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Preliminary Mineralogical Characterization of Weathered and Less-Weathered Strata of the Meade Peak Phosphatic Shale Member of the Permian Phosphoria Formation: Measured Sections C and D, Dry Valley, Caribou County, Idaho

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ABSTRACT

The Permian Phosphoria Formation of southeastern Idaho is one of the largest phosphate producing deposits in the world. Despite the economic significance of this Formation, the fine-grained nature of this phosphorite deposit has discouraged detailed mineralogical characterization and quantification studies. Recently Se and other potentially hazardous trace elements in mine wastes have drawn increased attention to this formation, and motivated more extensive study. Part of this effort has focused on a more detailed geological, including a mineralogical, characterization of the area.

Past research identified the major minerals in the Formation, including carbonate-fluorapatite, quartz, and dolomite, and a variety of sheet silicates and feldspars. Minor phases such as pyrite and sphalerite have also been identified in the deposit and may be sources of Se.

This study used powder X-ray diffraction, with Rietveld quantification software to quantify and characterize the mineralogy of the 83 samples collected from two stratigraphic sections measured by the U.S. Geological Survey at the Dry Valley mine in the Meade Peak Member of the Phosphoria Formation. Analyses show extensive variability of carbonate substitution in the fluorapatite structure, determined by measuring the apatite a-cell dimension, as well as patterns of correlation between mineralogy and the stratigraphy.

INTRODUCTION

Location and Background

The U. S. Geological Survey (USGS) has studied the Permian Phosphoria Formation and related rock units in southeastern Idaho and the entire Western U.S. Phosphate Field through much of the twentieth century. The Phosphoria Formation hosts one of the world's most economically significant phosphate deposits; however, it is also enriched in Se and other environmentally sensitive trace elements, including As, Cd, Cr, Mo, Ni, V, and Zn. Elevated concentrations of these trace elements, and the possible environmental impact they pose, have increased interest in the geology of the area. In response to a request by the Bureau of Land Management (BLM), a new series of resource, geological, and geoenvironmental studies was undertaken by the USGS in 1998. To carry out these studies, the USGS has formed collaborative research relationships with two federal agencies, the BLM and the U.S. Forest Service (FS), tasked with land management and resource conservation on public lands, and with five companies currently leasing or developing phosphate resources in southeast Idaho. The five companies are Agrium U.S. Inc. (Rasmussen Ridge mine), Astaris (Dry Valley mine), J. R. Simplot Company (Smoky Canyon mine), Monsanto (Enoch Valley mine), and Rhodia Inc. (Wooley Valley mine – inactive).

Present studies consist of integrated, multidisciplinary research directed toward (1) resource and reserve estimation of phosphate in selected 7.5-minute quadrangles; (2) elemental residence, mineralogical, and petrochemical characteristics; (3) mobilization and reaction pathways, transport, and fate of potentially toxic elements associated with the occurrence, development, and societal use of phosphate; (4) geophysical signatures; and (5) improved understanding of depositional origin. This study addresses the bulk mineralogical character of the Formation at Astaris' Dry Valley mine, providing researchers in the USGS, collaborating agencies, and other interested scientists, as well as those in industry a better understanding of the local and regional geology and mineralogy of the Meade Peak member of the Phosphoria Formation. Because raw data acquired during the project will require time to interpret, the data are released in open-file reports for prompt availability to other workers. Open-file reports associated with this series of resource and geoenvironmental studies are submitted to each of the Federal and industry cooperators for comment; however, the USGS is solely responsible for the data contained in the reports. This report summarizes the results of mineralogical studies conducted on samples collected from two measured stratigraphic sections at an operating mine in Dry Valley (figure 1).

Previous Studies

This report follows the format of the recent open file report (Knudsen and others, 2000) that characterized the mineralogy of measured sections A and B from the central part of Rasmussen Ridge. Historic mineralogical analyses of the Phosphoria Formation produced qualitative characterizations of the distribution of major and minor mineral phases in the deposit. Petrographic analyses, particularly Mabie and Hess (1963) combined with XRD studies supported by chemical analyses (Lehman, 1966) identified many of the minerals found in the area. The most significant attempt to quantify the mineralogy of the region was made by Medrano and Piper (1992). This study used normalizing techniques to arrive at the mineralogy of the Phosphoria Formation. Along with the more common minerals considered in these

studies, Gulbrandsen (1974) identified the presence of the ammonium feldspar buddingtonite in the Phosphoria Formation. These studies, along with current work on the mineral chemistry (Desborough and others, 1999) constitute the foundation of background literature for the mineralogical investigation.

METHODS

X-ray diffraction (XRD) and Inductively Coupled Plasma (ICP) analyses were conducted on splits from samples collected by the USGS from two measured stratigraphic sections across the Meade Peak Phosphatic Shale Member of the Phosphoria Formation in Dry Valley, Caribou County, Idaho. Lithologic descriptions of the measured stratigraphic sections are reported in Tysdal and others (2000), and chemical analyses of samples are presented in Herring and others (2000). The two measured sections include one from a shallow (less that 10 m), more-weathered exposure (C) and the other from a deeper, less-weathered exposure (D) at an active mine.

XRD analyses were conducted with a 2-Theta scan from 2° - 62° over 28 minutes, using Cu radiation on a Siemens D5000 diffractometer operating at 40 kV and 30 mA; all samples were crushed to <100mesh. These relatively fast scans reveal the major phases in the samples; however, low peak to background ratios prevent accurate identification of minor phases, generally those less than 1%, depending on the diffractability of a phase in a given sample. Diffractability is higher for more crystalline samples and minerals with higher electron density. The patterns are subsequently analyzed using the Siroquant program (Taylor 1991). Using Rietveld analysis, the Siroquant program generates a scan with a known mineralogy, matching it to the collected scan, thus quantifying and characterizing the collected scan. Measurement of the a-cell dimensions of the fluorapatite provides an estimate of the CO_3^{2-} substitution for PO_4^{3-} in the fluorapatite structure, as calculated by McClellan (1980). Finally, a calculated chemistry is determined, based on the quantification results from the XRD, and then compared to the ICP data of Herring and others (2000).

RESULTS

Carbonate substitution

As well as quantifying the mineralogy of a sample, Rietveld analysis can be used to characterize individual mineral phases. This is particularly useful for the primary ore mineral in the Phosphoria Formation and other phosphorite deposits, carbonate-fluorapatite. In this mineral, varying amounts of planar CO_3^{2-} groups substitute into the fluorapatite structure for PO_4^{3-} tetrahedra. The resulting charge imbalance can be accounted for with an additional F^- entering the structure. This relationship has been observed (McClellan and Van Kauwenbergh, 1990) in numerous chemical analyses where substitution of CO_3^{2-} for PO_4^{3-} is coupled with F^- to balance the charges. However, the charge can also be balanced with the addition of an OH^- or with the substitution of a monovalent cation such as Na^+ for Ca^{2+}. McClellan (1980) devised a method with which to estimate the degree of substitution in a given carbonate-fluorapatite based on the change of the a-cell parameter, as can be measured using the Rietveld analysis. McClellan's formula yields the proportion of carbonate to phosphate in a sample based on the following equation where Z is the molar quantity of CO_3^{2-} present in the apatite:

$$CO_3^{2-} / PO_4^{3-} = Z / (6 - Z) = (9.369 - a_{obs}) / 0.185$$

McClellan also determined that substitution of Na and Mg could be estimated using the measured a-cell parameter:

$$\text{(Moles Na) } X = 7.173\ (9.369 - a_{obs})$$
$$\text{(Moles Mg) } Y = 2.784\ (9.369 - a_{obs})$$

These substitutions are based on the assumption that the formula for carbonate-fluorapatite is $Ca_{10-X-Y}\ Na_X\ Mg_Y\ (PO_4)_{6-Z}\ (CO_3)_z\ F_{0.4Z}F_2$.

This method has been used for preliminary compositional estimates based on the a-cell parameters measured using the Siroquant software. For each sample, the calculated CO_3^{2-}, Na^+, and Mg^{2+} content in the carbonate fluorapatite are produced (tables 1a,b: figures 2a,b). However, the method does not take into account other substitutions such as SO_4^{2-} for PO_4^{3-} so the calculations are a maxima.

While tables 1a and 1b list the average amounts of substitution in the samples, the samples are not homogenous in their apatite composition. Splitting of the apatite peaks on the XRD pattern (figure 3) reveals that the degree of CO_3^{2-} substitution varies not only between samples but within individual samples as well. Some of the peak splitting in the samples could be a result of slight mineralogical variation over the length of the sample trenches. However, this phenomenon has also been observed in grab samples collected from nearby Rasmussen Ridge. This multi-apatite phase presence suggests that apatite may have recrystallized since deposition forming the carbonate free apatite.

Quantified mineralogy

The Siroquant software package uses Rietveld analysis to quantify the mineralogical content in weight percent based on the XRD patterns as described in the Methods section. First, every phase in a sample must be identified; the program then calculates an XRD pattern based on the known crystal structure of each mineral to match the actual pattern to determine the quantities of each phase. Siroquant refines the calculated pattern for each phase to match the collected pattern, correcting for variable peak shape, preferred orientation, and shifts in cell parameters (figure 4). The quantity of each phase is reported along with an error value (tables 2a,b; figures 5a,b). The overall quality of the match between the calculated and collected patterns is shown by "χ^2", a statistical value reflecting the quality of the fit between the collected and calculated patterns, where lower values represent better matches and any value under 3.0 is considered acceptable.

Comparison of XRD and ICP data

To compare the results from the ICP with those from the XRD, the quantified mineralogical data derived from XRD analysis were used to calculate a theoretical chemical composition and were then compared to the ICP data (tables 3a,b; figures 6a,b). Weight percents for the major elements were calculated using ideal formulas for the identified mineral phases. These formulas include; apatite $Ca_{10-x-y}\ Na_x\ Mg_y\ (PO_4)_{6-z}\ (CO_3)_z\ F_{0.4z}F_2$, quartz SiO_2, muscovite/illite $KAl_2(AlSi_3)O_{10}(OH)_2$, albite $NaAlSi_3O_8$, orthoclase $KAlSi_3O_8$, buddingtonite $(NH_4)AlSi_3O_8 \bullet 0.5H_2O$, $Al_2Si_2O_5(OH)_4$, kaolinite $Al_2Si_2O_5(OH)_4$, dolomite $CaMg(CO_3)_2$, calcite $CaCO_3$, and pyrite FeS_2. These weight percents were then compared to the values gathered on the ICP. The ICP values used in this comparison were adjusted to exclude those elements that were not accounted for in the mineralogy (such as the trace elements and organic C) in order to improve the comparability of the data sets. Sulfur is also excluded from the comparison.

Although pyrite is measured, the vast majority of S occurs in unmeasured organic phases and not in sulfides. These adjusted ICP values were then renormalized for comparison to XRD data. This adjustment factor could be used in future study, particularly in analyzing the portion of non-diffracting material in these samples. The quality of the correlation between the two data sets reaffirms the reliability of the mineral quantification method. While many of the samples show nearly perfect matches for some elements, others reveal significant differences between the chemical and mineralogical data. These differences can be attributed to a combination of causes including experimental error, overly simplistic mineral stoicheometry, and unmeasured minor mineral phases, all a testament to the complexity of the mineral chemistry in the samples.

Each data set has standard experimental error, ICP data errors are listed in table 4 and errors generated from the Siroquant quantification are listed in tables 3a and 3b. In addition, the simplicity of the assumed stoicheometry in transferring mineralogical data to chemical data has likely skewed the results. By using the ideal chemical formulas, the presence of significant substitutions would not be taken into account. For instance, reported K values could be affected by this oversimplification. With sufficient NH_4^+ - K^+ substitution in orthoclase, the mineral buddingtonite is formed, as discussed by Gulbrandsen (1974). While end-member orthoclase and buddingtonite are both identified, it is possible that a solid solution between K^+ and NH_4^+ exists in these phases. In addition, this substitution could be occurring in muscovite/illite and other sheet silicates. With enough NH_4^+ substitution in muscovite/illite, the mineral toblerite is formed. This substitution is characterized by an increased inter-layer spacing thus an increase in the c unit-cell dimension that can in turn be measured using the XRD and Rietveld refinement analysis. Muscovite/illite unit cell parameters were not routinely measured for this study; however, preliminary analysis has shown a number of Phosphoria Formation muscovite/illite samples to indeed have an expanded c-cell dimension. The substitution of NH_4^+ - K^+ is only considered for the end-member compositions in the feldspars and not considered for the sheet silicates; consequently, failure to recognize the possibility of this and other solid solution series could play a major role in the discrepancies between the calculated and measured chemical compositions. Also, minor mineral phases could have gone undetected, thus skewing the calculated chemistry. Finally, it should be noted that those elements with the greatest error percentage are, as expected, the less abundant elements, such as K and Na, where small errors result in large error percents.

COMPARISON OF A & B TO C & D BENCHES

The mineralogy of the C & D benches is very similar to that found in the nearby A & B benches from the central part of Rasmussen Ridge (Knudsen and others, 2000). While these two pairs of weathered and less-weathered samples are similar mineralogically, there are differences. Mineralogically, there are three notable differences between the two data sets: 1) the C bench has considerably less feldspar than the comparable A bench; 2) the C & D benches have measurable pyrite, which is rare in the A & B benches; and finally 3) the C & D benches (particularly D) have far more calcite than is found in the A & B benches. The cause of these differences is not fully understood, with varied depositional environment, localized diagenesis, and weathering all as possible explanations.

Uncovering the cause of these differences will not only increase mineralogical understanding of the Phosphoria Formation as a whole, but it could lead to a better understanding of the behavior of trace elements in the deposit. Deposition, diagenesis, and weathering have all

affected the mineralogy and geochemistry. Further understanding of the relative importance of these factors will be gained on the current analysis of a deeper, less-weathered core (WUSP core J) than any of those previously analyzed. Once all the data have been collected, it should be possible to better recognize differences in weathering as well as localized variation in depositional environment. A more complete understanding of these variables could assist in the understanding in the origin and subsequent movement of problematic trace elements.

DISCUSSION

Lithologically, interbeds of mudstone, phosphorite, and dolomite define the majority of the two measured sections (C & D). Based on bulk mineral composition, these units are easily distinguished with the mudstone being rich in quartz and muscovite, the phosphorite high in carbonate fluorapatite, and the dolomite dominated by dolomite. Along with these major minerals, other phases are locally present in large amounts. High amounts of feldspars appear in some samples, particularly in mudstones of the middle waste in the less-weathered D section. Calcite is also a major mineral in some of the carbonate samples, with one sample (WPSD025) containing over 60% calcite. While these are the most abundant mineral phases, significant amounts of clays and pyrite were measured in many samples (tables 2a,b) as well. In addition, nondiffracting phases may be abundant in some samples, particularly those rich in organics.

The preliminary characterization of CO_3^{2-} substitution for PO_4^{3-} into fluorapatite reveals that the degree of substitution varies greatly between the two sections, within each section (tables 1a,b; figures 2a,b), and even within individual samples (figure 3). The less-weathered D-bench shows a generally higher level of substitution than the more-weathered C-bench. Because of the relatively unstable presence of the CO_3^{2-} in the fluorapatite structure, the more-weathered samples contain less CO_3^{2-}-rich apatite, as weathering effectively lowers the CO_3^{2-} levels in the apatite structure. The presence of multiple phases of fluorapatite within individual samples is evidence that, since initial deposition, originally higher carbonate fluorapatite has recrystallized to a more pure fluorapatite.

Also of note in this study is the significant presence of the rare ammonium feldspar mineral buddingtonite. Gulbrandsen (1974), who suggested its presence is related to diagenesis of organic matter and petroleum formation, first reported buddingtonite in the Phosphoria Formation. Buddingtonite's rarity in geologic deposits, as well as its geochemical sensitivity, makes it a notable presence in the Phosphoria Formation's mineral assemblage. This geochemical sensitivity holds the potential to help unfold some of the tangled geochemical history of the area. Although buddingtonite is not as abundant in the C & D benches as was previously measured in the nearby A & B benches (Knudsen and others, 2000), it was found at levels of over 30% in one sample and above 20% in many others. While buddingtonite and orthoclase have both been identified in the Phosphoria Formation, the extent of NH_4^+ -K solid solution between buddingtonite and orthoclase has not been fully determined. Also of note is the probability of this same solid solution between muscovite/illite and their ammonium analog toblerite. This substitution results in the expansion of the sheet structure, and thus an increase in the c-cell parameter (Juster and others, 1987), which can be measured using XRD and Rietveld refinement. Preliminary analysis has indeed shown that such a substitution may be occurring in these samples, and future work on these and related samples will attempt to better understand both the feldspar and the sheet silicate solid solutions and their potential for determining the geochemistry of the samples and the rock as a whole.

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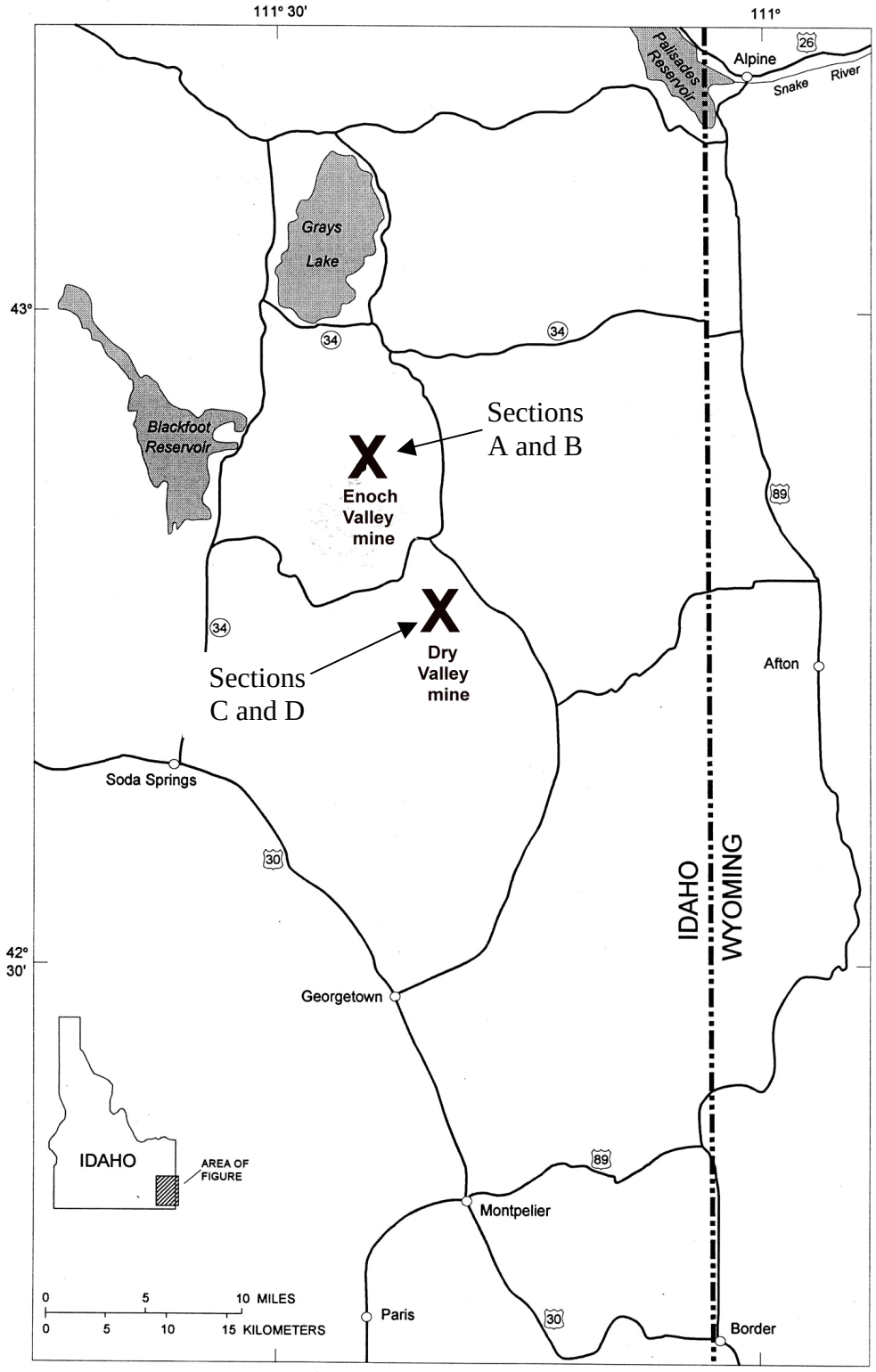

Figure 1. Index map of southeastern Idaho showing location of Dry Valley mine measured sections from which samples were collected.

Table 1a. Carbonate-fluorapatite composition for each sample in measured stratigraphic section C.

Sample #	Lithology	fluorapatite a-cell (Å)	CO_3^{2-} content (Z) per unit formula	Percent CO_3^{2-} substitution for PO_4^{3-}	Na content (X) per unit formula	Mg content (Y) per unit formula
WPSC170	Chert	9.366	0.1	1%	0.0	0.0
WPSC159	Phosphorite	9.354	0.4	7%	0.1	0.0
WPSC155	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC150	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC146	Chert	9.368	0.0	0%	0.0	0.0
WPSC144	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC138	Phosphorite	9.360	0.3	4%	0.1	0.0
WPSC137	Mudstone	9.360	0.3	4%	0.1	0.0
WPSC135	Phosphorite	9.368	0.0	0%	0.0	0.0
WPSC133	Phosphorite	9.364	0.1	2%	0.0	0.0
WPSC122	Mudstone	9.367	0.0	1%	0.0	0.0
WPSC116	Phosphorite	9.363	0.2	3%	0.0	0.0
WPSC112	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC108	Mudstone	9.364	0.2	3%	0.0	0.0
WPSC104	Mudstone	9.365	0.1	2%	0.0	0.0
WPSC096	Mudstone	9.364	0.1	2%	0.0	0.0
WPSC091	Mudstone	9.365	0.1	2%	0.0	0.0
WPSC090	Mudstone	9.365	0.1	2%	0.0	0.0
WPSC080	Mudstone	9.365	0.1	2%	0.0	0.0
WPSC075	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC070	Mudstone	9.363	0.2	3%	0.0	0.0
WPSC063	Phosphorite	9.365	0.1	2%	0.0	0.0
WPSC060	Mudstone	9.368	0.0	0%	0.0	0.0
WPSC056	Carbon seam	9.368	0.0	0%	0.0	0.0
WPSC055	Phosphorite	9.362	0.2	3%	0.0	0.0
WPSC050	Mudstone	9.361	0.2	4%	0.1	0.0
WPSC045	Phosphorite	9.361	0.2	4%	0.1	0.0
WPSC043	Mudstone	9.365	0.1	2%	0.0	0.0
WPSC041	Phosphorite	9.357	0.3	6%	0.1	0.0
WPSC039	Phosphorite	9.358	0.3	5%	0.1	0.0
WPSC035	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSC032	Phosphorite	9.360	0.3	4%	0.1	0.0
WPSC031	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSC028	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSC020	Phosphorite	9.357	0.3	6%	0.1	0.0
WPSC015	Phosphorite	9.361	0.2	4%	0.1	0.0
WPSC011	Mudstone	9.347	0.6	10%	0.2	0.1

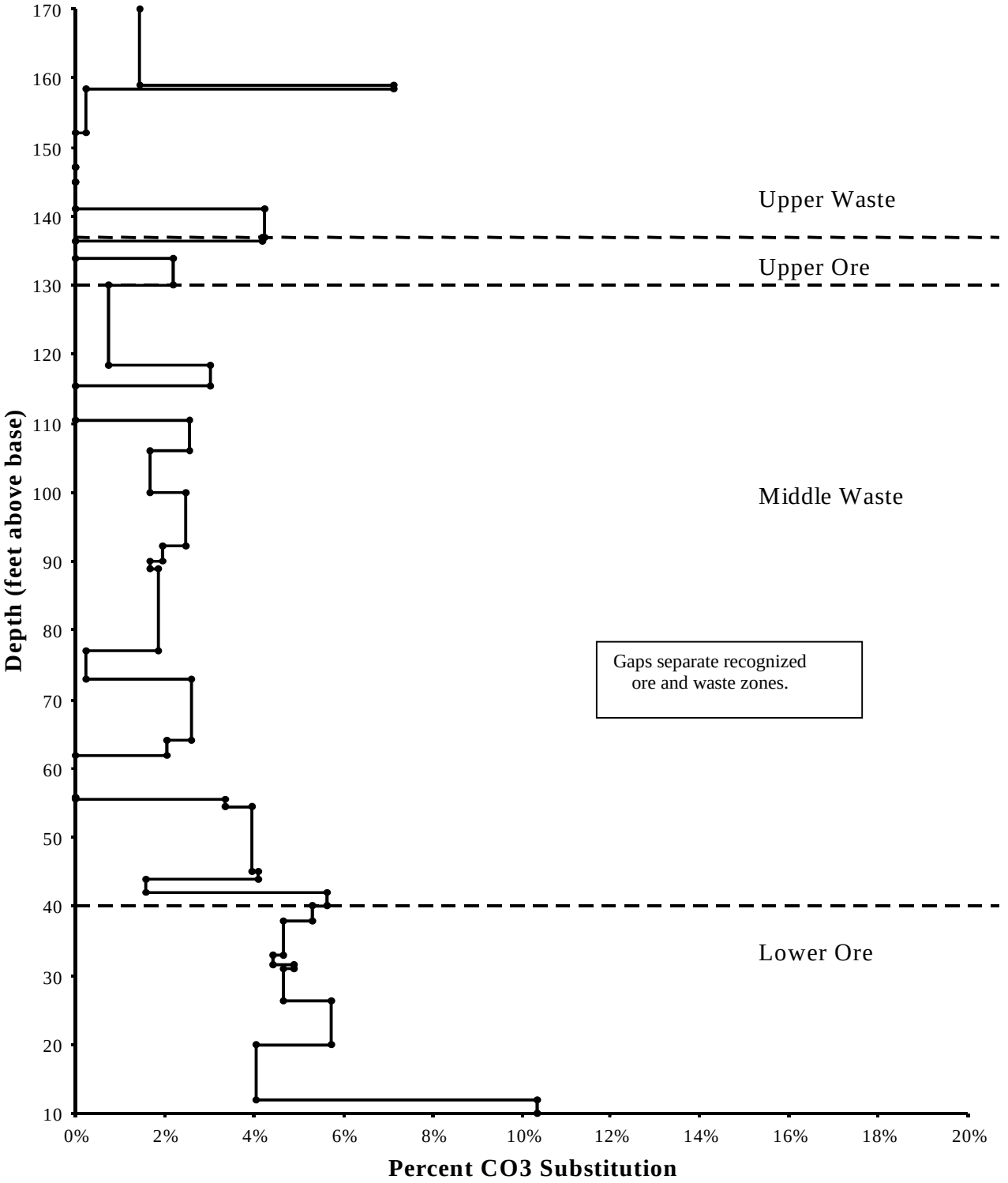

Figure 2a. Percent substitution of carbonate for phosphate in the fluorapatite structure over the measured stratigraphic section C.

Table 1b. Carbonate-fluorapatite composition for each sample in measured stratigraphic section D.

Sample #	Lithology	fluorapatite a-cell (Å)	CO_3^{2-} content (Z) per unit formula	Percent CO_3^{2-} substitution for PO_4^{3-}	Na content (X) per unit formula	Mg content (Y) per unit formula
WPSD210	Mudstone	9.362	0.2	3%	0.0	0.0
WPSD209	Phosphorite	9.364	0.1	2%	0.0	0.0
WPSD207	Mudstone	9.368	0.0	0%	0.0	0.0
WPSD206	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSD205	Mudstone	9.368	0.0	0%	0.0	0.0
WPSD203	Mudstone	9.362	0.2	3%	0.0	0.0
WPSD199	Phosphorite	9.363	0.2	3%	0.0	0.0
WPSD151	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD147	Mudstone	9.365	0.1	2%	0.0	0.0
WPSD142	Mudstone	9.367	0.0	1%	0.0	0.0
WPSD137	Mudstone	9.362	0.2	3%	0.0	0.0
WPSD132	Phosphorite	9.366	0.1	1%	0.0	0.0
WPSD130	Mudstone	9.362	0.2	3%	0.0	0.0
WPSD126	Carbon Seam	9.368	0.0	0%	0.0	0.0
WPSD120	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD114	Mudstone	9.362	0.2	3%	0.0	0.0
WPSD109	Phosphorite	9.368	0.0	0%	0.0	0.0
WPSD108	Mudstone	9.363	0.2	3%	0.0	0.0
WPSD104	Carbon Seam	9.358	0.3	6%	0.1	0.0
WPSD103	Mudstone	9.367	0.0	1%	0.0	0.0
WPSD102	Carbon Seam	9.359	0.3	5%	0.1	0.0
WPSD101	Mudstone	9.368	0.0	0%	0.0	0.0
WPSD098	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSD093	Siltstone	9.362	0.2	4%	0.0	0.0
WPSD087	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD084	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD080	Mudstone	9.351	0.5	9%	0.1	0.0
WPSD075	Siltstone	9.368	0.0	0%	0.0	0.0
WPSD071	Siltstone	9.368	0.0	0%	0.0	0.0
WPSD067	Siltstone	9.366	0.1	1%	0.0	0.0
WPSD062	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD058	Phosphorite	9.368	0.0	0%	0.0	0.0
WPSD055	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD052	Siltstone	9.364	0.1	2%	0.0	0.0
WPSD049	Phosphorite	9.363	0.2	3%	0.0	0.0
WPSD046	Phosphorite	9.365	0.1	2%	0.0	0.0
WPSD043	Phosphorite	9.334	0.9	16%	0.2	0.1
WPSD041	Phosphorite	9.364	0.1	2%	0.0	0.0
WPSD039	Dolostone	9.361	0.2	4%	0.1	0.0
WPSD036	Phosphorite	9.353	0.5	8%	0.1	0.0
WPSD033	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD031	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD030	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSD027	Phosphorite	9.361	0.2	4%	0.1	0.0
WPSD025	Limestone	9.368	0.0	0%	0.0	0.0
WPSD023	Phosphorite	9.359	0.3	5%	0.1	0.0
WPSD020	Phosphorite	9.357	0.3	6%	0.1	0.0
WPSD018	Dolostone	9.359	0.3	5%	0.1	0.0
WPSD016	Phosphorite	9.360	0.3	4%	0.1	0.0
WPSD014	Phosphorite	9.360	0.3	4%	0.1	0.0
WPSD009	Mudstone	9.358	0.3	5%	0.1	0.0
WPSD006	Dolostone	9.368	0.0	0%	0.0	0.0
WPSD000.5	Phosphorite	9.362	0.2	4%	0.0	0.0
WPSD000	Dolostone	9.368	0.0	0%	0.0	0.0

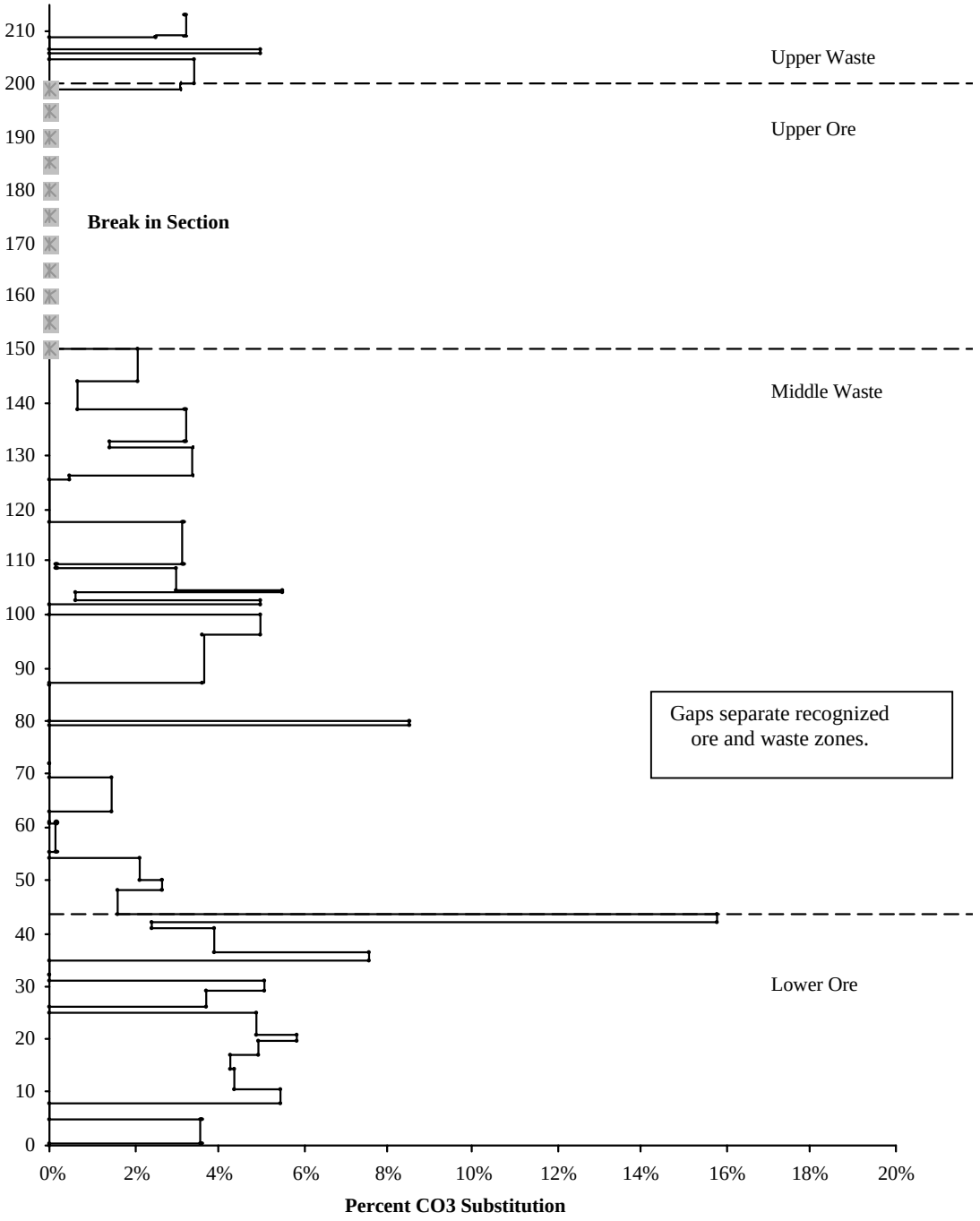

Figure 2b. Percent substitution of carbonate for phosphate in the fluorapatite structure over the measured stratigraphic section D.

