Lithological Description of Drill Core PH-1 Pawnee County, Nebraska

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August 2025

Kansas Geological Survey Open-File Report 2025-55

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Subject: Lithological Description of drill core Molycorp PH-1 August 1, 2025

Location: Pawnee County, Nebraska
Lat/long: 40.0444499, -96.2937334
Archival location: Conservation and Survey Division, University of Nebraska

This memo provides a detailed lithological description and photographic documentation of a portion of drill core Molycorp PH-1, spanning footages 574.4' and 886.6' (boxes 11-42). This core was described as part of the U.S. Department of Energy (DOE) Office of Fossil Energy and Carbon Management (FECM)'s Carbon Ore, Rare Earth and Critical Minerals (CORE-CM) Initiative for U.S. Basins (DE-FOA-0002364). The core was selected to evaluate Pennsylvanian strata in support of critical mineral potential, coal-related stratigraphy, and carbon ore systems in the Midcontinent. Core Molycorp PH-1 was measured by KGS staff Rachel Smith, described by KGS Assistant Scientist Dr. Stephan Oborny, and contributes to the geologic and geochemical characterization of the Cherokee-Forest City Basin.

Note: This drill core was processed on the Kansas Geological Survey's Multi-Sensor Core Logger (MSCL). While evaluating the drill core discrepancies in prior drill core footages were noted by MSCL lag manager Rachel Smith. Drill core depths were adjusted to accommodate these discrepancies. Masking tape was left in each box denoting these new footages for future use. While lithologically describing the drill core, Oborny tracked all prior sampling horizons (i.e., those denoted as being sampled in the past within boxes) and has updated those footages for comparison to the present description. **Updated footages are**:

Original Footage	New Footage	Sampled By	Sample Date
835.3'-835.45'	840.0'-840.15'	Matt Joeckel	2002.1.14
837.3'-837.4'	842.2'-842.3'	Matt Joeckel	2002.1.14
841.9'-842.0'	846.8'-846.9'	Matt Joeckel	2002.1.14
847.5'-847.7'	851.9'-852.1'	Matt Joeckel	2002.1.14
848.75'-848.9'	852.2'-852.35'	Matt Joeckel	2002.1.14
849.1'-849.25'	853.55'-853.7'	Matt Joeckel	2002.1.14
850.7'-850.9'	855.4'-855.6'	Matt Joeckel	2002.1.14
851.6'-851.85'	856.0'-856.15'	Matt Joeckel	2002.1.14
852.7'-852.8'	856.9'-857.0'	Matt Joeckel	2002.1.14
853.95'-854.2'	858.55'-858.65'	Matt Joeckel	2002.1.14
855.0'-855.1'	860.0'-860.1'	Matt Joeckel	2002.1.14
855.75'-855.95'	860.65'-860.85'	Matt Joeckel	2002.1.14
856.9'-857.0'	861.45'-861.55'	Matt Joeckel	2002.1.14
861.1'-861.2'	865.9'-866.0'	Matt Joeckel	2002.1.14
862.55'-862.65'	867.6'-867.75'	Matt Joeckel	2002.1.14
864.2'-864.3'	869.2'-869.3'	Matt Joeckel	2002.1.14
869.4'-869.6'	875.1'-875.3'	Andreas Moeller	2024.10.2
879.0'-879.24'	884.5'-884.74'	Andreas Moeller	2024.10.2

Molycorp PH-1 Lithological Description and Details

574.4’-576.0’ Non-silty fossiliferous wackestone. 1” of flat pebble lime at base.

576.0’-576.8’ Siltstone. Non-reactive.

576.8’ -586.9’ Fusulinid bearing wackestone. Impure black band 1” thick at 581.1’. Argillic between 582.8’ and 583.7’. Basal 2” is dominantly argillic with maroon mineralization along shale banding (visible under hand loop). Moderately argillic between 585.6’ and 586.9’.

586.9’-588.9’ Micro fossiliferous/oolitic grainstone under hand loop. Effervescent. Silty in part.

588.9’-590.34’ Calc Siltstone.

590.34’-600.4’ Fusulinid packstone. Crinoids sparce. Upper 3.5’ moldic and dolomitic. Lower 1’ slightly silty.

600.4’-601’ Calc siltstone. Stylolite at basal contact.

