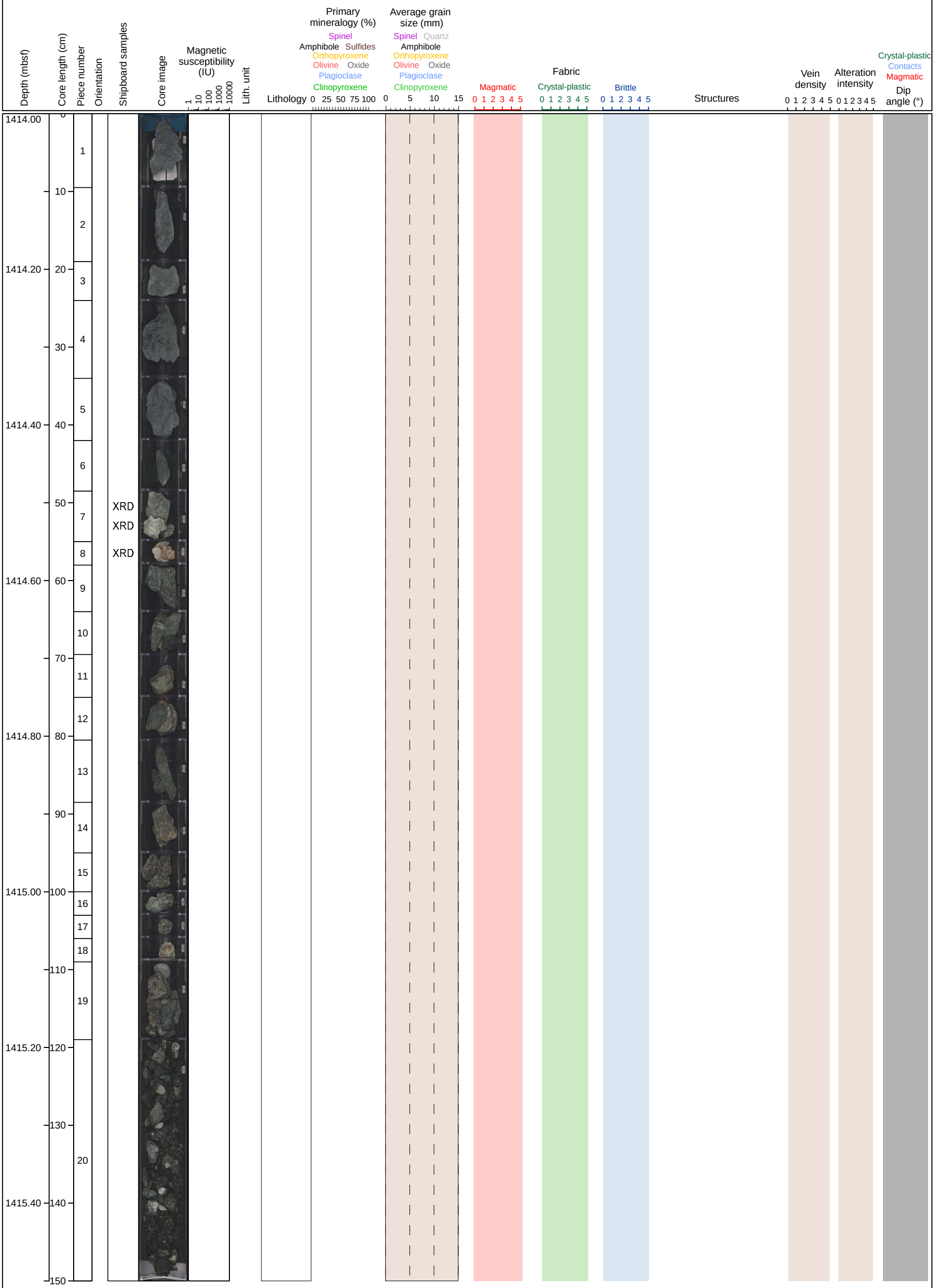
GHOST CORE

Hole 399-U1309D-296G Section 1, Top of Section: 1414.0 m

Igneous Petrology: The junk basket contained igneous rocks and vein fragments with a range of sizes. The largest pieces are typically ~4-8 cm in length and consist of medium-grained olivine-rich troctolite (some with cm-sized interstitial clinopyroxene oikocrysts), medium-grained olivine gabbro, coarse-grained gabbro and poikilitic microgabbro.

Alteration: Rubble and gravel sized pieces of diabase, olivine-gabbro, olivine-rich troctolite, and anhydrite chips. Mafic minerals in diabase are altered to amphibole and chlorite. Plagiocalse is relatively fresh with partial replacement by chlorite and epidote. In Ol-gabbro and Ol-rich troctolite olivine is partly to completely altered to serpentine and magnetite. Plagioclase seems less altered with chlorite forming at the boundary with olivine. Cpx in olivine-gabbro is partially altered to amphibole. Fine grained sulfide occurs in matrix of Ol-rich gabbro.

Structural Geology: Sand, chips and rock fragments recovered from the 'junk basket' at the bottom of Hole U1309D on reentry (April 2023).

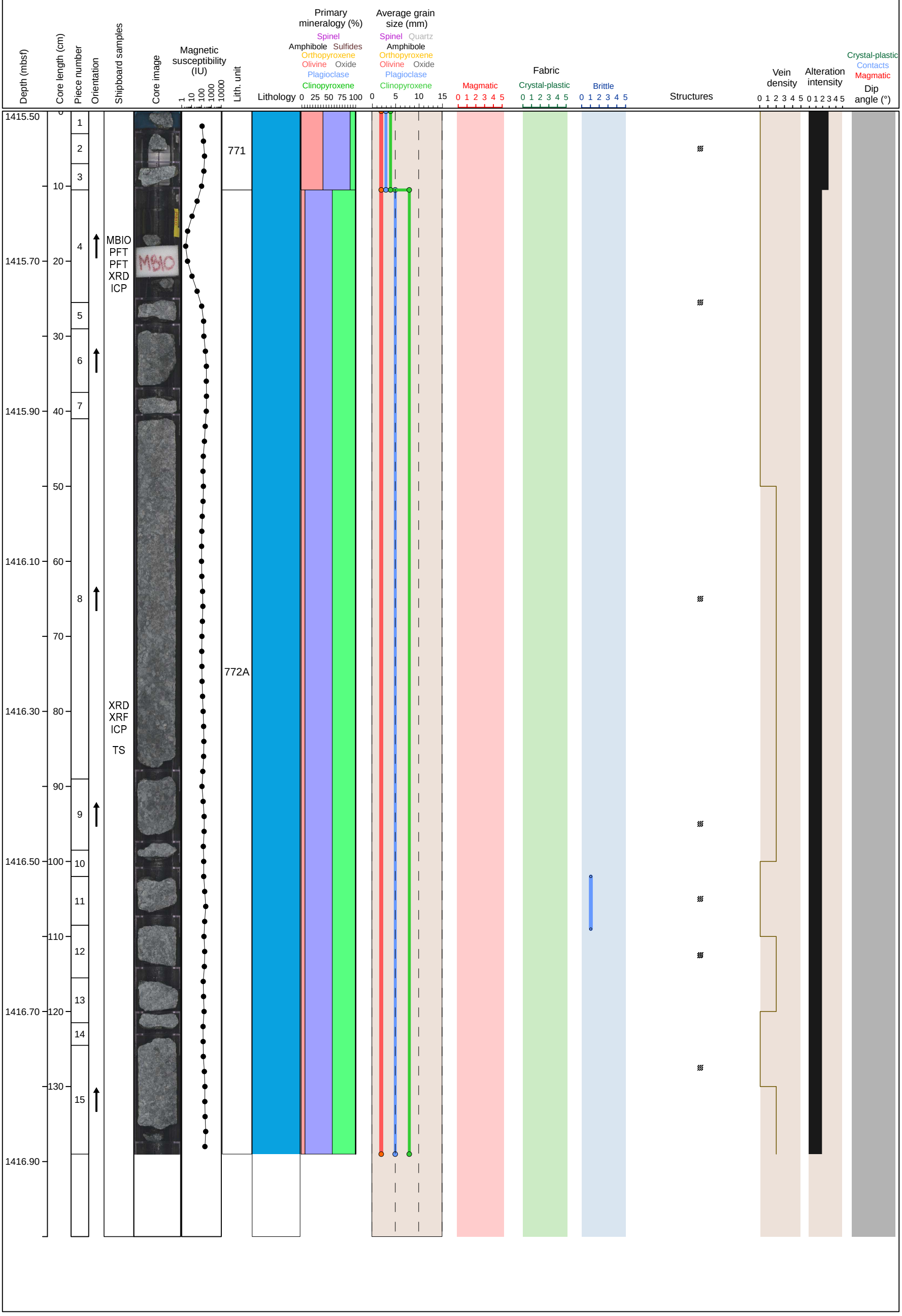


Hole 399-U1309D-297R Section 1, Top of Section: 1415.5 m

Igneous Petrology: Top of the section contains small interval of medium-grained olivine gabbro with poikilitic clinopyroxene. The remaining part is coarse-grained olivine gabbro with textures varying at ~10cm scale

Alteration: Olivine- and Opx-bearing gabbro showing slight to moderate extent of alteration. Olivine is partially to completely replaced by serpentine, talc, amphibole, magnetite and sulfides in varying proportions. Orthopyroxene is partially altered to talc, amphibole, and magnetite. Plagioclase shows moderate though variable extent of alteration to chlorite and amphibole. Cpx is partially to completely replaced by amphibole. Piece 3 shows a higher extent of alteration than pieces 1 and 2. Microscopic sulfide grains of primary and secondary origin. Two vein generations can be disinguished. The first genration consists of chlorite which is cut by a later generation of what appears to be zeolite.

Structural Geology: Olivine gabbro, locally with subhorizontal to subvertical planar variations in grain size, cut by rare, subhorizontal zeolite veins. M > V1

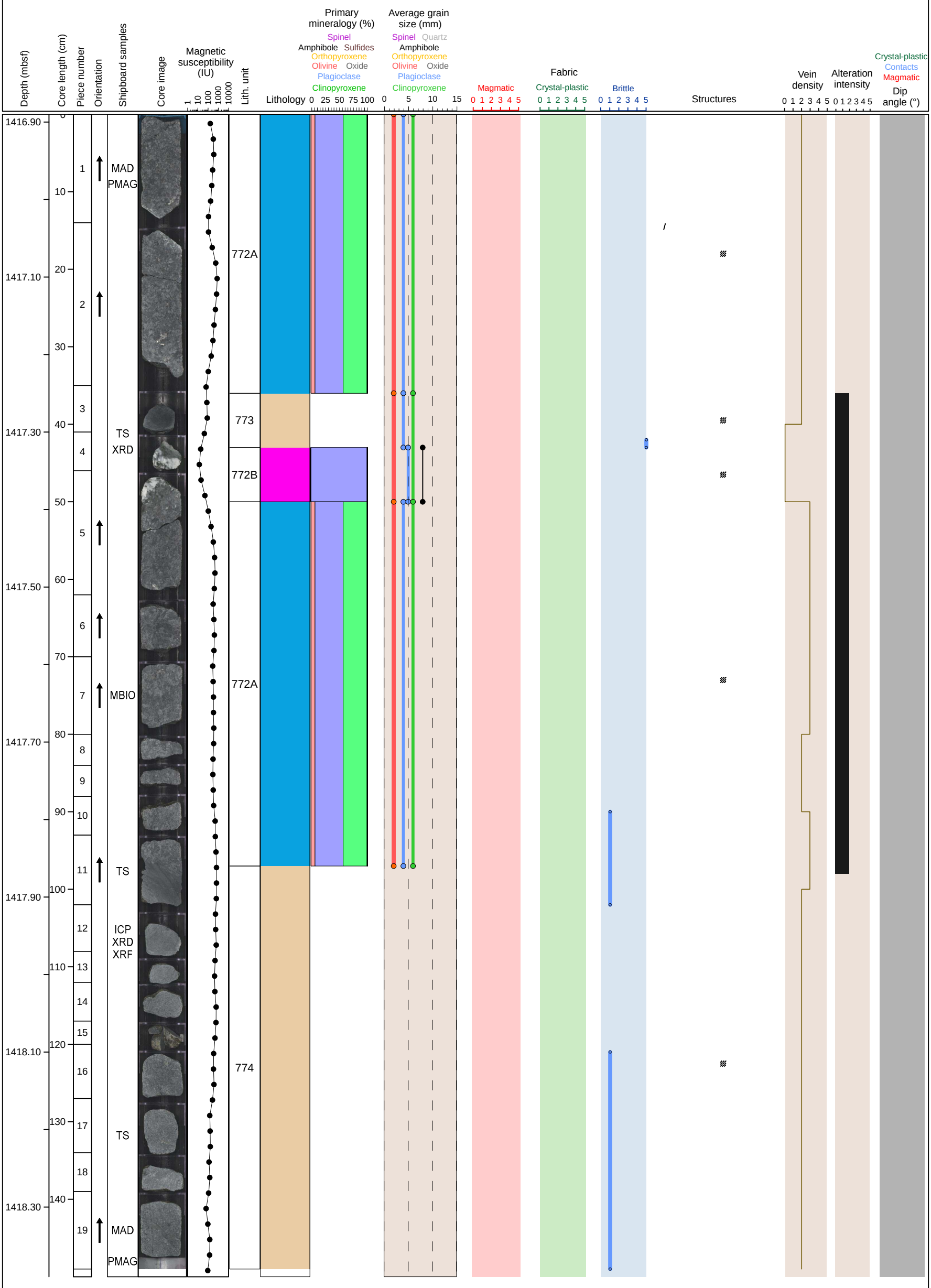


Hole 399-U1309D-297R Section 2, Top of Section: 1416.89 m

Igneous Petrology: Top is a continuation of the olivine gabbro from the former section but with an interval of a diabase pebble and a diorite vein with large acicular primary black amphiboles. At 97cm there is a sharp chilled margin with a diabase unit. Within the diabase unit, grain size increases downhole.

Alteration: Partially altered orthopyroxene-bearing olivine gabbro, diabase, and diorite. In the orthopyroxene-bearing olivine-gabbro, clinopyroxene and olivine are more altered than Plagioclase. Secondary silicates after olivine including serpentine and talc are associated with magnetite and sulfides. Plagioclase is crosscut by secondary amphibole. Diabase intruding gabbro is cut by thin chlorite-serpentine veins. Olivine phenocrysts are partially to completely altered to talc, magnetite, and sulfides. In some instances olivine is replaced by amphibole, serpentine, and chlorite without talc. The small size of the grains in the matrix makes it difficult to recognize their mineralogy. Diorite shows incipient alteration of primary to secondary amphibole. and plagioclase to chlorite. In the olivine- and orthopyroxene-bearing gabbro, scarce fluid inclusions occur in olivine, orthopyroxene and clinopyroxene. Two vein generations can be disinguished. The first genration consists of chlorite which is cut by a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine gabbro, cut by a thin, moderately dipping (35°), pegmatitic diorite vein (1471.3 mbsf). Thin interval of diabase (36-43 cm) shows no contacts; a thicker interval of diabase recovered from 97- 149 (~1m, with contact dip 22°). Thin zone of ultracataclasite recovered between 42-43 cm (1417.3 mbsf). Upper part of the section cut by rare, moderate dip (30+°) amphibole, chlorite veins, locally with slickenfibers on piece ends. Section cut by younger, subhorizontal zeolite veins. M > V1 > B > V2

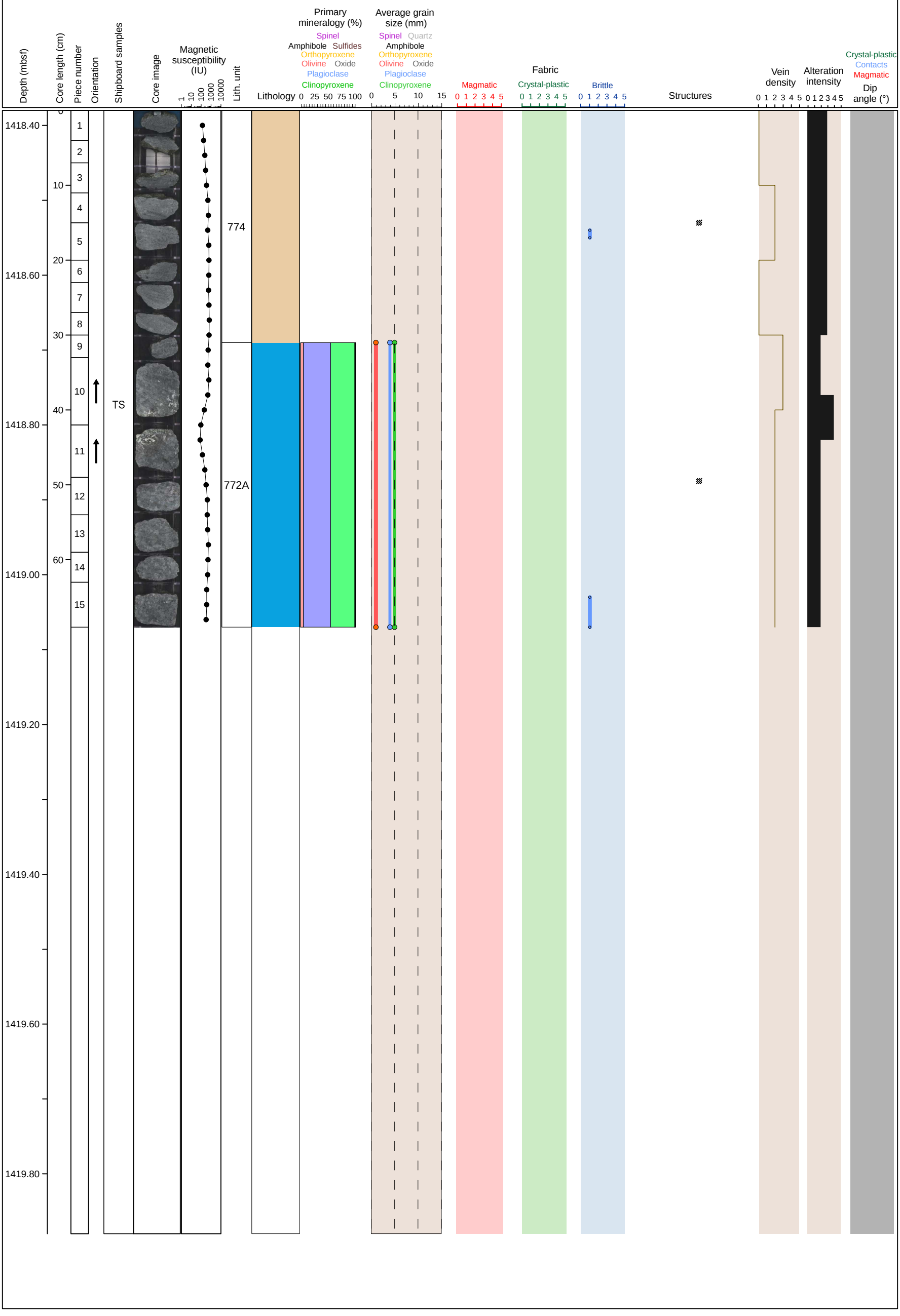


Hole 399-U1309D-297R Section 3, Top of Section: 1418.38 m

Igneous Petrology: Top is continuation of the diabase unit until 31cm, returning to the olivine gabbro unit that contains an alteration vein.

Alteration: Moderately altered fine-grained diabase and slightly altered Ol-bearing gabbro. The latter is cut by chlorite-amphibole veins with apparent normal sense of slip. The extent of alteration is highest in olivine, followed by clinopyroxene, and plagioclase whcih is least altered. At the contact with altered olivine, plagioclase is altered to chlorite. Mesh texture after olivine shows a systematic zonation from olivine in the mesh center to serpentine and clay minerals to amphibole and talc in the mesh rim. Two vein generations can be disinguished in the gabbro. The first genration consists of amphibole which is cut by a later generation of what appears to be zeolite.

Structural Geology: Diabase (30 cm) and isotropic olivine gabbro cut by dark green amphibole and chlorite veins. Younger, thin white zeolite veins are subhorizontal. Weak to moderate subhorizontal fractures overprint entire section M > V1 > V2 = B

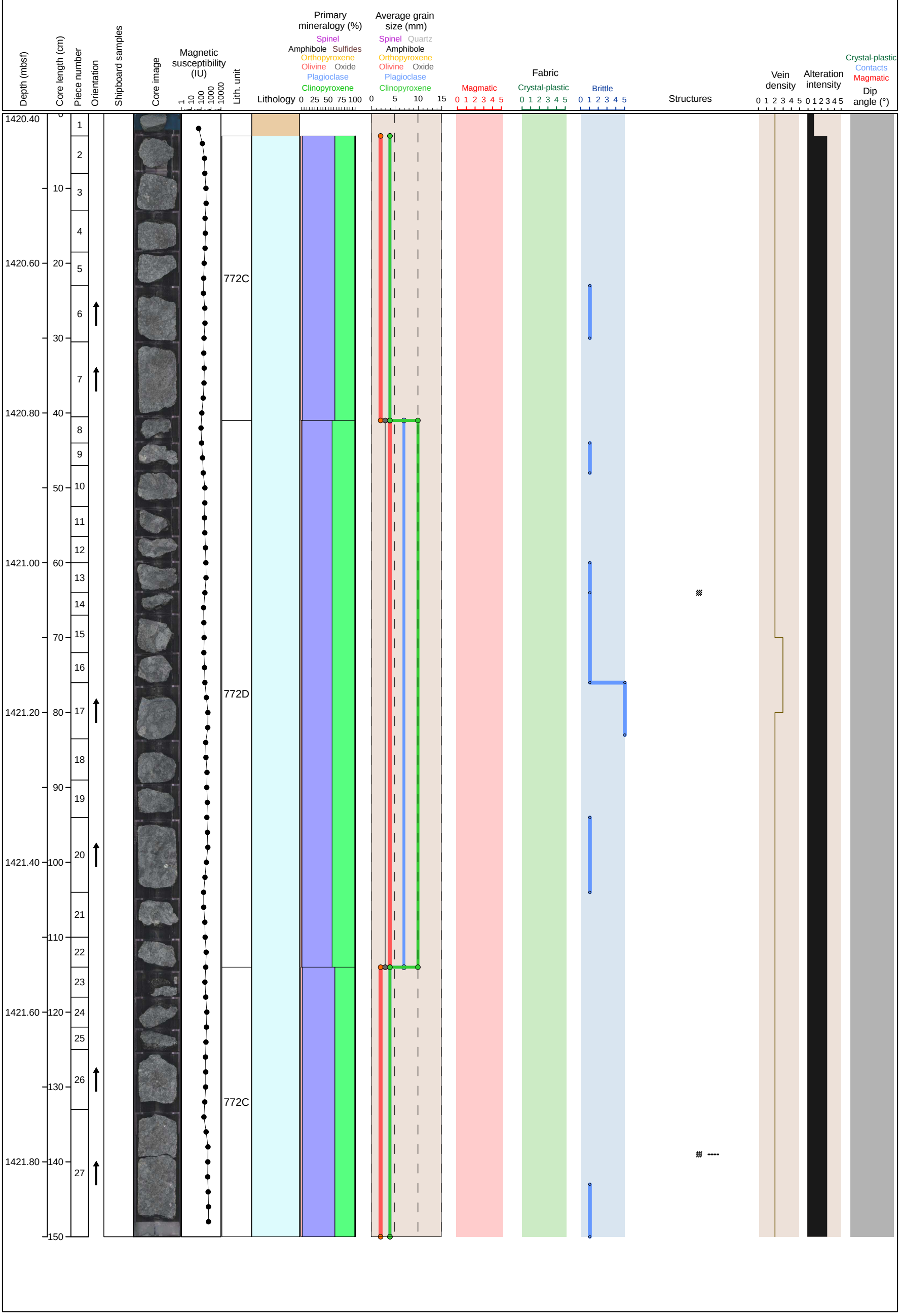


Hole 399-U1309D-298R Section 1, Top of Section: 1420.4 m

Igneous Petrology: Medium-grained , granular to subophitic olivine bearing gabbro with a coarse-grained olivine-bearing gabbro interval.

Alteration: Moderately olivine-bearing gabbro. Olivine is partially altered to serpentine and magnetite. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. Three vein types can be distinguished: the first two generations consist of dark green amphibole veins and greenish-white veins composed of chlorite and an unidentified white mineral. The last vein generation consists of what appears to be zeolite.

Structural Geology: Diabase (3 cm) above isotropic olivine-bearing gabbro showing grain size variation (contacts not recovered); cut by a narrow zone of cataclasis (76-83 cm), and younger thin white, zeolite veins (subhorizontal) and minor fractures. M > B > V1

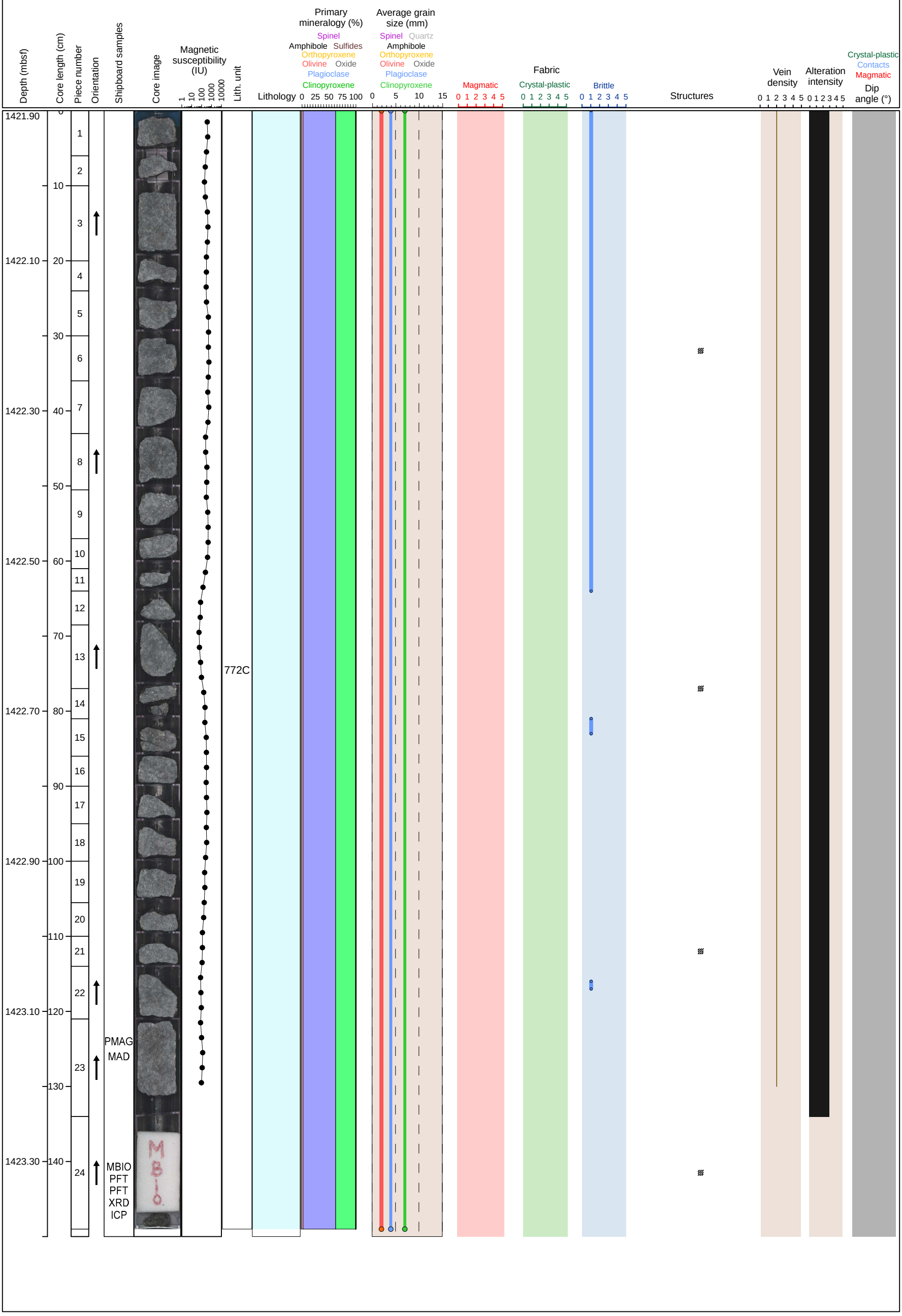


Hole 399-U1309D-298R Section 2, Top of Section: 1421.9 m

Igneous Petrology: Medium to coarse-grained , granular to subophitic olivine-bearing gabbro, continued from the previous section. Grain size varies considerably over 10cm scale. Some pieces (e.g. 13) are coarse-grained.