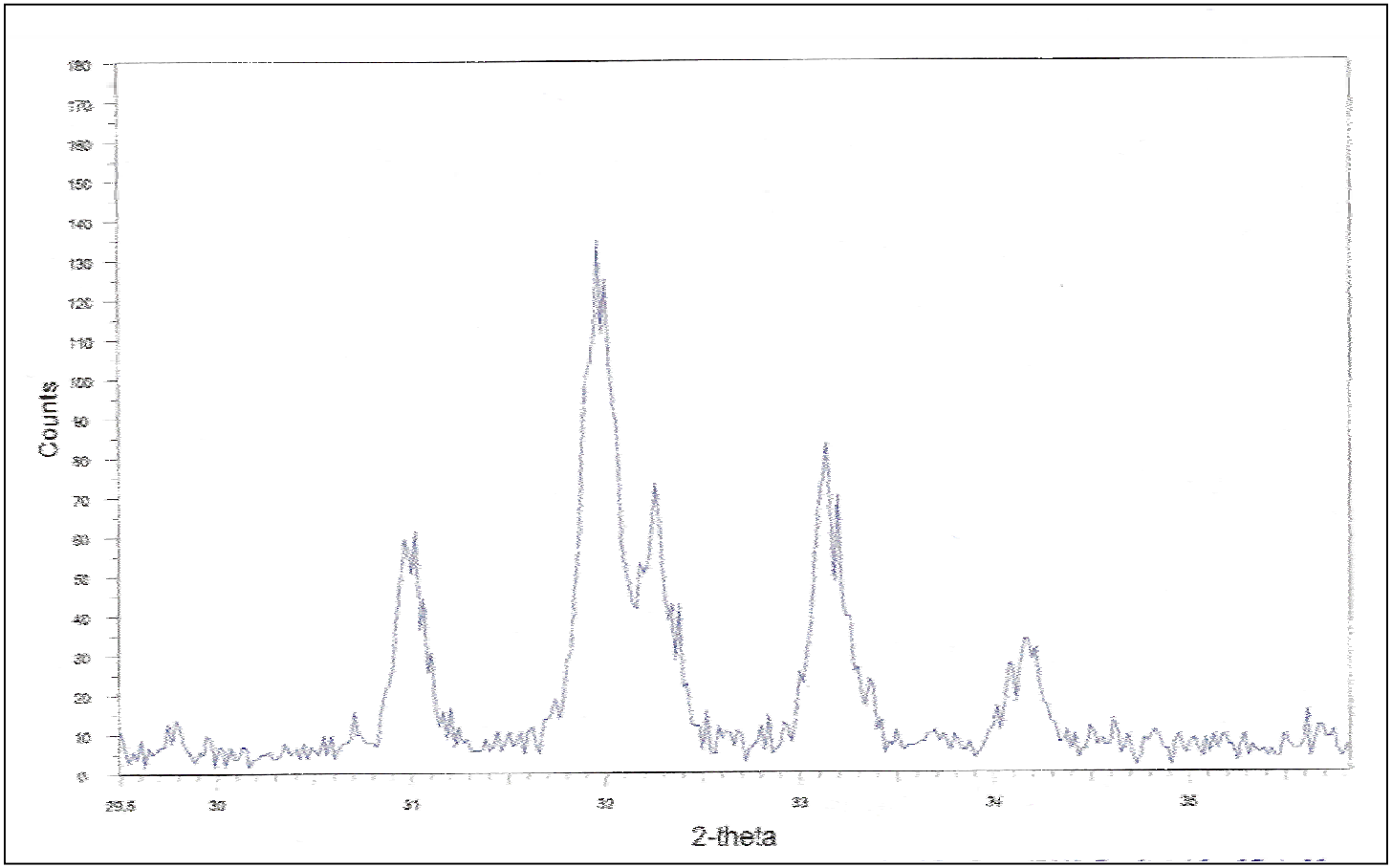

Figure 3. XRD pattern between 30° and 35° 2ϑ for a grab sample taken from the Rasmussen Ridge section.

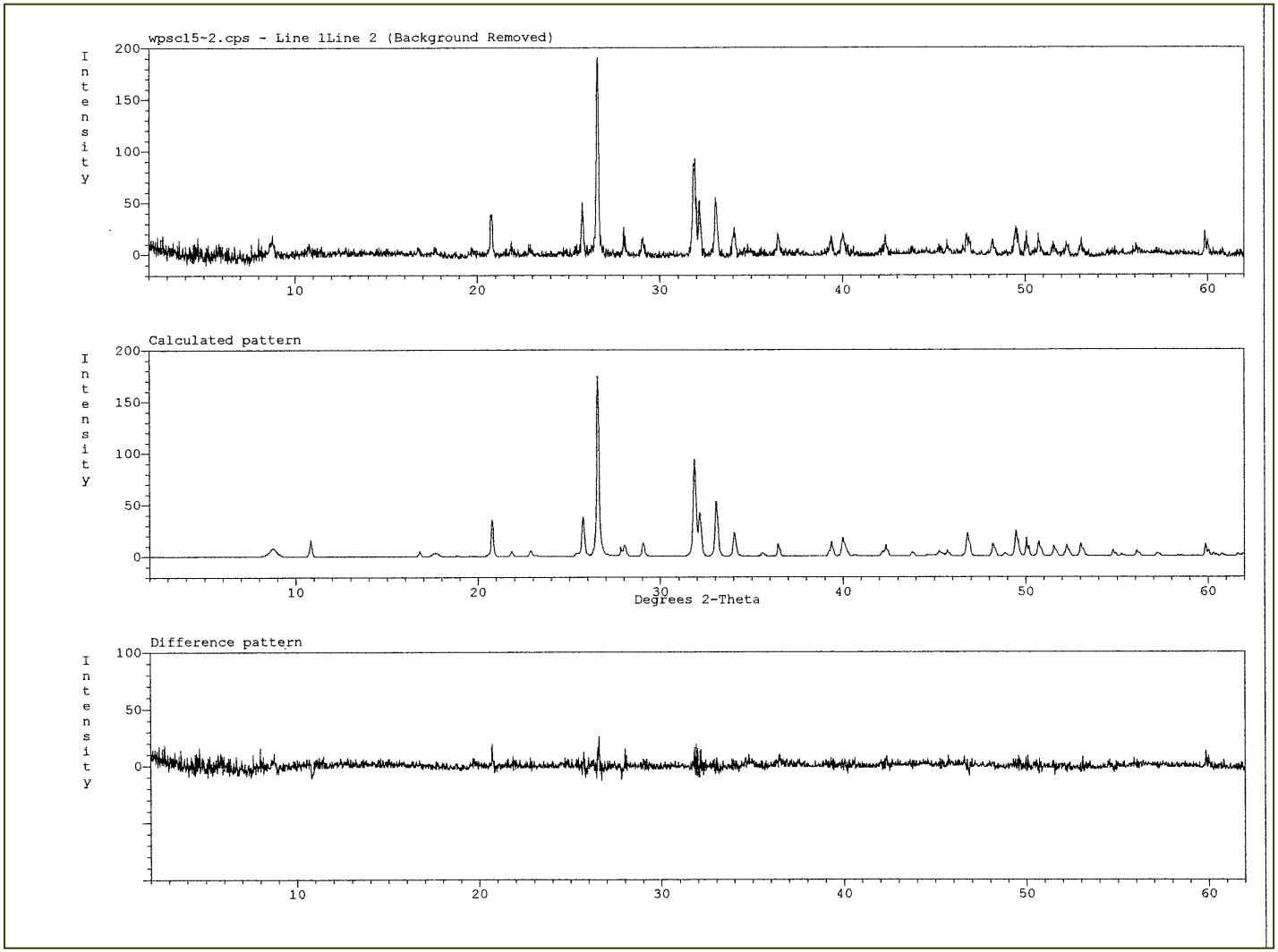

Figure 4. Collected and calculated XRD patterns from the Siroquant program for sample WPSA040C (Knudsen and others 2000); the difference pattern is also shown. This sample has a χ^2 value of 1.48, and contains 55% apatite, 25% quartz, 3% orthoclase, 9% buddingtonite, and 1% kaolinite.

Table 2a. Quantitative mineralogy for each C-bench sample calculated using the Rietveld method. The χ^2 value is a numerical statement of the quality of the match between the collected XRD pattern and the calculated Rietveld pattern where any value less than 3 is considered acceptable, with smaller χ^2 values inferring better results. Percents are listed with an accepted error in the last decimal place given in parentheses.

Sample #	Lithology	χ^2	apatite	quartz	muscovite	illite	albite	orthoclase	buddingtonite	dolomite	calcite	kaolin	pyrite
WPSC170	Mudstone	1.74	7.2 (7)	65 (2)	5 (1)	3.6 (8)	4.6 (9)	10.0 (9)	0.4 (2)	0.0 (4)	0.0 (4)	1.8 (6)	1.9 (2)
WPSC159	Phosphorite	1.35	57.7 (2)	28.5 (9)	6 (2)	2 (1)	0.2 (7)	0.1 (8)	1.7 (8)	0.0 (4)	0.0 (4)	1.6 (6)	2.2 (5)
WPSC155	Mudstone	1.83	5.2 (8)	59 (1)	15 (1)	3.5 (9)	7.5 (8)	3.0 (6)	3.5 (8)	1.7 (4)	0.4 (5)	1.8 (6)	0.0 (2)
WPSC150	Mudstone	1.83	3.7 (7)	65 (2)	7 (1)	4 (1)	6.1 (7)	6 (9)	6 (1)	0.0 (4)	0.0 (5)	1.2 (7)	0.9 (2)
WPSC146	Chert	1.5	10.1 (4)	83.7 (1)	1.2 (3)	0.3 (5)	0.0 (4)	2.9 (6)	0.4 (5)	0.0 (2)	0.0 (2)	1.3 (3)	0.0 (3)
WPSC144	Mudstone	1.96	13 (1)	53 (1)	30 (2)	0 (1)	0 (1)	3.4 (8)	0.1 (0)	0.3 (7)	0.0 (5)	0.0 (7)	0.0 (6)
WPSC138	Phosphorite	1.49	80 (2)	6.5 (4)	2.3 (4)	3 (2)	2.6 (9)	0.1 (8)	0.1 (0)	3 (1)	1.5 (7)	1 (9)	0.0 (8)
WPSC137	Mudstone	1.67	62 (2)	21 (1)	8 (2)	4 (2)	0 (1)	1.4 (8)	0 (1)	3 (3)	1.7 (7)	0.7 (8)	0.4 (8)
WPSC135	Phosphorite	1.71	74 (2)	13 (4)	8.2 (6)	2 (1)	0.1 (9)	1.7 (6)	0.7 (0)	0.0 (4)	0.0 (5)	0.0 (8)	0.0 (7)
WPSC133	Phosphorite	1.8	41 (1)	31 (9)	10 (1)	0.1 (1)	0.0 (7)	15 (1)	0.1 (0)	0.0 (1)	0.2 (5)	2.0 (6)	0.7 (4)
WPSC122	Mudstone	1.84	14.9 (8)	48 (1)	24 (1)	0.5 (8)	10.8 (7)	0.0 (1)	0.3 (0)	0.6 (2)	0.0 (4)	1.4 (5)	0.0 (4)
WPSC116	Phosphorite	1.53	63 (1)	25.3 (5)	6 (1)	1.1 (6)	3.4 (7)	0.1 (1)	0.1 (0)	0.3 (1)	0.0 (4)	0.0 (5)	0.7 (2)
WPSC112	Mudstone	1.88	11.6 (5)	63 (1)	14 (1)	2.8 (6)	4.8 (2)	0 (1)	0.2 (0)	0.6 (1)	0.0 (4)	1.6 (5)	1.3(2)
WPSC108	Mudstone	1.69	26.9 (7)	55 (1)	12 (2)	0.2 (7)	3.7 (3)	0 (1)	0.2 (0)	0 (1)	0.2 (4)	1.6 (5)	0.5 (2)
WPSC104	Mudstone	1.77	19 (2)	58 (2)	12 (2)	1 (2)	5.5 (9)	4.0 (6)	0.2 (0)	0 (1)	0.0 (5)	0.4 (6)	0.0 (6)
WPSC096	Mudstone	1.74	14.9 (7)	55.9 (1)	21 (2)	0.1 (9)	5.5 (7)	0.3 (1)	0.4 (0)	0.0 (2)	0.5 (5)	1.9 (6)	0.0 (3)
WPSC091	Mudstone	1.74	16.6 (6)	51.1 (1)	20 (1)	0.1 (8)	8.6 (8)	0.1 (1)	0.3 (0)	0.3 (1)	0.6 (4)	1.9 (5)	0.4 (2)
WPSC090	Mudstone	1.72	22.1 (8)	52 (1)	18 (1)	2.3 (8)	0.8 (1)	0.2 (1)	0.7 (0)	1.2 (2)	0.0 (5)	3.0 (6)	0.0 (3)
WPSC080	Mudstone	1.68	32.1 (9)	41.6 (1)	22 (2)	0.9 (9)	1.8 (1)	0.1 (1)	0.3 (0)	0.0 (4)	0.0 (5)	1.1 (7)	0.0 (3)
WPSC075	Mudstone	1.84	9.4 (8)	53 (2)	32 (2)	0 (1)	0.0 (1)	0.5 (1)	0.4 (0)	1.8 (7)	0.1 (5)	2.6 (7)	0.2 (3)
WPSC070	Mudstone	1.80	22.4 (9)	40 (1)	11 (1)	0 (1)	4.8 (8)	3 (1)	15 (1)	1.0 (5)	0.0 (4)	2.2 (7)	0.0 (3)
WPSC063	Phosphorite	1.61	65 (2)	19.1 (9)	15.4 (3)	0 (1)	0.1 (2)	0.1 (2)	0.2 (0)	0.0 (6)	0.0 (6)	0.0 (9)	0.0 (4)
WPSC060	Mudstone	1.91	7.2 (7)	47.4 (2)	42 (2)	0 (1)	0.3 (1)	0.2 (1)	0.6 (0)	0.0 (4)	0.0 (4)	2.5 (7)	0.1 (3)
WPSC056	Carbon seam	1.78	3 (1)	51 (3)	38 (4)	8 (3)	0.1 (3)	0.3 (3)	0.1 (0)	0.1 (9)	0.0 (9)	0 (1)	0.0 (5)
WPSC055	Phosphorite	1.4	76 (1)	13.2 (4)	8 (1)	0.9 (8)	0.1 91)	0.1 (1)	0.3 (0)	0.0 (4)	1.0 (4)	1.1 (5)	0.0 (2)

Table 2a. Quantitative mineralogy for each C-bench sample calculated using the Rietveld method - continued.

Sample #	Lithology	χ^2	apatite	quartz	muscovite	illite	albite	orthoclase	buddingtonite	dolomite	calcite	kaolin	pyrite
WPSC050	Mudstone	1.74	41 (1)	37 (1)	17 (2)	1 (1)	0.0 (1)	0.3 (1)	0.5 (0)	0.0 (4)	1.9 (6)	0.6 (6)	0.3 (2)
WPSC045	Phosphorite	1.62	71 (1)	19.1 (5)	5.3 (4)	2.4 (9)	1 (1)	0.1 (1)	0.1 (0)	0.0 (5)	0.0 (5)	1.1 (7)	0.1 (3)
WPSC043	Mudstone	1.76	26 (1)	52 (2)	10 (1)	1.3 (8)	0.4 (6)	0.0 (1)	0 (2)	0.0 (4)	5 (1)	5.0 (7)	0.2 (2)
WPSC041	Phosphorite	1.53	75 (2)	18.7 (6)	3 (2)	1 (1)	0 (1)	1.0 (7)	1 (1)	0.0 (2)	0.2 (4)	0.9 (7)	0.0 (3)
WPSC039	Phosphorite	1.54	81 (1)	14.1 (5)	2.0 (3)	1 (1)	0.1 (8)	0.2 (2)	0.3 (6)	0.0 (5)	0.0 (4)	0.3 (6)	0.7 (3)
WPSC035	Phosphorite	1.53	50.7 (8)	32.6 (6)	7.0 (3)	3 (8)	1.0 (6)	0.1 (1)	2.8 (5)	0.0 (4)	0.0 (5)	2.7 (4)	0.0 (2)
WPSC032	Phosphorite	1.47	94 (2)	5.1 (4)	0.3 (2)	0.8 (9)	0.1 (7)	0.1 (1)	0.1 (6)	0.0 (5)	0.1 (4)	0.0 (5)	0.0 (3)
WPSC031	Phosphorite	1.61	68 (2)	25.1 (7)	3 (1)	1.5 (9)	0.1 (7)	0.1 (1)	1.1 (5)	0.0 (4)	0.0 (4)	0.3 (5)	0.3 (3)
WPSC028	Phosphorite	1.56	83 (1)	10.8 (4)	3.5 (5)	0.3 (9)	0.1 (7)	0.1 (1)	0.8 (5)	0.0 (5)	0.0 (4)	0.5 (5)	1.2 (3)
WPSC020	Phosphorite	1.66	63 (1)	24.2 (6)	7 (1)	1.7 (9)	0.0 (7)	0.1 (1)	1.4 (5)	0.0 (4)	0.0 (4)	2.2 (9)	0.0 (3)
WPSC015	Phosphorite	1.52	84 (1)	8.2 (3)	6 (1)	0 (1)	0.1 (8)	0.3 (1)	0.1 (6)	0.0 (5)	0.0 (4)	1.0 (7)	0.0 (3)
WPSC011	Mudstone	1.87	4.9 (5)	67.2 (1)	10.9 (5)	1.3 (9)	0.1 (7)	0.2 (2)	12 (1)	0.6 (4)	0.0 (4)	2.6 (6)	0.2 (3)

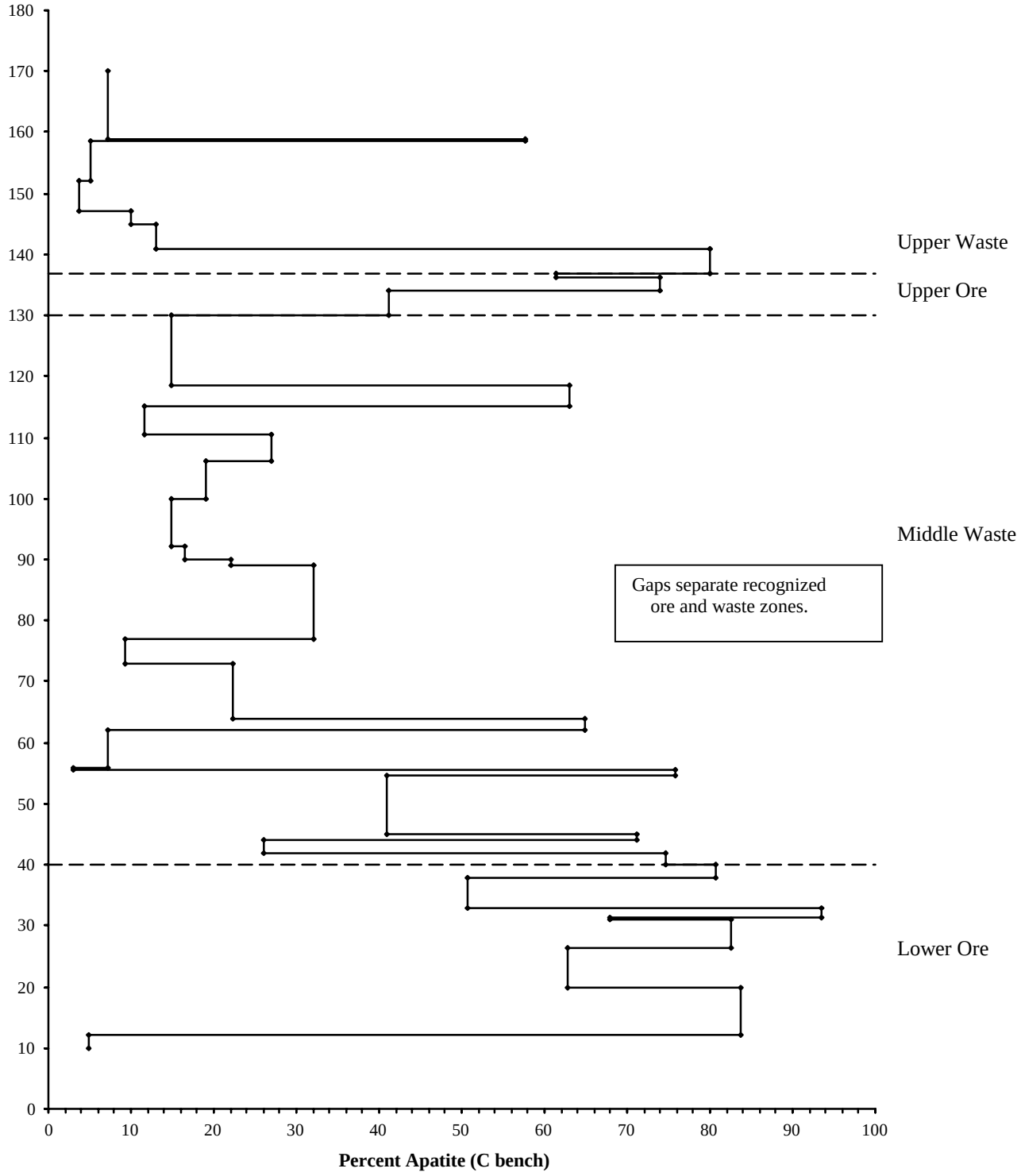

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C. Abundance of major mineral phases including; apatite, quartz, muscovite and illite, total feldspars (including albite, orthoclase, and buddingtonite), buddingtonite, and dolomite are shown.

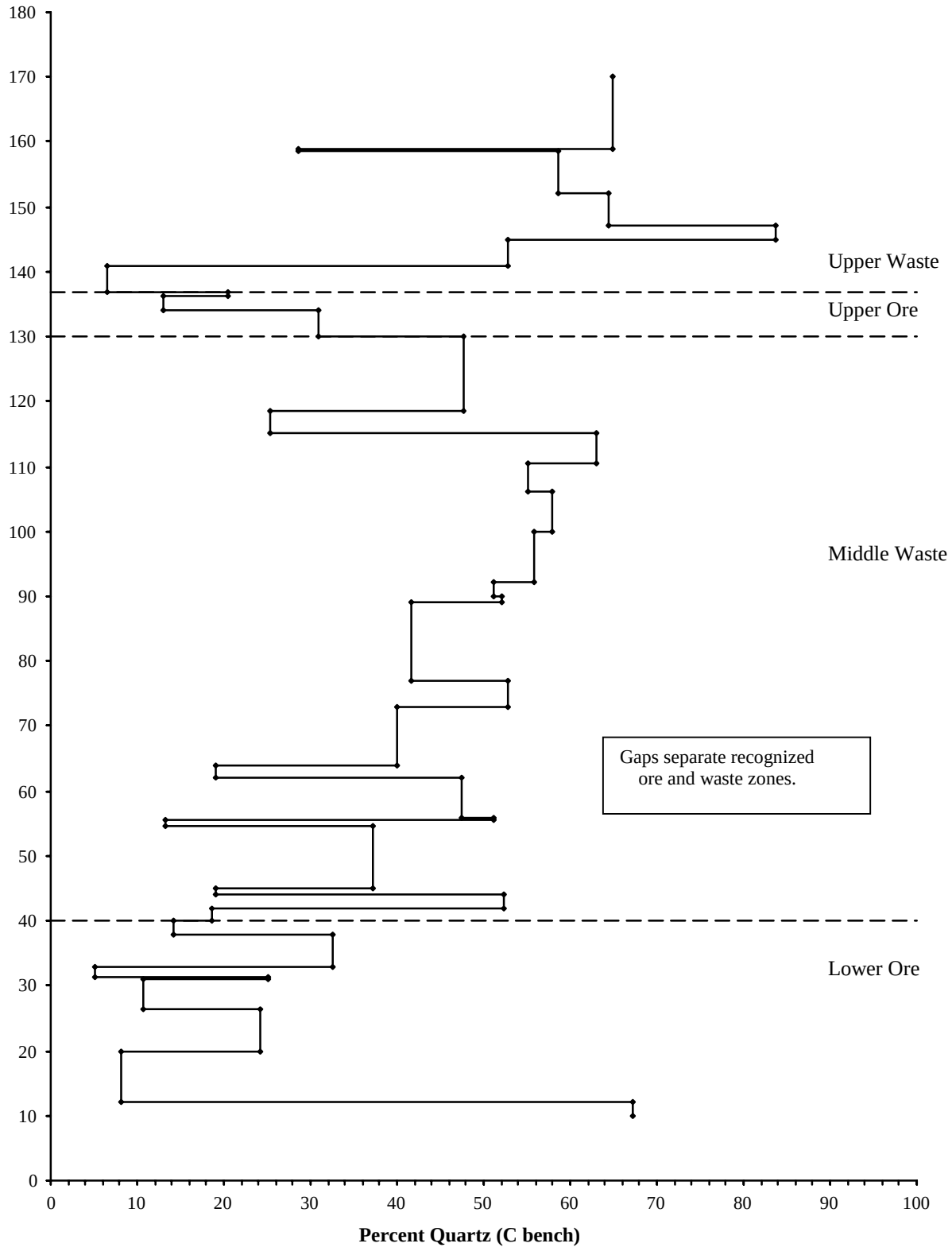

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C - continued.

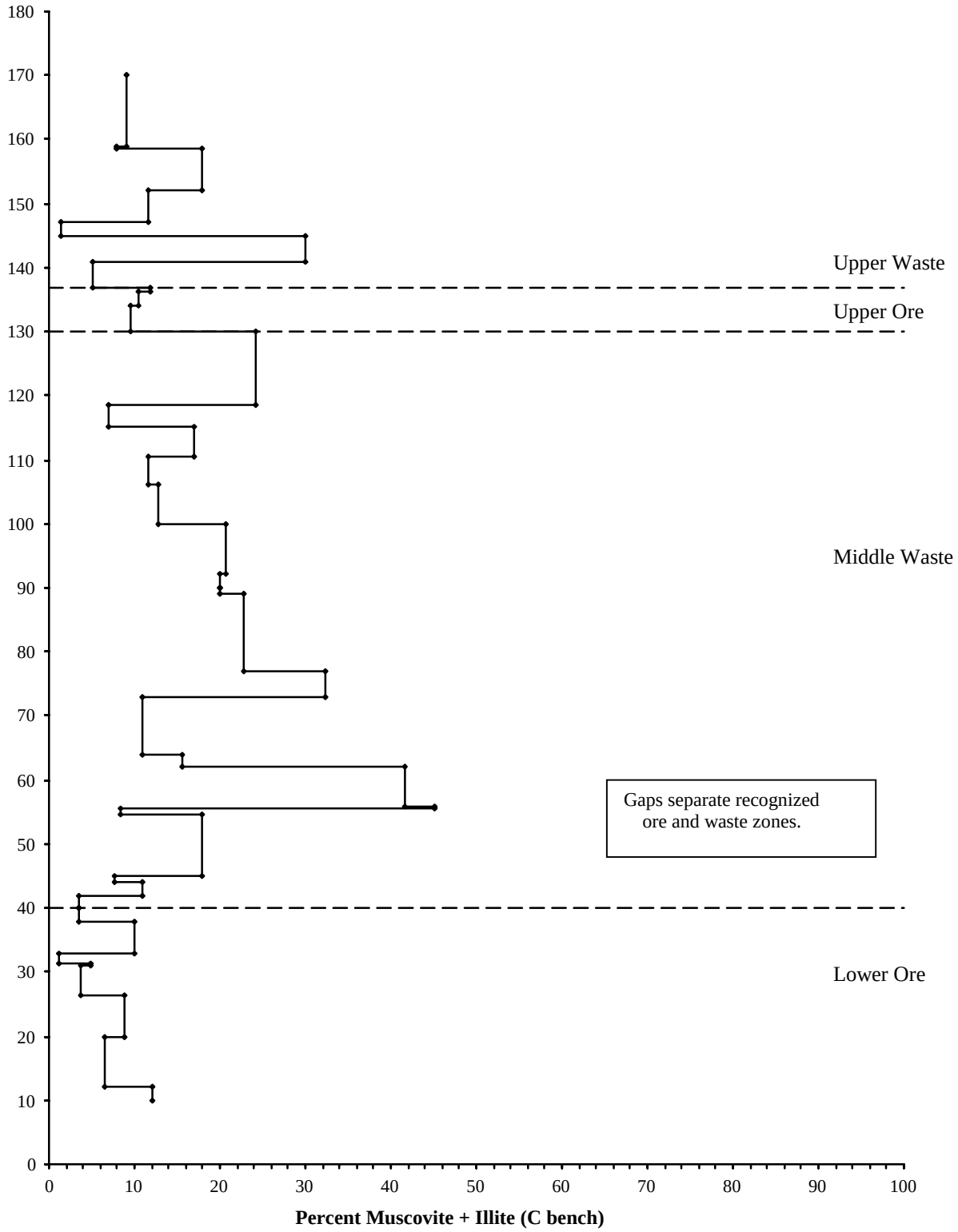

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C - continued.

