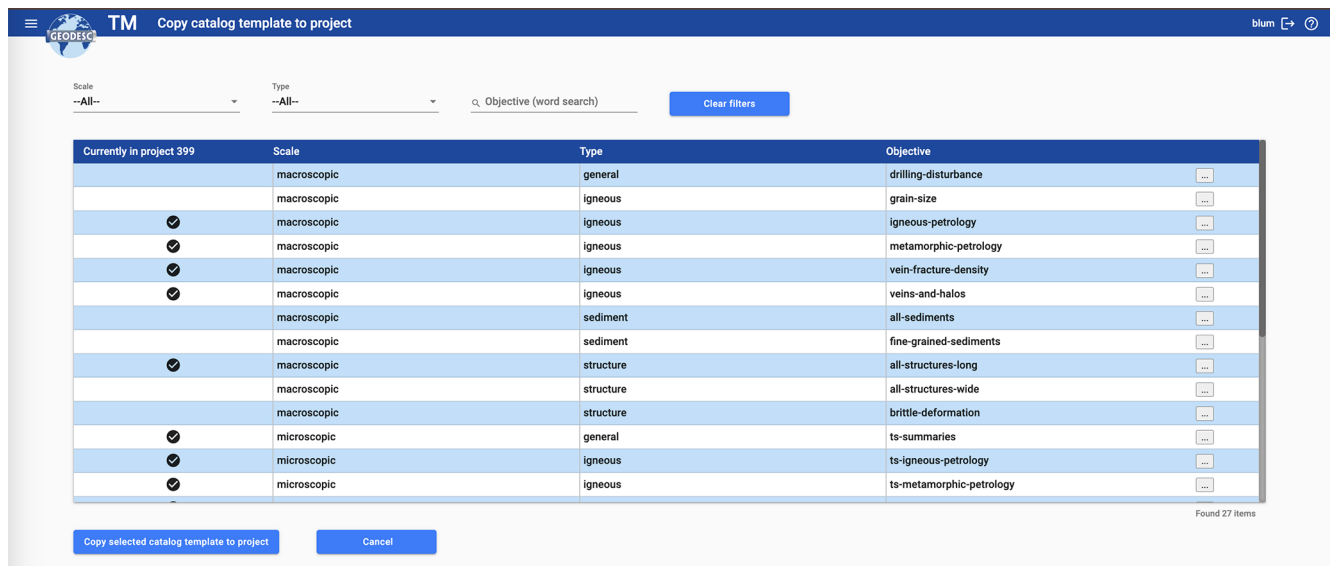


Figure 16. Example screen from the Template Manager application showing how project scientists start by copying suitable catalog templates to their project.

(Fig. 19). Of the 36 total TM user interfaces, 17 are dedicated to the configuration of micropaleontological templates. When catalog templates are added to a project, 17 fixed columns containing the scope of description parameters are added in front of the observable columns. These fixed columns are shared by all project templates and implement the longstanding SOD convention for sample and sample in-

terval identification. A sample or sample interval is defined by the parameters Expedition, Site, Hole, Core, Type, Section, A/W (archive or working half of split section), and Top offset and Bottom offset from the section top in centimeters. This sample ID is followed by three standard depth columns (CSF-A; IODP 2011) computed for the Top, Middle, and Bottom depths of the description interval in meters beneath

