MISSIONE 4
ISTRUZIONE
RICERCA

ITINERIS

Accessible thematic digital archive of data generated by scientific drilling activities

Finanziato dall'Unione europea
NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

Deliverable number:	D7.2
Work package:	WP 7
Intermediate Objective:	IO 7.4
Deliverable type:	X Document, report
	☐ Websites, patent filings, videos, etc.
	☐ Other: please specify ....
Dissemination level:	X Public
	☐ Restricted
Estimated delivery (bimester):	B11
Actual delivery date:	B17
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Reviewed by:	ITINERIS Executive Board
Note:	

IR0000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System - CUP B53C22002150006 (D.D. n. 130/2022)
Funded by EU - Next Generation EU
Mission 4 "Education and Research" - Component 2: "From research to business" -
Investment 3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"

Summary

I. SCOPE OF WORK 4
II. INTRODUCTION AND STATE OF ART 4
2.1 Drilling and coring data 4
2.2 Physical and digital archiving of drilling and coring data 5
III. MOBILE DRILLING SYSTEM 5
3.1 Introduction 5
3.2 mDIS Structure 6
IV. ITINERIS MDIS – SCIENTIFIC DRILLING DATA........ 7
4.1 Catalogue of existing (including vintage) scientific drilling data (samples and subsamples) 7
4.2 Structural Geology (University of Florence) 7
4.2.1. How Geological Structural Data is generated 7
4.2.2. Collection and Archiving of Vintage Structural Data 8
4.2.3. The use of mDIS for archiving structural geological data 11
4.3 Borehole Micropaleontology and Lithology: Activities developed at the University of Milan 15
4.4 Borehole Petrography, Petrology, and Geochemistry (University of Pavia) 17
4.4.1. How Petrological Data are generated 17
4.4.2. Collection and Archiving of Petrological Data 17
4.4.3. The use of mDIS for archiving petrological and geochemical data 18
V. ITINERIS MDIS - SEDIMENT CORES........ 19
5.1 Catalogue of land and marine sediment cores collected in Italy 19
5.1.1. Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) 19
5.1.2. ISMAR-CNR (Istituto di Scienze Marine – Consiglio Nazionale delle Ricerche) 22
5.1.2.1. ISMAR-CNR Core Repository 22
5.1.2.2. WP7.1 Activity (ISMAR-CNR, Bologna) and data representation in mDIS 26
5.1.2.3. The use of mDIS for archiving data 28
VI. DISCUSSION 30
6.1 Pros and cons using mDIS for scientific drilling data vs marine coring 30
VII. OUTLOOK 31
VIII. CONCLUSIONS........ 31
IX. REFERENCES........ 32

I. SCOPE OF WORK

In ITINERIS, WP 7.1-7.3 had the overall objective of improving access to the ECORD infrastructure and enabling scientific drilling microanalysis, geochemical and site survey data sharing (7.1), to the ICDP infrastructure and enabling the sharing of paleomagnetic data from scientific drilling (7.2), and to IODP scientific borehole geophysics, subsurface structural data, and stratigraphic/lithologic samples-data sharing (7.3). In particular, Deliverable D7.2 reports on the progress made throughout the entire project in establishing an accessible thematic digital archive of data generated by scientific drilling and coring activities, which facilitates and promotes increased physical and digital access to the infrastructure, enabling Italian researchers to access ECORD-ICDP infrastructures (in synergy with WP2). In the original definition of the D7.2 scope, reference was made to the embedding of the digital data archive in a Virtual Environment (synergy with WP8).

Scientific drilling in the oceanic, lacustrine, or terrestrial environments is enabled by the collection of geological and geophysical data that support the need to mobilize expensive drilling rigs. Marine coring and terrestrial/lacustrine shallow coring are key components of site characterization data for scientific drilling. For this reason, Deliverable D7.2 addresses digital archiving of both drilling and coring (marine and terrestrial) data.

II. INTRODUCTION AND STATE OF ART

Scientific drilling is a telescope into the Earth's interior. The aim is to gain a comprehensive understanding of the processes in the subsurface. Drilling is the only method that provides both data and samples from the depths and is applied in various scientific disciplines (https://www.gfz.de/en/spotlights/scientific-drilling).

The European Consortium for Ocean Research Drilling (ECORD) (https://www.ecord.org/) is a the European branch of a distributed scientific infrastructure that aims to manage the operation and access to the scientific community of its members to the scientific ocean drilling expeditions and legacy data archives of the International Ocean Discovery Program (IODP - https://www.iodp.org/) and its predecessors before 2025, and the International Ocean Drilling Program (IODP3 - https://iodp3.org/) since 2025. By institutional mandate, ECORD integrates its research activities with the International Continental Drilling Program (ICDP - https://www.icdp-online.org/), which pursues scientific objectives similar to those of IODP/IODP3 but through scientific drilling in a continental (including the lacustrine) environment. Such synergy is enabled by the joint implementation of the Land-to-Sea drilling projects and with the participation in the scientific drilling Forum. In line with the basic principles of scientific ocean drilling, the data collected are open to any user in the world after a 1-year moratorium period that follows data collection by drilling.

The reference disciplines for the research of ECORD and ICDP are: Geological exploration (geosphere) in the ocean and terrestrial environment, including Earth interior processes, geological hazard; paleoclimatic (atmosphere) and paleoceanographic (hydrosphere) reconstructions; and investigations of the deep biosphere (biosphere) through the study of microbial communities living within the Earth's crust.

The management of ad hoc MUR funds for participation in ECORD is entrusted to the CNR, which has set up a scientific commission with the main task of coordinating and promoting Italian participation in IODP activities and fostering synergies with ICDP activities representing Italian research institutions and universities (http://www.iodp-italia.cnr.it, iodp-italia@cnr.it alias italy@ecord.org).

ECORD has been included in the National Research Infrastructure Plan (PNIR) 2021-2027 in which it is classified as a high-priority Research Infrastructure.

2.1 Drilling and coring data

As a primary way to obtain resources like minerals and water from the subsurface, drilling has gradually developed from early prototypes of the pre-Cristian era in China to the modern high-technology industry (e.g., Gerali, 2019; https://www.thedriller.com/drilling-history). The use of this technique has been applied to scientific research in the second half of the 20th century with the purpose of collecting samples, downhole petrophysical measurements, and installing downhole observatories not related to the exploitation of resources. For this purpose, scientific drilling aims at continuous coring using two techniques: Push-through wireline piston coring used in marine and lacustrine sediments until the coring equipment is rejected by stiffening of the sediments, and wireline rotary coring further down (e.g., https://www.jamstec.go.jp/mare3/e/ships/research vessel/chikyu-drilling.html).

Shallow sediment sampling in the ocean and lake floor through coring techniques has been developed during the years of the second world war, primarily following the apparatus designed by F.L Ekman in Stokholm at the end of the 19th century, and widely applied by B. Kullenberg in 1946 during the Swedish Deep-Sea Expedition in the Western Mediterranean (Kullenberg, 1947). The device was called Piston Corer, made of a barrel pushed into the sediment by gravity, in which the recovery of the sediment in the barrel was aided by the action of a piston. When penetration is induced without the aid of a piston, the tool is called a Gravity Corer. The cores (whether or not they are obtained by rotary trilling) are split longitudinally into two halves. One is maintained untouched as an Archive (Archive Half (A)), and the other is used for subsampling (Working Half (W)).

2.2 Physical and digital archiving of drilling and coring data

Core repositories and digital data archives of drilling and coring exist in different countries. Scientific ocean drilling has developed a widely used physical archive of cores and data based on three Core Repositories based at Texas A&M (Gulf Coast repository - GCR), at Bremen University - MARUM (Bremen Core Repository - BCR), and at Kochi University (Kochy Core Center - KCC). The three repositories host and manage the data in a fully coordinated way (https://iodp3.org/resources/core-repositories/). The total length of cores curated by the three repositories, collected since 1968, is nearly 500 km.

Due to a different logistical approach, the cores collected by ICDP are physically archived in different locations based on drilling permit requirements.

The digital logging of drilling data is common between ECORD and IODP and is based on a tool developed by ICDP called the Drilling Information System, and its mobile version for drilling site use, Mobile Drilling Information System (mDIS) (see following chapter for details).

In the absence of an international program, marine/lacustrine core data collected with piston/gravity corers have different archiving systems in each country. In Italy, marine cores have been collected by research vessel owners independently over the years (CNR, mainly with research vessels Bannock, Marsili, Urania and Gaia Blu; OGS, with research vessels OGS-Explora and Laura Bassi; CONISMA, with research vessel Universitatis; PNRA with research vessels Italica and Laura Bassi). One core repository is managed by the CNR Institute for Marine Science (ISMAR) in Bologna. Other cores are managed locally, often without a digital archiving system. Because of this lack of a national core archiving and management system marine piston and gravity core data have been included in the scope of ITINERIS WP7.1, 2,3.

Currently, ECORD guarantees access to data and samples in accordance with the international policy of the IODP^3 Sample, Data, and Obligations Policy (https://iodp3.org/documents/sample-data-obligations-policy/)

Publicly accessible tools inherited from previous ocean drilling programs are:
"Scientific Earth Drilling Information Service – SEDIS" http://sedis.iodp.org/, an integrated portal of data and publications, funded by ECORD, which guarantees access to expedition data and metadata;
"Sample and Data request database", a simple computer application that allows access to samples from the current IODP program (and previous DSSP/ODP/IODP) upon request to the IODP^3 Curator/Curatorial and Advisory Board.

III. MOBILE DRILLING SYSTEM

3.1 Introduction

The Mobile Drilling Information System (mDIS), formerly DIS, was developed to meet the need for managing data generated during ICDP drilling campaigns. This open-source system has been in development and use for nearly 30 years, serving as a comprehensive tool for sample and data management (Behrends et al., 2019). Later on, ECORD-IODP also adopted mDIS for its operations. The system is maintained by the ICDP team at the Helmholtz Centre for Geosciences (GFZ) in Potsdam, Germany.

3.2 mDIS Structure

mDIS is designed to store and manage metadata, scientific data, images and files from scientific drilling activities. It can also generate various exports such as reports, labels and core visual descriptions. A key feature of the system is its generation of International Generic Sample Numbers (IGSNs), a globally unique and persistent identifier assigned to each sample. The use of IGSNs allows the integration of sample materials with their metadata and descriptions. In essence, an IGSN serves a similar purpose for physical samples as a DOI does for scientific publications. Every entry in mDIS is assigned to an IGSN. **Figure 1** shows a screenshot of an IGSN generated for a core (highlighted with a yellow rectangle). The red rectangle illustrates the selection of expedition, site, hole and core (hierarchy) and these elements form IGSN code. Data and metadata can be archived in mDIS during expeditions and/or after expeditions in the core repositories for purposes such as: sample requests, curation and storage. The use of mDIS allows shearing of metadata relative to scientific drilling and coring. The sample request, for example, makes it possible to track where samples are physically located and may enable the re-use of samples. Besides the unique identifier, mDIS contains a relational database, a hierarchical data structure, and naming conventions. This last guarantees data is findable. **Figure 2** is a fluxogram with the current hierarchy of mDIS uses.

Overall, the Mobile Drilling Information System (mDIS) demonstrates full compliance with the FAIR data principles. By assigning globally unique and persistent identifiers such as the IGSN, mDIS ensures that samples and their associated data are Findable. Its metadata management and adherence to standardized naming conventions enhance Accessibility and Interoperability across diverse scientific databases and platforms. Furthermore, mDIS supports Reusability by maintaining detailed records of sample provenance, curation, and scientific context, enabling researchers to confidently share and reuse data over time.

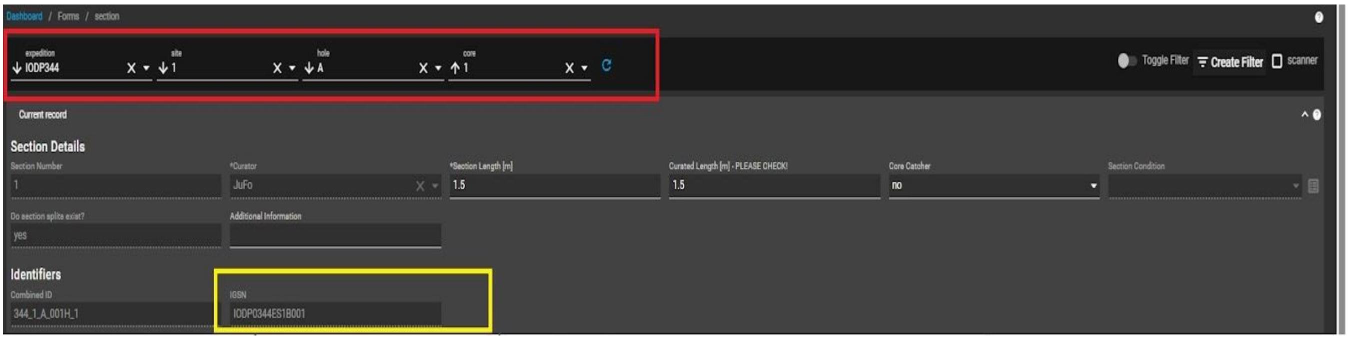


Figure 1- Screenshot from mDIS. The red rectangle shows the selection of an expedition, a site, a hole, and finally a core. The yellow rectangle is the automatic IGSN number generated for identifying this core.

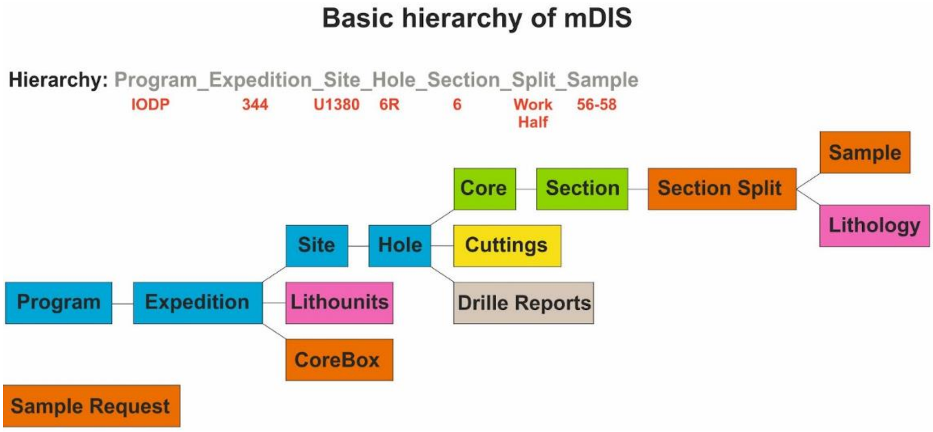


Figure 2- Basic hierarchy of mDIS. We use the example of Expedition IODP 344.

IV. ITINERIS MDIS – SCIENTIFIC DRILLING DATA

4.1 Catalogue of existing (including vintage) scientific drilling data (samples and subsamples)

The Universities of Florence, Milan, and Pavia were responsible for collecting, curating, and archiving geological data from scientific drillings (measurements, samples and subsamples). Three main categories of geological data were the focus:

- **Structural Geology**: Activities developed at the University of Florence.
- **Borehole Micropaleontology and Lithology:** Activities developed at the University of Milan.
- **Borehole Petrography, Petrology, and Geochemistry:** Activities developed at the University of Pavia.

Below we describe the activities for each of the universities.