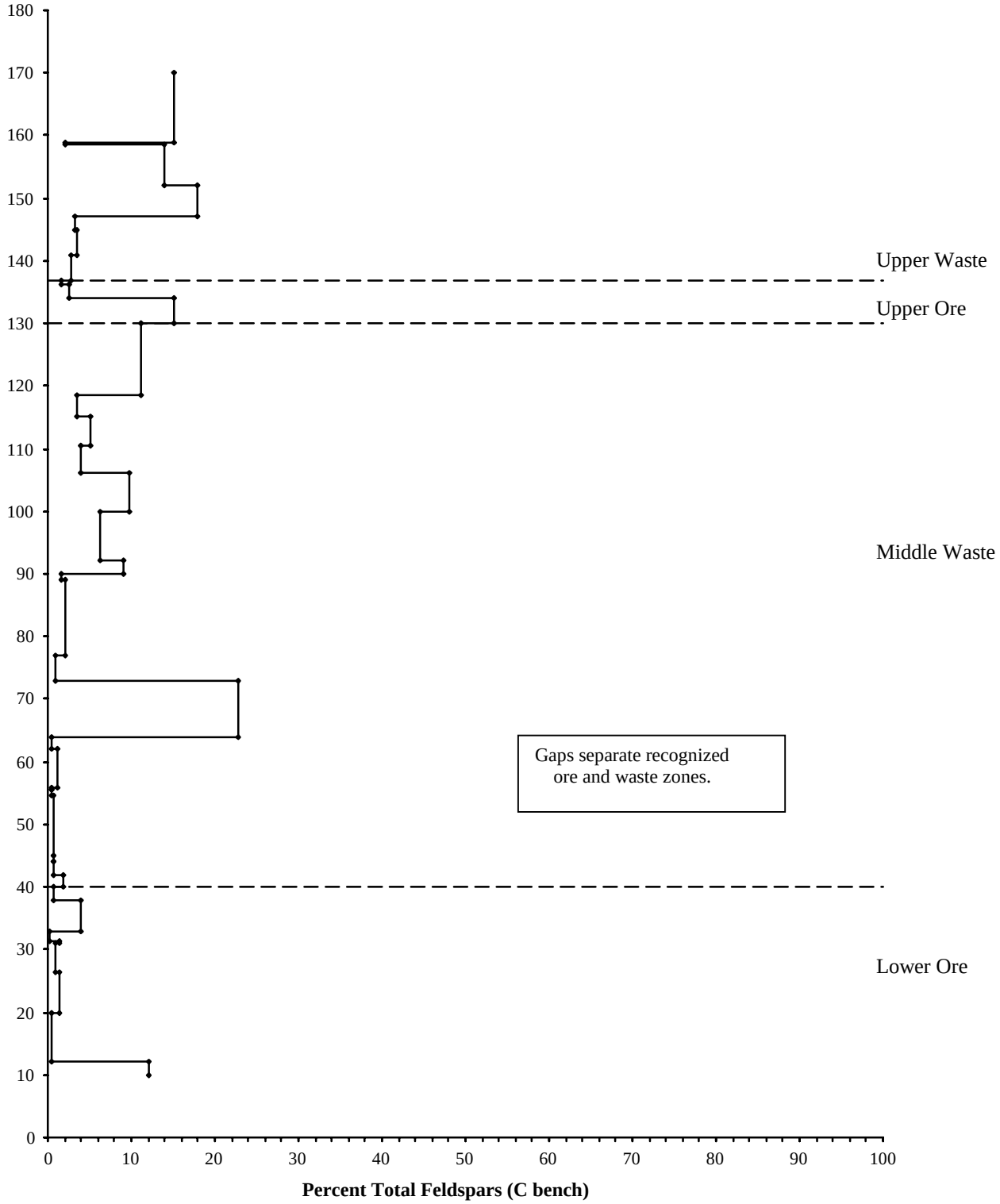

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C - continued.

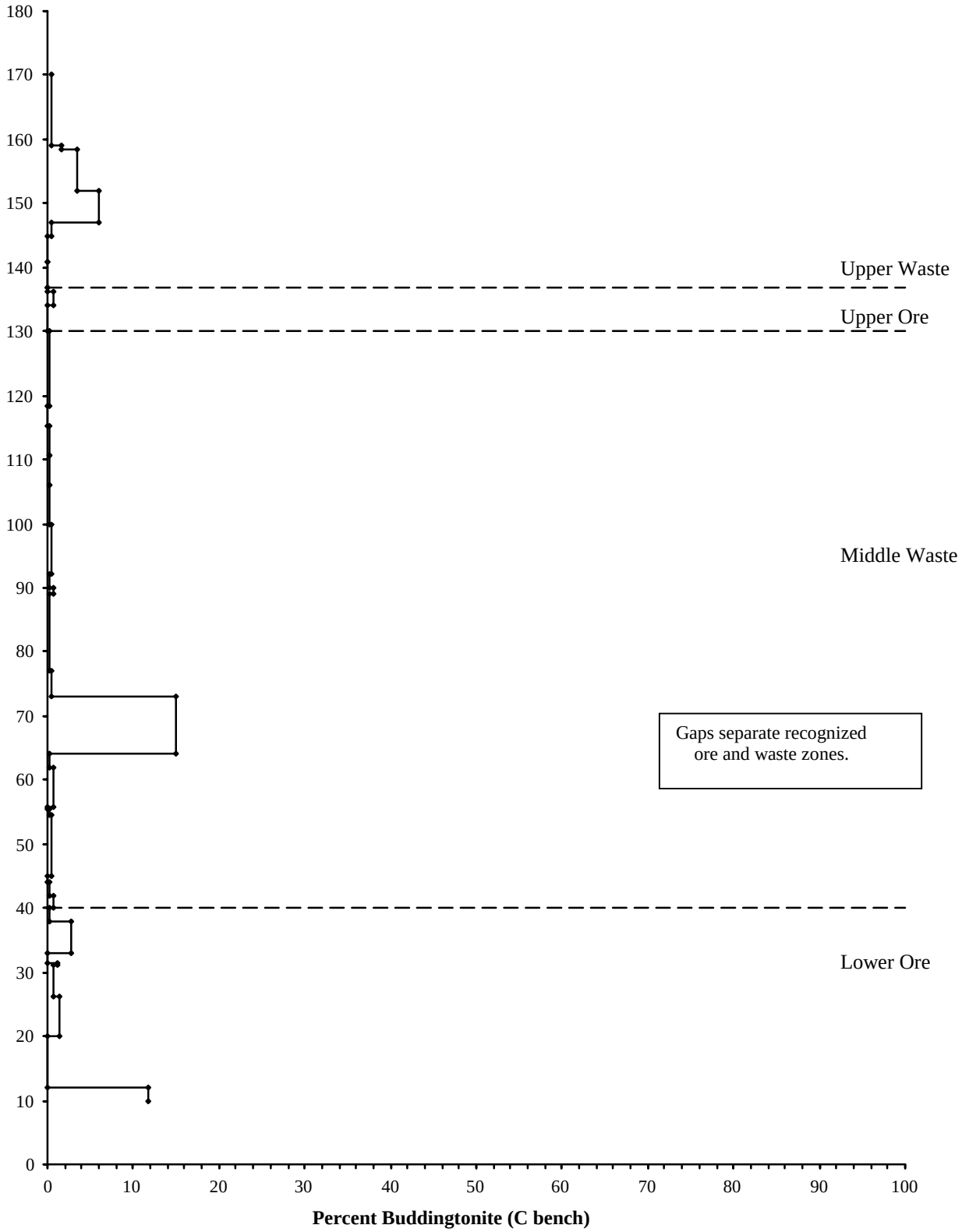

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C - continued.

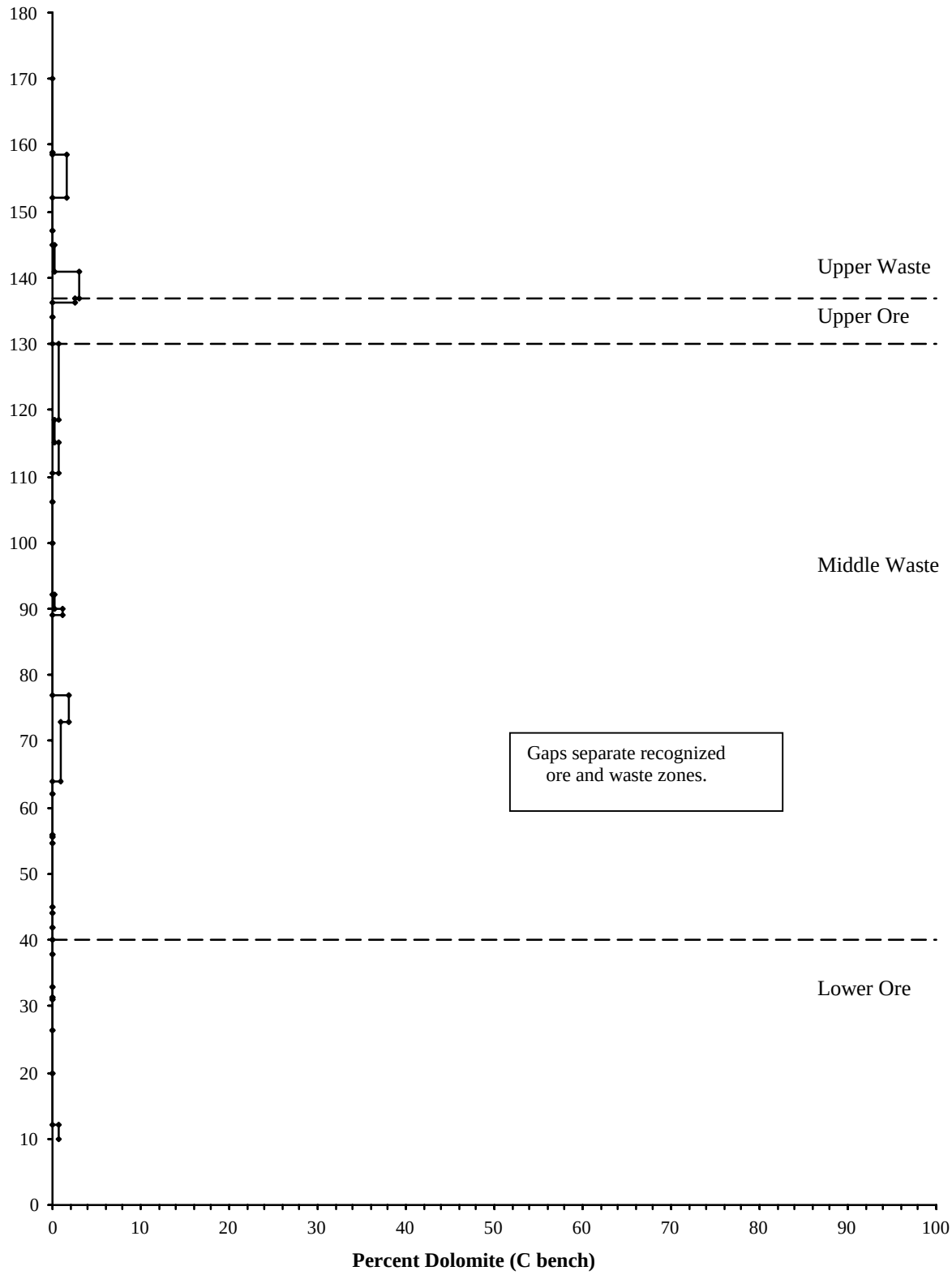

Figure 5a. Mineral composition of each sample over the measured stratigraphic section C - continued.

Table 2b. Quantitative mineralogy for each D-bench sample calculated using the Rietveld method. The χ^2 value is a numerical statement of the quality of the match between the collected XRD pattern and the calculated Rietveld pattern where any value less than 3 is considered acceptable, with smaller χ^2 values inferring better results. Percents are listed with an accepted error in the last decimal place given in parentheses.

Sample #	Lithology	χ^2	apatite	quartz	muscovite	illite	albite	orthoclase	buddingtonite	dolomite	calcite	kaolin	pyrite
WPSD210	Mudstone	1.88	3.5 (5)	49 (1)	25 (1)	2.3 (9)	2.5 (9)	1.0 (6)	3 (1)	0.2 (2)	7.5 (4)	0.0 (6)	4.7 (4)
WPSD209	Phosphorite	1.67	26.9 (8)	39 (1)	17 (2)	0.1 (8)	13 (1)	1.8 (6)	0.6 (7)	0.0 (2)	0.0 (3)	0.0 (5)	1.0 (2)
WPSD207	Mudstone	1.7	2.6 (5)	67 (1)	10 (1)	3.1 (4)	12.7 (7)	1.5 (2)	0.3 (1)	0.9 (3)	0.0 (4)	0.7 (5)	0.5 (1)
WPSD206	Phosphorite	1.88	64 (2)	29 (1)	0 (3)	0.1 (7)	3 (6)	0.1 (7)	3.2 (2)	0.0 (2)	0.1 (2)	0.7 (7)	0.1 (3)
WPSD205	Mudstone	2.00	1.9 (7)	52 (1)	24 (1)	3 (1)	8.3 (3)	1.5 (4)	0.0 (0)	0.1 (3)	0.1 (3)	0.3 (6)	8.8 (5)
WPSD203	Mudstone	1.82	19.4 (7)	35 (1)	11 (1)	0.1 97)	8.1 (7)	0.0 (9)	7 (1)	5.2 (9)	9.2 (9)	0.3 (6)	5.0 (4)
WPSD199	Phosphorite	1.65	48 (1)	32.1 (8)	5 (1)	2.2 (9)	9.8 (8)	1.2 (3)	0.1 (4)	0.0 (4)	0.0 (5)	1.6 (6)	0.5 (2)
WPSD151	Dolostone	1.55	1.0 (3)	3.2 (2)	0.3 (3)	0.2 (4)	5.8 (3)	0.0 (4)	1.3 (4)	63.9 (8)	23.2 (5)	0.0 (4)	0.5 (2)
WPSD147	Mudstone	1.7	24.0 (9)	49 (1)	5 (2)	0 (1)	16.4 (8)	2.3 (3)	0.1 (6)	0.7 (4)	0.0 (5)	0.6 (7)	0.4 (1)
WPSD142	Mudstone	1.75	14.5 (5)	32 (7)	8 (8)	0.1 (5)	13.5 (6)	5.3 (6)	7.9 (8)	7.7 (7)	5.4 (6)	0.3 (5)	5.1 (3)
WPSD137	Mudstone	1.74	10.7 (5)	38.5 (9)	6 (1)	3.1 (5)	8.5 (7)	2.2 (5)	12.1 (8)	3.7 (4)	10.3 (6)	0.0 (5)	5.1 (3)
WPSD132	Phosphorite	1.27	70 (1)	12.5 (4)	5 (1)	0.9 (5)	1.5 (6)	0.2 (7)	5.1 (7)	0.0 (3)	0.0 (3)	0.0 (5)	4.3 (3)
WPSD130	Mudstone	1.68	11.3 (4)	40.1 (7)	2.6 (8)	0.1 (4)	15.4 (5)	5.3 (5)	15.0 (7)	4.8 (4)	0.0 (2)	0.2 (4)	5.1 (3)
WPSD126	Carbon Seam	1.47	61 (1)	11.9 (3)	3.6 (3)	0.4 (5)	3.8 (2)	2.9 (9)	9 (1)	0.2 (3)	0.0 (3)	0.1 (5)	7.0 (3)
WPSD120	Dolostone	1.93	3.3 (4)	15 (4)	1 (1)	0.8 (7)	3.0 (7)	3.2 (6)	9 (1)	54(1)	7.3 (6)	0.0 (5)	2.7 (2)
WPSD114	Mudstone	1.79	8.2 (4)	36.0 (7)	5.3 (9)	1.1 (4)	10.0 (6)	5.5 (6)	22.3 (8)	4.4 (3)	0.0 (2)	0.0 (4)	7.2 (3)
WPSD109	Phosphorite	1.6	35.5 (7)	24.7 (5)	5.1 (9)	0.1 (5)	13.0 (7)	2.8 (6)	12.7 (8)	0.0 (3)	0.0 (2)	0.0 (4)	5.9 (2)
WPSD108	Mudstone	1.81	20.8 (6)	31.3 (7)	4 (1)	1.6 (5)	15.1 (6)	3.2 (5)	16.3 (8)	0.0 (3)	0.0 (3)	0.7 (5)	6.8 (3)
WPSD104	Carbon Seam	1.56	49 (1)	22.0 (7)	7 (2)	0.1 (7)	2 (6)	2.5 (7)	9.0 (9)	0.0 (5)	0.0 (4)	0.5 (7)	7.9 (4)
WPSD103	Mudstone	1.74	5.6 (4)	41.9 (7)	12.1 (8)	0.1 (4)	17.4 (6)	2.6 (5)	13.4 (7)	0.6 (3)	0.0 (2)	0.0 (4)	6.3 (2)
WPSD102	Carbon Seam	1.45	68 (1)	12.0 (3)	11 (1)	0.9 (4)	2.1 (5)	0.3 (4)	4 (6)	0.0 (3)	0.0 (2)	0.0 (5)	2.0 (2)
WPSD101	Mudstone	1.74	10.3 (4)	38.8 (6)	11.0 (6)	0.1 (5)	13.2 (5)	7.0 (6)	13.2 (6)	0.6 (3)	0.0 (2)	0.3 (4)	5.4 (2)
WPSD098	Phosphorite	1.76	25.6 (8)	34.3 (8)	13 (1)	0.3 (6)	9 (1)	0.9 (5)	11 (1)	0.1 (4)	0.0 (2)	0.0 (6)	6.3 (3)
WPSD093	Siltstone	1.46	20.8 (6)	36 (9)	15.6 (1)	0.1 (8)	3.7 (6)	2.2 (7)	13.1 (9)	0.0 (3)	0.0 (2)	1.0 (5)	7.2 (3)
WPSD087	Dolostone	1.48	1.5 (3)	5.7 (2)	0.1 (7)	0.1 (4)	4.4 (5)	2 (6)	13.0 (7)	71 (1)	0.5 (2)	0.0 (4)	1.6 (2)
WPSD084	Dolostone	1.33	0.0 (3)	7.9 (2)	0.1 (7)	0.1 (6)	0.3 (4)	0.1 (5)	10.1 (9)	73 (1)	6.9 (5)	0.2 (4)	1.4(1)
WPSD080	Mudstone	1.97	6.0 (6)	25.9 (7)	8 (1)	0 (1)	0.7 (2)	5 (7)	41 (1)	5.8 (3)	0.3 (2)	1.5 (6)	5.4 (3)
WPSD075	Siltstone	1.89	13.3 (8)	42 (1)	16 (1)	5 (1)	15.7 (8)	2.9 (3)	0.1 (3)	4.6 (3)	0.0 (5)	0.2 (6)	0.0 (1)
WPSD071	Siltstone	1.84	0.0 (5)	50.1 (9)	13 (1)	0.1 (8)	29.3 (8)	2.5 (3)	0.0 (2)	3.3 (2)	0.0 (4)	1.1 (6)	0.4(1)
WPSD067	Siltstone	1.73	20.9 (6)	24.7 (6)	17 (1)	1.5 (8)	1.6 (1)	2.0 (3)	16 (1)	2.7 (4)	5.9 (3)	0.0 (5)	7.1 (3)

Table 2b. Quantitative mineralogy for each D-bench sample calculated using the Rietveld method. The χ^2 value is a numerical statement of the quality of the match between the collected XRD pattern and the calculated Rietveld pattern where any value less than 3 is considered acceptable, with smaller χ^2 values inferring better results. Percents are listed with an accepted error in the last decimal place given in parentheses.

Sample #	Lithology	χ^2	apatite	quartz	muscovite	illite	albite	orthoclase	buddingtonite	dolomite	calcite	kaolin	pyrite
WPSD062	Dolostone	1.37	0.0 (3)	2.2 (1)	0.4 (4)	0.1 (4)	0.0 (1)	0.2 (2)	1.9 (5)	69.6 (8)	23.0 (5)	0.0 (3)	2.4 (3)
WPSD058	Phosphorite	1.67	32 (1)	23.7 (7)	8 (8)	0.1 (8)	1.4 (1)	2 (1)	20 (1)	2.9 (7)	5.6 (6)	0.4 (5)	4.6 (2)
WPSD055	Dolostone	1.88	0.0 (1)	5.2 (2)	0.3 (2)	1.4 (8)	2.7 (7)	0.4 (9)	2.8 (9)	67 (1)	17.5 (8)	0.2 (6)	1.9 (3)
WPSD052	Siltstone	1.70	20.9 (8)	12.1 (5)	10 (1)	0.3 (8)	13 (1)	1.7 (8)	8 (2)	10.6 (9)	17.4 (8)	0.0 (5)	5.7 (3)
WPSD049	Phosphorite	1.58	28.4 (7)	14.4 (4)	15.1 (8)	0.6 (8)	1.1 (2)	0.4 (4)	17 (1)	3.3 (4)	10.9 (7)	1.8 (6)	7.0 (3)
WPSD046	Phosphorite	1.75	27.8 (8)	16.3 (4)	17 (1)	0.1 (9)	2.1 (2)	0.1 (3)	11 (1)	6.8 (9)	12.6 (7)	0.0 (6)	5.9 (3)
WPSD043	Phosphorite	1.93	24 (1)	27 (1)	39 (2)	3 (2)	0.3 (1)	0.1 (4)	0 (1)	1.5 (4)	0.6 (6)	0.0 (9)	0.4 (2)
WPSD041	Phosphorite	1.54	81 (1)	8.8 (3)	3.0 (6)	0.1 (9)	0.4 (6)	1.0 (3)	0.1 (8)	5.8 (4)	0.0 (5)	0.0 (6)	0.1 (1)
WPSD039	Dolostone	1.49	10.9 (4)	8.4 (2)	0.3 (1)	0.1 (6)	2.0 (6)	1.9 (7)	2.5 (7)	66.2 (1)	7.5 (2)	0.0 (4)	0.0 (2)
WPSD036	Phosphorite	1.78	30 (1)	34 (1)	4.1 (3)	3 (1)	5 (1)	18 (1)	3 (2)	2.3 (4)	0.4 (1)	0.0 (7)	1.0 (3)
WPSD033	Dolostone	1.49	7.8 (4)	5.2 (2)	0.3 (3)	0.6 (6)	0.4 (1)	1.5 (2)	1.7 (6)	72 (1)	9.5 (5)	0.0 (5)	0.6(2)
WPSD031	Dolostone	1.58	1.0 (4)	6.5 (2)	0.4 (1)	0.2 (5)	9.1 (5)	1.1 (4)	0.0 (6)	69 (1)	11.3 (6)	0.0 (4)	0.8 (2)
WPSD030	Phosphorite	1.57	68 (2)	11.5 (4)	8 (2)	0.1(9)	0.6 (6)	1.6 (7)	1.3 (7)	8.0 (8)	0.3 (3)	0.1 (5)	0.1 (2)
WPSD027	Phosphorite	1.55	69 (1)	18.7 (4)	8 (1)	0.1 (9)	0.4 (5)	0.9 (2)	0.1 (7)	0.3 (2)	0.3 (4)	0.0 (5)	0.2 (1)
WPSD025	Limestone	1.48	0.8 (4)	17.5 (3)	0.1 (0)	0.1 (5)	10.7 (9)	1.7 (4)	0.4 (1)	4.3 (2)	63 (1)	1.8 (7)	0.0 (2)
WPSD023	Phosphorite	1.39	68 (1)	12.7 (3)	3.6 (4)	0.3 (7)	0.1 (1)	0.1 (2)	0.8 (6)	11.0 (7)	1.6 (3)	0.0 (5)	1.5 (4)
WPSD020	Dolostone	1.64	37.8 (8)	16.7 (3)	7.4 (6)	0.1 (8)	5.9 (6)	1.5 (2)	0.0 (6)	29.2 (5)	0.0 (4)	1.1 (6)	0.3 (1)
WPSD018	Dolostone	1.5	29.7 (9)	9.9 (3)	6 (1)	0 (1)	0.2 (7)	0.5 (3)	0.1 (8)	49.8 (1)	0.0 (4)	0.1 (6)	4.2 (6)
WPSD016	Phosphorite	1.48	37.8 (6)	10.1 (2)	0.5 (1)	0.3 (4)	0.1 (3)	0.4 (3)	0.0 (5)	50.4 (7)	0.2 (3)	0.0 (4)	0.0 (4)
WPSD014	Phosphorite	1.5	86 (1)	8.1 (3)	1.5 (2)	1.3 (5)	0.1 (4)	0.2 (5)	0.1 (8)	0.3 (4)	2.5 (5)	0.0 (6)	0.0 (5)
WPSD009	Mudstone	1.74	34 (1)	47 (2)	6 (2)	3 (1)	0.1 (7)	5.4 (9)	0.1 (4)	0.0 (5)	0.1 (7)	2.3 (8)	2.9 (4)
WPSD006	Dolostone	2.16	0.9 (4)	36.8 (7)	7.8 (7)	0.1 (7)	4.4 (2)	2.0 (7)	0.0 (6)	46.2 (9)	1.7 (2)	0.0 (5)	0.0 (2)
WPSD000.5	Phosphorite	1.92	77 (1)	7.8 (3)	0.1 (4)	0.1 (7)	0.2 (7)	11.5 (7)	1.2 (8)	0.0 (6)	1.3 (6)	0.0 (8)	0.2 (6)
WPSD000	Dolostone	1.58	4 (1)	4.5 (4)	0.4 (4)	0.1 (7)	0.0 (7)	1 (1)	0.4 (8)	89 (2)	0.0 (4)	0.3 (8)	0.2 (6)

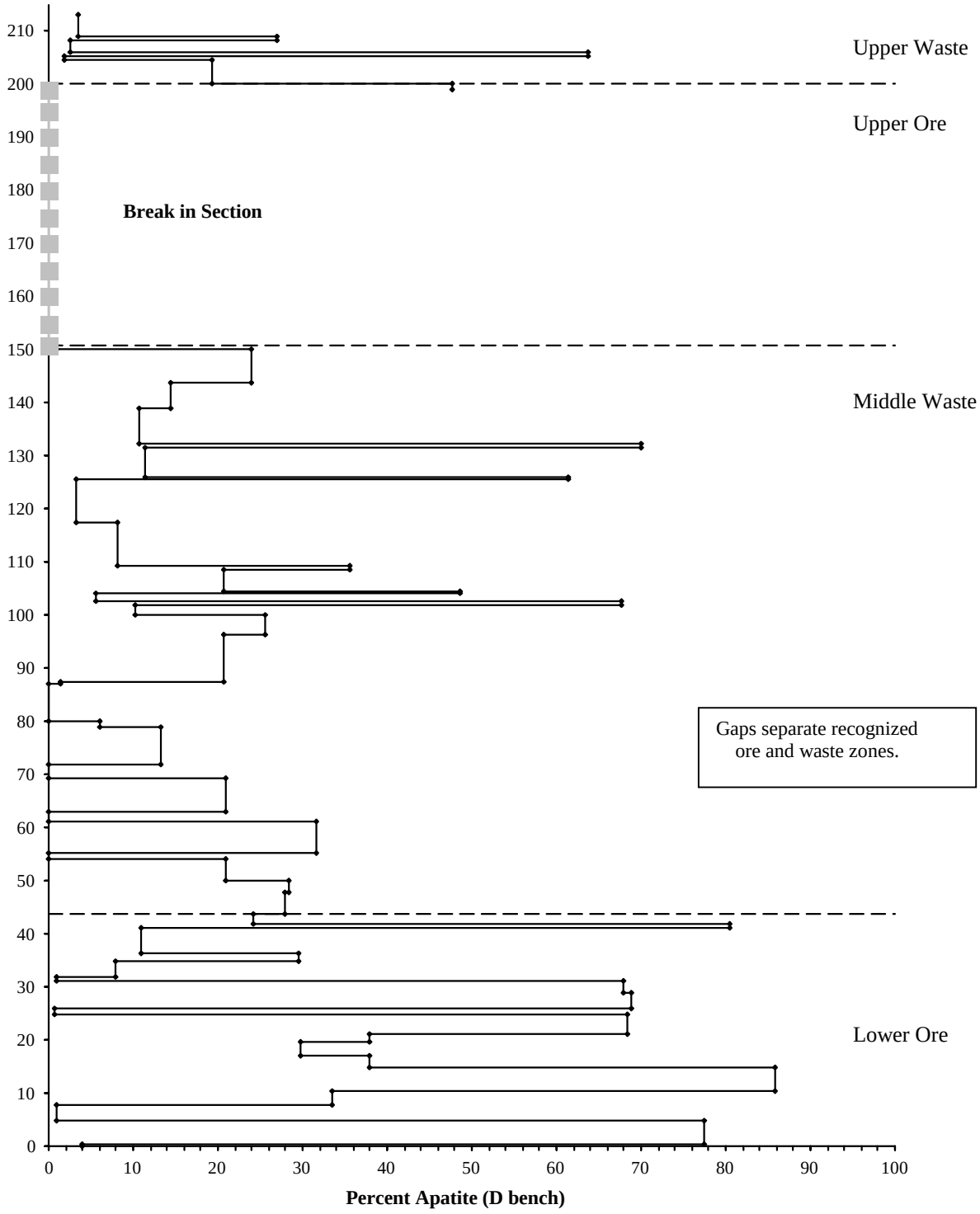

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D. Abundance of major mineral phases including; apatite, quartz, muscovite and illite, total feldspars (including albite, orthoclase, and buddingtonite), buddingtonite, and dolomite are shown.