Alteration: Moderately altered coarse-grained olivine gabbro. The extent of alteration decreases from olivine, to clinopyroxene, to plagioclase. Olivine is partially altered to serpentine and magnetite, clinopyroxene is partially altered to amphibole, and chlorite is partially altered to chlorite. crosscut by veins. Presence of primary sulfides. Two vein generations can be distinguished; an earlier generation composed of amphibole and/or chlorite, and a later generation of what appears to be zeolite.

Structural Geology: Olivine-bearing gabbro hosting grain size variations, locally with a sharp, subvertical boundary (45-53 cm). Entire section cut by shallow - moderate dip amphibole-chlorite veins and younger, thin white, subhorizontal zeolite veins. M > V1 > V2

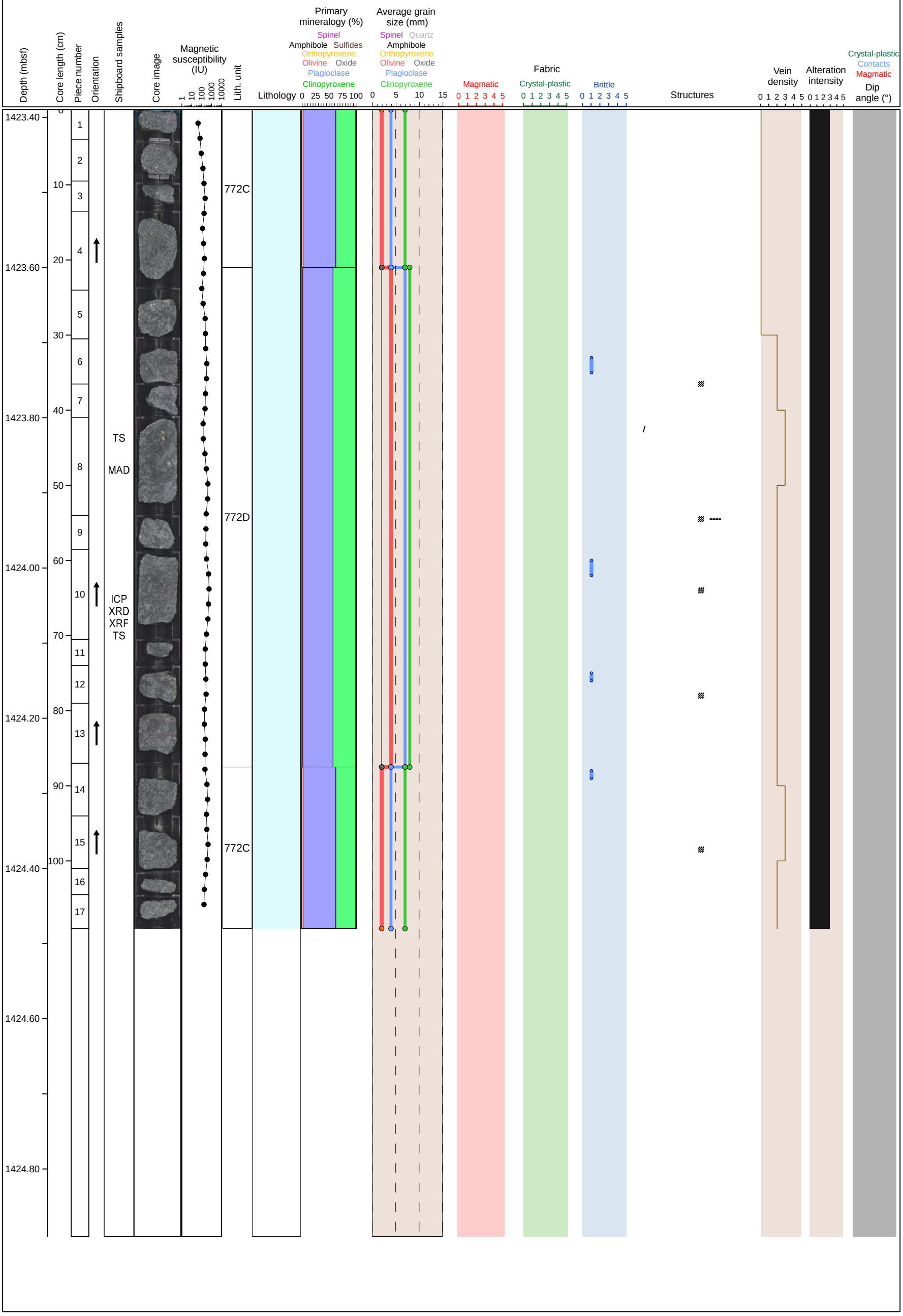


Hole 399-U1309D-298R Section 3, Top of Section: 1423.39 m

Igneous Petrology: Medium to coarse-grained, subophitic olivine-bearing gabbro, continued from the previous section with a coarse-grained granular olivine-bearing gabbro inteval in between. Coarse-grained gabbro contains small proportions of Fe-Ti oxides.

Alteration: Moderately altered coarse-grained olivine gabbro. The extent of alteration decreases from olivine, to clinopyroxene, to plagioclase. Olivine is partially altered to serpentine and magnetite, clinopyroxene is partially altered to amphibole, and chlorite is partially altered to chlorite. crosscut by veins. Presence of primary sulfides. Two vein generations can be distinguished; an earlier generation composed of chlorite, and a later generation of what appears to be zeolite.

Structural Geology: Olivine-bearing gabbro, cut by younger, moderate to gently dipping, white zeolite veins, locally with slickenfibers on piece ends. M > V1 > B

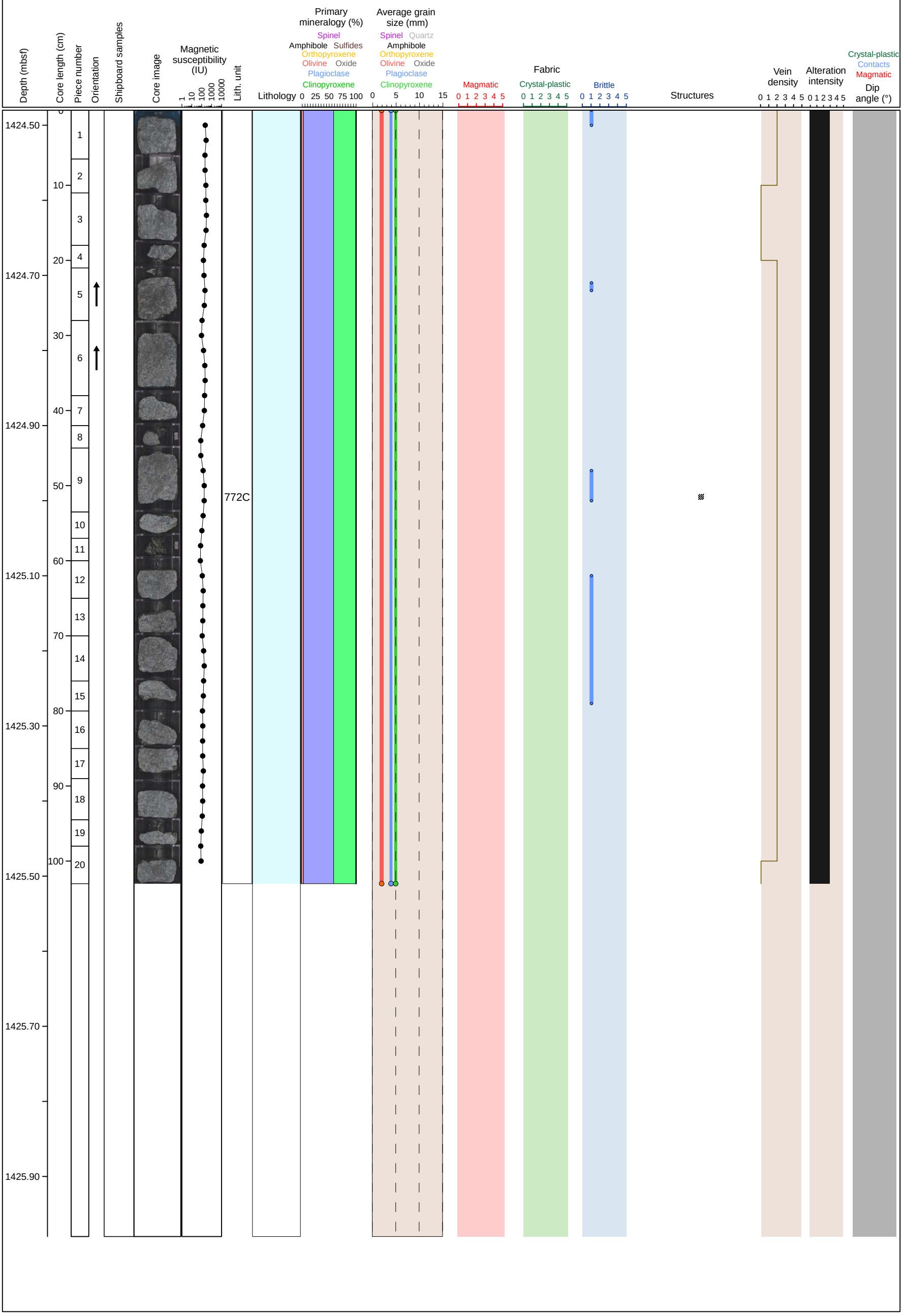


Hole 399-U1309D-298R Section 4, Top of Section: 1424.48 m

Igneous Petrology: Medium grained, subophitic olivine-bearing gabbro, continued from previous section. Grain size variable on the cm scale.

Alteration: Moderately altered medium-grained olivine-bearing gabbro. The extent of alteration decreases from olivine, to clinopyroxene, to plagioclase. Olivine is partially altered to serpentine and magnetite, clinopyroxene is partially altered to amphibole, and chlorite is partially altered to chlorite. crosscut by veins. Presence of primary sulfides. Two vein generations can be distinguished; an earlier generation composed of amphibole and/or chlorite, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine and olivine-bearing gabbro; section cut by shallow - to moderate dip amphibole-chlorite veins and younger, thin white, subhorizontal zeolite veins. M > V1 > V2

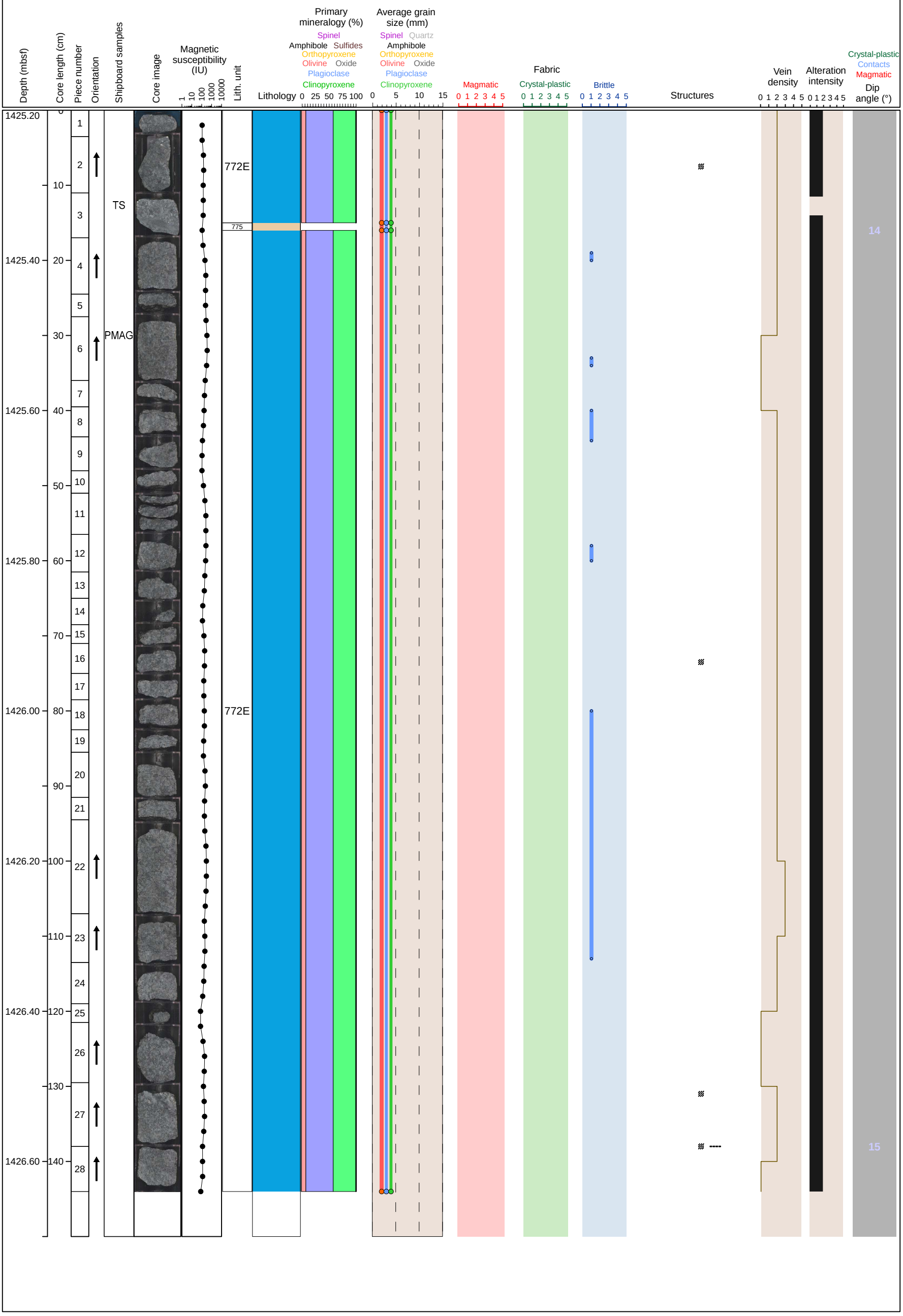


Hole 399-U1309D-299R Section 1, Top of Section: 1425.2 m

Igneous Petrology: Olivine gabbro with texture varying from granular to subophitic. Contains a 1cm thick cryptocrystalline diabase dikelet in piece 3 and a coarse-grained patch in piece 27.

Alteration: Slightly altered olivine gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. The extent plagioclase alteration and the abundance of chlorite is higher in proximity to the amphibole-chlorite vein. Sulfide grains of uncertain primary or secondary origin. Zeolite veins are present throughout the section. One domain (11.5-14 cm) corresponds to a diabase with fresh plagioclase and clinopyroxene phenocrysts. Clinopyroxene shows extensive alteration to amphibole. The matrix is too fine-grained to determine the extend of alteration or the presence of secondary minerals. Toward the contact with the gabbro the chilled margin of the mafic vein shows a greenish color and the presence of amphibole and chlorite.

Structural Geology: Isotropic, olivine gabbro with local grain size variations across a diffuse planar boundary dipping 15° (132-134 cm). Thin interval (15-17 cm) of diabase (contact dip 15°). Diabase cut by a singular, subhorizontal black vein; remainder of the section cut by thin white, subhorizontal zeolite veins. M > V1 > V2

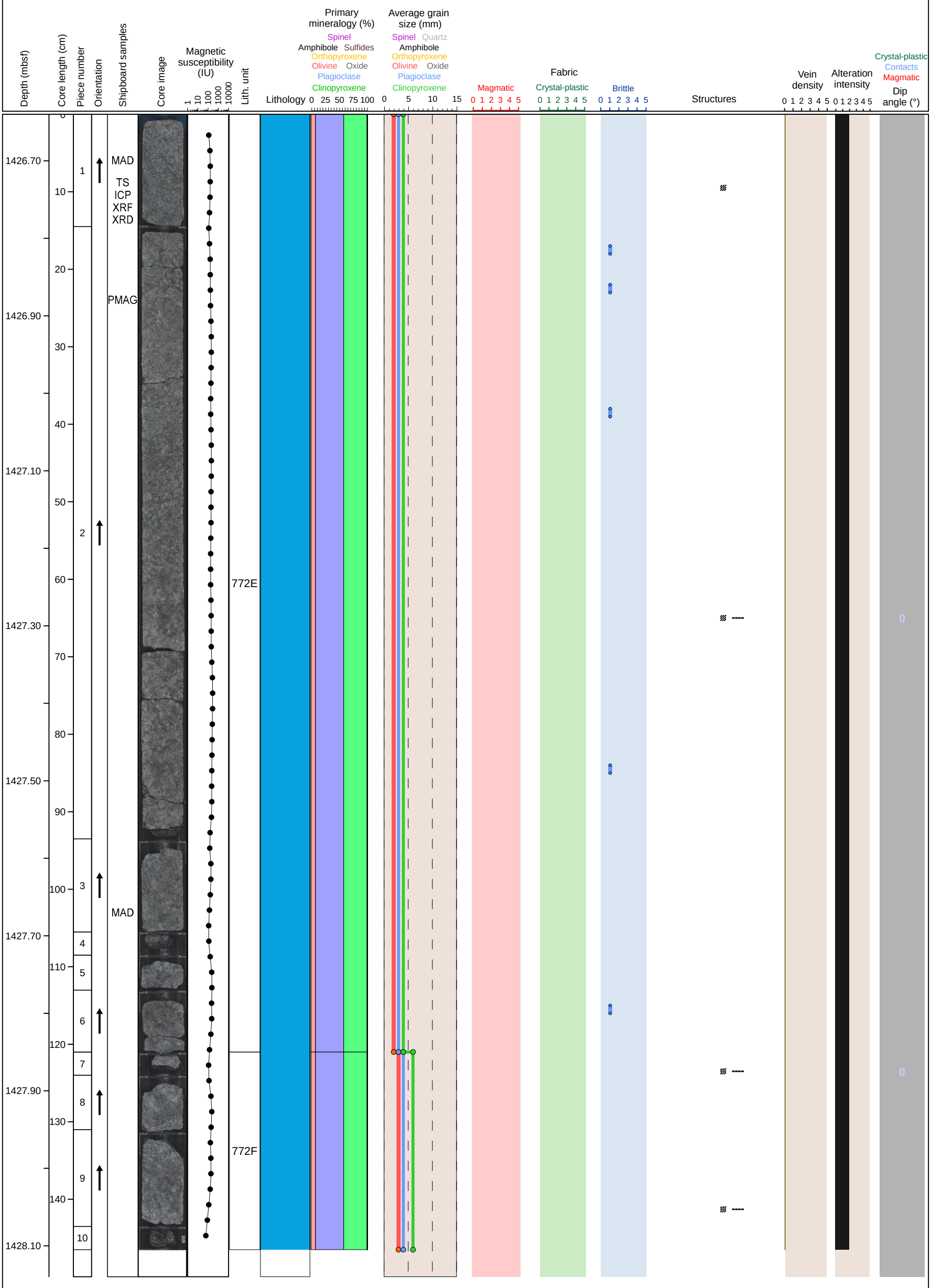


Hole 399-U1309D-299R Section 2, Top of Section: 1426.64 m

Igneous Petrology: Medium-grained, subophitic olivine gabbro; grades via some coarse-grained patches into coarse-grained, subophitic olivine gabbro.

Alteration: Orthopyroxene-bearing olivine-gabbro that underwent incipient alteration. The extent of olivine alteration varies from incipient to high. Olivine is altered to either serpentine, magnetite, and sulfide, or to serpentine, talc, magnetite and sulfide. Interstitial orthopyroxene appears unaltered. Clinopyroxene is altered along thin veins and cleavage planes. Plagioclase is mostly unaltered. Fluid inclusions occur in all primary silicates. White veins, likely composed of zeolite can be observed in this section.

Structural Geology: Isotropic, olivine gabbro, locally with cyclic grain size variations across diffuse, subhorizontal planar boundaries, cut by sparse thin white, subhorizontal zeolite veins. M > V1

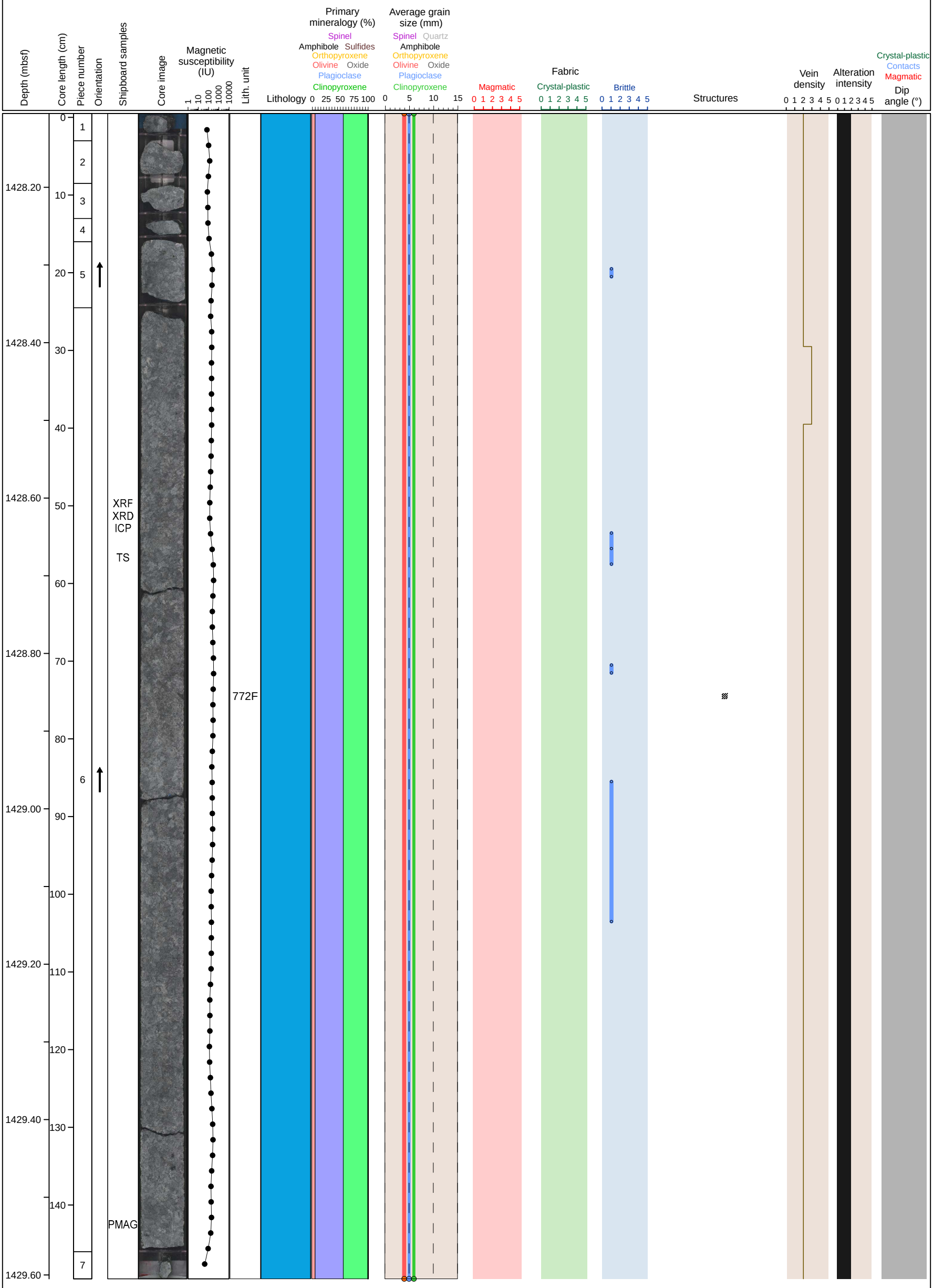


Hole 399-U1309D-299R Section 3, Top of Section: 1428.105 m

Igneous Petrology: Coarse grained olivine gabbro with ophitic to subophitic textures.

Alteration: Slightly altered Ol-gabbro. Plagioclase alteration to chlorite is variable and tends to be higher in proximity to veins. Clinopyroxene is partially altered to amphibole. Olivine is partially altered to serpentine and magnetite. Submilimetric sulfide grains of primary or secondary origin are present. Two generations of veins are present; a first one composed of chlorite which is cut by zeolite veins.

