

DOE/ID-22265

Prepared in cooperation with the U.S. Department of Energy

Standardized Method for Logging Drill Core at the Idaho National Laboratory, Idaho

Chapter 1 of
Section E. Lithologic Analysis
Book 5. Laboratory Analysis

Techniques and Methods 5-E1

U.S. Department of the Interior
U.S. Geological Survey



Cover. Overhead view of a row of drill core boxes. Photograph by Caden Anderson, U.S. Geological Survey

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By Haley M. Dietz

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**U.S. Department of the Interior
U.S. Geological Survey**

U.S. Geological Survey, Reston, Virginia: 2026

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Suggested citation:

Dietz, H., 2026, Standardized method for logging drill core at the Idaho National Laboratory, Idaho: U.S. Geological Survey Techniques and Methods, book 5, chapter E1, 54 p., <https://doi.org/10.3133/tm5E1>.

ISSN 2328-7055 (online)

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
mile, nautical (nmi)	1.852	kilometer (km)
yard (yd)	0.9144	meter (m)
Area		
square foot (ft ²)	929.0	square centimeter (cm ²)
square foot (ft ²)	0.09290	square meter (m ²)
square inch (in ²)	6.452	square centimeter (cm ²)
section (640 acres or 1 square mile)	259.0	square hectometer (hm ²)
square mile (mi ²)	259.0	hectare (ha)
square mile (mi ²)	2.590	square kilometer (km ²)
Mass		
pound, avoirdupois (lb)	0.4536	kilogram (kg)

International System of Units to U.S. customary units

Multiply	By	To obtain
Length		
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)

Datums

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations

BLS	below land surface
CSL	Core Storage Library
DOE	U.S. Department of Energy
HCl	hydrochloric acid
INL	Idaho National Laboratory
INLPO	Idaho National Laboratory Project Office
NRF	Naval Reactors Facility
USGS	U.S. Geological Survey

Standardized Method for Logging Drill Core at the Idaho National Laboratory, Idaho

By Haley M. Dietz

Abstract

The U.S. Geological Survey's (USGS) Lithologic Core Storage Library (CSL) at the Idaho National Laboratory stores more than 120,000 feet of drill core that is accessible to the public for research and sampling. To effectively convey the physical and descriptive properties of the drill core, USGS staff at the Idaho National Laboratory Project Office log the drill core and publish the lithologic logs as data releases. The logs provide essential data on the lithology, texture, mineralogy, alteration, and other physical properties of the core, which serve as valuable information for researchers to guide their research and sampling efforts. To ensure consistent, quality, and dependable lithologic logs, this document outlines the procedures and expectations for logging drill core at the CSL. This document describes the processes for storing, photographing, and logging core, and includes a variety of resources, reference materials, and appendixes designed to standardize and aid the logging process. Following the procedures outlined in this document will produce consistent, detailed logs that facilitate dependable observations and serve as an easy reference for researchers and other interested parties.

Plain Language Summary

The U.S. Geological Survey (USGS) manages the Lithologic Core Storage Library (CSL) at Idaho National Laboratory in southeastern Idaho. The CSL stores drill core, which are long cylinders of rock that have been removed from the subsurface of the Earth through drilling. USGS staff describe these drill cores in detail to create lithologic logs, which record features of the drill core like rock type, mineralogy, and appearance. This report explains how to describe drill cores at the CSL so that the lithologic logs are consistent and dependable. The report also includes helpful tools and resources like charts and dictionaries. Following the steps outlined in this report ensures that researchers have detailed and reliable information about the subsurface geology of southeastern Idaho.

Introduction

The Idaho National Laboratory (INL) operated by the U.S. Department of Energy (DOE) encompasses about 890 square miles (mi²) of the eastern Snake River Plain in southeastern Idaho (fig. 1). The INL was originally established as the National Reactor Testing Station by the U.S. Atomic Energy Commission (now the DOE) in 1949 to develop atomic energy and to conduct nuclear safety and defense program research. In the modern day, the INL focuses on developing advanced energy concepts and energy solutions to ensure the future security of the Nation's energy resources and technologies.

Throughout developing these energy concepts, the INL has generated wastewaters contaminated with chemical and radioactive constituents. The INL has disposed of wastewater contaminated with radioactive and chemical constituents in injection wells, infiltration ponds, and trenches. Infiltration of the wastewater into the subsurface and its potential migration to the underlying Snake River Plain aquifer has encouraged ongoing subsurface stratigraphy and hydrology studies of the eastern Snake River Plain at and near the INL. Data collection on the geologic, hydrologic, paleomagnetic, geophysical, and geochemical properties of the subsurface supports conceptual and numerical models used in predicting potential groundwater migration and contaminant transport pathways (Anderson and Lewis, 1989; Anderson, 1991; Anderson and Bartholomay, 1995; Anderson and Bowers, 1995; Anderson, Ackerman, and others, 1996; Anderson, Liszewski, and Ackerman, 1996; Anderson and Liszewski, 1997; Ackerman and others, 2006, 2010).

Material for data collection on subsurface lithologies is provided by drill core, a vital resource that supplies abundant material for sampling eastern Snake River Plain rocks. Since the 1950s, more than 500 test holes, auger holes, and coreholes have been drilled to characterize the subsurface geology and hydrology of the eastern Snake River Plain at and around the INL (Hodges and others, 2018). The material from these coreholes, defined herein as drill core, directly archive subsurface stratigraphy and provide abundant igneous and sedimentary layers for sampling and geologic data collection. However, for researchers to conduct data collection, the drill core must be consolidated, stored, cataloged, and accessible.

In 1990, the INL Lithologic Core Storage Library (CSL) was established to consolidate, store, and catalog non-radioactive drill cores and cuttings from eastern Snake River Plain and nearby coreholes (Hodges and others, 2018). Before 1990, many drill cores were lost, disposed of, or exposed to the elements, which led to the loss of important contextual and technical information needed for detailed geologic studies. As of 2018, the CSL contains over 120,000 feet (ft) of drill core sourced primarily from the eastern Snake River Plain. The stored drill core provides a valuable resource for conducting various subsurface geologic studies. However, for the drill core to be used fully, the available drill core and their lithologies must be known, documented, and described. Lithologic core logs present a way to describe and visualize features of the drill core, which communicates what material is available for sampling and guides sample collection.

To support USGS personnel and other researchers in their research efforts, the USGS Idaho National Laboratory Project Office (INLPO) logs drill core stored in the CSL and publishes these lithologic core logs (table 1; fig. 1). A core log consists of a series of observations of a stratigraphic column of core, ensuring comprehensive descriptions while minimizing interpretations. While the observations a logger records depend on lithology and the purpose for logging, most core logs often include observations on lithology, color, texture, mineralogy, and alteration. The observations recorded in a core log provide important lithologic context for researchers interested in conducting geochemical, paleomagnetic, subsurface, and other geological analyses. To effectively record and communicate important lithologic, textural, and mineralogical observations, the procedures for logging drill core must be defined and standardized. Therefore, the purposes of this report are to define the components of a lithologic core log produced by INLPO personnel and interns, describe the procedures for logging drill core, and attach supporting reference materials to aid the logging process.

Purpose and Scope

The CSL continuously receives and stores drill core from ongoing INLPO drilling projects. To describe the subsurface stratigraphy of the eastern Snake River Plain and material available for sampling, CSL personnel log the drill cores. Because multiple individuals log various drill cores, following a standardized logging procedure ensures consistent and quality data collection. The purpose of this document is to outline the standard procedures for creating a lithologic core log, which includes photographing and logging the drill core. Recognizing that a single system may not be applicable to all circumstances, this report documents the required details in a log, the procedures to follow when logging, and includes appendixes and references to ensure consistent naming, recognizing, and defining schemes across different individuals and drill cores. Following the procedures outlined in this report will generate

lithologic core logs with consistent and reliable observations, which facilitates quick reference, effective communication, and easy comparison across different drill cores.

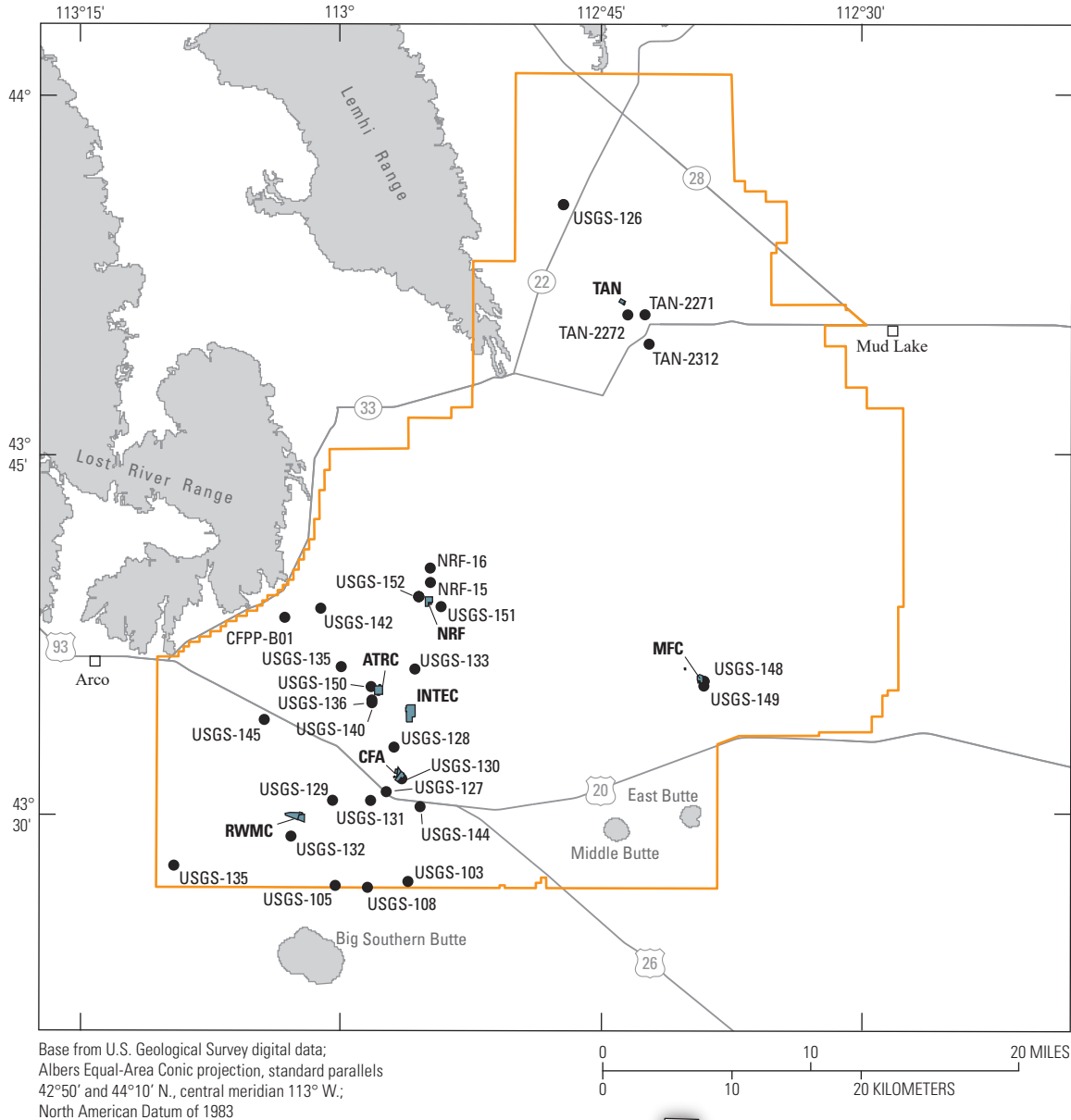
Geologic Background

The Idaho National Laboratory (INL) resides on the eastern Snake River Plain, which is an east-northeast trending topographic depression that extends from Twin Falls to Ashton, Idaho (Leeman, 1982). The eastern Snake River Plain developed as the North American tectonic plate migrated southwestward over a fixed, upper mantle melting anomaly beginning around 17 million years ago (Pierce and Morgan, 1992; Pierce and others, 2002; Morgan and McIntosh, 2005). This melting anomaly is often referred to as the Yellowstone hotspot. The track of the North American plate over the Yellowstone hotspot produced a time-transgressive series of silica-rich volcanic fields that young from west to east (Braile and others, 1982; Anders and Sleep, 1992; Peng and Humphries, 1998; Rodgers and others, 2002; Shervais and others, 2006). In the wake of the Yellowstone hotspot, the track subsided and created the arcuate depression in southern Idaho known as the Snake River Plain (Braile and others, 1982; Anders and Sleep, 1992; McQuarrie and Rodgers, 1998; Rodgers and others, 2002). In the eastern Snake River Plain, the subsidence created accommodation space for a 1–2-kilometer-thick package of plains-style basaltic lava flows interbedded with eolian, fluvial, and alluvial sediments (Greeley, 1982; Kuntz and others, 1992; Peng and Humphreys, 1998; Hughes and others, 2002; Potter and others, 2019).

Volcanism on the eastern Snake River Plain is representative of plains-style volcanism (Greeley, 1982). Plains-style volcanism is characterized by fissure eruptions from shield volcanoes that produce voluminous tube-fed pahoehoe flows. Shield volcanoes produce individual lava flows that range from <1–40 meters (m) thick, extend as far as 40 kilometers (km) away from the source vent, and cover an area as much as 155 square meters (m²) (Kuntz and others, 1992).

Most of the basalt flows on the eastern Snake River Plain classify as olivine tholeiites and are petrographically and geochemically similar to each other (Leeman, 1982). Eastern Snake River Plain olivine tholeiites contain olivine, plagioclase, clinopyroxene, ilmenite, magnetite, glass, and accessory apatite. Rocks of more evolved compositions are also found in the eastern Snake River Plain, such as at Craters of the Moon, Cedar Butte, and the Spencer-High Point area (Kuntz and others, 1992).

Lithologies present in drill cores stored at the CSL include unconsolidated sediment, consolidated sediment, basalt, and intermediate to felsic igneous rocks such as rhyolite. While the most common lithology is basalt, individual basalt flows are often interbedded with sediment and rhyolite is expected in deep (>1000 feet) drilling projects. Any person logging core at the CSL should expect to encounter any of these lithologies. The following sections describe how to recognize, name, and describe basalt, rhyolite, and sediment in CSL cores.



EXPLANATION




	Selected facility at Idaho National Laboratory
ATRC	Advanced Test Reactor Complex
CFA	Central Facilities Area
INTEC	Idaho Nuclear Technology and Engineering Center
MFC	Materials and Fuel Complex
NRF	Naval Reactors Facility
RWMC	Radioactive Waste Management Complex
TAN	Test Area North
	Boundary of Idaho National Laboratory
	Corehole location and name
USGS-131	



Figure 1. Map showing location of selected coreholes, with available data, and selected facilities at the Idaho National Laboratory (INL), Idaho.

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Table 1. Corehole locations, identifiers, and lithologic core log information for cores logged following USGS Idaho National Laboratory Project Office protocol and stored at the Lithologic Core Storage Library.

[“Borehole name” column lists the common identifier used in this study. “Site number” column displays unique numerical identifier used to access borehole data (U.S. Geological Survey [USGS], 2024). Latitude and longitude are taken at brass survey marker located adjacent to the borehole head on a cement pad and are in decimal degrees. “Land-surface altitude” is in feet above the North American Vertical Datum of 1988 (NAD 88). “Total depth” is depth in feet below land surface of the borehole and corresponds to the stratigraphic thickness of the core. “Reference of published lithologic core log” column lists the publication containing the lithologic core log for that borehole.]

Borehole name	Site number	North latitude	West longitude	Land-surface altitude	Total Depth (feet)	Reference of published lithologic core log
CFPP-B01	433814113031801	43.637233	113.055125	5,094.00	1,338	(Dietz, 2025)
NRF-15	433942112545001	43.661622	112.914886	4,845.37	759	(Hodges and others, 2012)
NRF-16	434018112545101	43.671650	112.915108	4,831.05	425	(Hodges and others, 2012)
TAN-2271	435053112423101	43.848056	112.709408	4,784.42	289	(Twining and others, 2016)
TAN-2272	435053112423001	43.847939	112.725931	4,784.69	287	(Twining and others, 2016)
TAN-2312	434939112422001	43.827603	112.705436	4,796.00	568	(Twining and others, 2018)
TAN-2336	435053112423203	43.847933	112.708861	4785.77	256	(Twining and others, 2023)
USGS-103	432714112560701	43.453678	112.935975	5,010.82	1,307	(Hodges and others, 2012)
USGS-105	432703113001801	43.450853	113.005769	5,098.58	1,409	(Hodges and others, 2012)
USGS-108	432659112582601	43.449572	112.974814	5,034.79	1,218	(Hodges and others, 2012)
USGS-126a	435529112471301	43.924561	112.787750	4,992.25	648	(Twining and others, 2008)
USGS-126b	435529112471401	43.924492	112.787961	4,992.81	472	(Twining and others, 2008)
USGS-127	433058112572201	43.516097	112.956953	4,959.91	598	(Twining and others, 2008)
USGS-128	433250112565601	43.547092	112.949583	4,938.40	768	(Twining and others, 2008)
USGS-129	433036113002701	43.510050	113.004560	5,029.68	779	(Twining and others, 2008)
USGS-130	433130112562801	43.525094	112.942053	4,931.02	723	(Twining and others, 2008)
USGS-131	433036112581601	43.509986	112.971956	4,980.77	1,239	(Twining and others, 2008)
USGS-132	432906113025001	43.485094	113.048314	5,032.08	1,238	(Twining and others, 2008)
USGS-133	433605112554301	43.601419	112.929647	4,893.62	812	(Twining and others, 2008)
USGS-134	433611112595801	43.603003	113.000353	4,972.38	949	(Twining and others, 2008)
USGS-135	432753113093601	43.464758	113.160731	5,139.38	1,198	(Hodges and others, 2012)
USGS-136	433447112581501	43.579828	112.970831	4,938.51	1,048	(Twining and others, 2012)
USGS-140	433441112581201	43.577939	112.970831	4,940.02	546	(Twining and others, 2014)
USGS-142	433837113010901	43.643606	113.020117	4,995.32	1,880	(Twining and others, 2017)
USGS-144	433021112552501	43.505714	112.924439	4,954.22	639	(Trcka and Twining, 2023a)
USGS-145	433358113042702	43.566178	113.074161	5,134.87	1,368	(Trcka and Twining, 2023b)
USGS-148	433535112390801	43.593172	112.652089	5,140.55	759	(Twining and others, 2021)
USGS-148a	433535112390801	43.593172	112.652089	5,140.55	759	(Twining and others, 2021)
USGS-149	433524112390800	43.589925	112.652300	5,132.42	974	(Twining and others, 2021)
USGS-150	433521112581801	43.589278	112.971611	4935.00	1,400	(Trcka and Twining, 2025)
USGS-151	433846112540701	43.644839	112.904639	4,853.25	1,720	(Trcka and Twining, 2023c)
USGS-152	433906112553401	43.651761	112.926075	4,853.98	1,259	(Trcka and Twining, 2023d)
USGS-152a	433906112553401	43.651761	112.926075	4,853.98	1,259	(Trcka and Twining, 2023d)
USGS-152b	433906112553401	43.651761	112.926075	4,853.98	1,259	(Trcka and Twining, 2023d)

Lithologic Core Storage Library

The Lithologic Core Storage Library (CSL) is a 6,163 square feet (ft²) building located at the Central Facilities Area of the Idaho National Laboratory (INL) (fig. 2a). The building consists of 4,110 ft² of core storage space, 1,340 ft² of laboratory space, including a separate room for sampling, 420 ft² of office space, a 143 ft² restroom, and a 150 ft² mechanical room for heating, cooling, plumbing, and electrical systems (Hodges and others, 2018; fig. 2b). An additional 6,400 ft² of core storage space is allocated in a separate building called “The Annex” (fig. 2a). It is recommended that all core is logged at the CSL because of better lighting, equipment, and table space. CSL personnel are available to move core between the buildings upon request. In the event of future building migration and consolidation, building functionality, building use, and logging procedures will largely remain unchanged.

The main area for logging and working with core is the core examination room (CER) of the CSL (fig. 2a). The core examination room includes multiple tables that can accommodate up to 600 feet of core and examination equipment such as binocular and petrographic microscopes, hand lens, and various hand tools. The CER also contains resources for logging core following the methods outlined in this report, including color charts, photographic jig stand, and printed copies of the appendixes included in this report.

The main area for sampling or altering core is the sample preparation room (SPR), which is attached to the CER (fig. 3b). The sample preparation room includes equipment such as drying ovens, an oil-cooled rock saw, a water-cooled rock saw, two drill presses with 0.5–1.0 inch-diameter coring bits, petrographic microscopes, balances, mechanical sediment shaker and sieves, and an array of standard laboratory glassware and equipment.

The main area for managing the databases and records related to the drill core is the office. The office also provides workspaces and office equipment such as a printer and scanner for visitors as needed. The manager of the CSL is referred to as the Core Storage Library Custodian, often shortened to Core Library Custodian, and is the main point of contact for any visitor. Interested visitors should visit the INLPO’s website at <https://www.usgs.gov/centers/idaho-water-science-center/science/inlpo-core-storage-library>. A visitor must obtain prior permission and approval before traveling to the CSL for any purpose, which includes logging and sampling. Visitors are allowed to use any of the provided equipment for logging and sampling. However, visitors must obtain prior approval before bringing any analytical electronics or chemicals because of potential requirements or restrictions by the INL. Visitors must bring the user manual for analytical electronics and safety data sheets for any chemicals that they bring to the Core Library. All visitors must sign in using the log provided at the main entry of the CSL. For researchers, institutions, companies, and other parties that are interested in storing core at the CSL, please see Hodges and others (2018).

Logging Procedures

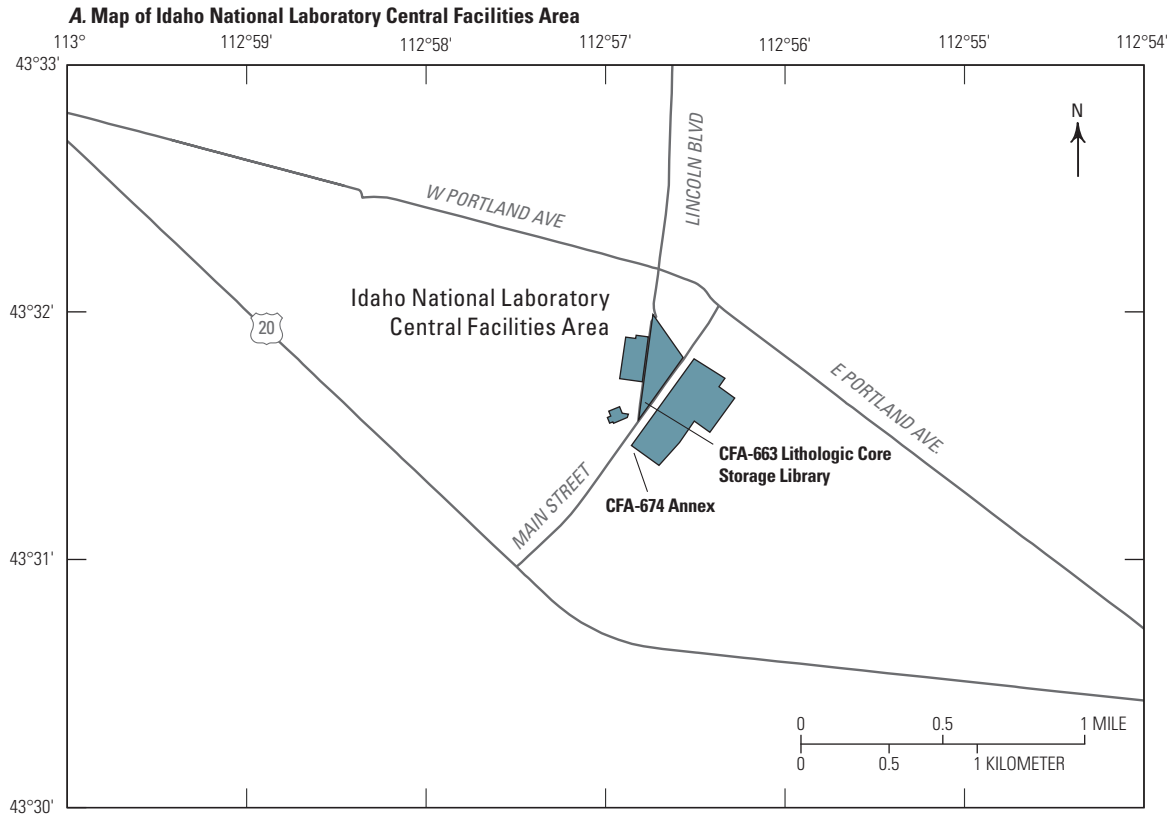
A lithologic core log is a series of recorded observations of a drill core along set intervals. The specific contents of a lithologic core log depend on a wide variety of factors, including lithology, the overall purpose of logging, and the individual practices of the person logging the core (referred to herein as the “logger”). Every Idaho National Laboratory Project Office (INLPO) core log will contain core photographs, a lithologic description that describes the physical and visual properties of the drill core, an evaluation of the fracture frequency, an evaluation of vesicle size and concentration, and the type and location of any sedimentary and igneous structures. The most important aspect of the lithologic core log is the lithologic description. The lithologic description contains a detailed lithologic name and a description of the color, texture, composition, and alteration of the given interval. Additional information is added to the lithologic description or other parts of the core log depending on if the rock is sedimentary or igneous. For example, basalt intervals include a description of vesicle size and concentration, and sedimentary intervals contain a description of biological activity. The specific aspects of a core log for each lithology and how to collect that data are described in more detail in the “Core Descriptions” section of the report.