601’-620.35’ Internally complex. Predominantly wackestone. Fusulinids notable down to ~611’. Very abundant fusulinids between ~604 and 610’ (Packstone) with brown matrix. Basal 6” silty and gradational with below.

620.35’-623.9’ Non calcareous shale. 620.35’-621.5’ Gray silty shale with rhyolites uncertain. 621.5’ to 623.9’ PO^4 bearing fissile black shale.

623.9’-625.45’ Wackestone

625.45’-626.4’ Fossiliferous calcareous shale with 2” lime stringer at 626’. Effervescent. Notable Brachiopoda at base.

626.4’-634.8’ Calcareous shale. Homogenous gray green down to ~633.2’. Non-effervescent below 632’. Maroon at base but non-pedogenic, no rootlets.

634.8’-638.8’ Fusulinid wackestone. Tan brown in color.

638.8’-640.7’ Fusulinid packstone. Maroon throughout due to reworked maroon shale.

640.7’-641.65’ Reworked Maroon shale. Few fossils with lime stringer at 641’.

641.65’-654.6’ Calcareous shale. Gray down to 647.3’ w rootlets. 647.3’-654.6’ maroon with slickens.

654.6’-655.6’ Fossiliferous shale. Ostracoda at 655’

655.6’-~657.2’ Very impure argillaceous lime. Fossiliferous.

~657.2’-669.15’ Siltstone. Primarily laminar bedded w some trough bedding in upper half.

669.15’-676.35’ Clean wackestone (calcilutite).

676.35’-676.45’ ~1” green shale

676.45’-678’ Phylloid bafflestone in upper foot with crinoidal grainstone below (argillic lower contact).

678’-678.6’ Crinoidal shale. Calcareous.

678.6’-691.6’ Homogenous dark gray calcareous shale.

691.6-693.7’ Crinoidal and brachiopod bearing wackestone.

693.7’-694.7’ Fissile PO^4 bearing black shale. Upper and lower 2” respectively are gray and fossiliferous.

694.7’-696.2’ Brachiopod bearing wackestone.

696.2’-701.1’ Shale. Gray and calcareous down to ~697.8’. 697.8’-701.1’ maroon and non-effervescent.

701.1’-708.1’ Reworked. Rounded wackestone with green shale matrix. Tempestite? Potential for notable unconformity at 708.1’.

708.1’-714.35’ Ooid-to-oolitic grainstone. Green shale stringers in lowest foot.

714.35’-721.8’ Interval is dominated by black shale with crinoidal grainstone stingers

714.35’-715’ Sulfur-stained shale

Grainstone stringers at 715’-715.4’, 715.7’-715.8’, 718.2’-718.4’, 719.2’-720.7’

720.7’-721.8’ Fissile PO^4 bearing black shale. Lower half gray.