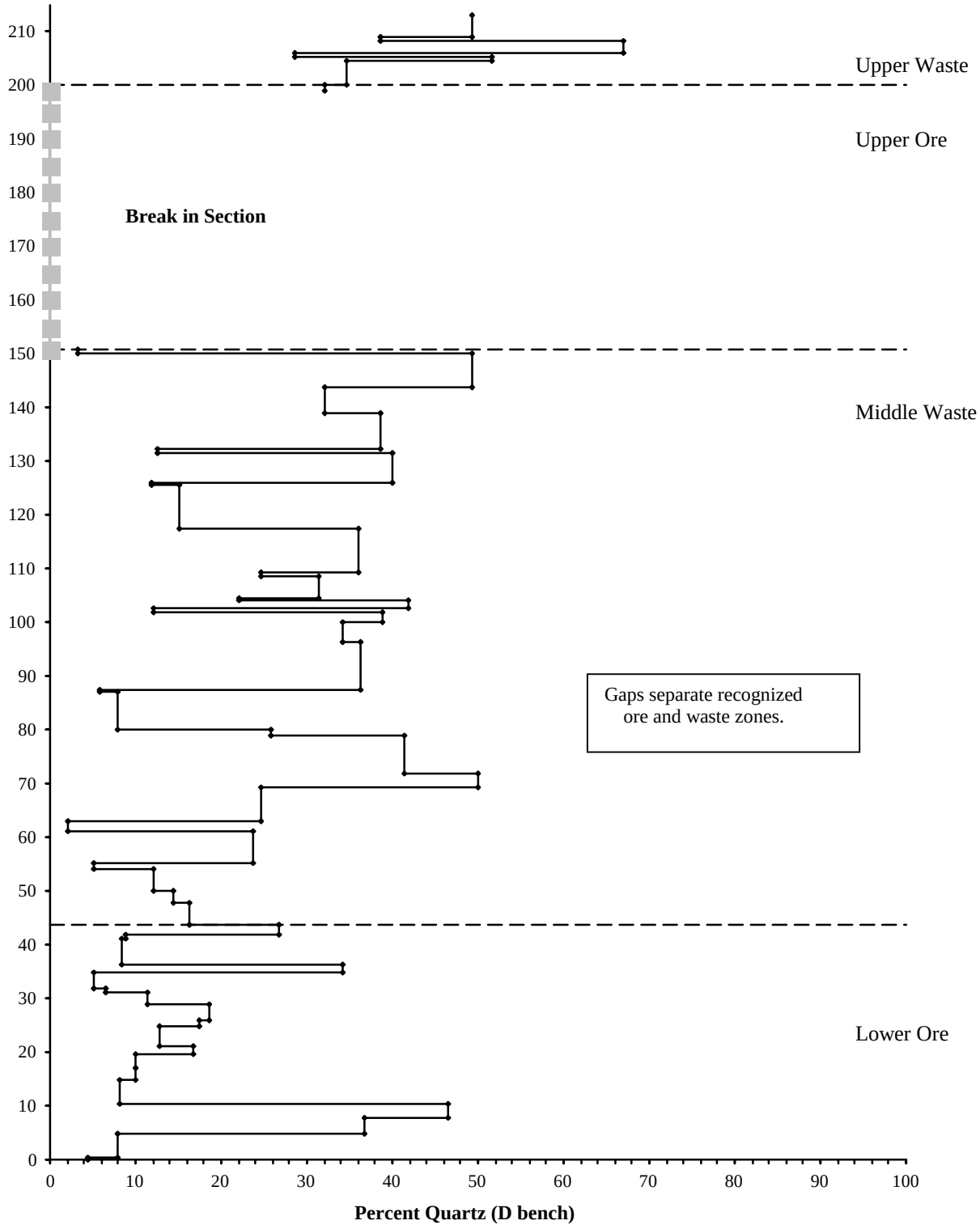

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D - continued.

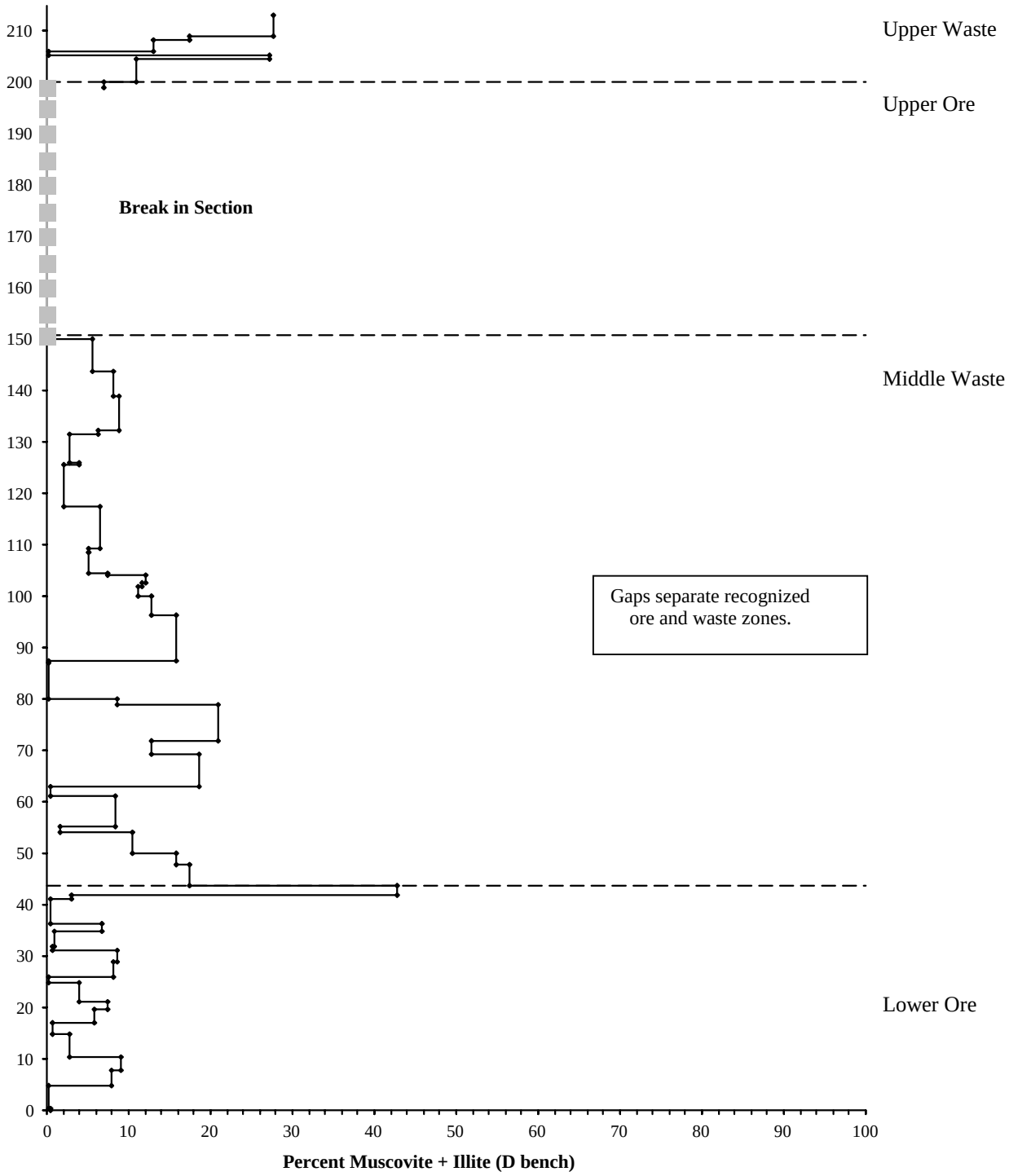

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D - continued.

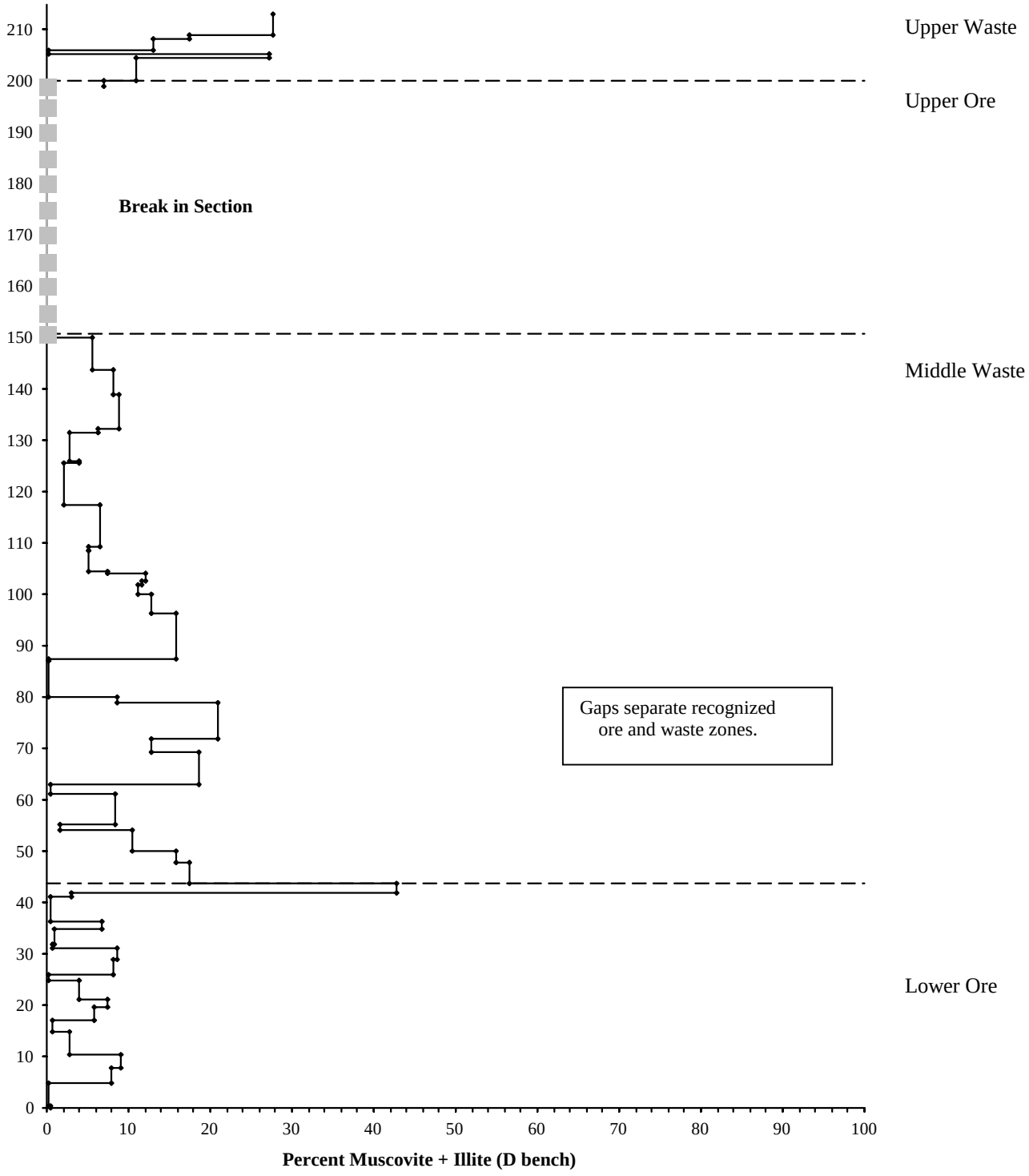

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D - continued.

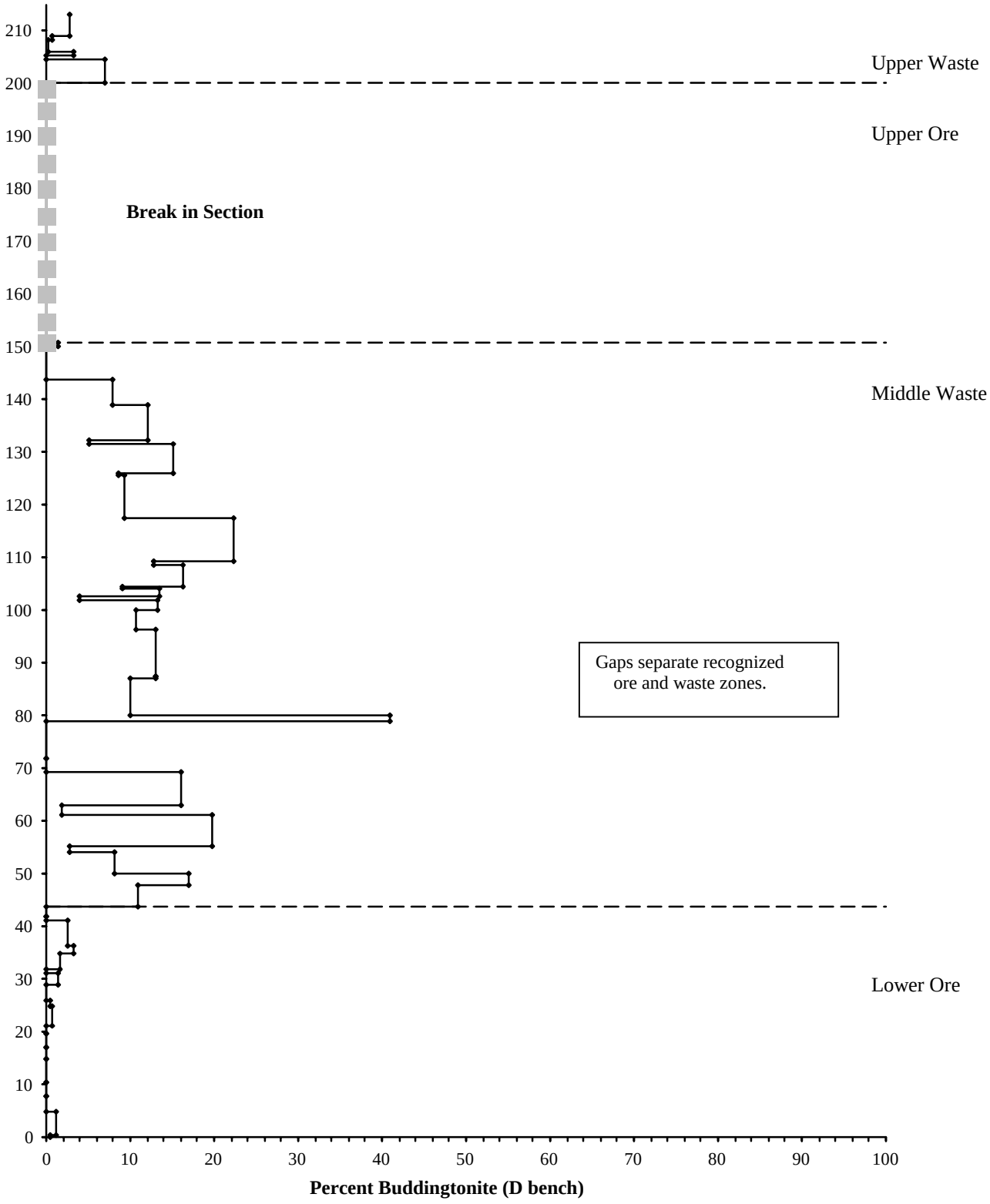

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D - continued.

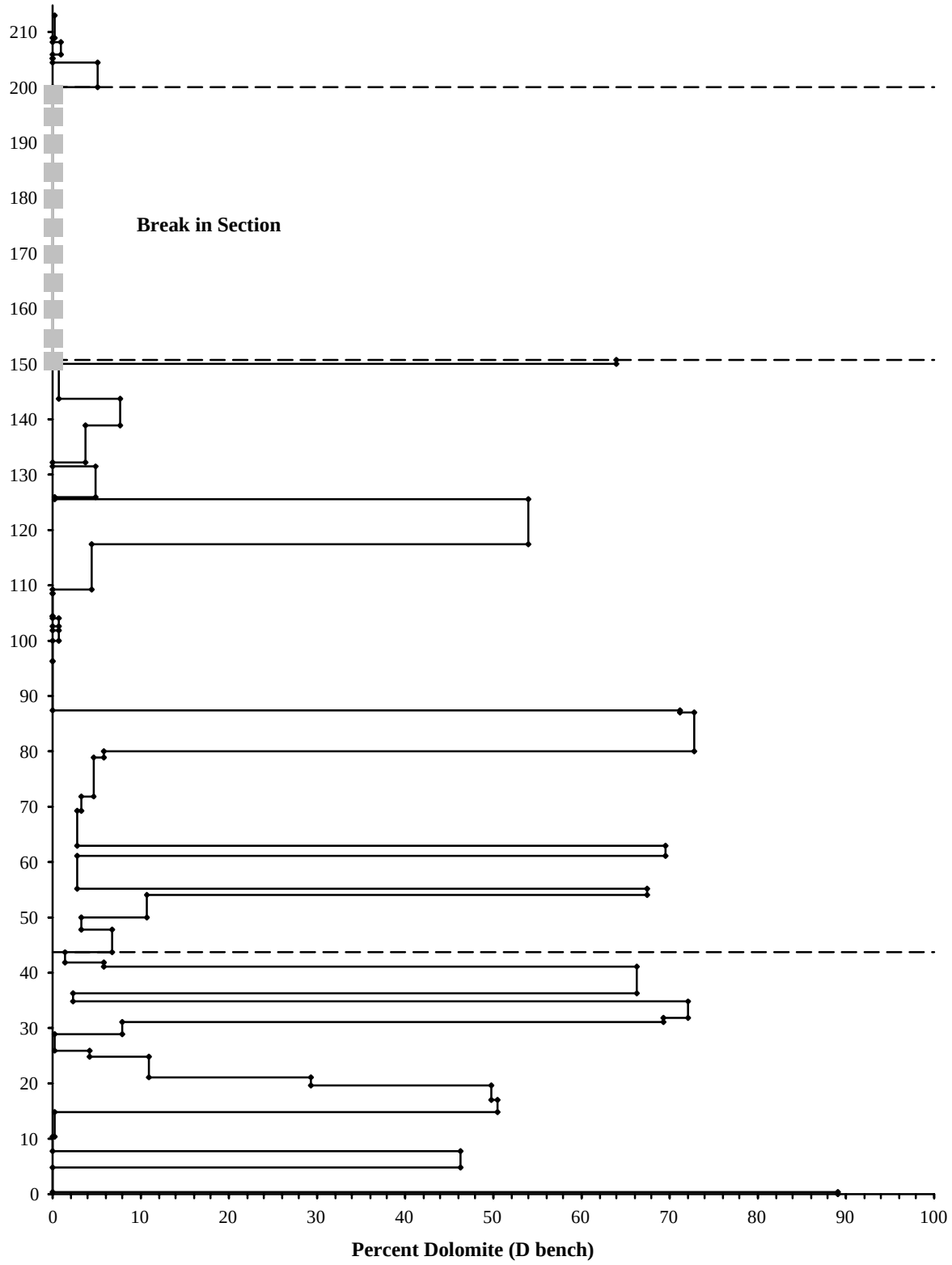

Figure 5b. Mineral composition of each sample over the measured stratigraphic section D - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C.

Ca (C bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	2.97	3.51	2.86	0.64	18	4
WPSC159	Phosphorite	24.00	25.02	22.92	2.10	8	12
WPSC155	Mudstone	2.44	2.57	2.60	-0.03	-1	0
WPSC150	Mudstone	2.14	2.35	1.47	0.88	38	5
WPSC146	Chert	4.35	4.67	4.01	0.66	14	4
WPSC144	Mudstone	6.37	6.55	5.23	1.32	20	8
WPSC138	Phosphorite	33.70	34.07	33.11	0.97	3	6
WPSC137	Mudstone	23.30	25.49	25.66	-0.18	-1	1
WPSC135	Phosphorite	24.70	28.80	29.36	-0.56	-2	3
WPSC133	Phosphorite	15.45	17.42	16.45	0.97	6	6
WPSC122	Mudstone	4.99	6.17	6.05	0.12	2	1
WPSC116	Phosphorite	22.00	25.79	25.10	0.69	3	4
WPSC112	Mudstone	7.37	8.22	4.74	3.48	42	21
WPSC108	Mudstone	10.40	12.47	10.77	1.70	14	10
WPSC104	Mudstone	4.99	5.85	7.55	-1.70	-29	10
WPSC096	Mudstone	6.30	6.83	6.12	0.70	10	4
WPSC091	Mudstone	8.19	8.84	6.90	1.94	22	12
WPSC090	Mudstone	8.26	8.94	9.04	-0.10	-1	1
WPSC080	Mudstone	10.80	12.29	12.76	-0.47	-4	3
WPSC075	Mudstone	3.16	3.65	4.17	-0.51	-14	3
WPSC070	Mudstone	7.35	11.59	9.12	2.47	21	15
WPSC063	Phosphorite	22.95	25.13	25.75	-0.62	-2	4
WPSC060	Mudstone	3.30	4.02	2.86	1.16	29	7
WPSC056	Carbon seam	2.46	3.09	1.21	1.88	61	11
WPSC055	Phosphorite	26.20	29.74	30.48	-0.75	-3	4
WPSC050	Mudstone	14.60	16.20	17.05	-0.85	-5	5
WPSC045	Phosphorite	25.70	27.84	28.25	-0.41	-1	2
WPSC043	Mudstone	13.10	14.06	12.21	1.85	13	11
WPSC041	Phosphorite	27.70	28.63	30.40	-1.77	-6	11
WPSC039	Phosphorite	33.00	32.35	32.11	0.25	1	1
WPSC035	Phosphorite	18.50	20.85	20.15	0.70	3	4
WPSC032	Phosphorite	31.90	34.86	37.20	-2.34	-7	14
WPSC031	Phosphorite	26.90	27.79	26.98	0.81	3	5
WPSC028	Phosphorite	30.40	33.24	32.82	0.42	1	2
WPSC020	Phosphorite	24.50	26.81	24.99	1.82	7	11
WPSC015	Phosphorite	33.25	33.68	33.30	0.38	1	2
WPSC011	Mudstone	2.43	2.45	2.08	0.37	15	2

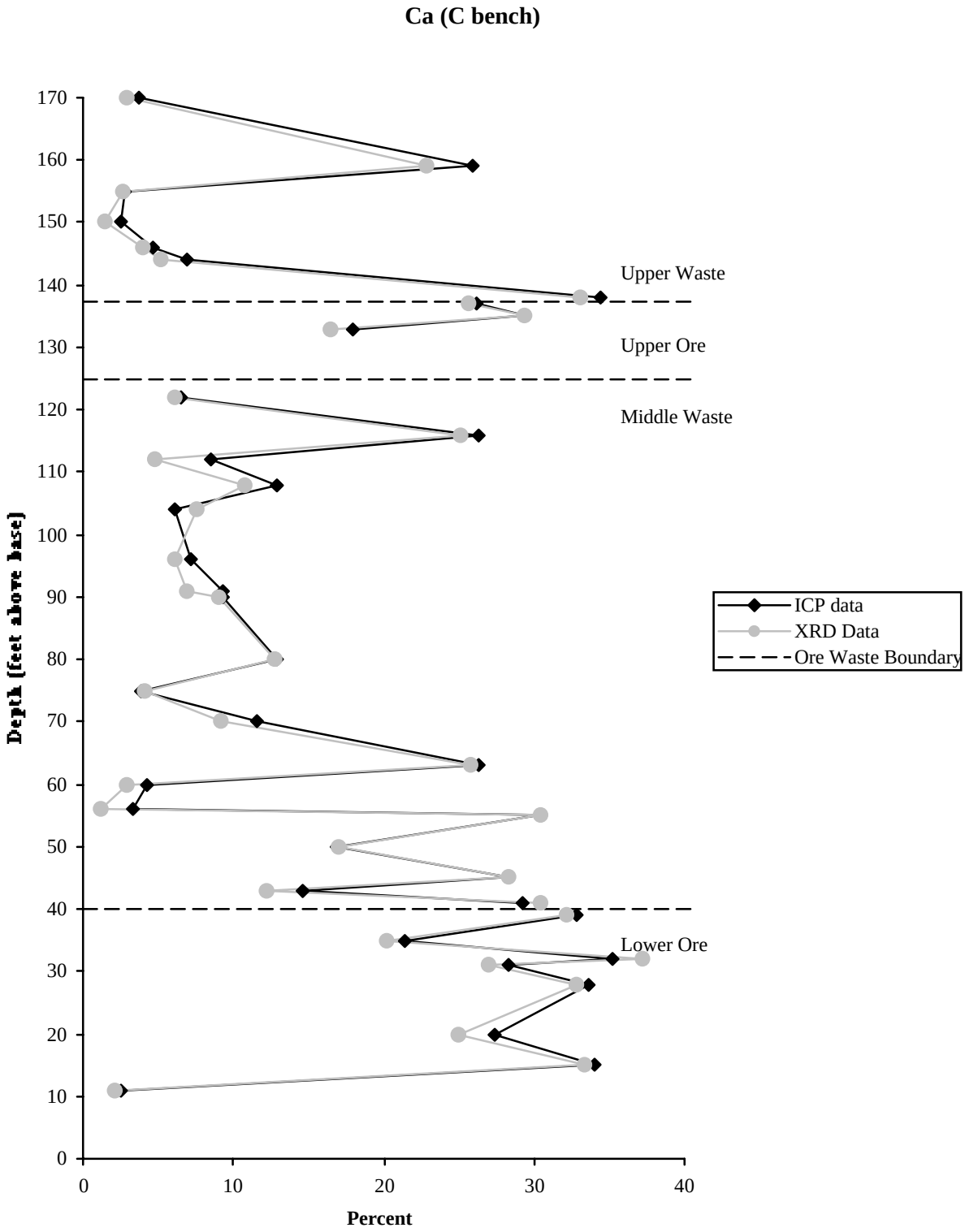

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

		P (C bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	2.97	3.51	2.86	0.64	18	4
WPSC159	Phosphorite	24.00	25.02	22.92	2.10	8	12
WPSC155	Mudstone	2.44	2.57	2.60	-0.03	-1	0
WPSC150	Mudstone	2.14	2.35	1.47	0.88	38	5
WPSC146	Chert	4.35	4.67	4.01	0.66	14	4
WPSC144	Mudstone	6.37	6.55	5.23	1.32	20	8
WPSC138	Phosphorite	33.70	34.07	33.11	0.97	3	6
WPSC137	Mudstone	23.30	25.49	25.66	-0.18	-1	1
WPSC135	Phosphorite	24.70	28.80	29.36	-0.56	-2	3
WPSC133	Phosphorite	15.45	17.42	16.45	0.97	6	6
WPSC122	Mudstone	4.99	6.17	6.05	0.12	2	1
WPSC116	Phosphorite	22.00	25.79	25.10	0.69	3	4
WPSC112	Mudstone	7.37	8.22	4.74	3.48	42	21
WPSC108	Mudstone	10.40	12.47	10.77	1.70	14	10
WPSC104	Mudstone	4.99	5.85	7.55	-1.70	-29	10
WPSC096	Mudstone	6.30	6.83	6.12	0.70	10	4
WPSC091	Mudstone	8.19	8.84	6.90	1.94	22	12
WPSC090	Mudstone	8.26	8.94	9.04	-0.10	-1	1
WPSC080	Mudstone	10.80	12.29	12.76	-0.47	-4	3
WPSC075	Mudstone	3.16	3.65	4.17	-0.51	-14	3
WPSC070	Mudstone	3.59	5.66	4.01	1.65	29	22%
WPSC063	Phosphorite	22.95	25.13	25.75	-0.62	-2	4
WPSC060	Mudstone	3.30	4.02	2.86	1.16	29	7
WPSC056	Carbon seam	2.46	3.09	1.21	1.88	61	11
WPSC055	Phosphorite	26.20	29.74	30.48	-0.75	-3	4
WPSC050	Mudstone	14.60	16.20	17.05	-0.85	-5	5
WPSC045	Phosphorite	25.70	27.84	28.25	-0.41	-1	2
WPSC043	Mudstone	13.10	14.06	12.21	1.85	13	11
WPSC041	Phosphorite	27.70	28.63	30.40	-1.77	-6	11
WPSC039	Phosphorite	33.00	32.35	32.11	0.25	1	1
WPSC035	Phosphorite	18.50	20.85	20.15	0.70	3	4
WPSC032	Phosphorite	31.90	34.86	37.20	-2.34	-7	14
WPSC031	Phosphorite	26.90	27.79	26.98	0.81	3	5
WPSC028	Phosphorite	30.40	33.24	32.82	0.42	1	2
WPSC020	Phosphorite	24.50	26.81	24.99	1.82	7	11
WPSC015	Phosphorite	33.25	33.68	33.30	0.38	1	2
WPSC011	Mudstone	2.43	2.45	2.08	0.37	15	2