Procedures Before Logging

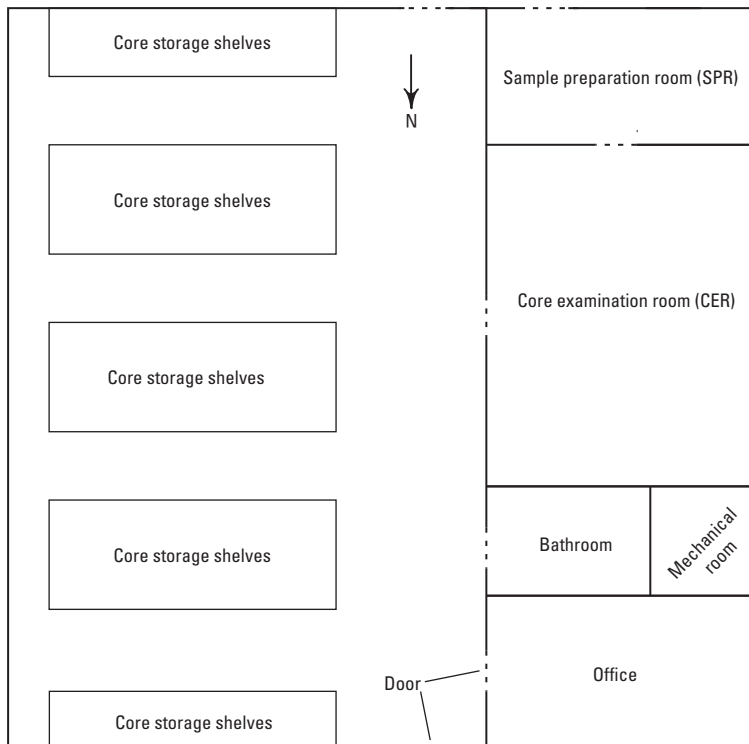
In general, most drill cores are stacked on pallets that are placed on 0- (ground level) to 15-foot-high shelves. The pallet containing the drill core is removed from the shelves by Core Storage Library (CSL) personnel that have passed all Idaho National Laboratory certifications for forklift operation. Pallets are placed using a pallet jack or forklift near the doorway of the CER. Before transporting the core from the pallet to the CER, it is recommended to take a picture of the core boxes on the pallet. The picture can be used as a reference to ensure that the boxes are returned to the pallet in the proper orientation and order, saving time and limiting future confusion and frustration. Core boxes are then removed from the pallet and either walked to the CER or carted using a trolley, which has a weight limit of around 300 pounds.

The person lifting and transporting core needs to follow safe lifting practices and wear protective equipment, including gloves and closed-toe shoes. Safe lifting practices include lifting core with a secure grip on the top and bottom of the box, using two hands, and not attempting to lift more than what can reasonably be carried. It is important to be mindful that not all core boxes weigh the same. The total weight of the core box depends on the size of the core, the type of box the core is stored in, and the lithology and amount of the core in the box itself. Most core boxes stored at the CSL weigh between 25–50 pounds. When walking core from the pallet to the CER, a person should be mindful of their surroundings to prevent damage to the core, other people, to their fingers and to their toes. If a core box has deteriorated while in storage, the box should be transported using a trolley or lifted with the support of multiple people.

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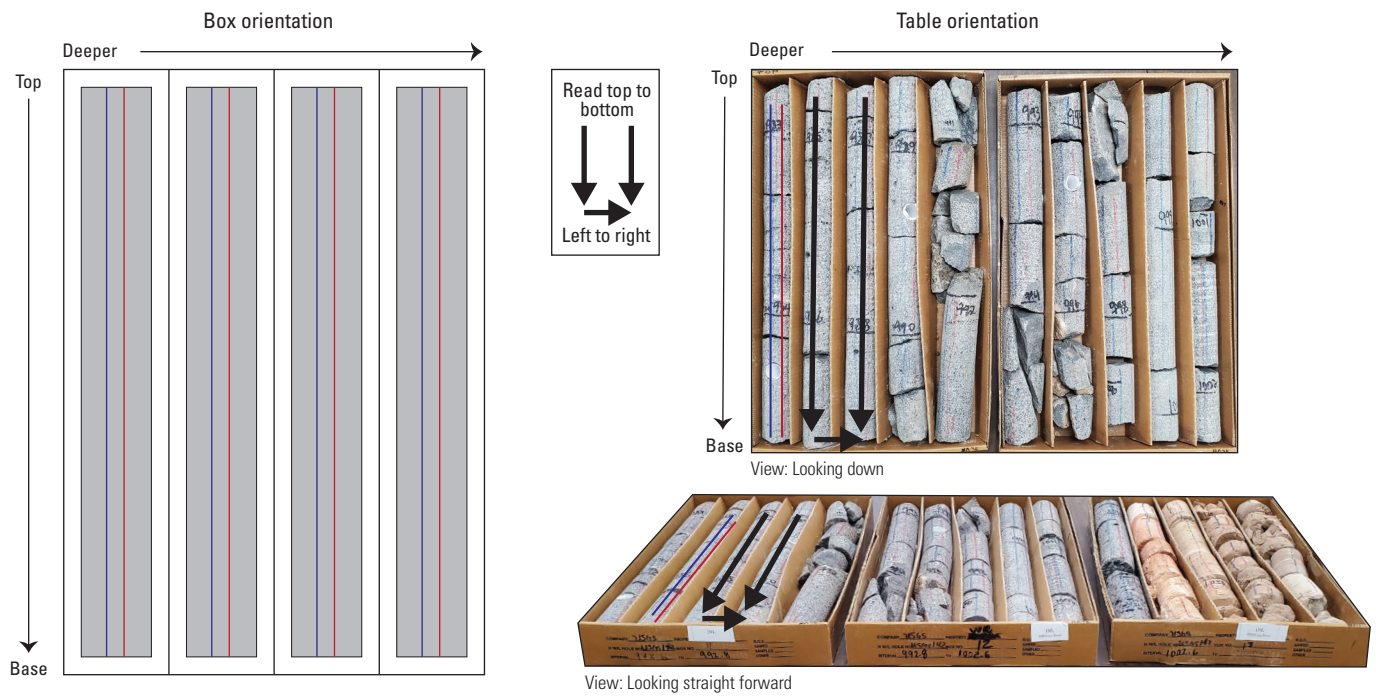
B. Lithologic Core Storage Library



NOT TO SCALE

Figure 2. Maps displaying the location of *A*, the Lithologic Core Storage Library (CSL) and Annex at the Idaho National Laboratory and *B*, the internal layout of the CSL.

A. Typical USGS core box layout



B. Typical contractor core box layout

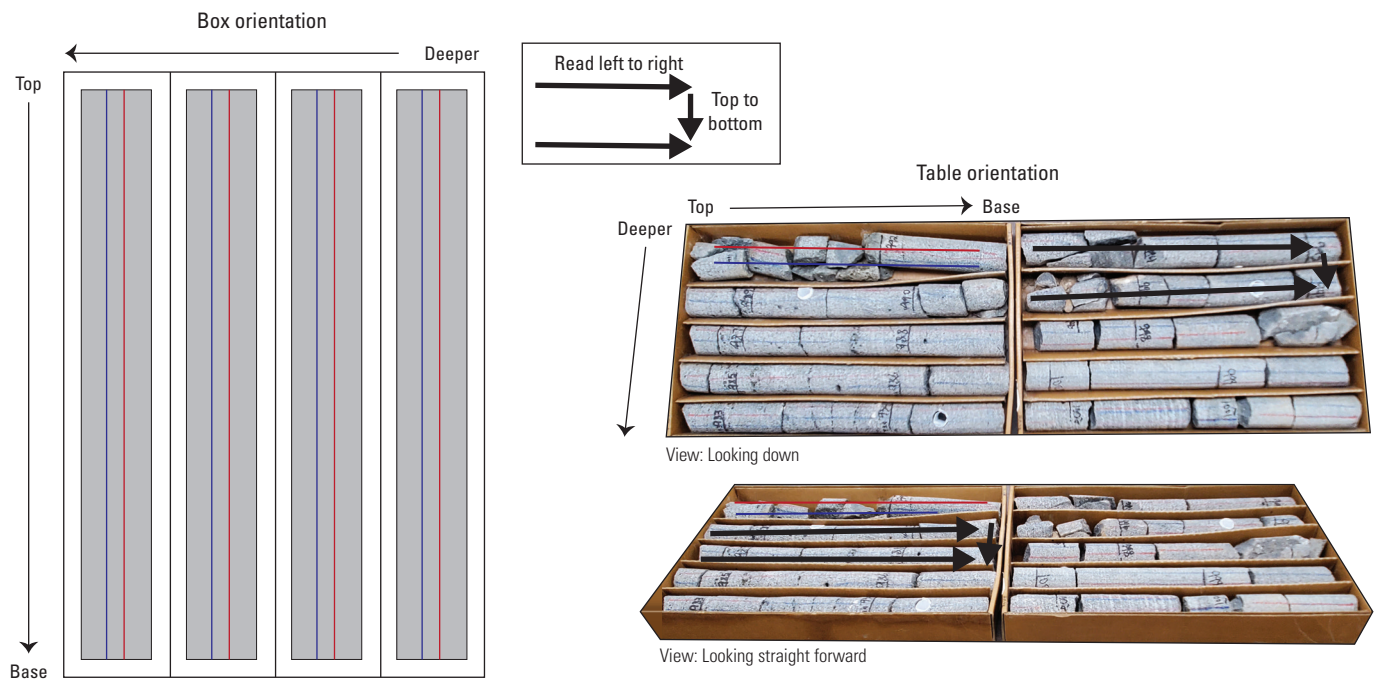


Figure 3. Diagram illustrating the box orientation (left) and table placement (right) of (A) USGS and (B) contractor-drilled core placed in core boxes.

Core Layout

The tables of the CER can hold between 500–600 feet of core, which amounts to about 60 boxes of core or one and a half pallets. Before laying out the core boxes, the logger should ensure that the work area and tables are clean and clear from clutter. A clean area limits contamination, maintains a safe working environment, and removes potential tripping hazards that can lead to personal injury and dropped boxes.

Maintaining proper core orientation and the correct order of boxes facilitates easier and more accurate data collection. However, knowing which way the core is oriented in the box can be challenging, especially because USGS-drilled and contractor-drilled core often have different orientations (fig. 3). There are a few indications in any core box that the logger can use to determine top from bottom and deep from shallow. Many cores, especially those drilled by the USGS, are marked with two parallel lines colored red and blue (fig. 3a). When the core is properly oriented, or where shallow is at the top and deep is at the bottom, the red line is always on the right side of the core.

The orientation of the core is also directly indicated by depth markings, where more shallow depths are expected at the top of the box and deeper depths are expected at the base of the box (fig. 3). Depth is frequently marked on the core itself in permanent marker and often indicated by writing on wooden or foam blocks, core boxes or lids, and other pieces. Knowing the depth of the core is vitally important for logging and sampling. Therefore, a logger must also confirm that the depths on the core are marked properly and that all missing intervals are accounted for. The logger should pay special attention to rubbly intervals, sedimentary interbeds, and lithologic contacts when confirming depths and missing intervals because these areas often have low recovery, which can be challenging to measure and indicate properly.

The logger should use as many of the orientation and depth indicators as possible to determine proper core orientation and placement because the core could have been misplaced or mislabeled. If drill core has been marked incorrectly, multiple depth indicators do not match, there are missing intervals that have not been indicated or recorded within the core box, or if there are any other questions, the logger should alert the CSL Custodian. Working with the CSL Custodian, the logger may properly orient and mark the drill core by using any of the orientation indicators and additional resources such as drilling and sampling notes. Marking the core includes adding red and blue orientation lines or adding or altering depth indicators where appropriate.

Core Photographs

Every box of core needs to be photographed before being logged. A photograph of a box of core serves many purposes, including:

- Visually representing the core without interpretation or description.

- Offering a tangible product if the core is lost or destroyed.
- Providing context for physical descriptions.
- Aiding reconstruction of core if the box is dropped or core is misplaced.

At the INLPO, core is photographed using a specially designed photographic jig (fig. 4). Using the jig for photographing ensures consistent lighting, reduces artifacts caused by lighting such as glare, and includes metadata information like corehole name, box orientation, and interval depth.

The photographic jig remains in the CER, though it is not permanently affixed to any location. If necessary, the logger should move the jig with permission and help from CSL personnel to a safe, secure, and accessible location. Before photographing, the logger should ensure that the jig is set up properly (fig. 4) by checking for the following:

- Lights on the jig are pointed at opposite ends of the box.
- Arms holding the lights are oriented at 60 degrees.
- Mirror and camera mount are attached and secure.
- Jig is plugged in.
- Lights are not burned out and roughly emit the same amount of light.

The CSL keeps and maintains multiple handheld, digital cameras for photographing core. CSL personnel will show the logger where the cameras, spare batteries, and battery chargers are stored, as well as provide verbal instruction on camera maintenance and use. Before securing the camera to the jig, the logger should ensure that the camera is set-up properly by checking for the following:

- SD card and battery are in the camera, free from corrosion, and have available storage space.
- Lens protector is removed and stored safely.
- Lens and digital screens are clean and free from dust and smudges.
- Camera is on.
- Mode wheel on the camera is set to “auto.”
- Flash is off.
- External trigger is attached to the camera.

Once the camera is set up properly, the logger can attach the camera to the jig. The camera screws into the back arm of the jig through a pilot hole on the bottom of the camera. Before tightening the camera completely, ensure that the camera is level by using the bubble level in the jig toolbox (fig. 4). Place the bubble level on the flattest part of the camera and use the mirror to make adjustments as needed. Once leveled, tighten the screw just until the camera is snug. Use the mirror to check that the core box and data plate will be within the frame of the picture. Adjust the height of the camera on the arm as needed by using the levers.

With the camera and the jig set up properly, the logger can begin to take photographs by placing each core box on the jig. The long axis of the core box is always placed against the long axis of the jig, but the exact orientation of the box is controlled by depth direction. The core box must be placed in the jig where the core orientation follows the directions of the “up” and “depth” arrows on the jig (fig. 4). If needed, the depth arrow can be replaced with an arrow going the opposite way. If the arrow placements still do not align with the core orientation, alert the CSL Custodian before taking any pictures. Once the core box aligns with the arrows, the logger should push the box until it is flush against the back rest and the data plate and is positioned squarely. The logger needs to write the name of the corehole and the depth interval represented in core box using legible handwriting in the designated areas, which are labeled “corehole name” and “depth interval” in figure 4. The name of the corehole remains the same throughout all pictures and does not need to be erased and rewritten before each picture, unless the logger is photographing drill core from multiple coreholes. The depth interval changes for each core box and does need to be rewritten before each photograph. The depth interval is often found written on the box or its corresponding lid and needs to be

recorded on the jig in the same precision as it was found. Before taking the picture, the logger should ensure that the red and blue parallel lines (fig. 3) as well as other depth indicators will be clearly visible in the photograph.

To take the picture, the logger holds the trigger, steps away from the box, and depresses the button on the trigger. The camera should be set to auto focus, so there is no need to manually focus here. To produce consistent and quality core photographs, the logger should:

- Take pictures of core within the same day or at similar times of day to avoid inconsistent lighting.
- Turn off all lights and close all blinds and doors to limit the light source in the room to only the light coming from the jig.
- Avoid casting a shadow on the core box when taking a picture.
- Periodically check the camera orientation and jig stability because placing and removing core boxes can jostle equipment.
- Ensure that no cords, extra equipment, or other material is obstructing the photograph.

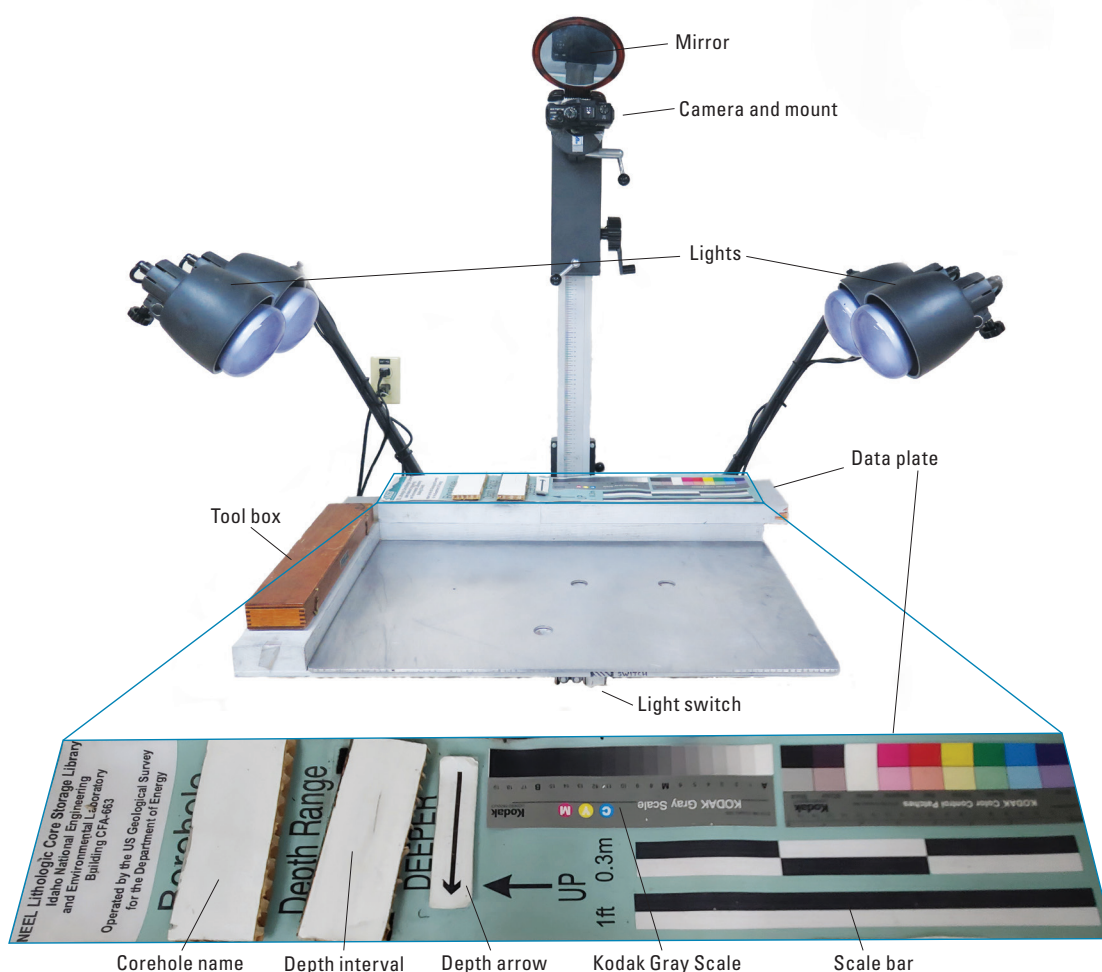


Figure 4. Annotated photographs of the photographic jig and data plate used to take and process core box photographs at the Lithologic Core Storage Library.

Core Photograph Post Processing

Once all core boxes have been photographed or the logger is finished photographing for the day, the logger should:

- Return the jig to its normal state: turn off the jig lights; wipe away all dry-erase writing; unscrew the camera from the mount.
- Take care of the camera: unplug the trigger and return it to the camera case; remove the battery and charge it, even if the camera was not used for very long; remove the SD card and place somewhere safe.
- Clean up the jig and surrounding areas: use a brush to remove any dust or rock fragments that fell on the base of the jig; return any equipment and tools that were used back to their normal location so they may be found easily for the next time.

- Turn off all lights and close the door if leaving the CER after photographing.

As soon as practical, the logger should transfer the core photographs from the SD card to an internal INLPO file server to prevent potential loss and support data archiving (fig. 5). Every photograph will include a .jpeg and a raw file. Original photographs should be retained to serve as backup in case other copies are lost, misplaced, or corrupted. If the logger is unable to transfer pictures, alert CSL personnel. CSL personnel will work with the logger to transfer the pictures.