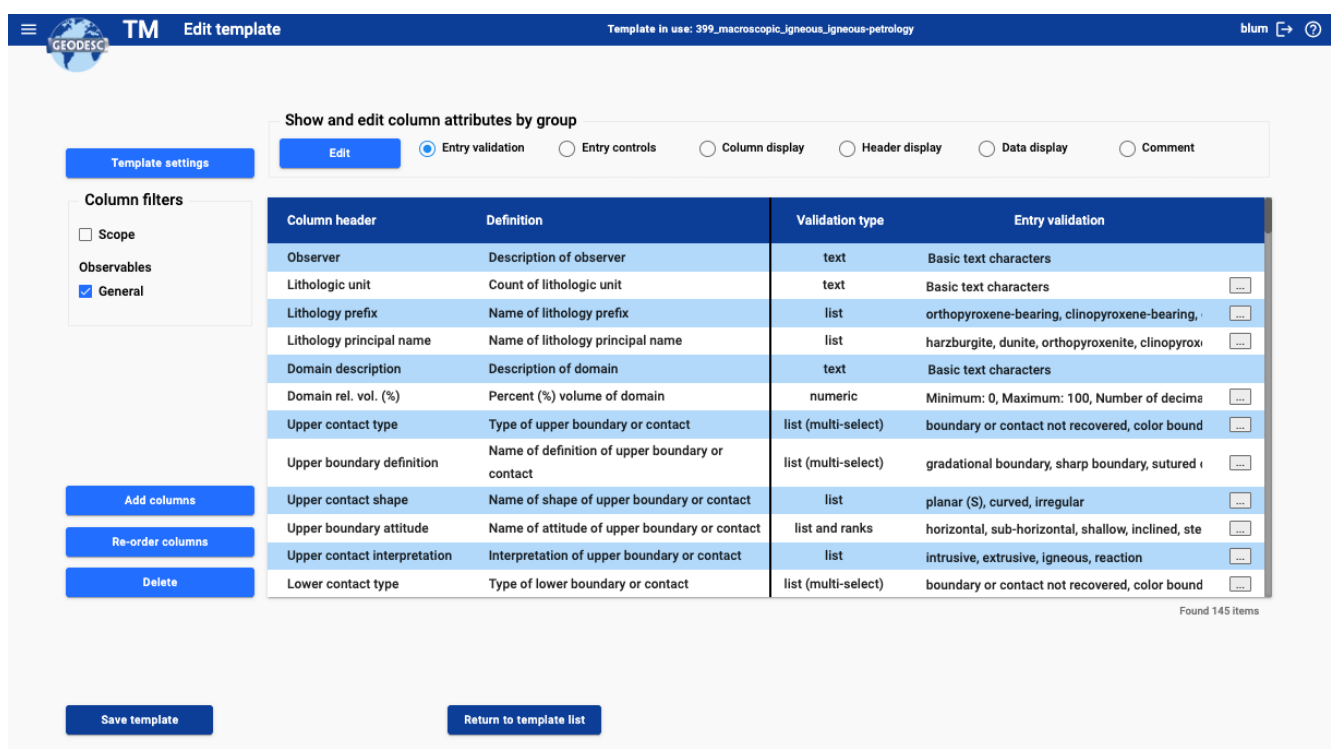


Figure 17. Example screen from the Template Manager application showing the dashboard from where project scientists can configure any aspect of a selected project template by adding, deleting, and reordering existing observable columns displayed as a list or editing any attribute of selected observable columns.

the seafloor and another three columns for an alternate depth scale type (CSF-B by default; IODP 2011), also in meters. A new standard scope column added in GEODESC is the Domain. Domains are parts within a sample or sample interval not defined by a layer, such as two lithologies in a thin section or clast populations in a matrix. The final scope parameter is Piece numbers, a comma-delimited string of curated hard-rock pieces resulting from the drilling process, enumerated for each section and added automatically to the description interval if they exist.

3.5 Data Capture application

The Data Capture application (DC) is used to capture observational data in custom spreadsheets using the project templates configured in TM. DC is the GEODESC application used by all core describers and paleontologists during a project. It has only two major interfaces, the “capture sheet dashboard” and the worksheet where observations are entered.

The initial design called for using Excel for the worksheets because most users are familiar with that application. However, customizing Excel and controlling the myriads of unnecessary and conflicting features was too complicated and costly. Furthermore, making an Excel application universally accessible on the web presented additional

issues and costs. The decision was made to use the fully customizable SpreadJS platform instead, which also allowed for a smooth integration with the Angular framework used for all GEODESC applications. All GEODESC user applications except Data Access use SpreadJS for various implementations of spreadsheet functionality. The capture sheet dashboard (Fig. 20) was developed for safe and practical multi-user collaboration. Only one user can add or edit data for a given combination of template and cores at any one time. Observers create worksets by selecting a template; a hole; and, optionally, a subset of cores from that hole. Worksets can be deleted and re-created at any time since they are not the final data products – they just define the combination of a specific set of cores and a specific template an observer is “checking out” to work on temporarily. The existing worksets are listed on the dashboard, along with useful status information such as who created it, who is currently using it, and whether the latest changes have been published (Fig. 20). In GEODESC, “published” means that the autosaved data are written to the database entity from which any project team member can access the information using the Data Access applications (see next section). In addition to being a data security feature, the workset concept also allows collaborators to break down and divide up the task of describing and reviewing multiple and/or long stratigraphic sections.

