Geologic Cross Sections Showing the Concentrations of As, Cd, Co, Cu, Cr, Fe, Mo, Ni, Pb, and Zn in Acid-Insoluble Residues of Paleozoic Rocks within the Doniphan/Eleven Point Ranger District of the Mark Twain National Forest, Missouri, USA.

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By Lopaka Lee *and* Martin B. Goldhaber

Introduction

This report is a product of a U.S. Geological Survey investigation that is focused on characterizing the potential environmental impacts of lead-zinc mining within the Doniphan/Eleven Point ranger district of the Mark Twain national forest. The elemental concentrations of iron (Fe), arsenic (As), cadmium (Cd), cobalt (Co), copper (Cu), chromium (Cr), nickel (Ni), lead (Pb), and zinc (Zn) in acid-insoluble residues are shown for boreholes along two geologic cross sections within Doniphan/Elevan Point ranger district (Figure 1).

The purpose of this report is to characterize, in a general sense, the distribution of economically and environmentally important elements within the rocks and aquifers of the Doniphan/Eleven Point ranger district.

Other related open-file reports include: *The distribution of MVT-related metals in acid-insoluble residues of Paleozoic rocks of the Ozark Plateaus region of the United States* (Lee and Goldhaber, 2001a), and *The distribution of dissolved MVT-related metals in ground-water of the Ozark Plateaus region of the United States* (Lee and Goldhaber, 2001b).

Description of the Dataset

The cross sections of figures X through X summarize the metal content of 1,123 acid-insoluble residues of rock samples from 9 boreholes within the Doniphan/Eleven Point ranger district. These samples were collected and analyzed as part of the U.S.G.S Conterminous U.S. Mineral Assessment Program (CUSMAP) of the Ozark region (Erickson and others, 1978a, 1978b, 1981, 1985, 1988a, 1988b, 1990, 1991, Martin and Pratt, 1991). This program evaluated the mineral resource potential of selected 1x2 degree quadrangles within the Ozarks. The CUSMAP project identified areas with a high potential for Mississippi Valley Type (MVT) ore deposits by analyzing and mapping the concentrations of metals in acid(HCl)-insoluble residues of borehole rock samples. The acid-insoluble residues of Ozark rocks predominately contain metal sulfides such as pyrite (FeS_2), sphalerite (ZnS), and galena (PbS) (Erickson and others, 1981). These metal sulfides also contain trace amounts of other metals within their structure, such as As, Cd, Co, Cr, Cu, Mo, and Ni (Ericskson and others, 1981, Hagni, 1983).

The rock samples from which the acid-insoluble residues were derived are representative composites of borehole intervals. In most cases, samples are representative composites of each 10ft of borehole. However, some samples are composites of larger intervals.

Semi-quantitative direct current arc emission spectrometer analyses were used to determine concentrations of 32 elements in the acid insoluble residues of rock samples using a method described by Grimes and Marranzino (1968). This technique reports elemental concentrations in six steps per order of magnitude (The upper limits each step for each order of magnitude being: 0.15, 0.2, 0.3, 0.5, 0.7, 1). The precision of chemical determinations is within two steps of the reported value 96 percent of the time.

Data Compilation Procedures

The data of this report was compiled from the USGS National Geochemical Database. The dataset was checked for both positional, geologic, and analytical errors. Latitudes, longitudes, and geologic formation information were checked against maps and paper records of borehole logs on file at the USGS Denver office and the Missouri Department of Natural Resources, Rolla Missouri. The reported analytical results were compared to the original paper lab reports on file at the

USGS Denver office.

Nine MVT-related metals were chosen for investigation: iron (Fe), arsenic (As), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn). These elements were chosen because: (1) elevated concentrations of these metals are associated with MVT mineralization, and can therefore indicate the presence of MVT sulfides; and (2) each has important economic and environmental significance.

Cross Sections Showing the Down-Hole Distribution Of Metals

Figure 1 shows the location and orientation of the cross sections A-A' and B-B' within the Doniphan/Eleven Point ranger district. Table 1 shows a generalized stratigraphic section of the Ozark region. The shaded formations of Table 1 are the formations that are represented within the boreholes of A-A' and B-B'.

Figures 1 through X show the down-hole distribution of metals along cross sections A-A' and B-B'. The cross sections are "strip logs" that show the down-hole concentration of elements and formation boundaries. Elemental concentrations are shown as a down-hole bar chart – the horizontal length of bars is proportional to elemental concentration and the vertical thickness of the bars correspond to the total interval that was composited for each sample. All cross sections use the Bonneterre Formation as a reference horizon; the displayed vertical units of the cross sections are feet relative to the top of the formation.