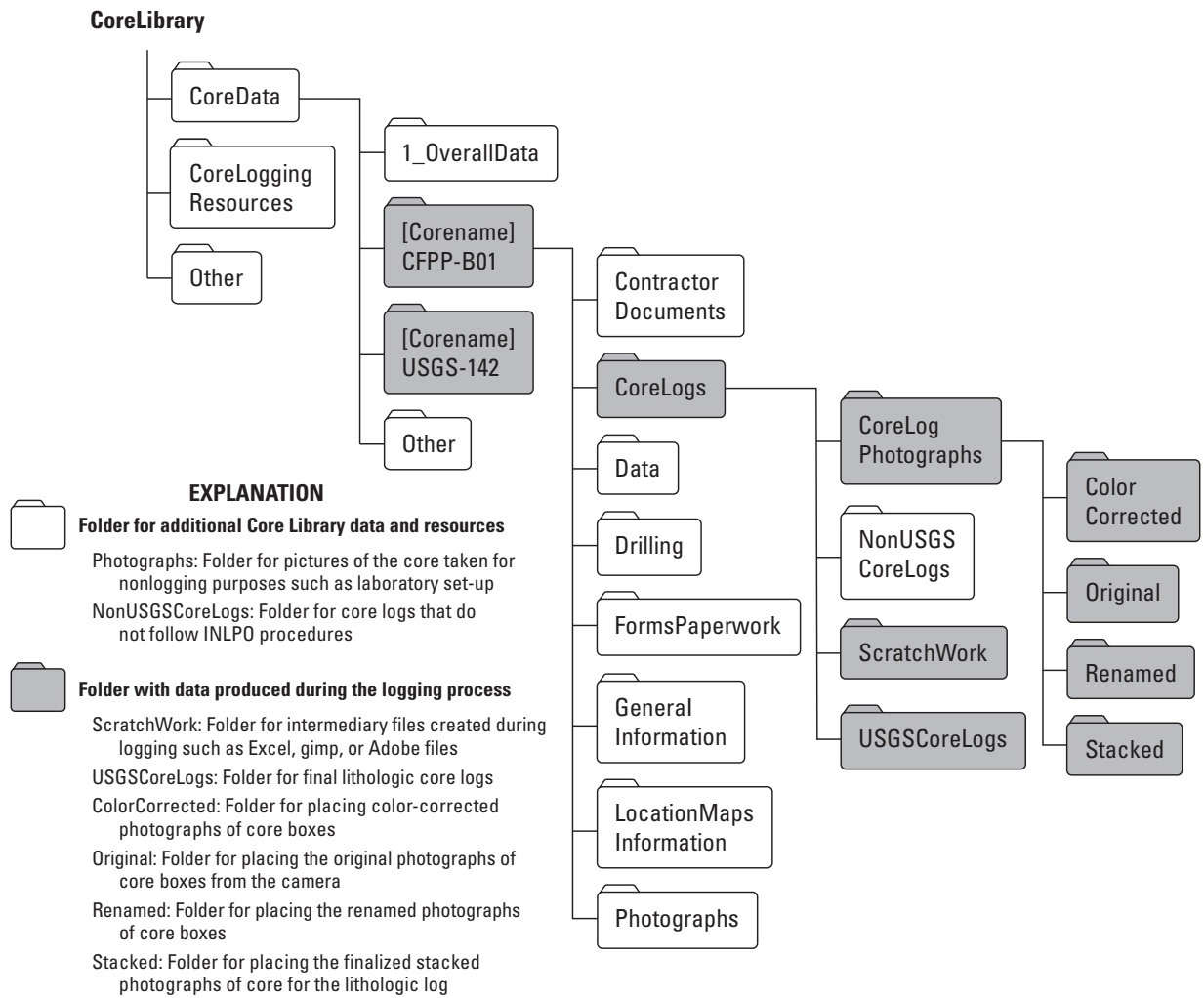


Figure 5. Diagram of select folders of the file tree on the Idaho National Laboratory Project Office’s internal server for file organization and data storage.

Core Descriptions

Standard Practices

There are a few practices that any logger should follow when logging core. These practices include:

- Double check that all core boxes are oriented and ordered properly (fig. 3). The core could have become disordered or stored upside-down during photographing.
- Remove all lids from the core boxes. There is no correct way to store lids. Make sure that the lids do not obstruct walkways or interfere with the work of others. Lids can be stacked on spare tables, underneath tables, or placed upright with the lip underneath the core box to hold the lid in place. A spare lid can also be used as a table, workstation, or to carry equipment because it is a solid, flat surface that fits easily on a box of core.
- Periodically sweep and dust workspace to limit cross-contamination with other drill cores and to keep the work area clean.
- Wear sturdy shoes.
- Do not eat in the CER. Drinking water in the CER is fine and encouraged.
- Remove only a single piece of core at a time to avoid misplacing core. It is also helpful to place some sort of marker such as a pen, foam block, and other pieces of detritus to mark the location of the missing core for easy reference later.
- Retain the original integrity of the core. Limit breaking, chipping, or altering the core as much as possible.
- Note the interval of any characteristic being described. An interval is given by the top and base in feet below land surface (BLS) of the feature being described, which together is referred to as “depth.”
- Log from shallow to deep.
- Be mindful of what is described. Consistency is the most important aspect of any lithologic core log. If a specific feature is described in one part of the log, the feature should be described at every other occurrence elsewhere in the log.
- The logger ultimately chooses the overall level of detail in the log. Be mindful of time constraints, the overall purpose for the logging, and what others would want to see in the core log.
- It is generally faster if the logger chooses one specific characteristic or section of the core log to focus on at a time. This approach helps ensure consistency and limits missing data.

- Record the depth in feet BLS to the top and base of each missing interval. This information will be useful for creating the finalized core log. It also reminds the logger to start a new lithologic description after every missing interval.
- The logger may record any information collected during the logging process by hand or in the provided digital logbook (app. 1) depending on personal preference.

Lithologic Description

The main aspect of the core log, and the one that contains the most information, is the lithologic description. The lithologic description is a written description of certain characteristics of the drill core such as color, texture, mineralogy, and alteration, though its exact contents vary by the interval of description and its lithology. A lithologic description provides details of the core not visible in pictures and context for sampling. A lithologic description also provides important data and context researchers can use to better understand the geologic history of the area, assess the chemical and physical properties of the different lithologies, and support scientific studies. To create a lithologic description, the logger must be as specific as possible while minimizing interpretation. Ultimately, logging drill core is an individualized experience and always contains some level of interpretation. However, consistency is the key to good lithologic descriptions.

Interval Selection

The first step a logger takes when beginning a lithologic description is choosing the interval of the description. The interval is the depth in feet BLS to the top and to the base of the portion of core being described. The thickness of the interval is dependent on the lithology of the core, the occurrence of missing intervals, and the personal preference of the logger.

On a broad scale, a lithologic core log describes change. Substantial changes in the core, such as a compositional or lithologic change, warrant a new lithologic description to prevent generalizations and loss of detail (fig. 6). Other changes in the core, such as a textural or color change, warrant noting in the lithologic description but not necessarily a new lithologic description. For INLPO core logs, a new lithologic description is required each time the lithology changes regardless of the stratigraphic thickness of that lithology (fig. 6). A change in lithology occurs when the lithology changes from basalt to sediment, or from basalt to rhyolite, for example. A new lithologic description is also required after each missing interval (fig. 6). Even if the lithology immediately above and below the missing interval appears continuous, it is possible the missing interval could have contained a lithologic contact.

On a fine scale, the same continuous lithologic type should be broken into multiple lithologic descriptions, which is especially true for basalt. Each drill core consists of tens to

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hundreds of feet of layered basalt flows (fig. 6). A flow refers to all eruptive products from the same eruptive event. Basalt flows can be broken into two or more subdivisions called basalt flow units. A basalt flow unit represents a single eruptive product from an event and therefore defines the minimum

subdivision of a basalt flow. It is required at the INLPO for a logger to include at least one lithologic description for every basalt flow (fig. 6). If the basalt flow has multiple flow units, it is recommended the logger create a lithologic description for each flow unit (fig. 6).

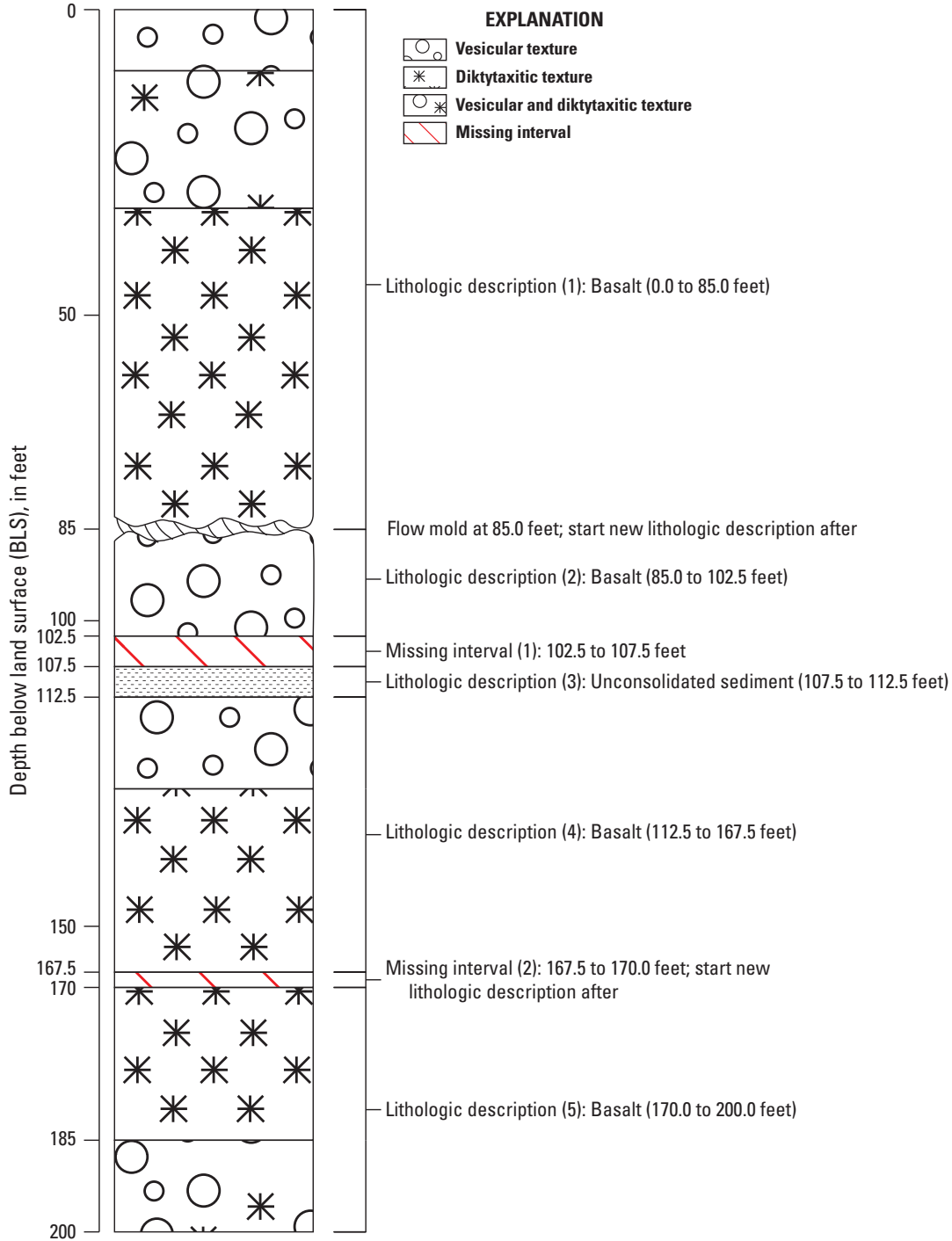


Figure 6. An example of a stratigraphic column of a drill core that recommends intervals for the lithologic description based on textures, igneous structures, and missing intervals.

Differentiating between basalt flows and layers in drill core can be challenging because of their visual similarities. However, the contact between different flows and layers often produces predictable features that are occasionally preserved in the drill core. These features include oxidation, alteration, flow molds, spatter features, and rubble zones. If the logger notices and recognizes one or more of these features in the drill core along with other features such as missing intervals and distinct mineralogical or textural changes, the logger should initiate a new lithologic description for the basalt package following the observations (fig. 6). Because these features are not unique, the logger does not need to determine or name if the package of basalt is a flow or layer. In general, differentiating between and correlating basalt flows and layers requires additional datasets such as paleomagnetism and geochemistry. However, identifying and defining basalt flows and their flow layers in a core log provides important context for collecting samples for these and other datasets. Ultimately it is up to the discretion of the logger to determine and distinguish between basalt flows and flow layers. While this requires some interpretation, which logging attempts to minimize, a recommended practice is to include more lithologic descriptions rather than less.

Assigning a Generalized Lithologic Name to Intervals

Once the logger has chosen an interval for the lithologic description, the logger must assign a generalized lithologic name to that interval (table 2). An interval can only have a single generalized lithologic name. Assigning a generalized

lithologic name is important for maintaining consistent and predictable data collection across multiple loggers and different drill cores. The generalized lithologic name controls the specific components or categories of the lithologic description and therefore the features of the core that the logger describes. The lithologic description itself includes a detailed lithologic name that a logger can use to expand on and refine the generalized lithologic name if possible.

The generalized lithology for most lithologic units in CSL drill cores will fall into one of the following five categories: basalt, rhyolite, volcanic ash, consolidated sediment, and unconsolidated sediment (table 2). Choosing the generalized lithologic name for the interval is up to the discretion of the logger, and figure 7 presents a flow diagram to help the logger make this choice (fig. 7). If the logger encounters a general lithology that does not fall within one of these five categories, the logger should alert the CSL Custodian and work with the Custodian to determine the new category for the lithologic description.

Many of the basalt flows in drill core are separated by intervals of sediment. The generalized lithologic name of any sediment-bearing interval is controlled by the degree of sediment compaction. For CSL core logs, the two possible generalized lithologic names of the sediment intervals are “unconsolidated sediment” and “consolidated sediment.” Unconsolidated sediment is a sediment interval that consists primarily of loose material. This material ranges from loose, disaggregated grains to large, individual chunks of aggregated grains.

Table 2. List of categories to include in a lithologic description for each generalized lithologic name, including potential detailed lithologic names.

[“Generalized lithologic name” column refers to the name for the interval assigned by the logger and is based on the general lithology of the interval. “Potential detailed lithologic names” column displays a list of expected or potential full lithologic names that correspond to each generalized lithologic name. “Categories” column displays list of topics controlled by the generalized lithologic name to include in the lithologic description of the core log. Abbreviations: HCl, hydrochloric acid]

Generalized lithologic name	Potential detailed lithologic names	Categories
Basalt	Basalt	Lithology ¹ ; Color; Texture; Composition; Xenoliths; Alteration
Rhyolite	Rhyolite, welded rhyolite tuff, welded rhyolite tephra	Lithology ¹ ; Color; Texture; Composition; Xenoliths; Alteration
Andesite	Andesite	Lithology ¹ ; Color; Texture; Composition; Xenoliths; Alteration
Dacite	Dacite	Lithology ¹ ; Color; Texture; Composition; Xenoliths; Alteration
Volcanic ash	Non-welded rhyolite tuff, non-welded rhyolite tephra, rhyolitic ash, dacitic ash	Lithology ¹ ; Color; Texture; Composition; Xenoliths; Alteration
Unconsolidated sediment	Clean sand, sand with fines, silt, clay, mud	Lithology ¹ ; Color; Texture; Composition; Consistence; Reaction to HCl; Roots/fossils; Alteration
Consolidated sediment	Siltstone, mudstone, claystone, lithic sandstone, feldspathic sandstone	Lithology ¹ ; Color; Texture; Composition; Cement; Reaction to HCl; Roots/fossils; Alteration

¹Lithology corresponds to the detailed lithologic name of the interval

There are two different types of consolidated sediment: cemented and compacted. Cemented sediment consists of grains that are bound together by materials such as quartz, calcite, and iron oxides, which fill the space between grains as the rock forms. Compacted sediment is sediment that has undergone compression, which reduces volume and increases the density of the sediment, because of the weight of the overlying materials. Both cemented and compacted sediment have the same categories for the lithologic description.

Ultimately, it is up to the logger to distinguish between consolidated and unconsolidated sediment. There is a continuous spectrum between consolidated and unconsolidated sediment, and figure 7 presents a flow diagram to help the logger with assigning a generalized lithologic name to a sedimentary interval (fig. 7).

Consistency in naming consolidated and unconsolidated sediment intervals matters more than the name itself. The format of the lithologic description for consolidated and unconsolidated sediment is very similar, which means that similar data are collected for both intervals regardless of their generalized lithologic names. The primary purpose of distinguishing between consolidated and unconsolidated sediment is to facilitate consistent and predictable core logs.

Assigning a Detailed Lithologic Name to Intervals

A detailed lithologic name usually provides more context and information than the generalized lithologic name. A detailed lithologic name is dependent on specific properties of the interval, including texture, grain size, composition, and compaction. If these properties are descriptive only, then the detailed lithologic name and the generalized lithologic name will remain the same. For example, a basalt containing macroscopic minerals is often referred to as “porphyritic basalt.” While “porphyritic” is an important textural term, it describes the lithology of the interval without changing its name. However, if these properties change the overall generalized lithologic name of the interval, then the generalized lithologic name and the detailed lithologic name will diverge. For example, a volcano erupts fragments of rocks, glass, and other materials that can solidify (weld) into a rock called a “tuff” under the right conditions. If the tuff is primarily rhyolitic in composition, then the generalized lithologic name of the interval is “rhyolite” and the detailed lithologic name of the interval is “welded rhyolite tuff.” In this example, rhyolite becomes a descriptive term while “tuff” is the overall name of the

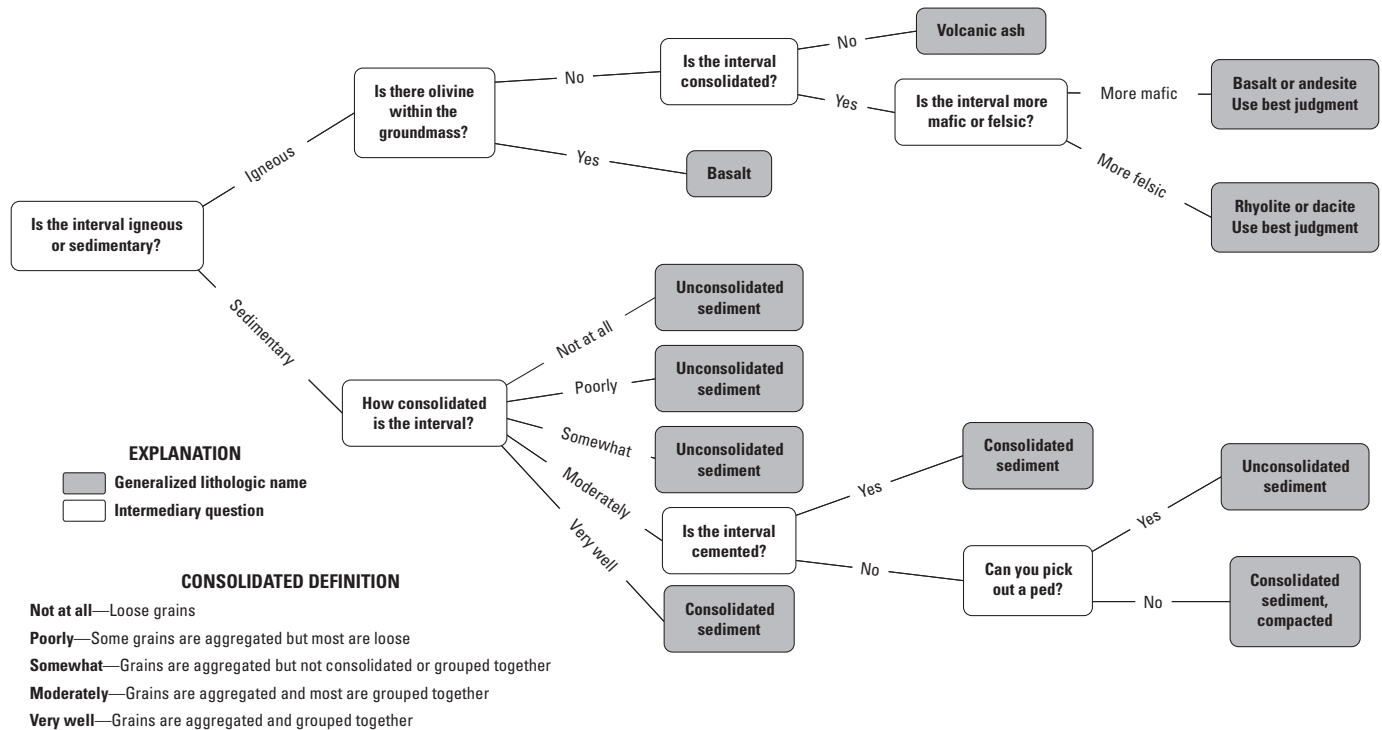


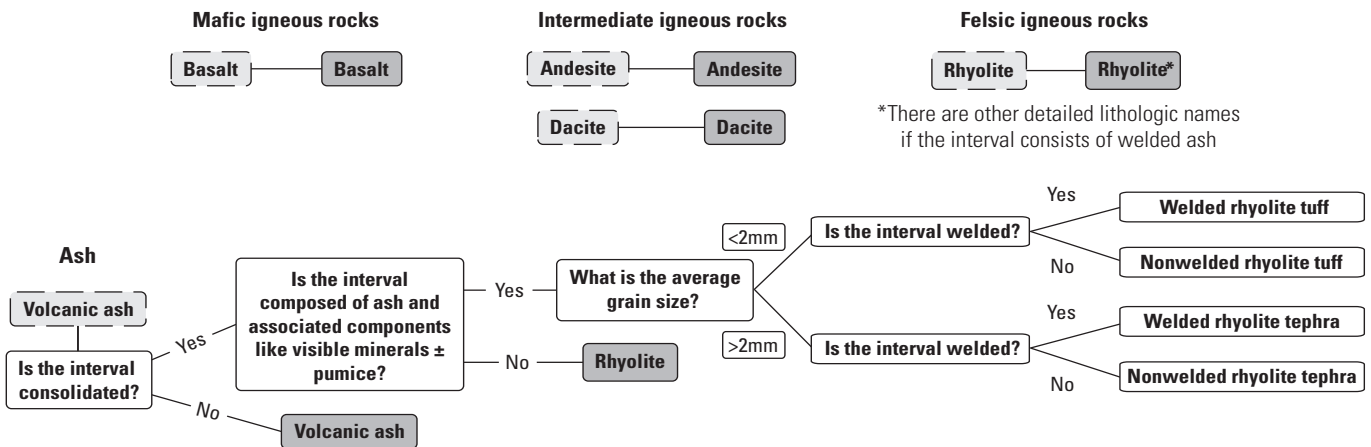
Figure 7. A flow chart displays generalized lithologic names based on mineralogical evidence and degree of consolidation within the interval.

rock. Ultimately, it is up to the logger to determine a detailed lithologic name. To assist with this process, figure 8 represents a flow chart that recommends detailed lithologic names based on overall rock type and specific observations expected in CSL drill core (fig. 8). If the logger is unable to assign a detailed lithologic name, the generalized lithologic name may be used as the detailed lithologic name.

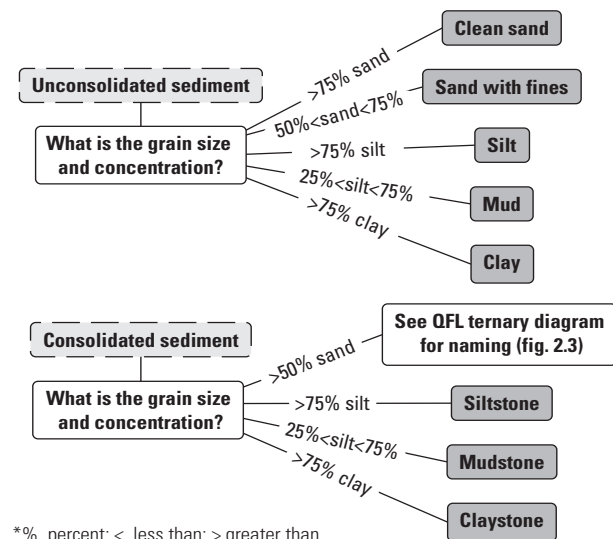
Igneous rocks, including basalt and intermediate rocks, will always have the same generalized and detailed lithologic name (fig. 8a). While the basalt and intermediate rocks might have unique textures and mineral sizes, these observations qualify rather than alter the generalized lithologic name of the interval. Textures, mineral sizes, and other descriptive features are mentioned in the texture and composition categories of the log and do not need to be included in the detailed lithologic name.

The detailed lithologic name for rhyolite is dependent on how the interval formed and its overall grain size. If the rhyolite was formed as a lava flow cooled, similar to how basalt is formed, the generalized and detailed lithologic name are both “rhyolite.” If a volcano erupted rhyolitic ash that was later welded (consolidated), the generalized lithologic name is rhyolite and a partial detailed lithologic name would be “welded rhyolite.” The detailed lithologic name is further quantified by the dominant grain size in the interval. If the grain size is less than 2 millimeters (mm), the detailed lithologic name is a “welded rhyolite tuff.” If the grain size is greater than 2 mm, the detailed lithologic name is “welded rhyolite tephra.” The groundmass of welded rhyolite tuff and tephra is generally finer grained than rhyolite and includes other eruptive products such as lithics and pumice.