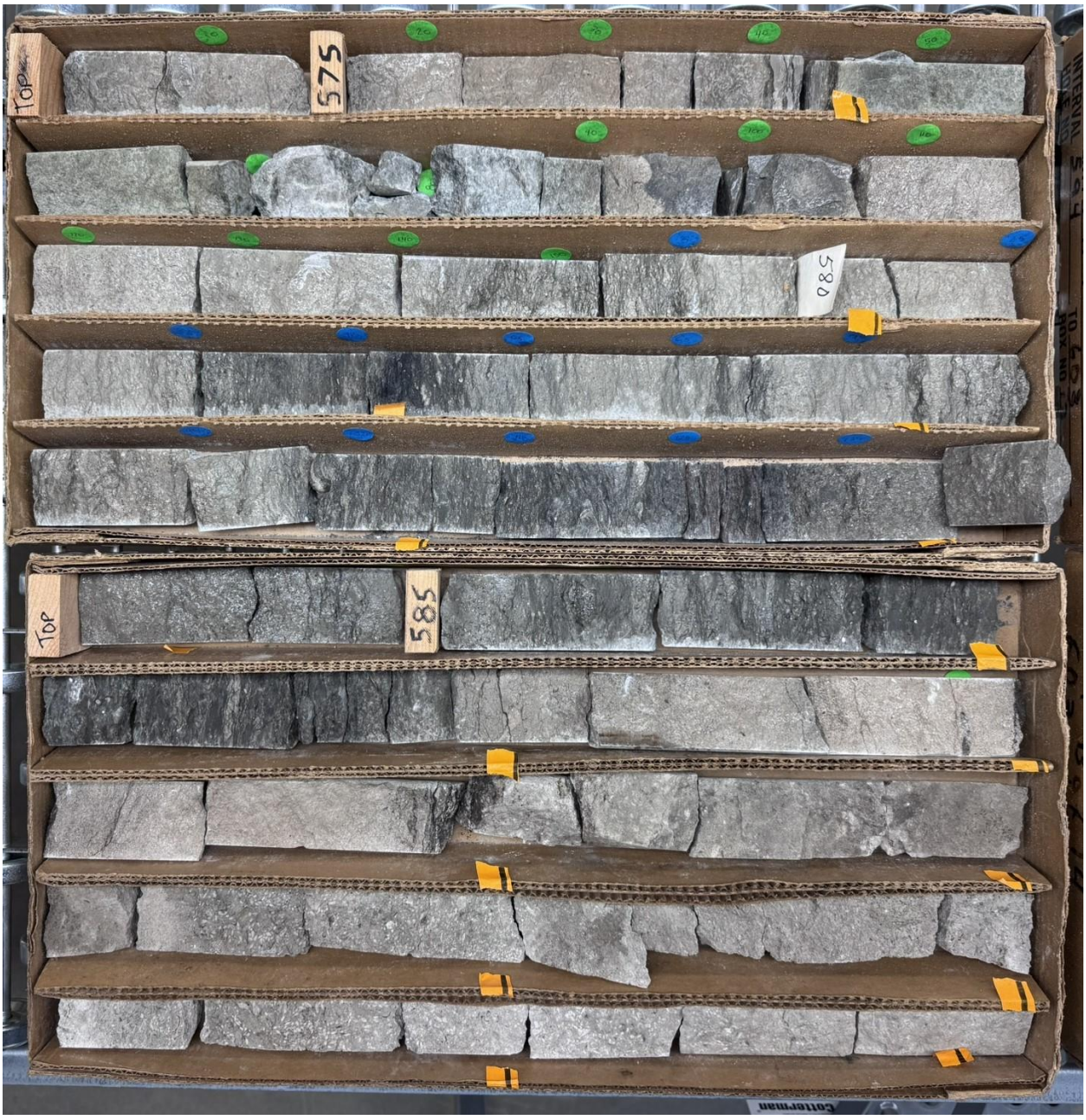
721.8’-724.15’ Green siltstone with lime intraclasts at the base, and near the top.

724.15’-732.75’ Limestone. Moldic and oolitic in upper 3’. Remainder of the interval is wackestone with some moldic porosity. Abundant stylization in this interval.

732.75’-734.7’ Crinoidal siltstone. 3” wackestone tongue near top.
734.7’-737.05’ Wackestone.
737.05’-737.7’ Dark fossiliferous shale. Reworked.
737.7’-741.55’ Calcilutite. Birdseye in upper foot. Rhizoliths.
741.55’742.3’ Shale with lime intraclasts.
742.3’-750’ Fossiliferous grainstone with shale partings.
750’-753’ Oolitic grainstone. Moldic porosity.
753’-766.5’ Internally complicated. Stylolites, vuggy, and gray. This interval appears more crystalline than what is immediately above and below but is not dolomitized.
766.5’-778.5’ Wackestone.
778.5’-784.4’ Dark gray shale. Effervescent. Some fossil content in upper part of rubble. Core may be missing here.
784.4’791.5’ Impure argillaceous limestone. Reworked? Crinoids and fossiliferous.
791.5’-799’ Wackestone-to-packstone. Predominantly packstone in lower half.
799’-803.8 Shale. Upper third is gray, middle rusty, lower third maroon. Too fractured to evaluate internal structure.
803.8’-814’ Karsted wackestone. Kart filled with green shale.
814’-817.35’ Maroon blocky shale. Effervescent. Mottled with gray in upper foot.
817.35’-821.6’ Karsted limestone. Collapsed limestone with green shale matrix. Wackestone. Sand reworked in lower inch of interval.
821.6’-822’ Fine sand with feldspar, quartz, and other fine minerals.
822’-828.2’ Maroon shale. Blocky and effervescent.
828.2’-848.2’ Varying forms of limestone. Evidence of karsting (subaerial?) and hydrothermal alteration.
    828.2’-838.6’ Karsted lime. Phylloid algae between ~833’ and 836’. Mottled green and maroon within karst fills. Difficult to tell but upper and lower parts appear to be packstone or wackestone
    838.6’-842.10’ Wackestone. Differs from what is above (less coarse grained). Well developed maroon mottling. Interval is karsted with maroon matrix fill.
    842.10’-848.2’ Silty wackestone to calcareous siltstone. Biotite flakes observed throughout with Fe staining yellow-red. Brachiopoda observed along core break at 848.1’.
848.2’ **Base of marine succession?** Below 848.2’ through 862’ appears to be terrestrial.
848.2’-862’ Terrestrial sediments.
    848.2’-~852’ Maroon Shale. Paleosol? Non effervescent.
    ~852’-854’ medium feldspathic sand. Feldspars are ≤6mm. Gray-green in color.
    854’-858.4’ Fe-cemented siltstone.
    858.4’-862’ Sandstone. Medium sand down to 861’. Coarse sand in lower foot with ≤1.4cm feldspars.
862’-886.6’ **Igneous rock**.
    862’-871.2’ Leached
    871.2’-873.5’ Non weathered gabbro.
    873.5’-876.1’ Leached
    876.1’-886.6’ Non weathered gabbro.