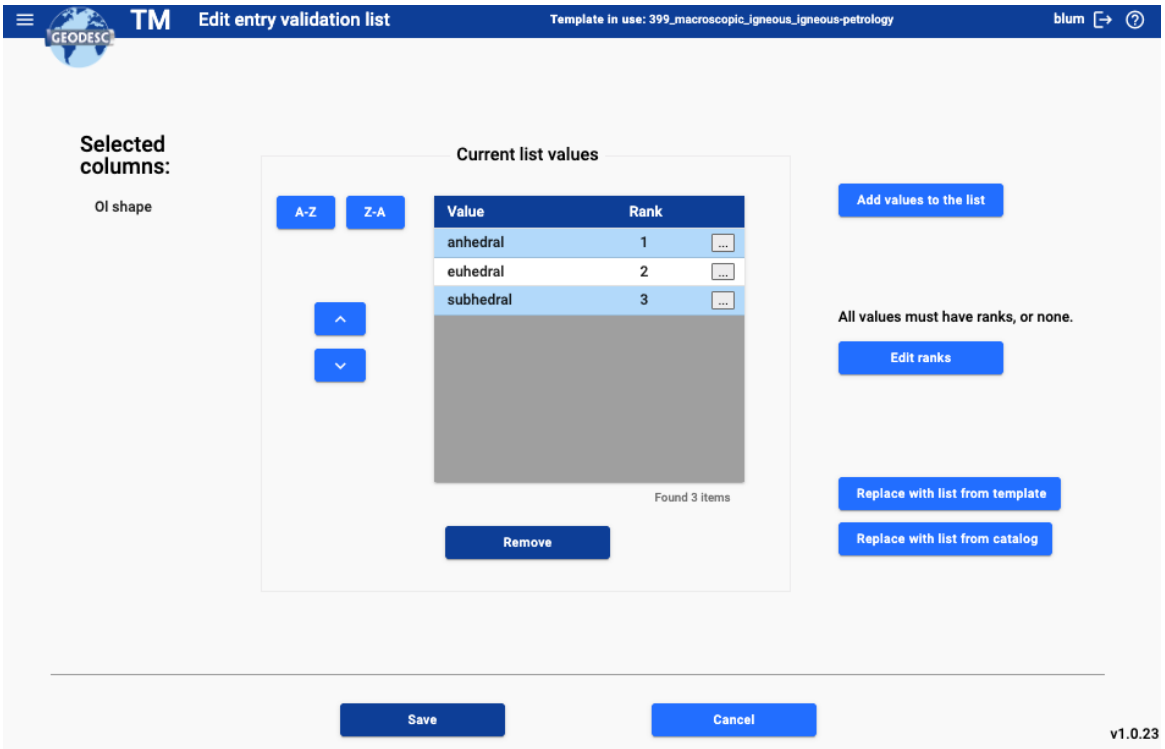


Figure 18. Example screen from the Template Manager application showing how project scientists can edit the list of allowed values for an observable of type list. The values will appear in a dropdown list in the Data Capture application. Template makers can add and delete values, sort the values, assign ranks to values, and copy existing lists from the template or from the catalog if that is the most efficient method.