A. Igneous rocks



B. Unconsolidated and consolidated sediments



EXPLANATION

- Generalized lithologic name
- Detailed lithologic name
- Intermediary step

*%, percent; <, less than; >, greater than

Figure 8. A flow chart that displays detailed lithologic names based on mineralogy and grain size for A, igneous rocks and B, unconsolidated and consolidated sediments.

The detailed lithologic name for volcanic ash is dependent on the composition of the ash. The composition of the ash can be basaltic, andesitic, dacitic, or rhyolitic, which depend on the minerals present and their relative abundances. Basaltic ash contains mafic minerals such as biotite and olivine in high quantities, while rhyolitic ashes will contain high quantities of felsic minerals such as quartz and feldspar with few to no mafic minerals. Volcanic ash is assigned to intervals that are not welded, which means the intervals consist of loose ash particles.

Sedimentary Unit Naming

Unconsolidated Sediments

The detailed lithologic name for an interval of unconsolidated sediment is based on the dominant grain size of the interval (app. 2, fig. 2.1). Describing the interval based on grain size allows for limited interpretation and easy reference to a dominant feature of the interval. It is important to note that intervals of unconsolidated sediment should not be called “soils.” Calling an interval a soil requires interpretation, which logging avoids as much as possible. In addition, the eastern Snake River Plain has large quantities of loess. Differentiating between soils and loess in drill core is challenging and not expected here.

Consolidated Sediments

The detailed lithologic name of a consolidated sedimentary interval is dependent on the dominant grain size of the interval and the interval’s composition. For fine-grained intervals composed primarily of silt and clay-sized grains (grain sizes <0.008–0.6 mm), naming is based on grain size using the consolidated sedimentary interval ternary diagram (app. 2, fig. 2.2). For intervals composed primarily of sand-sized grains, naming is based on composition using a quartz-lithic-feldspar ternary diagram (app. 2, fig. 2.3).

To use a ternary diagram, the logger first determines the abundance of each component, represented by the apexes of the triangle, in percent. If the total abundance of the components does not equal 100, the logger must normalize the abundances by adding them together and calculating the percentage of each relative to the total. The logger then finds the point on the ternary diagram that corresponds to the intersection of each normalized abundance. The location of this point on the ternary diagram gives the detailed lithologic name of the interval.

Assigning Color

Describing color follows the same process for every lithology. Color is estimated using a Munsell color chart provided by the CSL. Color must be taken on a weathered (not recently fractured) and non-altered surface of the core that is clear from sediment and drilling artifacts like staining or striation. Every description of color needs to include the alphanumeric code from the Munsell color chart (for

example, N7) and its associated description (for example, light gray). If the color of the core does not match an option in the Munsell color chart, the logger should determine the closest match in the Munsell color chart and then briefly describe how the color deviates (for example, N7 light gray with a pale purple tint).

In some cases, the interval chosen for the lithologic description will have multiple different colors. If this is the case, the logger must note the interval of each color. For example, a logger might say N6 medium light gray from (715.0–716.6 ft) and N7 light gray from (716.26–720.1 ft).

In other cases, the interval oscillates between colors on a fine scale of millimeters-centimeters (cm). If this occurs, the logger should note the individual colors using the Munsell color chart, the nature of the contact(s) between the different colors, and estimate a single, average color for the interval. The logger does not need to note the interval of each color because that causes extraneous and tedious data collection beyond the scale the INLPO is looking for.

Assigning Texture

The most important feature of any lithologic description is the texture. The texture describes the overall appearance of a rock, which is controlled by the rock’s evolution and the arrangement of its components like grains or minerals. The texture and its description for any rock are highly dependent on lithology. It is beyond the scope of this document to account for every possible texture in CSL core.

In many cases, the interval chosen for the lithologic description will have multiple different textures. If this is the case, the logger must note the interval of each texture and the degree of the texture if applicable (app. 3, table 3.1). For example, a logger might say vesicular from (131.2–136.4 ft) and vesicular and strongly diktytaxitic from (131.2–136.4 ft).

Igneous Textures

Common igneous textures of basalt, intermediate, and felsic rocks related to appearance include massive, diktytaxitic, and vesicular (table 3). Massive texture occurs in the absence of vesicular and diktytaxitic textures. It is sufficient to note only the interval of vesicular textures because vesicle size and concentration data are collected separately. However, if the vesicles are oriented, elongated, or have other strange characteristics, the logger should note that information here.

Sedimentary Textures

For consolidated and unconsolidated sediments, texture refers to select characteristics of the overall sediment grains, including how the grains appear and how they are aggregated together (Compton, 1985; Retallack, 1988). These descriptions are limited by visibility factors such as grain size, lighting, and individual eyesight. A visual description of the sediment grains should include:

- **Size:** A description of the overall range of grain sizes of all grains given in common grain size terms (table 4).
- **Rounding:** A description of the overall range of rounding of all grains given in qualitative terms, where rounding refers to the degree of how round a grain is (fig. 9).
- **Sorting:** A description of the overall range of sorting of all grains given in qualitative terms, where sorting refers to the degree of uniformity in size and degree of roundness of grains in an interval (fig. 10). More uniform intervals indicate better sorting.

For unconsolidated sediments, the overall texture of the interval is also dependent on how the individual grains are packed together and the shape the aggregated grains make, which is called packing. The aggregated grains are called peds. If the grains are completely loose and not connected, there are no peds and the packing of the interval is referred to as single-grained. If there are peds, the peds can form blocky, columnar, or platy shapes, which is reflected in the type of packing (table 5). The texture for every unconsolidated sedimentary interval must include a description of packing using the terms outlined in table 5.

Table 3. Description of select igneous textures, including their definitions and how to recognize them in core stored at the Lithologic Core Storage Library.

[“Texture” column lists the name of the texture being described. “Definition” column provides the definition of the texture adapted from the Glossary of Geology by the American Geosciences Institute (2025). “Description” column provides a list of the potential defining features or characteristics of the texture to help the logger identify that texture in the core. “Additional comments” column includes additional descriptions, recommendations for logging, and other characteristics of the texture not included in the previous columns. Abbreviations: cm, centimeter; ft, foot; in, inch; mm, millimeter; N/A, not applicable; %, percent; >, greater than; <, less than]

Texture	Definition	Description	Additional comments
Basalt and intermediate rocks			
Vesicular	Texture characterized by vesicles, where vesicles are cavities or voids in a rock caused by gas expansion and expulsion.	Presence of oblong to circular cavities a few mm to a few cm wide and deep.	A vesicular texture applies if the vesicles are >0.05 inches (in.) and >0.5% for concentration. A basalt with vesicle concentration >50% has a scoriaceous texture. Be sure to note vesicle shape and any alignment in the “Texture” category of the lithologic description.
Diktytaxitic	Texture characterized by numerous, jagged, angular and interstitial cavities bounded by plagioclase crystals.	Presence of plagioclase laths that surround small (<0.05 in.), often irregular vesicles repeated throughout the interval in varying degrees.	Varying degrees of diktytaxitic texture include weak, moderate, and strong. Weak diktytaxitic texture is characterized by few plagioclase-bound vesicles and strong diktytaxitic texture is characterized by many plagioclase-bound vesicles in the interval. Diktytaxitic texture can occur concurrently with vesicular texture.
Massive	Texture characterized by homogeneity with lack of layering, other features, or textures.	Phenocrysts are visible but small (<1 mm), of constant size, and vesicular and (or) diktytaxitic textures are not present.	Massive texture occurs in the absence of vesicular, diktytaxitic, and other textures. Phenocryst size determines assigning massive, porphyritic, aphanitic, and phaneritic textures to the interval.
Aphanitic	Texture where minerals cannot be distinguished without magnification.	Minerals are not visible using the naked eye. Mineral phases might be distinguishable using a hand lens or microscope, but are <1 mm.	N/A
Phaneritic	Texture where there are one or more macroscopic mineral phases.	All main mineral phases of the basalt, usually plagioclase and olivine, are of consistent size and >2 mm.	If two phases are present but only one mineral phase is >2 mm, the interval is not phaneritic. The mineral >2 mm should be described as porphyritic.

Table 3. Description of select igneous textures, including their definitions and how to recognize them in core stored at the Lithologic Core Storage Library.—Continued

["Texture" column lists the name of the texture being described. "Definition" column provides the definition of the texture adapted from the Glossary of Geology by the American Geosciences Institute (2025). "Description" column provides a list of the potential defining features or characteristics of the texture to help the logger identify that texture in the core. "Additional comments" column includes additional descriptions, recommendations for logging, and other characteristics of the texture not included in the previous columns. Abbreviations: cm, centimeter; ft, foot; in, inch; mm, millimeter; N/A, not applicable; %, percent; >, greater than; <, less than]

Texture	Definition	Description	Additional comments
Rhyolite			
Eutaxitic	Texture characterized by the parallel arrangement and alteration of layers of different mineral compositions, colors, or banded and flattened pumice.	Presence of distinct, though often thin and sometimes faint, alternating layering. Layering can either be controlled by mineral composition, color, or stretched and flattened pumice.	Varying degrees of eutaxitic texture include weak, moderate, and strong. Faint eutaxitic texture is characterized by weakly discernible or minimal alternating layers and strong eutaxitic texture is characterized by consistent, easily discernible layering,
Lithophysal	Texture characterized by lithophysae, which are vesicles filled with a mineral.	Vesicular cavity contains crystals of feldspar, quartz, and other minerals such as pyroxene or even olivine.	Similar to a vug.
Porphyritic	Texture where macroscopic minerals (phenocrysts) are set in a finer-grained groundmass.	All main mineral phases of the rhyolite are >2 mm in size consistently.	Rare
Aphanitic	Texture where minerals cannot be distinguished without magnification.	Mineral phases are not visible using the naked eye. Mineral phases might be distinguishable using a hand lens or microscope, but are <1 mm.	N/A
Glassy or vitreous	Texture characterized by no distinct or visible crystallization.	Mineral phases are not visible using the naked eye or with magnification. Often looks like obsidian or broken glass.	N/A

Table 4. Description of grain size and name.

["Lower diameter and upper diameter" columns give the upper and lower dimensions for each grain size name. "Grain size name" column provides the name given to the grain being described if it falls between the upper and lower dimensions. "Group name" column lists the common, less-detailed name given to the grain sizes. Modified from Wentworth (1922). Abbreviations: mm, millimeter; >, greater than; <, less than]

Lower diameter (mm)	Upper diameter (mm)	Grain size name	Group name
256	>256	Boulder	Gravel
128	256	Coarse cobble	Gravel
64	128	Fine cobble	Gravel
32	64	Very coarse pebble	Gravel
16	32	Coarse pebble	Gravel
8	16	Medium pebble	Gravel
4	8	Fine pebble	Gravel
2	4	Very fine pebble	Gravel
1	2	Very coarse sand	Sand
0.5	1	Coarse sand	Sand
0.25	0.5	Medium sand	Sand
0.125	0.25	Fine sand	Sand
0.06	0.125	Very fine sand	Sand
0.008	0.06	Silt	Mud
<0.004	0.008	Clay	Mud

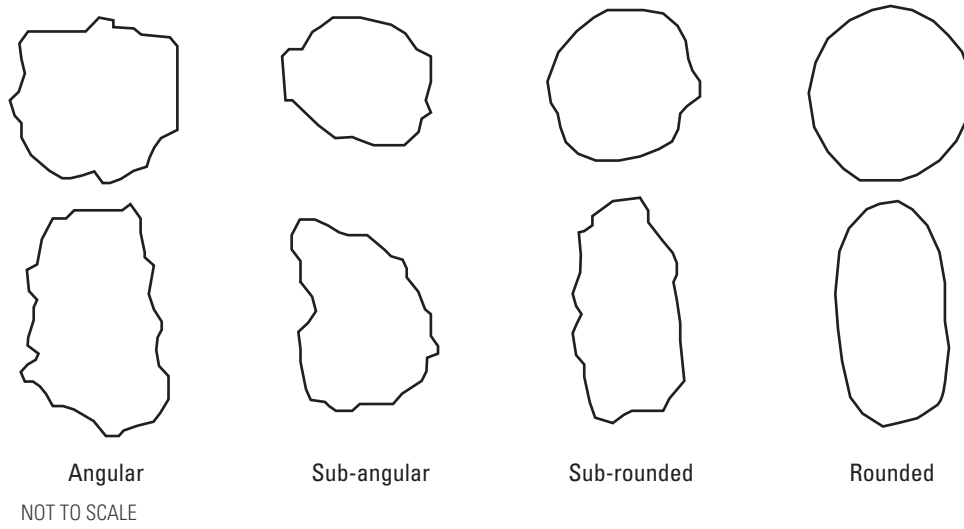


Figure 9. Schematic diagram illustrating different degrees of rounding for circular (top) and oblong (bottom) sedimentary grains as modeled after Compton (1985).

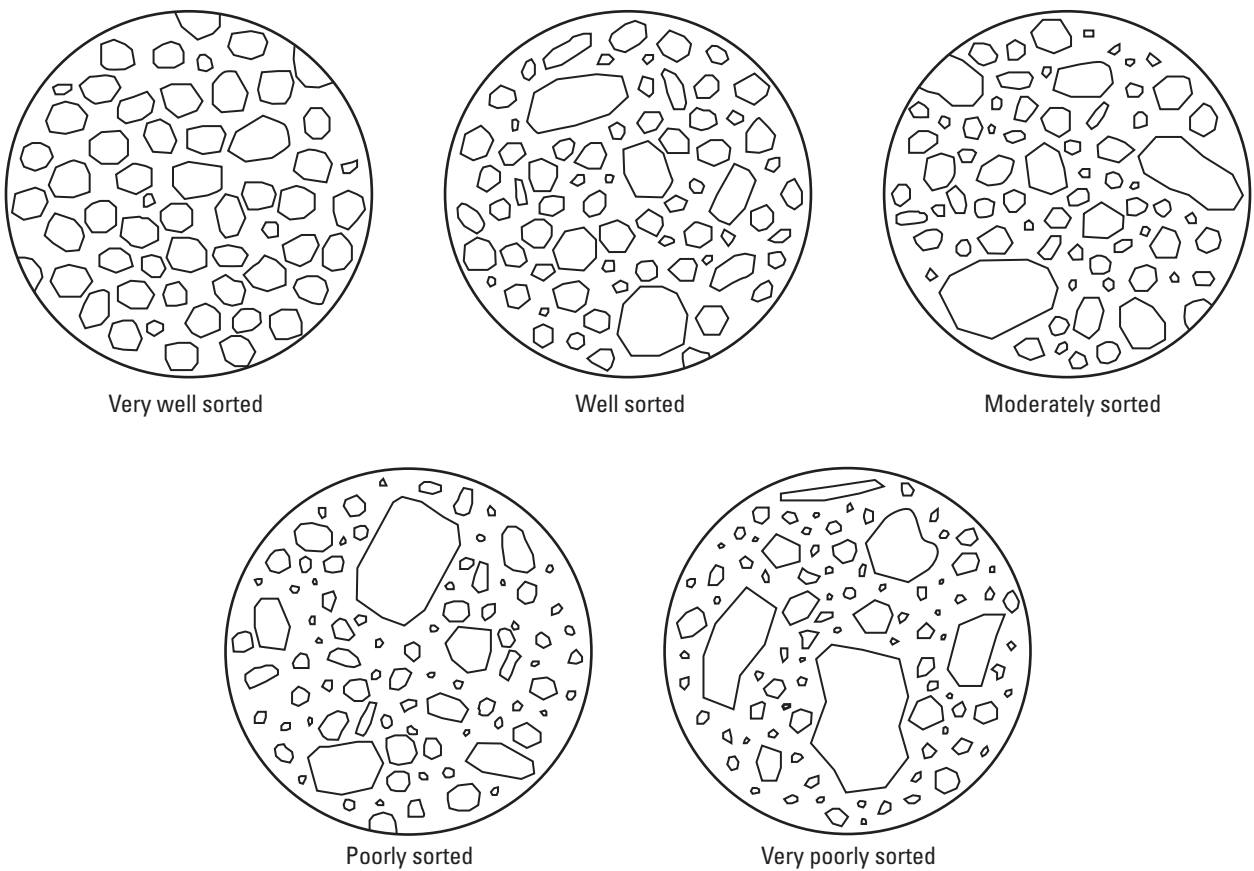


Figure 10. Schematic diagram illustrating different degrees of sorting in sedimentary intervals, similar to model in Compton (1985).

Table 5. Description of packing types and how to recognize each type in core stored at the Lithologic Core Storage Library.

[“Packing” column provides the name of the type of packing being described. “Definition” column displays the definition of the packing adapted from the Glossary of Geology by the American Geosciences Institute (2025) and Retallack (1988). “Description” column provides a list of potential defining features or characteristics of the packing to help the logger identify that packing in the core. “Additional comments” column provides additional descriptions, recommendations for logging, and other characteristics of the packing not included in the previous columns. Abbreviations: cm, centimeter; mm, millimeter]

Packing	Definition	Description	Additional comments
Single-grained	No peds; disaggregated, loose sediment with no cohesion.	Interval consists of disaggregated grains with no cohesion.	Interval often consists entirely of loose sand or silt; always accompanied by a loose consistence.
Massive	Peds occur as large clods.	The interval consists of large clods of sediment that are hard to break apart. It can be challenging to choose an individual ped.	Closest texture to consolidated sedimentary rock.
Granular	Peds occur as individual, pebble-sized pieces of sediment.	Individual peds are subrounded to rounded and generally do not exceed the size of coarse pebbles. Peds are often disconnected from each other and move freely.	Peds of this texture resemble crumbs.
Blocky	Peds occur as irregular blocks of sediment.	Individual peds are angular to subangular and range in size from coarse pebble to very coarse pebble. Peds are often disconnected from each other and move freely.	Peds are generally larger and more angular in this texture than in intervals with granular texture.
Platy	Peds occur as thin, flat plates of sediment.	Individual peds are flat layers that are often stacked on each other. Layer thickness generally ranges from 1 mm to over 10 cm.	Similar to lamination in a consolidated sedimentary rock.
Prismatic	Peds occur as vertical columns of sediment that stretch up to a few cm long.	Individual peds are columns that generally range from 1 to over 10 cm tall with a width that is generally less than a few cm.	Peds can have flat or domed top as used here.

Assigning Structures

Also included in the texture category of a lithologic description is a place to note any igneous and sedimentary structures (table 6). It is beyond the scope of this document to account for every possible structure in CSL core.

For any igneous and sedimentary structure, the logger should note the depth (single occurrence, given in feet BLS) or interval (multiple occurrences, given in top and base in feet BLS) of the structure, its recurrence interval (that is, how many times it occurs in the interval), and if the structure seems to be controlled or influenced by any other features of the core (for example, fractures, banding, and grain size change). Using these observations and table 6, the logger also needs to name the structure. If there is a structure present in the core but not mentioned in table 6, the logger should alert the CSL Custodian and describe the structure as much as possible. These descriptions should include the same information mentioned above, as well as the shape, overall appearance, and size of the structure.

Common igneous structures include vesicle alignments such as vesicle sheets and vesicle cylinders, emplacement features such as flow molds and spatter, and select textural characteristics such as rheomorphic folding and lithophysae (table 6). Common sedimentary structures include bedding features such as trough-crossbeds, bedding types such as massive, thin, or graded bedding, and additional features such as mud cracks and root casts (table 6). If a logger recognizes

any of these structures, the logger should note the depth or interval of the structure and describe any additional information such as size, shape, and extent in the texture category of the lithologic description.

Assigning Composition

To fully describe the composition of an interval, the logger must describe the visual and physical characteristics of every mineral and other major components like lithics and pumice to the best extent possible. Composition descriptions are limited by visibility factors such as grain size, lighting, and individual eyesight. However, all composition and mineral descriptions should include:

- Name: If known, name the mineral being described. If unknown, describe the mineral in the following format and include any other possible identification information like hardness, cleavage, and luster.
- Size: Mineral size should be given in mm (table 4). Include maximum and minimum mineral size and any textural terms related to grain size (figs. 9, 10)
- Color: Describe the general color of the mineral using common colors; do not use the Munsell color chart. Add qualifiers as needed such as “light” or “dark.” List all the colors or give a range of the colors the mineral exhibits.

- **Shape:** Describe the overall or average shape the mineral has. Include any textural terms related to mineral shape (table 7).
- **Concentration:** Concentration refers to the composition by volume of a macroscopic mineral present in the given interval. Concentration is estimated using best judgement and standardized figures (app. 4). While the most accurate representation of concentration comes from point-counting a thin section, the concentration recorded here can be used to compare relative mineral abundance across different intervals.
- **Mineral alteration:** Describe the type, nature, and visual properties of any altered minerals. Descriptions can include but are not limited to color, name, location of the alteration in the mineral, and any visible controls on the alteration like banding, fractures, or other internal arrangements within the interval.

Igneous Composition

The composition category for an igneous rock includes a description of each mineral and the groundmass. Minerals are described using the format mentioned previously. Common minerals in eastern Snake River Plain basalts include olivine and plagioclase. Clinopyroxene is also common but usually too small to detect without a petrographic microscope and is therefore not expected to be described here. Common minerals and components of eastern Snake River Plain rhyolites include quartz, lithics, and pumice. Descriptions for pumice, lithics, and minerals should follow the mineralogic format as much as possible. Because the mineralogical components of a groundmass are generally too small to differentiate, an overall description of the color, grain size, and (or) texture is usually sufficient (for example, basalt groundmass is aphanitic and dark gray).

Sedimentary Composition

A category to describe the composition is included for consolidated and unconsolidated sedimentary intervals. For each mineral that is large enough to be recognized and identified, the logger should note the size, color, shape, concentration, and alteration of the mineral. The logger should also note the degree of rounding in the mineral (Compton, 1985) (fig. 9). Any lithics in the interval should be described as if they were minerals. The composition of the cement is described separately and not included here (see section “cement”). If the interval consists dominantly of fine sand to clay and it is difficult to obtain a quantitative estimation of concentration, the logger may use the qualitative terms in appendix 3, table 3.1 to estimate relative abundance of minerals and lithics.

Assigning Alteration

Alteration is a change in the physical, chemical, or mineralogical composition of a rock that occurred after its formation. Physical and chemical alteration is noted here, while mineral alteration is noted in the composition category of the lithologic description. Noticeable aspects in the core related to physical or chemical alteration include but are not limited to staining, spotting, or color changes in the core that cannot be attributed to changes in lithology or texture alone. When describing alteration, the logger should include its interval, prevalence and extent, color, and texture. Color should be described using the Munsell color chart as much as possible. The logger should also note if the alteration follows any other structures, patterns, or other features in the core. Sediment and (or) calcium carbonate in fractures and vesicles are also a form of alteration and should be recorded here. If the alteration is sediment in fractures and vesicles, the logger should include a general grain size, composition, and reaction to hydrochloric acid (HCl) of the sediment if possible.

Assigning Xenoliths

A xenolith is a fragment of rock that is incorporated into a magma before the magma cools and solidifies around it. Xenoliths are most often found in basalt and intermediate igneous rocks. Xenoliths are rare in the basalts and intermediate rocks stored at the CSL, but possible. If the interval does not have a xenolith, which is most likely, the recommended way to fill out this section of the lithologic description is to write “None noted.” If the interval does have a xenolith, the logger must describe the xenolith as if the xenolith is its own lithologic interval. The description for the xenolith needs to follow the lithologic description for the rock type it shares.