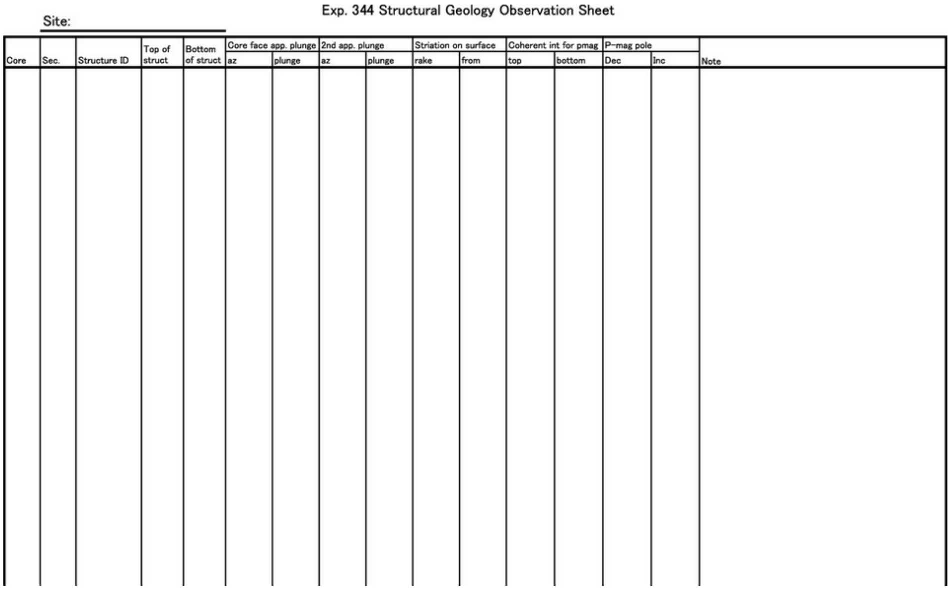
4.2 Structural Geology (University of Florence)

4.2.1. How Geological Structural Data is generated

During scientific drilling expeditions (e.g., ODP, IODP), the structural geology team is responsible for describing geological structures visible in the recovered cores, such as faults, folds, and bedding planes. These observations are generally made on the working half of the core, and less frequently on the archive half, typically during the expedition. Once the structures are identified, geometric measurements are acquired when applicable. These include determining depth extent, measuring orientations, and recording the sense of displacement.

Structural observations made during expeditions are recorded on work paper worksheets, printed and filled with handwritten text during core description. Basic information on the spreadsheet are the Site Number, the Hole, Core, Section and Split. Furthermore, the spreadsheet should contain the top and the base centimeter (on the section) in which the observer identified the structure and the structure name identification. When applicable, orientations of planar and linear features in cored materials are determined relative to the core axis, which represents the vertical axis in the core reference frame. Measurements are taken in the planar feature with the split face of the core and in an intersection perpendicular or parallel to the core axis. These measurements are the apparent dips of the elements. When the structure presents striations, the rake (or pitch) is also measured on the paper worksheets. Measurements for paleomagnetism, when available, must also be recorded on the paper worksheets. The sheet generally contains a structure geometry description and/or comments, and notes sections for further information. Depending on the expedition, extra columns may be added to fill the paper worksheet. Image in **Figure 3** is an example of the empty paper worksheet that scientists print before an expedition and use to fill during the expedition.

The image **in Figure 4** is the same sheet displayed in **Figure 3** filled with data from (IODP Exp. 344), more specifically from Site U138, Hole C, Cores 3R, 4R, 5R and 6R. The handwriting reflects the urgent necessity of describing cores during the expedition. However, to ensure this information will be available in the future for users, it must be digitally archived/stored. Furthermore, the measurements taken during the core description should be used for calculations for real (or at least core-oriented) orientation of structures.



					Core face app. plunge		2nd app. plunge		Striation on surface		Coherent int for pmag		P-mag pole		
Core	Sec.	Structure ID	Top of struct	Bottom of struct	az	plunge	az	plunge	rake	from	top	bottom	Dec	Inc	Note

Figure 3- Example of paper worksheet used to record structural data, apparent orientation, and observations from the working half of the split core for expedition IODP 344 (Harris et al., 2013 in Methods. In: Proceedings of the Integrated Ocean Drilling Program, vol. 344. 2013).

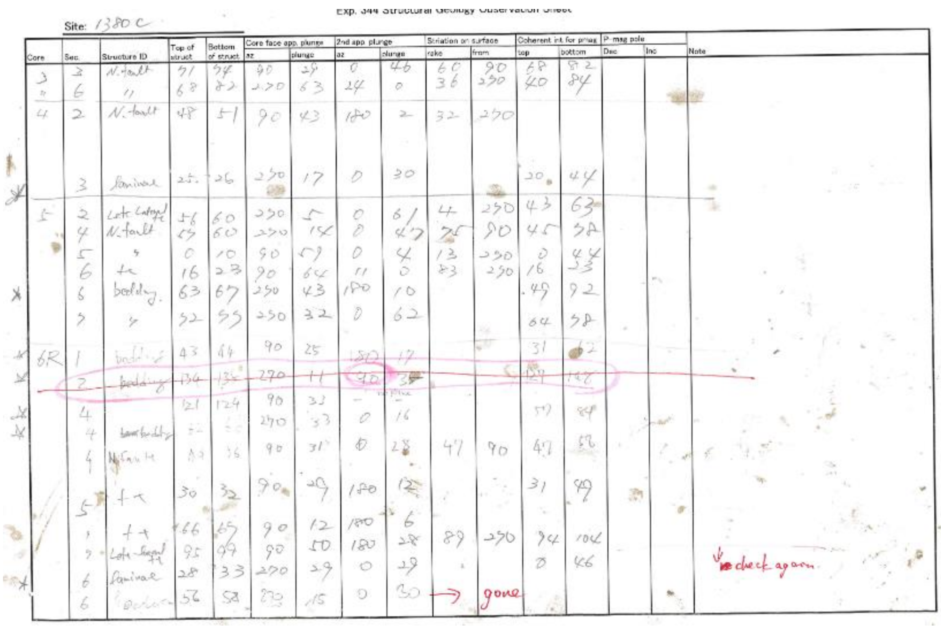


Figure 4- The same sheet displayed in **Figure 3** filled with data from (IODP 344), more specifically from Site U1380, Hole C, Cores 3R, 4R, 5R and 6R.

4.2.2. Collection and Archiving of Vintage Structural Data

Some IODP expeditions, especially the more recent ones, make Excel files available through repositories containing digitized structural data and derived calculations from the original paper worksheets.

However, several other IODP and ODP expeditions do not have Excel Spreadsheet or any other digital record of structural geology data from scientific drilling.

Therefore, we reviewed all IODP and ODP expeditions that included structural geology teams on board and assessed the availability of digital data. For expeditions in which the digital records of structural data were not available, but original paper worksheets were accessible, we created standardized Excel spreadsheets (**Figure 5)** to organize and preserve the information. The paper worksheets were available either (1) as scanned PDF documents or (2) in physical form, archived at the University of Florence. The Excel files are named following the hierarchy:
PROGRAM_NAME_EXP_NUMBER_U_SITE_NUMBER_Structure_Calculations.xls

The scanned paper worksheet and/or macrostructure typically include the following information (e.g., Figure 3):

- Site
- Hole
- Core
- Section
- Structure ID
- Structure details
- Structure comments
- Confidence level (not always available)
- Top and bottom of the structure within the core section
- Azimuth and dip measurements of the structure on the core face (in the core reference system)
- A second azimuth and dip measurement, parallel or perpendicular to the core face (in the core reference system)
- Striation surface measurements (when applicable)
- Coherent interval (for P-mag, very rarely available)
- P-mag pole (very rarely available)

For each expedition site, all relevant information is integrated into a single Excel file (e.g., Figure 5). The following parameters are calculated for each identified structure:

- Plane orientation
- Plane orientation (RHR)
- Striation (when applicable)
- Corrected orientation (RHR)

The calculation methods were created for IODP Exp. 344 (Harris et al., 2013) and further improvements were made in IODP Exp. 352 and IODP Exp. 362 (Reagan et al., 2015; McNeill et al., 2017). We used the spreadsheet created by scientists at IODP Exp. 375 as a standardized model.

Localization of Structures in Meters Below Sea Floor (mbsf):

During the core description, the observer annotates the top and depth (centimeters) in which the structure appears (e.g., columns I and J at **Figure 5a**). These values refer to the centimeters in the section in which they are observed. Then, to properly locate structures in depth, we calculated each sample meter below the seafloor (mbsf) using the information on https://web.iodp.tamu.edu/LORE/ for each section (on the section report). This allows us to determine the structure's corrected depth and bottom (e.g., columns F and G in **Figure 5**) at meters below the seafloor (msbl). **Figure 5** is a screenshot from Excel Spreadsheet created from the original handwritten spreadsheet for Expedition 344, Site U1380. Furthermore, several times the paper worksheet had unorganized information regarding the order in which structures appear, so we reorganized it in crescent order.

A

	A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1					structure ID	Top depth	bottom depth	av. Depth	top of struct	bottom of struct	average depth	core face app. dip		2nd app. dip		striation on surface		plane-normal orientation					plane orientation (RHR)		
2	Site	Hole	core	sect		m	m	m				az	dip	az	dip	rake	from	l	m	n	az	dip	dip dir	strike	dip
3	U1380	C	3R	3	Normal Fault	451.21	451.24	451.225	71.0	74.0	72.5	90	29	0	46	60	90	0.63	0.34	-0.61	28	-40	28	298	50
4	U1380	C	3R	6	Normal Fault	455.38	455.52	455.45	68.0	82.0	75	270	63	24	0	36	270	-0.36	0.81	0.41	114	25	294	204	65
5	U1380	C	4R	2	Normal Fault	458.61	458.64	458.625	48.0	51.0	49.5	90	43	180	2	32	270	0.03	-0.68	0.73	272	47	92	2	43
6	U1380	C	4R	3	Lamination	459.45	459.46	459.455	25.0	26.0	25.5	270	17	0	30			-0.48	0.25	0.83	152	57	332	242	33
7	U1380	C	5R	2	Strike-slip Fault (sinistra	468.83	468.87	468.85	56.0	60.0	58	270	5	0	61	4	270	-0.87	0.04	0.48	177	29	357	267	61
8	U1380	C	5R	4	Normal Fault	471.21	471.27	471.24	54.0	60.0	57	270	14	0	47	75	90	-0.71	0.16	0.66	167	42	347	257	48
9	U1380	C	5R	5	Normal Fault	471.74	471.84	471.79	0.0	10.0	5	90	59	0	4	13	270	0.04	0.86	-0.51	88	-31	88	358	59
10	U1380	C	5R	6	Fault	473.06	473.13	473.095	16.0	23.0	19.5	90	64	11	0	83	270	-0.17	0.88	-0.43	101	-26	101	11	64
11	U1380	C	5R	6	Bedding	473.53	473.57	473.55	63.0	67.0	65	270	43	180	10			-0.13	-0.67	-0.72	259	-46	259	169	44
12	U1380	C	5R	7	Bedding	474.56	474.58	474.57	72.0	74.0	73	270	32	0	62			-0.75	0.25	0.40	162	27	342	252	63
13	U1380	C	6R	1	Bedding	477.23	477.24	477.235	43.0	44.0	43.5	90	25	180	17			0.26	-0.40	0.87	303	61	123	33	29
14	U1380	C	6R	4	Normal Fault	481.81	481.88	481.845	49.0	56.0	52.5	90	31	0	28	47	90	0.40	0.45	-0.76	48	-51	48	318	39
15	U1380	C	6R	4	Bedding	481.94	481.98	481.96	62.0	66.0	64	270	33	0	16			-0.23	0.52	0.81	114	55	294	204	35
16	U1380	C	6R	4	Bedding	482.53	482.56	482.545	121.0	124.0	122.5	90	33					0.00	0.54	-0.84	90	-57	90	0	33
17	U1380	C	6R	5	Fault	482.88	482.9	482.89	30.0	32.0	31	90	29	180	12			0.18	-0.47	0.86	291	59	111	21	31
18	U1380	C	6R	5	Fault	483.24	483.25	483.245	66.0	67.0	66.5	90	12	180	6			0.10	-0.21	0.97	296	77	116	26	13
19	U1380	C	6R	5	Strike-slip Fault (sinistra	483.53	483.57	483.55	95.0	99.0	97	90	50	180	28	89	270	0.30	-0.68	0.57	294	37	114	24	53
20	U1380	C	6R	6	Lamination	484.36	484.41	484.385	28.0	33.0	30.5	270	29	0	29			-0.42	0.42	0.76	135	52	315	225	38
21	U1380	C	6R	6	Fracture	484.64	484.66	484.65	56.0	58.0	57	270	15	0	30			-0.48	0.22	0.84	155	58	335	245	32
22	U1380	C	6R	7	Vein	485.99	486.38	486.185	41.0	80.0	60.5	270	81	0	30			-0.08	0.86	0.14	95	9	275	185	81
23	U1380	C	6R	7	Fault	486.31	486.42	486.365	73.0	84.0	78.5	270	60	338	0	37	270	0.32	0.80	0.46	68	28	248	158	62
24	U1380	C	7R	1	Strike-slip Fault (sinistra	487.1	487.13	487.115	60.0	63.0	61.5	90	11	80	35	2	270	0.41	0.03	-0.14	4	-19	4	274	71
25	U1380	C	7R	1	Fracture Zone (Breccia)	487.4	487.58	487.49	90.0	108.0	99	270	71	344	0	53	90	0.26	0.91	0.31	74	18	254	164	72
26	U1380	C	7R	1	Normal Fault	487.85	487.86	487.855	135.0	136.0	135.5	90	10	0	55	80	270	0.81	0.10	-0.56	7	-35	7	277	55
27	U1380	C	7R	1	Fracture Zone (Breccia)	487.86	487.99	487.925	136.0	149.0	142.5							0.00	0.00	0.00	90	#DIV/0!	270	180	#DIV/0!
28	U1380	C	7R	2	Fracture Zone (Breccia)	488	488.37	488.185	0.0	37.0	18.5	270	10	0	40	20	270	-0.63	0.13	0.75	168	49	348	258	41

B

AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
striation								coherent interval (for P-mag)		P-mag pole		corrected orientation (RHR)			striation				
csf rake	str rake	l	m	n	trend	plunge	slip sense	top	bottom	Dec	Inc	dip dir	srtike	dip	rake	trend	plunge	slip sense	Remarks
43	163	-0.96	0.19	0.22	107	13	0.00	68	82			28	298	50	163	107	13		
66	102	-0.21	0.41	0.89	321	62	0.00	40	84			294	204	65	102	321	62		
92	124	-0.56	0.61	0.56	135	34	0.00					92	2	43	124	135	34		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	20	44			332	242	33	#####	#####	#####		
3	7	0.99	0.06	0.11	271	6	0.00	43	63			357	267	61	7	271	6		
42	147	-0.83	0.37	0.41	53	24	0.00	45	78			347	257	48	147	53	24		
88	101	-0.18	0.51	0.84	108	57	0.00	0	44			88	358	59	101	108	57		
101	4	1.00	0.03	0.06	13	3	0.00	16	23			101	11	64	4	13	3		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	49	92			259	169	44	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	64	78			342	252	63	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	31	62			123	33	29	#####	#####	#####		
54	7	0.99	0.10	0.08	324	4	0.00	47	58			48	318	39	7	324	4		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!					294	204	35	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!					90	0	33	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	31	49			111	21	31	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!					116	26	13	#####	#####	#####		
113	22	0.93	0.23	0.29	38	17	0.00	94	104			114	24	53	22	38	17		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	0	46			315	225	38	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!					335	245	32	#####	#####	#####		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!	0	25			275	185	81	#####	#####	#####		
112	149	-0.86	0.24	0.46	322	27	0.00	45	96			248	158	62	149	322	27		
4	6	0.99	0.03	0.10	276	6	0.00	40	60			4	274	71	6	276	6		
104	51	0.63	0.24	0.74	185	47	0.00					254	164	72	51	185	47		
18	98	-0.14	0.57	0.81	21	54	0.00					7	277	55	98	21	54		
#DIV/0!	#####	#####	#####	#####	#####	#####	#DIV/0!					270	180	#DIV/0!	#####	#####	#####		
13	33	0.84	0.41	0.35	284	21	0.00					348	258	41	33	284	21		Drillied induced

Figure 5- Example from standardized Excel spreadsheet created. The image above shows the first 28 rows from site U1380 are from Expedition 344. a) Columns from A to Z, b) Columns AA to AT. The spreadsheet represents the information written during the expedition, represented in **Figure 4,** plus the derived calculations.