Molycorp PH-1 Drill Core Photos

Images are in order from box 11 through box 42. Core is boxed in engineering style. Red and orange masking tape represent footage used by this study. Colored circle stickers are sites of MSCL and pXRF point analyses.

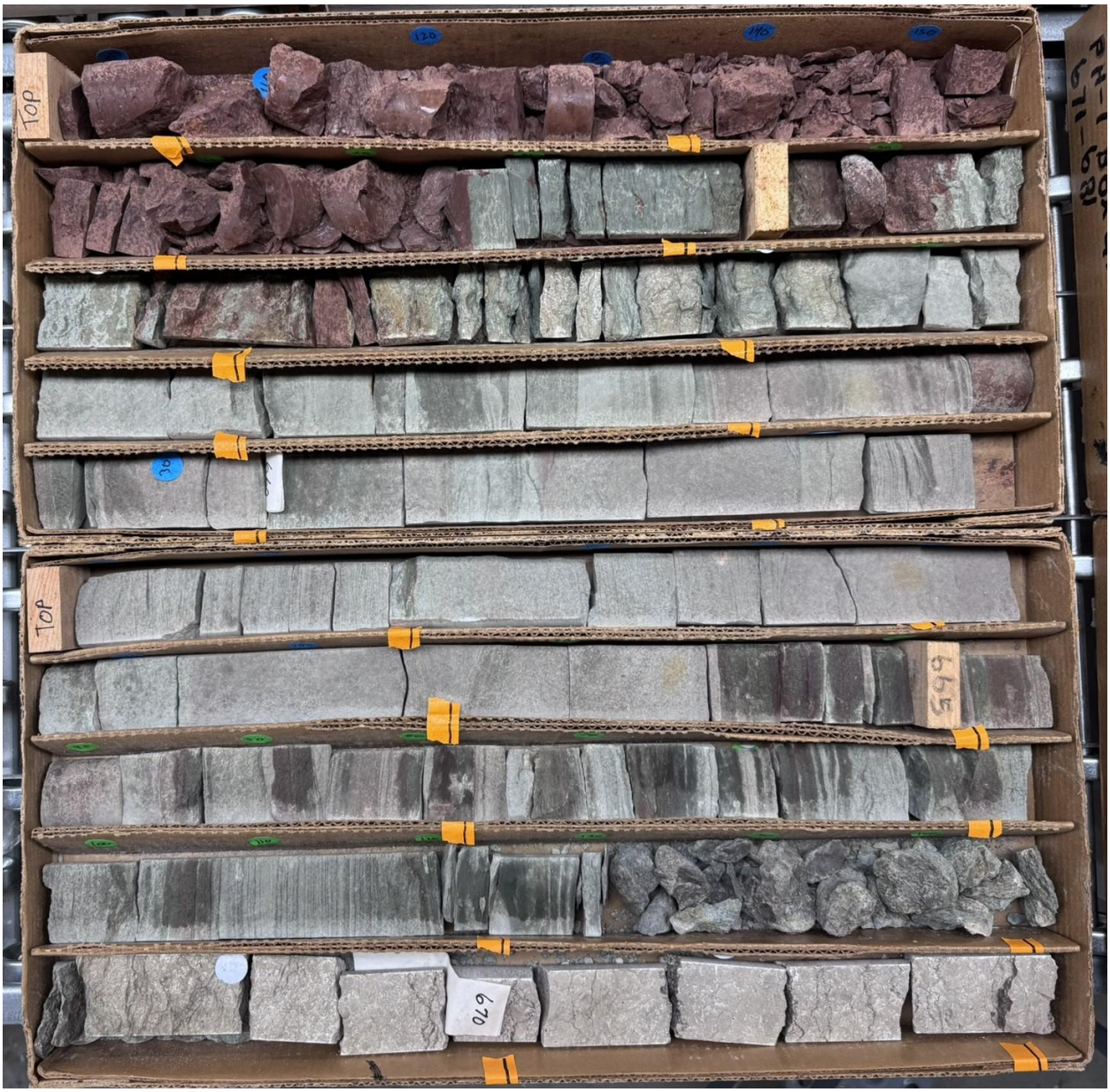


Boxes: 11-12

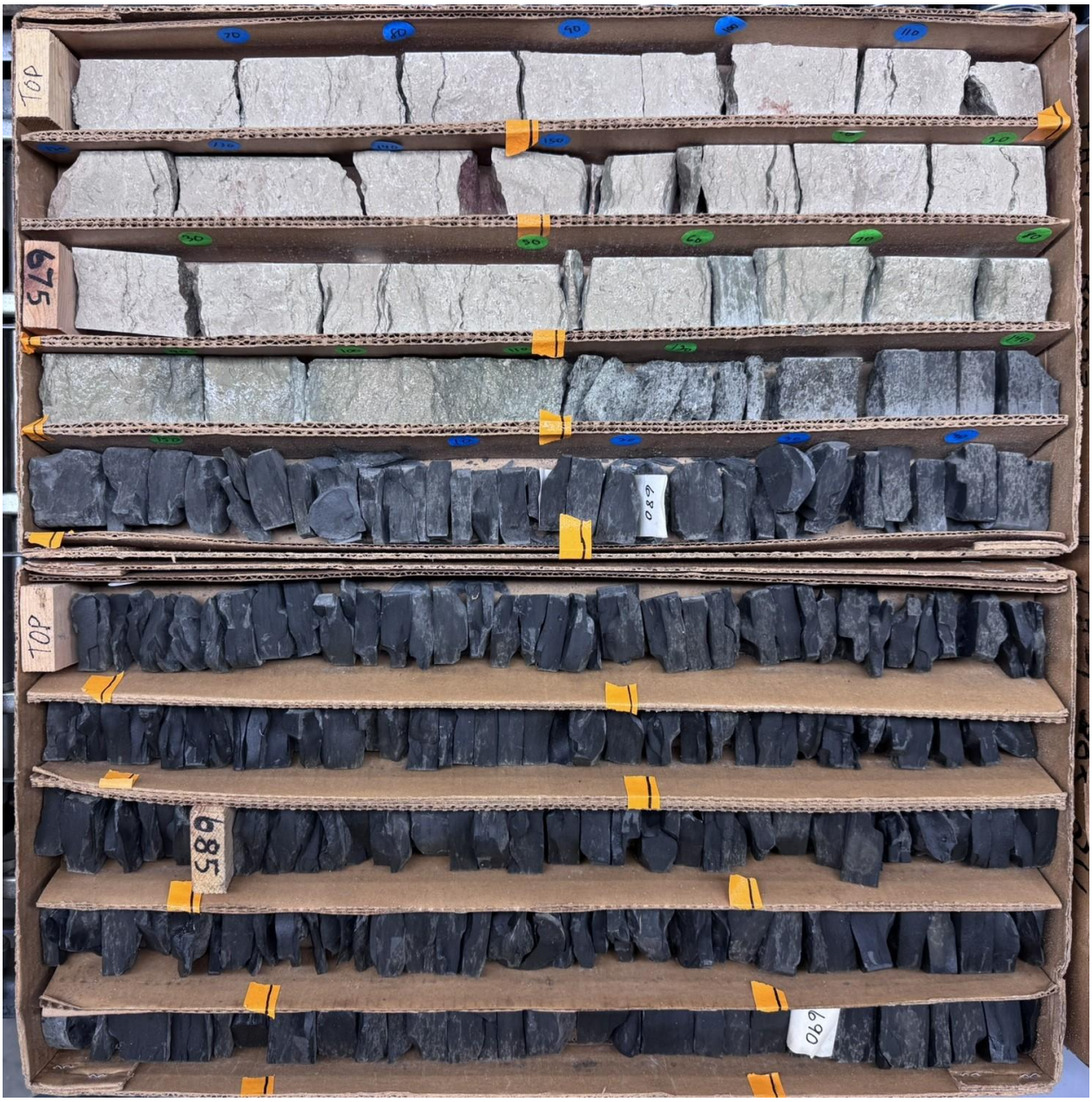
Boxes: 13-14

Boxes: 15-16

Boxes: 17-18



Boxes: 19-20



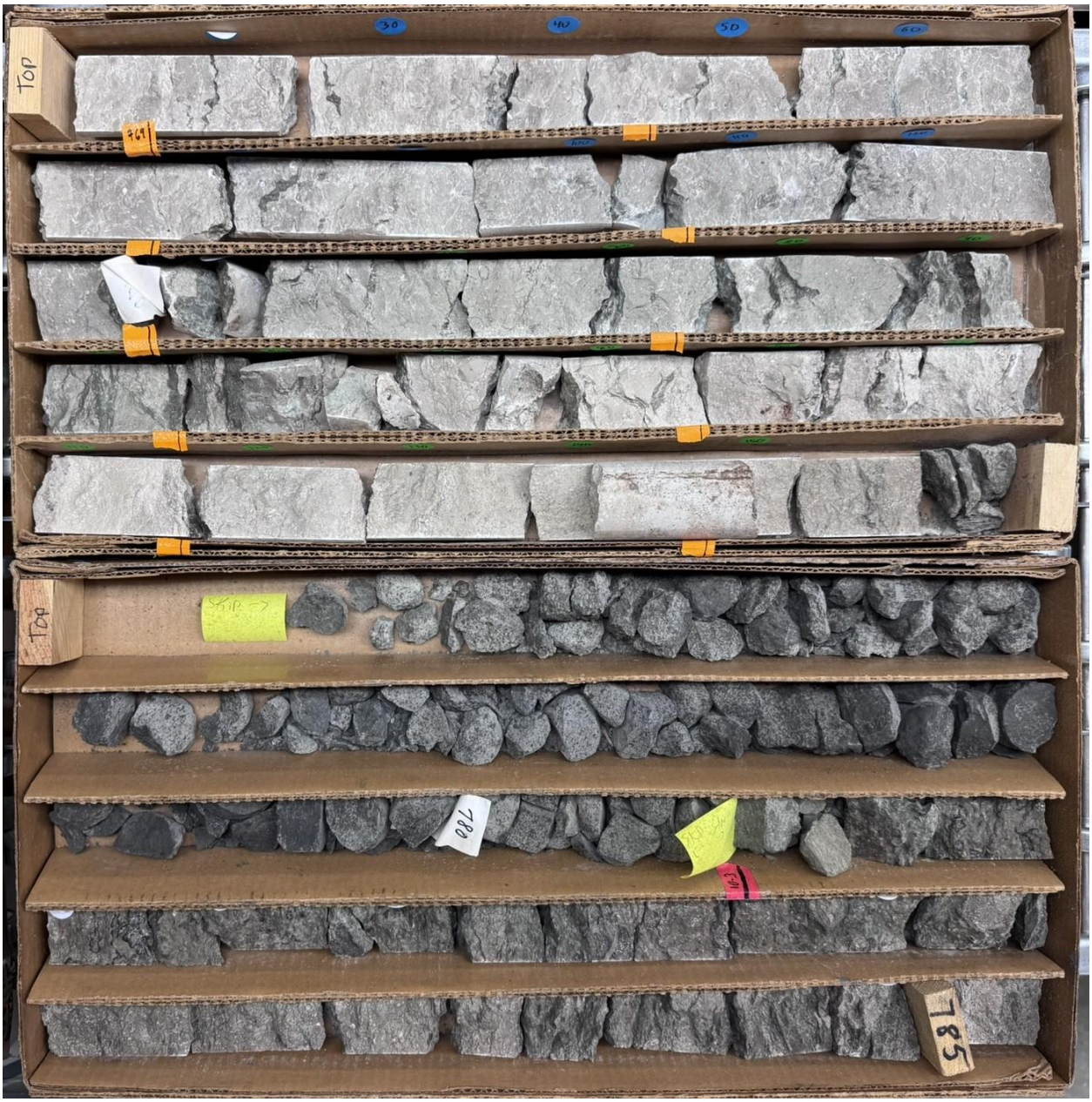