Structural Geology: Isotropic, olivine and olivine-bearing gabbro, locally with patchy grain size variations; cut by sparse thin white zeolite veins with no consistent orientation. M > V1

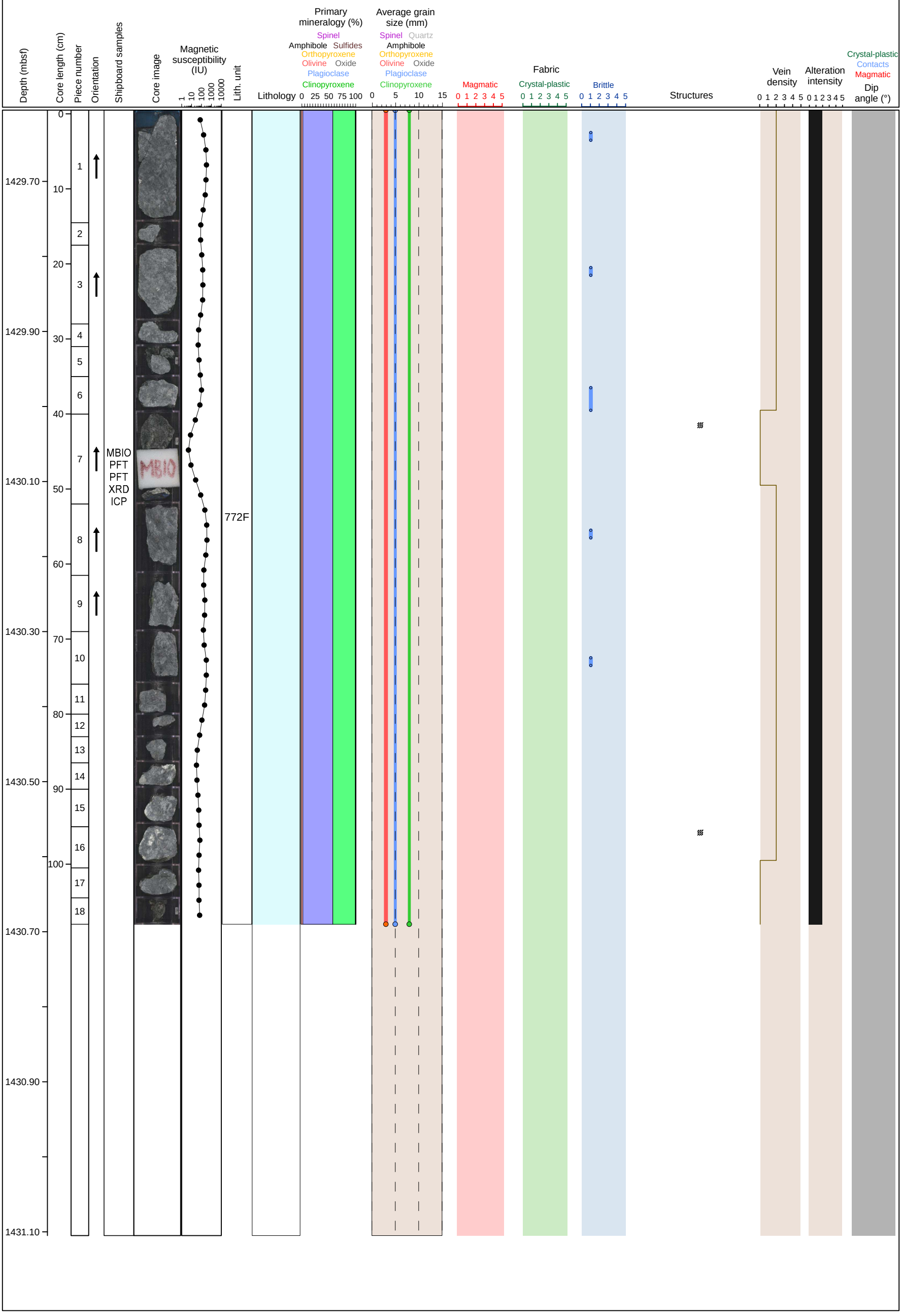


Hole 399-U1309D-299R Section 4, Top of Section: 1429.605 m

Igneous Petrology: Coarse grained olivine-bearing gabbro, texture ranges from granular to subophitic on 10s cm scale.

Alteration: Slightly to moderately altered coarse-grained olivine-bearing gabbro. The extent of alteration decreases from olivine, to clinopyroxene, to plagioclase. Olivine is partially altered to serpentine and magnetite, clinopyroxene is partially altered to amphibole, and chlorite is partially altered to chlorite. crosscut by veins. Sulfide minerals of primary and/or secondary origin can be observed. White veins, likely composed of zeolite form a network in this section.

Structural Geology: Isotropic, olivine-bearing gabbro, cut by inclined chlorite veins, in turn cut by thin white, subhorizontal and subvertical zeolite veins. M > V1 > V2

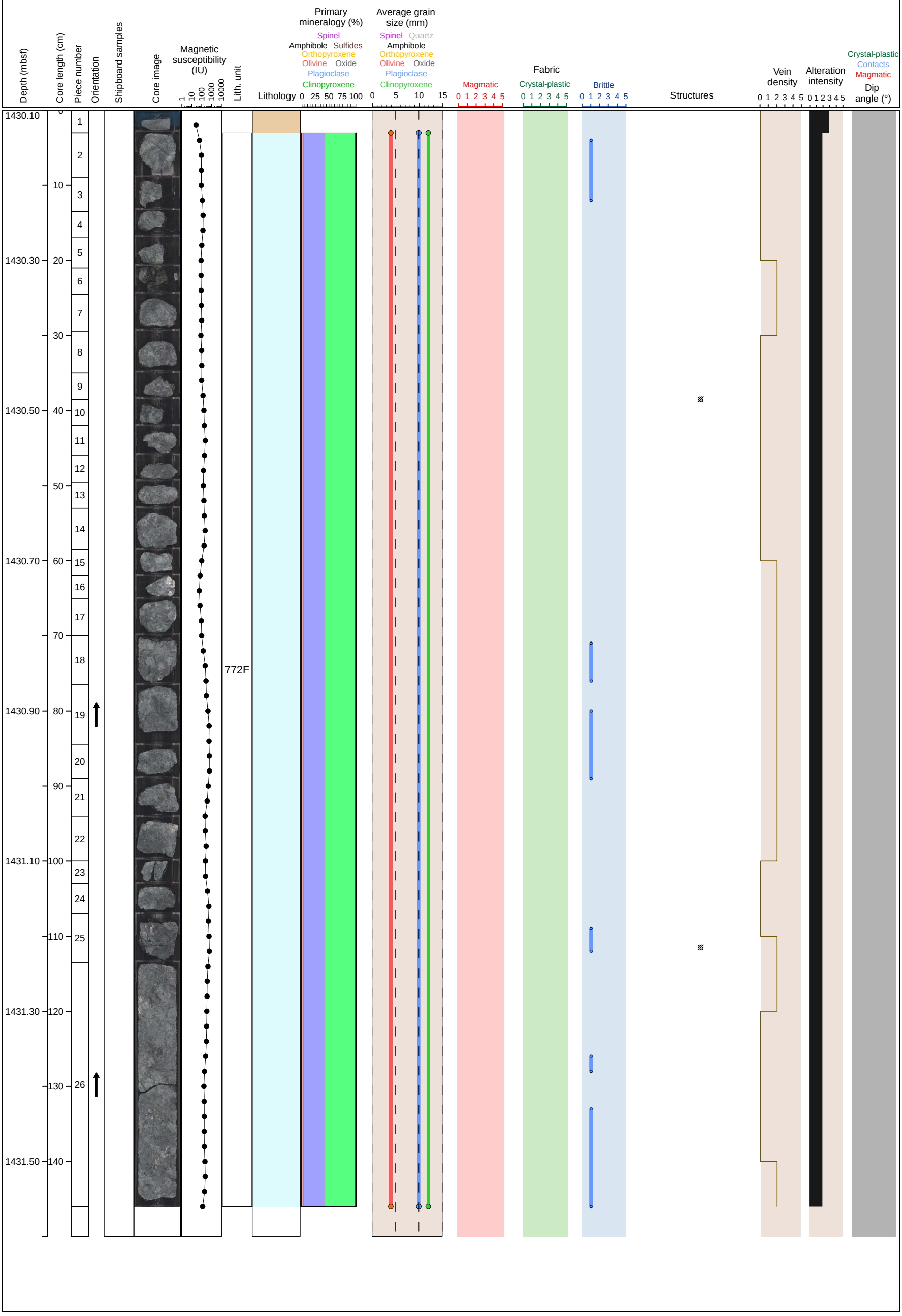


Hole 399-U1309D-300R Section 1, Top of Section: 1430.1 m

Igneous Petrology: Coarse-grained olivine-bearing gabbro with poikilitic to granular texture.

Alteration: Slightly altered gabbro. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. White veins, likely composed of zeolite form a network in this section.

Structural Geology: Isotropic, olivine-bearing gabbro, cut by inclined chlorite veins, in turn cut by thin white, subhorizontal zeolite veins. M > V1 > V2

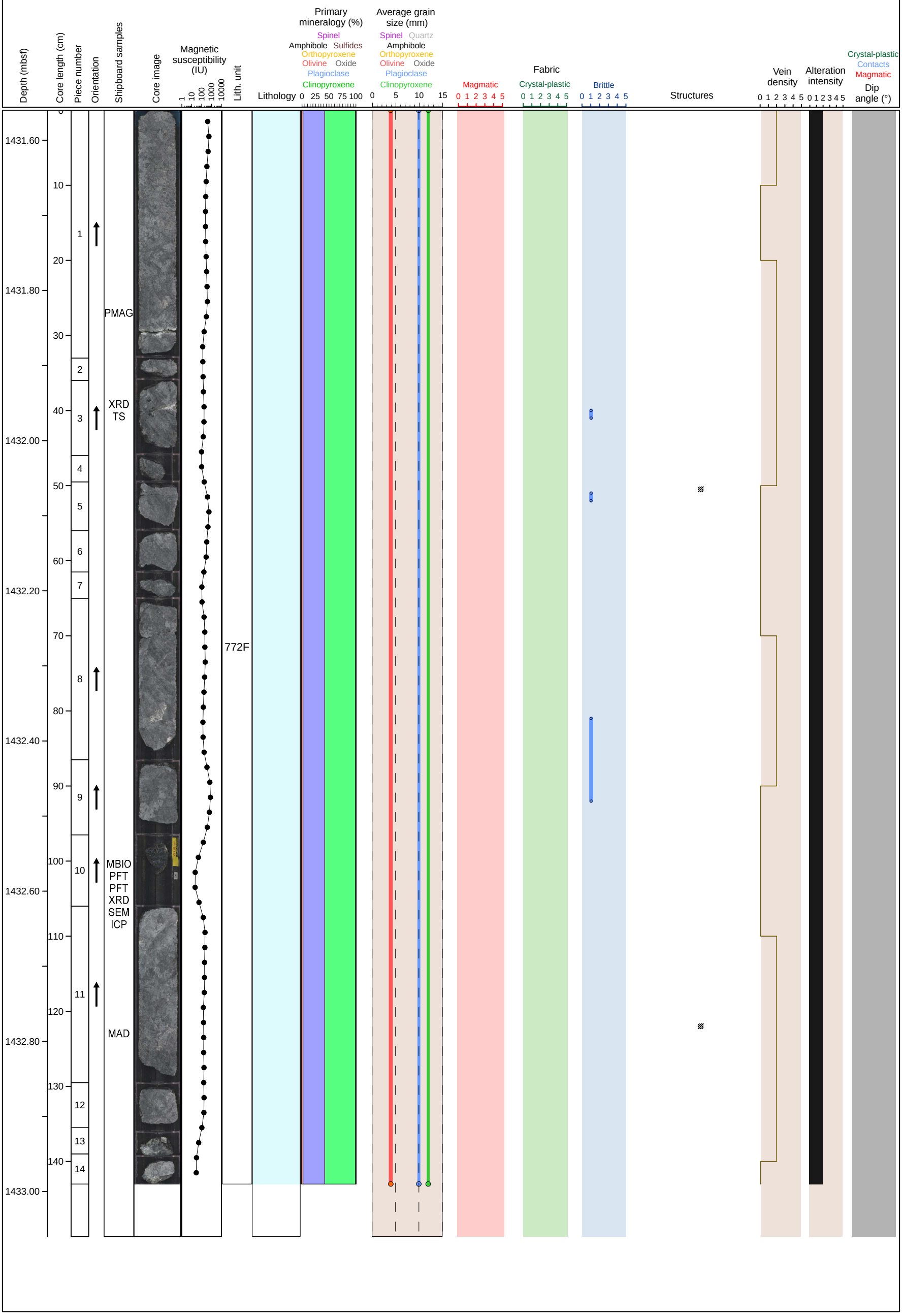


Hole 399-U1309D-300R Section 2, Top of Section: 1431.56 m

Igneous Petrology: Coarse-grained olivine-bearing gabbro with poikilitic to granular texture, continuation from the previous section. Piece 3 has aggregates of altered olivine with secondary sulfides.

Alteration: Slightly altered olivine gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains of probable primary origin are present. Two vein generations are present with a first one composed of amphibole which is cut by a network of zeolite veins. The latter is locally associated with chlorite and clay minerals

Structural Geology: Isotropic, olivine- bearing gabbro, cut by inclined (40° dip) branched, amphibole-chlorite veins, in turn cut by thin white, subhorizontal zeolite veins. M > V1 > V2

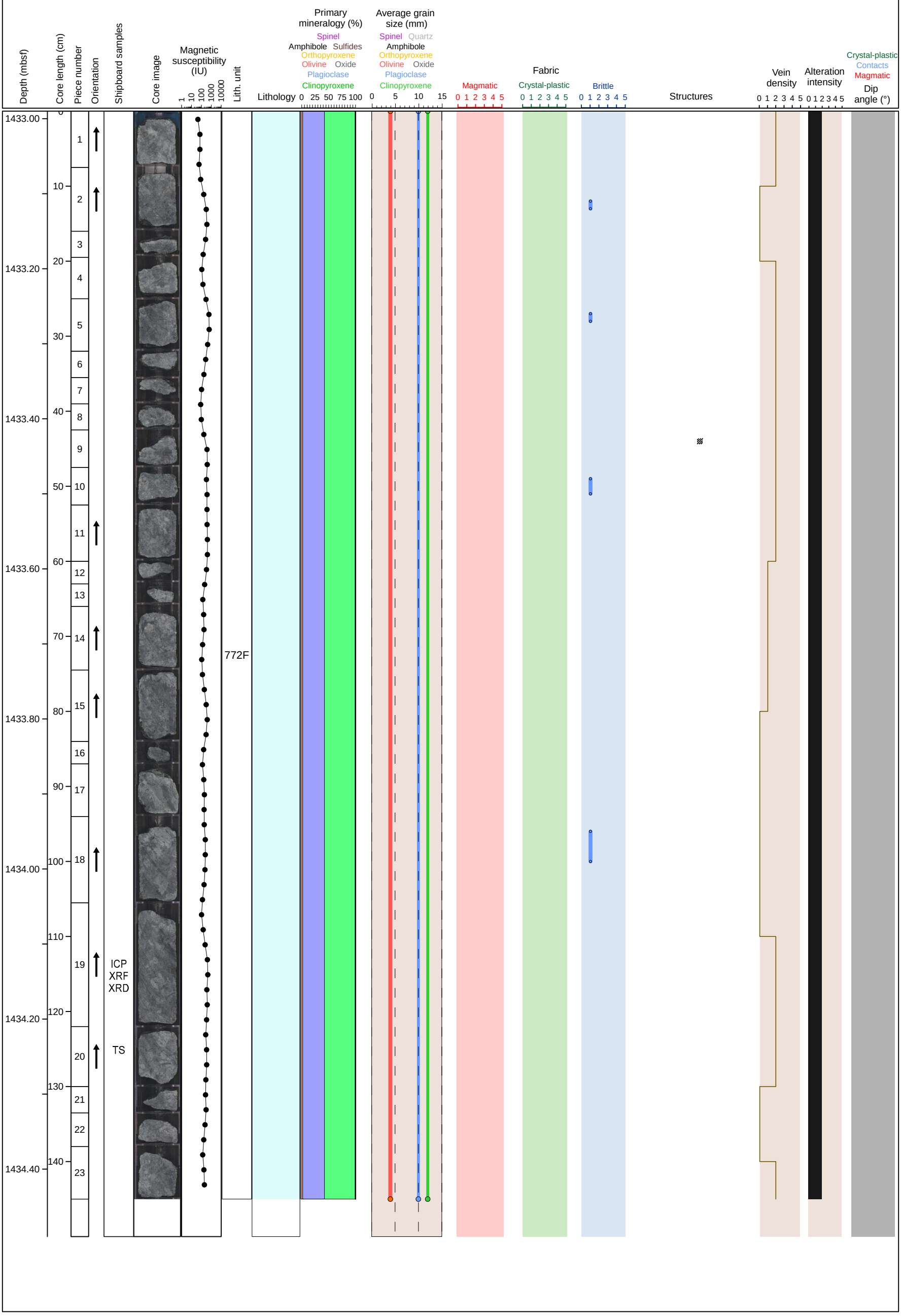


Hole 399-U1309D-300R Section 3, Top of Section: 1432.99 m

Igneous Petrology: Coarse-grained olivine-bearing gabbro with poikilitic to granular texture, continuation from the previous section. Piece 17-18 has pegmatitic plagioclase and clinopyroxene.

Alteration: Slightly altered olivine gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains of probable primary origin are present. Two vein generations are present with a first one composed of amphibole-chlorite which is cut by a network of zeolite veins.

Structural Geology: Isotropic, olivine-bearing gabbro, cut by shallow to moderate dip (20-55°) branched, amphibole-chlorite veins, in turn cut by thin white, subhorizontal zeolite veins. M > V1 > V2

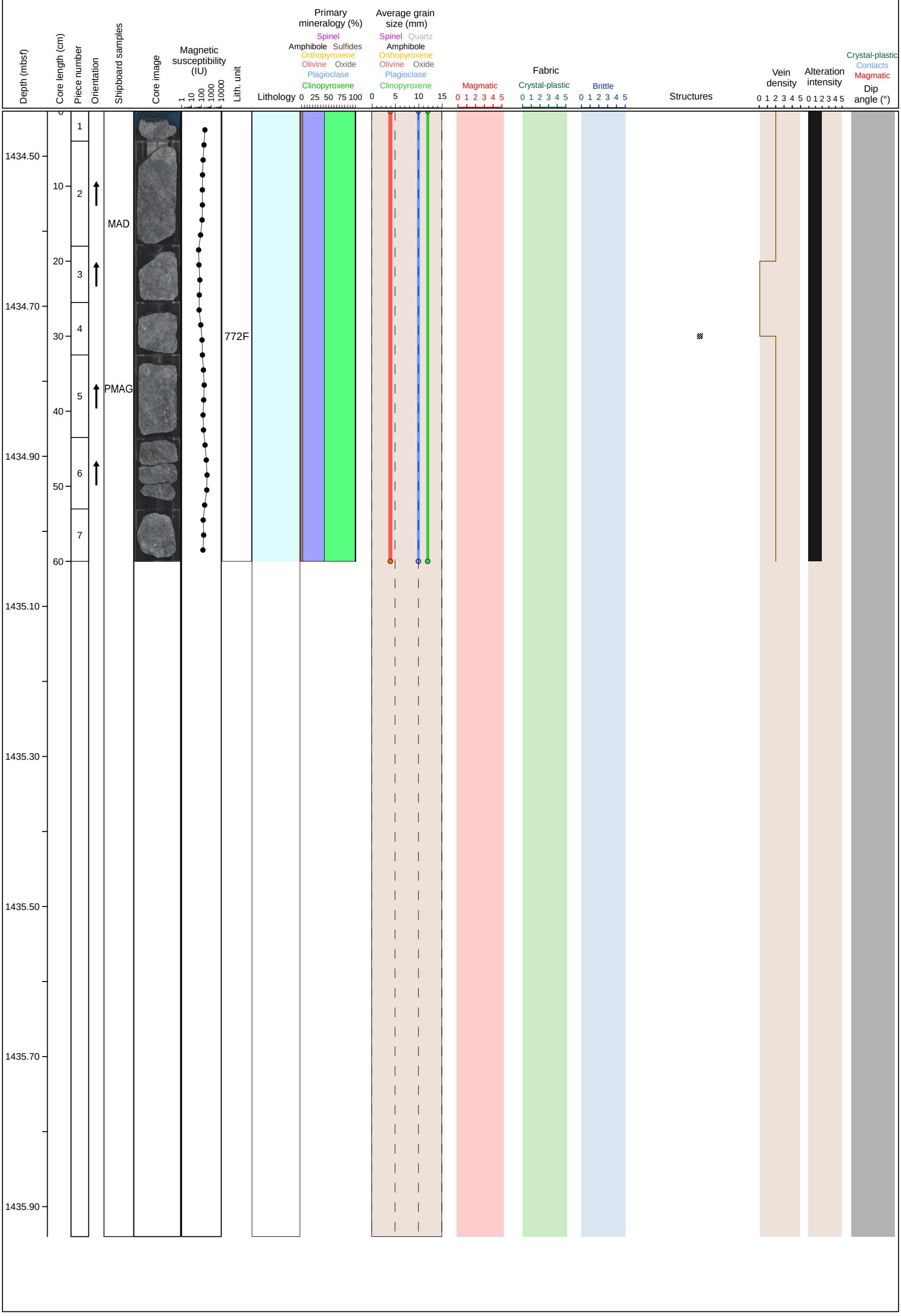


Hole 399-U1309D-300R Section 4, Top of Section: 1434.44 m

Igneous Petrology: Coarse-grained olivine-bearing gabbro with poikilitic to granular texture, continuation from previous section.

Alteration: Slightly altered olivine-bearing gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains are of probable primary origin. White veins, likely composed of zeolite form a network in this section.

Structural Geology: Isotropic, olivine-bearing gabbro, cut by shallow to moderate dip (20-55°) thin white, zeolite veins. M > V1

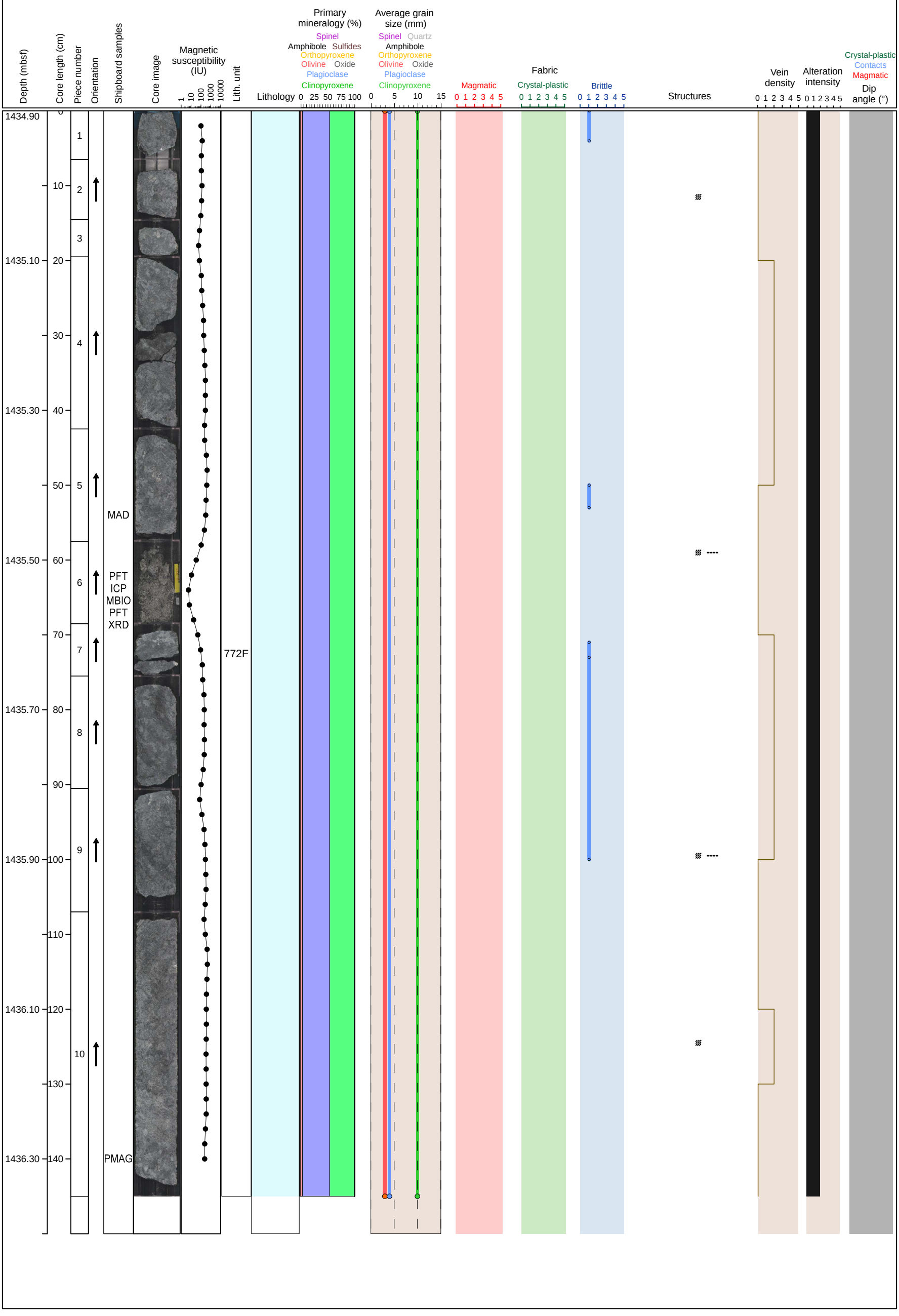


Hole 399-U1309D-301R Section 1, Top of Section: 1434.9 m

Igneous Petrology: Coarse-grained, generally ophitic but locally poikilitic olivine-bearing gabbro.

Alteration: Slightly altered gabbro. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. Small sulfide grains are associated with clinopyroxene and are possibly of primary origin. Two vein generations can be distinguished; an earlier generation composed of amphibole and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across a diffuse boundary (not recovered); cut by shallow to moderate dip (20-55°) branched, amphibole-chlorite veins, in turn cut by thin white, subhorizontal zeolite veins. Cut by minor fractures with shallow to moderate dips (10-45°) M > V1 > V2 > B

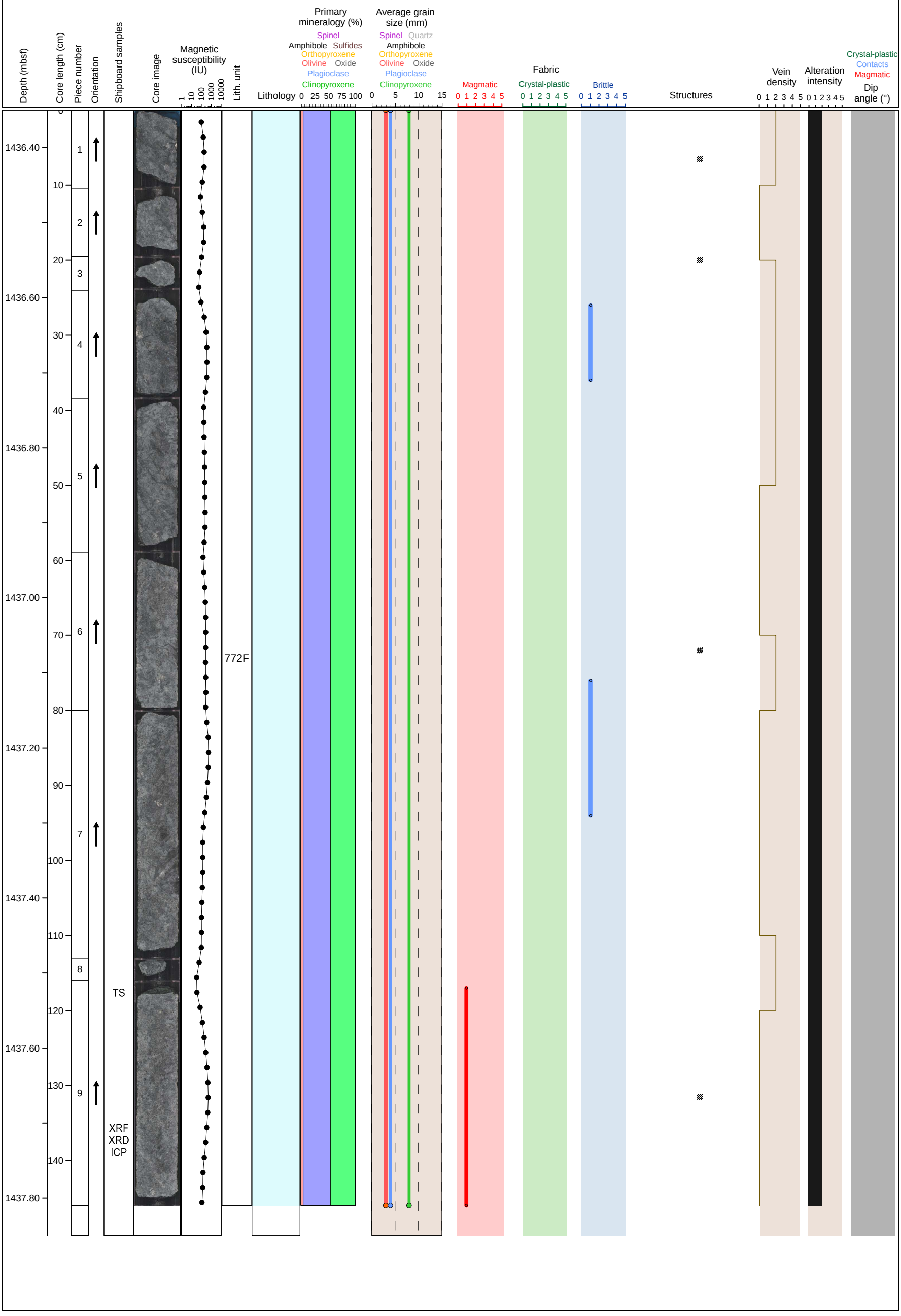


Hole 399-U1309D-301R Section 2, Top of Section: 1436.35 m

Igneous Petrology: Coarse-grained, ophitic olivine-bearing gabbro.