In this context, we digitized data for ODP Leg 205, IODP Exp. 344, 352, 362, 402 (this last still under moratorium). Although no physical samples derived from structural measurements are available, we refer to each described structure as a "sample" for ease of tracking and workload quantification.

Table 1 (below) shows the catalog of samples collected at the University of Florence ordered by expedition. The table illustrates the number of structures (samples) described per Site which were archived into the Excel spreadsheet for calculations. In the last row of the table, the total number of structures recorded is described, which so far (until August 2025) represents **4266 records**.

Expedition					*Number of Samples (structures) per Expedition:*
ODP 205 Costa Rica Convergent Margin	Site U1253	Site U1254	Site U1255		
Number of Samples (structures) per Site	409	85	3		**497**
IODP 344 Costa Rica Seismogenesis Project A Stage 2 (CRISP-A2)	Site U1380	Site U1381	Site U1412	Site U1413	
Number of Samples (structures) per Site	370	47	88	514	**1019**
IODP 352 Izu-Bonin-Mariana Fore Arc	Site U1439	Site U1440	Site U1441	Site U1442	
Number of Samples (structures) per Site	646	227	68	209	**1150**
IODP 362 Sumatra Subduction Zone	Site U1480	Site U1481			
Number of Samples (structures) per Site	698	137			**835**
IODP 402 Tyrrhenian Continent–Ocean Transition - UNDER MORATORIUM PERIOD	Site U1612	Site U1613	Site U1614	Site U1617	
Number of Samples (structures) per Site	120	137	508 (in progress)	in progress	**765 (in progress)**
Total Number of Samples digitalized at University of Florence					**4266**

Table 1 - Catalog of samples collected at the University of Florence ordered by expedition. The table illustrates the number of structures (samples) described per Site which were archived into the Excel spreadsheet for calculations.

With the end of the Project and all the standardized Excel Spreadsheets done (**Table 1**) we will contact the repositories responsible for holding the cores for each expedition to make the files available. These Excel Spreadsheets provide not only the measurements and observations recorded during the scientific drilling campaign, but also the results from calculations that provide the real orientation of structures and allow users to easily build graphics and export the data.

4.2.3. The use of mDIS for archiving structural geological data

At the University of Florence, we worked only with data originating from scientific drilling. For this reason, the current data hierarchy and relational structure used by mDIS follows the same model adopted by IODP and earlier scientific drilling programs. In this context, recording the basic metadata from expeditions is straightforward. **Figure 6** shows the mDIS interface, where metadata from IODP Expedition 344 was entered into the system. The interface includes fields for expedition details such as code, acronym, full name, date, location, chief scientist (including name and contact information), and funding. This information is entered by the user, and a PDF containing the expedition metadata can be generated using the export function (see **Figure 7**). Both **Figures 6 and 7** present data records from IODP Exp. 344.

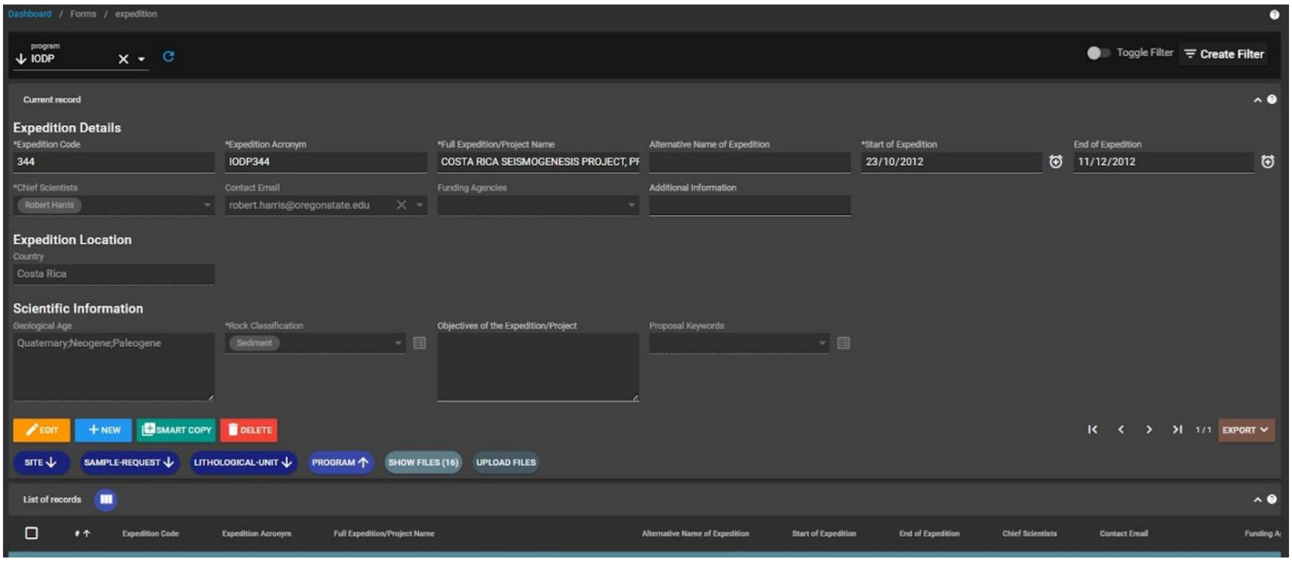


Figure 6 - Screenshot from mDIS interface where metadata from scientific drilling expeditions is inserted. The export button (lower right corner) generates a pdf file with the metadata from the expedition (e.g., **Figure 7**). In this example the fields are fed by metadata from IODP Exp. 344.

29/07/25, 11:30 data.icdp-online.org/mdis/itineris/report/Details?model=ProjectExpedition&form=expedition&id=8

icdp

COSTA RICA SEISMOGENESIS PROJECT, PROGRAM A STAGE 2 (CRISP-A2)

Details of Expedition record

Expedition	Program Name
344	**International Ocean Discovery Program**

Column	**Value**
ID	8
Program ID	4
Expedition Acronym	IODP344
Expedition Code	344
Expedition Name	COSTA RICA SEISMOGENESIS PROJECT, PROGRAM A STAGE 2 (CRISP-A2)
Alternative Name of Expedition	
Contact Person	robert.harris@oregonstate.edu
Rock Classification	Sediment
Objectives of the Expedition	
Proposal Keywords	
Additional Information	
Start of Expedition	2012-10-23
End of Expedition	2012-12-11
Country	Costa Rica
Geological Age	Quaternary;Neogene;Paleogene
Chief Scientists	Robert Harris
Funding Agencies	
SampleRequest	

Figure 7- Screenshot from the pdf generated by mDIS with metadata from IODP expedition 344.

The structural model previously available by default on mDIS was insufficient to archive the type metadata/ data described in sections *4.1.1.1* and *4.1.1.2*. Thus, we have developed a structural model (**Figure 8**) adapted to archive metadata in ITINERIS. The model was set inside the Geology Structure Template, called Structure 4. We then created the form adapted to fill metadata from the cores. The form is what will appear for the user to record the metadata and data (limited to data collected during the core description, at the drilling campaign). We defined the type of field necessary to be inserted into. Type of data had to be defined in the forms for each new entry field. Below, we describe the four groups that contain relative columns, their description followed by the data type we defined for each:

Group 1: Top and Bottom on the section

Columns:

a) **Top/location on the section [cm]** *INTEGER*

b) **Bottom/location on the section [cm]** *INTEGER*

Group 2: Structure Details

a) **Structure ID**: structure type *STRING*

b) **Remarks:** column destined to include larger comments about the structure *STRING*

c) **Structure Details:** columns to inform geometry or short features of the structure *STRING*

Group 3: Measurements

a) **Az1**: is the azimuth measured on core face (in the core reference system) *INTEGER*

b) **Dip1:** is the dip direction measured on core face *INTEGER*

c) **Az2:** represents the azimuth measured parallel or perpendicular to the core face (in the core reference system) *INTEGER*

d) **Dip2:** is the dip direction measured parallel or perpendicular to the core face (in the core reference system) *INTEGER*

e) **Striation**: measurement of striation (if exists) *INTEGER*

Group 4: Curator

a) **Curator:** Person who curated the sample (structure) *STRING*

Figure 9 is a screenshot from one single record from structural data identified on a section of a core(from Expedition 344). The image exemplifies data being recorded on the system with the structural model developed by the University of Florence. Figure 10 is an example of the export mDIS produces, showing all the records from all structures identified on the Section 1 from Core 1H at Site ID 1 (U1413) during expedition 344. The columns described for the model are all visible on the image: top/depth (cm), structure ID, remarks, structure details, Az1, Dip1, Az2, Dip2, Striation, and Curator.

Figure 8- Screenshot from MDIS website showing the front-end/ interface from the structural model we created for structural metadata recording, adapted to mDIS.

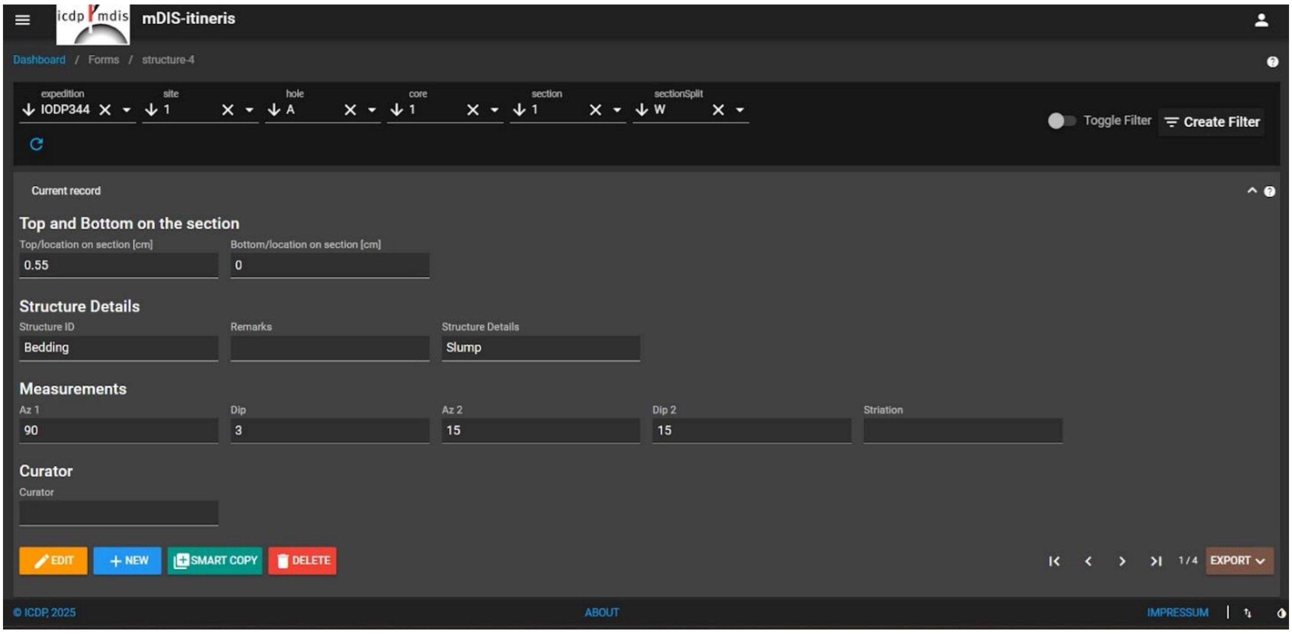
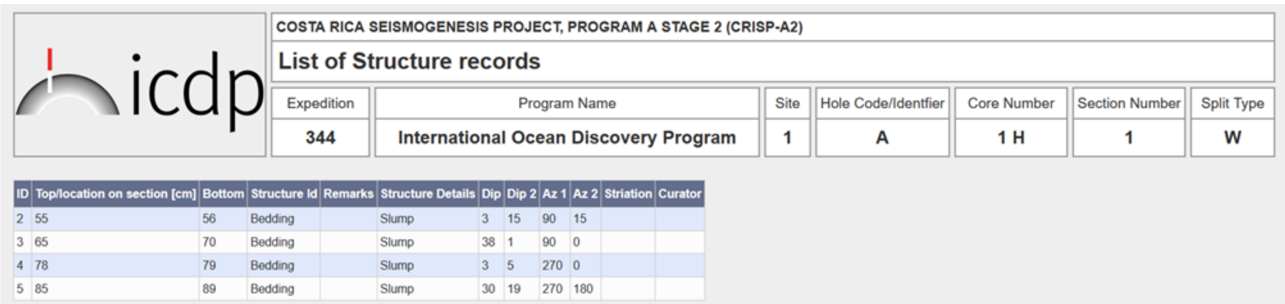


Figure 9 - Screenshot from a single structure recorded from one core from IODP Exp. 344



COSTA RICA SEISMOGENESIS PROJECT, PROGRAM A STAGE 2 (CRISP-A2)

List of Structure records

Expedition	Program Name	Site	Hole Code/Identfier	Core Number	Section Number	Split Type
344	International Ocean Discovery Program	1	A	1 H	1	W

ID	Top/location on section [cm]	Bottom	Structure Id	Remarks	Structure Details	Dip	Dip 2	Az 1	Az 2	Striation	Curator
2	55	56	Bedding		Slump	3	15	90	15		
3	65	70	Bedding		Slump	38	1	90	0		
4	78	79	Bedding		Slump	3	5	270	0		
5	85	89	Bedding		Slump	30	19	270	180		

Figure 10- Screenshot from mDIS showing the List of Structure records from IODP Exp. 344 Site U1413, Hole A, Core 1H, Section 1, Working Half.

In conclusion, the model developed for structural geological data from scientific drilling is suitable to record both metadata and data collected during or after a scientific drilling campaign. Specifically, it captures the basic observations acquired during the expedition and can serve as a digitized version of the paper worksheet shown in **Figure 4**. It may serve either as a substitute or a complement to the original document. The derived results that we present in Excel spreadsheets (e.g., corrected azimuth and dip values), obtained through post-expedition calculations, are already processed data and therefore fall outside the scope of mDIS. Access to these products (the Excel spreadsheets generated by ITINERIS) should be ensured by the respective core repositories. The export presented in **Figure 10** represents an effective visualization of all samples (structures) collected in a section and facilitates its fast connection with the expedition information at the top of the figure.