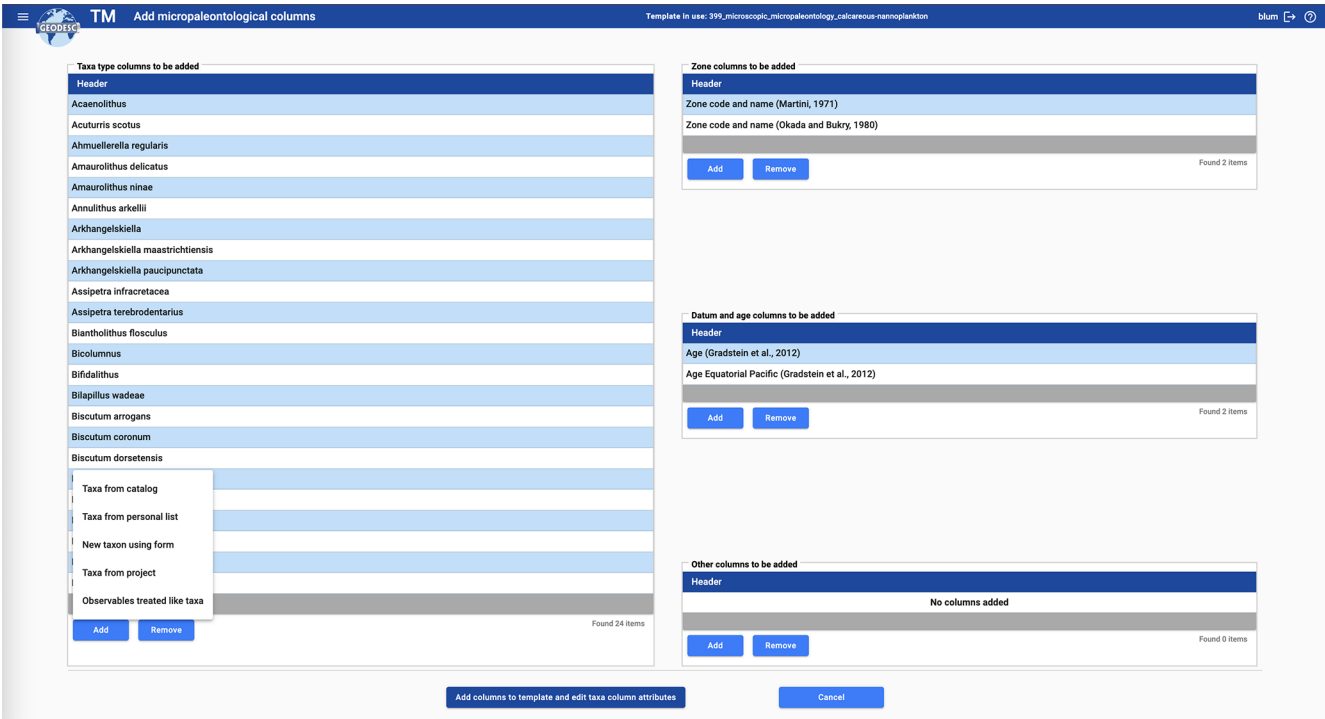


Figure 19. Example screen from the Template Manager application showing the column configuration options for micropaleontology. Users can add taxa columns by selecting taxa from the catalog and from personal taxa lists, with relevant validation features. Columns to add biostratigraphic zones from multiple zonal schemes and columns to add datums using multiple timescales can be added to a template.