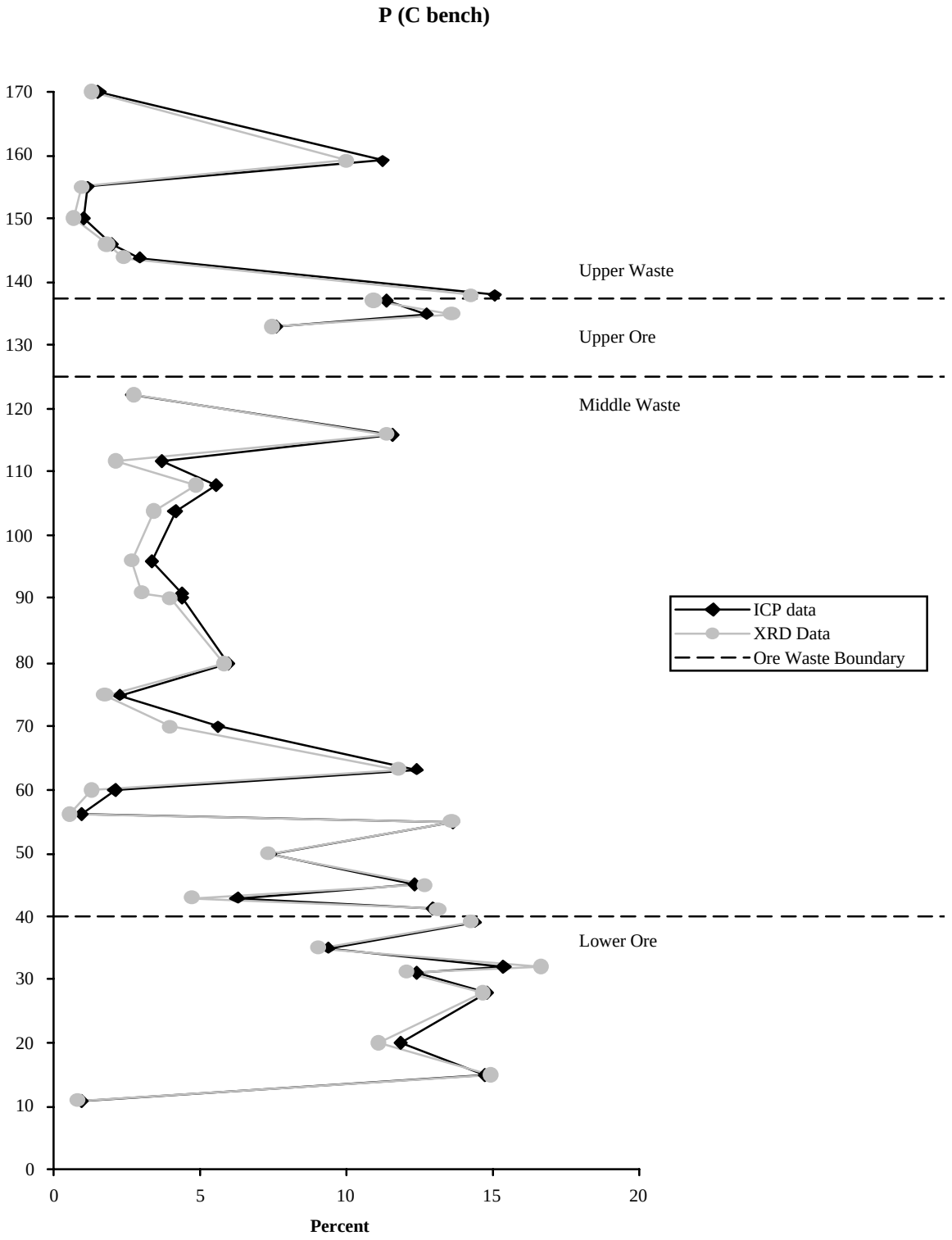

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

		Si (C bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	29.60	34.94	37.27	-2.33	-7	11
WPSC159	Phosphorite	12.40	12.93	15.99	-3.06	-24	15
WPSC155	Mudstone	30.40	32.01	36.10	-4.10	-13	20
WPSC150	Mudstone	30.75	33.92	38.58	-4.66	-14	23
WPSC146	Chert	38.00	40.82	40.74	0.09	0	0
WPSC144	Mudstone	28.50	29.30	32.16	-2.86	-10	14
WPSC138	Phosphorite	4.36	4.41	5.23	-0.82	-19	4
WPSC137	Mudstone	11.10	12.14	12.74	-0.60	-5	3
WPSC135	Phosphorite	8.27	9.64	9.05	0.59	6	3
WPSC133	Phosphorite	17.85	20.13	21.56	-1.43	-7	7
WPSC122	Mudstone	24.10	29.79	31.27	-1.48	-5	7
WPSC116	Phosphorite	10.80	12.66	14.46	-1.80	-14	9
WPSC112	Mudstone	25.70	28.67	34.98	-6.32	-22	31
WPSC108	Mudstone	21.10	25.31	29.79	-4.48	-18	22
WPSC104	Mudstone	24.80	29.08	32.95	-3.87	-13	19
WPSC096	Mudstone	27.30	29.58	32.89	-3.31	-11	16
WPSC091	Mudstone	25.10	27.10	31.45	-4.35	-16	21
WPSC090	Mudstone	25.10	27.17	29.72	-2.55	-9	12
WPSC080	Mudstone	21.20	24.12	25.22	-1.09	-5	5
WPSC075	Mudstone	27.60	31.91	32.36	-0.45	-1	2
WPSC070	Mudstone	21.30	33.59	27.33	6.26	19%	30
WPSC063	Phosphorite	10.40	11.39	12.34	-0.95	-8	5
WPSC060	Mudstone	24.60	29.95	31.86	-1.90	-6	9
WPSC056	Carbon seam	23.30	29.28	33.58	-4.30	-15	21
WPSC055	Phosphorite	6.86	7.79	8.35	-0.56	-7	3
WPSC050	Mudstone	17.95	19.92	21.63	-1.71	-9	8
WPSC045	Phosphorite	9.49	10.28	11.05	-0.77	-7	4
WPSC043	Mudstone	20.40	21.90	28.06	-6.16	-28	30
WPSC041	Phosphorite	9.24	9.55	9.89	-0.34	-4	2
WPSC039	Phosphorite	6.61	6.48	7.57	-1.09	-17	5
WPSC035	Phosphorite	14.30	16.12	19.21	-3.09	-19	15
WPSC032	Phosphorite	4.02	4.39	2.71	1.68	38	8
WPSC031	Phosphorite	9.42	9.73	13.24	-3.50	-36	17
WPSC028	Phosphorite	5.10	5.58	6.29	-0.71	-13	3
WPSC020	Phosphorite	9.42	10.31	14.16	-3.85	-37	19
WPSC015	Phosphorite	4.54	4.59	5.56	-0.97	-21	5
WPSC011	Mudstone	32.30	32.54	38.52	-5.98	-18	29

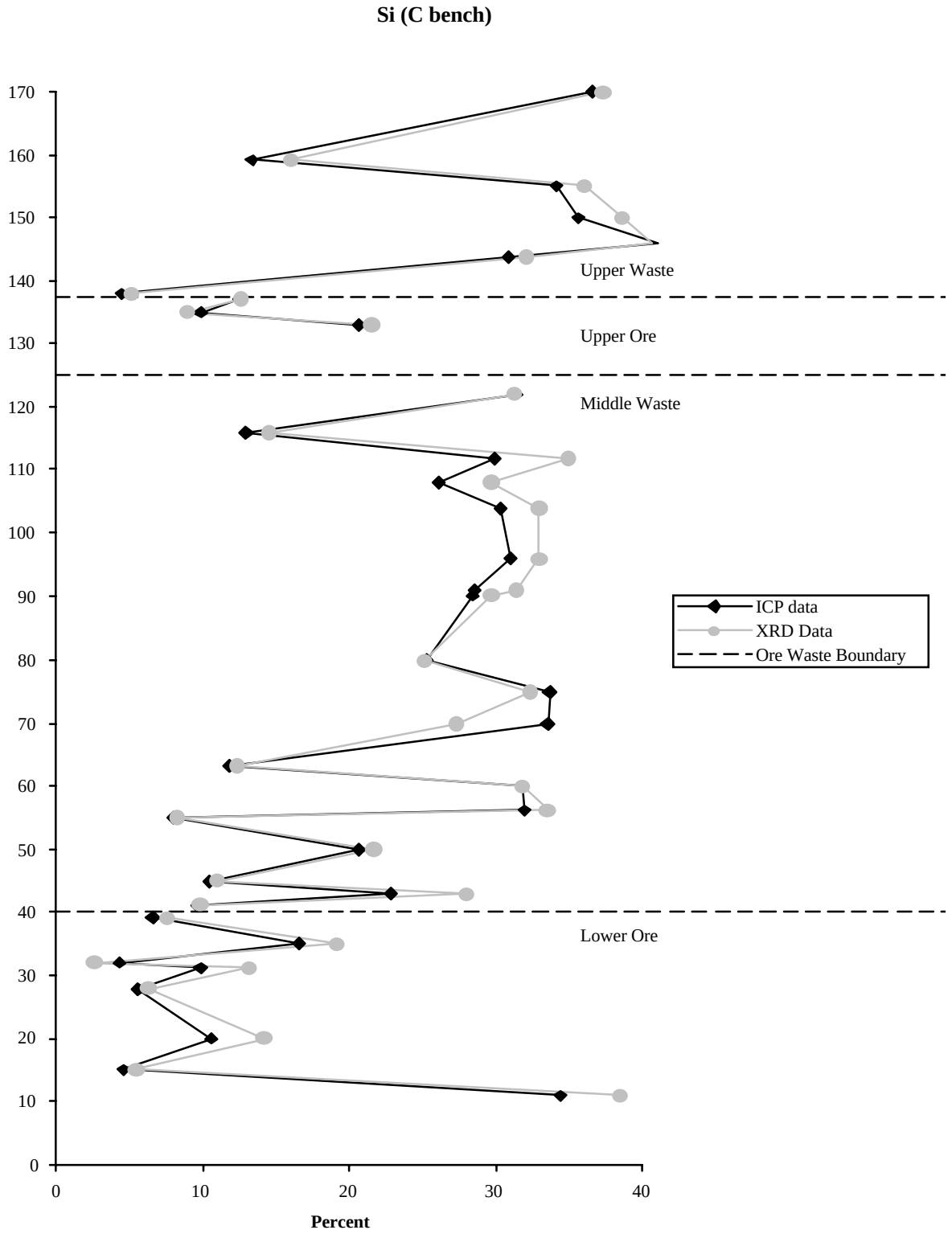

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

		K (C bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	1.51	1.78	2.29	-0.51	-28	36
WPSC159	Phosphorite	0.65	0.68	0.79	-0.11	-17	8
WPSC155	Mudstone	2.17	2.28	2.19	0.10	4	7
WPSC150	Mudstone	1.95	2.15	1.98	0.16	8	12
WPSC146	Chert	0.06	0.06	0.55	-0.49	-760	35
WPSC144	Mudstone	1.98	2.04	3.43	-1.40	-69	98
WPSC138	Phosphorite	0.33	0.33	0.51	-0.18	-54	13
WPSC137	Mudstone	0.94	1.03	1.36	-0.34	-33	24
WPSC135	Phosphorite	0.76	0.89	1.26	-0.37	-42	26
WPSC133	Phosphorite	1.54	1.74	3.06	-1.33	-76	93
WPSC122	Mudstone	1.78	2.20	2.37	-0.17	-8	12
WPSC116	Phosphorite	0.60	0.70	0.70	0.00	0	0
WPSC112	Mudstone	1.52	1.70	1.66	0.04	2	3
WPSC108	Mudstone	1.14	1.37	1.15	0.22	16	15
WPSC104	Mudstone	1.27	1.49	1.82	-0.33	-22	23
WPSC096	Mudstone	1.82	1.97	2.06	-0.09	-5	7
WPSC091	Mudstone	1.66	1.79	1.99	-0.19	-11	14
WPSC090	Mudstone	1.78	1.93	1.98	-0.06	-3	4
WPSC080	Mudstone	1.47	1.67	2.25	-0.58	-35	41
WPSC075	Mudstone	2.23	2.57	3.24	-0.67	-26	47
WPSC070	Mudstone	1.50	2.37	1.50	0.87	37	61%
WPSC063	Phosphorite	0.80	0.88	1.54	-0.66	-75	46
WPSC060	Mudstone	1.88	2.29	4.11	-1.82	-80	128
WPSC056	Carbon seam	2.52	3.17	4.47	-1.30	-41	92
WPSC055	Phosphorite	0.73	0.83	0.84	-0.01	-1	1
WPSC050	Mudstone	1.92	2.13	1.81	0.32	15	22
WPSC045	Phosphorite	0.80	0.87	0.77	0.10	11	7
WPSC043	Mudstone	1.68	1.80	1.08	0.72	40	51
WPSC041	Phosphorite	0.84	0.87	0.40	0.47	54	33
WPSC039	Phosphorite	0.57	0.56	0.36	0.20	35	14
WPSC035	Phosphorite	1.20	1.35	1.00	0.36	26	25
WPSC032	Phosphorite	0.33	0.36	0.12	0.24	66	17
WPSC031	Phosphorite	0.91	0.94	0.49	0.46	48	32
WPSC028	Phosphorite	0.40	0.44	0.39	0.05	12	4
WPSC020	Phosphorite	0.78	0.85	0.89	-0.03	-4	2
WPSC015	Phosphorite	0.32	0.32	0.67	-0.35	-110	25
WPSC011	Mudstone	2.15	2.17	1.23	0.94	43	66

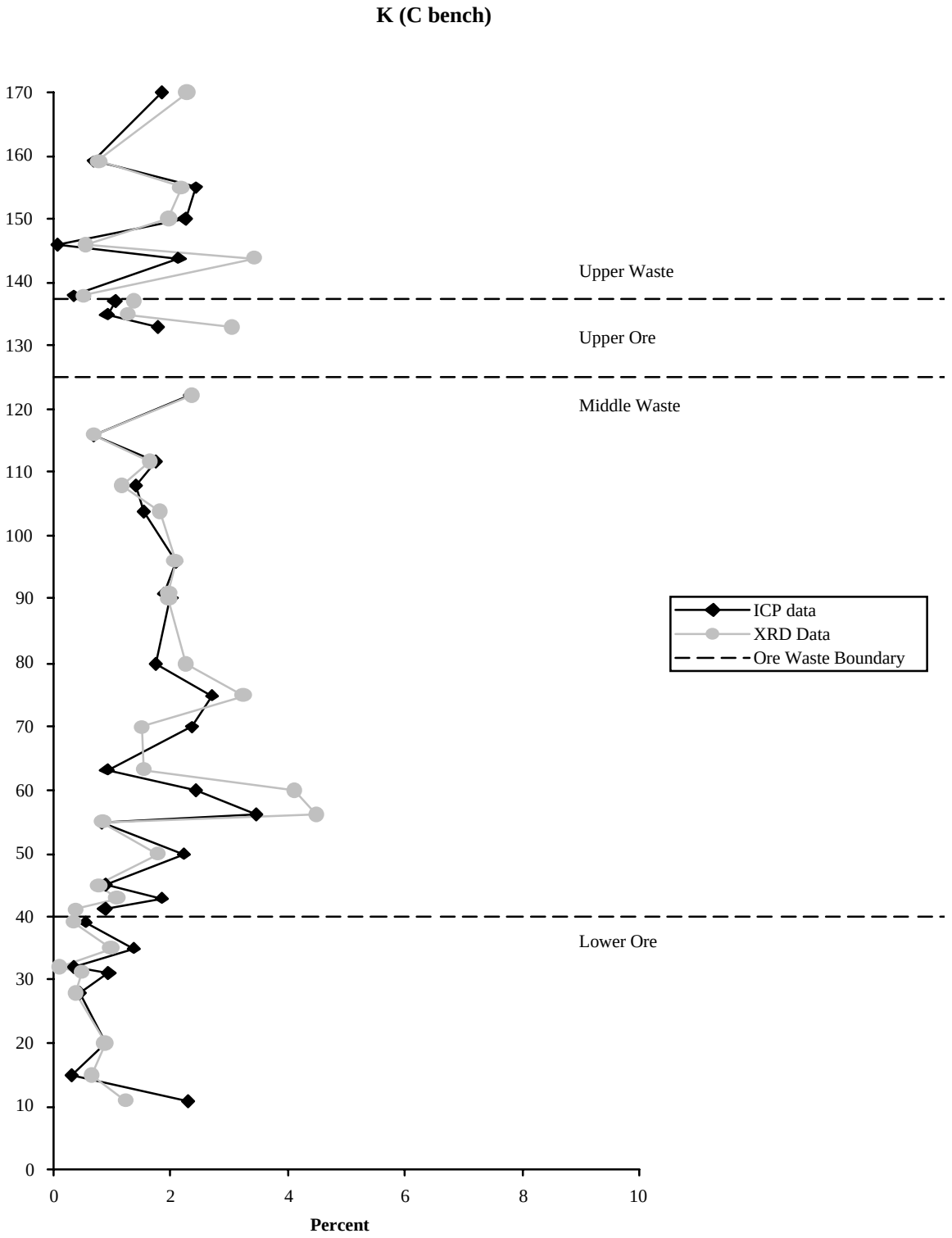

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

		Al (C bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	4.37	5.16	3.69	1.47	28	39
WPSC159	Phosphorite	2.02	2.11	2.15	-0.04	-2	1
WPSC155	Mudstone	6.18	6.51	5.46	1.04	16	27
WPSC150	Mudstone	5.29	5.83	4.44	1.40	24	37
WPSC146	Chert	0.25	0.27	0.90	-0.63	-235	17
WPSC144	Mudstone	5.58	5.74	6.46	-0.72	-13	19
WPSC138	Phosphorite	1.10	1.11	1.53	-0.42	-38	11
WPSC137	Mudstone	2.54	2.78	2.72	0.06	2	2
WPSC135	Phosphorite	2.01	2.34	2.36	-0.02	-1	0
WPSC133	Phosphorite	3.78	4.26	3.84	0.41	10	11
WPSC122	Mudstone	4.47	5.53	6.33	-0.81	-15	21
WPSC116	Phosphorite	1.69	1.98	1.79	0.19	10	5
WPSC112	Mudstone	4.00	4.46	4.28	0.18	4	5
WPSC108	Mudstone	3.06	3.67	3.11	0.56	15	15
WPSC104	Mudstone	6.05	7.09	3.66	3.44	48	91
WPSC096	Mudstone	4.58	4.96	5.22	-0.26	-5	7
WPSC091	Mudstone	4.43	4.78	5.41	-0.62	-13	16
WPSC090	Mudstone	4.55	4.92	4.85	0.08	2	2
WPSC080	Mudstone	4.07	4.63	5.09	-0.46	-10	12
WPSC075	Mudstone	5.25	6.06	7.20	-1.13	-19	30
WPSC070	Mudstone	4.45	7.02	4.56	2.46	35	65
WPSC063	Phosphorite	2.21	2.41	3.19	-0.78	-32	20
WPSC060	Mudstone	6.22	7.57	9.09	-1.52	-20	40
WPSC056	Carbon seam	5.79	7.28	9.21	-1.94	-27	51
WPSC055	Phosphorite	1.61	1.83	1.99	-0.16	-9	4
WPSC050	Mudstone	3.90	4.33	3.86	0.46	11	12
WPSC045	Phosphorite	1.84	1.99	1.88	0.12	6	3
WPSC043	Mudstone	3.82	4.10	3.34	0.76	18	20
WPSC041	Phosphorite	1.93	2.00	0.94	1.06	53	28
WPSC039	Phosphorite	1.26	1.24	0.81	0.42	34	11
WPSC035	Phosphorite	2.69	3.03	3.00	0.03	1	1
WPSC032	Phosphorite	0.93	1.02	0.25	0.76	75	20
WPSC031	Phosphorite	1.93	1.99	1.17	0.82	41	22
WPSC028	Phosphorite	1.13	1.24	0.98	0.26	21	7
WPSC020	Phosphorite	2.01	2.20	2.42	-0.22	-10	6
WPSC015	Phosphorite	1.07	1.08	1.56	-0.48	-44	13
WPSC011	Mudstone	5.85	5.89	4.29	1.60	27	42

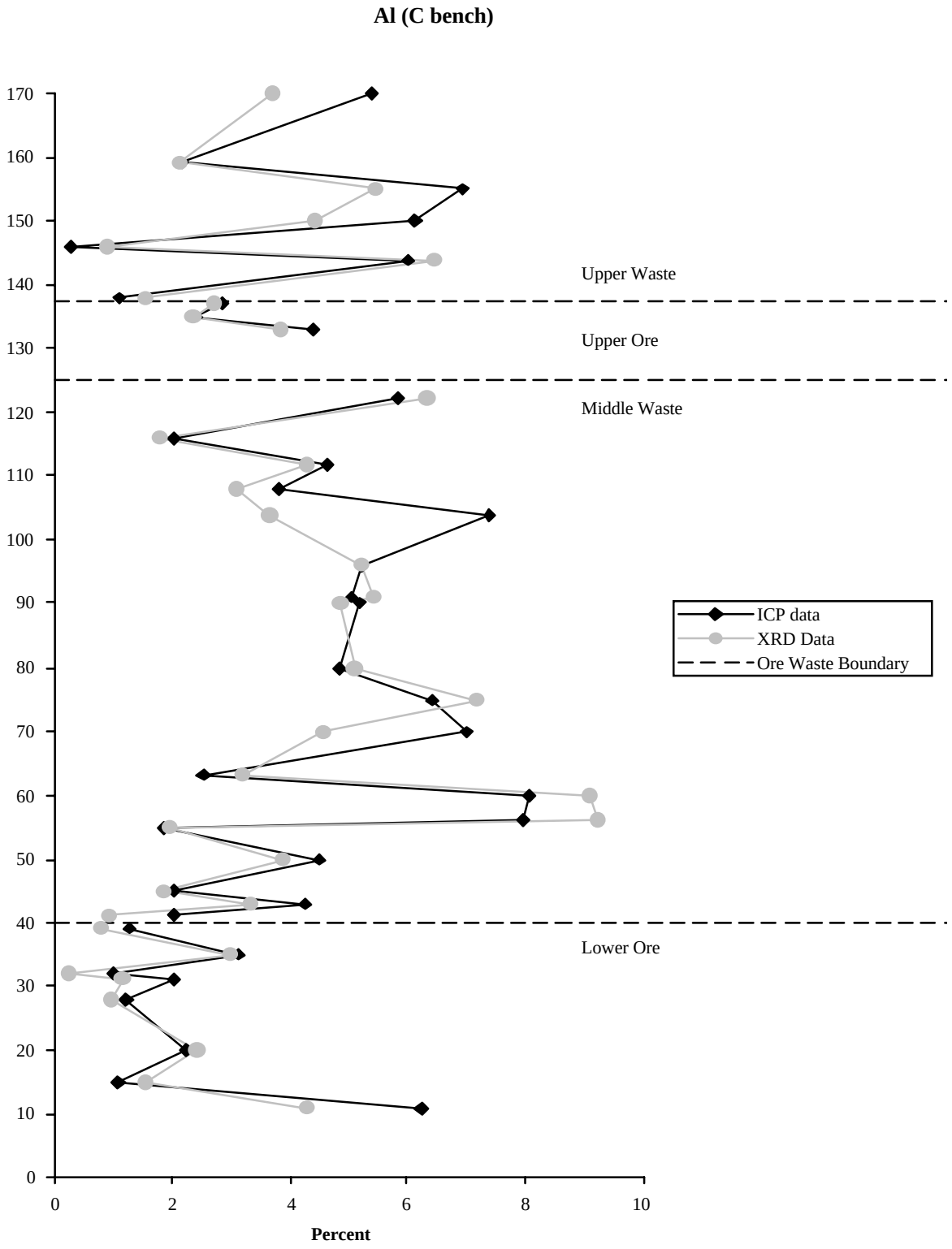

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

Sample #	Lithology	Na (C bench) Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	0.27	0.32	0.54	-0.22	-69	64
WPSC159	Phosphorite	0.16	0.17	0.02	0.15	89	43
WPSC155	Mudstone	0.61	0.64	0.66	-0.02	-2	4
WPSC150	Mudstone	0.58	0.63	0.53	0.10	16	29
WPSC146	Chert	0.05	0.05	0.00	0.05	100	16
WPSC144	Mudstone	0.43	0.44	0.01	0.43	98	125
WPSC138	Phosphorite	0.11	0.11	0.31	-0.20	-179	58
WPSC137	Mudstone	0.13	0.14	0.01	0.13	94	39
WPSC135	Phosphorite	0.12	0.14	0.04	0.10	74	30
WPSC133	Phosphorite	0.22	0.24	0.00	0.24	99	69
WPSC122	Mudstone	0.74	0.91	1.01	-0.09	-10	27
WPSC116	Phosphorite	0.49	0.57	0.30	0.28	48	80
WPSC112	Mudstone	0.87	0.97	0.44	0.53	54	153
WPSC108	Mudstone	0.43	0.52	0.34	0.18	35	52
WPSC104	Mudstone	0.25	0.29	0.59	-0.30	-101	86
WPSC096	Mudstone	0.47	0.51	0.49	0.02	3	5
WPSC091	Mudstone	0.52	0.56	0.77	-0.20	-36	59
WPSC090	Mudstone	0.30	0.32	0.09	0.24	73	68
WPSC080	Mudstone	0.21	0.24	0.16	0.08	34	23
WPSC075	Mudstone	0.26	0.30	0.02	0.28	93	81
WPSC070	Mudstone	0.31	0.49	0.04	0.45	92	130
WPSC063	Phosphorite	0.23	0.25	0.01	0.24	96	69
WPSC060	Mudstone	0.24	0.29	0.03	0.27	91	77
WPSC056	Carbon seam	0.12	0.15	0.09	0.06	41	18
WPSC055	Phosphorite	0.26	0.30	0.06	0.23	80	68
WPSC050	Mudstone	0.22	0.24	0.09	0.15	62	44
WPSC045	Phosphorite	0.20	0.22	0.07	0.15	70	44
WPSC043	Mudstone	0.16	0.17	0.17	0.00	0	0
WPSC041	Phosphorite	0.20	0.21	0.14	0.07	33	20
WPSC039	Phosphorite	0.21	0.21	0.08	0.12	59	35
WPSC035	Phosphorite	0.20	0.23	0.22	0.01	2	1
WPSC032	Phosphorite	0.19	0.21	0.12	0.09	44	27
WPSC031	Phosphorite	0.19	0.20	0.13	0.06	33	19
WPSC028	Phosphorite	0.19	0.21	0.13	0.08	39	24
WPSC020	Phosphorite	0.32	0.35	0.11	0.24	69	70
WPSC015	Phosphorite	0.67	0.67	0.03	0.65	96	188
WPSC011	Mudstone	0.28	0.28	0.01	0.27	97	79

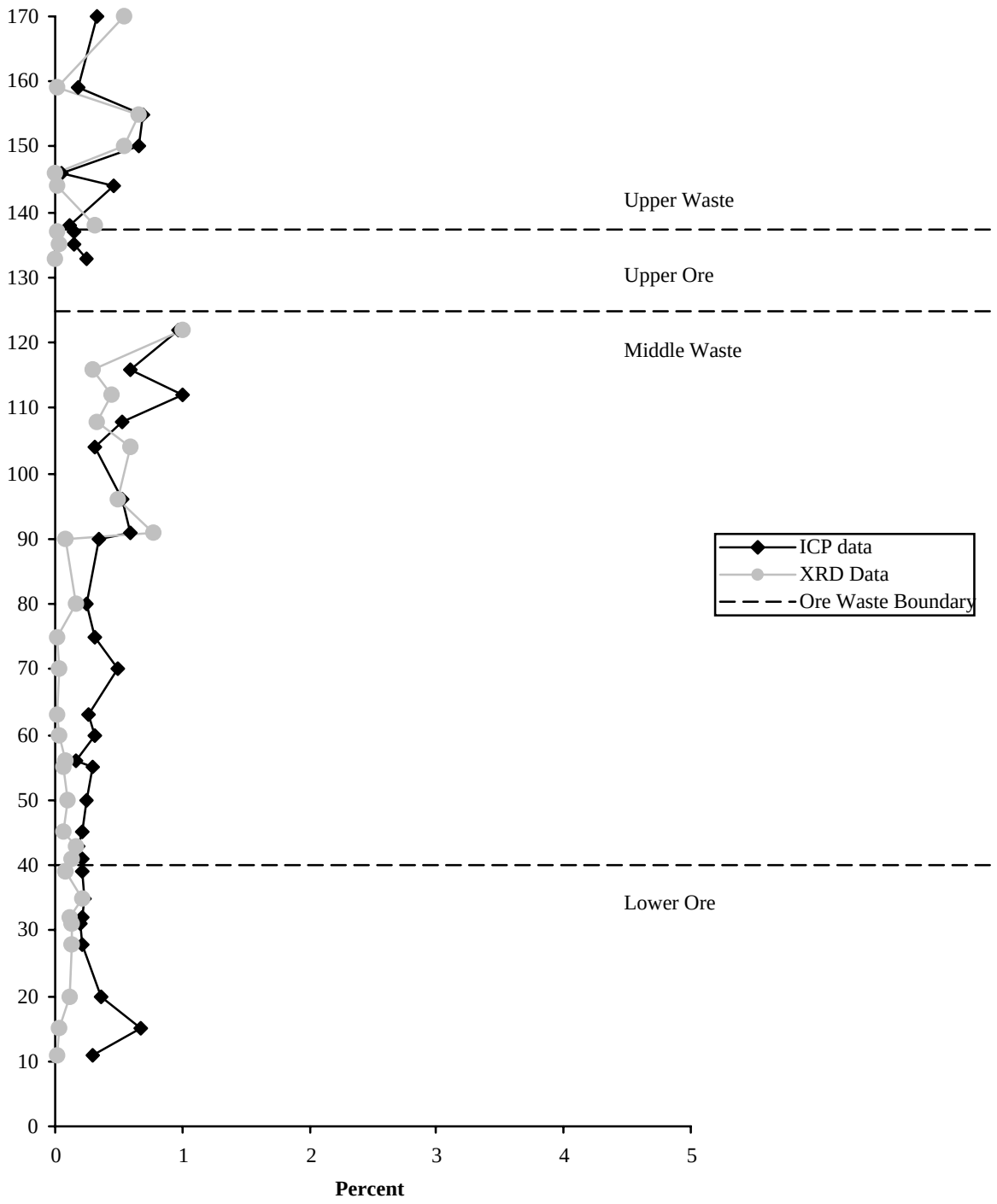

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

		Mg (C bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	0.35	0.41	0.00	0.41	100	169
WPSC159	Phosphorite	0.24	0.25	0.06	0.19	78	80
WPSC155	Mudstone	0.48	0.51	0.22	0.28	56	115
WPSC150	Mudstone	0.38	0.42	0.00	0.42	100	174
WPSC146	Chert	0.02	0.02	0.00	0.02	100	9
WPSC144	Mudstone	0.41	0.42	0.04	0.38	91	157
WPSC138	Phosphorite	0.12	0.12	0.45	-0.33	-274	136
WPSC137	Mudstone	0.27	0.30	0.36	-0.07	-23	28
WPSC135	Phosphorite	0.19	0.22	0.00	0.22	100	91
WPSC133	Phosphorite	0.23	0.26	0.01	0.25	96	102
WPSC122	Mudstone	0.16	0.20	0.08	0.12	59	48
WPSC116	Phosphorite	0.05	0.06	0.06	-0.01	-10	2
WPSC112	Mudstone	0.08	0.09	0.08	0.01	11	4
WPSC108	Mudstone	0.11	0.13	0.01	0.12	93	50
WPSC104	Mudstone	0.12	0.14	0.00	0.14	97	56
WPSC096	Mudstone	0.18	0.19	0.00	0.19	98	78
WPSC091	Mudstone	0.14	0.15	0.04	0.11	71	44
WPSC090	Mudstone	0.19	0.21	0.16	0.04	21	17
WPSC080	Mudstone	0.25	0.28	0.01	0.28	97	114
WPSC075	Mudstone	0.16	0.19	0.24	-0.05	-25	19
WPSC070	Mudstone	0.20	0.32	0.14	0.17	55	71
WPSC063	Phosphorite	0.10	0.11	0.02	0.09	84	38
WPSC060	Mudstone	0.21	0.26	0.00	0.26	100	105
WPSC056	Carbon seam	0.85	1.07	0.01	1.05	99	433
WPSC055	Phosphorite	0.12	0.14	0.03	0.10	76	42
WPSC050	Mudstone	0.21	0.24	0.02	0.22	91	89
WPSC045	Phosphorite	0.17	0.18	0.04	0.15	79	60
WPSC043	Mudstone	0.22	0.24	0.01	0.23	98	95
WPSC041	Phosphorite	0.16	0.17	0.06	0.11	66	45
WPSC039	Phosphorite	0.14	0.14	0.06	0.08	58	33
WPSC035	Phosphorite	0.21	0.24	0.03	0.21	87	84
WPSC032	Phosphorite	0.11	0.12	0.05	0.07	55	27
WPSC031	Phosphorite	0.22	0.23	0.04	0.18	81	75
WPSC028	Phosphorite	0.14	0.15	0.05	0.10	67	42
WPSC020	Phosphorite	0.21	0.23	0.05	0.18	79	75
WPSC015	Phosphorite	0.16	0.16	0.04	0.12	73	48
WPSC011	Mudstone	0.46	0.46	0.09	0.38	81	155