Alteration: Slightly altered gabbro. Plagioclase is partially altered to chlorite. Clinopyroxene is altered to amphibole. Small sulfide grains are associated with clinoyroxene and plagioclase, possibly of primary origin. A network of zeolite veins is present throughout the section.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries (not recovered); locally (117-146 cm) recording a weak planar, shape preferred orientation (SPO) of plagioclase laths (25° dip). Section cut by thin, shallow to moderate dip (20-65°) white zeolite veins and fractures. M > V1 > V2 = B

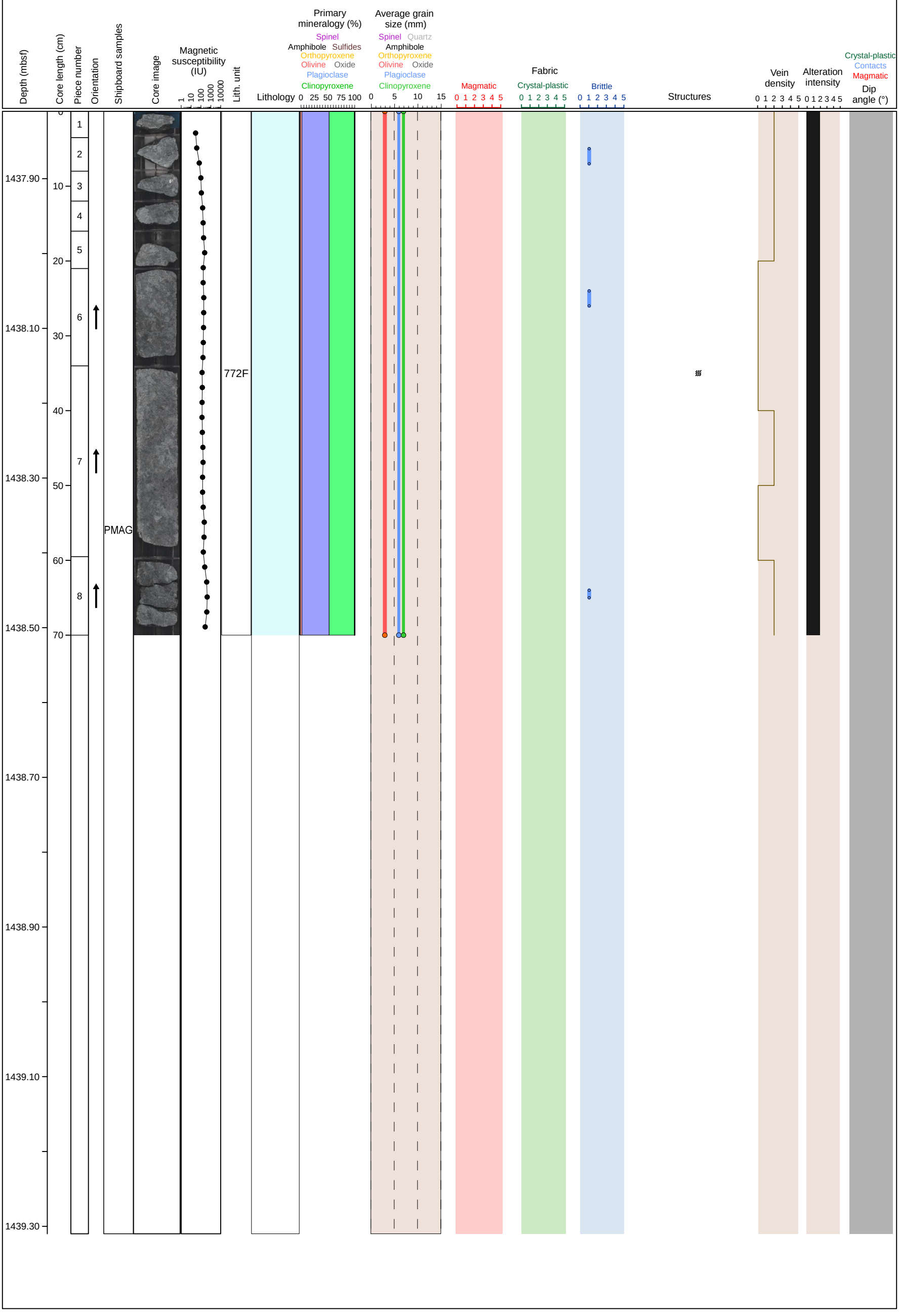


Hole 399-U1309D-301R Section 3, Top of Section: 1437.81 m

Igneous Petrology: Coarse-grained, subophitic olivine-bearing gabbro.

Alteration: Slightly altered olivine-bearing gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains are of probable primary origin. Two vein generations can be distinguished; an earlier generation composed of amphibole and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries (not recovered). Upper part of the section is cut by one branched, amphibole vein (3-16 cm), and younger thin white, subhorizontal zeolite veins. M > V1 > V2

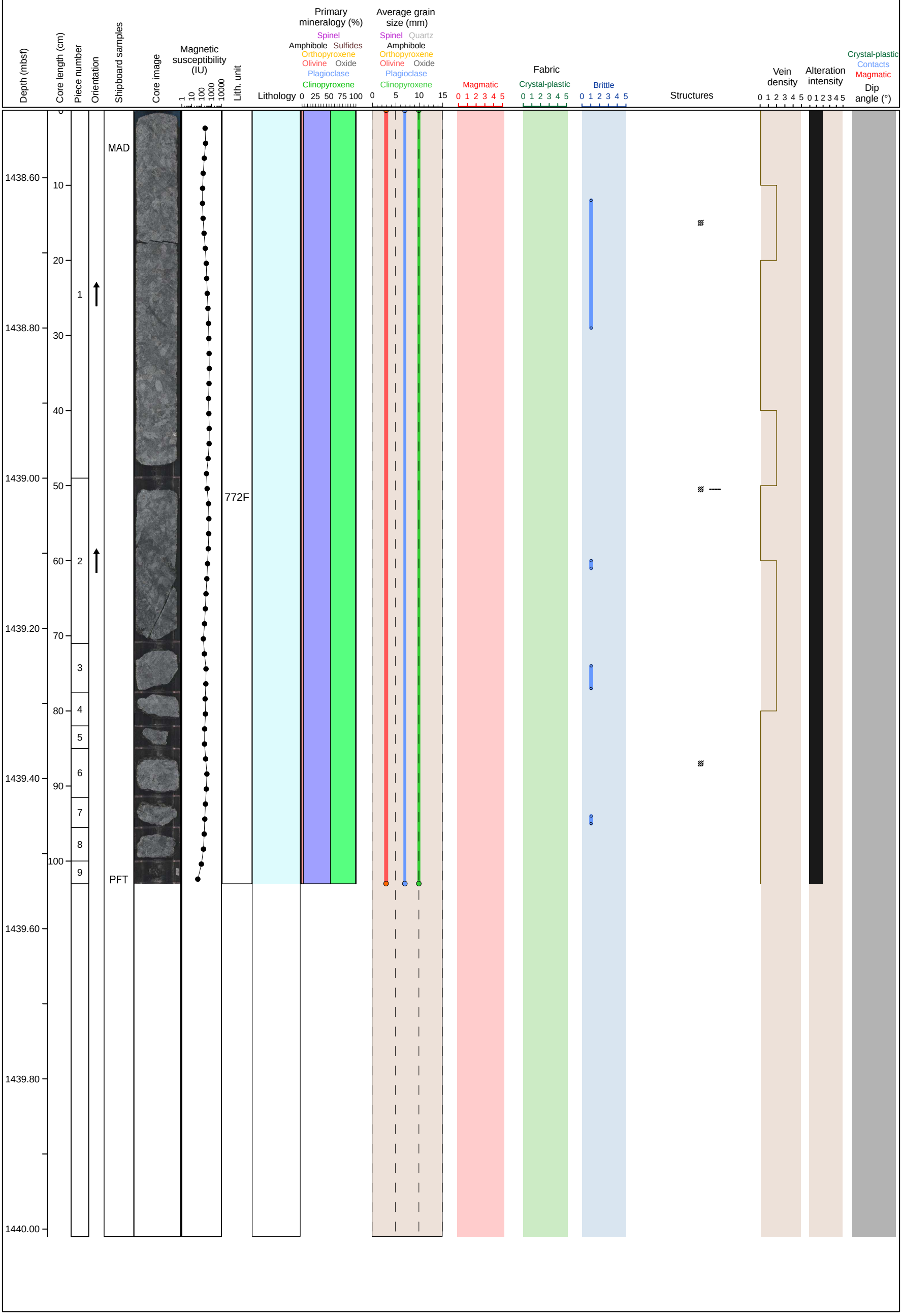


Hole 399-U1309D-301R Section 4, Top of Section: 1438.51 m

Igneous Petrology: Coarse-grained, granular olivine-bearing gabbro.

Alteration: Slightly altered olivine-bearing gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains are of probable primary origin. Two vein generations can be distinguished; an earlier generation composed of chlorite and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries. Section cut by thin, subhorizontal, and rare moderate dip (65°) white zeolite veins and fractures. M > V1 > V2

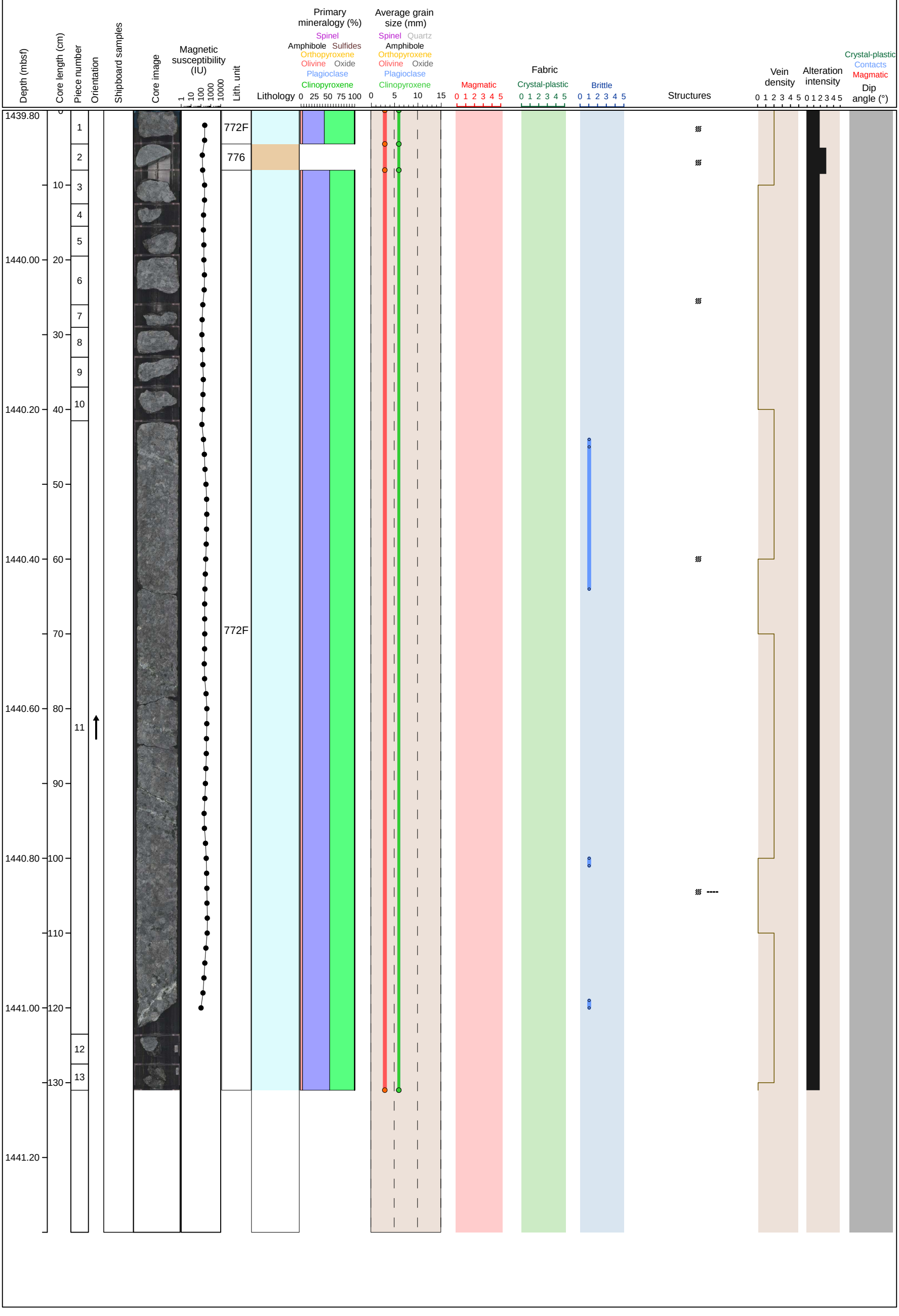


Hole 399-U1309D-302R Section 1, Top of Section: 1439.8 m

Igneous Petrology: Medium-grained granular olivine-bearing gabbro; the top few pieces are relatively cpx rich and coarse-grained.

Alteration: Slightly altered olivine-bearing gabbro and diabase vein. In the olivine-bearing gabbro clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains are of probable primary origin. Fine-grained diabase intrusion in piece # 1. Small size of grains makes it difficult to estimate total alteration extent and to identify secondary minerals at the expense of primary matrix. Plagioclase phenocrysts are partially altered to chlorite. Two vein generations can be distinguished; an earlier generation composed of chlorite and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries, cut by massive chlorite veins with subhoriontal to moderate dips (20-40°), cut locally by subhorizontal zeolite veins. M > V1 > V2

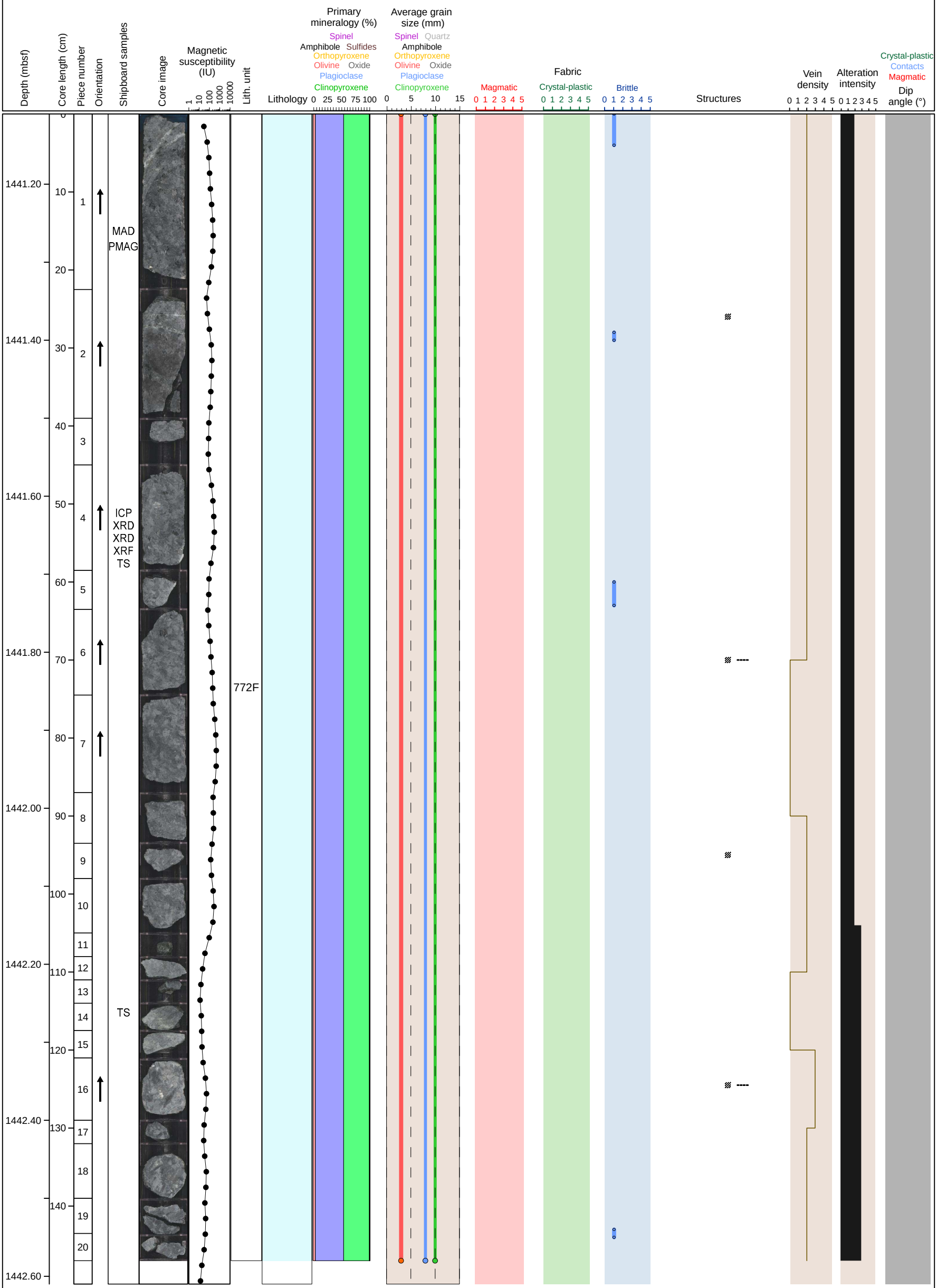


Hole 399-U1309D-302R Section 2, Top of Section: 1441.11 m

Igneous Petrology: Medium to coarse-grained granular olivine-bearing gabbro with piece 2 being a diabase pebble. Cpx abundance and grain size varies at 10cm scale

Alteration: Slightly altered olivine-gabbro to highly altered Ol-bearing gabbro. The extent of hydrothermal alteration increases down-section. Clinopyroxene is partially altered to amphibole and sulfide. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite and to talc-serpentine-clay minerals in the bleached patches down-section. Chlorite and amphibole-chlorite veins are cut by zeolite veins.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries. Section cut by chlorite veins with subhoriontal to moderate dips (15-48°), cut locally by subhorizontal zeolite veins. M > V1 > V2

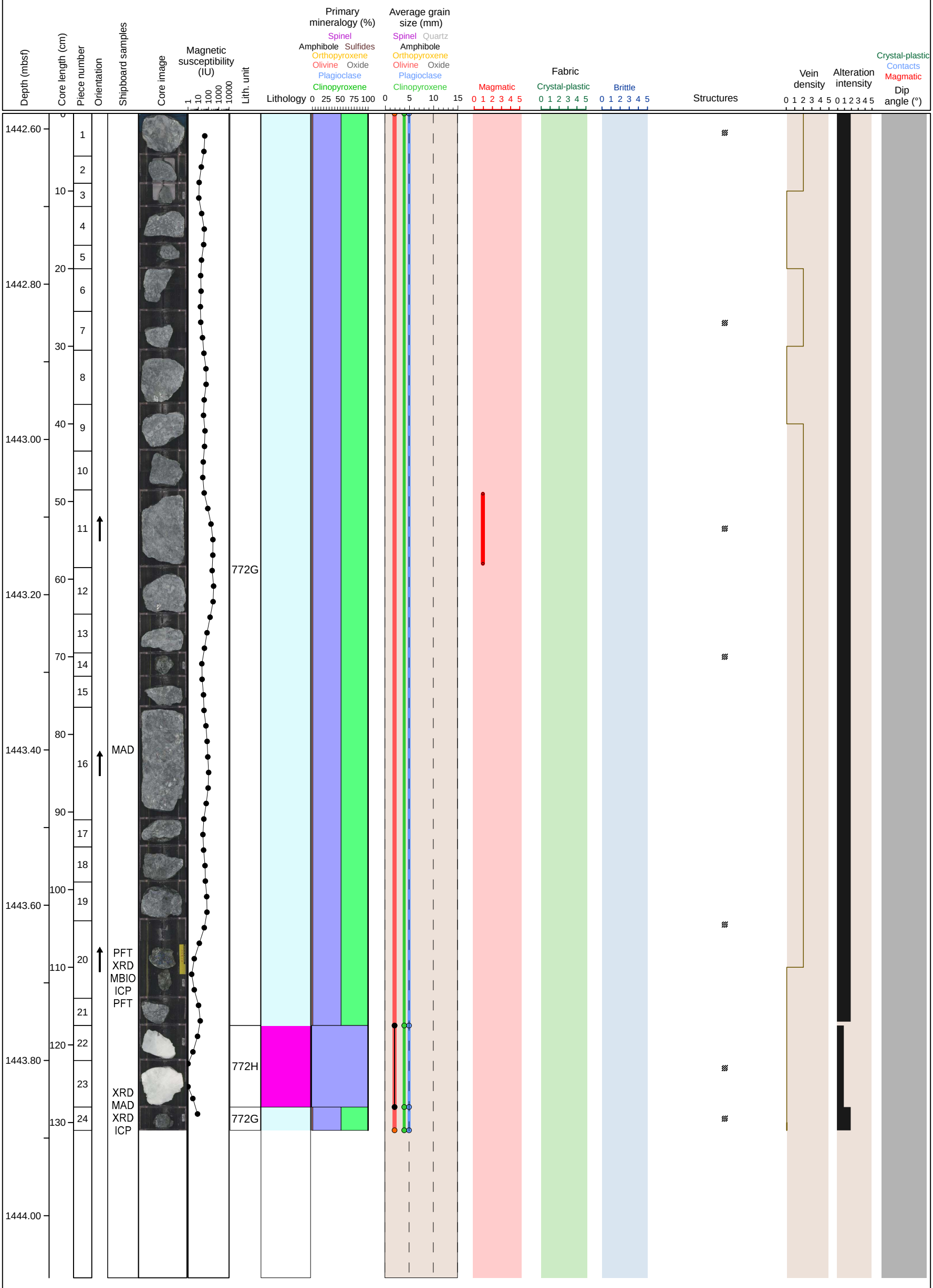


Hole 399-U1309D-302R Section 3, Top of Section: 1442.58 m

Igneous Petrology: Coarse-grained granular to subophitic olivine-bearing gabbro with grain size increasing down section.

Alteration: Slightly altered olivine-gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to completely altered to serpentine, talc, magnetite, and chlorite. Sulfide grains associated with clinopyroxene and plagioclase of possible primary origin in piece 11. Piece 24 consists of white felsic rock mainly composed of plagioclase, minor quartz, and amphibole. In the gabbro and olivine gabbro two vein generations can be distinguished; an earlier generation composed of chlorite and an unidentified white mineral, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic, olivine- bearing gabbro, with local grain size variations across diffuse boundaries (not recovered). Between 49-58 cm the section records a weak planar, shape preferred orientation (SPO) of plagioclase and clinopyroxene with a subvetical dip. Thick plagioclase vein cuts the section at 118-128 cm (contacts not recovered). Section cut by rare shallow to moderate dip chlorite-talc veins (20-30°), and thin white, subhorizontal zeolite veins. M > V1 > V2

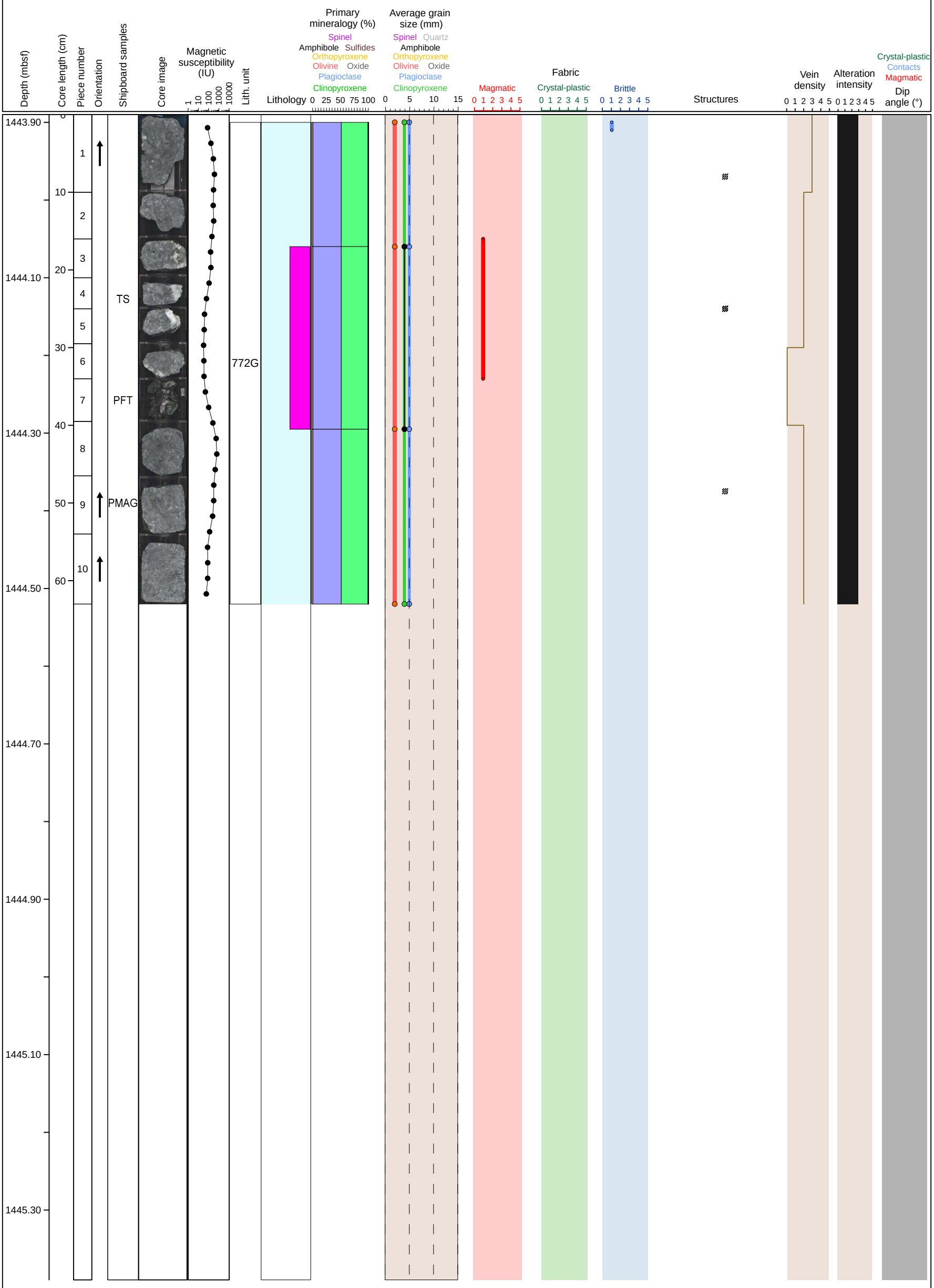


Hole 399-U1309D-302R Section 4, Top of Section: 1443.89 m

Igneous Petrology: Medium to coarse-grained subophitic to ophitic olivine-bearing gabbro with finer-grained pieces at the top and a leucocratic diorite vein at the bottom of the core.