4.3 Borehole Micropaleontology and Lithology: Activities developed at the University of Milan

At University of Milan (Università Statale di Milano), the activities on the scope of ITINERIS consisted in collection and physical and digital archiving of geological data obtained from subsurface drillings for scientific purposes in the field of micropaleontology and well lithology. The main goal Milan`s group is the cataloging of samples and data produced by the researchers of Milano Statale, derived from the analysis of sedimentary rocks and drill sediments from DSDP-ODP-IODP cores, with reference to micropaleontological, stratigraphic, and lithological content. This work includes the creation of both a physical and a digital archive. The activities conducted so far have produced the physical archiving of 8 wells at the repository of the Department of Earth Sciences from University of Milano. For another 26 wells, various data have been collected and cataloged, including rock/sediment samples, smear slides, powders, and thin sections. The completed wells are as follows:

- DSDP 241
- DSDP 249
- DSDP 361
- DSDP 364
- DSDP 367
- ODP 692
- ODP 959
- ODP 962

The physical archiving for each well has produced:

- Boxes with original samples
- Boxes with smear slides
- Boxes with thin sections
- Boxes with powders for nannofossils and geochemical analyses
- Boxes with foraminifera wash residues
- Boxes with foraminifera slides

For 34 DSDP-ODP wells, archived or in the process of archiving, the following number of units has been checked and cataloged so far:

- 4,162 original sedimentary rock or sediment samples
- 4,046 smear slides
- 2,459 vials with powders for nannofossils or geochemical analyses
- 2,384 foraminifera wash residues
- 359 thin sections

The digital database is temporarily implemented in Microsoft Excel sheets, which contain all the data related to physical archiving combined with those related to analyses performed on samples, smear slides, powders, wash residues, and thin sections. Files have been created for the 34 DSDP-ODP wells analyzed so far, and for 8 of them, both physical and digital archiving have been completed. Below, **Figure 11** is an example of the Excel table for well DSDP 364:

DSDP LEG 40 - Site 364

Barren

					Age		Physical archive					Nannofossils				Foraminifers					Physical archive: washed residues								
Core	Section	Interval (cm)	MBSF	Litology	Nannofossils	Foraminifers	Original sample	N° Box Simple slides	N° Box Settling slides	Nannofossil powder	Thin sections billets	Simple slides	Settling slides	Biostratigraphy	Counts	H_2O_2	Acid Acetic	Biostratigraphy	Planktonic counts	Benthic counts	> 355 µm	> 250 µm QUA (split)	> 250 µm BIO	> 125 µm QUA (split)	> 125 µm BIO	> 38 µm BIO	> 38 µm QUA (Split)	Slide benthic	Thin Section
20R	1	139-143	578.89	Marly chalk with black shales	Coniacian	Coniacian	x	8/8	5/8	x		x	x			x		x	x	x	x		x		x	x		x	
	2	43-46	579.43				x	8/8	4/8	x	x	x	x	x	x	x										x			x
	3	70-74	581.2				x	8/8	5/8	x		x	x			x										x			
	4	7-10	582.07				x	8/8	4/8	x		x	x	x	x	x		x	x	x	x		x		x	x		x	
	4	91-94	582.91				x	8/8	5/8	x		x	x			x										x			
	4	137-141	583.37				x	8/8	4/8	x	x	x	x	x	x	x										x			x
	5	27-30	583.77				x	8/8	5/8	x		x	x			x										x			
	5	129-133	584.79				x	8/8	4/8	x		x	x	x	x	x		x	x	x	x		x		x	x		x	
21R	1	63-65	597.28				x	8/8	5/8	x		x	x			x					x		x		x	x			
	2	135-138	599.5				x	8/8	4/8	x	x	x	x	x	x	x										x			x
	3	36-40	600.01				x	8/8	5/8	x		x	x			x		x	x	x	x		x		x	x		x	
	3	121-125	600.86				x	8/8	4/8	x	x	x	x	x	x	x		x		x						x		x	x
	4	106-110	602.21					8/8	5/8	x		x	x			x		x		x						x		x	
	5	76-78	603.41		Turonian	Turonian	x	8/8	4/8	x		x	x	x		x		x	x	x	x		x		x	x		x	
	5	121-125	603.86				x	8/8	5/8	x		x	x			x										x			
	6	69-72	604.84				x	8/8	4/8	x	x	x	x	x	x	x										x			x
	6	140-143	605.55				x	8/8	5/8	x		x	x			x										x			
22R	1	139-141	616.89				x	8/8	4/8	x		x	x	x	x	x		x	x	x	x		x		x	x		x	
	2	24-27	617.24				x	8/8	5/8	x		x	x			x										x			
	3	18-21	618.68				x	8/8	4/8	x		x	x	x	x	x										x			
	3	137-139	619.87				x	8/8	5/8	x		x	x			x		x		x						x		x	
	4	77-80	620.77				x	8/8	4/8	x		x	x	x	x	x		x	x	x	x		x		x	x		x	
23R	1	80-82	644.8				x	8/8		x		x				x		x			x		x		x	x			
	2	57-59	646.07				x	8/8	4/8	x		x	x	x	x	x		x			x		x		x	x			
	2	103-105	646.53				x	8/8		x		x				x					x		x		x	x			
	3	26-29	647.26				x	8/8	4/8	x		x	x	x	x	x		x	x	x	x		x		x	x	x	x	
	3	114-118	648.14				x	8/8		x		x				x		x		x	x		x		x	x		x	
	3	133-138	648.33				x	8/8		x		x				x		x			x		x		x	x			
	4	52-54	649.02				x	8/8	4/8	x		x	x	x	x	x					x		x		x	x			
	4	138-141	649.88				x	8/8	4/8	x		x	x	x		x		x		x	x		x		x	x		x	
24R	1	38-41	672.88				x	7/8	4/8	x		x	x	x		x		x			x		x		x	x			
	1	81-83	673.31				x	7/8	4/8	x		x	x	x	x	x		x			x		x		x	x			

Figure 11 - Example of digital archiving for DSDP 364 at the University of Milan.

Furthermore, Milan`s team compiled a list of publications related to the samples analyzed in Milan. At the same time, all PDFs of the aforementioned publications are collected and, where available, individual links/DOIs are included. All **PhD theses from UNIMI** in which the wells present in the database were studied are also cataloged. Currently, 52 publications and PhD theses have been collected. Below, **Figure 12** exemplifies of the structure of the table related to the publications:

Year	Authors	Title	Journal	Vol., Pages	DOI	Site	Type of Analysis
1999	Larson R.L. & Erba E.	Onset of the mid-Cretaceous greenhouse in the Barremian-Aptian: Igneous events and the biological, sedimentary and geochemical responses	Paleoceanography	14, 663-678	https://doi.org/10.1029/1999PA900040	463	Quantitative analyses
2002	Tremolada F. & Erba E.	Morphometric analyses of Aptian Assipetra infracretacea and Rucinolithus terebrodentarius nannoliths: Implications for taxonomy, biostratigraphy and paleoceanography	Marine Micropaleontology	44, 77-92	https://doi.org/10.1016/S0377-8398(01)00038-X	463	Quantitative and morphometric analyses
2004	Erba E., Bartolini A. & Larson R.L.	The Valanginian "Weissert Oceanic Anoxic Event"	Geology	32, 149-152	https://doi.org/10.1130/G20008.1	1149	Quantitative analyses
2004	Tremolada F. & Bralower T.J.	Nannofossil assemblage fluctuations during the Paleocene-Eocene Thermal Maximum at Sites 213 (Indian Ocean) and 401 (North Atlantic Ocean): paleoceanographic implications	Marine Micropaleontology	52, 107-116	https://doi.org/10.1016/j.marmicro.2004.04.002	213	Quantitative analyses
2004	Tremolada F. & Bralower T.J.	Nannofossil assemblage fluctuations during the Paleocene-Eocene Thermal Maximum at Sites 213 (Indian Ocean) and 401 (North Atlantic Ocean): paleoceanographic implications	Marine Micropaleontology	52, 107-116	https://doi.org/10.1016/j.marmicro.2004.04.002	401	Quantitative analyses
2006	Tremolada F., Erba E. & Bralower T.J.	Late Barremian to Early Aptian calcareous nannofossil paleoceanography and paleoecology from the Ocean Drilling Program Hole 641C (Galicia Margin)	Cretaceos Research	27, 887-897	https://doi.org/10.1016/j.cretres.2006.04.007	641	Quantitative analyses
2007	van Breugel Y., Schouten S., Tsikos H., Erba E., Price G.D. & Sinninghe Damst J.S	Synchronous negative carbon isotope shifts in marine and terrestrial biomarkers at the onset of the early Aptian oceanic anoxic event 1a: Evidence for the release of 13C-depleted carbon into the atmosphere	Paleoceanography	22, PA1210	https://doi.org/10.1029/2006PA001341	463	Geochemical analyses
2008	Tremolada F., De Bernardi B. & Erba E.	Size variations of the calcareous nannofossil taxon Discoaster multiradiatus (Incertae sedis) across the Paleocene-Eocene Thermal Maximum in Ocean Drilling Program Holes 690B and 1209B	Marine Micropaleontology	67, 239-254	https://doi.org/10.1016/j.marmicro.2008.01.010	690	Quantitative and morphometric analyses

Figure 12- Screenshot from the compilation of a list of publications related to the samples analyzed in Milan.

4.4 Borehole Petrography, Petrology, and Geochemistry (University of Pavia)

4.4.1. How Petrological Data are generated

During scientific drilling programs (e.g., ODP, IODP, and ICDP), the petrology team is responsible for the identification and classification of igneous, metamorphic, and mantle rocks. This is accomplished through the recognition of constituent minerals and estimation of their modal abundances. In addition, petrologists document the textural features of the recovered core samples, including any anisotropies and, where applicable, the degree of alteration. These observations are primarily conducted on the working half of the core and, less frequently, on the archive half, typically during the expedition itself. The International Ocean Discovery Program (IODP) provides access to expedition datasets through several international science operators, each with a dedicated online portal:

- JRSO (web.iodp.tamu.edu): Offers a broad range of drilling-related data.
- MarE3 (www.jamstec.go.jp/sio7): Specializes in marine environmental datasets.
- ESO (iodp.pangaea.de): European hub for ocean drilling data.
- Downhole Logging Data (mlp.ldeo.columbia.edu/data): Provides geophysical and stratigraphic data from borehole logs.

To support data integration and retrieval, IODP also maintains:

- SEDIS: A unified portal for searching and aggregating data from past and current programs, including post-expedition results.
- SSDB: A digital archive of preliminary site survey data for IODP, ODP, and DSDP proposals, with partial open access depending on data type.

In general, the vast amount of data collected during expeditions is not organized under a unified hierarchy but is instead dispersed across the previously mentioned digital repositories. The European Science Operator (ESO) is linked to a modified Drilling Information System (mDIS), which, however, only reports basic information such as the Site Number, Hole, Core, Section, and Split. Additionally, the system should include the top and base centimeter positions within the section where the lithology was identified, along with the sample name or identifier assigned by the observer. Despite its utility for quick reference, the current structure of the mDIS presents limitations for integrated analyses. The lack of hierarchical or relational links between geological features, sample metadata, and analytical results hinders the ability to perform large-scale correlations or automated data extraction. To improve accessibility and interoperability, it is recommended that a more structured data model be implemented.

4.4.2. Collection and Archiving of Petrological Data

We have catalogued samples stored at the University of Pavia. A single Excel file has been created for each site, following the naming convention:
PROGRAM_NAME_EXP_NUMBER_U_SITE_NUMBER_Structure_Calculations.xlsx. Each Excel file is organized according to the following hierarchical structure designed to record information that is consistent across all expeditions (e.g., **Figure 13**).

- Site
- Hole
- Core
- Section

- Section Split
- Lithology
- Interval (cm)
- Top (mbsf)
- Bottom (mbsf)
- Age
- Sample Lithology
- Additional material
- Available data

Expedition	Site	Hole	Core	Section	Section Split	Interval (cm)	Top (mbsf)	Bottom (mbsf)	Lithology	Age	Sample Lithology	Additional material	Available data
360	U1473	A	6R	3	WR	95-97	44.53	44.55	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	32R	6	WR	17-21	291.44	291.53	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	32R	6	WR	48-53	291.67	291.88	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	33R	2	WR	30-32	295.41	295.45	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	42R	2	WR	79-85	383.40	383.45	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	51R	1	WR	99-103	460.30	460.40	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	51R	2	WR	6-10	460.80	460.90	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry
360	U1473	A	52R	1	WR	0-4	469.00	469.05	Diabase dyke	/	Diabase dyke	Thin section	Petrography, Geochemistry

Figure 13 - Example from standardized Excel spreadsheet created by Expedition 360.

In this context, we digitized data for: (i) Expedition 360 (SW Indian Ridge Lower Crust and Moho): 140 samples; and (ii) Expedition 402 (Tyrrhenian Continent-Ocean Transition): 110 samples. All the archived samples are physically available at the University of Pavia. With the end of the Project and all the standardized Excel Spreadsheet done, we will contact the repository responsible to hold the cores for each expedition to make available the files. These Excel Spreadsheets provide not only the measurements and observations recorded during the scientific drilling campaign, but new data and results from investigations and allow users to easily build graphics and export the data.

4.4.3. The use of mDIS for archiving petrological and geochemical data

At the University of Pavia, the work conducted focused exclusively on data derived from scientific drilling. Consequently, the base hierarchy implemented in mDIS mirrors that adopted by the IODP. The structure includes sections containing expedition details such as Code, Acronym, Full Name, Date, Location, Chief Scientist (name and contact information), funding. These fields are user-editable, and a dedicated export function allows for the generation of a standardized PDF report summarizing the expedition metadata (e.g., **Figure 7**). However, each expedition displays variability in the description and classification of rocks, depending on whether the samples are of intrusive, volcanic, metamorphic or mantle origin. For this reason, the revised hierarchy has been streamlined to enhance clarity and improve accessibility of relevant information. In the *"Sample Lithology"* category, several specific entries have been included, such as:

- Rock class *STRING*
- Lithological unit code *STRING*
- Major minerals *STRING*
- Accessory minerals *STRING*
- Secondary minerals *STRING*

- Grain size *STRING*
- Mineral shape *STRING*
- Mineral habit *STRING*
- Texture *STRING*
- Contacts *STRING*
- Alteration Intensity *STRING*
- Curator *STRING*

Furthermore, the updated hierarchy now includes two additional categories: *Sample Data* and *Additional Material*. These fields allow users to upload supplementary files such as Excel spreadsheets, images, or PDFs containing (i) more petrological details not reported in the *"Sample Lithology"* category, and (ii) data collected either during the expedition or as part of subsequent analyses.

V. ITINERIS MDIS - SEDIMENT CORES

5.1 Catalogue of land and marine sediment cores collected in Italy

Below we present the catalogue and mDIS use from marine and/or land sediment cores by structures.

5.1.1. Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS)

The National Institute of Oceanography and Applied Geophysics (OGS) is a research institution, supervised by the Ministry of Universities and Research (MUR), which operates in the fields of physical, chemical, biological, and geological oceanography; experimental and exploration geophysics; seismology; and engineering seismology. Currently, OGS serves as a repository to several marine cores from scientific expeditions undertaken with the OHS-Explora, Laura Bassi, and other research vessels. **Figure 14** is a table chart with the marine sediment cores that are stored at OGS on the scope of ITINERIS.

All the metadata referring to sediment cores displayed in **Figure 14** were recorded in mDIS. **Figure 15** is a screenshot from mDIS showing the list of oceanographic expeditions which marine cores are in OGS. As **Figure 14** evidenced, marine sediment cores stored in OGS do not have any specification for Site or Hole, and sometimes Cores are understood as Sections (see Eurofleets Buster and PRSA2021-0012-IRIDYA in **Figure 14**). That is, the current hierarchy used in mDIS is not the same as that used for marine sediment cores. We then adapt the data to the current hierarchy:

- Attributing one single site for each expedition
- For each Core, we attributed a single Hole

The metadata inserted in mDIS also included expedition aims, chief scientists, vessel type, vessel name, coring tool, and date of expedition. The majority of this information is found on expedition reports, available online. With this, mDIS now has an online complete catalogue with the relation of marine cores located in OGS, all included on a major hierarchy created for ITINERIS-OGS. mDIS allows the generation of different exports with the expeditions, holes, cores, and sections. **Figure 16** is an example of Core/Section summary (from a single Hole/Core), from expedition SVAIS. The export shows the Core/Sections names, core on deck time, Core Bottom Depth (m), Length Core (m), the amount recovered (%), the number of sections, section length(m), curated length (m), and bottom depth (m). Another interesting possibility of mDIS is that exports such as the ones exemplified by **Figures 10, 15** and **16** can also be exported in CSV file format, which is the most suitable format for Excel. This is useful when a user needs not only to visualize metadata but also to manage metadata.

The mDIS also allows inserting photos of the cores. Below we show an example of a Visual Core Description (**Figure 17**) from the IRIDYA expedition. The figure is from Core 1 PC and section 1.