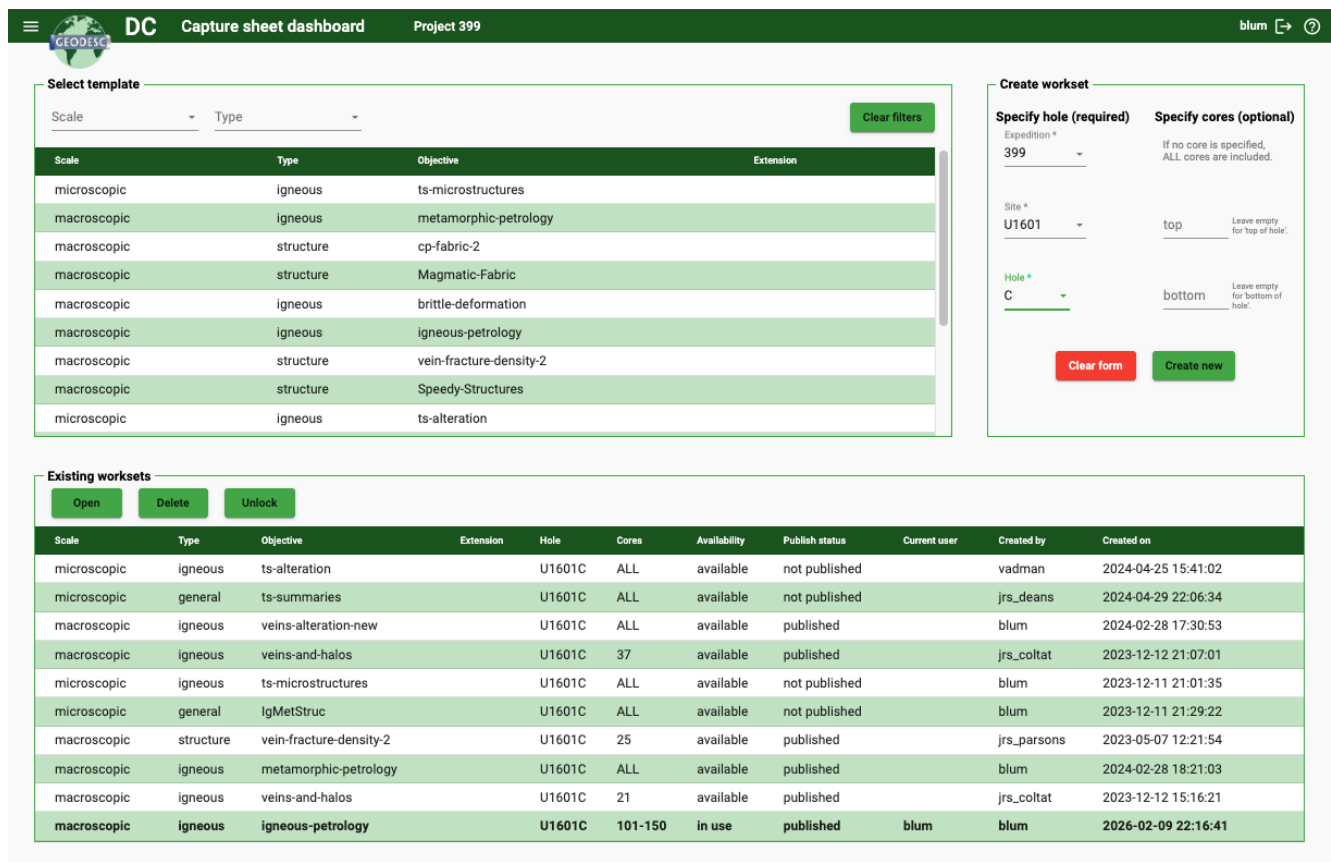


Figure 20. Example view of the dashboard page of the Data Capture application. The dashboard is for users to create worksets by selecting a template; a hole; and, optionally, a set of cores in order to manage the multi-user workflows. A user can open one or more worksets into worksheets if they are not already in use by another user.

When observers open a workset, they are presented with the spreadsheet interface with all existing data (autosaved and/or published) for the workset (Fig. 21). This is where observers spend most of their time. The DC spreadsheet has numerous quality control and convenience features, and a few are described here. For observables of the type “list”, observers can select from approved values using dropdown lists (Fig. 21 and 22c). The “Add Samples” button on the ribbon opens a modal window where users can filter all existing samples for sample type and/or test group and then select the ones they want to add to the spreadsheet for description (Fig. 21 and 22a). The row context menu can be activated anywhere on the row and presents a list of methods to add, insert, or delete rows (description intervals; Fig. 22b). Errors such as intervals that do not physically exist within a sample or numbers or list items not allowed based on the column configuration are indicated with a red box around the cell, and a pop-up explanation can be displayed by hovering the cursor. New data entries and data edits are autosaved immediately as the data entry cell is exited. Autosaved data are only accessible to the observer until published using the “Publish” button on the ribbon. Publishing triggers the up-

date of the “currently final” data product file available via the Data Access application (next section). Closing a spreadsheet prompts the observer to publish the changes (or keep them unpublished) and to keep the workset so it can be opened again by any observer or to delete it as a way of keeping the workset list tidy.

3.6 Data Access application

The Data Access (DA) application provides all project team members (and the public for data no longer protected by moratorium) with an interface to access all published GEODESC data. Data are downloaded as TSV text files, with one file per template and hole (Fig. 23; <https://web.iodp.tamu.edu/DataAccess/>, last access: 13 October 2026). Users can filter the files by expedition, site, and hole and/or by template scale, type, and objective. Users can also download project template metadata files. Furthermore, DA provides public access to all GEODESC catalog contents (<https://web.iodp.tamu.edu/DataAccess/#/catalogs>, last access: 13 October 2026). The TSV files for IODP expeditions were also typically published as supplemen-

Figure 21. Example view of the worksheet page of the Data Capture application. When users open a workset, existing data for the workset are loaded into a worksheet from the database, and the authenticated user enters new observations. Convenient custom functions are available through the ribbon at the top. Columns A through R are the scope of the description columns. The shaded columns cannot be edited by the user; their values are copied from the sample registry. Green boxes around the “Offset bottom (cm)” numbers indicate that those are maximum lengths of the sections. If a larger value is entered, the cell frame turns red, and the user must fix the error before the worksheet can be published.