Alteration: Slightly altered olivine-bearing gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine is partially altered to serpentine and magnetite. Sulfide grains associated with clinopyroxene are of probable primary origin. Amphibole-chlorite and plagioclase-chlorite-amphibole veins are cut by a network of zeolite veins.

Structural Geology: Isotropic, olivine-bearing gabbro, hosting grain size variations across diffuse boundaries (not recovered). Locally (16-34 cm), the section records a weak planar, shape preferred orientation (SPO) of clinopyroxene with a moderate dip. Felsic vein recovered between 18-34 cm, with estimated moderate dip. Section cut by rare shallow dip amphibole and chlorite-talc veins, moderate dip (62°) thin white, zeolite veins, and minor 20° dipping fractures. M > V1 > V2

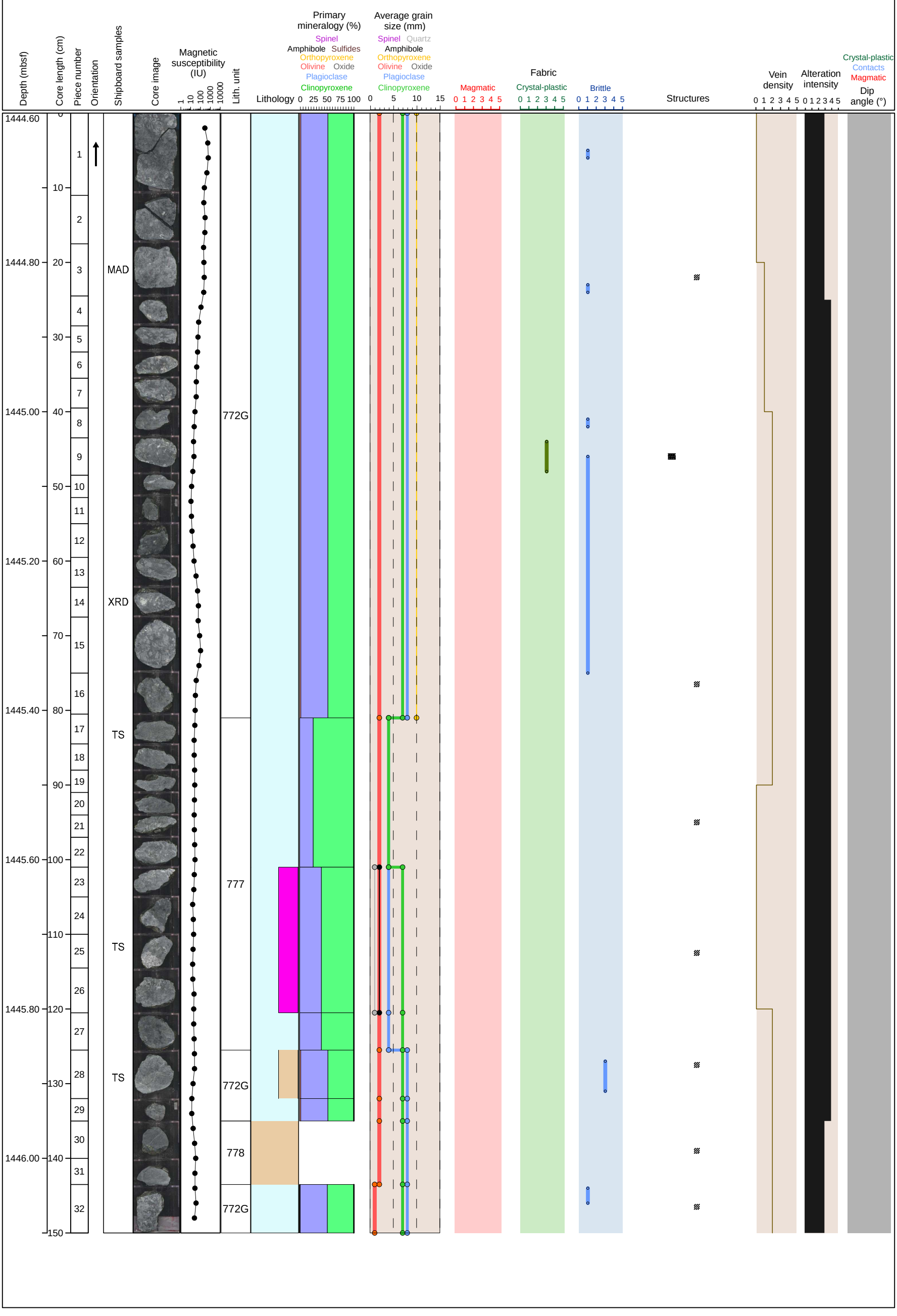


Hole 399-U1309D-303R Section 1, Top of Section: 1444.6 m

Igneous Petrology: Olivine-bearing gabbro with varying grain size and cpx modal proportions. Contains a unit of medium-grained, cpx-rich gabbro subunit, a vein of leucodiorite and small intervals of diabase.

Alteration: Highly altered Ol-Opx-bearing gabbro with bleached patches. Olivine is variably altered to talc, serpentine, magnetite, and chlorite. Amphibole replaces clinopyroxene. Chlorite replaces plagioclase. Some others domains include moderately altered Ol-gabbro, Opx-bearing gabbro and fine-grained diabase. Several vein types including amphibole, chlorite and a unidentified mineral, plagioclase-quartz-amphibole that are cut in turn by a network of zeolite veins.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries (not recovered). Isotropic diabase recovered between 135-143 cm. A thin zone of protomylonitic cutting a plagioclases/prehnite and amphibole vein ? was recovered between 44-48 cm. M > V1 > CP

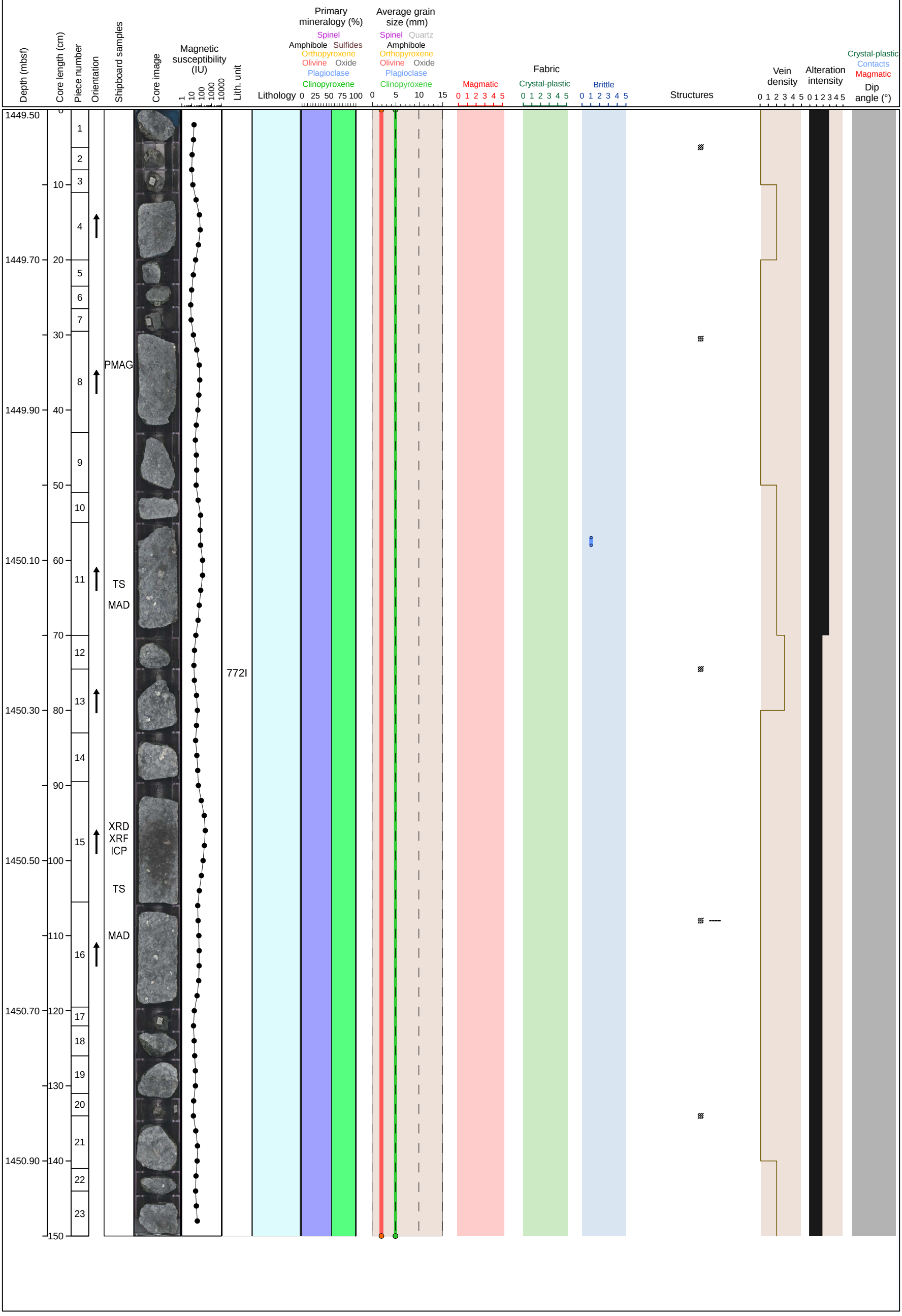


Hole 399-U1309D-304R Section 1, Top of Section: 1449.5 m

Igneous Petrology: Medium to coarse-grained granular to ophitic gabbro with trace amounts of olivine.

Alteration: Moderately to slightly altered Opx-Ol-bearing gabbro. The extent of alteration decreases down-section. Bleached light patches occur after former orthopyroxene and olivine in the moderately altered zone. Orthopyroxene is altered to talc and chlorite. Olivine is altered to talc and chlorite (and presumably amphibole) in bleached patches. Clinopyroxene is altered to amphibole and plagioclase is altered to chlorite. Several vein types include amphibole, chlorite, chlorite and an unidentified mineral are cut by zeolite veins.

Structural Geology: Isotropic, olivine-bearing gabbro, with local grain size variations across diffuse boundaries (not recovered). Cut by variably dipping black amphiboel and green chlorite veins (V1), and white veins (V2). M>V1>V2

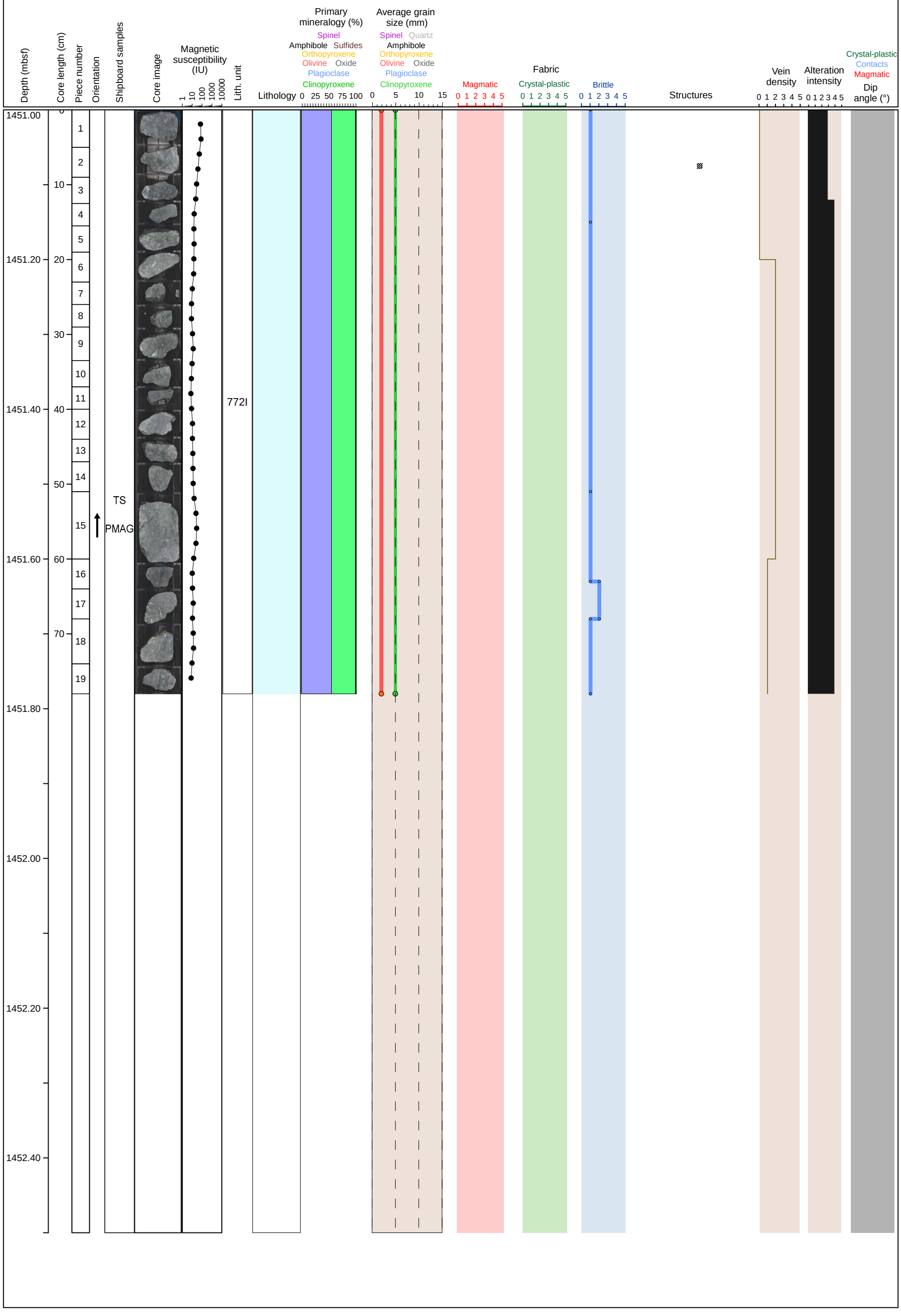


Hole 399-U1309D-304R Section 2, Top of Section: 1451.0 m

Igneous Petrology: Medium to coarse-grained granular to ophitic gabbro with trace amounts of olivine, continuous from previous section.

Alteration: Moderately (0-12 cm) to highly (12-78 cm) altered Ol-Opx-bearing gabbro. Clinopyroxene is partially altered to amphibole and chlorite. Plagioclase is partially altered to chlorite. Olivine is completely to chlorite and talc in bleached patches. Amphibole veins are cut by zeolite veins

Structural Geology: Isotropic gabbro in the interval from 0-15cm, from 15-150cm no magmatic fabric is visible. Cataclasite at 51-53cm and microfaults present from 15-150cm. Cataclasites cemented by green amp veins (V1) crosscut by white veins (V2). M>B>V1>V2

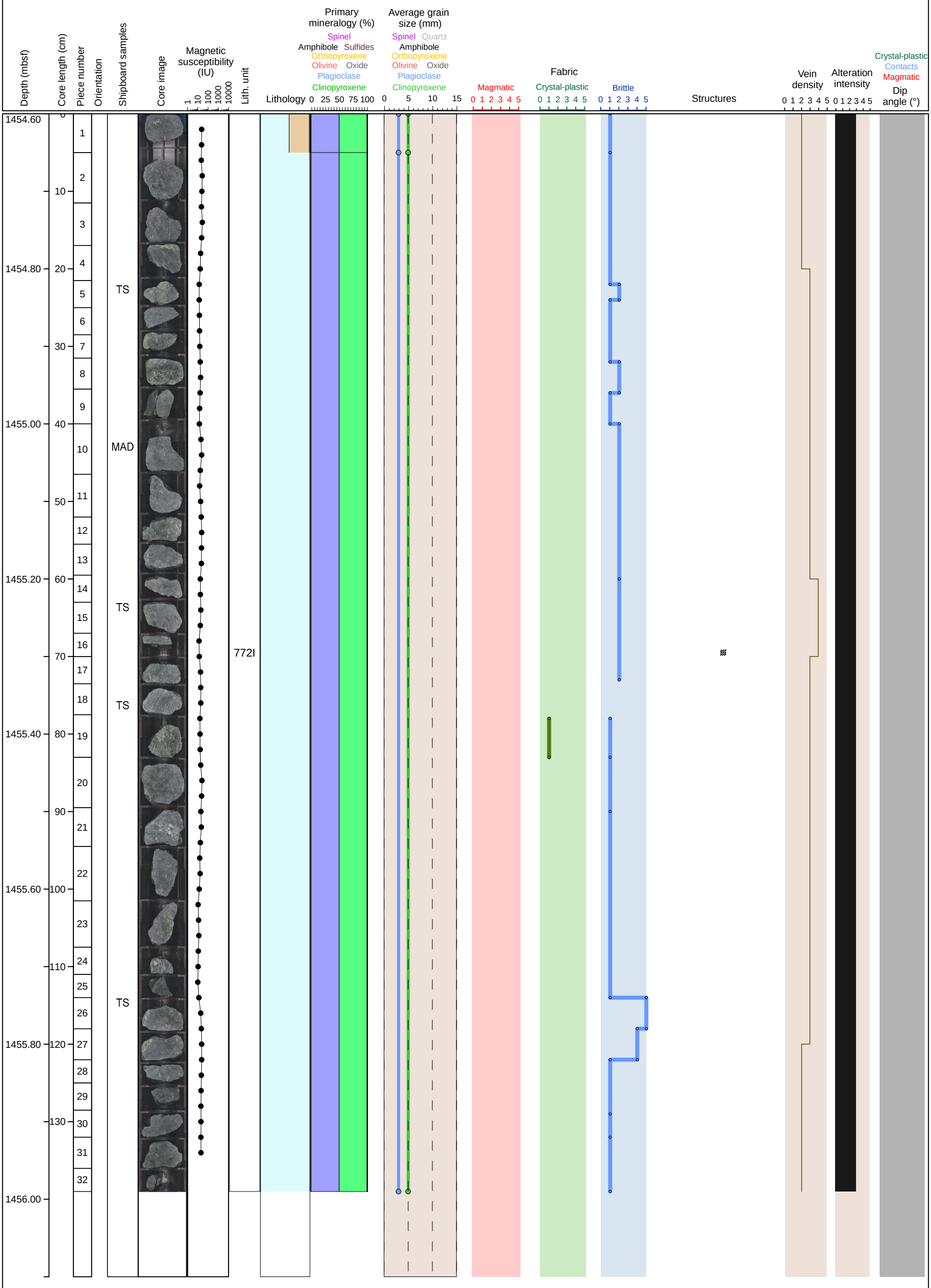


Hole 399-U1309D-305R Section 1, Top of Section: 1454.6 m

Igneous Petrology: Medium-grained gabbro heavily overprinted by alteration and deformation. Small domain of altered diabase in piece 1.

Alteration: Moderately altered deforrmed gabbro with diabase in Piece 1. One type of unidentified pyroxene is altered to chlorite and a white mineral, and alteration extent was not estimated for this pyroxene. Two generations of veins including amphibole, chlorite and amphibole-chlorite veins that are cut by zeolite veins.

Structural Geology: Isotropic gabbro with interval of diabase at 0-5cm mostly overprinted by deformation and alteration. Weak, subvertical CP foliation at 78-83cm. Cataclastic zones at 22-24cm,114-118cm, 129-132cm and fault breccia 118-122cm within a faulted magmatic vein. Microfaults are present within the whole section. Sheared green veins (V1) follow cataclasites and are cut by white horizontal to shallowly inclined white veins (V2). M>CP=B=V1>V2

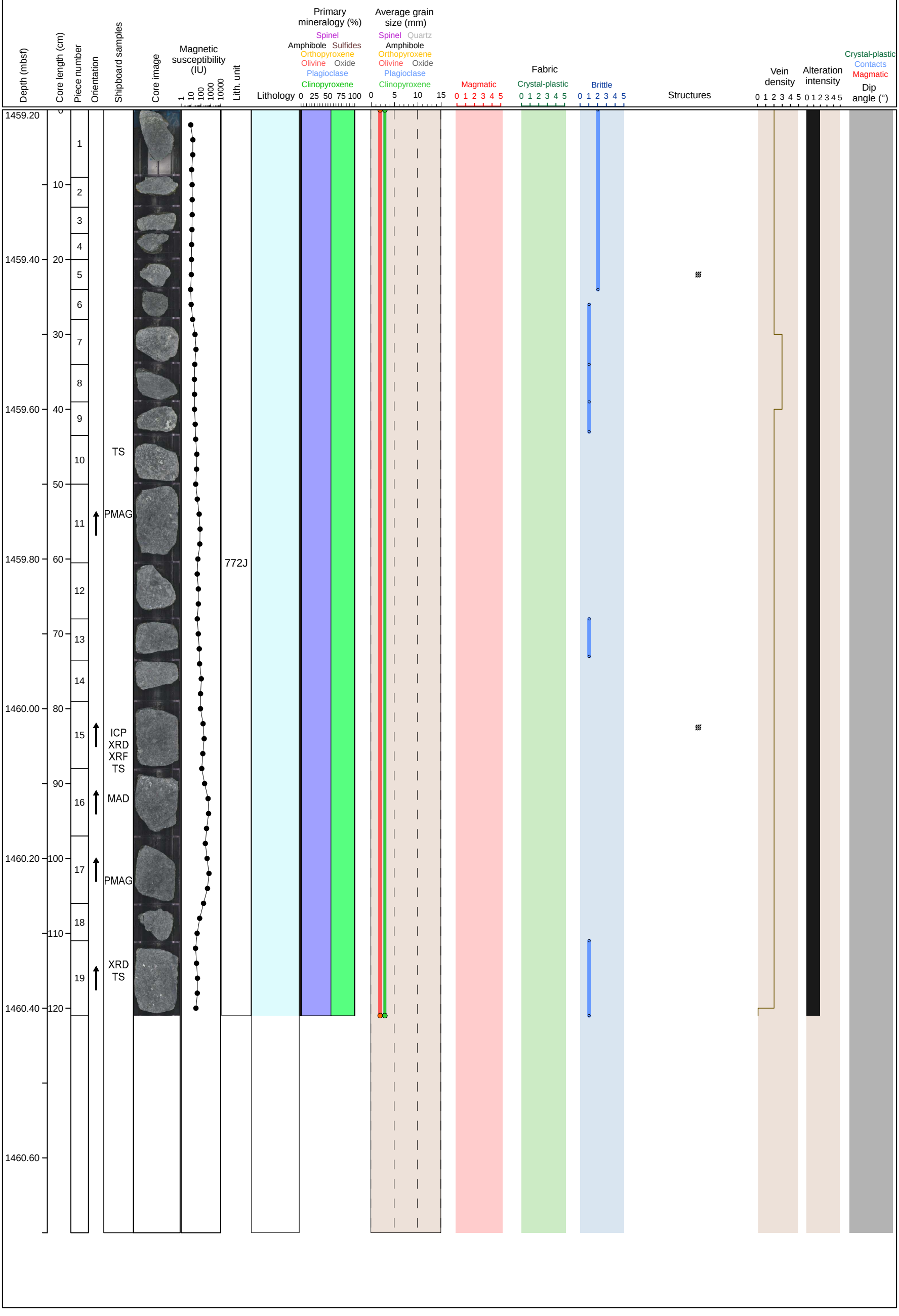


Hole 399-U1309D-306R Section 1, Top of Section: 1459.2 m

Igneous Petrology: Medium-grained granular-subophitic opx-bearing gabbro.

Alteration: Variably altered Ol-Opx-bearing gabbro. Extent of alteration increases down-section. Two types (light green and dark green) amphibole replace plagioclase in shallower intervals. Zeolite veins are present throughout the section.