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Table 1. Generalized stratigraphic section of the Ozark Plateaus region. Shaded area show the formations present in boreholes A-A′ and B-B′.

Geologic Age	Geologic Formation	Hydrologic Unit	Hydrologic System
Pennsylvanian	Pennsylvanian, undifferentiated	*Western Interior Plains confining units*	*Western Interior Plains confining system*
Mississippian	Keokuk-burlington Limestones, undiff. Elsey Formation Warsaw Formation Boone Formation Fern Glen Limestone Reeds Spring Limestone Pierson Formation Grand Falls Formation	*Springfield Plateau aquifer unit*	*Ozark aquifer system*
	North View Shale Compton Formation Chattanooga Shale	*Ozark confining unit*	
Ordovician	St. Peter Sandstone Everton Formation Powell Dolomite Cotter Dolomite Cotter-Jefferson City Dolomites, undiff. Jefferson City Dolomite Roubidoux Formation	*Ozark aquifer unit*	
Cambrian	Gasconade Dolomite Gunter Sandstone Eminence Dolomite Potosi Dolomite	*Ozark aquifer unit*	
	Derby-Doerun Formation Davis Shale Bonneterre-Davis undifferentiated	*St. Francois confining unit*	
	Bonneterre Formation Lamotte Sandstone	*St. Francois aquifer unit*	
Precambrian	Precambrian, undifferentiated	*Precambrian confining unit*	