Figure 22. Three selected Data Capture worksheet features: (a) the top-leftmost button on the ribbon on the worksheet page opens the Add new samples window where users can filter the authorized part of the LIMS sample registry by sample type, test type, and cores and then select the samples to be added to the worksheet for description. (b) Row context menu that can be opened anywhere on the sheet. It offers convenient ways of adding intervals in a core section, copy-pasting observations, and deleting rows. (c) Dropdown list of allowed values for an observable column of type list.

tary materials in Proceedings (<https://publications.iodp.org/>, last access: 13 October 2026), which will ultimately be available on Zenodo (<https://zenodo.org/communities/iodp/records?q=&l=list&p=1&s=10&sort=newest>, last access: 13 October 2026).

3.7 GEODESC database and operation

The GEODESC user applications are directly supported by two groups of Oracle database tables (Fig. 10): project tables and catalog tables. The project tables contain project template definitions managed with the TM user application, defined worksets, and descriptive data autosaved by the DC

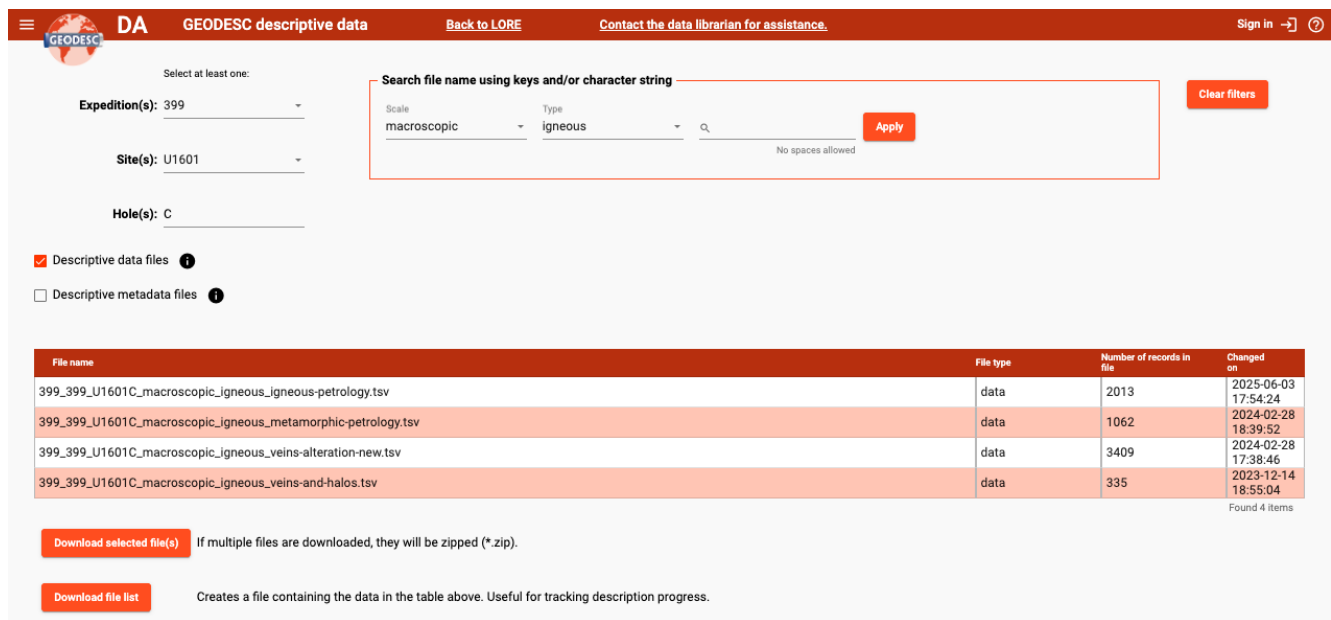


Figure 23. Example view of the Data Access application, which provides access to the published description data and metadata. In addition to performing general character string searches, users can filter by site and hole and by template scale, type, and objective.

application. A new copy of the project tables is created for each project. The catalog tables store all of the GEODESC catalog contents.