Structural Geology: Opx-bearing gabbro, in the interval from 0-44cm no magmatic fabric is visible due to strong alteration and fracturing. From 44-121cm an isotropic magmatic fabric is visible. Deformation is present in a strong SC-fabric in the interval from 112-121cm and a cataclasite at 34-39cm as well as microfaulting which is present in most of the core. Cut by steep to subvertical green veins (V1) and white veins (V2). M>CP/B= V1>V2

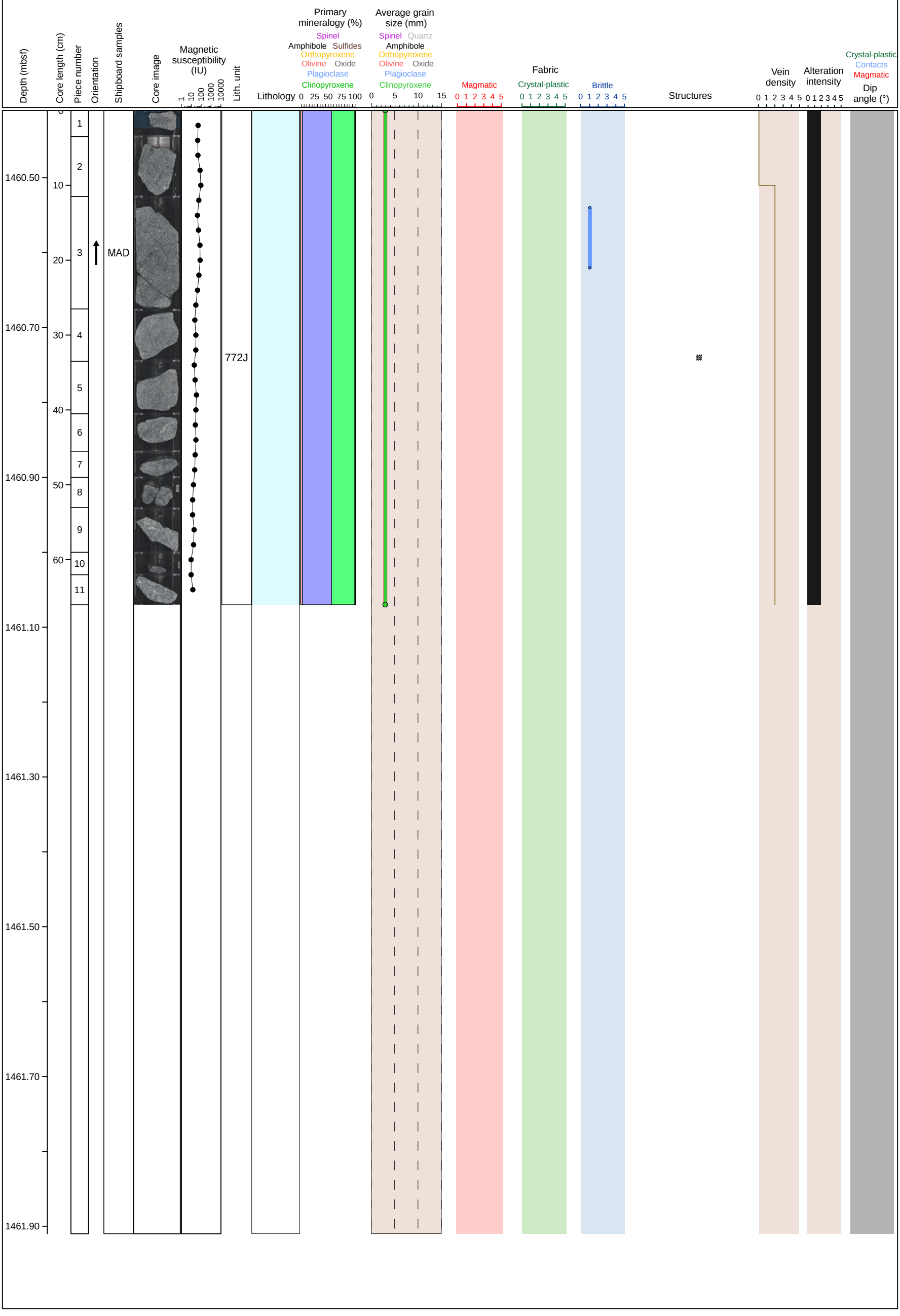


Hole 399-U1309D-306R Section 2, Top of Section: 1460.41 m

Igneous Petrology: Medium-grained granular-subophitic opx-bearing gabbro, continuous from previous section.

Alteration: Variably altered olivine and orthopyroxene-bearing gabbro. Clinopyroxene is partially altered to amphibole. Plagioclase is partially altered to chlorite. Olivine and orthopyroxene are partially altered to chlorite and talc. Sulfide grains are of probable primary origin. White veins, likely composed of zeolite form a network in this section.

Structural Geology: Isotropic opx-bearing gabbro. Cut by a green chlorite vein (V1) and horizontal to shallow white veins (V2). M>V1>V2

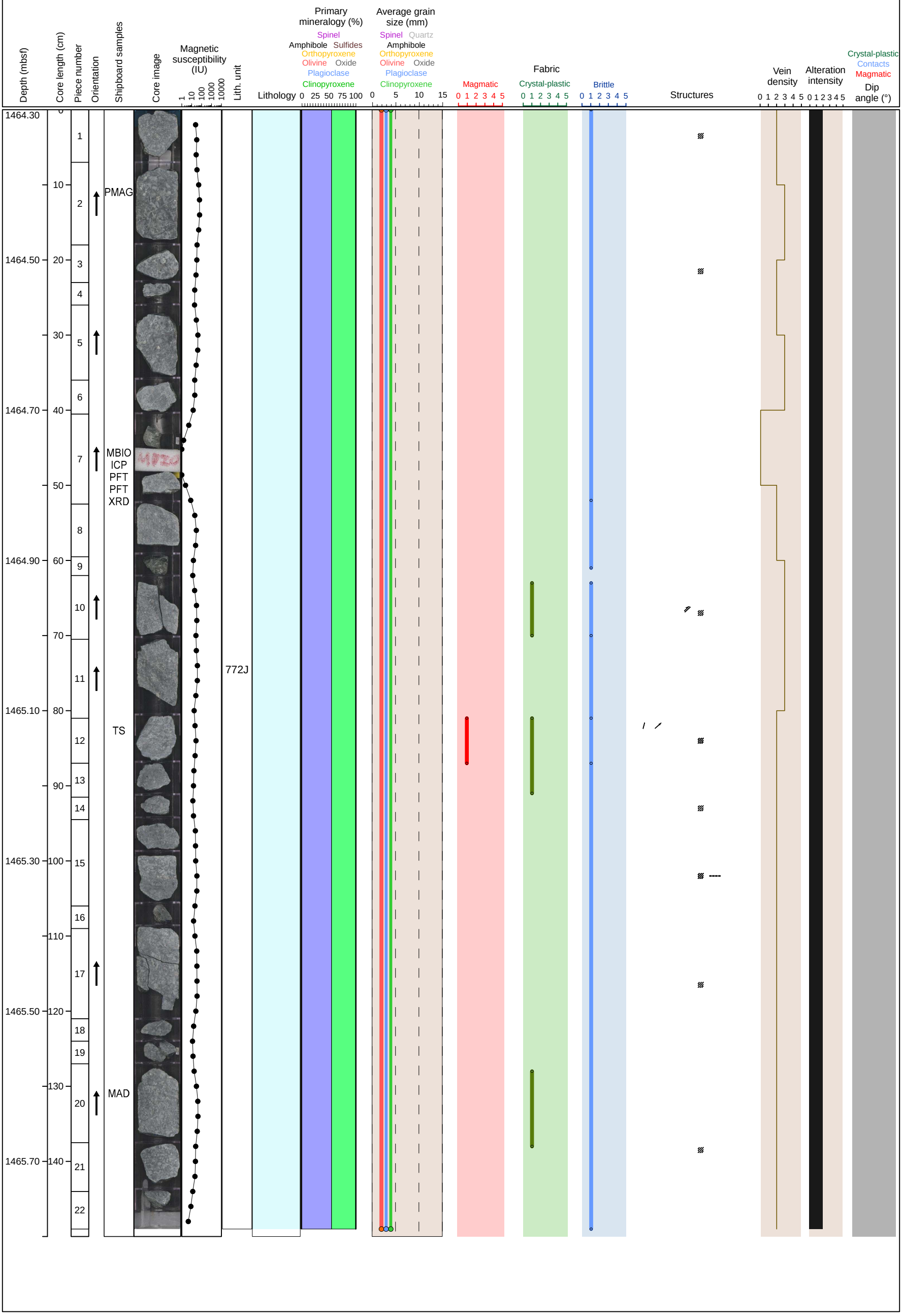


Hole 399-U1309D-307R Section 1, Top of Section: 1464.3 m

Igneous Petrology: Medium-grained subophitic opx-bearing gabbro continuation from previous section.

Alteration: Overall slightly but locally variably altered Opx-bearing gabbro. Amphibole veins are cut by a network of zeolite veins.

Structural Geology: Mostly isotropic opx-bearing gabbro with an interval of opx-bearing gabbro with a weak, vertically dipping shape preferred orientation at 81 to 87cm. Deformed intervals of weakly foliated gabbro with steep (63-70cm) dipping SC-fabrics and moderately dipping interval of weak SPO (128-138cm) differing from the magmatic fabric in grain size. Another subvertical zone of deformation at 81-91cm shows sheared bands of amp-chl within a zone of brittle deformation with fault breccia and cataclasites. Zones of brittle microfaulting throughout the hole section. Steep green to dark veins (V1) Horizontal to subhorizontal white veins (V2). M>CP=B=V1>V2

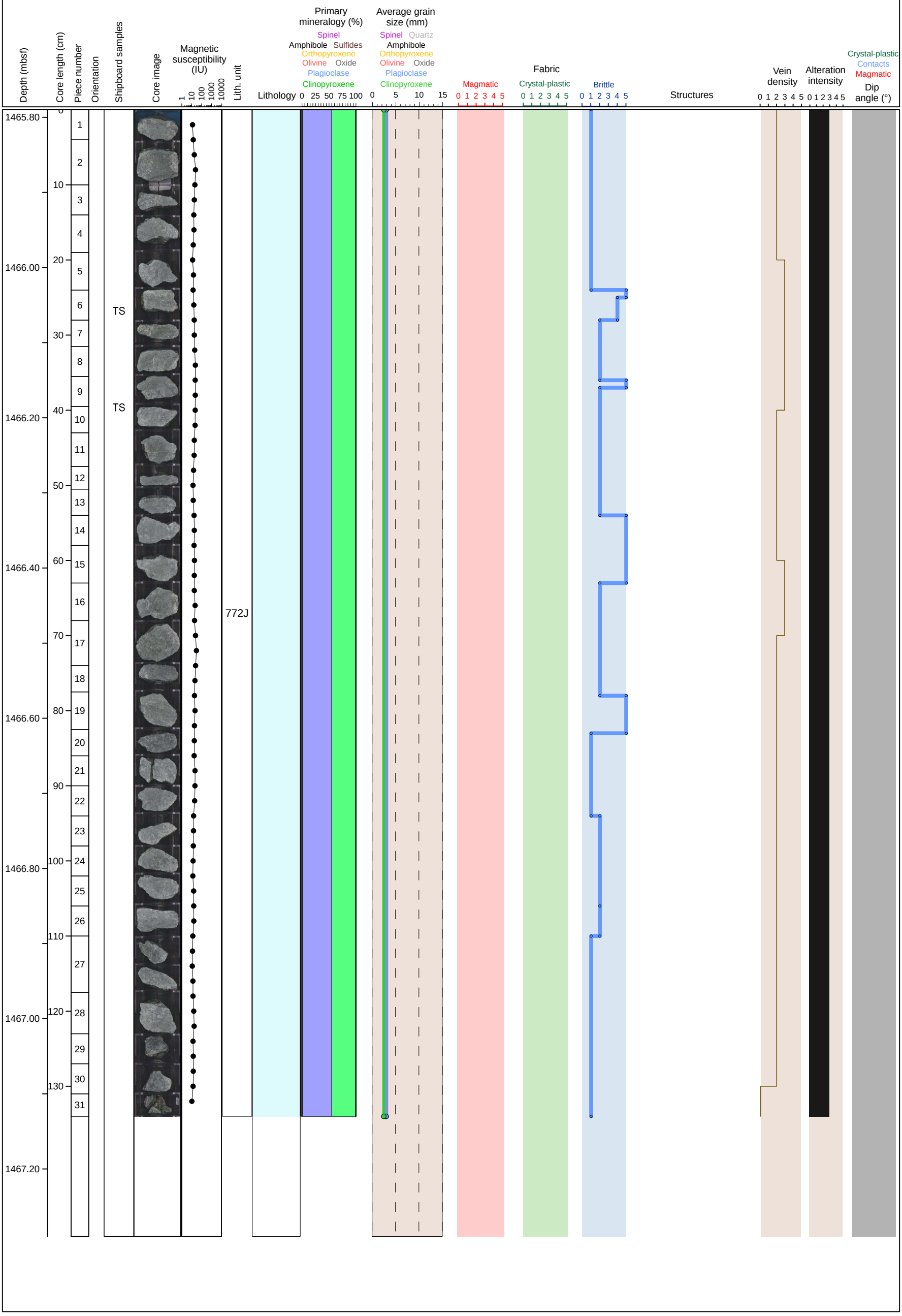


Hole 399-U1309D-307R Section 2, Top of Section: 1465.79 m

Igneous Petrology: Medium-grained subophitic opx-bearing gabbro continuation from previous section with slightly finer grain sizes.

Alteration: Highly deformed and moderately altered Opx-bearing gabbro crosscut by felsic intrusion. Three generations of veins; a first one corresponding to a felsic quartz-plagioclase-amphibole vein; a second made of amphibole-chlorite and a third composed of zeolite veins

Structural Geology: Opx-bearing gabbro with no primary magmatic fabric visible. Brittle deformation is evident in cohesive cataclasites (B1) at 24-25cm, 36-37cm, 54-63cm, 78-83cm, 106-11cm and a fault breccia (B1) at 25-28cm. Brittle microfaulting (B2) is present throughout the core. Cut by green veins (V1) and subvertical (V2) white veins. M>B1>B2 V1>V2

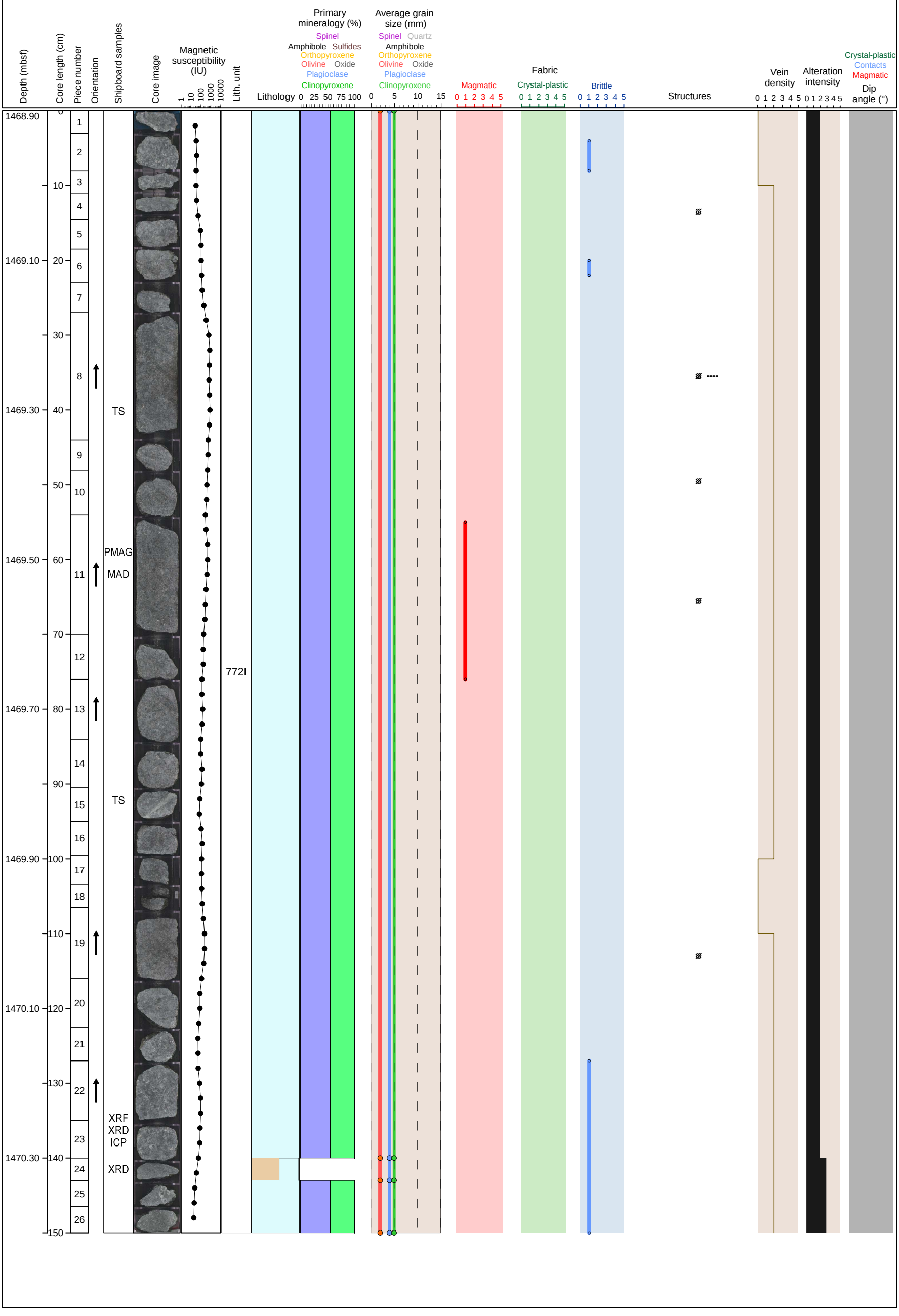


Hole 399-U1309D-308R Section 1, Top of Section: 1468.9 m

Igneous Petrology: Medium-grained subophitic opx-bearing gabbro with rare olivine. Grain size varies at 10s of cm and slightly decreases down section. Contains a diabase subunit close to the bottom of the section.

Alteration: Slightly to moderately (140-150 cm) altered Opx- and Ol-bearing gabbro. Orthopyroxene partially to completely altered to chlorite and an unidentified mineral. Three vein generations with a first one made of an unidentified mineral; a second composed of amphibole and a third generation consisting of zeolite veins

Structural Geology: Isotropic, opx-bearing gabbro with an interval of gabbro with a weak, shallow dipping shape preferred orientation of plg and px (55-76 cm). Cut by a magmatic vein (V1) at 92-93cm, horizontal to inclined amphibole veins (V2) and a shallow chlorite vein (V2), and white veins (V3). M>V1>V2>V3

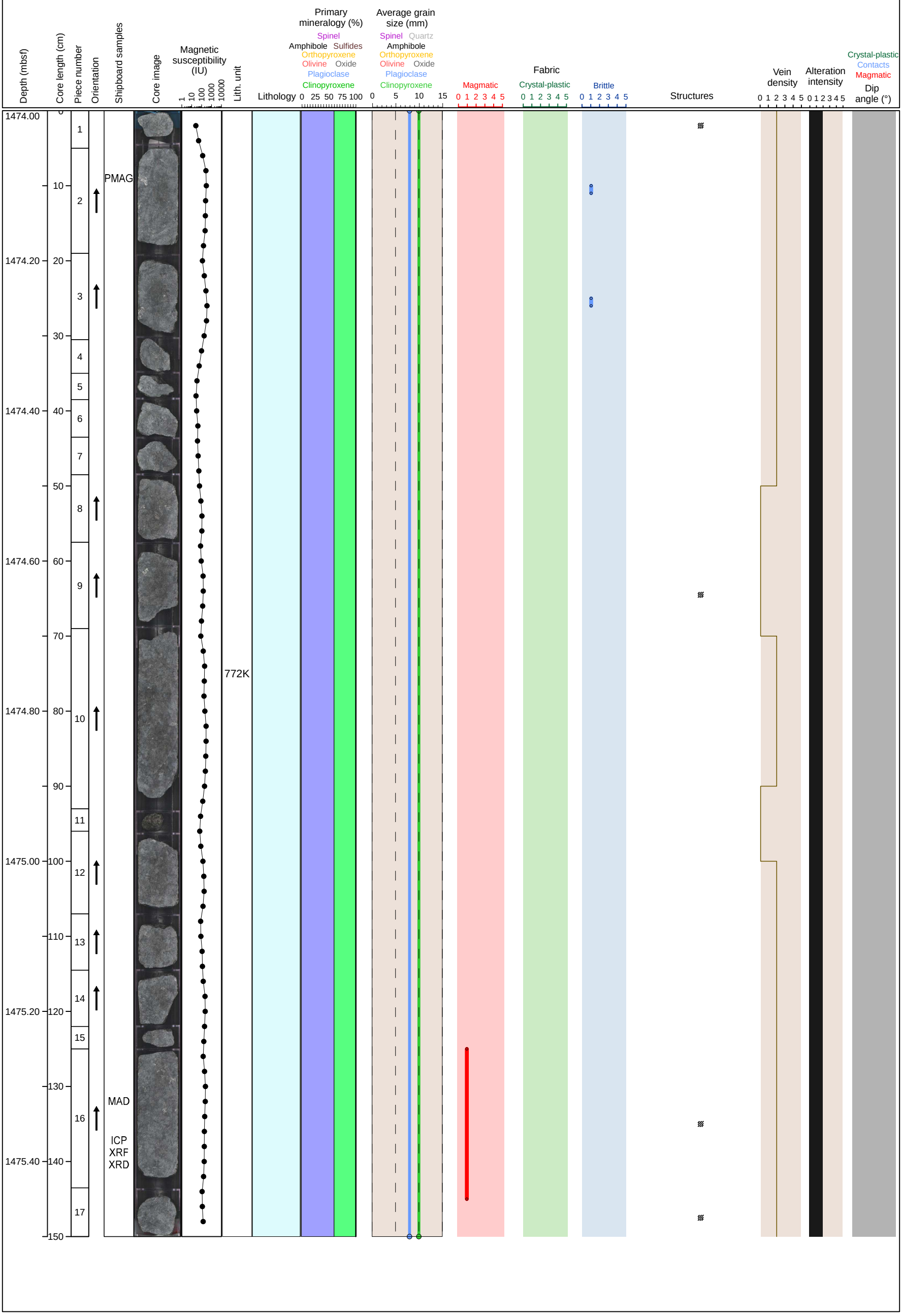


Hole 399-U1309D-309R Section 1, Top of Section: 1474.0 m

Igneous Petrology: Coarse-grained granular-subophitic gabbro. Piece 1 is medium-grains, and small, centimeter-scale patches of cpx oikocryst occur occasionally throughout the section.

Alteration: Slightly altered orthopyroxene-bearing gabbro. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. Orthopyroxene is partially altered to chlorite. Two vein generations can be distinguished; an earlier generation composed of amphibole, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic gabbro with grain size layering and an interval of gabbro with a weak, steeply dipping shape preferred orientation of plagioclase from 125 to 145 cm. Cut by amphibole veins in variable dips (V1) and subhorizontal to shallow white veins (V2). M>V1>V2

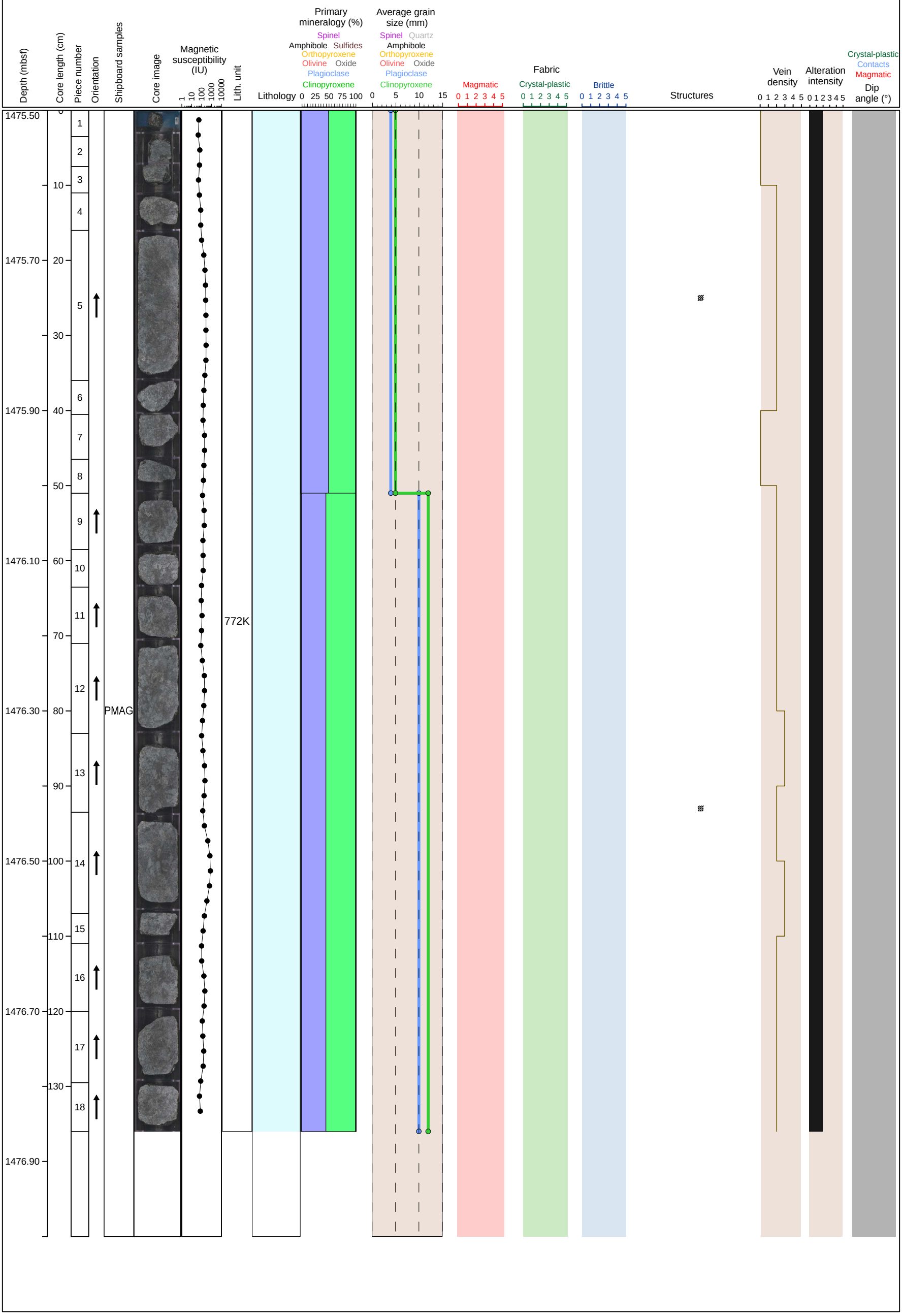


Hole 399-U1309D-309R Section 2, Top of Section: 1475.5 m

Igneous Petrology: Contains a medium-grained gabbro in the upper 51cm of the section, followed by coarse-grained subophitic-ophitic gabbro where the coarsest cpx grains trending towards poikilitic.

Alteration: Slightly altered orthopyroxene-bearing gabbro. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. Orthopyroxene is partially altered to chlorite. Two vein generations can be distinguished; an earlier generation composed of amphibole, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic gabbro with decimeter-scale grain size layering. Cut by steep green veins (V1) and variably dipping white veins (V2).