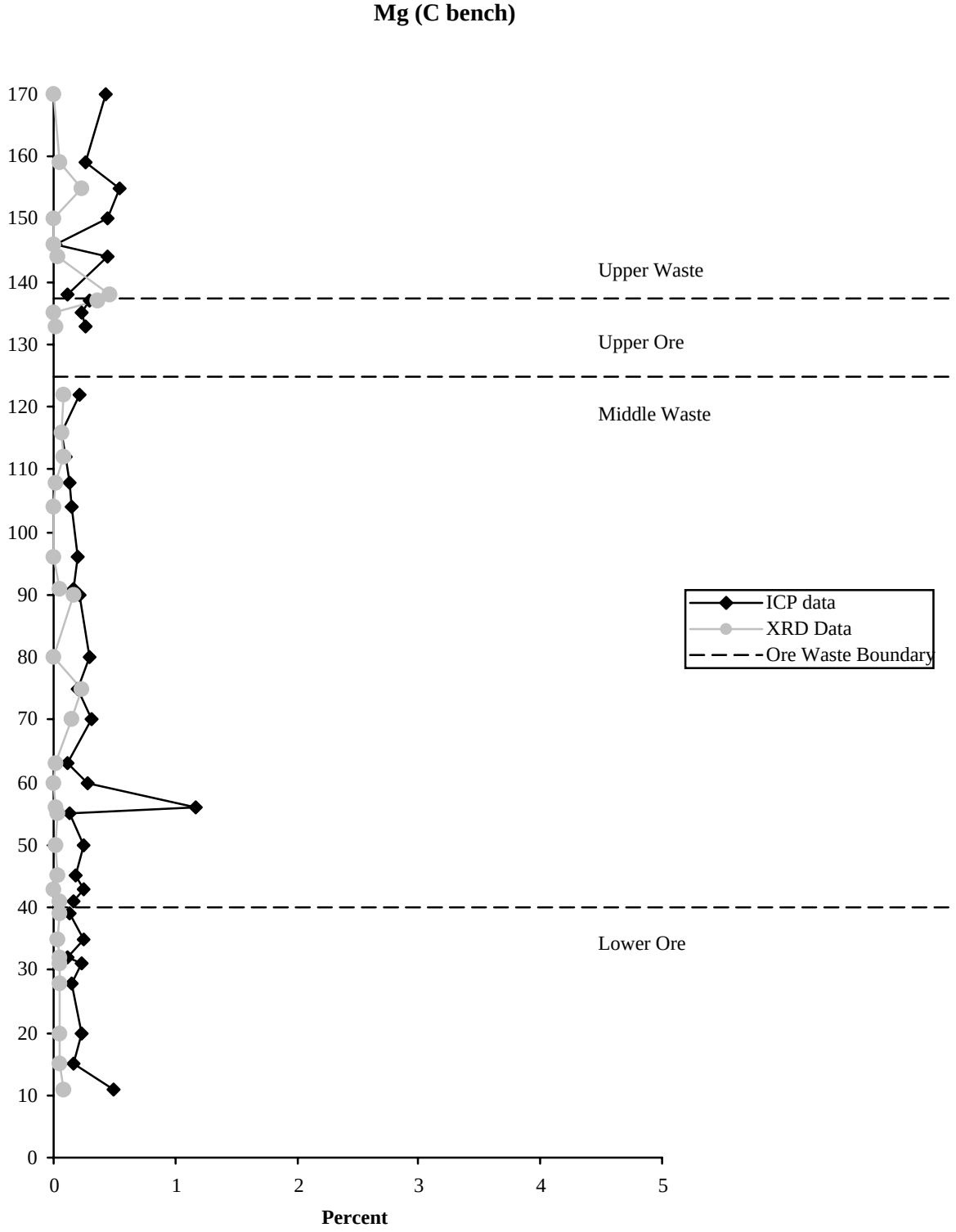

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

Sample #	Lithology	CO_3 (C bench) Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	0.04	0.05	0.00	0.05	100	29
WPSC159	Phosphorite	0.26	0.27	0.00	0.27	100	165
WPSC155	Mudstone	0.03	0.03	0.27	-0.24	-753	144
WPSC150	Mudstone	0.02	0.02	0.00	0.02	100	13
WPSC146	Chert	0.04	0.04	0.00	0.04	100	26
WPSC144	Mudstone	0.06	0.06	0.04	0.02	37	14
WPSC138	Phosphorite	0.33	0.33	0.58	-0.25	-75	152
WPSC137	Mudstone	0.24	0.26	0.53	-0.27	-102	162
WPSC135	Phosphorite	0.26	0.30	0.00	0.30	100	184
WPSC133	Phosphorite	0.14	0.15	0.02	0.13	84	78
WPSC122	Mudstone	0.05	0.06	0.08	-0.02	-26	10
WPSC116	Phosphorite	0.18	0.21	0.04	0.17	81	104
WPSC112	Mudstone	0.06	0.07	0.08	-0.01	-17	7
WPSC108	Mudstone	0.10	0.12	0.02	0.10	80	58
WPSC104	Mudstone	0.07	0.08	0.00	0.08	100	50
WPSC096	Mudstone	0.05	0.05	0.06	-0.01	-11	4
WPSC091	Mudstone	0.07	0.08	0.11	-0.04	-47	22
WPSC090	Mudstone	0.06	0.06	0.16	-0.09	-141	55
WPSC080	Mudstone	0.08	0.09	0.00	0.09	100	55
WPSC075	Mudstone	0.02	0.02	0.25	-0.22	-966	136
WPSC070	Mudstone	0.07	0.11	0.13	-0.02	-18	12
WPSC063	Phosphorite	0.21	0.22	0.00	0.22	100	136
WPSC060	Mudstone	0.03	0.04	0.00	0.04	100	22
WPSC056	Carbon seam	0.01	0.01	0.01	0.00	-4	0
WPSC055	Phosphorite	0.24	0.27	0.12	0.15	56	93
WPSC050	Mudstone	0.17	0.18	0.23	-0.04	-24	27
WPSC045	Phosphorite	0.29	0.31	0.00	0.31	100	191
WPSC043	Mudstone	0.14	0.15	0.55	-0.40	-267	244
WPSC041	Phosphorite	0.28	0.29	0.23	0.06	21	37
WPSC039	Phosphorite	0.05	0.05	0.00	0.05	100	30
WPSC035	Phosphorite	0.22	0.25	0.00	0.25	100	151
WPSC032	Phosphorite	0.34	0.37	0.01	0.36	97	218
WPSC031	Phosphorite	0.28	0.29	0.00	0.29	100	176
WPSC028	Phosphorite	0.34	0.37	0.00	0.37	100	226
WPSC020	Phosphorite	0.28	0.31	0.00	0.31	100	186
WPSC015	Phosphorite	0.43	0.44	0.00	0.44	100	264
WPSC011	Mudstone	0.05	0.05	0.08	-0.03	-55	17

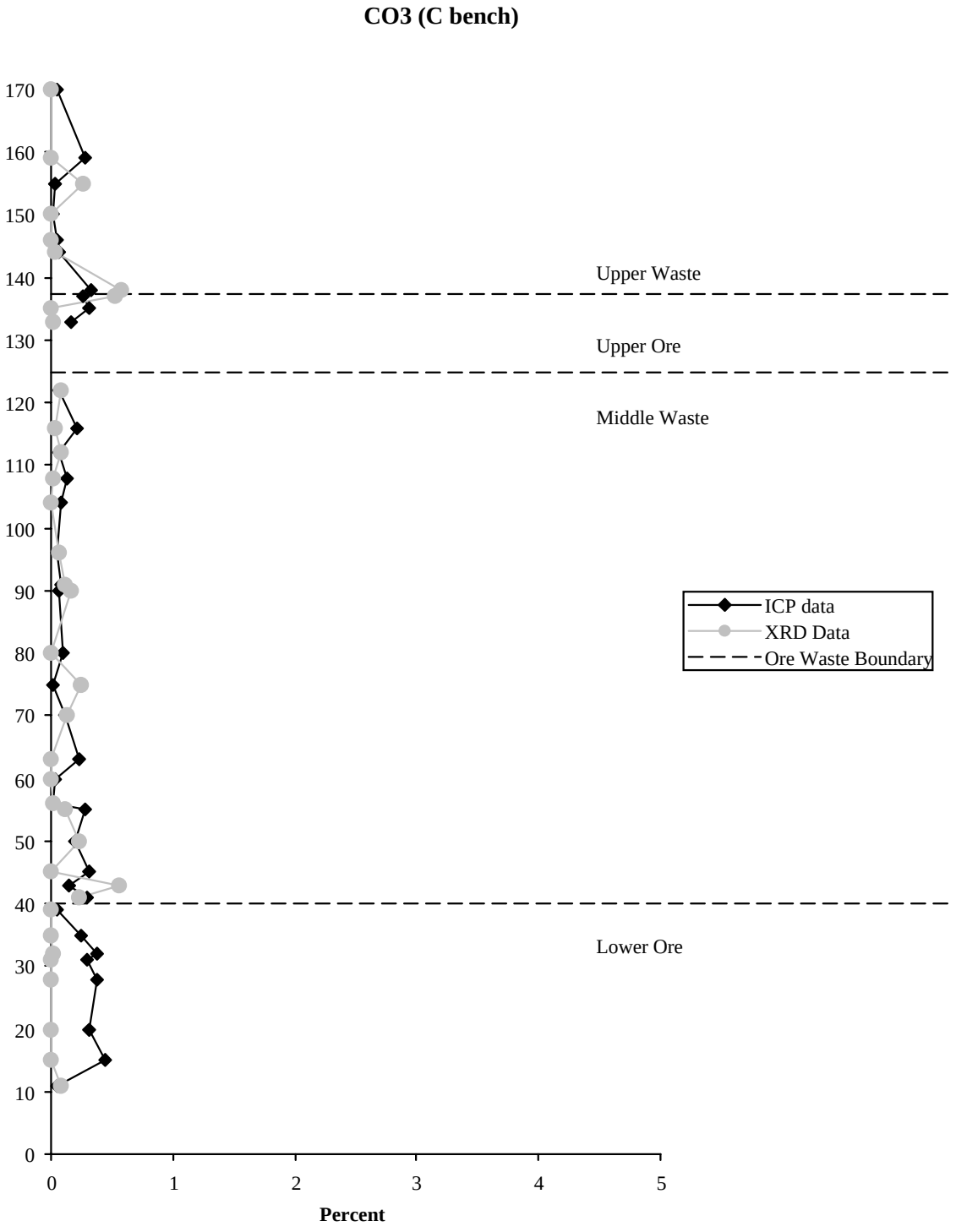

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3a. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section C - continued.

Sample #	Lithology	Fe (C bench) Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSC170	Chert	1.89	2.34	0.88	1.45	62	55
WPSC159	Phosphorite	1.80	1.94	1.02	0.92	47	35
WPSC155	Mudstone	2.77	3.10	0.00	3.10	100	118
WPSC150	Mudstone	2.05	2.37	0.42	1.95	82	74
WPSC146	Chert	0.12	0.13	0.00	0.13	100	5
WPSC144	Mudstone	2.36	2.55	0.00	2.55	100	97
WPSC138	Phosphorite	0.52	0.53	0.00	0.53	100	20
WPSC137	Mudstone	1.42	1.60	0.00	1.60	100	61
WPSC135	Phosphorite	0.92	1.09	0.19	0.91	83	34
WPSC133	Phosphorite	1.39	1.62	0.00	1.62	100	61
WPSC122	Mudstone	2.10	2.74	0.33	2.41	88	91
WPSC116	Phosphorite	1.03	1.23	0.00	1.23	100	47
WPSC112	Mudstone	1.75	2.03	0.33	1.71	84	65
WPSC108	Mudstone	1.32	1.63	0.61	1.03	63	39
WPSC104	Mudstone	1.68	2.05	0.23	1.82	89	69
WPSC096	Mudstone	2.06	2.34	0.00	2.34	100	89
WPSC091	Mudstone	2.43	2.77	0.19	2.58	93	98
WPSC090	Mudstone	2.11	2.39	0.00	2.39	100	91
WPSC080	Mudstone	2.11	2.52	0.00	2.52	100	95
WPSC075	Mudstone	2.19	2.67	0.09	2.58	97	98
WPSC070	Mudstone	2.16	3.41	0.00	3.41	100	190
WPSC063	Phosphorite	2.13	2.44	0.00	2.44	100	92
WPSC060	Mudstone	2.42	3.13	0.05	3.09	99	117
WPSC056	Carbon seam	3.35	4.60	0.00	4.60	100	175
WPSC055	Phosphorite	1.13	1.31	0.00	1.31	100	50
WPSC050	Mudstone	1.75	2.02	0.14	1.88	93	71
WPSC045	Phosphorite	0.91	1.00	0.05	0.96	95	36
WPSC043	Mudstone	1.78	1.99	0.09	1.89	95	72
WPSC041	Phosphorite	1.00	1.05	0.14	0.91	87	35
WPSC039	Phosphorite	0.71	0.70	0.33	0.38	54	14
WPSC035	Phosphorite	1.27	1.47	0.00	1.47	100	56
WPSC032	Phosphorite	0.51	0.56	0.00	0.56	100	21
WPSC031	Phosphorite	0.97	1.02	0.14	0.88	86	33
WPSC028	Phosphorite	0.57	0.63	0.56	0.07	11	3
WPSC020	Phosphorite	0.92	1.03	0.00	1.03	100	39
WPSC015	Phosphorite	0.55	0.56	0.00	0.56	100	21
WPSC011	Mudstone	2.48	2.64	0.09	2.54	96	96

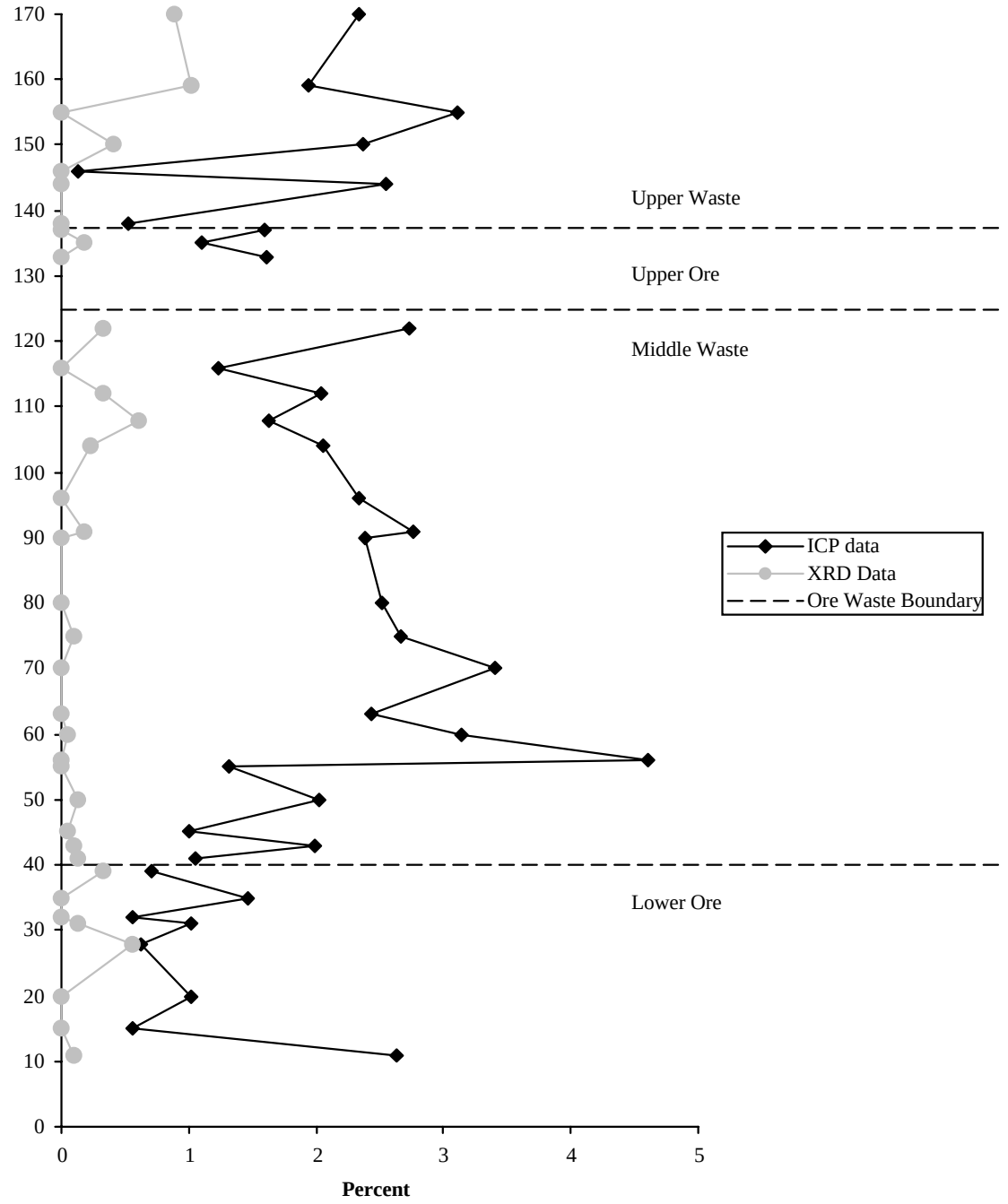

Figure 6a. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section C - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D.

Ca (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	5.17	5.74	4.44	1.31	23%	7%
WPSD209	Phosphorite	14.60	15.12	10.69	4.43	29%	25%
WPSD207	Mudstone	1.64	1.85	1.23	0.62	33%	3%
WPSD206	Phosphorite	22.70	23.82	25.39	-1.57	-7%	9%
WPSD205	Mudstone	2.76	3.46	0.82	2.65	76%	15%
WPSD203	Mudstone	13.10	14.61	12.52	2.08	14%	12%
WPSD199	Phosphorite	21.60	23.02	18.96	4.07	18%	23%
WPSD151	Dolostone	24.80	24.27	23.58	0.69	3%	4%
WPSD147	Mudstone	11.60	13.59	9.69	3.90	29%	22%
WPSD142	Mudstone	8.92	9.96	9.60	0.36	4%	2%
WPSD137	Mudstone	9.75	11.47	9.18	2.29	20%	13%
WPSD132	Phosphorite	28.00	29.58	27.82	1.76	6%	10%
WPSD130	Mudstone	7.06	7.50	5.53	1.97	26%	11%
WPSD126	Carbon Seam	22.20	25.52	24.40	1.12	4%	6%
WPSD120	Dolostone	14.90	15.46	15.95	-0.49	-3%	3%
WPSD114	Mudstone	4.62	5.11	4.21	0.90	18%	5%
WPSD109	Phosphorite	14.50	15.77	14.11	1.66	11%	9%
WPSD108	Mudstone	9.51	11.14	8.39	2.76	25%	16%
WPSD104	Carbon Seam	16.45	20.50	19.35	1.15	6%	7%
WPSD103	Mudstone	3.01	3.38	2.36	1.02	30%	6%
WPSD102	Carbon Seam	23.80	28.34	26.86	1.48	5%	8%
WPSD101	Mudstone	5.62	6.43	4.22	2.20	34%	12%
WPSD098	Phosphorite	13.45	18.59	10.19	8.39	45%	47%
WPSD093	Siltstone	8.60	11.88	8.27	3.62	30%	20%
WPSD087	Dolostone	14.20	15.36	16.25	-0.89	-6%	5%
WPSD084	Dolostone	18.00	18.57	18.61	-0.04	0%	0%
WPSD080	Mudstone	3.49	4.42	3.76	0.66	15%	4%
WPSD075	Siltstone	4.48	5.15	6.28	-1.14	-22%	6%
WPSD071	Siltstone	1.54	1.75	0.72	1.03	59%	6%
WPSD067	Siltstone	11.40	13.62	11.25	2.36	17%	13%
WPSD062	Dolostone	23.90	24.47	24.34	0.14	1%	1%
WPSD058	Phosphorite	14.30	16.41	15.43	0.98	6%	6%
WPSD055	Dolostone	22.20	22.34	21.66	0.68	3%	4%
WPSD052	Siltstone	19.10	22.37	17.58	4.79	21%	27%
WPSD049	Phosphorite	15.20	19.03	16.37	2.66	14%	15%
WPSD046	Phosphorite	15.10	18.26	17.57	0.69	4%	4%
WPSD043	Phosphorite	10.40	16.54	10.15	6.39	39%	36%
WPSD041	Phosphorite	30.00	32.49	33.25	-0.76	-2%	4%
WPSD039	Dolostone	20.80	21.63	21.72	-0.10	0%	1%
WPSD036	Phosphorite	9.39	10.57	12.42	-1.85	-17%	10%
WPSD033	Dolostone	20.70	21.26	22.60	-1.33	-6%	8%
WPSD031	Dolostone	19.90	19.87	20.01	-0.13	-1%	1%
WPSD030	Phosphorite	28.10	29.37	28.88	0.49	2%	3%
WPSD027	Phosphorite	28.00	28.26	27.53	0.73	3%	4%
WPSD025	Limestone	24.10	25.89	26.32	-0.43	-2%	2%
WPSD023	Phosphorite	29.70	30.99	30.17	0.82	3%	5%
WPSD020	Phosphorite	21.70	24.00	21.37	2.63	11%	15%
WPSD018	Dolostone	23.80	24.82	22.63	2.20	9%	12%
WPSD016	Phosphorite	25.20	25.50	26.06	-0.55	-2%	3%
WPSD014	Phosphorite	33.30	35.56	35.20	0.36	1%	2%
WPSD009	Mudstone	12.60	15.43	13.35	2.08	13%	12%
WPSD006	Dolostone	14.20	14.23	11.08	3.15	22%	18%
WPSD000.5	Phosphorite	35.50	30.85	31.28	-0.43	-1%	2%
WPSD000	Dolostone	22.70	22.98	20.95	2.03	9%	11%

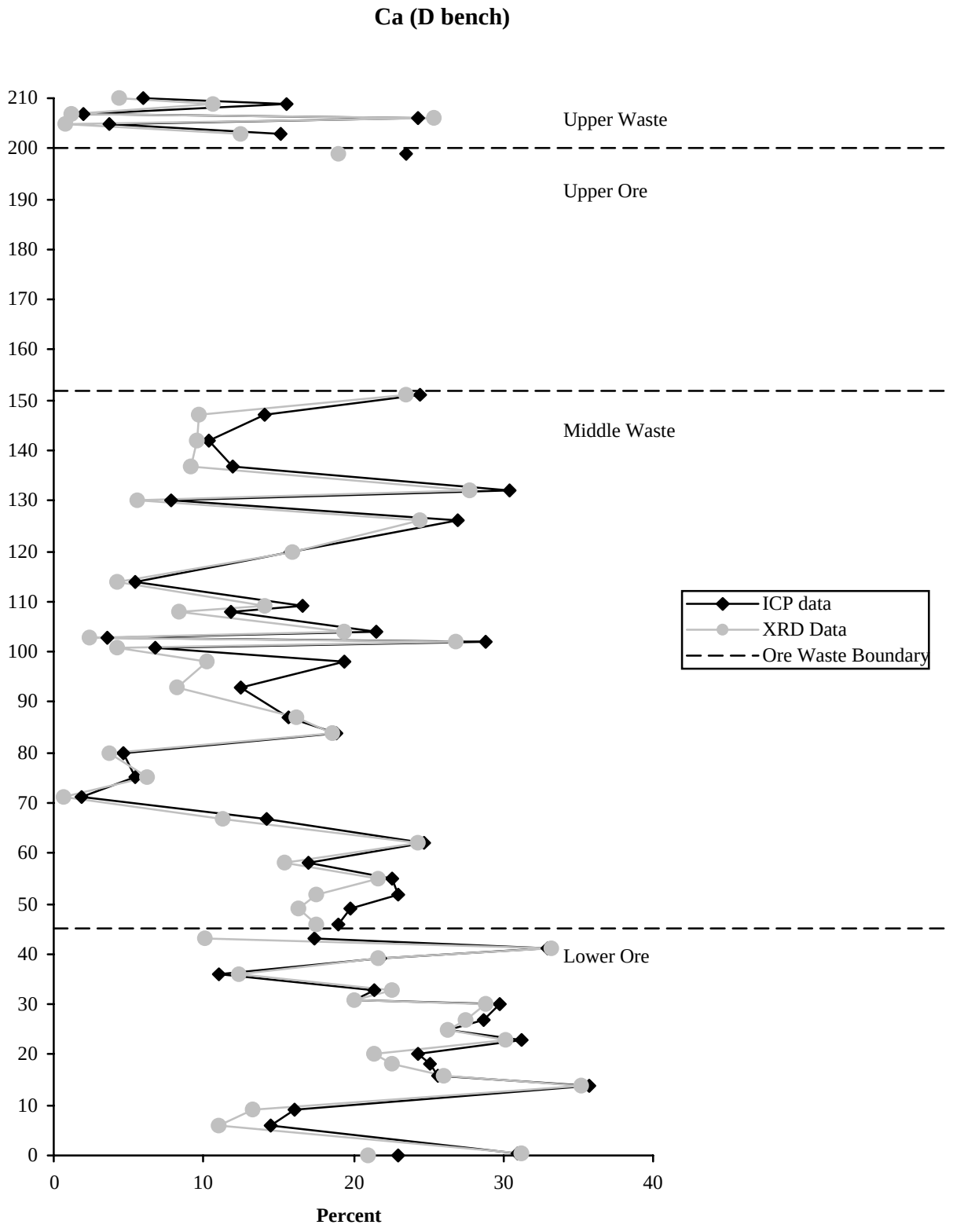

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D. Recognized ore and waste bodies are indicated

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

P (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	0.88	0.98	0.63	0.35	36%	7%
WPSD209	Phosphorite	6.41	6.64	4.86	1.78	27%	35%
WPSD207	Mudstone	0.22	0.25	0.48	-0.23	-93%	5%
WPSD206	Phosphorite	10.10	10.60	11.28	-0.68	-6%	13%
WPSD205	Mudstone	1.07	1.34	0.35	0.99	74%	19%
WPSD203	Mudstone	4.12	4.59	3.47	1.12	24%	22%
WPSD199	Phosphorite	9.57	10.20	8.57	1.63	16%	32%
WPSD151	Dolostone	0.12	0.12	0.18	-0.07	-57%	1%
WPSD147	Mudstone	4.10	4.80	4.35	0.45	9%	9%
WPSD142	Mudstone	2.49	2.78	2.66	0.12	4%	2%
WPSD137	Mudstone	2.36	2.78	1.92	0.86	31%	17%
WPSD132	Phosphorite	12.60	13.31	12.75	0.56	4%	11%
WPSD130	Mudstone	2.63	2.79	2.02	0.77	28%	15%
WPSD126	Carbon Seam	9.69	11.14	11.25	-0.11	-1%	2%
WPSD120	Dolostone	0.57	0.59	0.61	-0.02	-3%	0%
WPSD114	Mudstone	1.83	2.02	1.47	0.55	27%	11%
WPSD109	Phosphorite	6.60	7.18	6.53	0.65	9%	13%
WPSD108	Mudstone	4.18	4.90	3.74	1.16	24%	23%
WPSD104	Carbon Seam	7.18	8.95	8.57	0.38	4%	7%
WPSD103	Mudstone	1.14	1.28	1.03	0.25	20%	5%
WPSD102	Carbon Seam	10.60	12.62	11.95	0.67	5%	13%
WPSD101	Mudstone	2.46	2.82	1.90	0.92	33%	18%
WPSD098	Phosphorite	5.99	8.27	4.53	3.75	45%	73%
WPSD093	Siltstone	3.71	5.13	3.72	1.41	27%	27%
WPSD087	Dolostone	0.19	0.21	0.28	-0.07	-34%	1%
WPSD084	Dolostone	0.16	0.17	0.00	0.17	100%	3%
WPSD080	Mudstone	1.07	1.36	1.03	0.33	24%	6%
WPSD075	Siltstone	1.50	1.72	2.45	-0.73	-42%	14%
WPSD071	Siltstone	0.05	0.06	0.00	0.06	100%	1%
WPSD067	Siltstone	3.26	3.89	3.81	0.09	2%	2%
WPSD062	Dolostone	0.18	0.18	0.00	0.18	100%	4%
WPSD058	Phosphorite	4.96	5.69	5.82	-0.12	-2%	2%
WPSD055	Dolostone	0.30	0.30	0.00	0.30	100%	6%
WPSD052	Siltstone	3.84	4.49	3.79	0.71	16%	14%
WPSD049	Phosphorite	4.59	5.75	5.12	0.63	11%	12%
WPSD046	Phosphorite	4.29	5.19	5.06	0.13	3%	3%
WPSD043	Phosphorite	3.40	5.41	3.88	1.53	28%	30%
WPSD041	Phosphorite	13.10	14.19	14.55	-0.36	-3%	7%
WPSD039	Dolostone	2.00	2.08	1.94	0.13	6%	3%
WPSD036	Phosphorite	3.64	4.10	5.12	-1.02	-25%	20%
WPSD033	Dolostone	1.07	1.10	1.44	-0.34	-31%	7%
WPSD031	Dolostone	0.25	0.25	0.18	0.07	26%	1%
WPSD030	Phosphorite	11.90	12.44	12.01	0.43	3%	8%
WPSD027	Phosphorite	12.20	12.31	12.30	0.01	0%	0%
WPSD025	Limestone	0.65	0.70	0.15	0.55	79%	11%
WPSD023	Phosphorite	11.90	12.42	12.09	0.33	3%	6%
WPSD020	Phosphorite	6.37	7.05	6.64	0.41	6%	8%
WPSD018	Dolostone	6.38	6.65	5.25	1.40	21%	27%
WPSD016	Phosphorite	7.06	7.14	6.72	0.42	6%	8%
WPSD014	Phosphorite	14.60	15.59	15.27	0.32	2%	6%
WPSD009	Mudstone	5.35	6.55	5.90	0.65	10%	13%
WPSD006	Dolostone	0.50	0.50	0.17	0.34	67%	7%
WPSD000.5	Phosphorite	14.60	12.69	13.85	-1.16	-9%	23%
WPSD000	Dolostone	0.30	0.30	0.74	-0.43	-143%	8%