In addition, GEODESC draws information from pre-existing LIMS tables: the Samples table and a group of associated depth scale tables (Fig. 10). The Samples table contains all cores collected on the *JR* and millions of subsamples in a recursive hierarchy. Observers load sample records into DC for description using the Add Samples interface in the DC spreadsheet (Fig. 22a). The depth tables are linked to the Samples table and contain procedures that routinely compute two depth types for each sample and sample interval, the Core depth below Sea Floor, method A and method B (CSF-A, CSF-B; IODP 2011). Two final product tables in LIMS hold description data and template metadata, respectively. The final description data are only updated from the project tables when a user publishes data in the DC application.

GEODESC applications interface with the Oracle database via a set of Java-based web services. Based on the way in which user authentication and data moratorium are implemented within the broader LIMS infrastructure, these web services and the associated pool manager ensure that GEODESC data are available only to authorized users. Specific privileges for individual users are managed via the Auther custom application, as was the case with other applications used on the *JR*.

At the end of a project, GEODESC project schemas can, in principle, be deleted as the published descriptive data and metadata stored in the final products table and accessible with DA are independent permanent data archives. Because

GEODESC was built as a set of web applications with a database and is currently hosted at Texas A&M University (TAMU), it is not configured to be portable, installed, and managed at other locations. The advantage of web applications is that all future developments, including bug fixes and new features, as well as catalog edits and additions, are implemented in one place and become immediately accessible to all existing and future users and projects. This model supports collaborations over the internet and allows smaller organizations and projects such as university teaching labs to access and use the same tools that larger organizations such as scientific drilling programs employ. This model requires a hosting organization like TAMU with appropriate resources to provide the service. The required support is modest but critical and consists of science and IT components. Science support consists of a GEODESC administrator who interacts with new project users and directs and implements changes to the catalog content, as well as feature developments based on user monitoring and surveys. IT support consists of three types of tasks: support the project life cycle by initiating new projects with a copy of the GEODESC project data tables (and ultimately removing them), create project member accounts with appropriate application credentials and project roles, and development support to fix issues and potentially add features.

3.8 Development opportunities

3.8.1 Sample registry

Although the GEODESC system was designed to support any geological or micropaleontological description needs, it was also configured to support specific *JR* operations and workflow requirements through integration with the LIMS. The critically important LIMS dependency built into GEODESC is the use of the LIMS sample registry with its rich metadata and associated depth computation routines, which were used by all *JR* shipboard data acquisition and analytical systems. This allowed for a high degree of data quality control and integration, which was necessary on the *JR* due to the wide range of sample types, real-time recovery, and addition of a large number of samples while descriptions and measurements were ongoing 24/7. In the foreseeable future, GEODESC can be used as is if the samples to be described are registered in the LIMS sample registry. Making GEODESC work with user-supplied sample lists without the LIMS metadata and integration would require some type of development. One approach could be for the LIMS sample registry to accept user-supplied “simple” sample lists consisting of only a sample ID and for DC to offer a “simple” mode where the features taking advantage of LIMS sample metadata are turned off. Modifications to the sample registry along these lines are currently being planned and implemented for the *JR* analytical instruments, which are now offered for use at the Gulf Coast Repository (GCR) to any user and for any sample list. Alternatively, a generic and independent sample registry module could be added to GEODESC where users can provide some or all of the sample metadata used by the current DC application and so benefit from all of the features.

3.8.2 Visualization

GEODESC does not have its own graphics capability. For *JR* expeditions, two types of graphic solutions were offered, both combining descriptive information with instrument data. The browser-based program LIVE was used to instantly plot all data acquired on the *JR* in real time, primarily for workflow and scientific data quality control. LIVE included a few simple templates for the display of GEODESC observables. However, customizing the display with patterns and colors geologists expect for final presentations was not possible with LIVE. For publication purposes, more detailed and customized graphics were created with the Strater (Golden Software) geological plotting program (not available or supported anymore), summarizing selected descriptive and instrument data types for each section or core. These summary graphics were produced a day or more after data acquisition by a publication specialist and were ultimately published in the IODP Proceedings volumes (Fig. 9). In addition, scientists created graphics with their tools of choice, with an overall trend of scientists using powerful scripting