Assigning Consistence

The consistence of an interval is assessed for unconsolidated sedimentary intervals. Consistence is the degree of how resistant a ped is to being crushed or deformed, where a ped is a collection of grains aggregated together. To assess consistence, the logger chooses a ped (already broken, loose in the box, and <1 cm) or breaks a subunit off a larger (>1 cm) ped. The ped is then pinched between the logger’s fingers, and its deformation behavior indicates the consistence of the interval (table 8). Testing one or two peds per interval is sufficient to estimate the interval’s consistence. It is possible for an interval to have a range in its consistence if more than one kind of ped exists. Table 8 lists expected types of ped deformation and how to recognize each. If the interval consists of very loose, mostly to completely unconsolidated grains, the interval has a loose consistence. The shape of the individual peds and how the peds interact with each other is called packing and is described as part of the interval’s texture (table 5).

Table 6. Description of igneous and sedimentary structures, including their definitions and how to recognize each in core stored at the Lithologic Core Storage Library.

["Structure" column provides the name of the structure being described. "Definition" column provides the definition of the structure adapted from the Glossary of Geology by the American Geosciences Institute (2025). "Description" column provides a list of the potential defining features or characteristics of the structure to help the logger identify that structure in the core. "Additional comments" column provides additional descriptions, recommendations for logging, and other characteristics of the structure not included in the previous columns. Abbreviations: cm, centimeter; in., inch; ~, approximately; >, greater than; <, less than]

Structure	Definition	Description	Additional comments
Basalt and intermediate rocks			
Vesicle plane	A linear structure of vesicles aligned in a single row.	Consists of a series of vesicles that are aligned in a linear pattern along a singular row. The alignment of vesicles is often straight or curves gently. A vesicle plane ranges in length from 1 to ~5 cm and ranges in width from <1 to ~2 cm depending on vesicle size.	Similar to vesicle sheet but contains only one row of vesicles.
Vesicle sheet	A linear structure of vesicles aligned in multiple, stacked rows.	Consists of a series of vesicles that are aligned in a linear pattern along two or more stacked rows. The alignment of vesicles is often straight or curves gently. A vesicle sheet ranges in length from 1 cm to ~5 cm and ranges in width from <1 cm up to ~10 cm depending on vesicle size.	Contains multiple rows of vesicles stacked on top of each other.
Vesicle cylinder	A zone of vesicles arranged in a cylindrical shape.	Consists of abundant vesicles arranged in an overall cylindrical shape. A vesicle cylinder ranges in length from 1–30 cm and ranges in width from <1 cm up to a few cm.	Vesicles are arranged in the shape of a cylinder. The vesicles themselves are not cylindrical in shape.
Pipe vesicle	A slender, vertical cavity.	Consists of one or more slender vertical cavities that range in length from 1–30 cm and range in width from <1 cm up to a few cm.	The cavity is often caused by vapor streams and generally occurs near the base of a flow.
Megavesicle	A vesicle that widely exceeds the average vesicle size of the given interval.	A vesicle that is unusually large for the given interval. The size of the vesicle falls far outside the range of vesicle sizes in the interval by at least 2 cm.	An interval can have more than one megavesicle. Logger should note the depth of all megavesicles. Megavesicles are often elongated in width but generally small in length.
Flow mold	A feature that preserves the upper contact of a flow.	Indicated by ropy or wavy structures, including preserved pahoehoe features.	Flow molds are often not preserved, and so they are often located near broken edges of drill core along the horizontal plane. A flow mold indicates the top of a flow when it is preserved.
Spatter	Droplets of erupted basaltic material.	Consists of rubbly, broken basalt cinders that were not created from drilling. The cinders are often sharp, small, oxidized to a reddish-gray, and contain very small (<0.05 in.) vesicles. Sometimes the spatter is molded from the air, which occurs as the material erupts.	Presence of spatter indicates that the source of the eruption is near where the corehole was drilled.
Rhyolite			
Lithophysae	Vesicles that are filled with one or more minerals.	Vesicular cavities that contain crystals of feldspar, quartz, and other minerals.	The logger should note in the lithologic description the name and size of the minerals the lithophysae are filled with and the size and shape of the vesicle.
Spherulites	Spherical bodies of radiating mineral fibers.	Rounded, spherical features consisting of mineral fibers radiating from a central point. Spherulites range in size from <1 cm to a few cm in diameter.	The logger should note in the lithologic description the average size of the spherulites, the qualitative concentration of the spherulites in the interval, and what mineral the spherulites are made of.
Rheomorphic folding	An area where the rock has deformed by flow.	Swirled or curvy features in the rock indicated by banding or a change in color or composition. The interval appears as if the rhyolite has deformed like a fluid.	The logger should note in the lithologic description the interval where rheomorphic folding is present by giving the top and base of the interval in feet below land surface.

Table 6. Description of igneous and sedimentary structures, including their definitions and how to recognize each in core stored at the Lithologic Core Storage Library.—Continued

[“Structure” column provides the name of the structure being described. “Definition” column provides the definition of the structure adapted from the Glossary of Geology by the American Geosciences Institute (2025). “Description” column provides a list of the potential defining features or characteristics of the structure to help the logger identify that structure in the core. “Additional comments” column provides additional descriptions, recommendations for logging, and other characteristics of the structure not included in the previous columns. Abbreviations: cm, centimeter; in., inch; ~, approximately; >, greater than; <, less than]

Structure	Definition	Description	Additional comments
Rhyolite—Continued			
Bubble shards	A glassy fragment formed by the disintegration of pumice during or after an eruption.	Sharp, irregular fragments often in voids or cavities. Sometimes the fragments are curved.	The logger should note the qualitative concentration of the bubble shards and the interval bubble shards are present by giving the top and base of the interval in feet below land surface.
Sedimentary rocks			
Root cast	A tubular opening caused by a root that was later filled with other material.	Slender, nearly vertical downward branching structure. The fill can be a different material than the rest of the interval, indicated by change in color, grain size, or composition.	Occasionally the drill core cuts across the root cast and produces a cross section instead; the cross section is a circular opening with a diameter of a few mm up to 1 cm .
Fossil	Remains or trace of an animal or plant.	Includes any evidence of biological activity such as burrows, tracts, or physical material such as bone.	Includes fossils in lithics and other rock types such as limestone.
Mud cracks	Irregular fractures caused by sediment shrinking as it dries.	Crude, polygonal pattern of sediment separated by cracks.	Cracks could potentially be filled with some other material, as indicated by a change in composition or grain size.
Ripple marks	Wavelike structure caused by movement of water or wind over loose sediment.	Indicated by wavy layers of sediment or grain size variation that occurs in troughs or other wave-like shapes.	Can be symmetrical or asymmetrical.
Erosional contact	A contact between two different lithologies caused by erosion.	Contact between the two lithologies can appear asymmetrical, wavy, or non-planar. The upper lithology potentially contains clasts of the underlying lithology.	The type of contact is often not preserved in drill core because of recovery.
Large clasts	One or more clasts in a sedimentary rock that widely exceeds the average clast size for that interval.	A constituent, grain, or fragment of rock that is unusually large (at least an order of magnitude) for the given interval.	Large clasts per interval should be rare, occurring only once or twice, to maintain the stark size difference. The logger should note the size, shape, and rock type of large clasts in the lithologic description
Massive bedding	An interval that lacks discernable bedding.	Interval occurs in thick, homogeneous beds without any other visual structures.	Only occurs in consolidated sedimentary intervals.
Thin bedding	An interval with multiple, thin beds.	Interval occurs in multiple beds that range in thickness from <1 cm up to ~30 cm.	Only occurs in consolidated sedimentary intervals.
Graded bedding	An interval with beds that display a progression of grain sizes.	Interval contains beds with grain sizes that gradually and progressively change either in the same bed or across multiple beds.	Normal bedding is where the grain size fines upward (coarse at the base); reverse bedding is where the grain size fines downward (coarse at the top). The logger should note if the grading is reversed or normal and indicate the grain sizes in the lithologic description.
Cross bedding	An interval with one or more beds that are angled within the overall sedimentary package caused by the movement of wind or water.	Interval contains one or more beds that are striated or inclined within a larger bedding structure.	The logger should note the type of cross bedding (for example, planar, trough, chevron, angular) and the thickness of the cross beds in the lithologic description.

Table 7. Description of textural terms used to describe minerals, including their definitions and how to recognize them in core stored at the Lithologic Core Storage Library.

["Texture" column provides the name of the mineral texture being described. "Definition" column provides definition of the texture adapted from the Glossary of Geology by the American Geosciences Institute (2025). "Description" column provides a list potential defining features or characteristics of the texture to help the logger identify that texture in the core. "Additional comment" column provides additional descriptions, recommendations for logging, and other characteristics of the consistency not included in the previous columns. Modified from Retallack (1988). Abbreviations: N/A, not applicable]

Texture	Definition	Description	Additional comments
Euhedral	A mineral with well-formed crystal faces.	Crystal faces are well defined on all edges.	Commonly used to describe minerals in igneous rocks.
Subhedral	A mineral with partially formed crystal faces.	Crystal faces are well defined on some edges.	Commonly used to describe minerals in igneous rocks.
Anhedral	A mineral lacking developed crystal faces.	Crystal faces are not well defined across most or all edges.	Commonly used to describe minerals in igneous rocks.
Equant	A mineral that has the same or nearly the same diameter in all directions.	The mineral is the same size in all directions.	Often applies to square or circular minerals.
Tabular	A mineral that displays a shape where two axes are different lengths from each other.	The mineral is two different sizes in two different directions. One axis is much smaller in length than the other axis.	Often applies to rectangular minerals. Commonly used to describe minerals in igneous rocks, especially plagioclase.
Acicular	A mineral that is needle-like in form.	The mineral is shaped like a needle; the mineral occurs as long, slender crystals.	N/A
Fibrous	A mineral that is fiber like in form.	The mineral is shaped like a fiber. A fibrous mineral is similar to an acicular mineral but is generally more blunt and the interval often includes multiple crystals that parallel each other.	N/A
Glomerocrysts	An aggregate of the same mineral.	Multiple crystals of the same mineral cluster together and form a "blob."	Commonly used to describe minerals in igneous rocks. The logger should note the qualitative abundance of the glomerocrysts and their diameter in the lithologic description.
Equigranular	All crystals of the same mineral are the same or nearly the same size.	All occurrences of the mineral are of roughly the same size. The difference in size between the crystals varies little.	Commonly used to describe minerals in igneous rocks. Unimodal is a synonym for equigranular.
Bimodal	Crystals of the same mineral display two distinct populations based on size.	The crystals of the same mineral cluster in two distinct sized populations. The size difference within the two populations varies little.	Commonly used to describe minerals in igneous rocks.

Table 8. Description of sedimentary consistence, including definitions and how to recognize each in core stored at the Lithologic Core Storage Library.

["Consistence" column provides the name of the sedimentary consistence being described. "Definition" column provides the definition of the consistence adapted from the Glossary of Geology by the American Geosciences Institute (2025) and Retallack (1988). "Description" column provides a list of potential defining features or characteristics of the consistence to help the logger identify that consistence in the core. "Additional comments" provides additional descriptions, recommendations for logging, and other characteristics of the consistence not included in the previous columns. Abbreviations: N/A, not applicable]

Consistence	Definition	Description	Additional comments
Loose	Logger cannot choose a ped within the interval.	Interval consists of disaggregated grains with no cohesion.	Interval often consists entirely of loose sand or silt; always accompanied by single-grained texture.
Very friable	Logger can choose a ped within the interval but the ped falls apart before applying pressure.	Interval consists of some aggregated grains (peds), but the peds break apart as soon as the logger handles the peds.	Interval consists of partially loose sand or silt with some cohesion. Peds break before applying any pressure.
Friable	Logger can choose a ped within the interval and the ped breaks with a small amount of pressure.	Interval consists of aggregated grains (peds) that stay aggregated with handling. Peds break easily with minimal pressure.	N/A
Firm	Logger can choose a ped within the interval and the ped breaks with a moderate amount of pressure.	Interval consists of aggregated grains (peds) that stay aggregated with handling. Peds break with some pressure.	Application of pressure to the ped often dents the fingers of the logger.
Very firm	Logger can choose a ped within the interval and cannot break the ped between the fingers.	Interval consists of aggregated grains (peds) that stay aggregated with handling. Peds do not break regardless of pressure between the logger's fingers.	The ped only breaks if hammered. This interval is distinguished from consolidated sediment because the logger can break a ped off the core without using any equipment.

Assigning Strength of Reaction to Acid

The strength of an interval's reaction to hydrochloric acid (HCl) is described for both unconsolidated and consolidated sediment. HCl is the chosen acid because it reacts with calcium carbonate, which often cements sediment grains together or is incorporated into sedimentary intervals by the wind. Assessing the relative amount of calcium carbonate in sediment by judging the strength of its reaction to HCl provides important context for the rest of the lithologic description and core log. Judging the strength of the reaction is ultimately subjective, so consistency is key. [Appendix 3](#) lists qualitative terms with their definitions that a logger should use when describing HCl reaction strength.

To assess the strength of the reaction to HCl, a logger takes an acid bottle filled with dilute HCl, which is provided by the Core Storage Library, and drops 2–3 drops of acid onto the sediment. The logger observes the reaction and assigns a strength to the reaction using the terms in [appendix 3, table 3.1](#). It is a good practice to test reaction strength at multiple locations, especially if there are color, grain size, or textural changes within the interval. If reaction strength changes substantially and for an extended interval (>1 ft), the logger should note the interval and strength of each response. Otherwise, recording an average reaction strength is sufficient.

Assigning Roots and Fossils

Consolidated and unconsolidated sediment intervals occasionally contain evidence of biological activity such as root casts or fossils. For any evidence of biological activity, including fossils, the logger should note its depth or interval of occurrence, size, shape, color, and name of the feature, if possible. Evidence of biological activity is also noted in the "Texture" category because biological activity is included in sedimentary structures. The descriptions do not have to be reproduced in both categories, so describing the biological activity once is sufficient. It is recommended that evidence of biological activity is described here to emphasize its presence and because it helps to limit the length of the "Texture" category.

Assigning Cement

The grains of a cemented consolidated sedimentary interval are held together by a cement. Common sedimentary cements include calcium carbonate, fine-grained particles such as clays, quartz, and iron-oxides (Schoelle, 1979). The logger should describe the composition of the cement to the best of the logger's abilities given grain size and eyesight limitations. Describing the cement follows the same process outlined under the "Composition" category. Cements can be

differentiated from each other by color, hardness, reaction to HCl, and surrounding mineralogy. For example, rocks with calcium carbonate cement will react moderately to strongly with HCl and rocks with quartz cement are generally hard and resistant to breaking. Some consolidated sedimentary intervals are not held together by cement and are compacted instead. For compacted sedimentary intervals, the logger should note in the cement category “No cement—compacted” in the lithologic description.

Other Aspects of a Lithologic Description

Finally, the lithologic description of the core log gives a logger a chance to describe, note, or recognize any other aspect of the core that has not been noted elsewhere. Examples include noting if the core is mislabeled, if the box containing the core was dropped, if there were problems encountered during the logging progress, or if there are other features of the core that were not described elsewhere, such as evidence of faulting or magnetic properties. When describing any feature, the logger should include as much detail as possible, such as depth or interval, color, size, and shape. If the logger chooses to describe any additional aspects, the description should be added at the end of the lithologic description under an optional “Additional notes” category.

Igneous Vesicle Characterization

Basalt is often vesicular, so recording the size and concentration of vesicles provides important context. However, data on vesicle size and concentration are not recorded in the “Texture” category of the lithologic description. Instead, vesicle size and concentration data are collected separately from the lithologic description and constitute a separate portion of the core log. Separate data collection minimizes excessive text and confusion in the lithologic log, organizes data better, and hastens the logging process. In addition, most of the data in a lithologic description are qualitative, while vesicle size and concentration data are quantitative.

Vesicle Size

Any interval of vesicular basalt contains vesicles that vary in size. The logger must record the average vesicle size throughout the interval corresponding to the vesicular basalt. If the vesicle size changes within the interval of vesicular basalt, the logger should establish multiple subintervals to characterize and record the variations. A good practice is to choose an interval where the vesicle size is constant and record the average vesicle size for that interval. When the vesicle size changes, the logger should initiate a new interval and repeat the process. Data collection for every interval includes an estimate of average vesicle size, expressed to the nearest tenth of an inch, and its interval of occurrence given in ft BLS to its top and base (app. 5).

If the vesicle size changes gradually, the logger should attempt to capture the gradual change by recording the average vesicle size in small, frequent intervals, which helps to capture the gradual change in a stair-stepping pattern with a high level of detail.

Vesicle Concentration

Data collection for vesicle concentration follows the same process as data collection for vesicle size. The logger must record the vesicle concentration of the vesicular basalt as a percentage. If the vesicle concentration changes within the interval of vesicular basalt, the logger should establish multiple subintervals to characterize and record the variations. If the vesicle concentration changes gradually, the logger should attempt to capture the change by recording the concentration in small, frequent intervals. Each measurement of vesicle concentration should include the concentration given in whole-number percent and its interval of occurrence (app. 5).

Fracture Frequency

An INLPO core log includes a numerical estimate of the fracture frequency of an interval given on a scale of 0 to 5, where 0 is unfractured and 5 is extremely fractured (table 9; app. 6). Fracture frequency data are collected only for intervals of igneous rocks and consolidated sediment. Fracture frequency data are not collected for intervals of unconsolidated sediment because fractures are not preserved in loose, disaggregated material. When assessing the fracture frequency of an interval, the logger needs to consider both natural and drilling fractures, which are fractures caused by the drilling and storage of core. While fracture frequency includes drilling fractures, the logger must note the depth or interval where drilling fractures occur within the lithologic description under the optional “Additional notes” category; if there are no drilling fractures within the lithologic interval, the logger does not need add any notes related to drilling fractures under “Additional notes.” Drilling fractures are generally horizontal, clean, do not look weathered, and are usually without oxidation, sedimentation, and precipitated minerals.

Assessing fracture frequency is similar to collecting vesicle characterization data. The logger must record an average fracture frequency for igneous and consolidated sedimentary lithologic intervals. The fracture frequency will change throughout the lithologic interval, so the logger should establish multiple subintervals to characterize and record the variation. A good practice is to choose an interval where the fracture frequency is constant and record the fracture frequency for that interval. When the fracture frequency changes, the logger should initiate a new interval and repeat the process. An additional good practice is to include small intervals (<0.3 ft) where fracture frequency changes sharply, especially for very broken or rubbly core and rubble zones, to collect data as accurately as possible. The logger must record the fracture frequency and its interval of occurrence given in feet BLS to its top and base.

Missing Core Intervals

Almost any drill core will be incomplete and have portions missing. Portions of missing core exist for a variety of reasons, including that the interval was not recovered during drilling, was misplaced or lost, or was sampled by a previous researcher. While it is not required, it is good practice to note the interval of missing portions of core. Having this data will be helpful for creating a continuous lithologic log, recording where missing data are expected rather than accidental.

Finalizing a Lithologic Core Log

At the end of the logging process, the logger should have numerous notes of lithologic descriptions and data for vesicle size, vesicle concentration, and fracture frequency in either digital or written format. Regardless of the medium, the logger needs to scan and upload all notes and drafted

logs to the folder structure if the purpose of the core logging is to contribute to CSL records (fig. 5). If the core is logged for research or sampling purposes, sharing the log with CSL personnel is encouraged but not required. The logger also needs to alert the CSL custodian that the logging is complete.

To clean up, the logger needs to replace the lids on all the core boxes and return all equipment to their original locations. The CSL custodian or other CSL personnel will help the logger return the core to the pallets and return the pallets back to the shelves.

If the purpose of the logging was to characterize an entire drill core rather than describe portions of it for a sampling or research campaign, the data that were collected needs to be visualized for effective and easy access by others. The USGS uses proprietary software to compile, organize, and display the data from a lithologic core log. The logger would need to contact the Core Library Custodian to obtain the most recent version of the software and instructions on how to use it.

Table 9. Description of fracture frequency.

["Fracture frequency" column provides the numerical value given to an interval of core to describe the degree of fracturing in an interval. "Fracture extent" column provides a verbal description of how fractured the interval is. "Description" column provides the average length of the pieces of fractured core so the logger can determine the fracture frequency of the interval. "Additional comments" provides additional descriptions of fracture frequency not included in the previous columns. Abbreviations: ft, foot; in., inch; <, less than]

Fracture frequency	Fracture extent	Description	Additional comments
0	Unfractured	No fractures	Because drilling fractures are included in a fracture estimate, and the core must be split to fit in the box, obtaining this fracture frequency is highly unlikely. This fracture frequency is included for comparison purposes.
1	Very slightly fractured	Core averages lengths ¹ of 1–2 ft	Interval averages between 0 and 1 fractures per foot.
2	Slightly fractured	Core averages lengths ¹ of 6–12 in.	Interval averages between 1 and 3 fractures per foot.
3	Moderately fractured	Core averages lengths of 4–8 in.	Interval averages between 3 and 4 fractures per foot.
4	Intensely fractured	Core averages lengths of 1–4 in.	Interval averages between 4 and 7 fractures per foot.
5	Extremely fractured	Core averages lengths of <1 in.	Interval averages greater than 7 fractures per foot; interval mostly consists of chips and fragments of core.

¹Length assumes that core is placed in 2-foot boxes. Length would increase for core placed in boxes of length 2 feet or greater.

Summary

This publication outlines the systematic observations the person logging the drill core, called the “logger,” must make to produce a lithologic core log following Idaho National Laboratory Project Office (INLPO) procedures using core from the Core Storage Library (CSL). The nature and type of observations are determined by the lithology of the interval. The lithology of the interval can be broken into five generalized lithologic names, including basalt, rhyolite, volcanic ash, consolidated sediment, and unconsolidated sediment. The generalized lithologic name controls the specific observations or categories to include in the lithologic core log. For example, all intervals need a description of color, texture, alteration, and mineralogy, but the reaction to hydrochloric acid of the interval needs to only be described for sedimentary intervals and vesicle size and concentration is assessed only for igneous rocks. In addition, all intervals need an assessment of igneous and sedimentary structures, and igneous and consolidated sediments require an assessment of fracture frequency. This publication includes numerous appendixes and figures to guide the logger on choosing the extent and name of lithologic intervals, to recognize select igneous and sedimentary structures and textures, and to standardize numerical assessments of vesicle size, vesicle concentration, and fracture frequency.

This report describes the necessary steps to create an INLPO lithologic core log from discussing how to photograph core boxes to logging the core. By describing the procedures for logging and recommending certain practices, this report standardizes the logging procedures at the CSL across different drill cores and loggers. Following these procedures will produce consistent and detailed lithologic core logs, which are a valuable resource for the Idaho National Laboratory, U.S. Geological Survey, and researchers interested in the eastern Snake River Plain.

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Appendix 1. Digital Logbook

Appendix 1 is a digital logbook designed to aid the logger in recording and organizing data collected throughout the logging process. Appendix 1 is a Microsoft Excel file available for download at <https://doi.org/10.3133/>.

Appendix 2. Sedimentary Ternary Diagrams

Appendix 2 consists of sedimentary ternary diagrams for naming unconsolidated and consolidated sediment intervals based on grain size and composition.