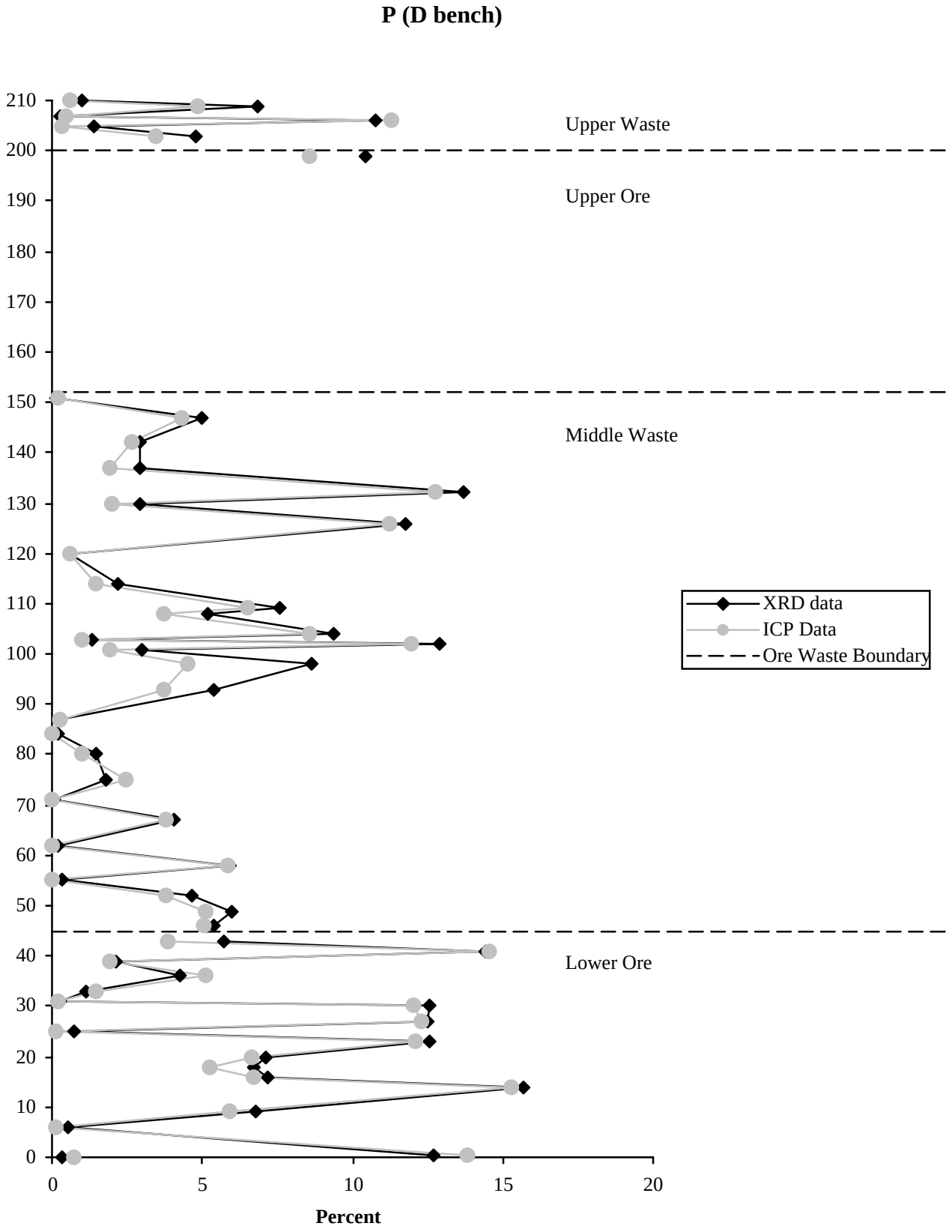

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

Sample #	Lithology	Si (D bench) Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	28.00	31.10	30.91	0.20	1%	1%
WPSD209	Phosphorite	22.00	22.78	26.84	-4.06	-18%	23%
WPSD207	Mudstone	31.40	35.35	38.88	-3.53	-10%	20%
WPSD206	Phosphorite	16.15	16.95	15.65	1.29	8%	7%
WPSD205	Mudstone	27.90	35.01	33.06	1.94	6%	11%
WPSD203	Mudstone	20.20	22.53	23.43	-0.90	-4%	5%
WPSD199	Phosphorite	15.80	16.84	20.36	-3.52	-21%	20%
WPSD151	Dolostone	4.12	4.03	3.89	0.14	3%	1%
WPSD147	Mudstone	20.70	24.25	30.34	-6.09	-25%	35%
WPSD142	Mudstone	24.90	27.79	25.31	2.48	9%	14%
WPSD137	Mudstone	22.00	25.88	27.22	-1.34	-5%	8%
WPSD132	Phosphorite	8.76	9.25	9.37	-0.12	-1%	1%
WPSD130	Mudstone	27.70	29.43	30.83	-1.40	-5%	8%
WPSD126	Carbon Seam	10.90	12.53	11.38	1.15	9%	7%
WPSD120	Dolostone	13.40	13.90	12.44	1.47	11%	8%
WPSD114	Mudstone	27.80	30.76	30.37	0.40	1%	2%
WPSD109	Phosphorite	19.80	21.54	21.83	-0.30	-1%	2%
WPSD108	Mudstone	22.50	26.36	27.02	-0.66	-3%	4%
WPSD104	Carbon Seam	14.20	17.70	16.31	1.39	8%	8%
WPSD103	Mudstone	30.60	34.33	32.94	1.40	4%	8%
WPSD102	Carbon Seam	8.28	9.86	10.16	-0.30	-3%	2%
WPSD101	Mudstone	26.75	30.62	31.24	-0.62	-2%	4%
WPSD098	Phosphorite	13.00	17.97	25.41	-7.44	-41%	43%
WPSD093	Siltstone	19.10	26.39	26.61	-0.21	-1%	1%
WPSD087	Dolostone	9.63	10.42	8.98	1.43	14%	8%
WPSD084	Dolostone	8.36	8.63	7.21	1.41	16%	8%
WPSD080	Mudstone	25.70	32.55	29.40	3.16	10%	18%
WPSD075	Siltstone	26.20	30.09	29.82	0.27	1%	2%
WPSD071	Siltstone	31.10	35.35	36.54	-1.19	-3%	7%
WPSD067	Siltstone	18.85	22.51	21.87	0.64	3%	4%
WPSD062	Dolostone	3.74	3.83	1.82	2.01	53%	12%
WPSD058	Phosphorite	17.40	19.97	20.36	-0.39	-2%	2%
WPSD055	Dolostone	5.45	5.48	4.74	0.74	14%	4%
WPSD052	Siltstone	10.95	12.83	15.17	-2.34	-18%	14%
WPSD049	Phosphorite	15.10	18.91	16.45	2.45	13%	14%
WPSD046	Phosphorite	14.70	17.77	15.58	2.20	12%	13%
WPSD043	Phosphorite	11.90	18.93	21.76	-2.84	-15%	16%
WPSD041	Phosphorite	4.97	5.38	5.23	0.15	3%	1%
WPSD039	Dolostone	6.10	6.34	6.05	0.29	5%	2%
WPSD036	Phosphorite	22.10	24.88	25.32	-0.45	-2%	3%
WPSD033	Dolostone	5.44	5.59	3.76	1.83	33%	11%
WPSD031	Dolostone	7.55	7.54	6.42	1.12	15%	6%
WPSD030	Phosphorite	7.32	7.65	8.30	-0.65	-8%	4%
WPSD027	Phosphorite	9.11	9.19	10.89	-1.70	-18%	10%
WPSD025	Limestone	11.50	12.36	12.70	-0.34	-3%	2%
WPSD023	Phosphorite	5.66	5.91	7.09	-1.18	-20%	7%
WPSD020	Phosphorite	8.63	9.54	11.98	-2.44	-26%	14%
WPSD018	Dolostone	7.25	7.56	6.10	1.46	19%	8%
WPSD016	Phosphorite	6.19	6.26	5.04	1.22	19%	7%
WPSD014	Phosphorite	2.42	2.58	4.50	-1.92	-74%	11%
WPSD009	Mudstone	20.30	24.86	25.86	-1.01	-4%	6%
WPSD006	Dolostone	14.20	14.23	20.89	-6.67	-47%	38%
WPSD000.5	Phosphorite	4.07	3.54	7.63	-4.09	-116%	24%
WPSD000	Dolostone	2.46	2.49	2.59	-0.10	-4%	1%

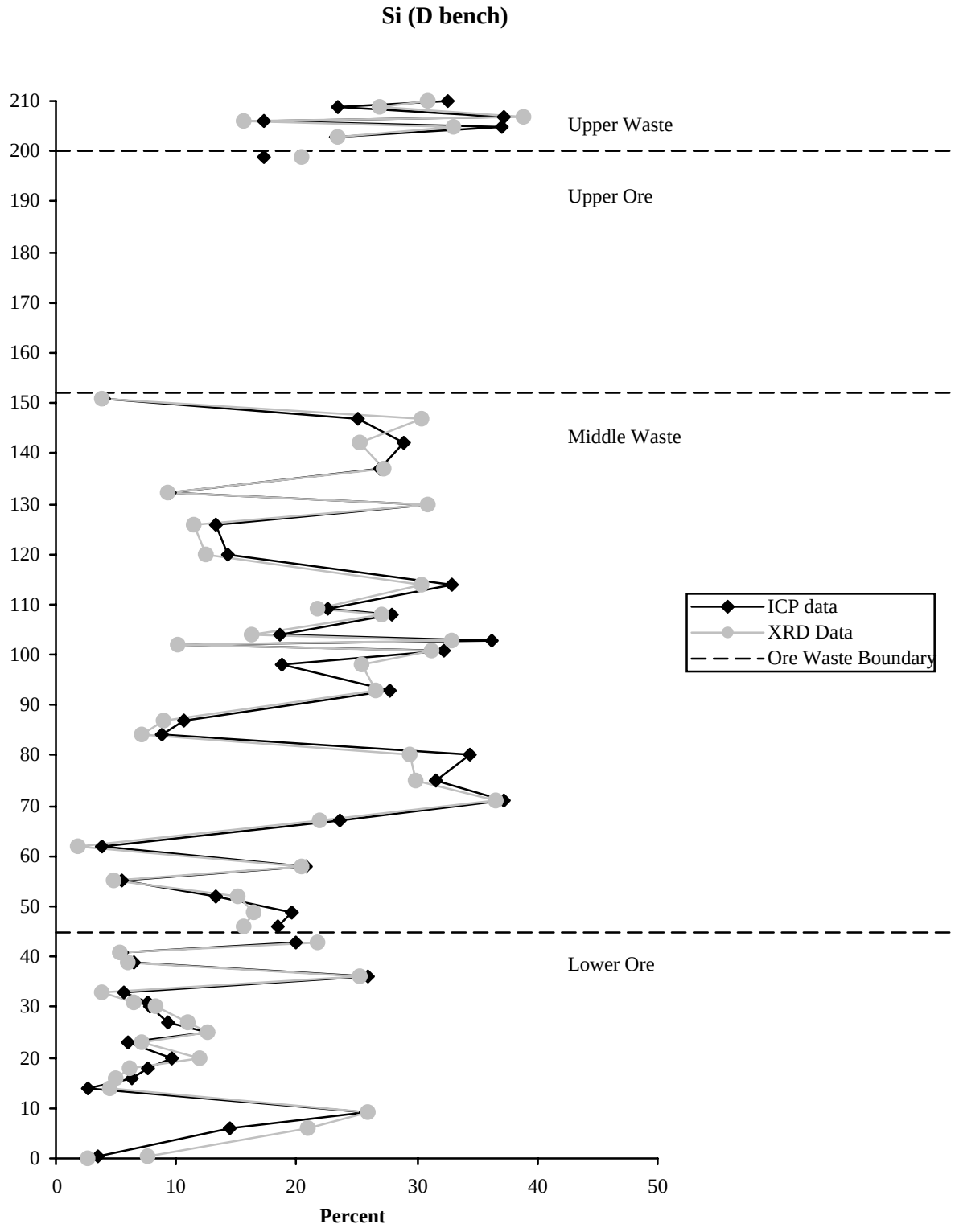

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

		K (D bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	1.88	2.09	2.85	-0.76	-36%	54%
WPSD209	Phosphorite	1.19	1.23	1.97	-0.74	-60%	53%
WPSD207	Mudstone	1.72	1.94	1.50	0.44	23%	31%
WPSD206	Phosphorite	0.53	0.56	0.03	0.52	94%	37%
WPSD205	Mudstone	1.69	2.12	2.88	-0.76	-36%	54%
WPSD203	Mudstone	1.45	1.62	1.08	0.54	33%	38%
WPSD199	Phosphorite	0.84	0.90	0.85	0.05	6%	4%
WPSD151	Dolostone	0.24	0.23	0.05	0.19	79%	13%
WPSD147	Mudstone	1.29	1.51	0.86	0.65	43%	46%
WPSD142	Mudstone	1.53	1.71	1.54	0.17	10%	12%
WPSD137	Mudstone	1.58	1.86	1.17	0.69	37%	49%
WPSD132	Phosphorite	0.68	0.72	0.64	0.08	11%	6%
WPSD130	Mudstone	1.88	2.00	1.01	0.99	49%	70%
WPSD126	Carbon Seam	1.11	1.28	0.80	0.48	37%	34%
WPSD120	Dolostone	0.93	0.96	0.66	0.31	32%	22%
WPSD114	Mudstone	2.22	2.46	1.40	1.06	43%	75%
WPSD109	Phosphorite	1.70	1.85	0.90	0.95	51%	67%
WPSD108	Mudstone	1.89	2.21	0.95	1.26	57%	90%
WPSD104	Carbon Seam	1.64	2.04	1.08	0.96	47%	68%
WPSD103	Mudstone	2.07	2.32	1.56	0.76	33%	54%
WPSD102	Carbon Seam	0.77	0.92	1.19	-0.27	-30%	19%
WPSD101	Mudstone	1.95	2.23	2.07	0.15	7%	11%
WPSD098	Phosphorite	1.15	1.58	1.38	0.20	13%	14%
WPSD093	Siltstone	1.64	2.27	1.85	0.42	18%	30%
WPSD087	Dolostone	1.00	1.08	0.30	0.78	72%	56%
WPSD084	Dolostone	0.76	0.78	0.03	0.75	96%	53%
WPSD080	Mudstone	2.11	2.67	1.54	1.14	43%	81%
WPSD075	Siltstone	2.06	2.37	2.46	-0.09	-4%	7%
WPSD071	Siltstone	1.81	2.06	1.61	0.45	22%	32%
WPSD067	Siltstone	1.95	2.32	2.11	0.22	9%	15%
WPSD062	Dolostone	0.36	0.37	0.08	0.29	79%	21%
WPSD058	Phosphorite	1.70	1.95	1.05	0.90	46%	64%
WPSD055	Dolostone	0.40	0.40	0.22	0.18	45%	13%
WPSD052	Siltstone	1.29	1.51	1.26	0.25	17%	18%
WPSD049	Phosphorite	1.81	2.27	1.60	0.67	30%	48%
WPSD046	Phosphorite	1.78	2.15	1.72	0.43	20%	31%
WPSD043	Phosphorite	1.41	2.24	4.23	-1.98	-88%	141%
WPSD041	Phosphorite	0.61	0.66	0.44	0.22	33%	15%
WPSD039	Dolostone	0.83	0.86	0.31	0.56	65%	40%
WPSD036	Phosphorite	2.65	2.98	3.14	-0.16	-5%	11%
WPSD033	Dolostone	0.67	0.69	0.30	0.39	57%	28%
WPSD031	Dolostone	0.57	0.57	0.21	0.36	63%	25%
WPSD030	Phosphorite	0.81	0.85	1.06	-0.21	-25%	15%
WPSD027	Phosphorite	0.84	0.85	0.92	-0.07	-9%	5%
WPSD025	Limestone	1.00	1.07	0.26	0.82	76%	58%
WPSD023	Phosphorite	0.51	0.53	0.40	0.14	25%	10%
WPSD020	Phosphorite	0.82	0.91	0.95	-0.04	-4%	3%
WPSD018	Dolostone	0.79	0.82	0.63	0.19	24%	14%
WPSD016	Phosphorite	0.43	0.44	0.13	0.30	69%	21%
WPSD014	Phosphorite	0.34	0.36	0.30	0.06	17%	4%
WPSD009	Mudstone	1.74	2.13	1.65	0.48	22%	34%
WPSD006	Dolostone	0.99	0.99	1.06	-0.06	-6%	5%
WPSD000.5	Phosphorite	0.15	0.13	1.64	-1.50	-1154%	107%
WPSD000	Dolostone	0.21	0.21	0.13	0.07	36%	5%

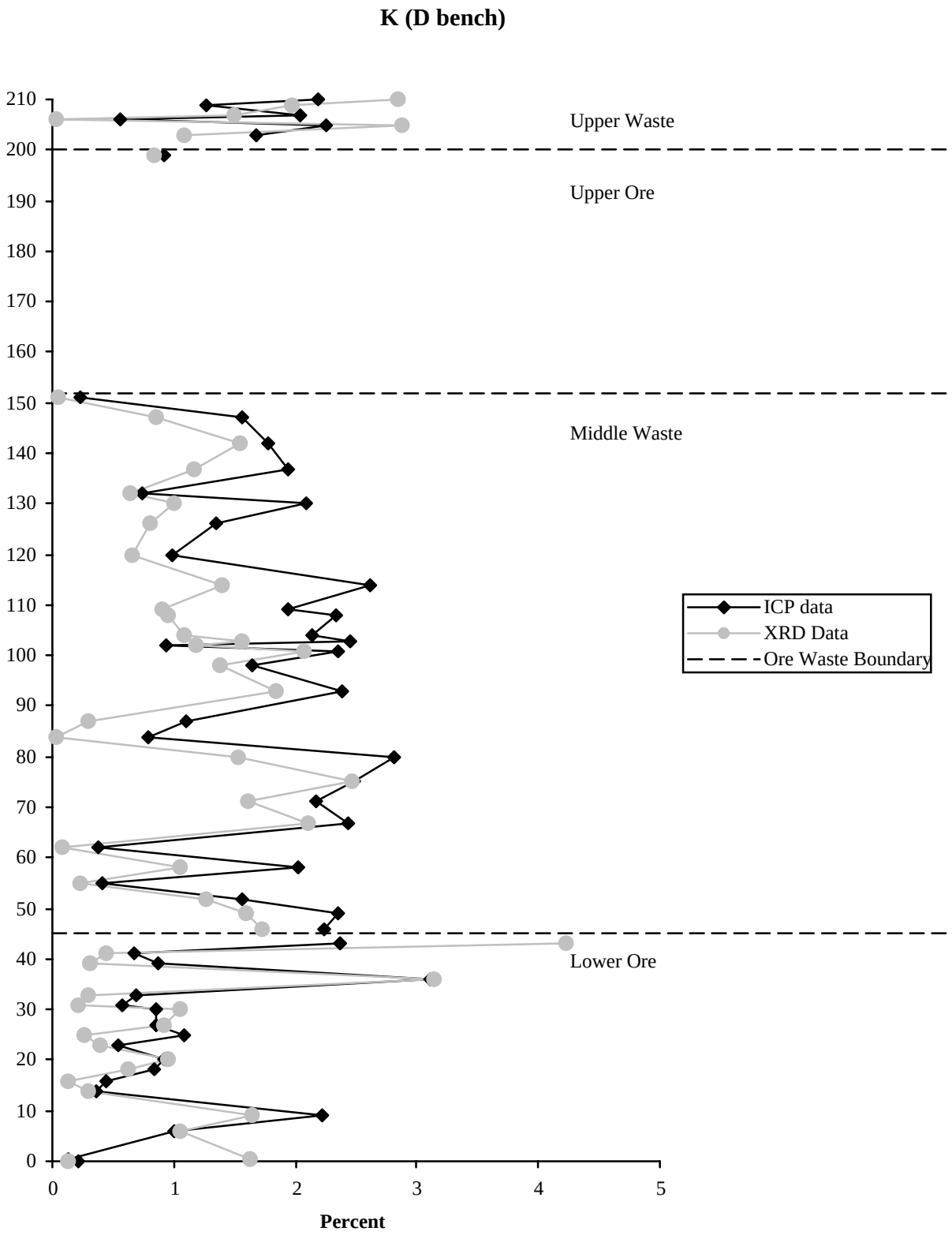

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

		Al (D bench)					
Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	5.61	6.23	6.26	-0.02	0%	1%
WPSD209	Phosphorite	3.38	3.50	5.17	-1.67	-48%	49%
WPSD207	Mudstone	5.30	5.97	5.49	0.48	8%	14%
WPSD206	Phosphorite	1.31	1.37	2.04	-0.67	-49%	20%
WPSD205	Mudstone	5.43	6.81	7.10	-0.29	-4%	8%
WPSD203	Mudstone	4.01	4.47	4.37	0.10	2%	3%
WPSD199	Phosphorite	2.46	2.62	5.60	-2.98	-114%	88%
WPSD151	Dolostone	0.72	0.70	0.83	-0.13	-18%	4%
WPSD147	Mudstone	3.47	4.06	4.19	-0.12	-3%	4%
WPSD142	Mudstone	4.10	4.58	4.95	-0.38	-8%	11%
WPSD137	Mudstone	3.88	4.56	4.14	0.42	9%	12%
WPSD132	Phosphorite	1.55	1.63	1.97	-0.34	-21%	10%
WPSD130	Mudstone	4.70	4.99	4.60	0.39	8%	12%
WPSD126	Carbon Seam	2.67	3.07	2.59	0.48	16%	14%
WPSD120	Dolostone	2.40	2.49	2.02	0.47	19%	14%
WPSD114	Mudstone	5.75	6.36	5.20	1.16	18%	34%
WPSD109	Phosphorite	3.98	4.33	4.00	0.33	8%	10%
WPSD108	Mudstone	4.66	5.46	5.95	-0.49	-9%	14%
WPSD104	Carbon Seam	3.61	4.50	3.85	0.65	14%	19%
WPSD103	Mudstone	5.39	6.05	5.93	0.12	2%	4%
WPSD102	Carbon Seam	1.71	2.04	3.04	-1.01	-49%	30%
WPSD101	Mudstone	5.24	5.99	6.25	-0.26	-4%	8%
WPSD098	Phosphorite	2.84	3.92	4.74	-0.82	-21%	24%
WPSD093	Siltstone	4.01	5.54	7.07	-1.53	-28%	45%
WPSD087	Dolostone	2.28	2.47	2.05	0.42	17%	12%
WPSD084	Dolostone	1.58	1.63	1.52	0.11	7%	3%
WPSD080	Mudstone	5.17	6.55	9.46	-2.91	-44%	86%
WPSD075	Siltstone	5.40	6.20	6.54	-0.33	-5%	10%
WPSD071	Siltstone	5.28	6.00	7.96	-1.96	-33%	58%
WPSD067	Siltstone	4.63	5.52	5.83	-0.30	-5%	9%
WPSD062	Dolostone	0.79	0.81	0.32	0.49	60%	14%
WPSD058	Phosphorite	3.85	4.42	4.85	-0.43	-10%	13%
WPSD055	Dolostone	1.11	1.11	1.34	-0.23	-20%	7%
WPSD052	Siltstone	2.92	3.41	4.45	-1.04	-30%	31%
WPSD049	Phosphorite	4.34	5.43	8.56	-3.13	-58%	92%
WPSD046	Phosphorite	3.85	4.65	4.90	-0.25	-5%	7%
WPSD043	Phosphorite	3.05	4.85	8.77	-3.92	-81%	116%
WPSD041	Phosphorite	0.87	0.94	0.78	0.16	17%	5%
WPSD039	Dolostone	1.12	1.16	0.73	0.43	37%	13%
WPSD036	Phosphorite	5.06	5.70	3.90	1.80	32%	53%
WPSD033	Dolostone	1.16	1.19	0.55	0.64	54%	19%
WPSD031	Dolostone	1.56	1.56	1.16	0.39	25%	12%
WPSD030	Phosphorite	1.34	1.40	2.27	-0.87	-62%	26%
WPSD027	Phosphorite	1.62	1.63	1.78	-0.16	-10%	5%
WPSD025	Limestone	2.21	2.37	4.80	-2.42	-102%	71%
WPSD023	Phosphorite	1.07	1.12	0.90	0.22	20%	6%
WPSD020	Phosphorite	1.59	1.76	4.38	-2.62	-149%	77%
WPSD018	Dolostone	1.58	1.65	1.43	0.22	13%	6%
WPSD016	Phosphorite	0.81	0.82	0.21	0.61	74%	18%
WPSD014	Phosphorite	0.45	0.48	0.61	-0.13	-27%	4%
WPSD009	Mudstone	3.42	4.19	6.80	-2.61	-62%	77%
WPSD006	Dolostone	2.18	2.18	2.25	-0.07	-3%	2%
WPSD000.5	Phosphorite	0.35	0.30	1.30	-1.00	-328%	29%
WPSD000	Dolostone	0.23	0.23	0.78	-0.55	-241%	16%

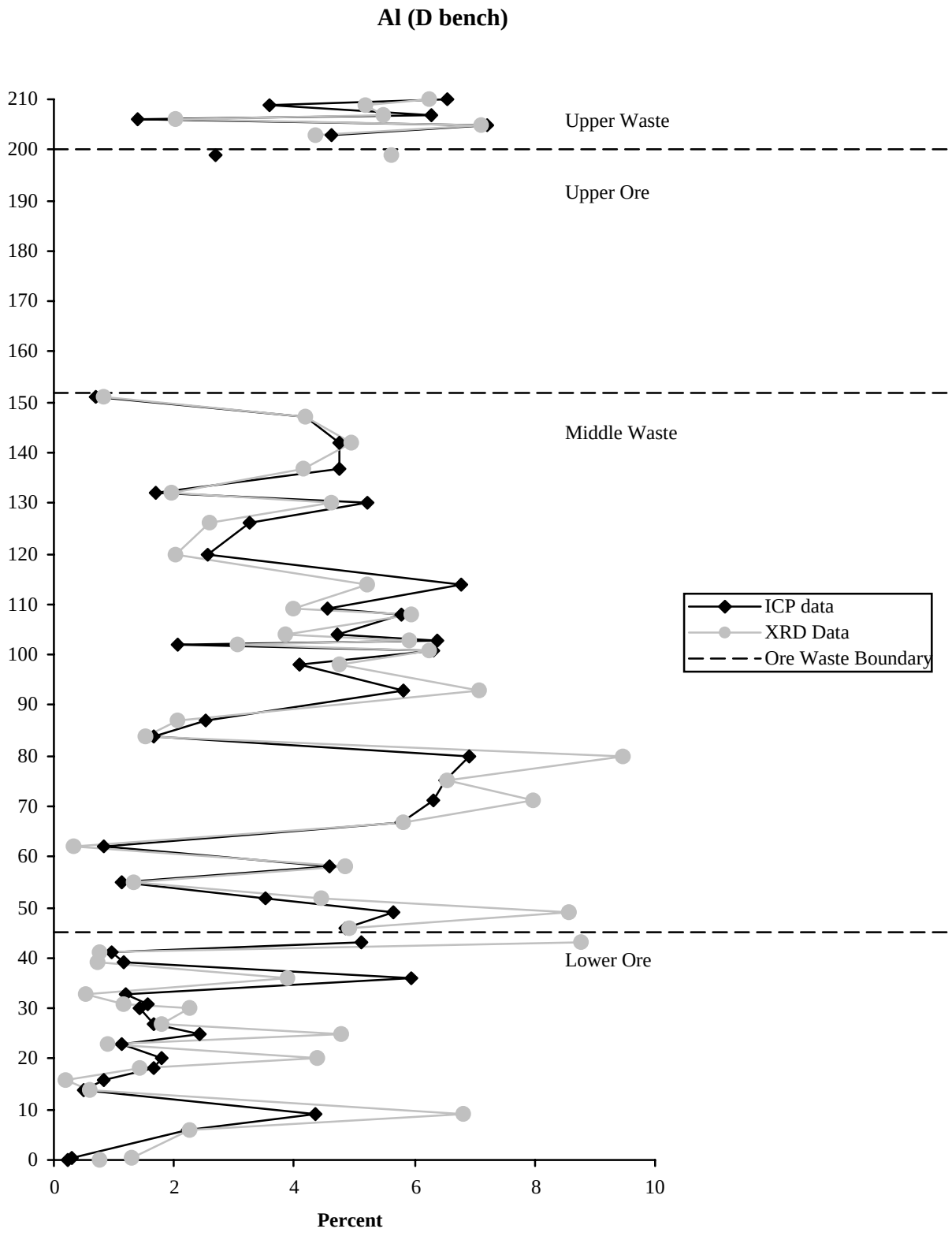

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

Na (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	0.76	0.84	0.22	0.62	74%	89%
WPSD209	Phosphorite	0.73	0.76	1.20	-0.44	-58%	63%
WPSD207	Mudstone	1.04	1.17	1.11	0.06	5%	8%
WPSD206	Phosphorite	0.24	0.25	0.37	-0.12	-48%	17%
WPSD205	Mudstone	1.21	1.52	0.73	0.79	52%	113%
WPSD203	Mudstone	0.62	0.69	0.73	-0.04	-6%	6%
WPSD199	Phosphorite	0.56	0.60	0.91	-0.31	-52%	44%
WPSD151	Dolostone	0.24	0.23	0.51	-0.27	-117%	39%
WPSD147	Mudstone	0.85	1.00	1.45	-0.46	-46%	65%
WPSD142	Mudstone	1.21	1.35	1.19	0.16	12%	23%
WPSD137	Mudstone	0.82	0.96	0.76	0.21	22%	30%
WPSD132	Phosphorite	0.60	0.63	0.16	0.47	74%	67%
WPSD130	Mudstone	1.26	1.34	1.36	-0.02	-2%	3%
WPSD126	Carbon Seam	0.60	0.69	0.34	0.35	50%	50%
WPSD120	Dolostone	0.73	0.76	0.26	0.49	65%	71%
WPSD114	Mudstone	1.20	1.33	0.88	0.44	33%	63%
WPSD109	Phosphorite	0.91	0.99	1.14	-0.15	-15%	22%
WPSD108	Mudstone	1.06	1.24	1.34	-0.10	-8%	14%
WPSD104	Carbon Seam	0.31	0.38	0.26	0.12	31%	17%
WPSD103	Mudstone	1.39	1.56	1.53	0.03	2%	5%
WPSD102	Carbon Seam	0.33	0.39	0.29	0.10	26%	14%
WPSD101	Mudstone	1.28	1.47	1.16	0.31	21%	44%
WPSD098	Phosphorite	0.32	0.44	0.84	-0.40	-93%	58%
WPSD093	Siltstone	0.61	0.84	0.35	0.49	59%	71%
WPSD087	Dolostone	0.38	0.41	0.39	0.03	6%	4%
WPSD084	Dolostone	0.25	0.26	0.03	0.23	90%	33%
WPSD080	Mudstone	0.51	0.65	0.08	0.57	88%	81%
WPSD075	Siltstone	1.14	1.31	1.38	-0.07	-5%	10%
WPSD071	Siltstone	1.74	1.98	2.57	-0.59	-30%	84%
WPSD067	Siltstone	0.73	0.87	0.15	0.72	83%	103%
WPSD062	Dolostone	0.31	0.32	0.00	0.32	100%	45%
WPSD058	Phosphorite	0.65	0.75	0.12	0.62	83%	89%
WPSD055	Dolostone	0.34	0.34	0.24	0.10	30%	14%
WPSD052	Siltstone	0.48	0.56	1.14	-0.59	-106%	84%
WPSD049	Phosphorite	0.59	0.74	0.12	0.62	84%	88%
WPSD046	Phosphorite	0.59	0.71	0.20	0.52	72%	74%
WPSD043	Phosphorite	0.20	0.32	0.17	0.15	47%	21%
WPSD041	Phosphorite	0.44	0.48	0.09	0.38	80%	54%
WPSD039	Dolostone	0.26	0.27	0.19	0.08	30%	12%
WPSD036	Phosphorite	0.49	0.55	0.48	0.07	13%	11%
WPSD033	Dolostone	0.32	0.33	0.04	0.29	89%	42%
WPSD031	Dolostone	0.70	0.70	0.80	-0.10	-14%	14%
WPSD030	Phosphorite	0.35	0.37	0.16	0.20	55%	29%
WPSD027	Phosphorite	0.39	0.39	0.12	0.28	71%	40%
WPSD025	Limestone	0.56	0.60	0.94	-0.34	-56%	48%
WPSD023	Phosphorite	0.32	0.33	0.12	0.22	65%	31%
WPSD020	Phosphorite	0.39	0.43	0.59	-0.16	-36%	22%
WPSD018	Dolostone	0.34	0.35	0.06	0.29	82%	41%
WPSD016	Phosphorite	0.24	0.24	0.06	0.18	75%	26%
WPSD014	Phosphorite	0.74	0.79	0.13	0.66	84%	94%
WPSD009	Mudstone	0.37	0.45	0.07	0.39	85%	55%
WPSD006	Dolostone	0.44	0.44	0.39	0.06	13%	8%
WPSD000.5	Phosphorite	0.50	0.43	0.10	0.33	76%	47%
WPSD000	Dolostone	0.07	0.07	0.00	0.07	100%	9%