Project	Core	Ghear	Year	Depth (mbsl)	Total Lenght (cm)	N. of Sections
SVAIS (IPY-SPAIN)	SVAIS-01	Pistone	2007	1813	277	3
	SVAIS-01TC	Trigger Corer	2007	1813	148	2
	SVAIS-02	Pistone	2007	743	640	7
	SVAIS-03	Pistone	2007	761	641	7
	SVAIS-03TC	Trigger Corer	2007	761	101	1
	SVAIS-04	Pistone	2007	1839	310	4
	SVAIS-04TC	Trigger Corer	2007	1839	166	2
	SVAIS-05	Pistone	2007	713	612	7
	SVAIS-06	Gravity	2007	303	176	2
EGLACOM (IPY-OGS)	EGLACOM-01	Gravity	2008	1069	219.5	3
	EGLACOM-02	Gravity	2008	1722	304.5	3
	EGLACOM-03	Gravity	2008	1432	285	3
	EGLACOM-04	Gravity	2008	374	103	1
EUROFLEETS2-PREPARED	GS191-01PC	Calypso Piston Corer	2014	1647	1967	21
	GS191-02PC	Calypso Piston Corer	2014	1322	1737	19
	GS191-01BC	Box Corer	2014	263	24	1
	GS191-02BC	Box Corer	2014	1647	24	1
	GS191-04BC	Box Corer	2014	1322	29	1
EUROFLEETS-BURSTER	PS99/02-2	TV Multi-Corer	2016	376.1	30	8 cores
	PS99/02-3	TV Multi-Corer	2016	376	27	8 cores
	PS99/03-1	TV Multi-Corer	2016	317.1	21	8 cores
	PS99/04-1	TV Multi-Corer	2016	304.7	30	8 cores
	PS99/05-2	TV Multi-Corer	2016	294.6	30	8 cores
	PS99/05-3	TV Multi-Corer	2016	293.6	30	8 cores
	PS99/06-3	TV Multi-Corer	2016	335.9	19	8 cores
	PS99/06-4	TV Multi-Corer	2016	335.7	19	8 cores
	PS99/07-2	TV Multi-Corer	2016	159	37	3 cores
	PS99/07-3	TV Multi-Corer	2016	159.1	38	8 cores
	PS99/21-3	TV Multi-Corer	2016	305.7	10	6 cores
	PS99/21-5	TV Multi-Corer	2016	305.4	25	8 cores
High North, Marina Militare Italiana	HN17-07BCO-02	Box Corer	2017	563	15	
	HN17-08BCO-03	Box Corer	2017	360	16.5	
	HN17-19BCO-04	Box Corer	2017	302	27	
	HN17-20BCO-05	Box Corer	2017	298	29	
	HN17-21BCO-06	Box Corer	2017	283	16.5	
	HN17-52BCO-07	Box Corer	2017	308	26	
	HN17-54BCO-08	Box Corer	2017	281	19	
	HN17-57BCO-09	Box Corer	2017	290	19	
	HN17-58BCO-10	Box Corer	2017	318	26	
	HN17-59GCO-01	Box Corer	2017	324	18	
CAGE19- Giant Piston Core Expedition	CAGE19-KH3-15MUC	Multi-Corer	2019	1580	39.5	
PRA2021-0012-IRIDYA	LB21-3-IRIDYA-01MC	Multi-Corer	2021	1732	1.65	5 cores
	LB21-3-IRIDYA-01PC	Piston Corer	2021	1719	8.37	9
	LB21-3-IRIDYA-02MC	Multi-Corer	2021	1725	1.61	6 cores
	LB21-3-IRIDYA-02PC	Piston Corer	2021	1724	4.99	5
	LB21-3-IRIDYA-03MC	Multi-Corer	2021	1485	1.58	6 cores
	LB21-3-IRIDYA-04MC	Multi-Corer	2021	1665	2.81	8 cores
	LB21-3-IRIDYA-04PC	Piston Corer	2021	1665	7.3	8

Figure 14- Image showing the catalogue of marine cores that were curated and are located at OGS.

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DEMO

List of Expedition records

Expedition	Program Name
	ITINERIS OGS

ID	Expedition Code	Expedition Acronym	Expedition Name	Alternative Name of Expedition	Start of Expedition	End of Expedition	Chief Scientists	Contact Person	Funding Agencies	Additional Information	Country	Geological Age	Rock Classification	Objectives of the Expedition	Proposal Keywords	SampleRequest
5	205	ODP_205	Fluid Flow and Subduction Fluxes Across the Costa Rica Convergent Margin: Implications for the Seismogenic Zone and Subduction Factory	ODP Expedition 205 Costa Rica	2025-01-02	2025-03-27		5			Costa Rica	Neogene, Quaternary,Neogene	Sediment	Investigate the subduction zone costa rica		
6	SVAIS	SVAIS	SVAIS (IPY-Spain)		2007-07-29	2007-08-17		4		Ministerio de Educacion y Ciencia - Ano Polar Internacional	Norway	Quaternary	Sediment	The overall objective of SVAIS is to contribute to the understanding of the evolution of glacial continental margins and the relationships with the changes in ice sheet dynamics induced by climatic changes. The study is based on the acquisition of an integrate set of geophysical and stratigraphic data from one single sedimentary system in the northern Barents Sea, as well as on the analysis of existing stratigraphic data in the Arctic and in the North Atlantic.		
7	IRIDYA	IRIDYA	Integrated reconstruction of ice sheet dynamics during Late Quaternary Arctic climatic transitions	IRIDYA	2021-08-08	2021-09-14					Norway	Quaternary	Sediment	The project PRA-IRIDYA targets a multidisciplinary, integrated reconstruction of the climatic transitions occurred in the Arctic during the late Quaternary, aiming at collecting new information necessary to understand the complex interconnections and feedback mechanisms regulating the climate-ocean-cryosphere system.		
11	EGLACOM1	EGLACOM1	Evolution of a glacial artic continental margin: the southern Svalbard ice stream-dominated sedimentary system		2008-07-09	2008-08-04		25			Norway	Neogene	Sediment	The EGLACOM project is an Italian contribution to the International Polar Year (IPY). The main objective of EGLACOM is the geophysical and stratigraphic high-resolution study of an ice stream dominated marine depositional system of the Arctic margin in order to reconstruct the margin evolution locally from the Pliocene to the recent-most deglaciation, and to define the sedimentary architecture and seafloor morphology as it changed through time since the onset of glacial conditions. The target study area is the southern margin of Svalbard, and in particular the glacial sedimentary system fed by the ice stream once occupying the Storfjorden glacial trough in the northern Barents Sea. Additional objectives are: 1) Study of oceanographic processes connected to the Polar front and hydrologic characterization of Storfjorden dense water plumes. This objective will be pursued by mean of integrated seismic oceanography: identification of the acoustic interfaces in the water column along the multichannel seismic (MCS) reflection profiles and calibration with conventional oceanographic data: continuous thermosalinograph (TSG) and ADCP data, surface water sampling (spilled from TSG pipeline) along transit transect, XBT (during MCS acquisition), and deep water sampling carousel (WSC) of bottles, on which CTD and SVP (Sound Velocity Probe) were fastened 2) Study of the organic carbon utilization, degradation and transformation processes along the water column in order to estimate the efficiency of biological pumps in the sequestration and export of CO2; calibration of the biochemical composition of organic matter as paleoenvironmental proxy, by assessing biopolymers concentration in the sediment cores and its relationship with production/degradation processes. 3) Detailed analysis of sound velocity and of the variation of the wavelet shape along a MCS profile close to the area of the geophysical investigation carried out within the EU HYDRATECH project. 4) Geological characterization of fluid flow systems in the area (potential identification of seabed seepage, mud volcanoes, pockmarks, Bottom Simulating Reflectors connected to the presence of gas hydrates).		
12	EUROFLEETS2-B	BURSTER	Bottom Currents in a Stagnant Environment	EUROFLEETS2-BUSTER	2016-06-13	2016-06-23		24			Norway	Neogene	Sediment	BURSTER project aimed to investigate the hydrographic conditions and the possible gas seepage activity present in the inner part of the Kveithola glacial trough (South of Svalbard). Additionally, it aimed to study climate induced environmental changes controlling the evolution of living organisms in extreme environments. The cruise was conceived as a preliminary investigation on which results would be defined a major project to reveal the Kveithola bio-geochemical system. Specific oceanographic objectives are: 1) The study of water mass properties through hydrographical sections along key transects (synoptic CTD measurements over the area), and 2) the definition of water masses characteristics through bio-geochemical analyses of water samples. Specific geological, biological and environmental objectives are: 1) Definition of isotopic signature to assess the origin of the seeping fluids; 2) Characterization of natural seepage using geophysical and geochemical data; 3) To investigate the presence of authigenic carbonates and/or chemosynthetic communities on the seafloor (video + sampling); 4) The analyses of past and recent benthic foraminiferal communities and their resilience to oxygen depletion and methane emissions as potential indicators of variation in oxygen and carbon dioxide concentrations and hydrocarbon seeps; 5) Definition of temporal variation of the benthic foraminiferal assemblages (through sediment cores) and study of living benthic foraminifera in terms of density and biodiversity; 6) Evaluation of existing and future impacts of dysoxia on pelagic and benthic ecosystems by assessment of its biogeochemical, biological and ecological consequences in the Kveithola drift (seafloor sampling); 7) Calibration of geochemical and biological proxies applied to living benthic and planktonic foraminifera in order to assess the variation in oxygen concentration and hydrocarbon emission and their impact in the biomineralization mechanisms. Proxies will be useful to interpret the fossil redox conditions; 8) To investigate high resolution centennial sedimentary records of the spatial and temporal changes in the redox conditions of the water column using inorganic and organic proxies, biomarkers, and isotopic signatures; 9) To study of the palaeoclimatic systems (from previous studies in the area) and their possible relation to oxygen depletion.		
13	CAGE19	CAGE19	CAGE19- Giant Piston Core Expedition		2019-10-19	2019-11-09		27			Norway	Neogene	Sediment	CAGE 19-3 cruise with RV "Kronprins Haakon" to the Atlantic-Arctic gateway region is organized and funded through the Tromsø Forskningsstiftelse (TFS) and Research Council of Norway (RCN) supported SEAMSTRESS project and the Center of Excellence "CAGE – Centre for Arctic Gas Hydrate, Environment and Climate" at UiT-The Arctic University of Norway in Tromsø. SEAMSTRESS focuses on studies of the effect of tectonic stress on methane release at Arctic continental margins while CAGE studies the amount of methane hydrate and magnitude of methane release in Arctic Ocean environments on time scales from the Neogene to the present. CAGE 19-3 cruise is directed to the Atlantic-Arctic gateway region to provide necessary field data for these objectives. From previous cruises, we have identified key localities which will be main targets for this cruise.		
15	EUROFLEETS2-P	PREPARED	Present and past flow regime on contourite drifts west of Spitsbergen: Preliminary results from the EUROFLEETS2 PREPARED cruise	EUROFLEETS2-PREPARED	2014-06-05	2014-06-15		24			Norway	Quaternary	Sediment	The aim of the project PREPARED is to investigate and define the present and past oceanographic conditions around two contourite drifts located on the eastern side of the Fram Strait (Bellsund and Isfjorden sediment drifts) using a full range of measurement time scales, from instantaneous (CTD) and seasonal (moorings) oceanographic measurements, to the recent (Box corer) and geologic (Calypso core) past record. The project is therefore conceived under a multidisciplinary and interdisciplinary view in order to consider the interaction between various components of the Arctic system in this area. Our study area is regarded as a key zone for the reconstruction of the Arctic Ocean circulation, which in turn, plays a key role in the global thermohaline system.		
16	High North 17	High North 17	High North, Marina Militare Italiana		2017-07-09	2017-07-29					Norway	Quaternary	Sediment	The Italian Navy, with the help of oceanographic and hydrographic research platforms and instruments from the Navy Hydrographic Institute, aimed to improve the knowledge of developments in that marine environment in order to better guarantee safety and the free use of resources. In particular, the completion of the geophysical picture of that part of the ocean obtained with the data collected during the High North 2017 Campaign will provide useful information for assessment in many sectors, not least climate. All this will be achieved using state-of-the-art instruments, such as gliders, integrated into complex digital underwater communication networks for the coordination and control of all scientific instruments (Digital Underwater Networked Communications).		

Figure 15- Screenshot from mDIS showing the list of expeditions in which cores are stored at OGS. The table shows expedition details such as name and full name, rock classification, and objectives of the expedition.

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SVAIS (IPY-Spain)

Core / Section Summary

Expedition	Program Name	Site	Hole Code/Identifier	total drilled length	core recovery	Cores	Sections
SVAIS	ITINERIS OGS	1	A	30.71 m	30.71 m 100%	9	3

Core	On-Deck	Core Top Depth [m]	Core Bottom Depth [m]	Length Cored [m]	Length Recovered [m]	Core Recovered [%]	Section Number	Section Length [m]	Curated Length [m]	Top Depth [m]	Bottom Depth [m]	Section Remarks
1 - H	2007-08-04 10:00:00	0	2.77	2.77	2.77	100.00	3 Section/s					
							1	1	1	0	1	
							2	1	1	1	2	
							3	0.77	0.77	2	2.77	
1 - PC	2007-08-04 10:00:00	0	1.48	1.48	1.48	100.00	0 Section/s					
1 - PC	2007-08-04 10:00:00	0	0.4	0.4	0.4	100.00	0 Section/s					
1 - PC	2007-08-04 10:00:00	0	6.41	6.41	6.41	100.00	0 Section/s					
1 - PC	2007-08-04 10:00:00	0	1.01	1.01	1.01	100.00	0 Section/s					
1 -	2007-08-04 10:00:00	0	3.1	3.1	3.1	100.00	0 Section/s					
1 - TC	2007-08-04 10:00:00	0	1.66	1.66	1.66	100.00	0 Section/s					
1 - PC	2007-08-04 10:00:00	0	6.12	6.12	6.12	100.00	0 Section/s					
1 - GC	2007-08-04 10:00:00	0	1.76	1.76	1.76	100.00	0 Section/s					

Figure 16 - Core/Section summary (from a single Hole/Core), from oceanographic expedition SVAIS

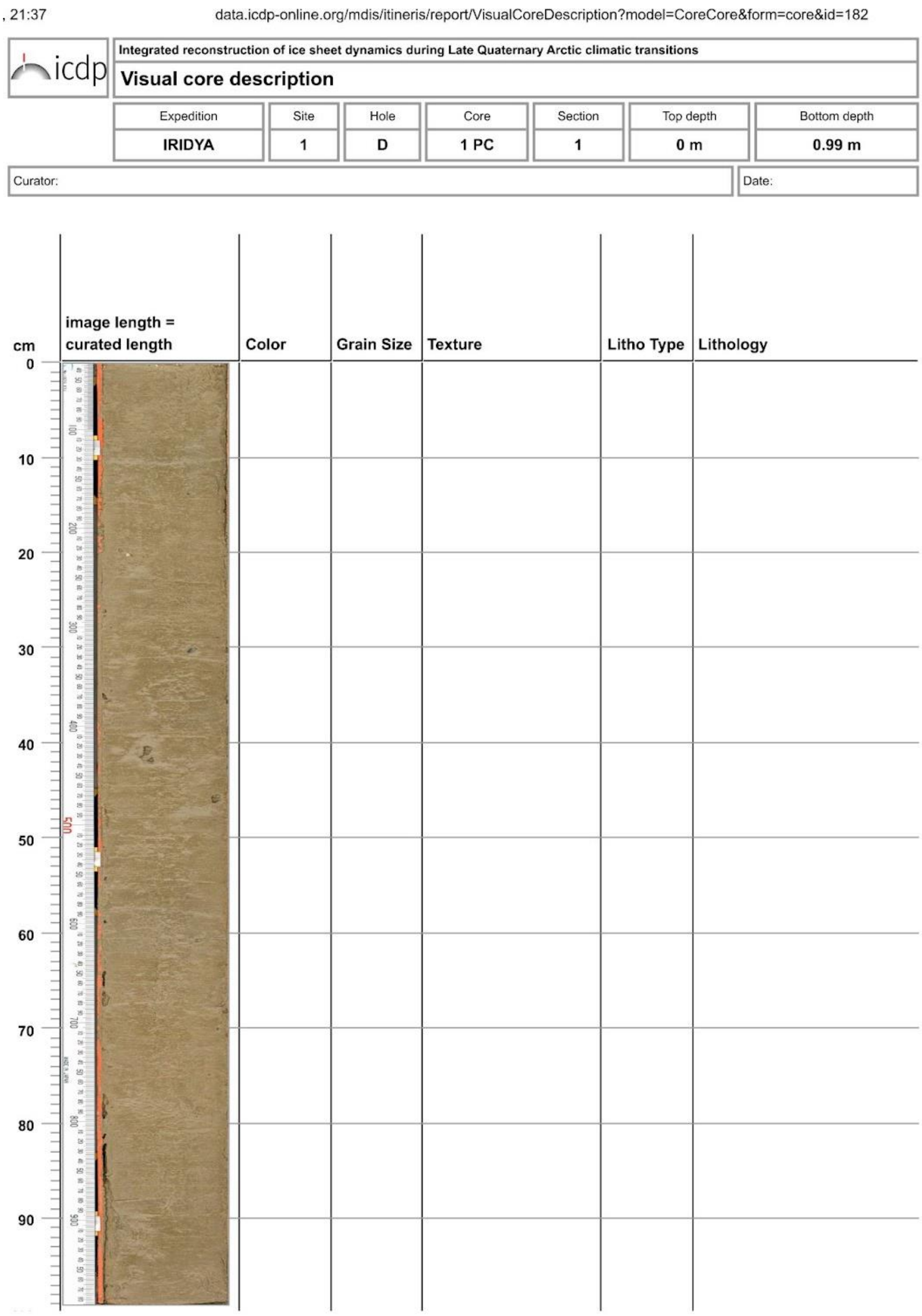


Figure 17 - Example of the export from Visual Core Description.