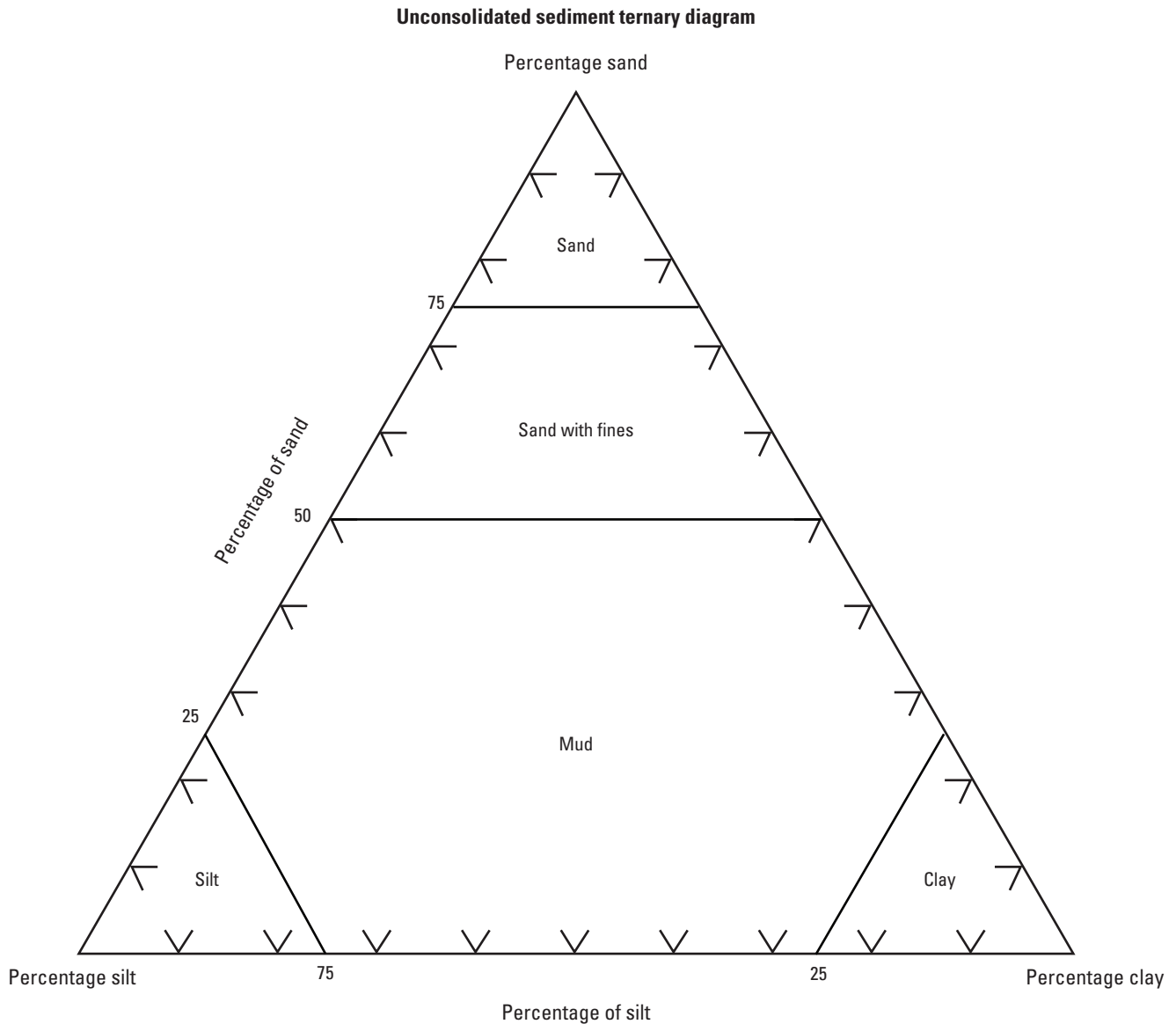


Figure 2.1. Sand-silt-clay ternary diagram for determining the detailed lithologic name of unconsolidated sediment intervals using grain size.

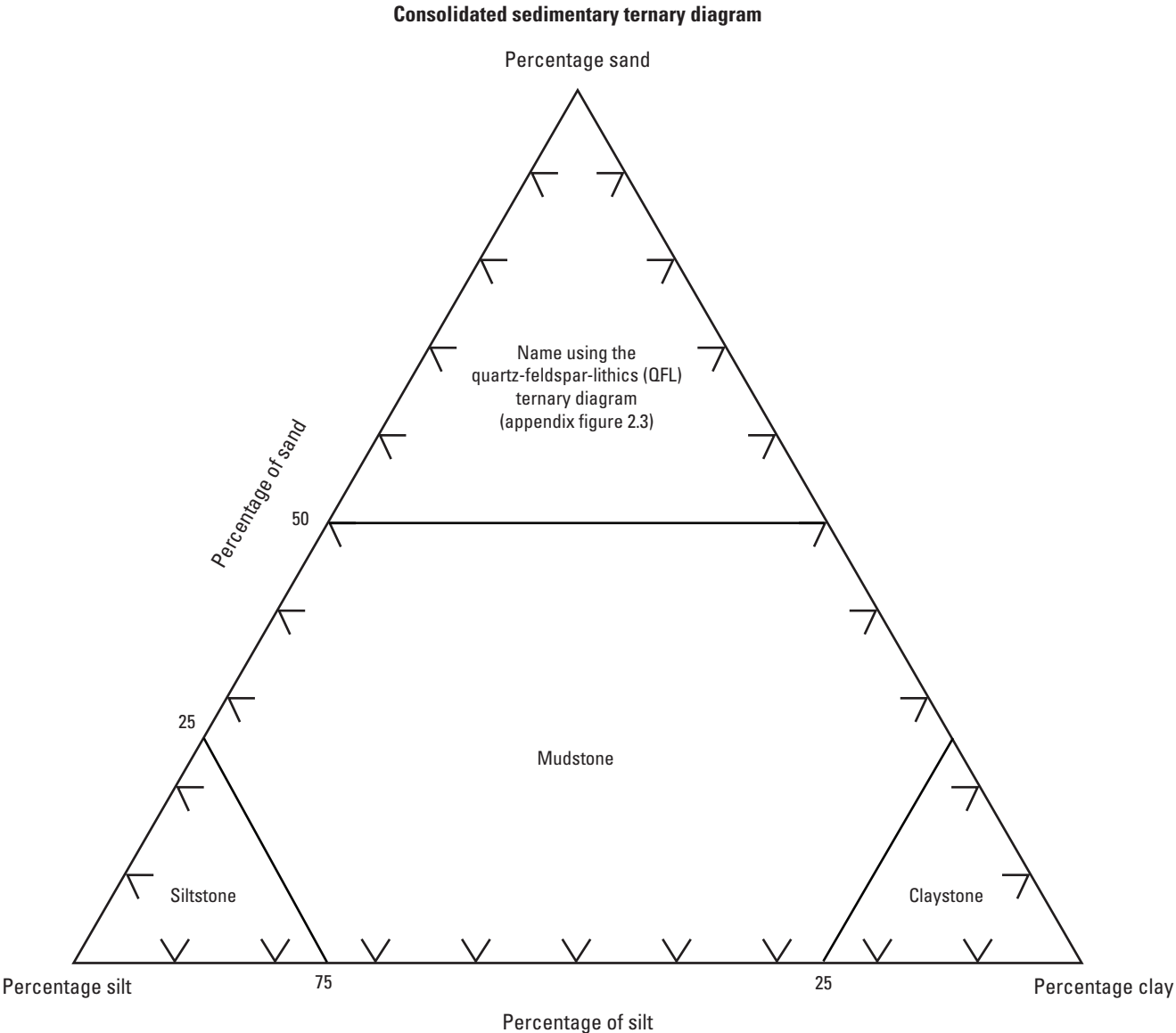


Figure 2.2. Sand-silt-clay ternary diagram for determining the detailed lithologic name of consolidated sediment intervals using grain size.

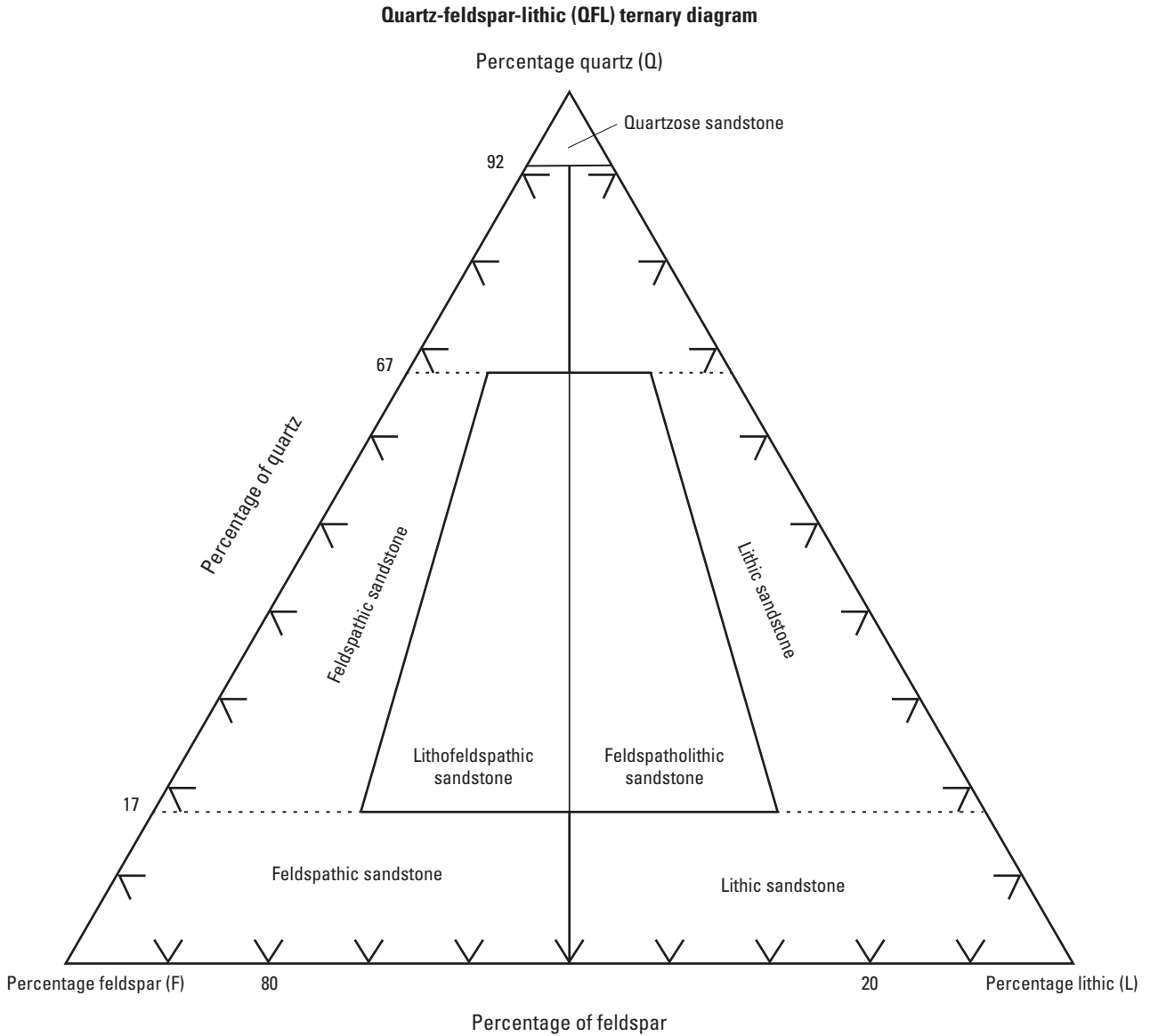


Figure 2.3. Quartz-feldspar-lithic ternary diagram for determining the detailed lithologic name.

Appendix 3. Qualitative Terms for Describing Concentration and Degree in Drill Core

Appendix 3 contains tables of qualitative terms for describing the concentration and degree of a feature within a given interval.

Table 3.1. Qualitative terms for describing the degree of a feature in drill core

Name	Definition	Visual description
Weak	Very slight	Barely noticeable
Mild	Slight	Somewhat noticeable
Moderate	Balanced	Noticeable without effort
Strong	Intense	Easy to notice
Very strong	Very intense	Very easy to notice

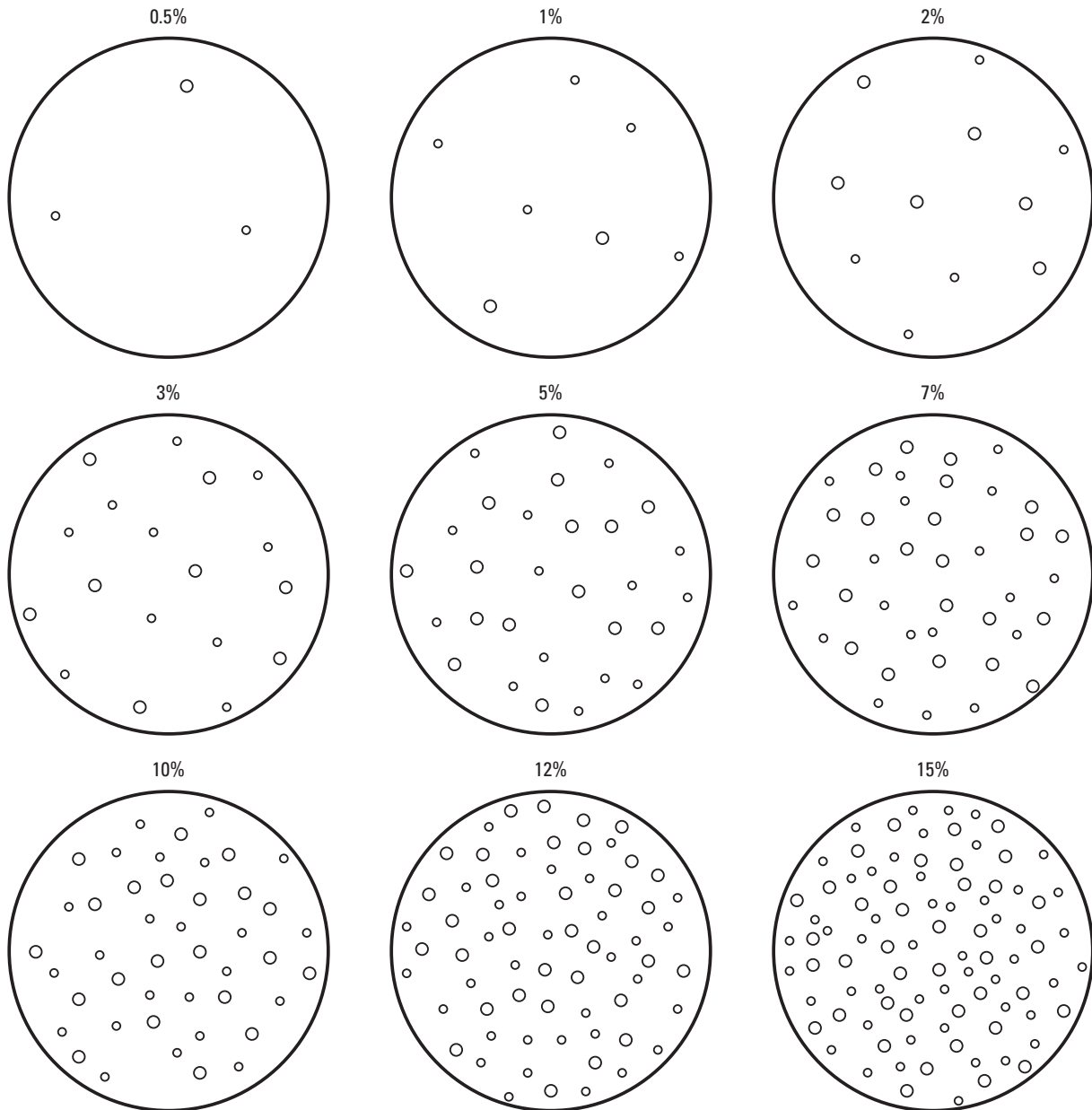
Table 3.2. Qualitative terms for describing the concentration of a feature in drill core

Name	Definition	Visual description
Very rare	Encountered very infrequently	Found very sporadically
Rare	Encountered infrequently	Found sporadically
Uncommon	Encountered occasionally	Found sometimes
Common	Encountered frequently	Found often
Very common	Encountered very frequently	Found very often

Appendix 4. Olivine and Plagioclase Concentration Charts

Appendix 4 contains visual charts for estimating olivine and plagioclase concentration percentage by volume within a given interval.

Olivine concentration percentage by volume

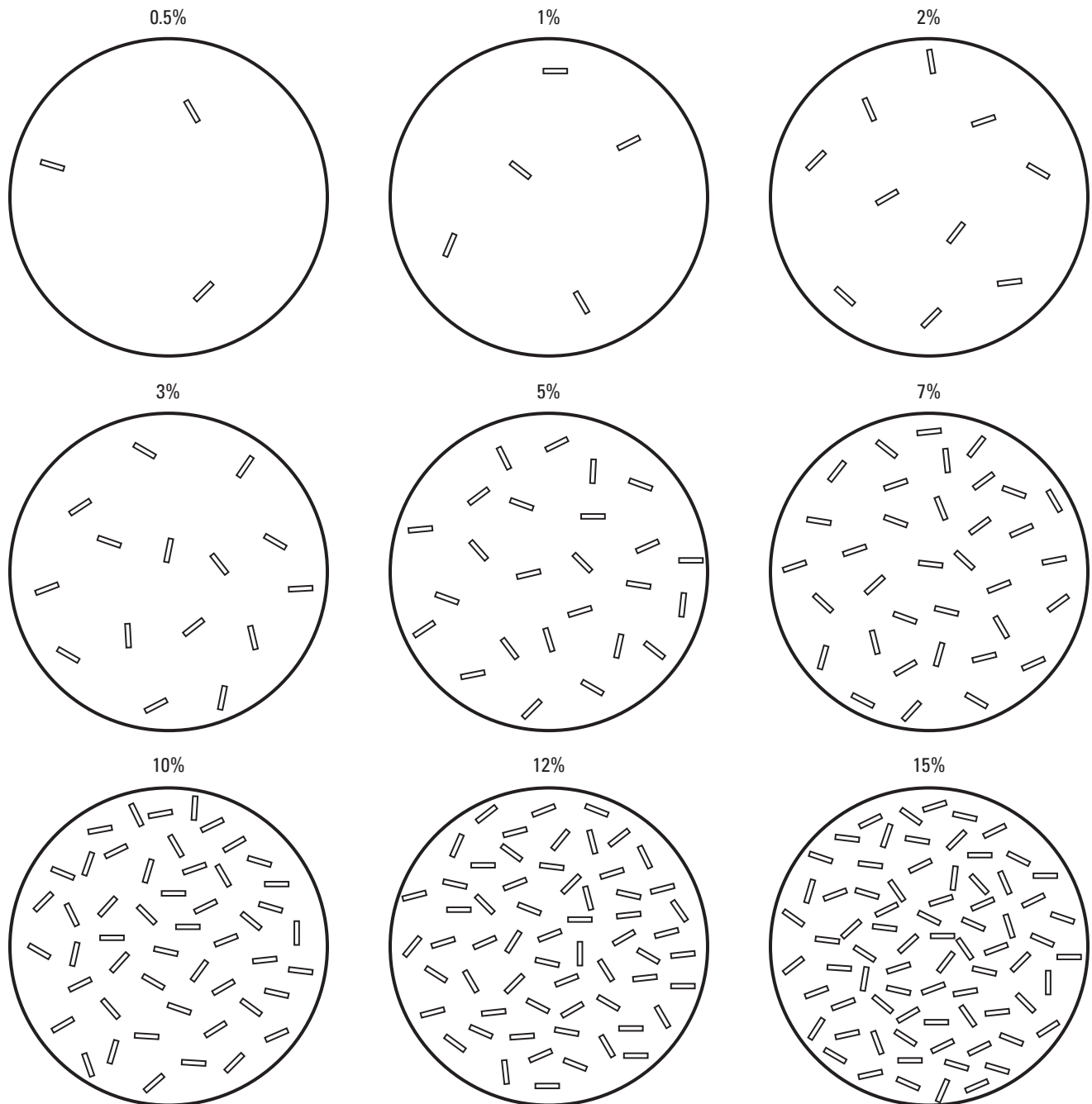


EXPLANATION

- About 1 millimeter diameter olivine (to scale)
- About 2 millimeters diameter olivine (to scale)

Figure 4.1 Diagram showing olivine concentration percentage (%) by volume.

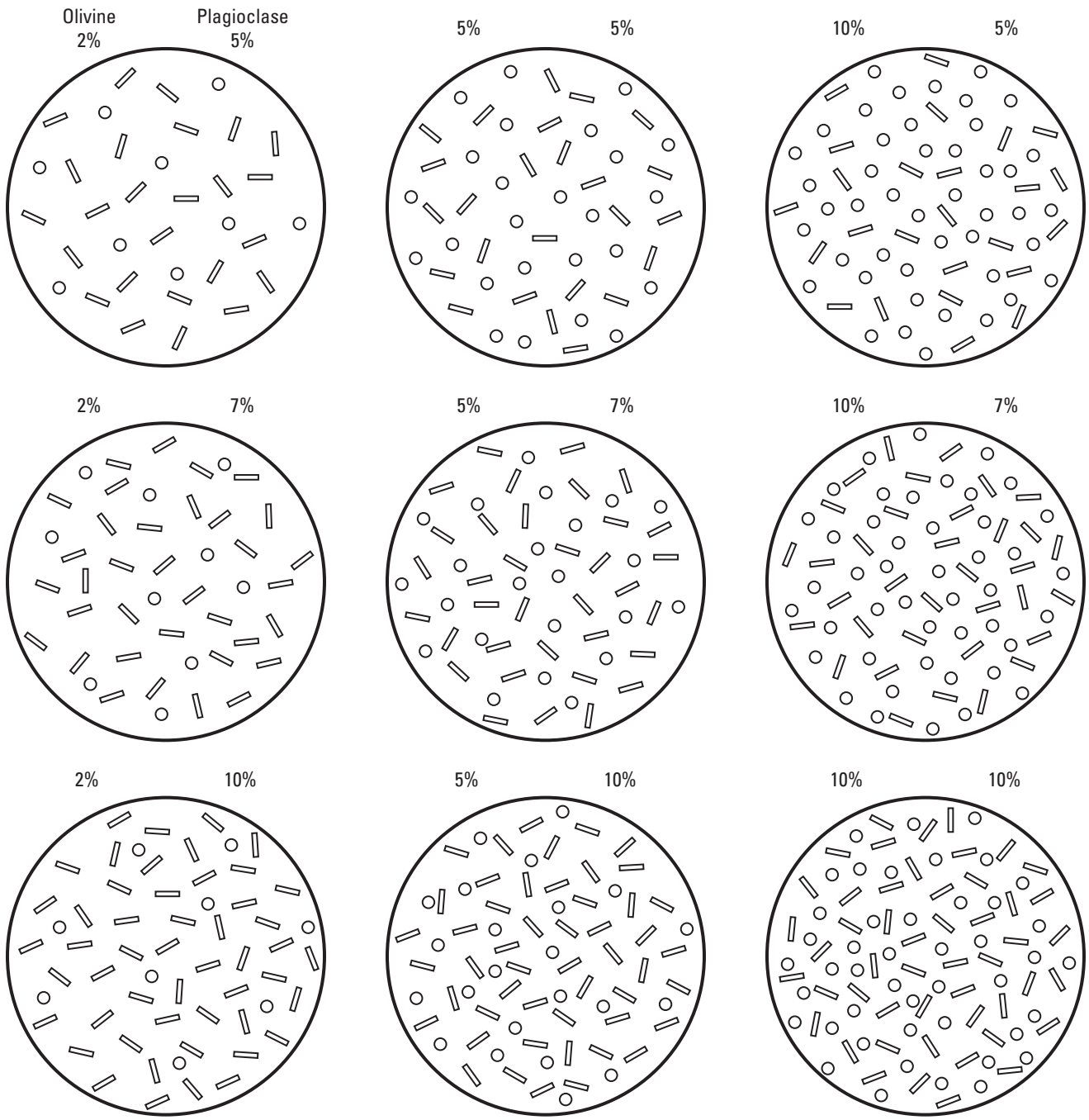
Plagioclase concentration percentage by volume

**EXPLANATION**

— About 4 millimeters width plagioclase (to scale)

Figure 4.2 Diagram showing plagioclase concentration percentage (%) by volume.