Boxes: 21-22

Boxes: 23-24

Boxes: 25-26

Boxes: 27-28

Boxes: 29-30



Boxes: 31-32


TOP
140
150
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80
90
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110
120
130
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150
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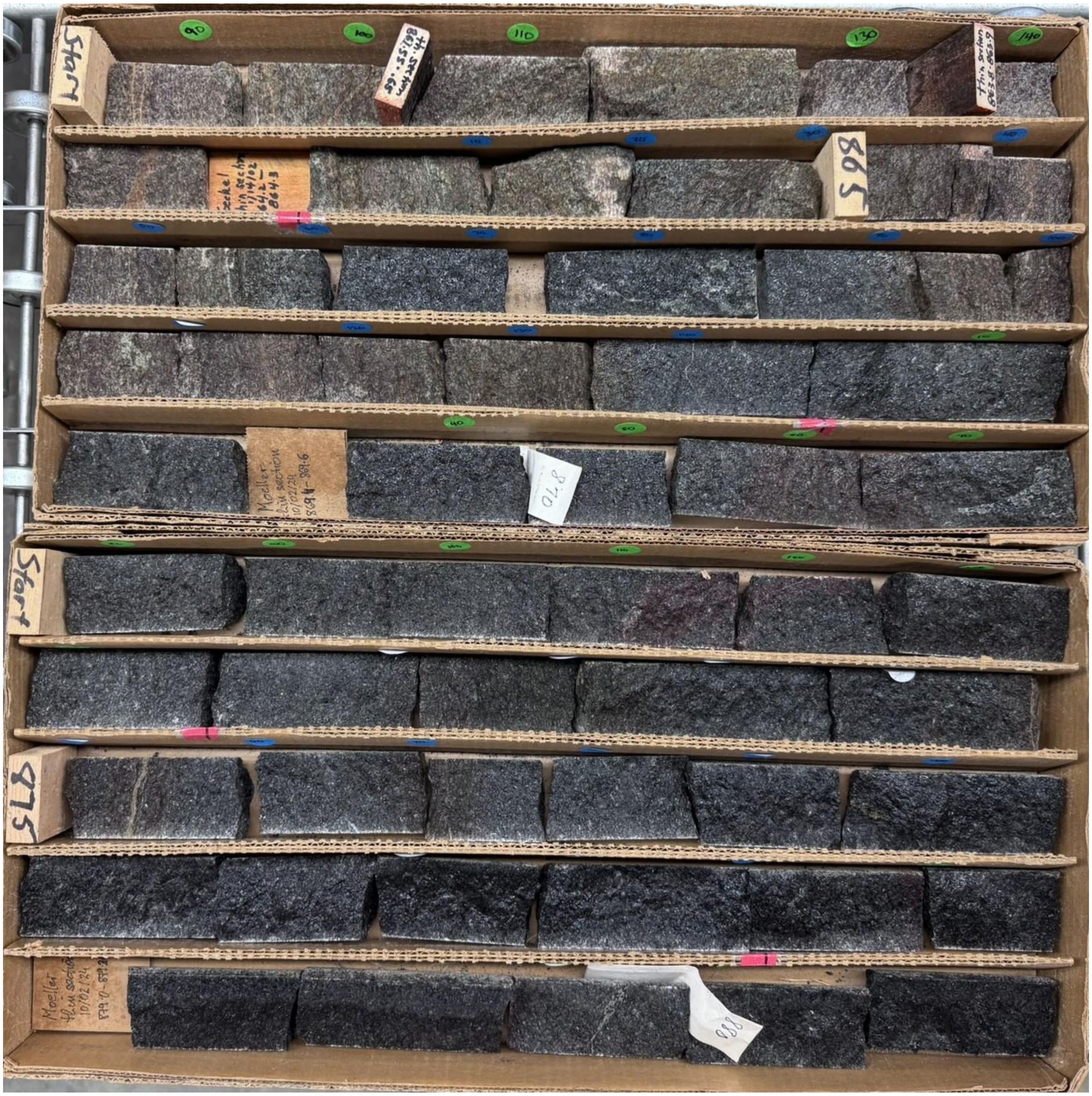
50
60
70
BASE

Boxes: 33-34

Boxes: 35-36

Boxes: 37-38

Boxes: 39-40



Boxes: 41-42