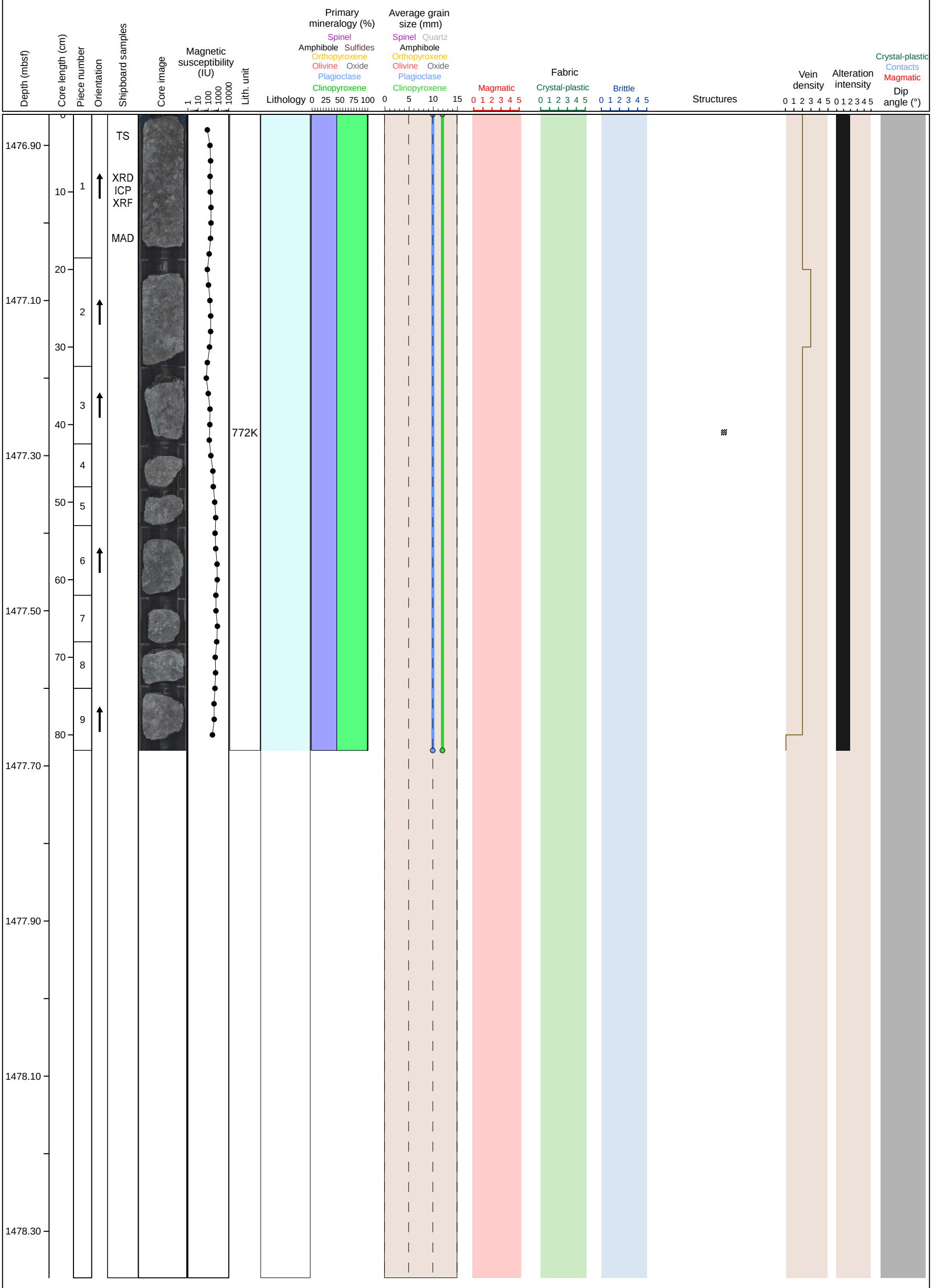


Hole 399-U1309D-309R Section 3, Top of Section: 1476.86 m

Igneous Petrology: Coarse-grained subophitic-ophitic gabbro continuous from the previous section with traces of olivine. Piece 4 and 5 are slightly finer in grain size

Alteration: Slightly altered Opx-bearing gabbro cut by a network of zeolite veins.

Structural Geology: Isotropic gabbro with a grain size up to 3cm. Cut by white veins with sub-horizontal to shallow dip. M>V

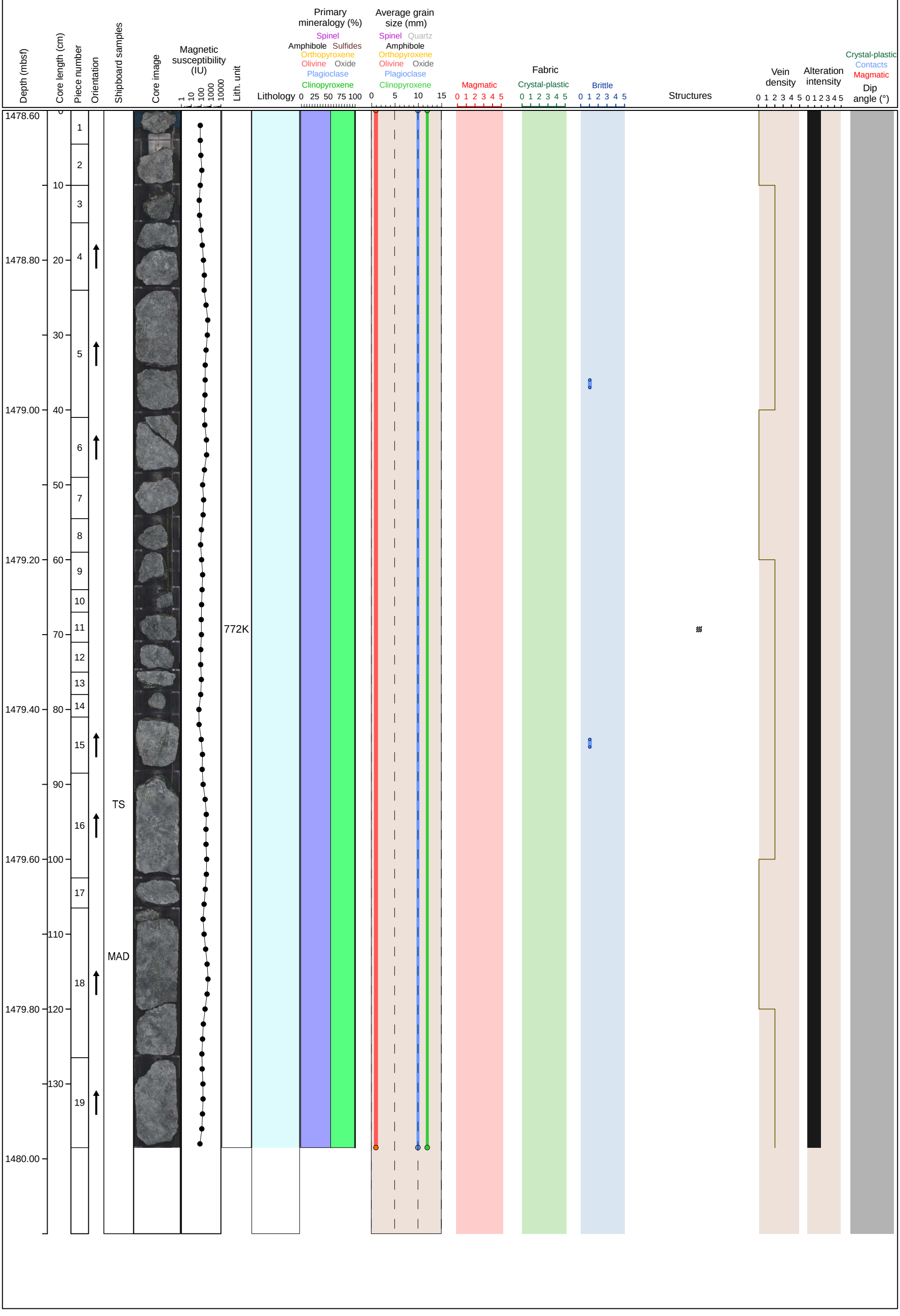


Hole 399-U1309D-310R Section 1, Top of Section: 1478.6 m

Igneous Petrology: Coarse-grained granular gabbro with trace amount of olivine, continuous from previous core with a few ophitic cpx present.

Alteration: Slightly altered Opx-bearing gabbro cut by amphibole-plagioclase veins in turn cut by a network of zeolite veins.

Structural Geology: Isotropic gabbro with grains size up to 30mm. Cut by subvertical dark green (amphibole) veins (V1) and sub-horizontal to shallowly dipping white veins (V2). M>V1>V2

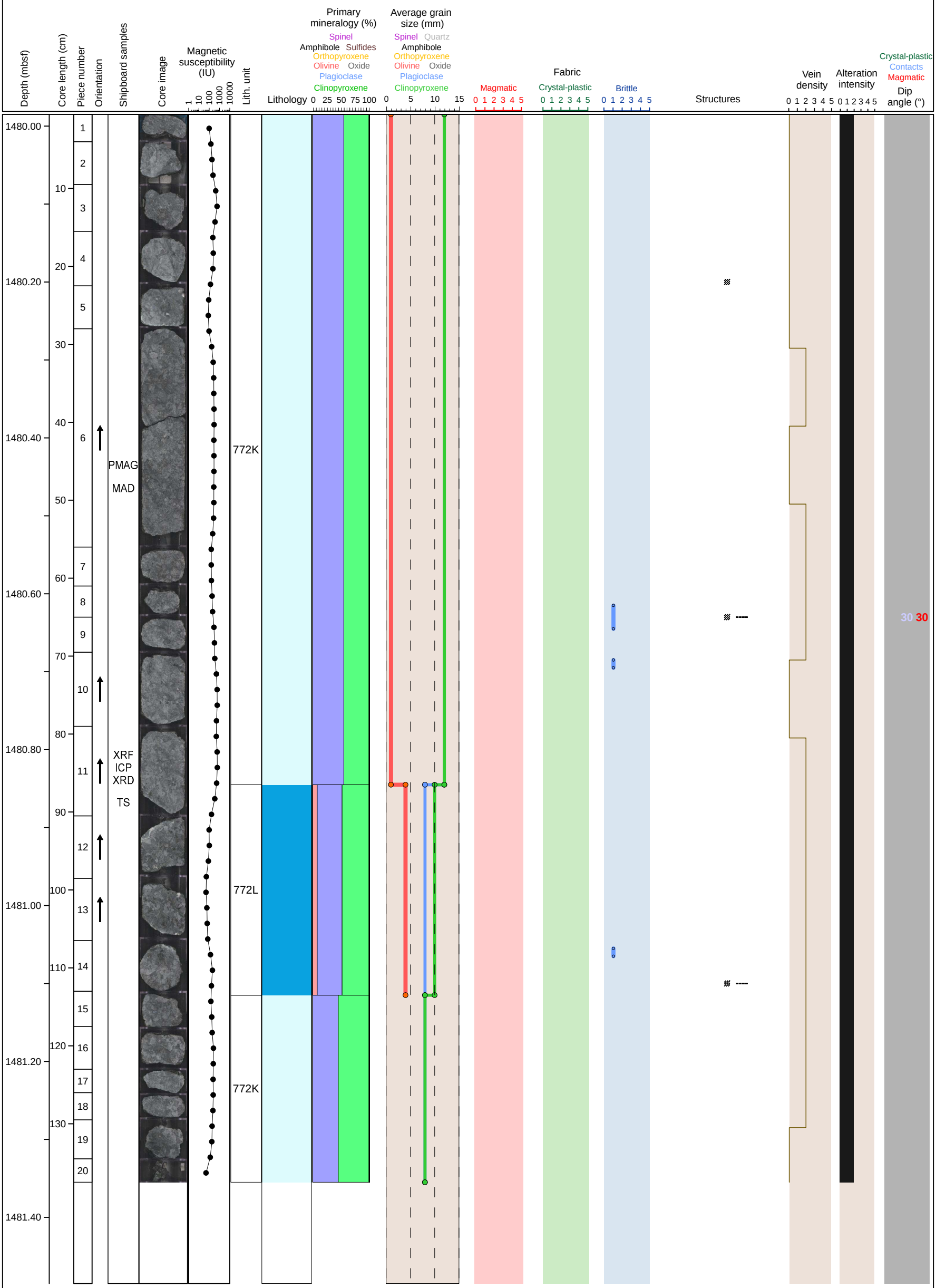


Hole 399-U1309D-310R Section 2, Top of Section: 1479.985 m

Igneous Petrology: Coarse-grained granular gabbro with trace amount of olivine continuous from previous section with an olivine gabbro subunit.

Alteration: Slightly altered Ol- and Opx-bearing gabbro. Sulfides occur at join boundaries between orthopyroxene and plagioclase. Green and white patches consist of chlorite and secondary plagioclase after plagioclase and pyroxene. Patches show corona of secondary plagioclase. The section contain amphibole and chlorite-talc veins.

Structural Geology: Isotropic gabbro and olivine gabbro with decimeter-scale grain size layering. Cut by inclined amphibole veins and inclined to shallow cholrite talc veins. M>V

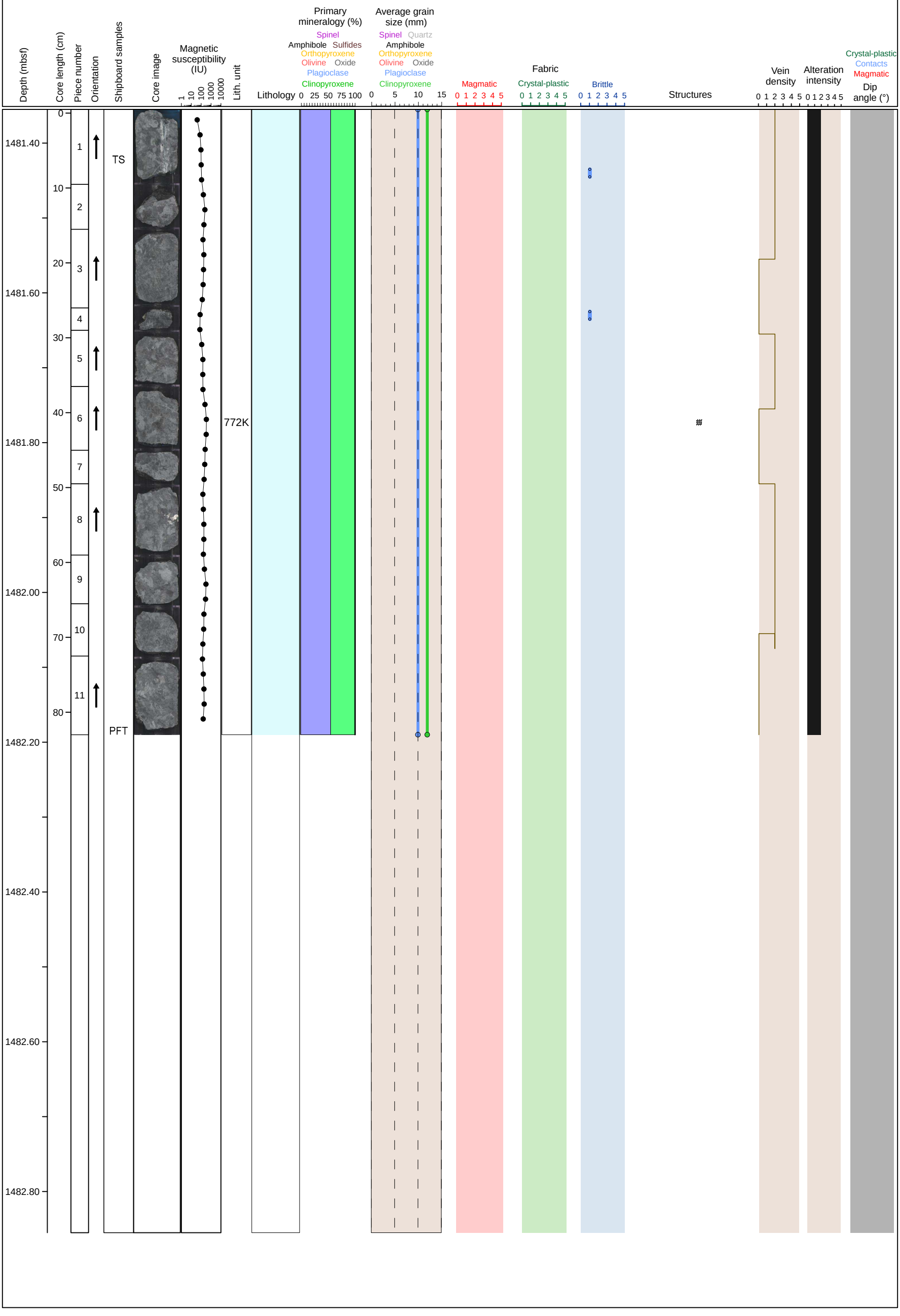


Hole 399-U1309D-310R Section 3, Top of Section: 1481.355 m

Igneous Petrology: Coarse-grained granular-subophitic gabbro with trace amount of olivine

Alteration: Slightly altered Opx-bearing gabbro. Sulfides at contact of pyroxene and plagioclase. Two vein generations with amphibole chlorite-talc, plagioclase-chlorite-amphibole cut by zeolite veins.

Structural Geology: Isotropic gabbro with grain size up to 40 mm. Cut by a subvertical magmatic vein (V1) at 0-10 cm and inclined to steep green and shallow white-green veins, all are crosscut by sub-horizontal to inclined white veins (V2). M>V1>V2

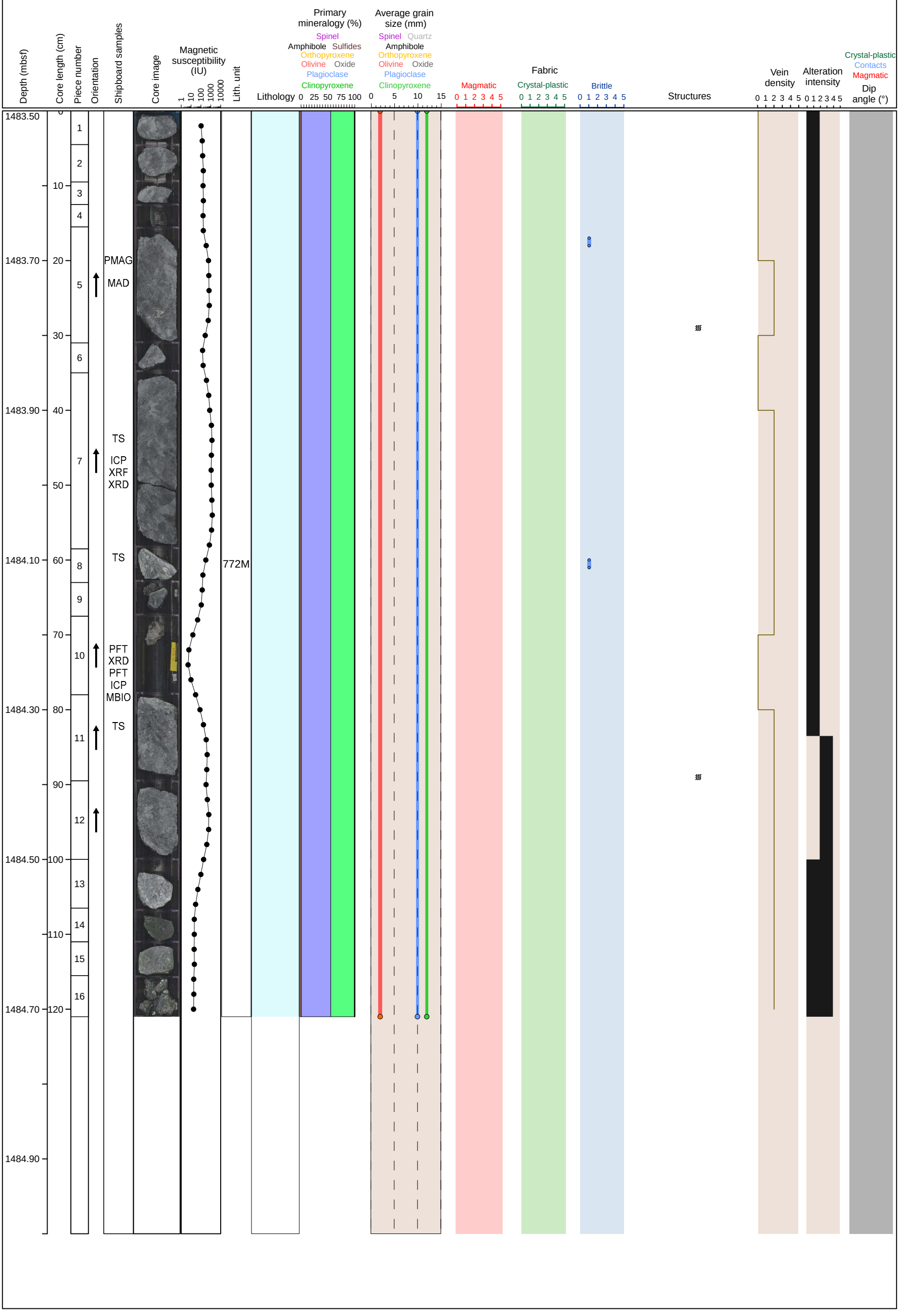


Hole 399-U1309D-311R Section 1, Top of Section: 1483.5 m

Igneous Petrology: Upper meter contains coarse-grained granular olivine-bearing gabbro with grain size peaking in piece#7 and decreasing down section and small olivine-rich patch between 95-97cm.

Alteration: Slightly to moderately to highly (83.5-121 cm) altered Ol- and Opx-bearing gabbro. Some orthopyroxene patches are completely to chlorite. Sulfides at the contact of orthopyroxene and plagioclase. Green and white patches consist of chlorite and secondary plagioclase after plagioclase and pyroxene. Patches show corona of secondary plagioclase. Two vein generations including amphibole and amphibole-chlorite are cut in turn by zeolite veins

Structural Geology: Isotropic olivine-bearing gabbro and gabbronorite with decimeter- to meter-scale grain size layering. Cut by sub-horizontal and sub-vertical dark green (amphibole) veins (V1) and shallow dipping white veins (V2). M > V1 >V2

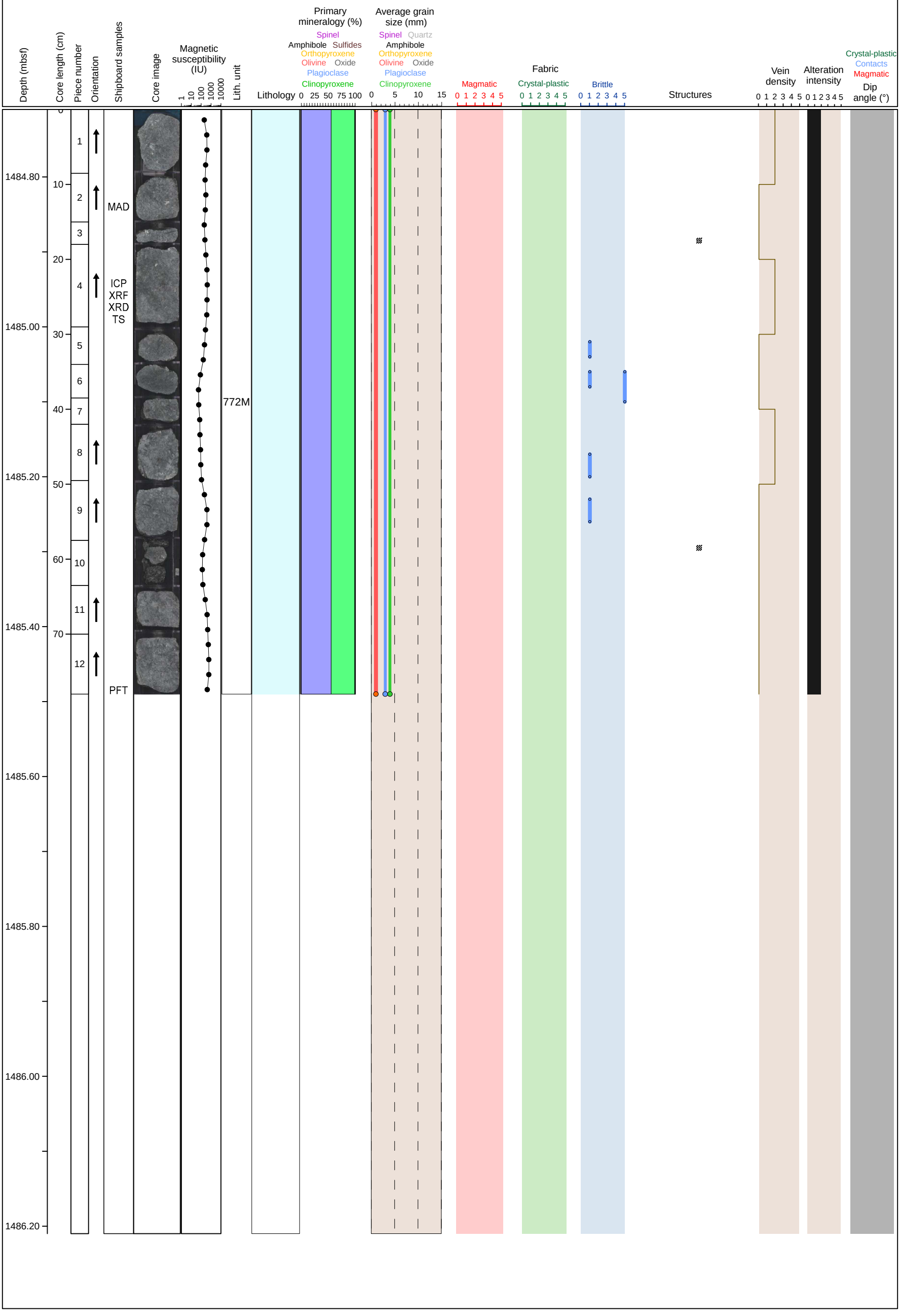


Hole 399-U1309D-311R Section 2, Top of Section: 1484.71 m

Igneous Petrology: Coarse-grained granular olivine-bearing gabbro continuous from previous section with grain size gradually increasing down section.