programs/languages like Python, R, MATLAB, and others to produce custom graphics. Going forward with GEODESC, providing a ready-to-use tool combining (near-) real-time graphing with publication-ready quality would require development. Fortunately, today’s AI-assisted programming tools offer tremendous possibilities to generate complex graphics in a browser. One approach could be to develop a dedicated GEODESC application module for true real-time plotting where users can configure which observables to plot and how. Alternatively, an independent program that combines plots of descriptive and instrument data from text files could be developed rather efficiently, even by scientists, given that the GEODESC descriptive data are well-structured spreadsheets just like instrument data.

3.8.3 Put pictures to the words

The GEODESC entry value catalog contains thousands of geological terms including lithologies and their constituents, compositions, and textures, as well as formation and deformation structures in all types of Earth materials. Scientific ocean drilling alone has produced hundreds of thousands of images of samples and sample intervals and associated them with these terms. Countless more images exist on the web from other programs and projects. Providing an image gallery for entry value terms would turn the GEODESC catalog into a powerful learning tool. This is not a novel idea but one that has begged for an implementation for decades (Allan et al. 2003, p. 21):

- *Recommendation no. 13.* A digital image library of rock features such as textures should be incorporated into the database or descriptive program.

Not only would the galleries allow DC observers to assess how their entry value selection compares with previous examples but teachers and students could use the image galleries with or without a GEODESC description project and potentially contribute new images. Machine learning (ML) has been employed in geoscience disciplines over the last 2 decades, primarily based on aerial and satellite imagery. Attempts to employ ML to extract lithologic information from drill core images are limited in scope and are still in their infancy, mainly due to the limited training data sets available (e.g., Dawson et al., 2023; Boiger et al., 2024; Mamode et al., 2025). ML success depends on the size and quality of the training data sets, and a GEODESC illustrated catalog based on a huge set of observations by some of the world’s top experts in their field could become a major resource.

4 Conclusions

The nearly 4-decades-long *JR* era of shipboard visual core description and biostratigraphy saw numerous software and database developments aiming to support the capture of observations in ever more efficient and consistent ways, with

the goal of making the results more accessible for further analysis. GEODESC is the ultimate product of this era, incorporating the lessons learned by hundreds of sedimentologists, petrologists, biostratigraphers, and technical support staff. Data capture is based on a feature-rich custom spreadsheet tool, the globally preferred method of data entry and editing, and the final products are text file versions of these structured spreadsheets suitable for visualization and analysis. The GEODESC web applications support data-gathering projects where multiple team members, including experts and novices in core description, may collaborate simultaneously, around-the-clock, and from different locations. As currently configured and maintained at the GCR, GEODESC can be used in small and large projects, from any IODP core repository or private location with Internet, to describe cores or any other geological materials. The Scientific Ocean Drilling Coordination Office (SODCO) is planning to use GEODESC on its upcoming expedition projects. The toolset could be further developed or serve as a reference for organizations wishing to develop their own core description tool, taking advantage of rapidly evolving technologies.

Code availability. Live hosted versions of the GEODESC user applications are currently available at <https://web.iodp.tamu.edu/CatalogManager/> (last access: 13 October 2026), <https://web.iodp.tamu.edu/TemplateManager/> (last access: 13 October 2026), <https://web.iodp.tamu.edu/DataCapture/> (last access: 13 October 2026), and <https://web.iodp.tamu.edu/DataAccess/>. The source code and web services are closed source for operational reasons. Parties interested in the GEODESC source code can write to gcr@tamu.edu, and the request will be reviewed.

Data availability. All data generated on the *JOIDES Resolution* using GEODESC are available in the form of text files, and all example data shown in the illustrations are available in the form of PDF files from the ODP and IODP Proceedings at <https://publications.iodp.org/>. GEODESC data are also available at <https://web.iodp.tamu.edu/DataAccess/#/descriptiveData> (last access: 13 October 2026).

Author contributions. PB initiated, conceptualized, and administered the project and prepared the paper. LBC contributed to the conceptual design, provided user expertise, participated in software testing, and edited the paper.

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