5.1.2. ISMAR-CNR (Istituto di Scienze Marine – Consiglio Nazionale delle Ricerche)

5.1.2.1. ISMAR-CNR Core Repository

The ISMAR-CNR Core Repository, managed by the Institute of Marine Sciences (ISMAR) of the Italian National Research Council (CNR), is one of Italy's principal facilities dedicated to the preservation, management, and scientific use of marine sediment cores. Located in Bologna and Naples, the repository houses more than 3000 cores, approximately 10000 meters of sediment, collected during decades of oceanographic expeditions across the Mediterranean Sea, Atlantic Ocean, and Arctic regions. The ISMAR-CNR Cores repository facility is a multifunctional lab operating continuously since 1968. In addition to the repository rooms (cold rooms, refrigerators and containers), there are several instruments for conducting and/or assisting with analyses of sea sediment cores, such as a core splitter, a magnetic susceptibility logger, X-radiograph, XRF scan, CT scan (coming soon), as well as a variety of microscopes, sieves, sampling tools and all traditional sediment lab supplies.

The digitalization of the ISMAR-CNR Cores Repository is still in progress. **Figure 18** shows the main components of the relational database developed for archiving the data and handling sample requests and creating subsample. The main component of the system is the table "CORE", containing information about location, source, sampling, coordinates and metadata of the sediment cores. Each core has a unique code name that is the key for relationships in the relational database. A sediment core consists of one or more sections that can be open or closed. As a procedure developed during the years, the sections are numbered onboard with ascending Roman numerals starting from the bottom, extracting one meter at a time from the corer's nose. Each section has two "sections halves", named "Archive" and "Working".

In addition to the relational database, there is also a file system in a NAS repository where all data related to the cores are stored. For each core, the archive contains scientific data and images, such as high-definition pictures, susceptibility data, X-ray images, XRF profiles, granulometric data. The sediment cores are also visualized in a digital map on the ISMAR-CNR Seamap Explorer and described with metadata accessible through the ISMAR-CNR Seamap Catalogue (https://www.ismar.cnr.it/cosa-facciamo/risorse-informative/geoportali-e-archivi-digitali/). Through the metadata catalogue, ISMAR-CNR is able to assign a DOI to the datasets and to generate a QR code for each core in the physical repository.

Digital archiving of ISMAR-CNR coring data in mDIS was assessed to be feasible but following certain adjustments to the default hierarchy of mDIS (**Figure 21**). The advantages of the new platform consist in the adaptation of a hierarchical data structure with more conventional names as well as the IGSN code release, and obviously the international exposure that mDIS will give to the repository.

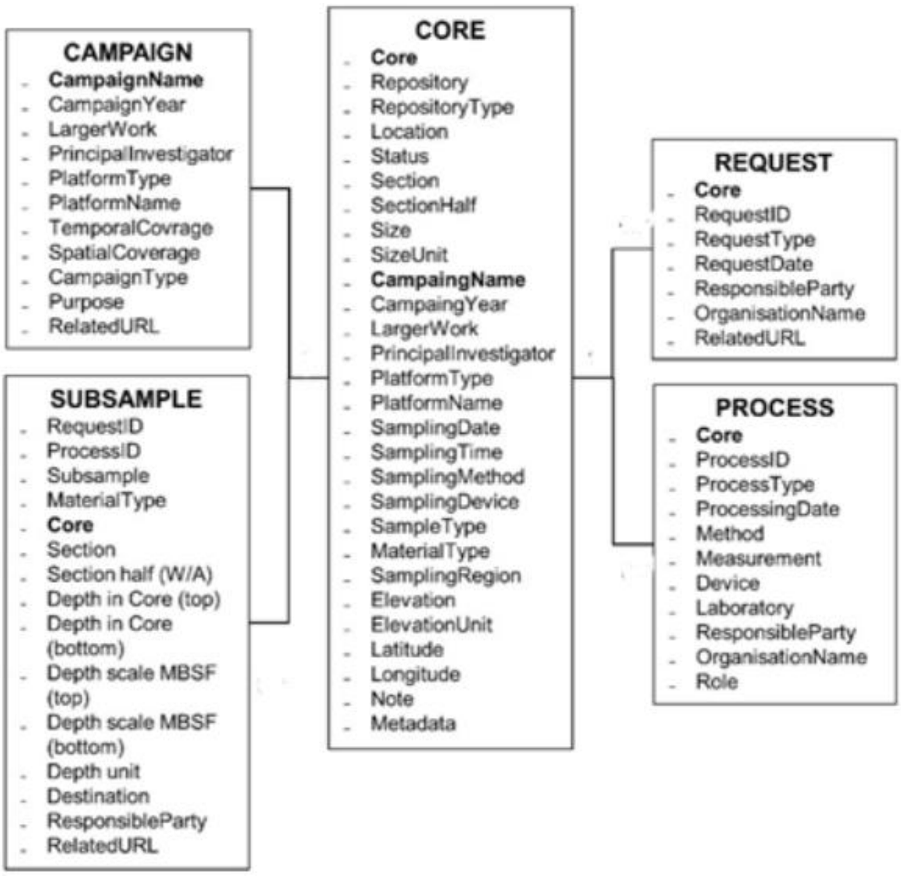


Figure 18 - Main components of the catalogue of marine sediment cores at ISMAR-CNR.

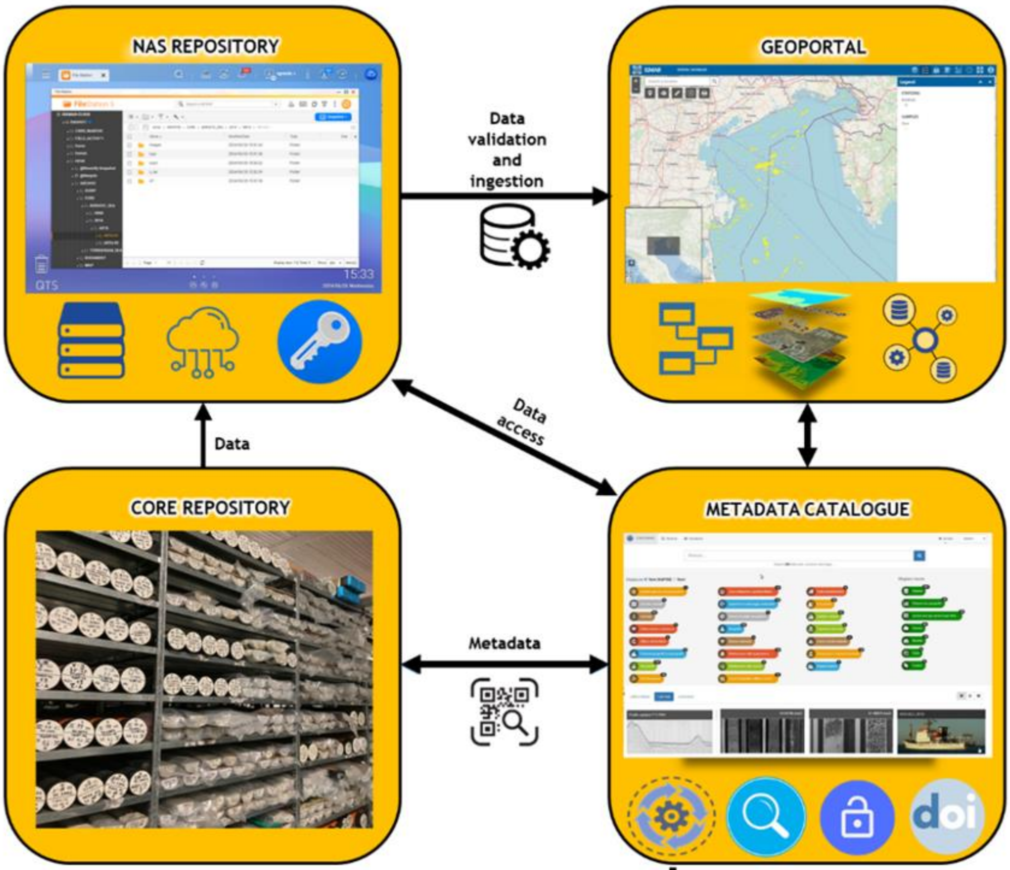


Figure 19 - ISMAR-CNR data infrastructure consisting of a core repository, a NAS repository, a geoportal, and a metadata catalogue.

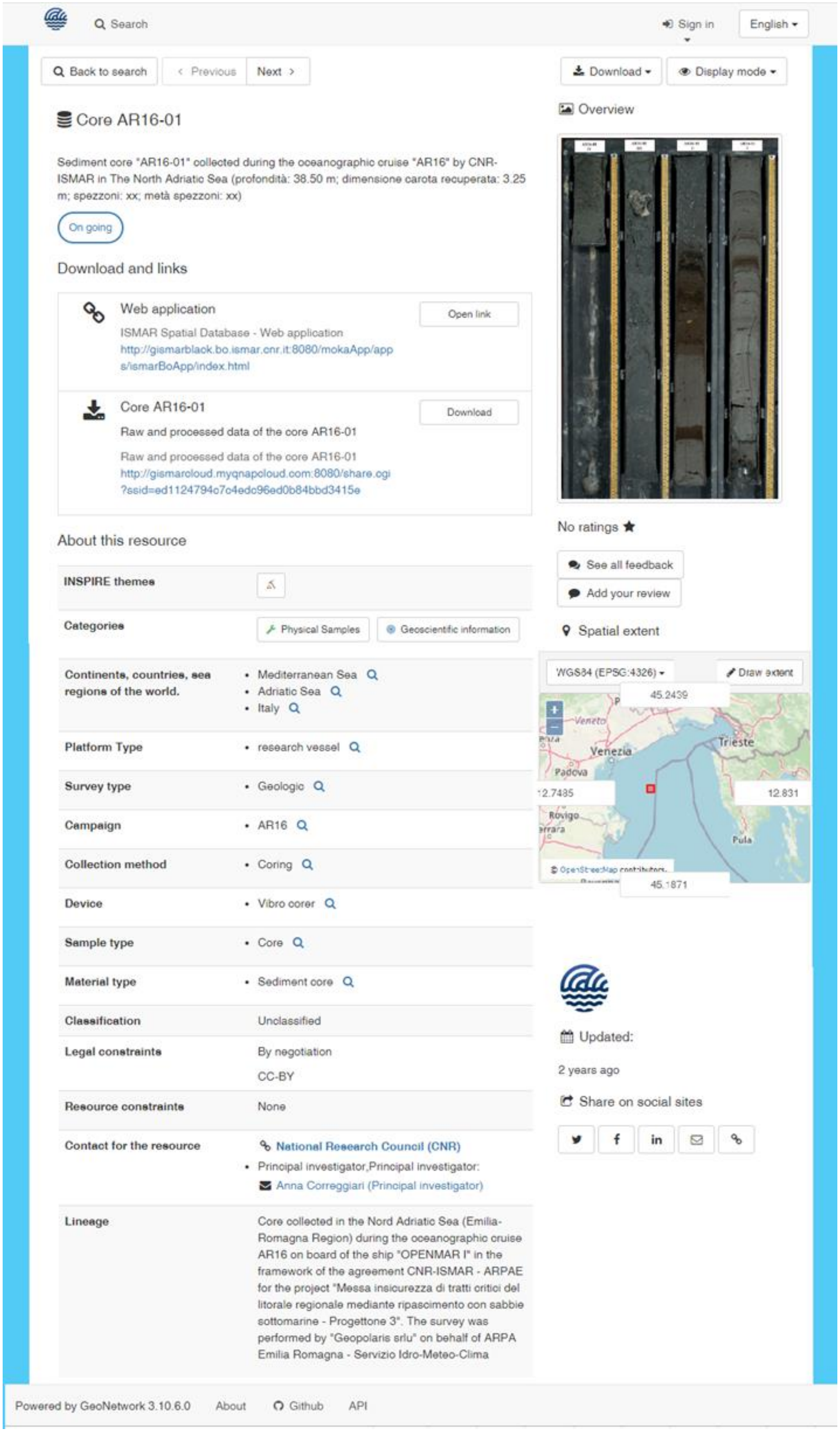


Figure 20 - Example of metadata form describing a core in the ISMAR-CNR Seamap Catalogue.