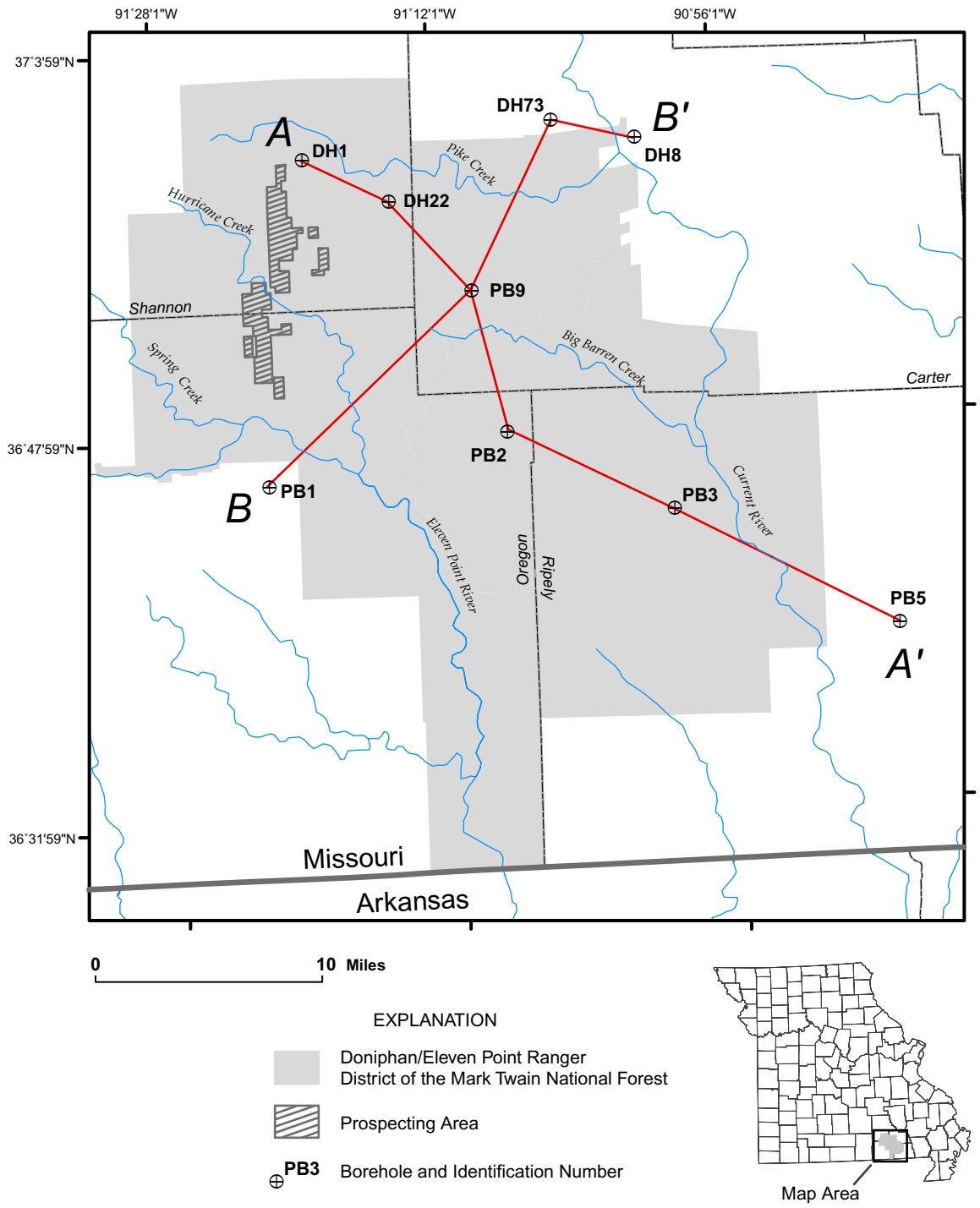

Figure 1. The location of boreholes and orientation of the cross sections A-A' and B-B' within the Doniphan/Eleven Point ranger district.

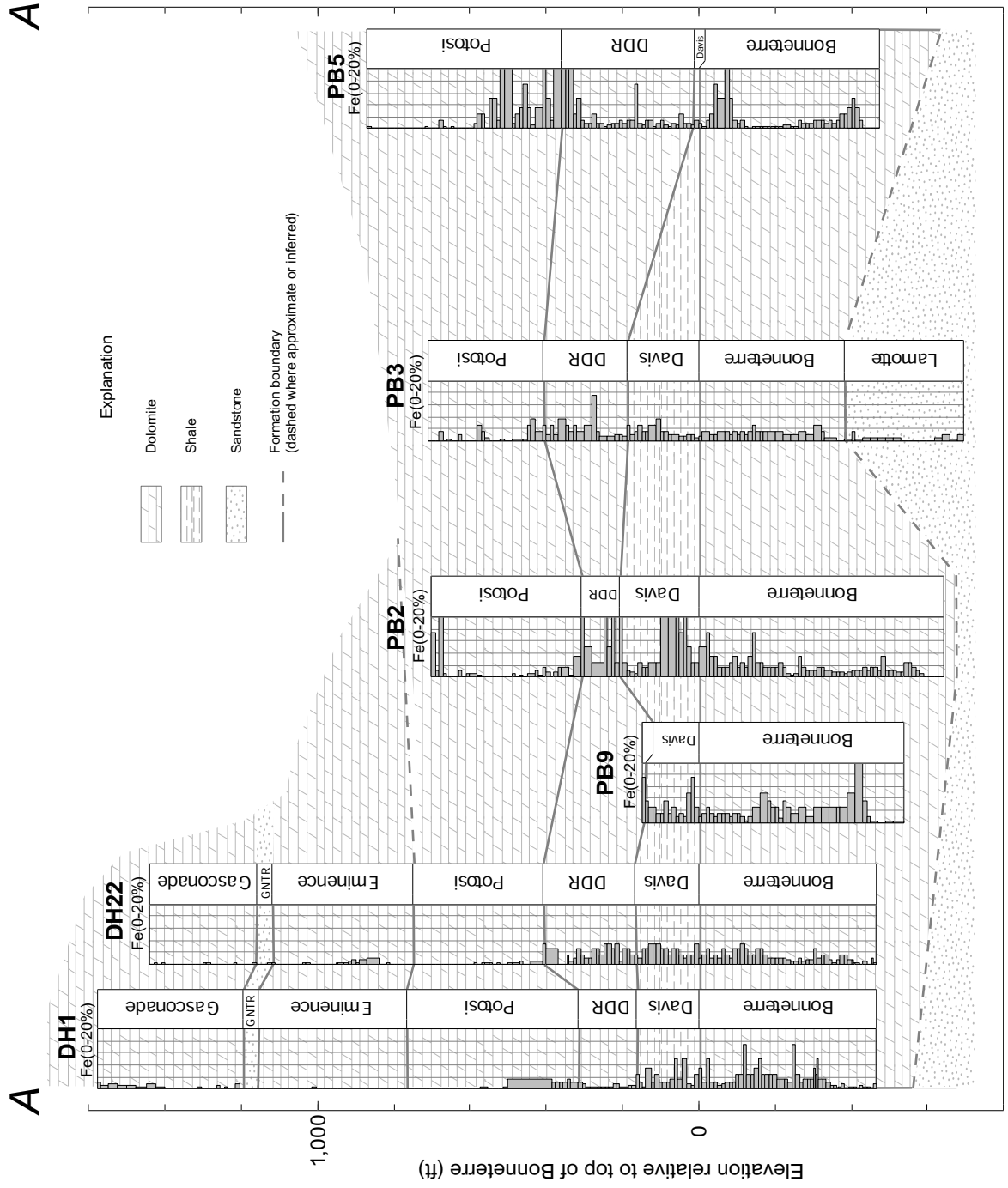

Figure 2. Cross section A-A' (see Figure 1) showing the down-hole distribution of iron in acid-insoluble residues of bore-hole rock samples.