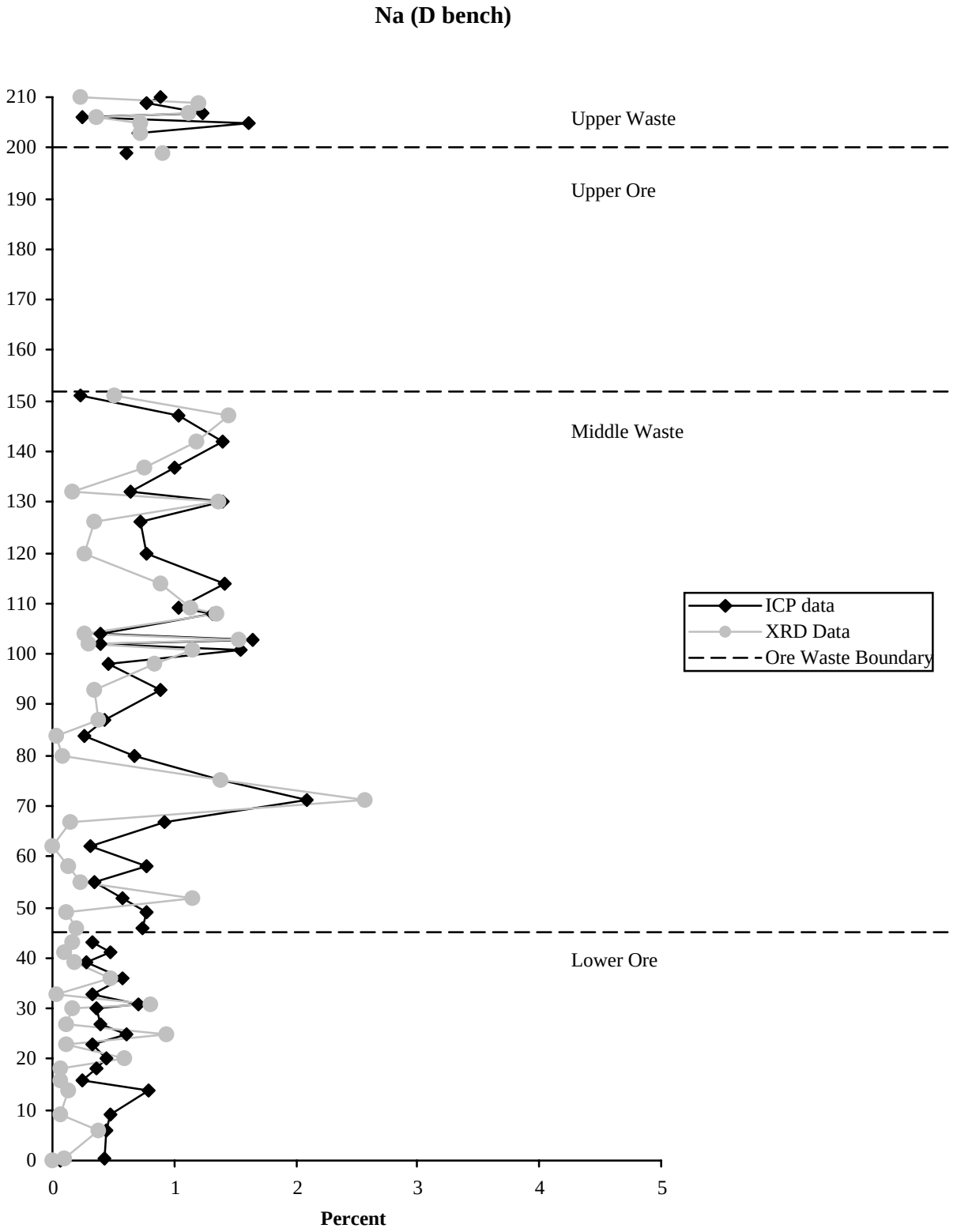

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

Mg (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	0.48	0.53	0.03	0.51	95%	21%
WPSD209	Phosphorite	0.23	0.24	0.01	0.23	96%	9%
WPSD207	Mudstone	0.47	0.53	0.12	0.41	78%	17%
WPSD206	Phosphorite	0.13	0.13	0.04	0.09	68%	4%
WPSD205	Mudstone	0.32	0.40	0.01	0.39	97%	16%
WPSD203	Mudstone	1.08	1.20	0.69	0.51	42%	21%
WPSD199	Phosphorite	0.17	0.18	0.02	0.16	90%	7%
WPSD151	Dolostone	8.89	8.70	8.42	0.28	3%	11%
WPSD147	Mudstone	0.31	0.36	0.10	0.26	73%	11%
WPSD142	Mudstone	1.13	1.26	1.02	0.24	19%	10%
WPSD137	Mudstone	0.50	0.59	0.49	0.10	16%	4%
WPSD132	Phosphorite	0.06	0.06	0.01	0.05	79%	2%
WPSD130	Mudstone	0.69	0.73	0.64	0.10	13%	4%
WPSD126	Carbon Seam	0.14	0.16	0.03	0.13	81%	5%
WPSD120	Dolostone	6.59	6.84	7.11	-0.27	-4%	11%
WPSD114	Mudstone	0.34	0.38	0.58	-0.21	-55%	9%
WPSD109	Phosphorite	0.08	0.09	0.00	0.09	99%	4%
WPSD108	Mudstone	0.14	0.16	0.01	0.16	95%	6%
WPSD104	Carbon Seam	0.30	0.37	0.04	0.34	90%	14%
WPSD103	Mudstone	0.10	0.11	0.08	0.03	29%	1%
WPSD102	Carbon Seam	0.18	0.21	0.04	0.17	79%	7%
WPSD101	Mudstone	0.11	0.13	0.08	0.05	37%	2%
WPSD098	Phosphorite	0.29	0.40	0.03	0.37	93%	15%
WPSD093	Siltstone	0.21	0.29	0.01	0.28	97%	12%
WPSD087	Dolostone	8.07	8.73	9.37	-0.64	-7%	27%
WPSD084	Dolostone	8.18	8.44	9.61	-1.17	-14%	48%
WPSD080	Mudstone	0.51	0.65	0.77	-0.13	-19%	5%
WPSD075	Siltstone	0.64	0.74	0.61	0.13	18%	5%
WPSD071	Siltstone	0.56	0.64	0.44	0.20	32%	8%
WPSD067	Siltstone	0.58	0.69	0.36	0.33	48%	13%
WPSD062	Dolostone	7.76	7.95	9.18	-1.23	-15%	51%
WPSD058	Phosphorite	0.70	0.80	0.38	0.42	52%	17%
WPSD055	Dolostone	8.93	8.99	8.89	0.10	1%	4%
WPSD052	Siltstone	2.00	2.34	1.40	0.93	40%	39%
WPSD049	Phosphorite	0.74	0.93	0.44	0.48	52%	20%
WPSD046	Phosphorite	0.76	0.92	0.90	0.02	2%	1%
WPSD043	Phosphorite	0.54	0.86	0.26	0.60	70%	25%
WPSD041	Phosphorite	0.30	0.32	0.79	-0.46	-143%	19%
WPSD039	Dolostone	7.36	7.65	8.73	-1.08	-14%	45%
WPSD036	Phosphorite	0.58	0.65	0.33	0.32	49%	13%
WPSD033	Dolostone	8.40	8.63	9.52	-0.89	-10%	37%
WPSD031	Dolostone	8.25	8.24	9.15	-0.91	-11%	38%
WPSD030	Phosphorite	0.93	0.97	1.10	-0.13	-13%	5%
WPSD027	Phosphorite	0.17	0.17	0.07	0.09	56%	4%
WPSD025	Limestone	1.54	1.65	0.57	1.09	66%	45%
WPSD023	Phosphorite	1.66	1.73	1.49	0.24	14%	10%
WPSD020	Phosphorite	4.18	4.62	3.88	0.74	16%	31%
WPSD018	Dolostone	5.18	5.40	6.58	-1.18	-22%	49%
WPSD016	Phosphorite	5.17	5.23	6.67	-1.43	-27%	59%
WPSD014	Phosphorite	0.15	0.16	0.09	0.07	45%	3%
WPSD009	Mudstone	0.44	0.54	0.02	0.51	95%	21%
WPSD006	Dolostone	7.39	7.40	6.09	1.31	18%	54%
WPSD000.5	Phosphorite	0.09	0.08	0.04	0.04	55%	2%
WPSD000	Dolostone	10.50	10.63	11.75	-1.11	-10%	46%

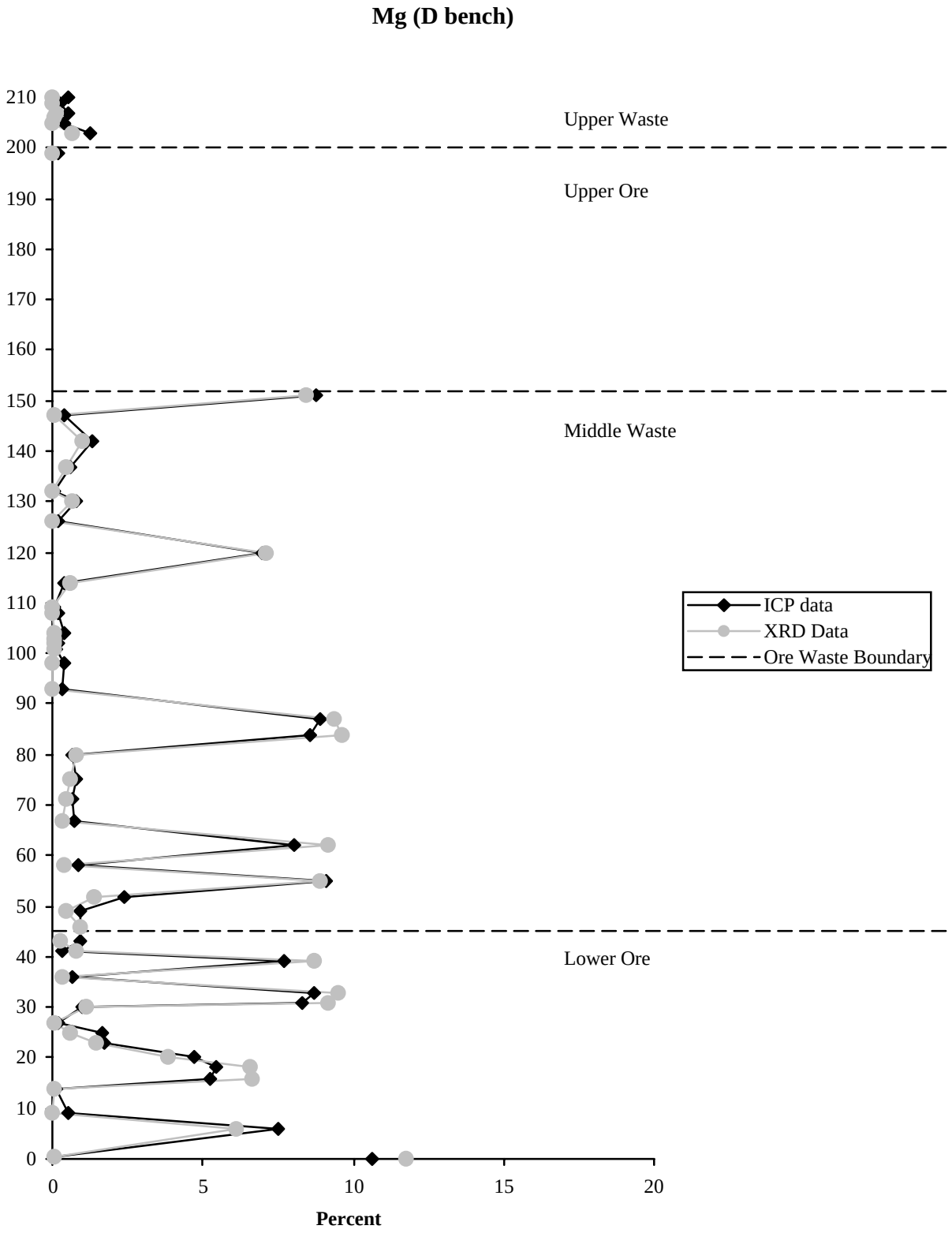

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

CO_3 (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	0.97	1.08	0.93	0.15	14%	5%
WPSD209	Phosphorite	0.13	0.13	0.00	0.13	100%	4%
WPSD207	Mudstone	0.37	0.42	0.12	0.30	72%	10%
WPSD206	Phosphorite	0.24	0.25	0.01	0.24	95%	8%
WPSD205	Mudstone	0.09	0.11	0.03	0.09	78%	3%
WPSD203	Mudstone	1.61	1.80	1.78	0.01	1%	0%
WPSD199	Phosphorite	0.22	0.23	0.00	0.23	100%	8%
WPSD151	Dolostone	11.24	11.00	11.11	-0.11	-1%	4%
WPSD147	Mudstone	0.88	1.03	0.09	0.94	91%	31%
WPSD142	Mudstone	1.47	1.64	1.65	-0.01	-1%	0%
WPSD137	Mudstone	1.47	1.73	1.72	0.01	1%	0%
WPSD132	Phosphorite	0.21	0.22	0.00	0.22	100%	7%
WPSD130	Mudstone	0.65	0.69	0.63	0.07	9%	2%
WPSD126	Carbon Seam	0.22	0.25	0.03	0.23	90%	7%
WPSD120	Dolostone	7.31	7.59	7.90	-0.31	-4%	10%
WPSD114	Mudstone	0.26	0.29	0.57	-0.29	-99%	9%
WPSD109	Phosphorite	0.11	0.12	0.00	0.12	100%	4%
WPSD108	Mudstone	0.08	0.09	0.04	0.06	62%	2%
WPSD104	Carbon Seam	0.17	0.21	0.00	0.21	100%	7%
WPSD103	Mudstone	0.03	0.03	0.08	-0.04	-132%	1%
WPSD102	Carbon Seam	0.24	0.29	0.00	0.29	100%	9%
WPSD101	Mudstone	0.05	0.06	0.08	-0.02	-37%	1%
WPSD098	Phosphorite	0.16	0.21	0.01	0.20	94%	7%
WPSD093	Siltstone	0.11	0.15	0.00	0.15	100%	5%
WPSD087	Dolostone	8.22	8.89	9.32	-0.43	-5%	14%
WPSD084	Dolostone	9.28	9.57	10.32	-0.75	-8%	24%
WPSD080	Mudstone	0.52	0.66	0.79	-0.13	-20%	4%
WPSD075	Siltstone	0.59	0.68	0.60	0.08	12%	3%
WPSD071	Siltstone	0.61	0.69	0.43	0.26	38%	9%
WPSD067	Siltstone	1.50	1.79	1.06	0.73	41%	24%
WPSD062	Dolostone	11.44	11.71	11.83	-0.11	-1%	4%
WPSD058	Phosphorite	1.41	1.62	1.05	0.57	35%	19%
WPSD055	Dolostone	10.43	10.49	10.88	-0.39	-4%	13%
WPSD052	Siltstone	4.18	4.90	3.47	1.43	29%	47%
WPSD049	Phosphorite	1.80	2.25	1.74	0.52	23%	17%
WPSD046	Phosphorite	2.09	2.53	2.40	0.13	5%	4%
WPSD043	Phosphorite	0.73	1.16	0.27	0.89	77%	29%
WPSD041	Phosphorite	0.66	0.71	0.76	-0.04	-6%	1%
WPSD039	Dolostone	8.71	9.06	9.52	-0.47	-5%	15%
WPSD036	Phosphorite	0.49	0.55	0.35	0.20	37%	7%
WPSD033	Dolostone	9.83	10.10	10.54	-0.45	-4%	15%
WPSD031	Dolostone	9.83	9.82	10.40	-0.58	-6%	19%
WPSD030	Phosphorite	1.24	1.30	1.08	0.22	17%	7%
WPSD027	Phosphorite	0.35	0.35	0.08	0.27	78%	9%
WPSD025	Limestone	7.64	8.21	8.07	0.14	2%	4%
WPSD023	Phosphorite	1.77	1.85	1.62	0.22	12%	7%
WPSD020	Phosphorite	4.39	4.86	3.80	1.05	22%	34%
WPSD018	Dolostone	5.27	5.50	6.49	-0.99	-18%	32%
WPSD016	Phosphorite	5.38	5.44	6.59	-1.14	-21%	37%
WPSD014	Phosphorite	0.57	0.61	0.34	0.27	44%	9%
WPSD009	Mudstone	0.26	0.32	0.01	0.31	96%	10%
WPSD006	Dolostone	7.37	7.38	6.22	1.16	16%	38%
WPSD000.5	Phosphorite	1.04	0.90	0.16	0.75	83%	24%
WPSD000	Dolostone	11.85	11.99	11.61	0.39	3%	13%

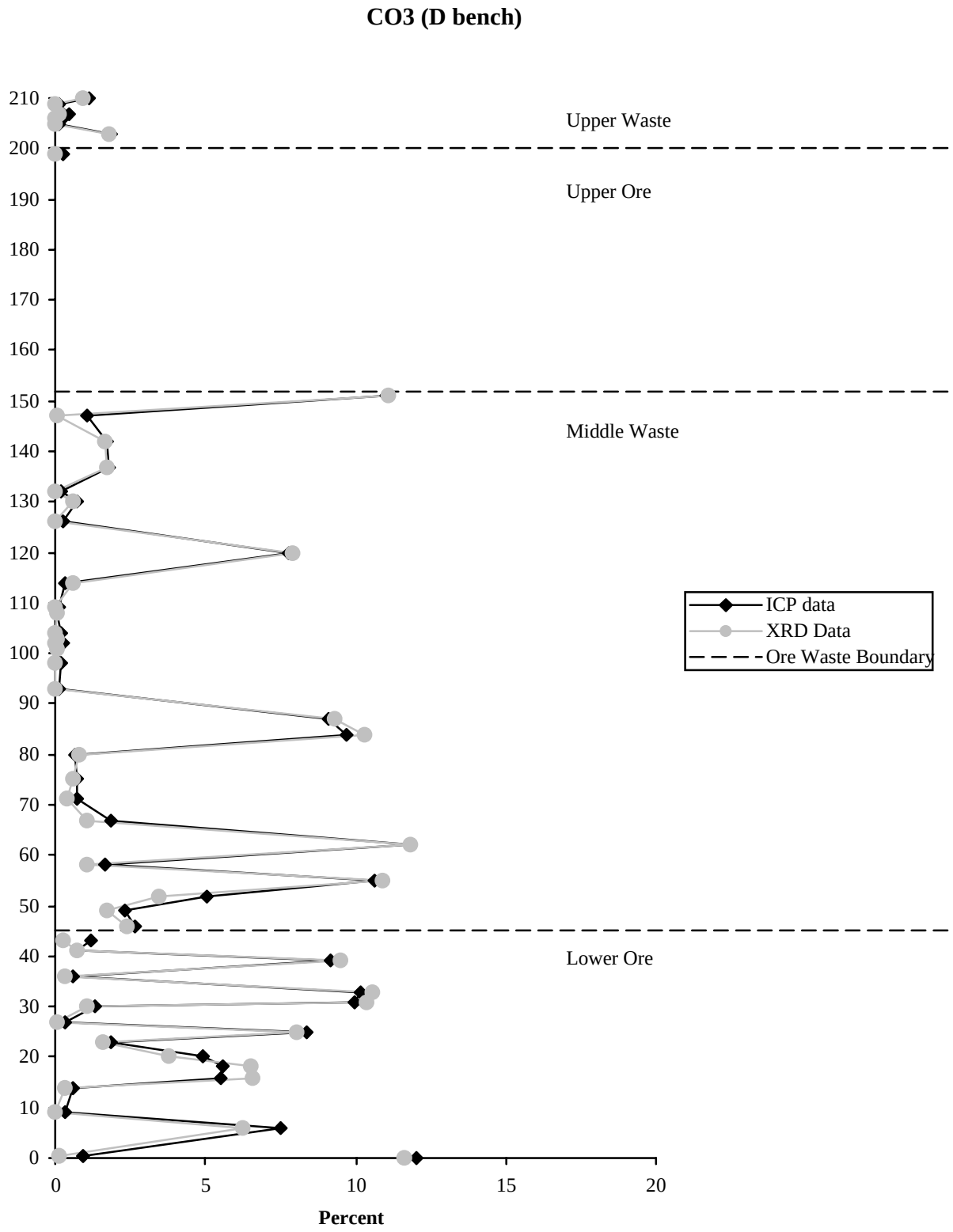

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 3b. Comparison of ICP data and calculated chemistry based on mineral compositions for each sample in measured stratigraphic section D - contunued.

Fe (D bench)

Sample #	Lithology	Measured % (ICP)	Normalized % (ICP)	Calculated % (XRD)	Difference (Normalized - Calculated)	% Error (Difference / Normalized)	Weighted % error
WPSD210	Mudstone	2.12	2.36	2.19	0.17	7%	10%
WPSD209	Phosphorite	1.30	1.35	0.47	0.88	65%	55%
WPSD207	Mudstone	2.18	2.45	0.23	2.22	91%	139%
WPSD206	Phosphorite	0.95	1.00	0.05	0.95	95%	59%
WPSD205	Mudstone	2.39	3.00	4.10	-1.10	-37%	69%
WPSD203	Mudstone	1.59	1.77	2.33	-0.55	-31%	35%
WPSD199	Phosphorite	1.09	1.16	0.23	-1.21	-104%	76%
WPSD151	Dolostone	0.29	0.28	0.23	-2.09	-736%	131%
WPSD147	Mudstone	1.42	1.66	0.19	-1.59	-96%	100%
WPSD142	Mudstone	1.84	2.05	2.37	0.80	39%	50%
WPSD137	Mudstone	1.77	2.08	2.37	-1.27	-61%	79%
WPSD132	Phosphorite	1.54	1.63	2.00	-1.12	-69%	70%
WPSD130	Mudstone	2.21	2.35	2.37	-0.82	-35%	51%
WPSD126	Carbon Seam	2.77	3.18	3.26	-0.49	-15%	31%
WPSD120	Dolostone	1.10	1.14	1.26	-1.79	-157%	112%
WPSD114	Mudstone	2.97	3.29	3.35	2.36	72%	147%
WPSD109	Phosphorite	2.44	2.65	2.75	0.14	5%	9%
WPSD108	Mudstone	2.53	2.96	3.17	0.03	1%	2%
WPSD104	Carbon Seam	2.17	2.70	3.68	-0.65	-24%	40%
WPSD103	Mudstone	2.43	2.73	2.93	1.98	73%	124%
WPSD102	Carbon Seam	0.90	1.07	0.93	0.42	39%	26%
WPSD101	Mudstone	2.33	2.67	2.51	0.15	6%	10%
WPSD098	Phosphorite	1.63	2.25	2.93	2.25	100%	141%
WPSD093	Siltstone	1.94	2.68	3.35	2.49	93%	156%
WPSD087	Dolostone	0.99	1.07	0.74	-2.23	-209%	140%
WPSD084	Dolostone	0.67	0.69	0.65	-0.43	-62%	27%
WPSD080	Mudstone	2.15	2.72	2.51	0.58	21%	36%
WPSD075	Siltstone	2.16	2.48	0.00	1.60	64%	100%
WPSD071	Siltstone	2.24	2.55	0.19	-0.11	-4%	7%
WPSD067	Siltstone	2.03	2.42	3.30	-0.83	-34%	52%
WPSD062	Dolostone	0.40	0.41	1.12	-2.34	-570%	146%
WPSD058	Phosphorite	1.79	2.05	2.14	1.87	91%	117%
WPSD055	Dolostone	0.51	0.51	0.88	0.47	91%	29%
WPSD052	Siltstone	1.33	1.56	2.65	1.56	100%	97%
WPSD049	Phosphorite	1.76	2.20	3.26	1.74	79%	109%
WPSD046	Phosphorite	1.69	2.04	2.75	1.76	86%	110%
WPSD043	Phosphorite	1.74	2.77	0.19	2.72	98%	170%
WPSD041	Phosphorite	0.75	0.81	0.05	0.72	89%	45%
WPSD039	Dolostone	0.43	0.45	0.00	0.45	100%	28%
WPSD036	Phosphorite	1.85	2.08	0.47	1.38	66%	87%
WPSD033	Dolostone	0.44	0.45	0.28	0.31	69%	20%
WPSD031	Dolostone	0.59	0.59	0.37	-1.37	-232%	85%
WPSD030	Phosphorite	0.59	0.62	0.05	0.62	100%	39%
WPSD027	Phosphorite	0.73	0.74	0.09	0.74	100%	46%
WPSD025	Limestone	0.87	0.93	0.00	-0.42	-44%	26%
WPSD023	Phosphorite	0.48	0.50	0.70	0.50	100%	31%
WPSD020	Phosphorite	0.65	0.72	0.14	0.63	87%	39%
WPSD018	Dolostone	0.59	0.62	1.95	0.52	85%	33%
WPSD016	Phosphorite	0.39	0.39	0.00	-1.00	-253%	63%
WPSD014	Phosphorite	0.29	0.31	0.00	0.31	100%	19%
WPSD009	Mudstone	1.72	2.11	1.35	2.11	100%	132%
WPSD006	Dolostone	0.78	0.78	0.00	0.78	100%	49%
WPSD000.5	Phosphorite	0.13	0.11	0.09	0.11	100%	7%
WPSD000	Dolostone	0.14	0.14	0.09	0.14	100%	9%

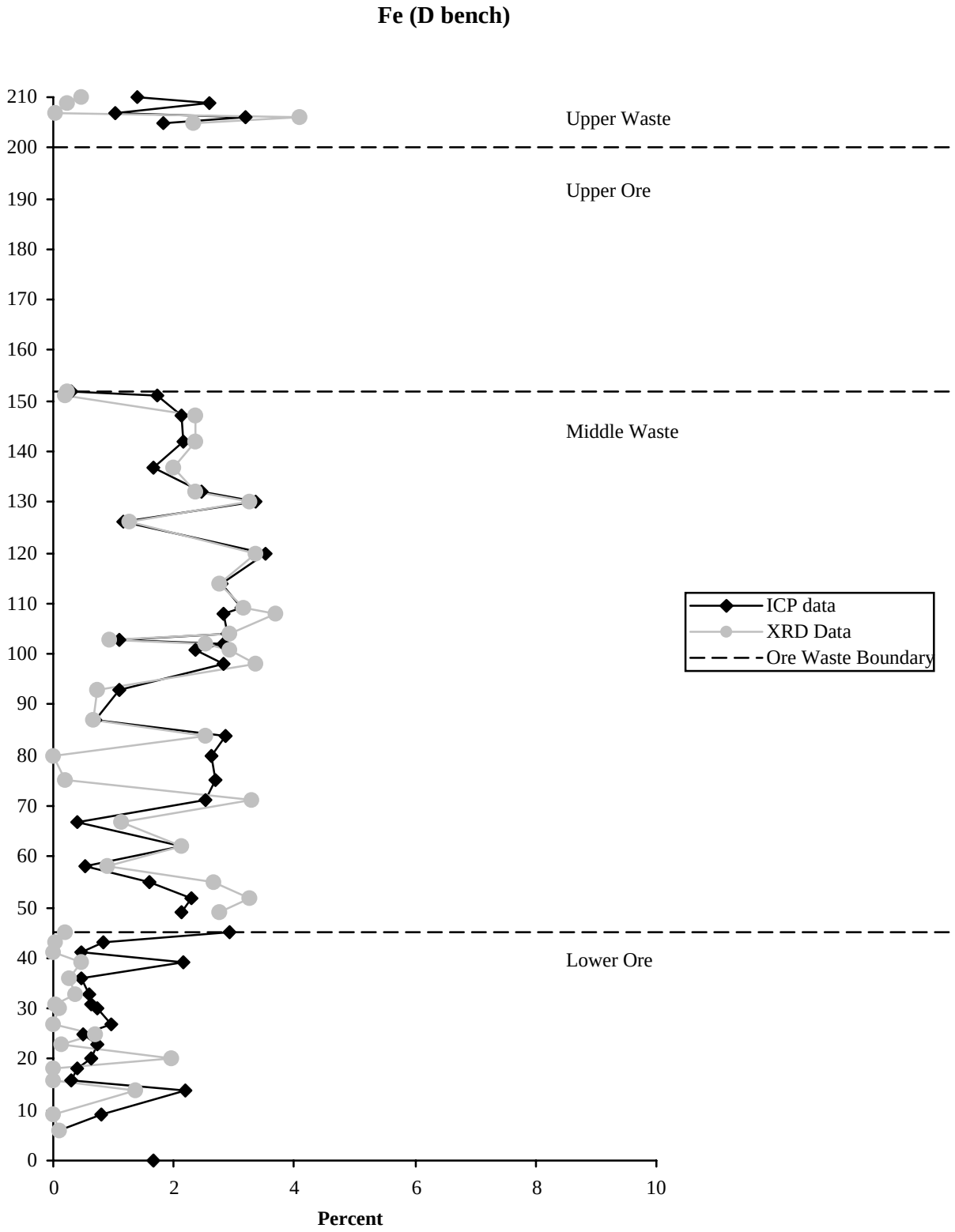

Figure 6b. Comparison of collected (ICP) and calculated (XRD) chemistry for each sample over the measured section D - continued.

Table 4. Reported errors for ICP data.

	Ca		P		Si		K	
	value	%	value	%	value	%	value	%
obs	1.08	2	0.07	-19	32.3	-4	2.92	-2
std	1.06		0.09		33.6		2.98	
obs	0.57	-1	0.07	-17	32.2	-4	2.89	-1
std	0.58		0.08		33.5		2.92	

	Al		Na		Mg		CO_3	
	value	%	value	%	value	%	value	%
obs	5.78	0	1.49	-2	0.51	-7	1.1	13
std	5.79		1.53		0.55		0.97	
obs	5.98	-2	1.14	-4	0.46	-8	0.29	-2
std	6.09		1.19		0.50		0.30	