Olivine and plagioclase concentration percentage by volume



EXPLANATION

- About 2 millimeters diameter olivine (to scale)
- ▬ About 4 millimeters width plagioclase (to scale)

Figure 4.3 Diagram showing olivine and plagioclase concentration percentage (%) by volume.

Appendix 5. Vesicle Concentration and Size Charts

[Appendix 5](#) contains visual charts for estimating vesicle concentration percentage and vesicle size within a given interval.

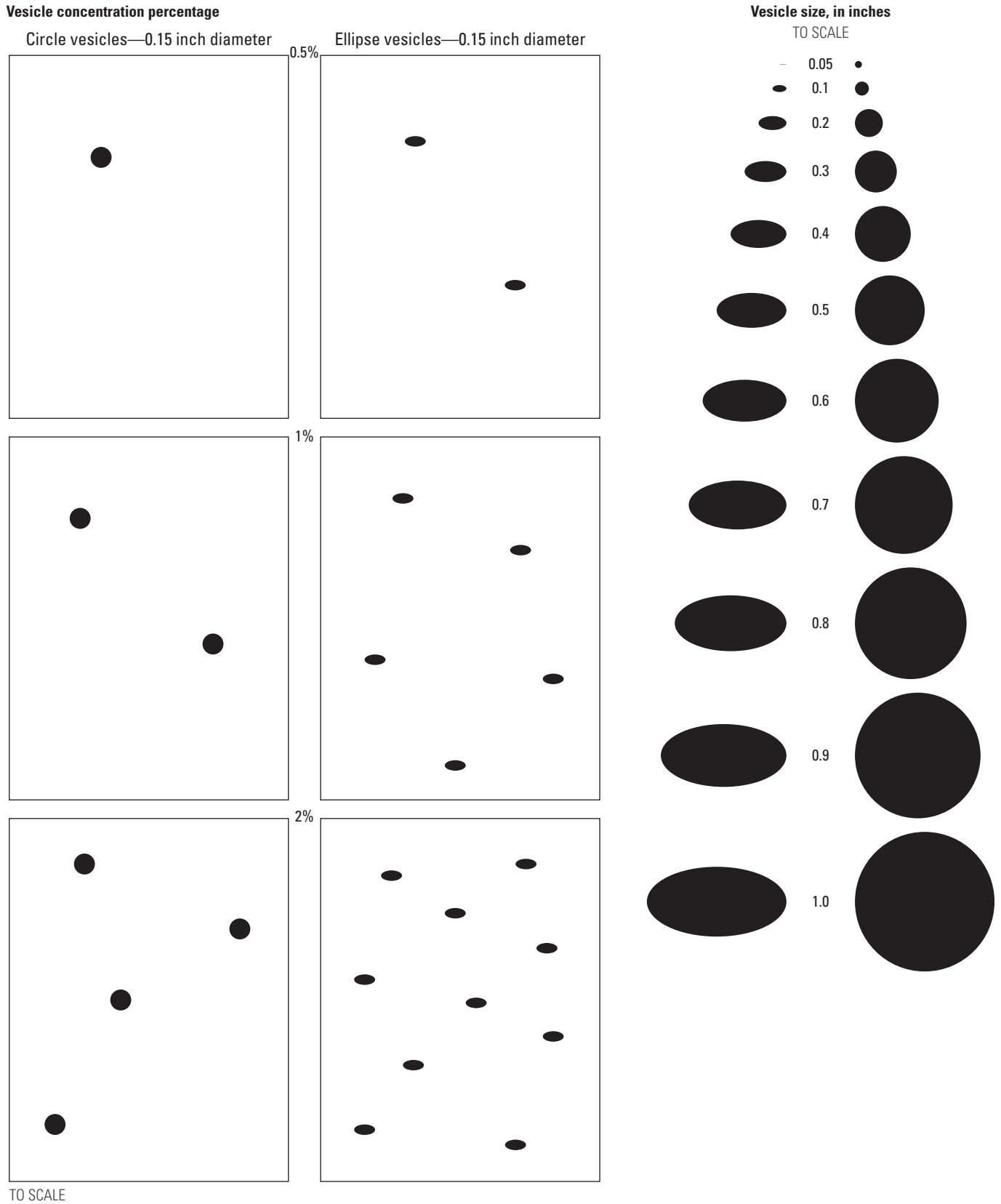


Figure 5.1 Diagram showing vesicle concentration percentage (%) and vesicle size.

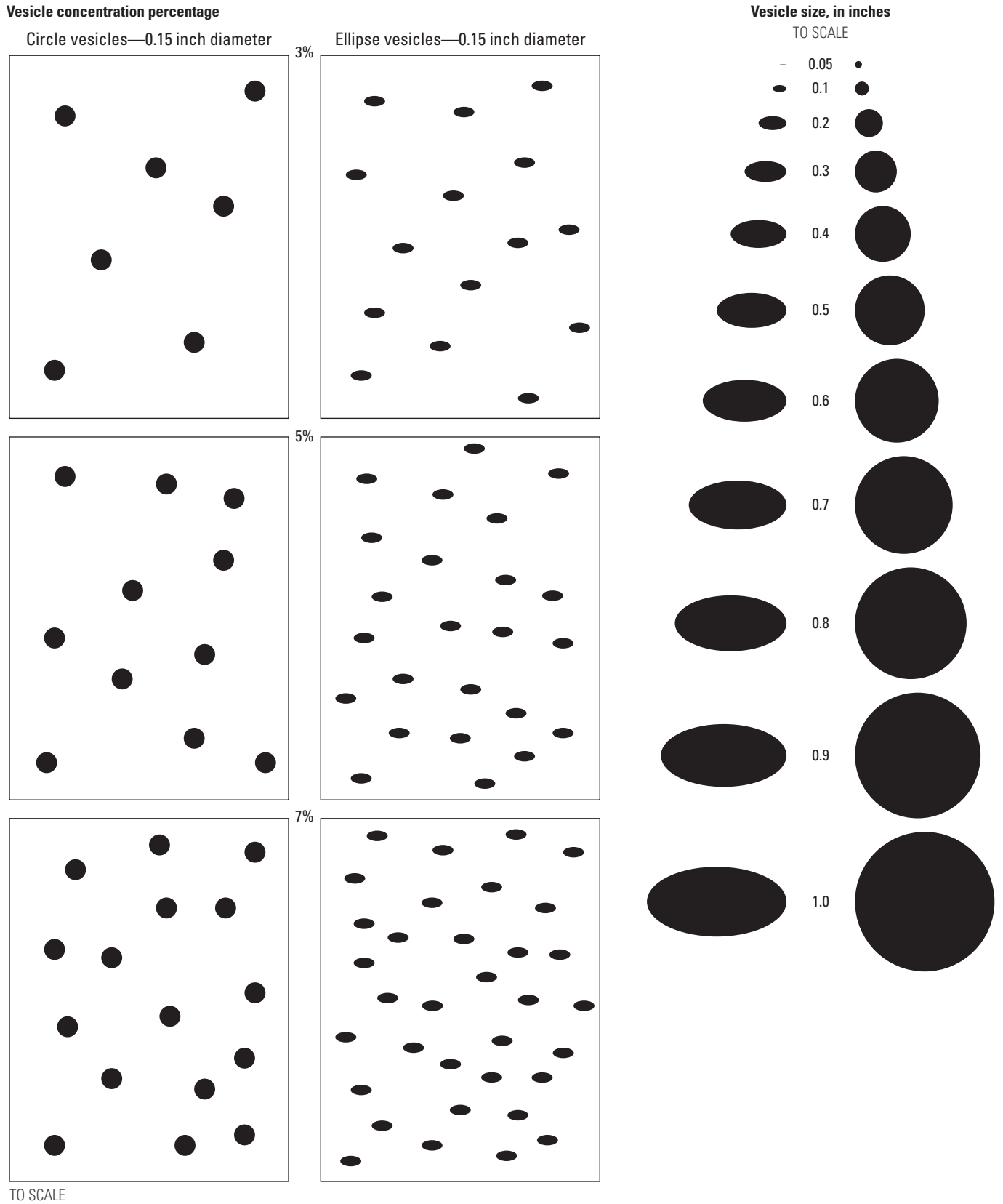


Figure 5.2 Diagram showing vesicle concentration percentage (%) and vesicle size.

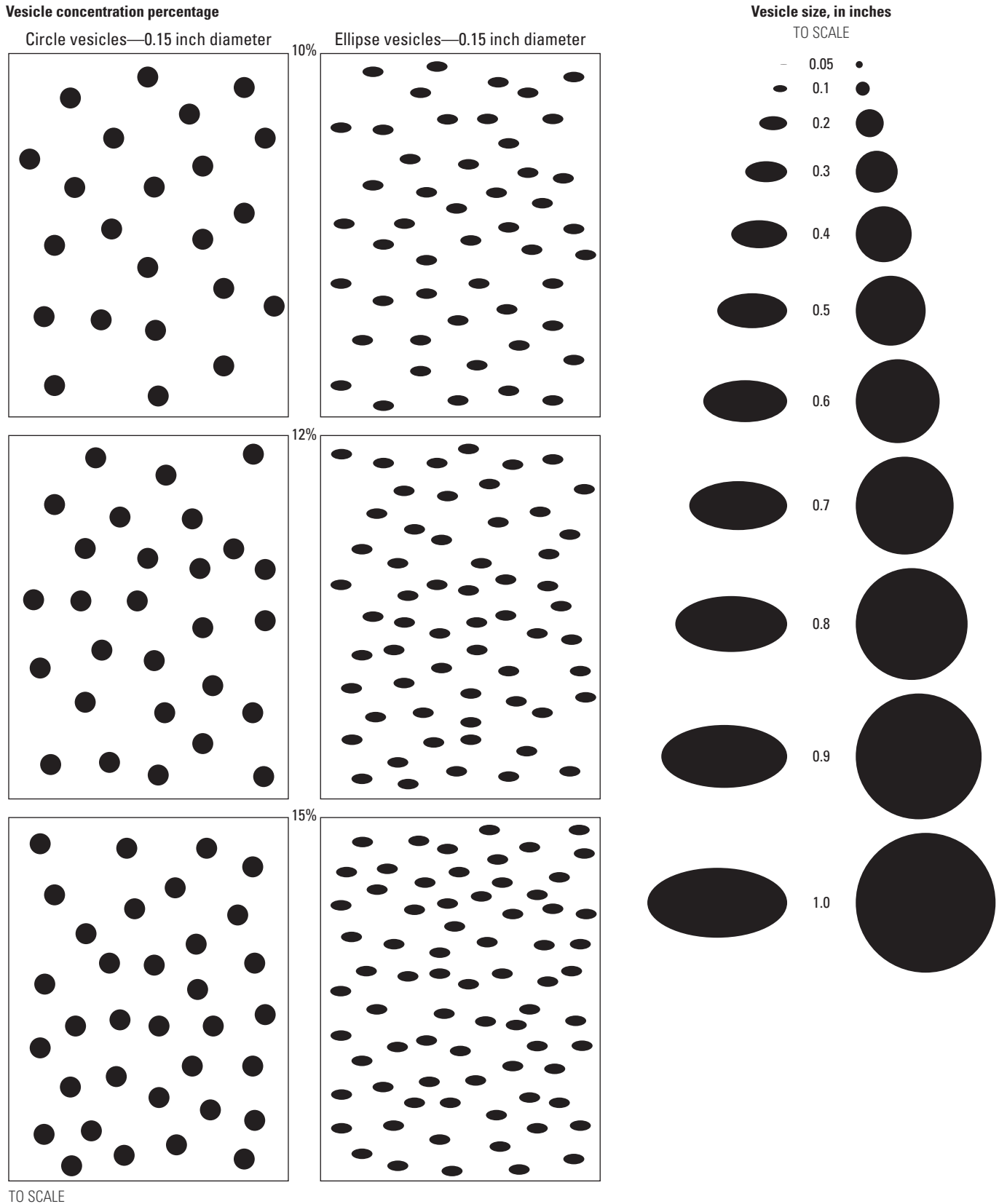


Figure 5.3 Diagram showing vesicle concentration percentage (%) and vesicle size.

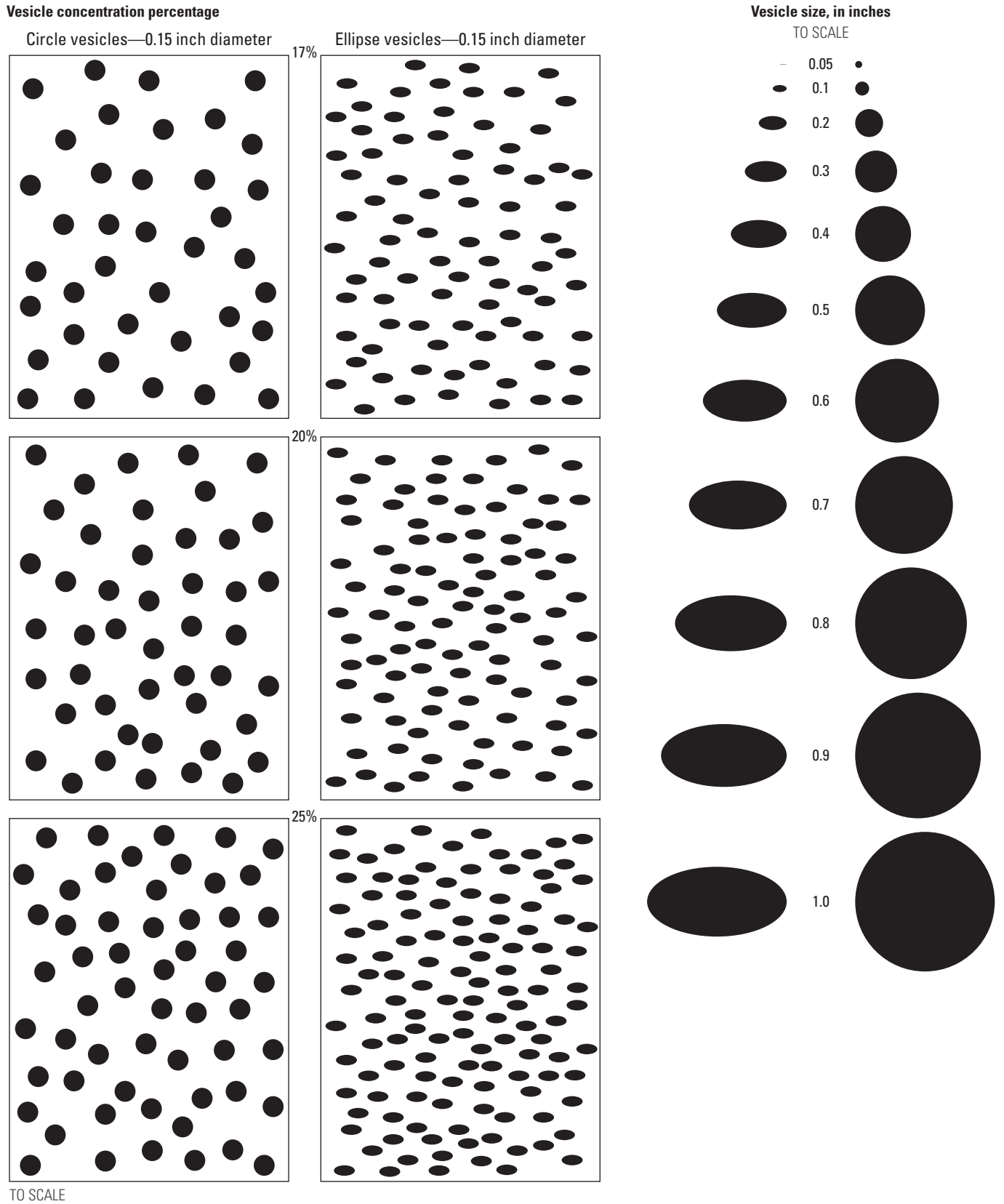


Figure 5.4 Diagram showing vesicle concentration percentage (%) and vesicle size.

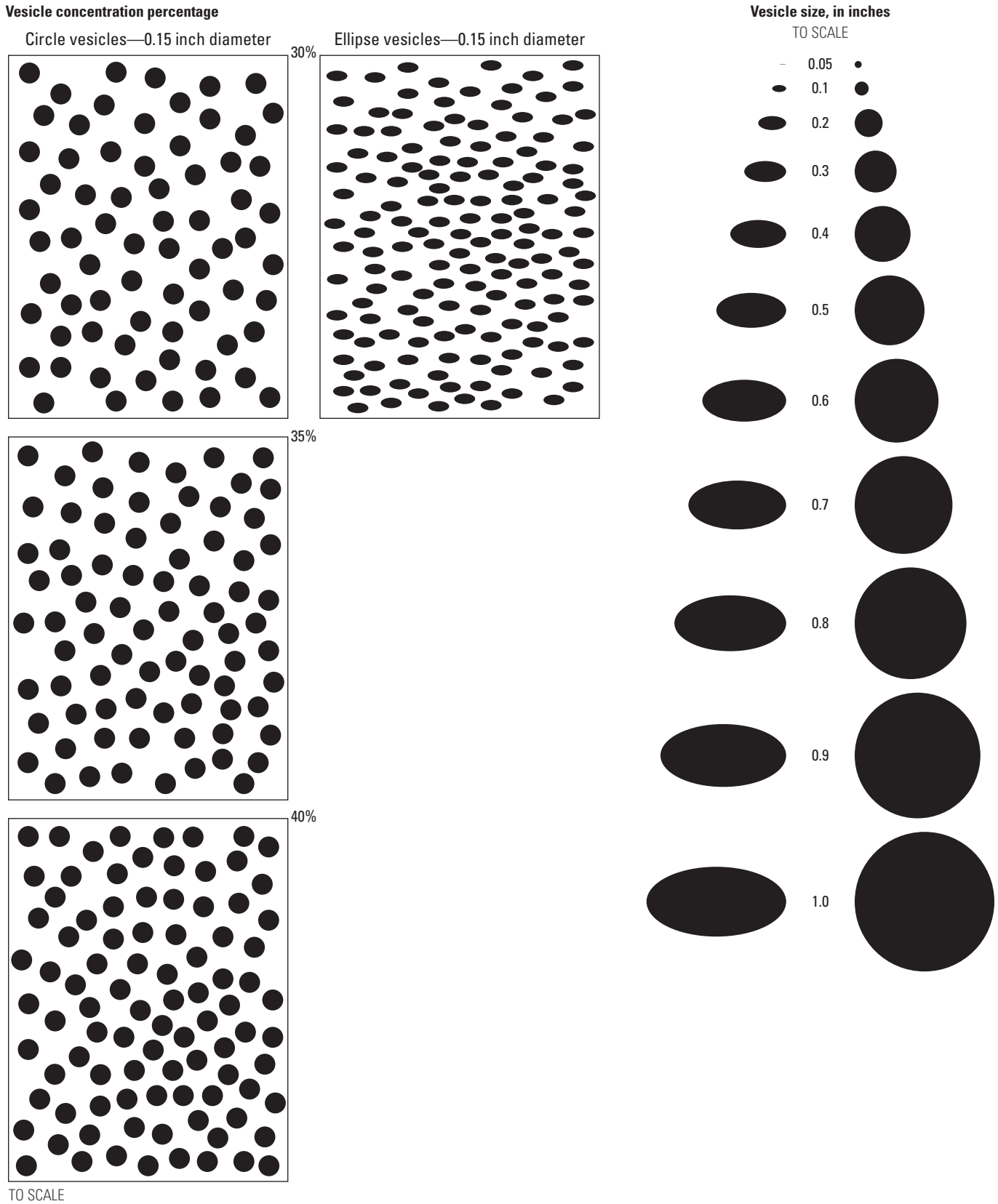


Figure 5.5 Diagram showing vesicle concentration percentage (%) and vesicle size.

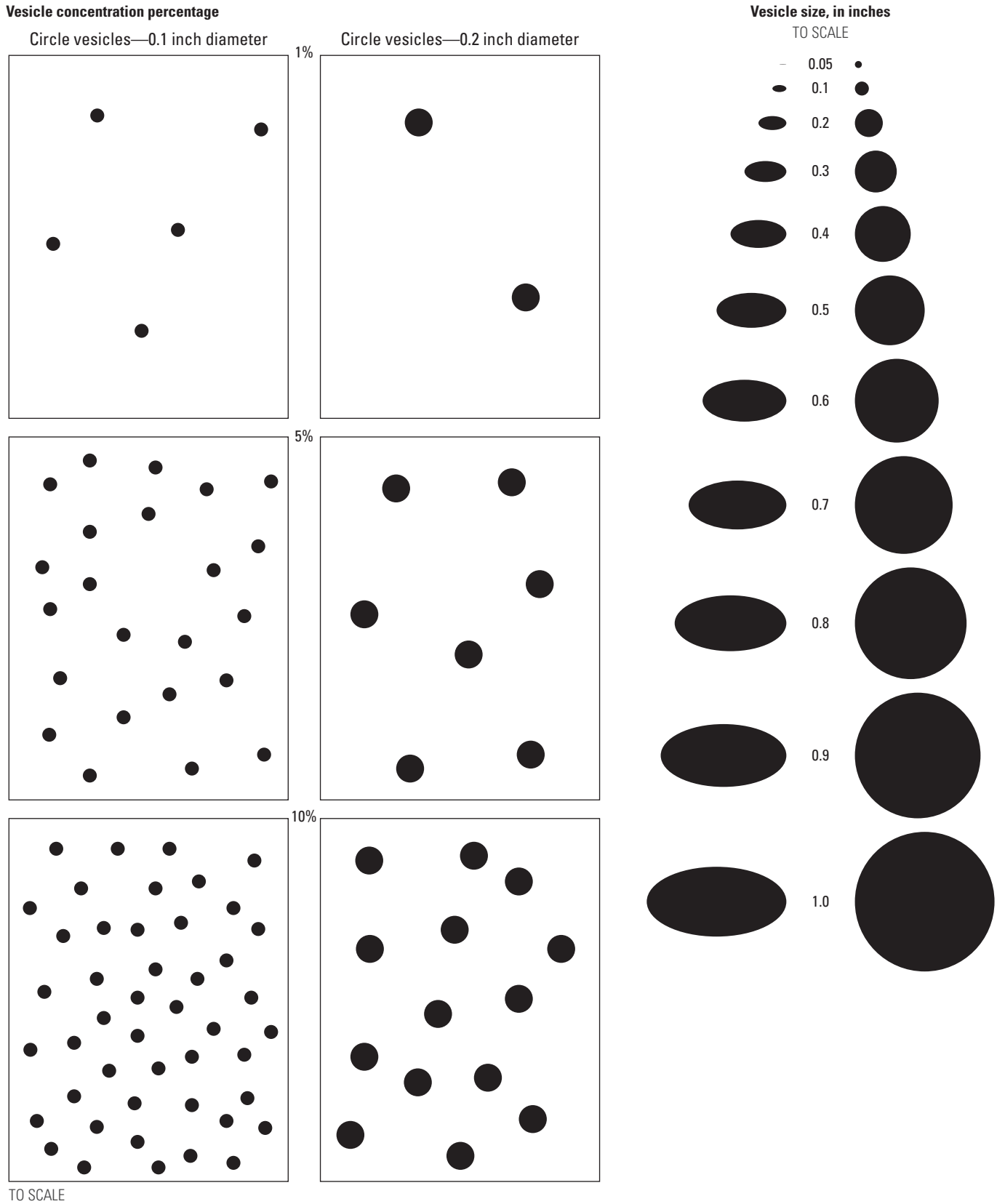


Figure 5.6 Diagram showing vesicle concentration percentage (%) and vesicle size.