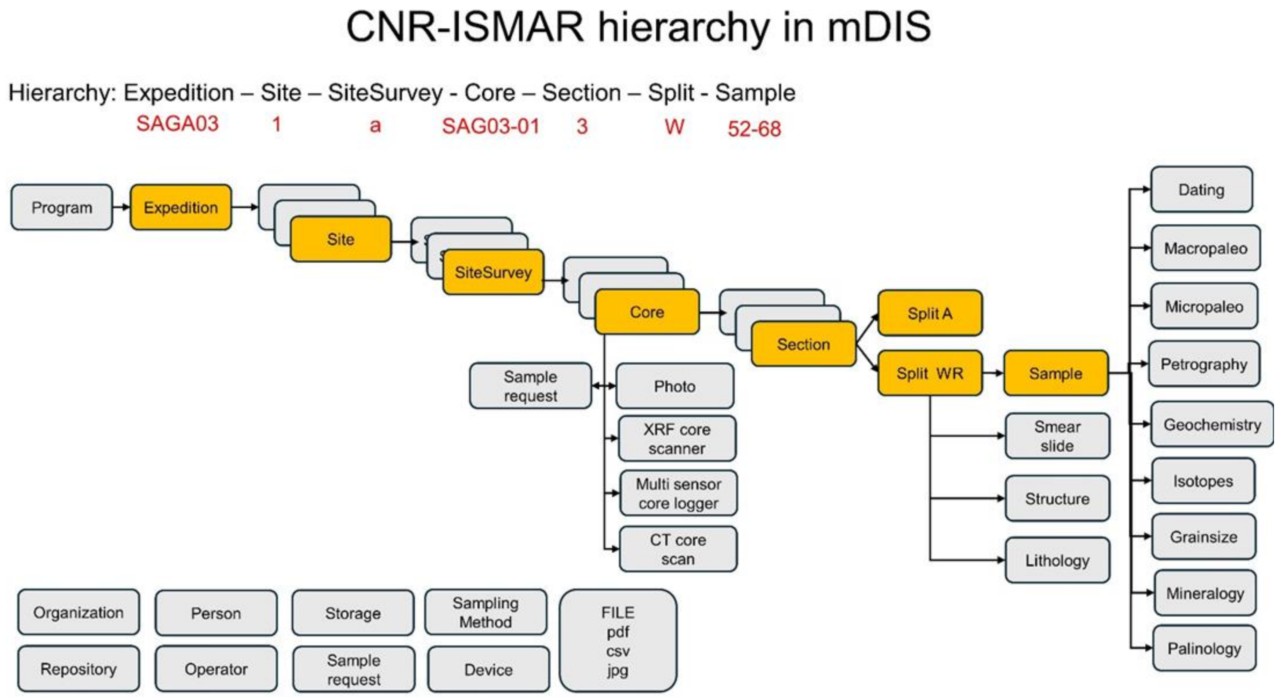


Figure 21 - Proposed mDIS hierarchy for the ISMAR-CNR Core Repository.

5.1.2.2. WP7.1 Activity (ISMAR-CNR, Bologna) and data representation in mDIS

Through the WP7.1 activity of ITINERIS, we developed an integrated approach to the collection and storage of large amounts of data generated from the multiproxy analysis of late Quaternary sedimentary cored successions. To this purpose, we focused on data from the Northern Adriatic shelf and adjacent coastal areas (**Figure 22**), which were entered into mDIS.

Project	Core	Core Type	Year	Depth	Total Length (cm)	N. of Sections
AGSS – CNR ISMAR (2020-25)	RER19-01	continous core	2020	0 m	3000	30
	RER19-02	continous core	2021	0 m	3000	30
	RER19-03	continous core	2022	0 m	3000	30
	RER19-04	continous core	2023	0 m	3000	30
	RER19-05	continous core	2024	0 m	3000	30
	RER96-C16	vibrocore	1996	6 m	315	3
	RER96-C17	vibrocore	1996	8,30 m	315	3
	RER96-C18	vibrocore	1996	7,60 m	306	3

Figure 22 - Catalogue of cores studied, as part of ISMAR-BO WP7.1 activity.

Analysis conducted on sediment cores include several types of non-destructive techniques that were carried out on the whole core profile: high-resolution photographs, stratigraphic log, XRF-CS analysis, and magnetic susceptibility.

High-resolution photographs: they were acquired when opening the cores, in order to maintain the original colors of the sediment (**Figure 23**).

Figure 23 - Example of high-resolution photograph: section 16-17 m of core RER19-02.

Stratigraphic log: stratigraphic logs from cored successions provide a wealth of stratigraphic information, including color, lithology, grain size, textural characteristics, and accessory components (organic matter, carbonate nodules, plant fragments, fossils, authigenic minerals, etc.) (**Figure 24**).

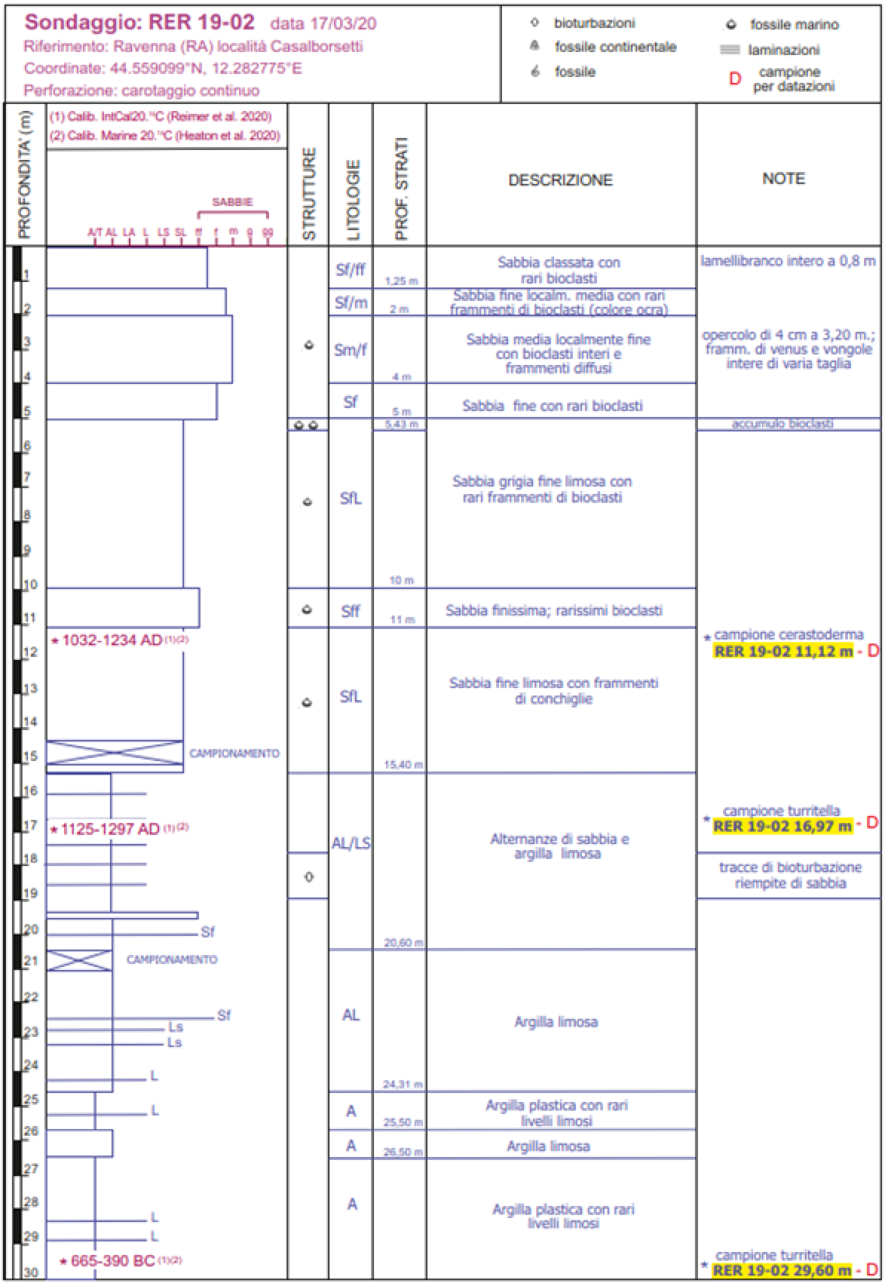


Figure 24 - Example of stratigraphic log (core RER19-02).

XRF core scanner analysis: the XRF core scanner is a fast and non-destructive technique that represents a very effective tool able to produce continuous geochemical profiles. Analysis resolution can vary from 10 mm to 0.1 mm. Chemical elements from Al to U can be measured obtaining around 50 elements for each step of analysis, which makes this technique capable of producing large amounts of data. As an example, **Figure 25** shows a part of the large XRF-CS core scanner dataset for core 19-02, representing a thin (50 cm) stratigraphic interval and only three variables.

RER19-02_AllKev Processed.xlsx - Excel

File | Home | Inserisci | Layout di pagina | Formule | Dati | Revisione | Visualizza | Guida

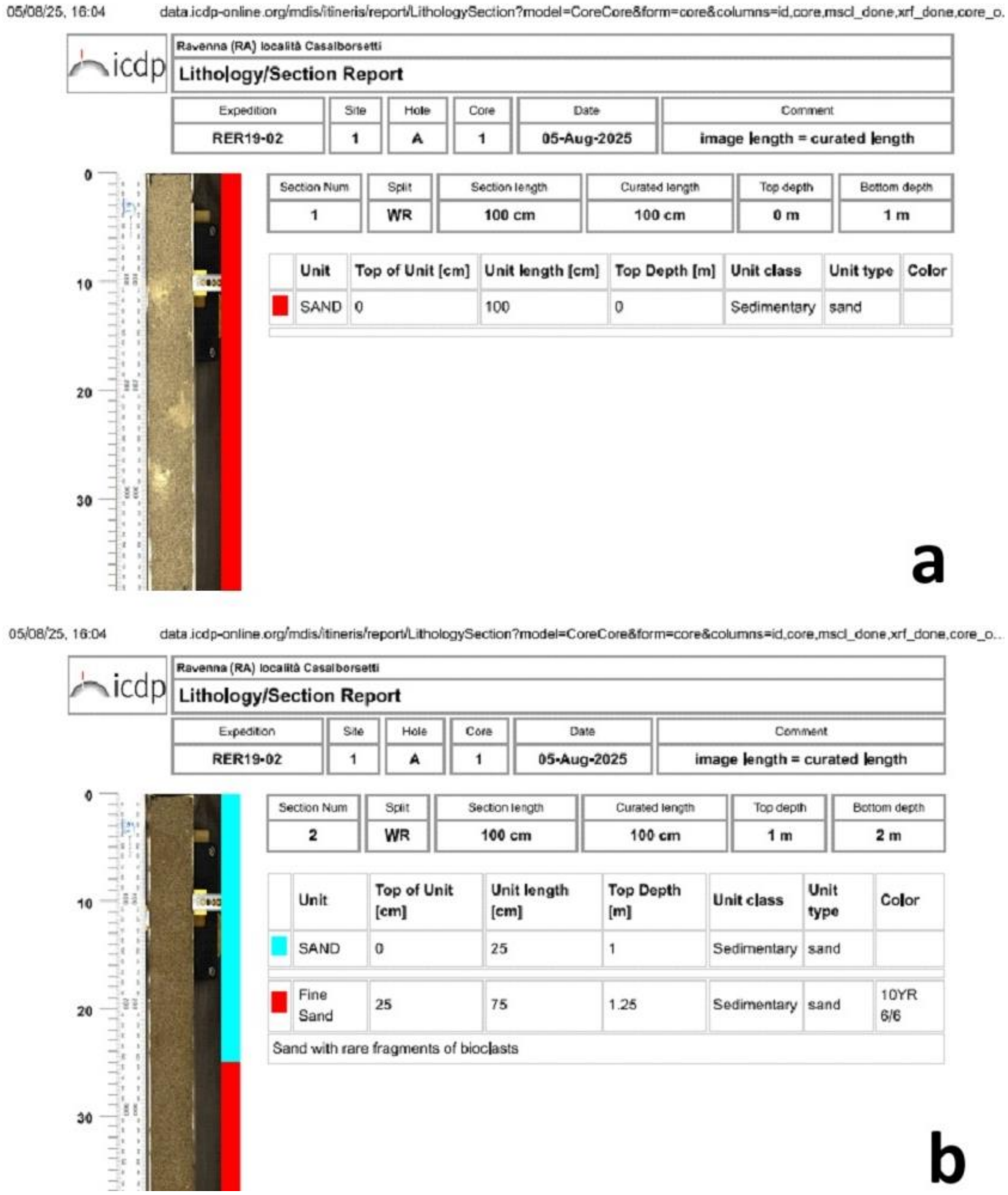
AA41 | 32,1

	A	B	C	E	G	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1	Spectrum	Cc	Se	RealDepth	TubeVolt	Mn-Ka Ar	Mn-Ka Ar	Mn-Ka cp	Mn-Ka cp	Fe-Ka Are	Fe-Ka Are	Fe-Ka cps	Fe-Ka cps	Ni-Ka Are	Ni-Ka Are	Ni-Ka cps	Ni-Ka cps
2	RER19-02_0-1	1	1	5,0	30	2939	65	293,9	6,5	99311	320	9931,07	31,97	415	39	41,5	3,9
3	RER19-02_0-1	1	1	14,9	30	3055	66	305,5	6,6	104570	328	10457	32,81	570	39	57	3,9
4	RER19-02_0-1	1	1	24,9	30	2698	62	269,8	6,2	92749	309	9274,92	30,9	356	36	35,6	3,6
5	RER19-02_0-1	1	1	35,0	30	3075	65	307,5	6,5	100754	322	10075,4	32,2	307	37	30,7	3,7
6	RER19-02_0-1	1	1	44,9	30	3229	67	322,9	6,7	98811	319	9881,13	31,88	320	36	32	3,6
7	RER19-02_0-1	1	1	54,9	30	3147	66	314,7	6,6	109710	336	10971	33,57	497	39	49,7	3,9
8	RER19-02_0-1	1	1	64,9	30	3261	67	326,1	6,7	107755	333	10775,5	33,29	434	40	43,4	4
9	RER19-02_0-1	1	1	74,9	30	3043	65	304,3	6,5	100572	322	10057,2	32,16	337	38	33,7	3,8
10	RER19-02_0-1	1	1	84,9	30	3034	66	303,4	6,6	105471	329	10547,1	32,95	358	37	35,8	3,7
11	RER19-02_0-1	1	1	94,9	30	3727	72	372,7	7,2	113196	341	11319,6	34,12	342	37	34,2	3,7
12	RER19-02_0-1	1	1	104,9	30	3895	72	389,5	7,2	119807	351	11980,7	35,1	391	38	39,1	3,8
13	RER19-02_0-1	1	1	114,9	30	3771	71	377,1	7,1	119229	350	11922,9	35	458	40	45,8	4
14	RER19-02_0-1	1	1	124,9	30	3245	68	324,5	6,8	100935	322	10093,5	32,24	322	38	32,2	3,8
15	RER19-02_0-1	1	1	135,0	30	2957	65	295,7	6,5	94187	312	9418,74	31,15	386	37	38,6	3,7
16	RER19-02_0-1	1	1	144,9	30	3009	65	300,9	6,5	96192	315	9619,19	31,48	345	37	34,5	3,7
17	RER19-02_0-1	1	1	154,9	30	3345	68	334,5	6,8	105936	330	10593,6	33,02	366	39	36,6	3,9
18	RER19-02_0-1	1	1	164,9	30	3338	67	333,8	6,7	100193	321	10019,3	32,11	390	38	39	3,8
19	RER19-02_0-1	1	1	174,9	30	2806	64	280,6	6,4	95207	313	9520,66	31,32	350	37	35	3,7
20	RER19-02_0-1	1	1	184,9	30	3242	68	324,2	6,8	105332	329	10533,2	32,93	398	38	39,8	3,8
21	RER19-02_0-1	1	1	194,9	30	3263	67	326,3	6,7	102596	325	10259,6	32,49	339	37	33,9	3,7
22	RER19-02_0-1	1	1	204,9	30	3242	67	324,2	6,7	100188	321	10018,8	32,12	305	37	30,5	3,7
23	RER19-02_0-1	1	1	214,9	30	3283	67	328,3	6,7	114297	343	11429,7	34,26	444	39	44,4	3,9
24	RER19-02_0-1	1	1	224,9	30	3773	72	377,3	7,2	118505	349	11850,5	34,89	322	38	32,2	3,8
25	RER19-02_0-1	1	1	235,0	30	2877	64	287,7	6,4	101567	323	10156,7	32,33	346	37	34,6	3,7
26	RER19-02_0-1	1	1	244,9	30	3060	65	306	6,5	90710	306	9070,96	30,57	372	36	37,2	3,6
27	RER19-02_0-1	1	1	254,9	30	2667	62	266,7	6,2	89269	303	8926,95	30,34	312	36	31,2	3,6
28	RER19-02_0-1	1	1	264,9	30	2947	64	294,7	6,4	100512	321	10051,2	32,15	314	37	31,4	3,7
29	RER19-02_0-1	1	1	274,9	30	3455	69	345,5	6,9	103033	326	10303,3	32,57	342	38	34,2	3,8
30	RER19-02_0-1	1	1	284,9	30	3595	70	359,5	7	106031	330	10603,1	33,04	352	37	35,2	3,7
31	RER19-02_0-1	1	1	294,9	30	3053	66	305,3	6,6	108009	333	10800,9	33,32	306	38	30,6	3,8
32	RER19-02_0-1	1	1	304,9	30	2974	65	297,4	6,5	106489	331	10649	33,08	331	38	33,1	3,8
33	RER19-02_0-1	1	1	314,9	30	3419	68	341,9	6,8	109523	336	10952,3	33,56	340	38	34	3,8
34	RER19-02_0-1	1	1	324,9	30	2915	64	291,5	6,4	107875	333	10787,5	33,31	343	39	34,3	3,9
35	RER19-02_0-1	1	1	335,0	30	3030	66	303	6,6	101227	323	10122,7	32,28	400	39	40	3,9
36	RER19-02_0-1	1	1	344,9	30	2758	63	275,8	6,3	95053	313	9505,3	31,29	435	37	43,5	3,7
37	RER19-02_0-1	1	1	354,9	30	2718	62	271,8	6,2	91992	308	9199,25	30,79	445	39	44,5	3,9
38	RER19-02_0-1	1	1	364,9	30	2822	63	282,2	6,3	93371	310	9337,11	31,03	470	39	47	3,9
39	RER19-02_0-1	1	1	374,9	30	2940	64	294	6,4	97800	317	9780,02	31,73	406	37	40,6	3,7
40	RER19-02_0-1	1	1	384,9	30	2861	64	286,1	6,4	105284	329	10528,4	32,9	399	38	39,9	3,8
41	RER19-02_0-1	1	1	394,9	30	3145	67	314,5	6,7	100045	321	10004,5	32,1	319	38	31,9	3,8
42	RER19-02_0-1	1	1	404,9	30	3218	66	321,8	6,6	110518	337	11051,8	33,71	295	37	29,5	3,7
43	RER19-02_0-1	1	1	414,9	30	3169	66	316,9	6,6	103261	326	10326,2	32,59	410	38	41	3,8
44	RER19-02_0-1	1	1	424,9	30	3226	67	322,6	6,7	102915	325	10291,5	32,55	432	38	43,2	3,8
45	RER19-02_0-1	1	1	435,0	30	3279	67	327,9	6,7	114462	343	11446,2	34,28	376	38	37,6	3,8
46	RER19-02_0-1	1	1	444,9	30	3140	66	314	6,6	94060	311	9406	31,11	341	36	34,1	3,6
47	RER19-02_0-1	1	1	454,9	30	2766	62	276,6	6,2	100353	321	10035,3	32,12	280	36	28	3,6
48	RER19-02_0-1	1	1	464,9	30	2672	62	267,2	6,2	91026	306	9102,56	30,62	447	38	44,7	3,8
49	RER19-02_0-1	1	1	474,9	30	2903	65	290,3	6,5	108907	335	10890,7	33,45	429	39	42,9	3,9
50	RER19-02_0-1	1	1	484,9	30	3076	65	307,6	6,5	105274	329	10527,4	32,93	376	39	37,6	3,9
51	RER19-02_0-1	1	1	494,9	30	3167	66	316,7	6,6	90353	305	9035,35	30,53	324	35	32,4	3,5
52	RER19-02_0-1	1	1	504,9	30	2643	61	264,3	6,1	85732	297	8573,25	29,72	401	38	40,1	3,8