Alteration: Slightly Opx- and Ol-bearing gabbro. Sulfide occur at the join boundaries between pyroxene and plagioclase and within pyroxene grains. Two vein generations include amphibole and amphibole-plagioclase-(minor pyroxene) are cut by zeolite veins

Structural Geology: Isotropic gabbronorite with decimeter- to meter-scale grain size layering. Cataclastic layer is observed at 35-39cm. Cut by shallow to steeply inclined dark green (amphibole) veins (V1) which are typically sheared, and horizontal to sub-horizontal white veins (V2). M > V1 = B > V2

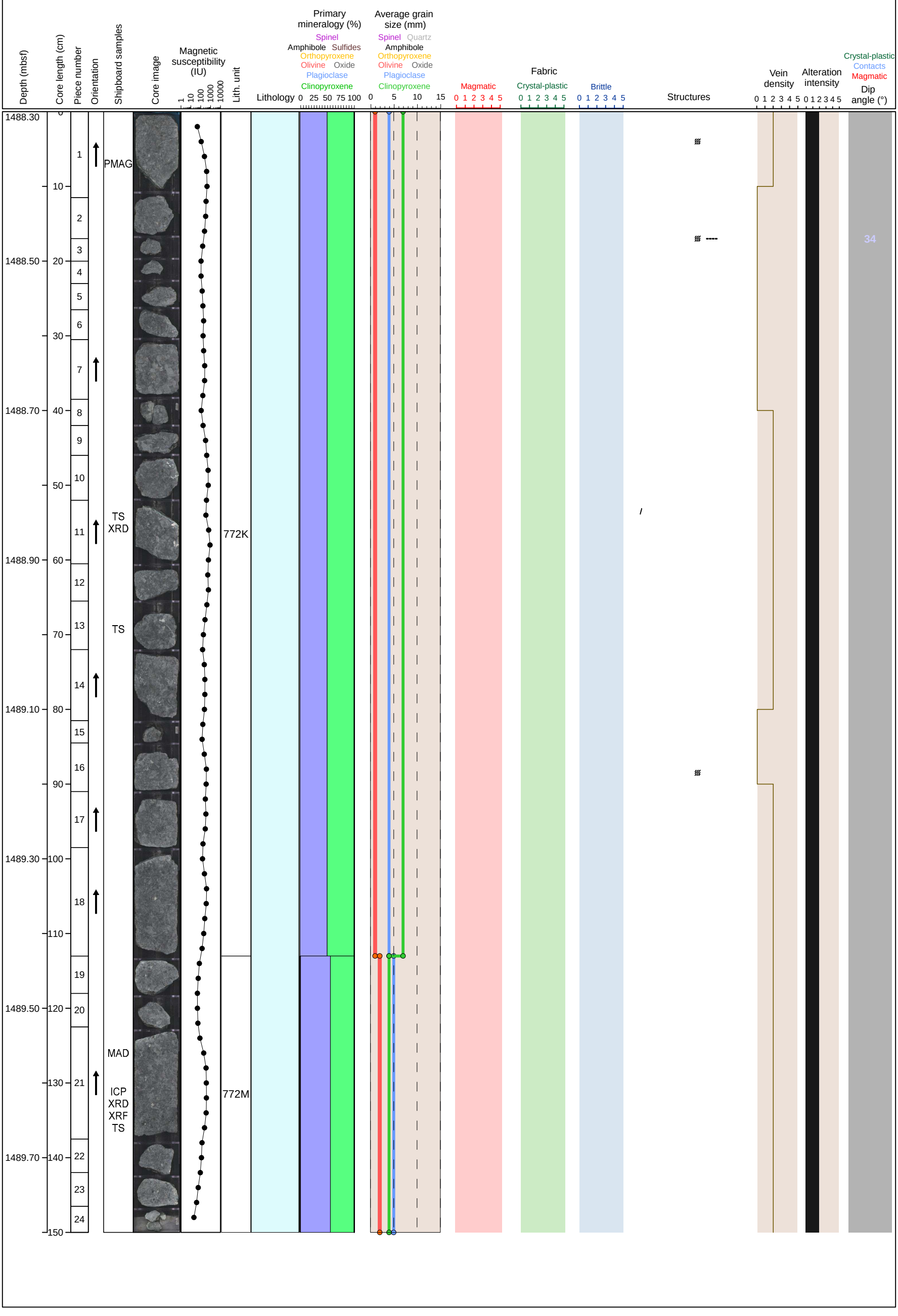


Hole 399-U1309D-312R Section 1, Top of Section: 1488.3 m

Igneous Petrology: Coarse-grained subophitic gabbro with trace olivine above a medium-grained subophitic olivine-bearing gabbro.

Alteration: Slightly altered gabbronorite. Sulfide occur at the join boundaries between pyroxene and plagioclase and within pyroxene grains. Piece 23 is moderately altered. Two vein generations include amphibole and amphibole-unidentified mineral are cut by zeolite veins.

Structural Geology: Isotropic gabbro and olivine-bearing gabbro with decimeter- to meter-scale grain size layering. Piece-end mineralized fault surface with white-green slickenfibers has a modertate dip. Section is cut by green (amphibole?) veins with moderate dip, which are typically sheared. Little white veins form a network of irregular shaped sub-horizontal veins (V2) across the section. M > V1 > CP > V2

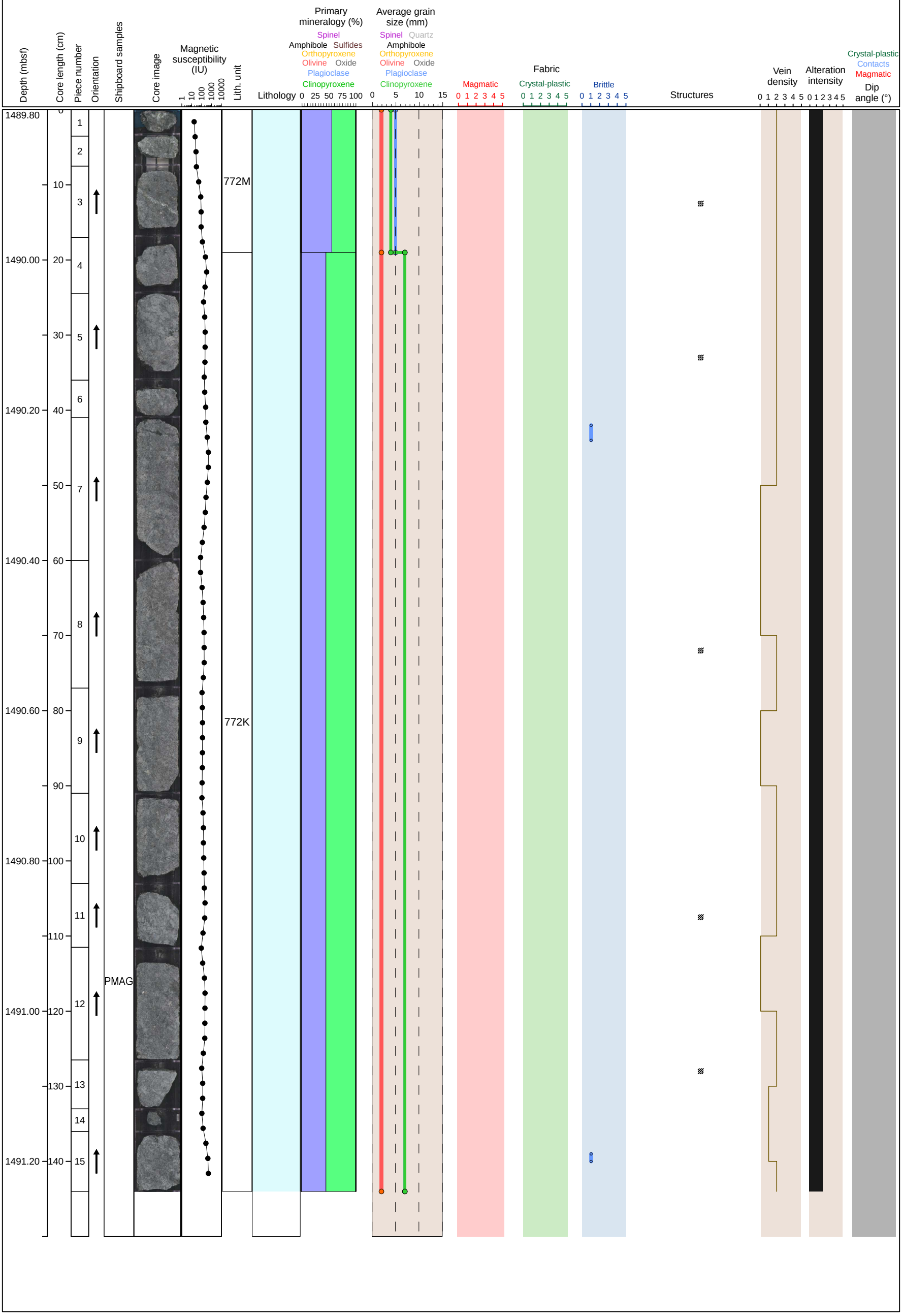


Hole 399-U1309D-312R Section 2, Top of Section: 1489.8 m

Igneous Petrology: Medium-grained subophitic olivine-bearing gabbro continued from the previous section transitioning into a coarse-grained subophitic gabbro with trace olivine and opx.

Alteration: Slightly altered olivine- and orthopyroxene-bearing gabbro. Olivine is partially altered to serpentine and magnetite. Plagioclase is partially altered to chlorite. Clinopyroxene is partially altered to amphibole. Orthopyroxene is partially altered to chlorite. Pieces 1 and 2 seem more altered. Two vein generations can be distinguished; an earlier generation composed of amphibole, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic gabbro and olivine-bearing gabbro with decimeter-scale grain size layering. Section is cut by white-green magmatic vein (V1), possibly of magmatic origin, with a sub-horizontal to moderately inclined dip, which are sometimes sheared (CP). Late dark green veins (V2) have a sub-horizpontal to steeply imnclined dip. M > V1 > CP > V2

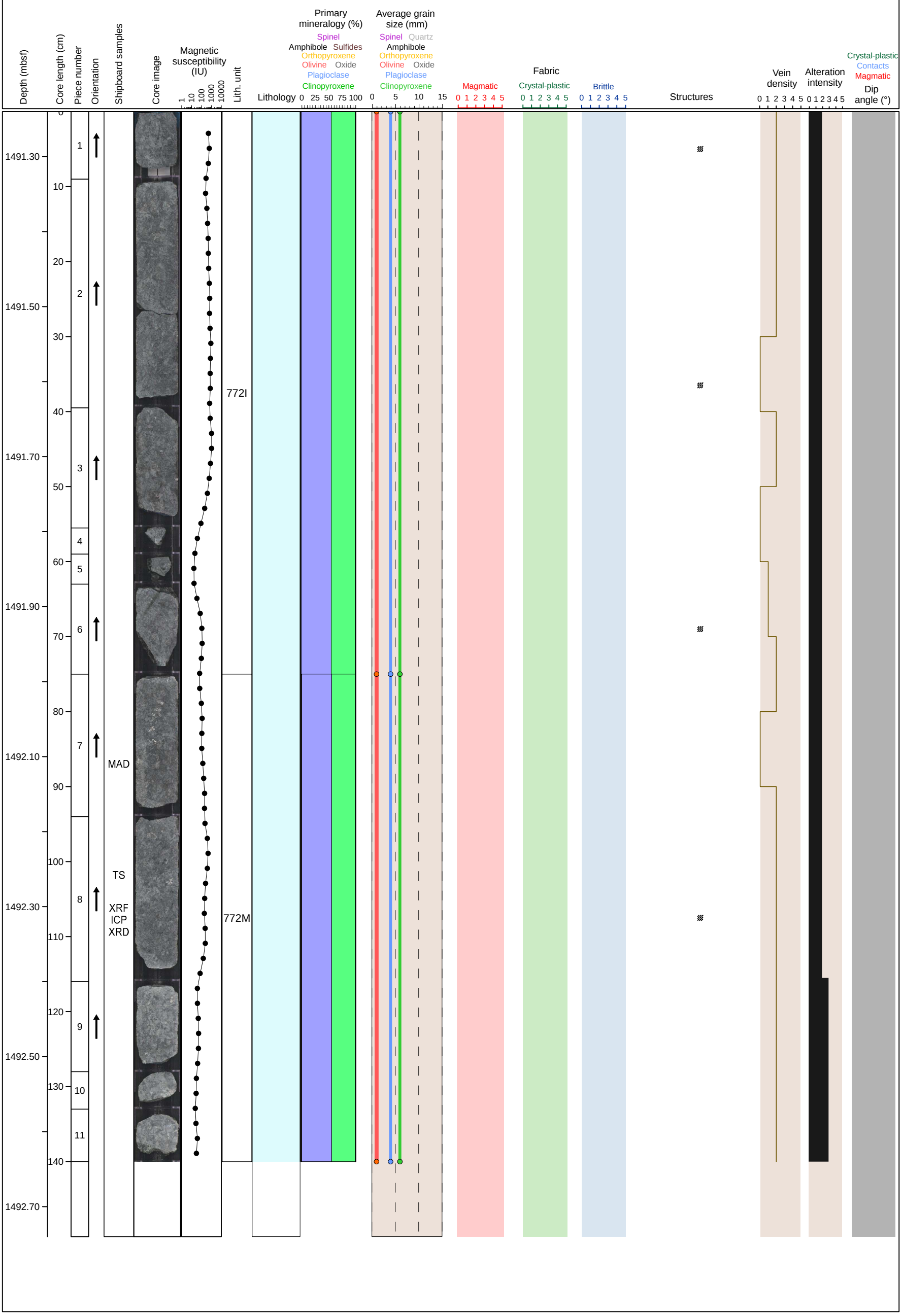


Hole 399-U1309D-312R Section 3, Top of Section: 1491.24 m

Igneous Petrology: Medium- to coarse-grained, opx-bearing subophitic gabbro gradational from unit above, then into medium- to coarse-grained, subophhitic olivine-bearing gabbro.

Alteration: Slightly altered Opx-bearing gabbro and moderately altered gabbronorite (115.5-140 cm). Extent of Opx alteration highly variable. In the gabbro, sulfide occur at the join boundaries between pyroxene and plagioclase and within pyroxene grains. Two vein generations can be distinguished; an earlier generation composed of amphibole and chlorite-unidentified mineral, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic orthopyroxene-bearing gabbro and gabbronorite with decimeter-scale grain size layering. Section is cut by shallow to sub-vertically inclined green veins (V1) and horizontal white veins (V2). M > V1 > V2

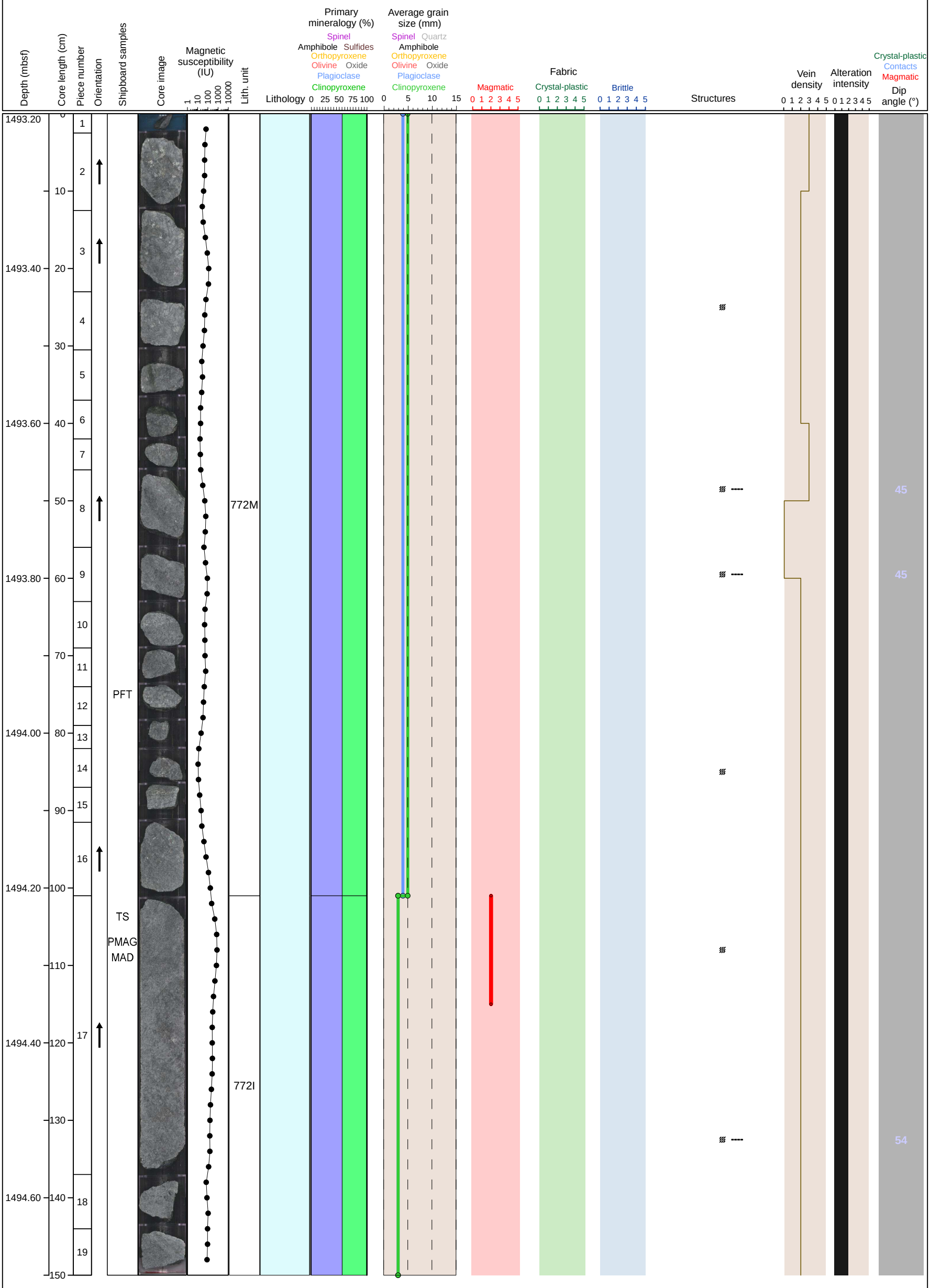


Hole 399-U1309D-313R Section 1, Top of Section: 1493.2 m

Igneous Petrology: Contains a medium-grained subophitic-poikilitic olivine-bearing gabbrowith grain size decreasing down section and transitions into fine- to medium-grained subophitic olivine-bearing gabbro.

Alteration: Slightly altered Opx-bearing gabbro. Extent of orthopyroxene alteration highly variable. Two vein generations can be distinguished; an earlier generation composed of amphibole and chlorite-zeolite, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic gabbronorite with grain size layering with decimeter-scale layer thickness and moderately dipping, planar, diffuse boundaries. A layer of moderately foliated gabbronorite, defined by moderately plunging plagioclase SPO is observed at 101-115 cm. Contians moderately to sub-vertical dipping, planar amphibole veins (V1) and a later set of horizontal to shallow dipping irregular chlorite veins (V2), which are cut by irregular white veins (V3). Section is undeformed. M > V1 > V2 > V3

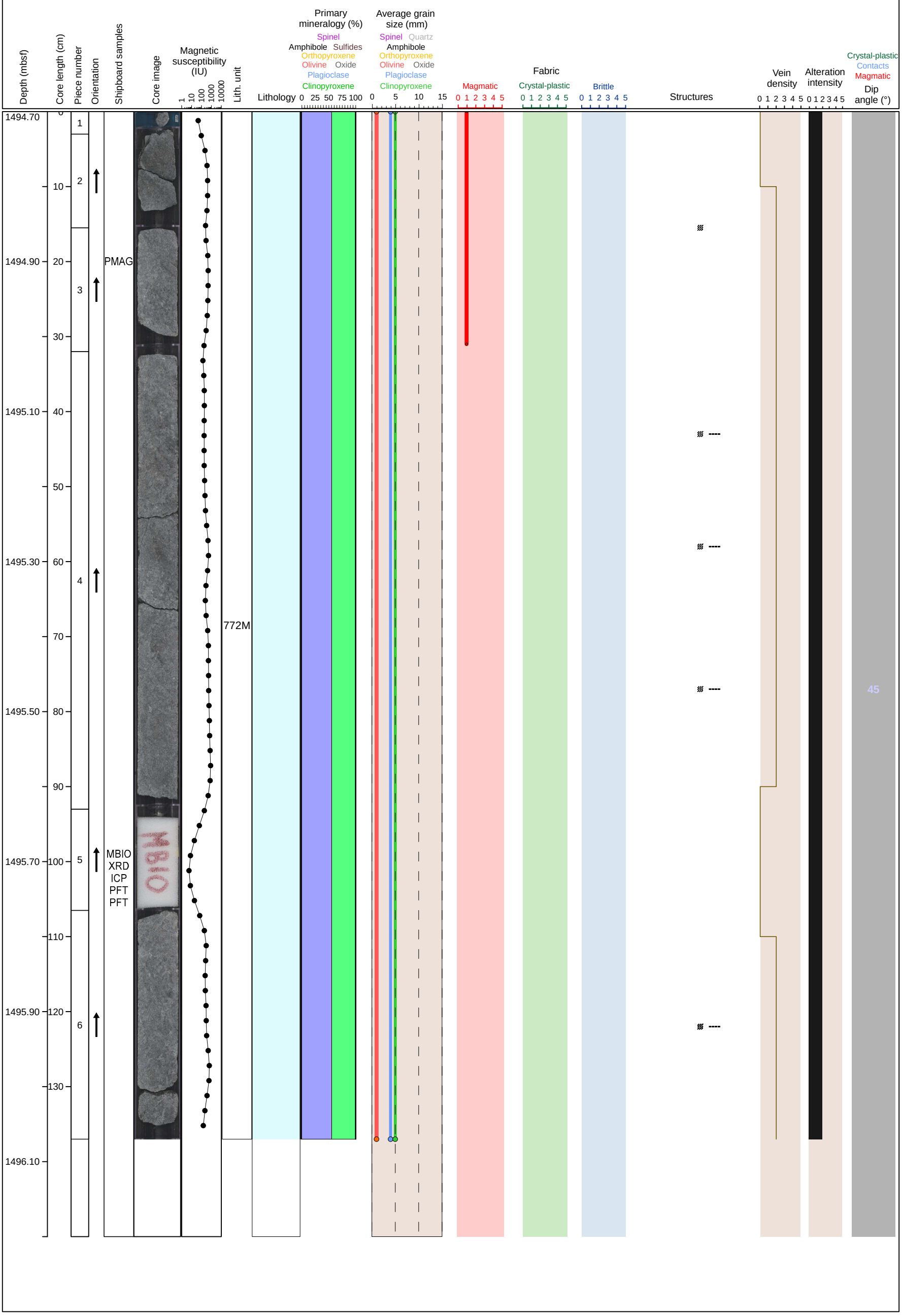


Hole 399-U1309D-313R Section 2, Top of Section: 1494.7 m

Igneous Petrology: Medium-grained subophitic-ophitic olivine-bearing gabbro with grain sizes and textures varying at 5cm scales.

Alteration: Slightly altered olivine- and Opx-bearing gabbro. Sulfide are present within pyroxene. Two vein generations can be distinguished; an earlier generation composed of amphibole, plagioclase-chlorite and talc-chlorite, and a later generation of what appears to be zeolite.

Structural Geology: Isotropic gabbronorite with grain size layering with 10-30cm layer thickness and moderately to vertical dipping, planar to irregular, diffuse boundaries. A layer of weakly foliated gabbronorite, defined by moderately plunging plagioclase SPO is observed at 0-31 cm. Contians steeply dipping planar amphibole veins (V1) and a later set of irregular networked white veins (V2). Section is undeformed. M > V1 > V2

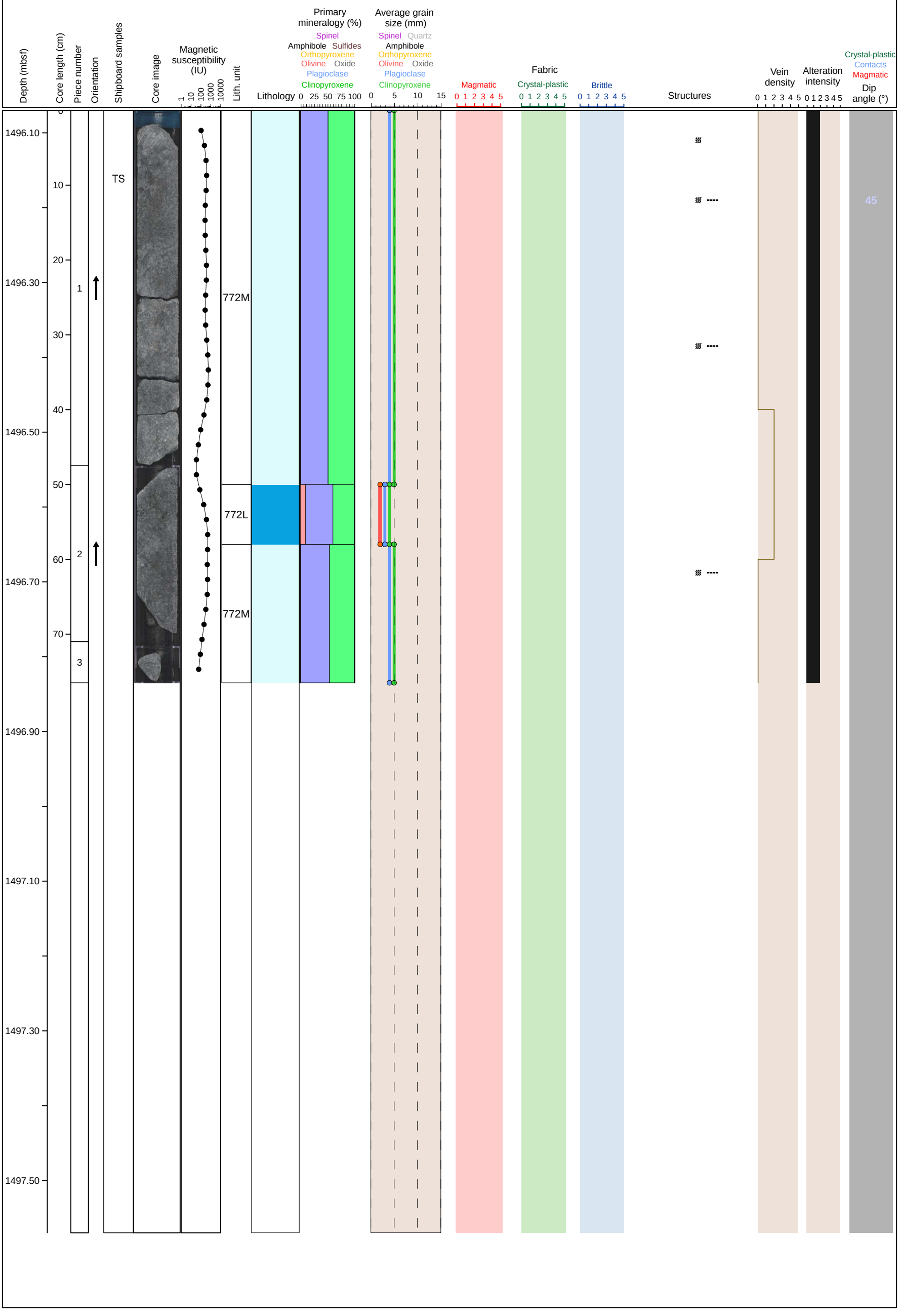


Hole 399-U1309D-313R Section 3, Top of Section: 1496.07 m

Igneous Petrology: Medium-grained subophitic-ophitic olivine-bearing gabbro continuous from previous section with grain sizes and textures varying at 5cm scales and contains a ~10cm wide olivine gabbro interval.

Alteration: Slightly altered olivine- and Opx-bearing gabbro. Possible presence of talc after orthopyroxene. Sulfide at the join boundaries between pyroxene and plagioclase. Amphibole-plagioclase veins are cut by zeolite veins.

Structural Geology: Isotropic gabbronorite and olivine gabbro with decimeter-scale grain size layering. Layer boundaries are diffuse, irregular shaped and moderately dipping. Core section is cut by a network of irregular shaped green veins (V1) and an irregular network of thin (<0.2mm) white veins (V2). Core section is undeformed. M > V1 > V2



Hole 399-U1309D-313R Section 4, Top of Section: 1496.835 m

Igneous Petrology: Medium-grained ophitic olivine-bearing gabbro continuous from previous section with grain sizes increasing and then decreasing down section, peaking at piece #1c.

Alteration: Slightly altered Opx-bearing gabbro. Sulfide at the join boundaries between pyroxene and plagioclase. Zeolite veins are present throughout the section.

Structural Geology: Isotropic gabbronorite with decimeter-scale grain size layering. Grain size layers have diffuse boundaries. Section is cut by a network of irregular shaped thin white veins (<0.2mm). Undeformed. M > V1