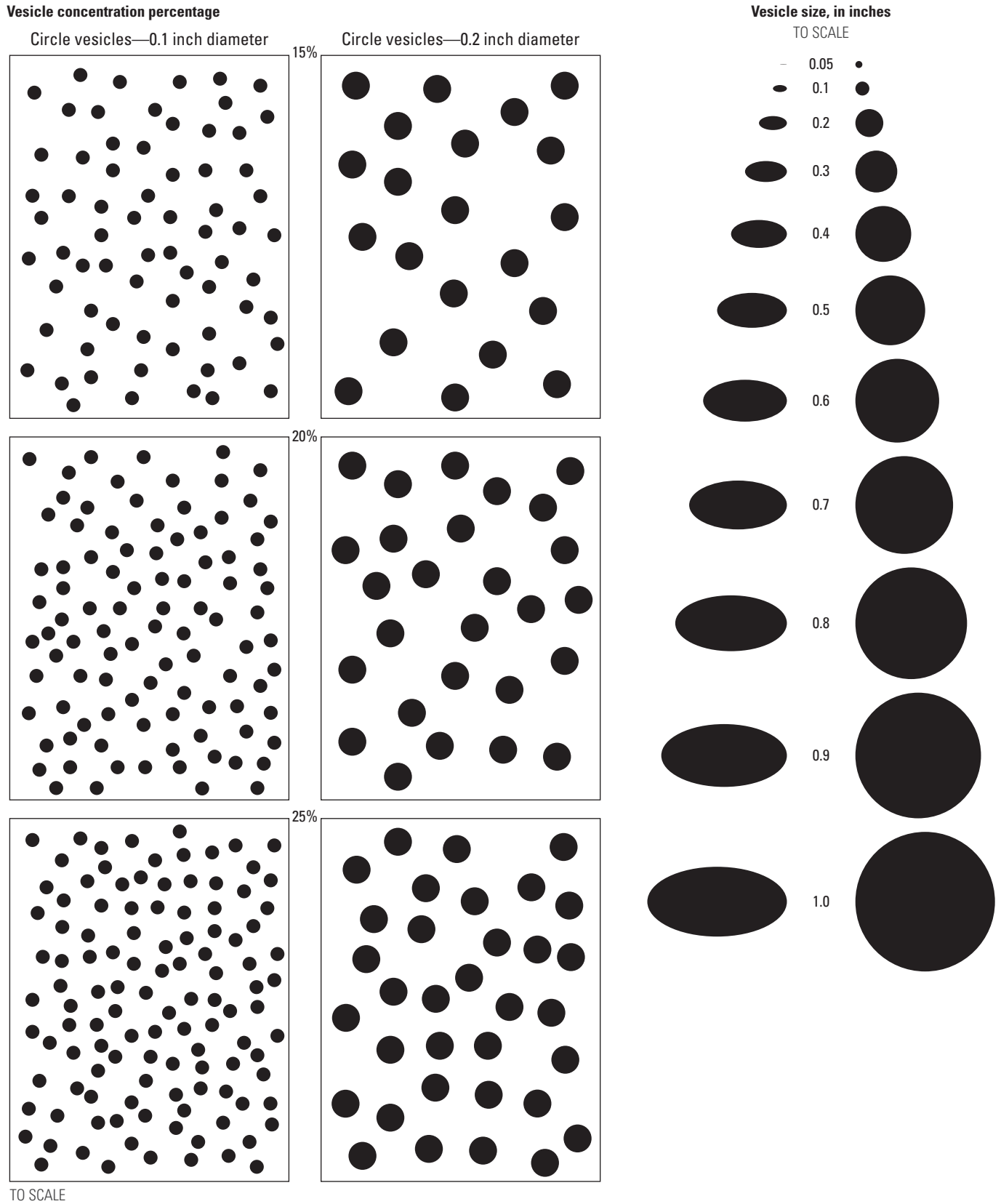
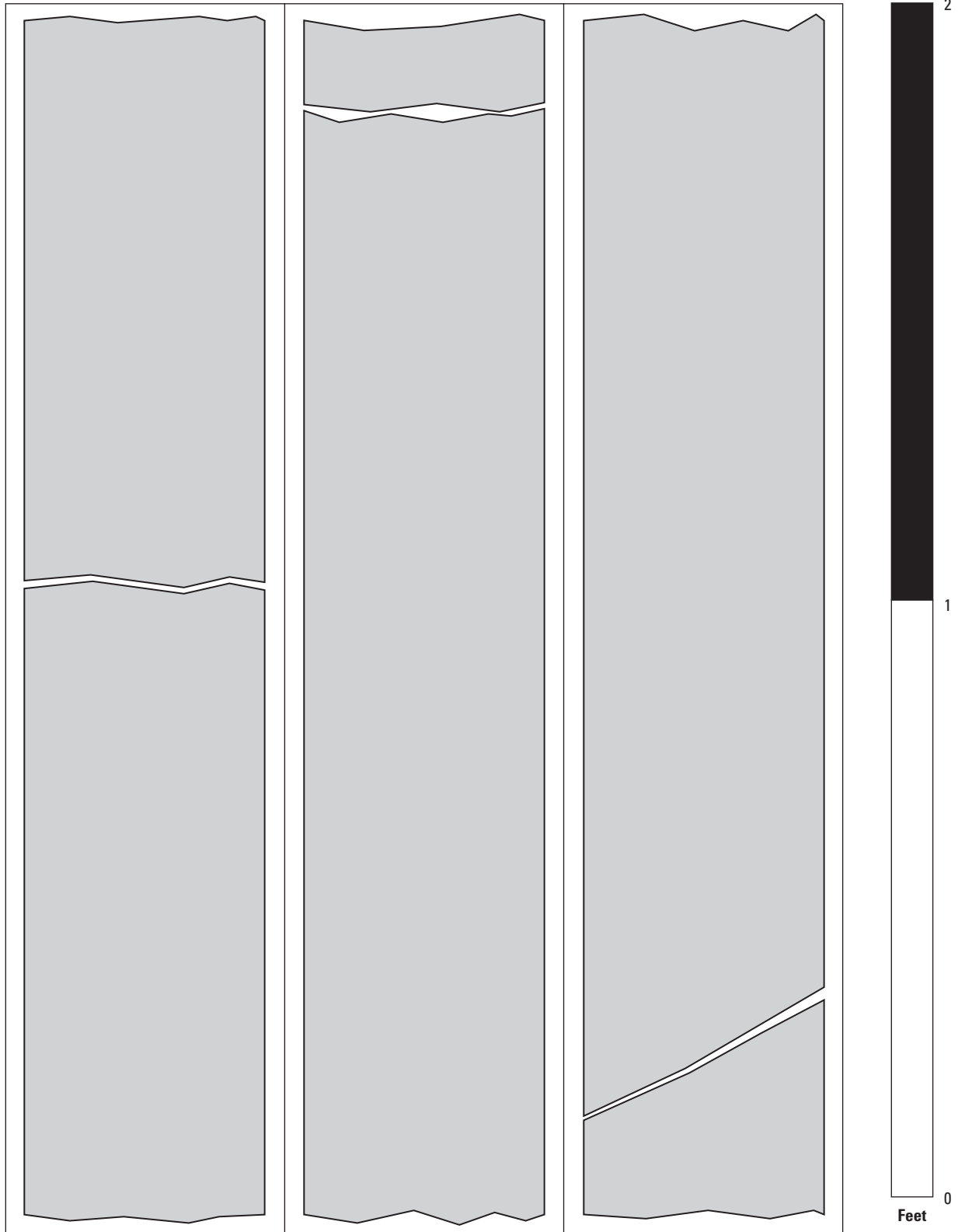


Figure 5.7 Diagram showing vesicle concentration percentage (%) and vesicle size.

Appendix 6. Fracture Frequency Charts

[Appendix 6](#) contains visual charts for estimating the fracture frequency within a given interval.

Fracture frequency: 1

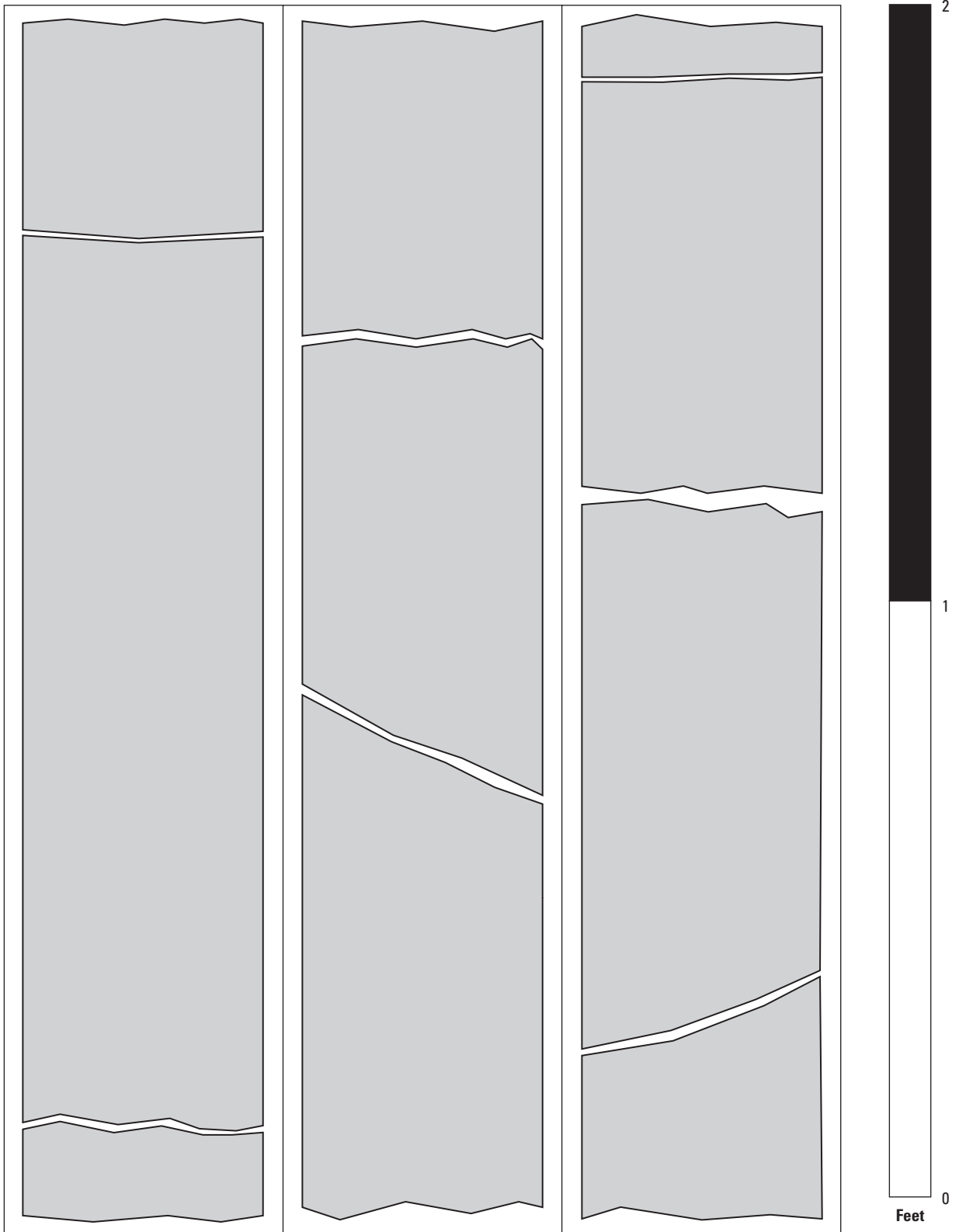


Internal fractures: 0 to 1 per column. Average core size: 1 to 2 feet per column. Assumes core is placed in 2 feet boxes.

NOT TO SCALE

Figure 6.1 A diagram displaying core with fracture frequency 1.

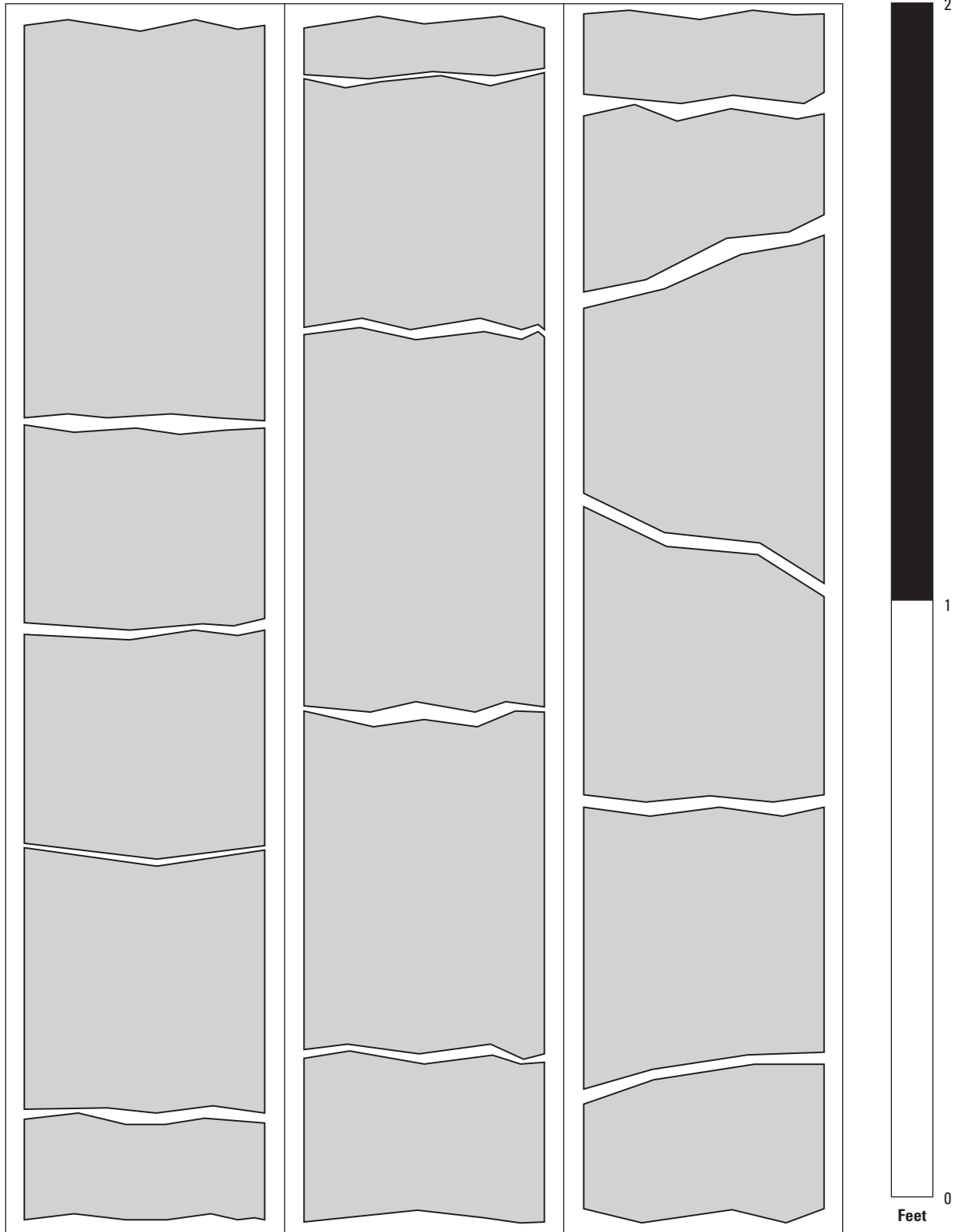
Fracture frequency: 2



Internal fractures: 2 to 3 per column. Average core size: 0.5 to less than 2 feet per column. Assumes core is placed in 2 feet boxes. NOT TO SCALE

Figure 6.2 A diagram displaying core with fracture frequency 2.

Fracture frequency: 3

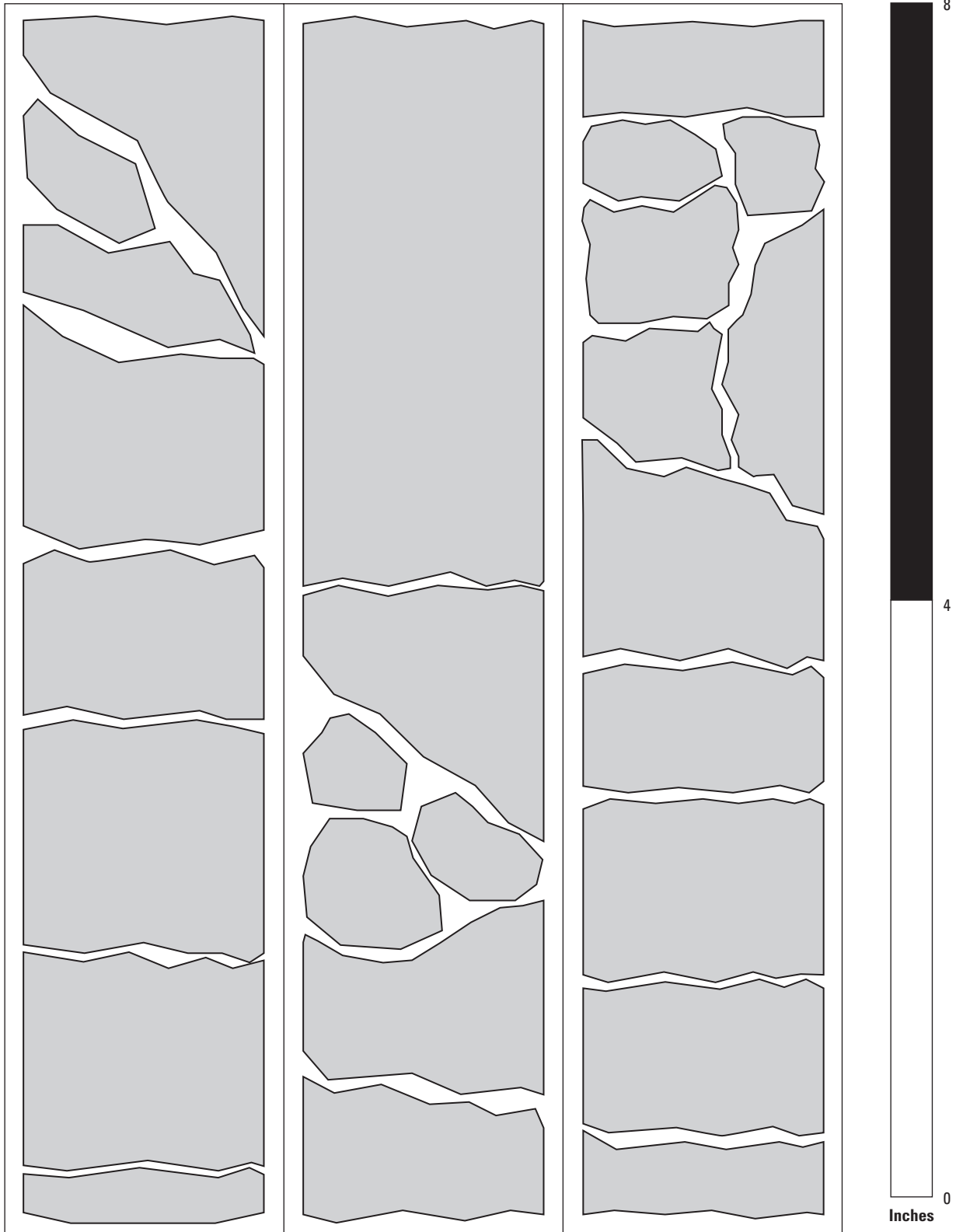


Internal fractures: 4 to 5 per column. Average core size: 4 to 7 inches per column. Assumes core is placed in 2 feet boxes.

NOT TO SCALE

Figure 6.3 A diagram displaying core with fracture frequency 3.

Fracture frequency: 4

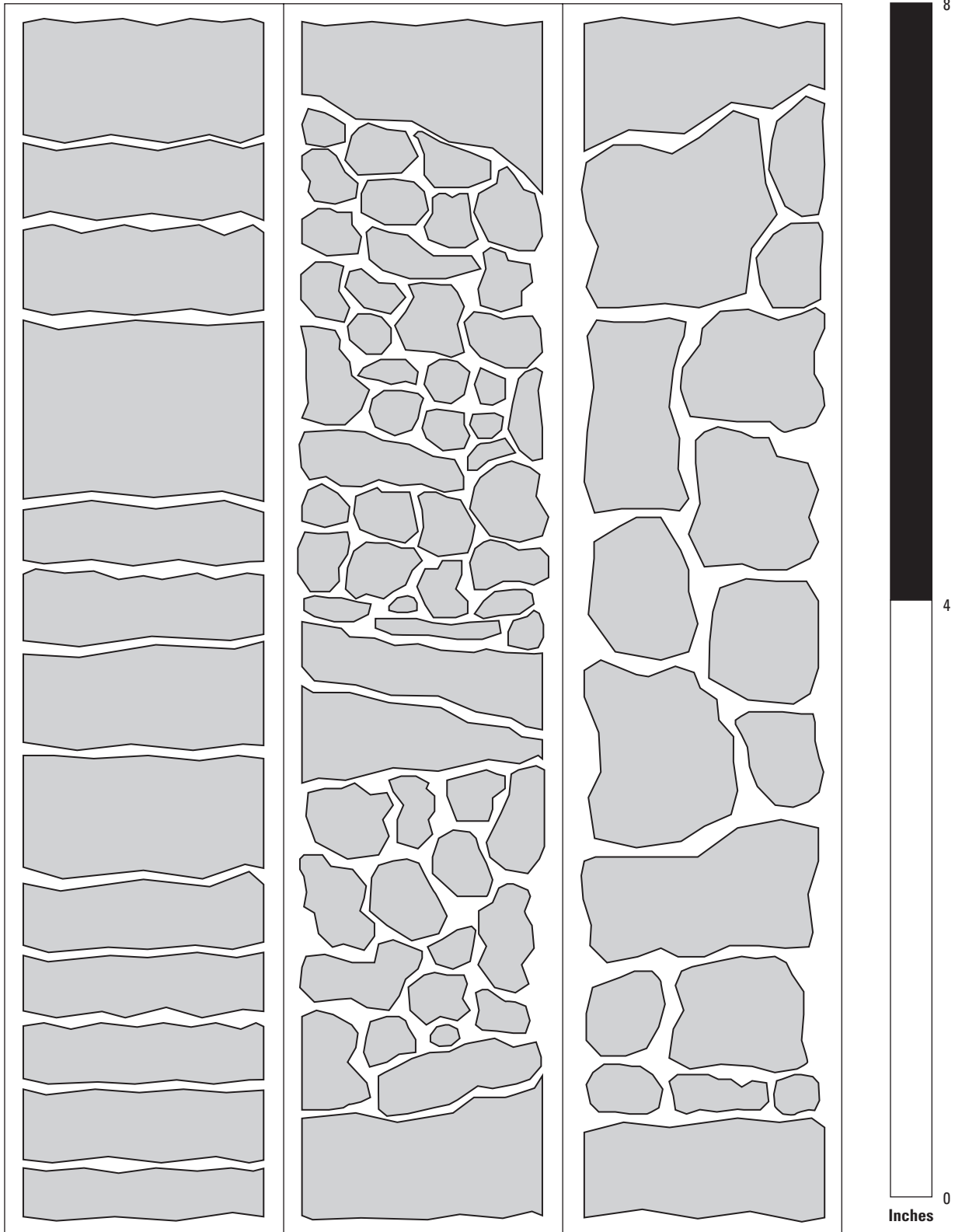


Internal fractures: Numerous. Average core size: 1 to 4 inches per column. Assumes core is placed in 2 feet boxes.

TO SCALE

Figure 6.4 A diagram displaying core with fracture frequency 4.

Fracture frequency: 5



Internal fractures: Numerous. Average core size: Less than 1 inch per column. Assumes core is placed in 2 feet boxes.

TO SCALE

Figure 6.5 A diagram displaying core with fracture frequency 5.

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Publishing support provided by the Science Publishing Network,
Reston and Tacoma Publishing Service Centers