Figure 25 - XRF-CS geochemical data referred to section 1 of core 19-02 from 0 to 0.5 m. Note that only three geochemical elements (Mn, Fe, Ni) are represented.

5.1.2.3. The use of mDIS for archiving data

We used the existing hierarchy in mDIS to insert data obtained through activity WP7.1. The aim was to examine the extent to which the mDIS system translates stratigraphic log data combined with images and descriptions. Core scanner XRF data have been intentionally excluded from this text. To this purpose, the multi-source dataset related to core RER19-02 was introduced into mDIS. Core 19-02 is 30 m long and consists of 30 sections, of 1 meter each (**Figure 22**). **Figures 26 a and b** show the exported data generated by mDIS through a Lithology/Section Report and designed for each section of the core. As an example, only the uppermost 2 meters of the core are shown: sections 1 and 2. The form clearly shows metadata with expedition, core references, section length, number, etc. Lithological data appears as "units" and the system automatically assigns a red color to section 1, which is composed solely of sand (**Figure 26a**).



05/08/25, 16:04 data.icdp-online.org/mdis/itineris/report/LithologySection?model=CoreCore&form=core&columns=id,core,mscl_done,xrf_done,core_o.

icdp

Ravenna (RA) località Casalborsetti

Lithology/Section Report

Expedition	Site	Hole	Core	Date	Comment
RER19-02	1	A	1	05-Aug-2025	image length = curated length

Section Num	Split	Section length	Curated length	Top depth	Bottom depth
1	WR	100 cm	100 cm	0 m	1 m

	Unit	Top of Unit [cm]	Unit length [cm]	Top Depth [m]	Unit class	Unit type	Color
	SAND	0	100	0	Sedimentary	sand	

0 10 20 30

a

05/08/25, 16:04 data.icdp-online.org/mdis/itineris/report/LithologySection?model=CoreCore&form=core&columns=id,core,mscl_done,xrf_done,core_o...

icdp

Ravenna (RA) località Casalborsetti

Lithology/Section Report

Expedition	Site	Hole	Core	Date	Comment
RER19-02	1	A	1	05-Aug-2025	image length = curated length

Section Num	Split	Section length	Curated length	Top depth	Bottom depth
2	WR	100 cm	100 cm	1 m	2 m

	Unit	Top of Unit [cm]	Unit length [cm]	Top Depth [m]	Unit class	Unit type	Color
	SAND	0	25	1	Sedimentary	sand	
	Fine Sand	25	75	1.25	Sedimentary	sand	10YR 6/6

Sand with rare fragments of bioclasts

0 10 20 30

b

Figure 26 a and b -Screenshot from the pdf generated by mDIS from data of the core RER19-02.

Concerning section 2B, although a lithological change from sand to fine sand is observed at 0.25 m from the top of the section, the system automatically assigns a blue color to the upper (sandy) part of the core and a red color to the lower portion, which is represented, instead, by fine sand. Entering the data from the whole log, which includes many lithologies, it was observed that the system is only able to assign two colors (blue and red). The way colors are assigned to the whole section shows that red is given to the single section, which exhibits no lithologic variations, whereas blue is given to the upper part of the section that has a variation, regardless of its lithology. As a result, stratigraphic descriptions, including simple lithologic distinctions from vertically stacked layers, cannot be readily shown in terms of colors or symbols. This is an important aspect that should be considered for the stratigraphic description of cores.

A second test to implement mDIS in the activity of WP 7.1 was done checking how to handle chemical and isotopic data performed on subsamples (i.e., on volumes of few cm^3). It was evaluated the possibility to implement the obtained data inside mDIS in order to allow filtering for specific geochemical parameters. However, the large variety of geochemical data and the different analytical methods used are not suitable for being implemented in the system because an unrealistic amount of work would be required to set up the numerous fields and especially inserting each individual data. Moreover, filtering geochemical data is done in an easier way by using a common spreadsheet.

In order to implement geochemical data of sub samples on mDIS the best identified solution was to attach the geochemical data as tables (e.g., CSV, XLS) into a specific level of the hierarchy of mDIS. For example, in the proposed mDIS hierarchy for the ISMAR-CNR Core Repository, the table would be stored under "SiteSurvey" (see **Figure 27**).

User	Label user	IGSN	Core	Sect.	Sample Top [cm]	Sample Length [cm]	Sample description (opt)	Sample prep.	Analyzed material	Li	Be	P	S	K	Sc	Ti
										ICP-MS K μg/g	ICP-MS K μg/g	ICP-MS K μg/g	ICP-MS K μg/g	ICP-MS K μg/g	ICP-MS K μg/g	ICP-MS K μg/g
XyZ	'8_1	ITIN....	3	2	81	6		powder	bulk	0.08	0.03	9.1	2470	62.0	2.06	12.5
XyZ	'8_2	ITIN....	3	2	119	3		powder	bulk	0.02	0.01	1.0	585	20.2	1.36	2.2
XyZ	'8_3	ITIN....	5	2	130	7		powder	bulk	0.08	0.03	7.9	1087	107.5	2.53	141.6
XyZ	'8_4	ITIN....	13	1	42	3		powder	bulk	0.69	0.05	23.4	246	52.5	5.25	121.6
XyZ	'8_5	ITIN....	13	1	56	4		powder	bulk	0.04	0.01	4.1	1230	25.3	3.07	35.9
XyZ	'8_6	ITIN....	13	1	60	4		powder	bulk	0.04	0.02	20.6	394	40.3	3.42	55.8
XyZ	'8_7	ITIN....	13	1	64	4		powder	bulk	1.74	0.15	21.3	233	140.1	3.97	52.0
XyZ	'8_8	ITIN....	13	1	71	4		powder	bulk	1.20	0.11	42.0	421	67.3	4.53	148.3
XyZ	'8_9	ITIN....	13	1	77	4		powder	bulk	5.71	0.13	60.0	215	373.0	5.19	290.5
XyZ	'8_10	ITIN....	13	1	81	4		thin section	serpentine	1.20	0.37	16.7	4965	76.7	6.02	90.9
XyZ	'8_11	ITIN....	13	1	113	3		mineral separate	talc	0.10	0.21	3.8	877	75.4	5.20	120.4

Figure 27- Table reporting some example geochemical data. This table would be stored under "SiteSurvey" of the proposed mDIS version for CNR-ISMAR.

VI. DISCUSSION

6.1 Pros and cons using mDIS for scientific drilling data vs marine coring

Data produced by scientific drilling from IODP/IODP[3] and their precursors present the same hierarchy currently used by ICDP and consequently hierarchy adopted by mDIS is appropriate. This hierarchy is the following: Program - Expedition - Site - Hole - Core - Section - Split (**Figure 1**). For this reason, archiving data and metadata coming from scientific ocean drilling does not require major changes in mDIS. A few adjustments need to be made to fully implement mDIS for IODP data for and in the future by IODP[3]. One difference is, for example, mDIS labels the Sites with numbers (e.g., 1, 2, 3) and IODP labels their site with a letter followed by the four-digit number. The letter before the four numbers represents the vessel used (e.g., U for Joides Resolution). In case future IODP[3] expeditions will use mDIS, this adjustment needs to be solved in mDIS.

The mDIS is not only a useful tool for recording legacy data but also a valuable alternative to replace, or at least complement, the data traditionally recorded on paper worksheets during drilling (e.g., **Figure 4**). Although paper worksheets provide a quick way to document core descriptions during an expedition, they often contain illegible handwriting that can be difficult or even impossible to interpret. Another common issue with handwritten descriptions is the lack of standardized terminology to describe features such as rock type, color, texture, grain size, and structure. To ensure accessibility, descriptions should follow international standards so that they can be properly understood and reused by other researchers. In some cases, core describers also forget to specify which core, section, or split is being described, which makes the data unusable since its depth cannot be identified. Such problems may render otherwise valuable information inaccessible or lost. In this sense, using mDIS during expeditions as a complement to paper worksheets helps ensure that at least a sufficient amount of standardized information is recorded and correctly linked to the core hierarchy and the expedition

Regarding marine and land coring data, the use of mDIS to record legacy data and metadata outlined the problem of lack of standardization of hierarchy used in cores acquired/stored in Italy. This lack of rules in how cores are named and labeled makes it a challenge to insert data from a core that fits into the current hierarchy adopted by mDIS. To clarify the issue, in some oceanographic expeditions sites are described as holes, and core sections are understood as different cores. We suggest that a standardization should be done: either using the same hierarchy already used for ICDP/IODP or defining a more suitable hierarchy specific to this kind of data and adapting it to mDIS. Having the metadata for a planned expedition to acquire cores would help scientists to keep track of the hierarchy they should follow in order to name their cores/sections. This would be essential for marine and land cores to adopt the ISGN.

Disadvantages of using mDIS, especially for recording legacy data, is that the system requires larger amounts of time to insert data, particularly when compared to data recording in Excel. The ideal situation would be before an expedition all the metadata with the planned Sites/Holes to be previously recorded there, saving time during an expedition, entering just the data/description and not all the parent data related. In ITINERIS we tested mDIS, created a dedicated structural model (**Figures 8 - 10**), and inserted example data to test how it works. However, we did not record all the samples because it would require many more people dedicated to doing only that. In addition, as we have been advised by the team from GFZ from Potsdam, to maintain an mDIS for Itineris - Italy, it is necessary to hire someone with expertise in **Backend Development** to be fully dedicated to working with it**.** A professional hired with that expertise would meet the necessities for data curated/acquired in Italy and maintain the system.

In conclusion, although not all the samples curated/cataloged and archived by ITINERIS were stored in mDIS, it brought to light important questions in data management that must be addressed in order to keep data FAIR. Furthermore, ITINERIS provided models in mDIS that are ready to be implemented on further expeditions/campaigns (e.g., structural model). The mDIS has the potential to be a single system used in Italy to record both legacy and new data from scientific drilling/coring.

VII. OUTLOOK

mDIS would be an ideal tool for marine and core repositories in Italy promoting a central system where metadata (and also data, when possible) would be findable and accessible to scientific community and stakeholders. If ITINERIS continued, it would be possible to define a standard hierarchy for marine and land cores acquired in Italy and/ or stored in Italian repositories. The central system would allow researchers to request samples easily and have the information from where the cores/samples are stored.

Regarding mDIS use to derive data/metadata from scientific drilling data such as petrology and structural data, the use of mDIS can be exported to future programs of international drilling. The adaptations of the system towards the current hierarchy used for IODP for example, would be minimal.

Nonetheless, if **ITINERIS** continued and decided to centralize the information on a dedicated ITINERIS-mDIS, the backend adaptations of the system and its maintenance would require a dedicated team.

VIII. CONCLUSIONS

The activity in WP 7.1, 7.2, and 7.3 of ITINERIS project permitted the curation, categorization and archiving into digital environments of thousands of samples, including physical samples and core descriptions, measurements and their derived calculations, obtained in Italian laboratories (public research institutions and universities) through research performed with scientific drilling and marine coring. Such samples and data were, for some reason,not in compliance with the FAIR principles.

Regarding scientific drilling (e.g., ODP, IODP), ITINERIS permitted curation, archivation and standardization of vintage data from structural geology, borehole measurements, micropaleontology, lithology, petrography, petrology and geochemistry.

Regarding marine and land core data acquired in Italy or stored in Italian core repositories, ITINERIS brought to light the necessity of creating standard guidelines for labeling holes, cores, and sections and using a common digital archiving system. The lack of standard hierarchy, such as the one used for IODP and ICDP, and the lack of assignment of the International Generic Sample Numbers (IGSNs) to request and locate a core, section, a split, or a sample, are the main problems related to an integrated digital archiving of marine core data in Italy.

The system proposed for such integrated archiving of both scientific drilling and marine core data is the mDIS, developed within the ICDP and now adopted by ECORD. The close work with the developers of mDIS at GFZ Potsdam, who also provided an ITINERIS Course, allowed all the participants to understand the principles and familiarize themselves with the software, proposing an original hierarchy for marine and land cores, and filing sample data sets. The tests indicate that the system may be used for legacy data and for data that will be acquired in future drilling/coring expeditions.

All the data that was transferred to digital form within ITINIERIS now has the potential to be reused for scientific research.

The legacy of ITINERS with respect to scientific drilling and marine/land cores should be an effort of the owners of marine coring, land coring, and shallow drilling to coordinate the common approach to FAIR data, establishing centralized core repositories and identifying key personnel to become data managers for the scientific community.

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