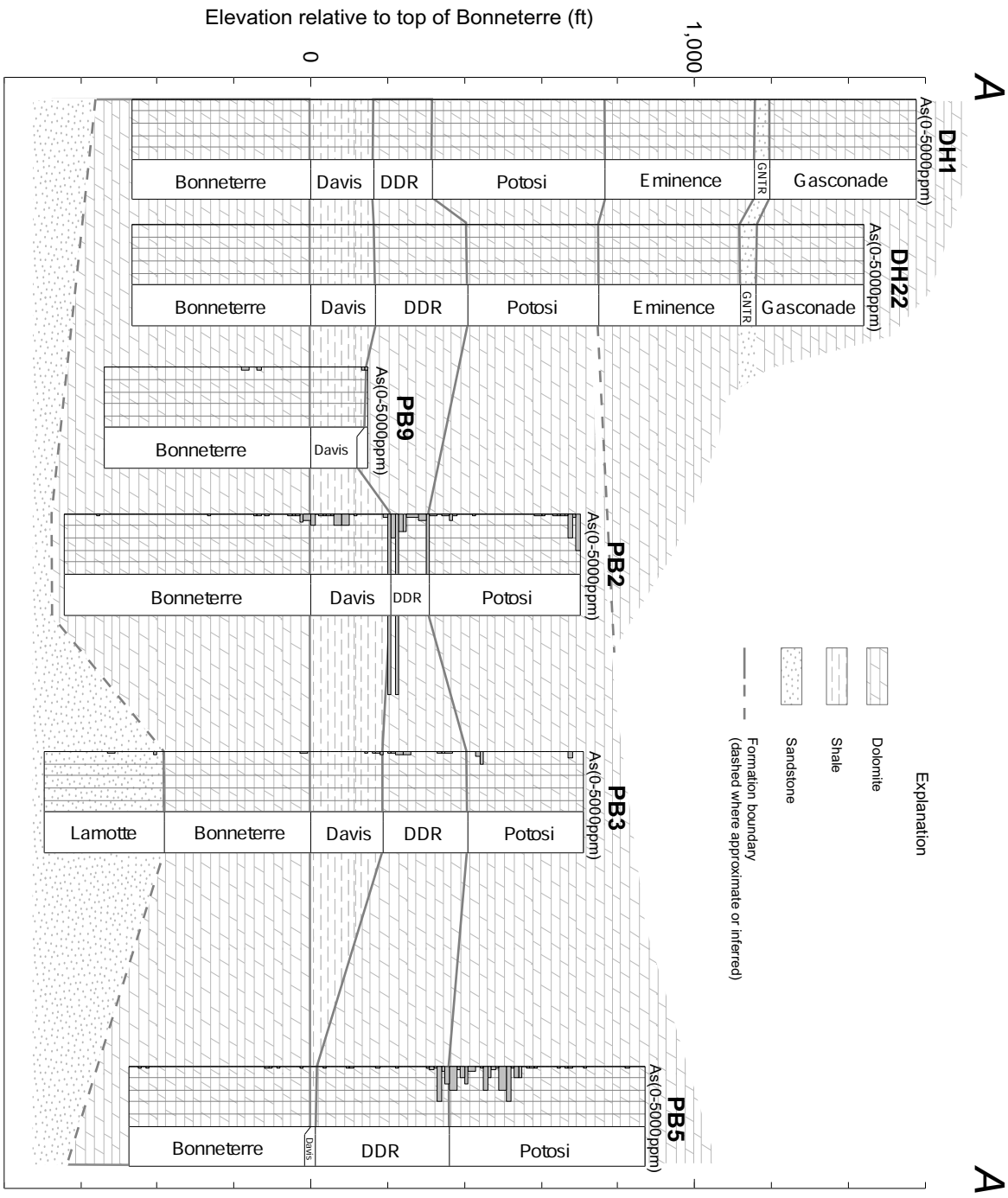

Figure 3. Cross section A-A' (see Figure 1) showing the down-hole distribution of arsenic in acid-insoluble residues of bore-hole rock samples.

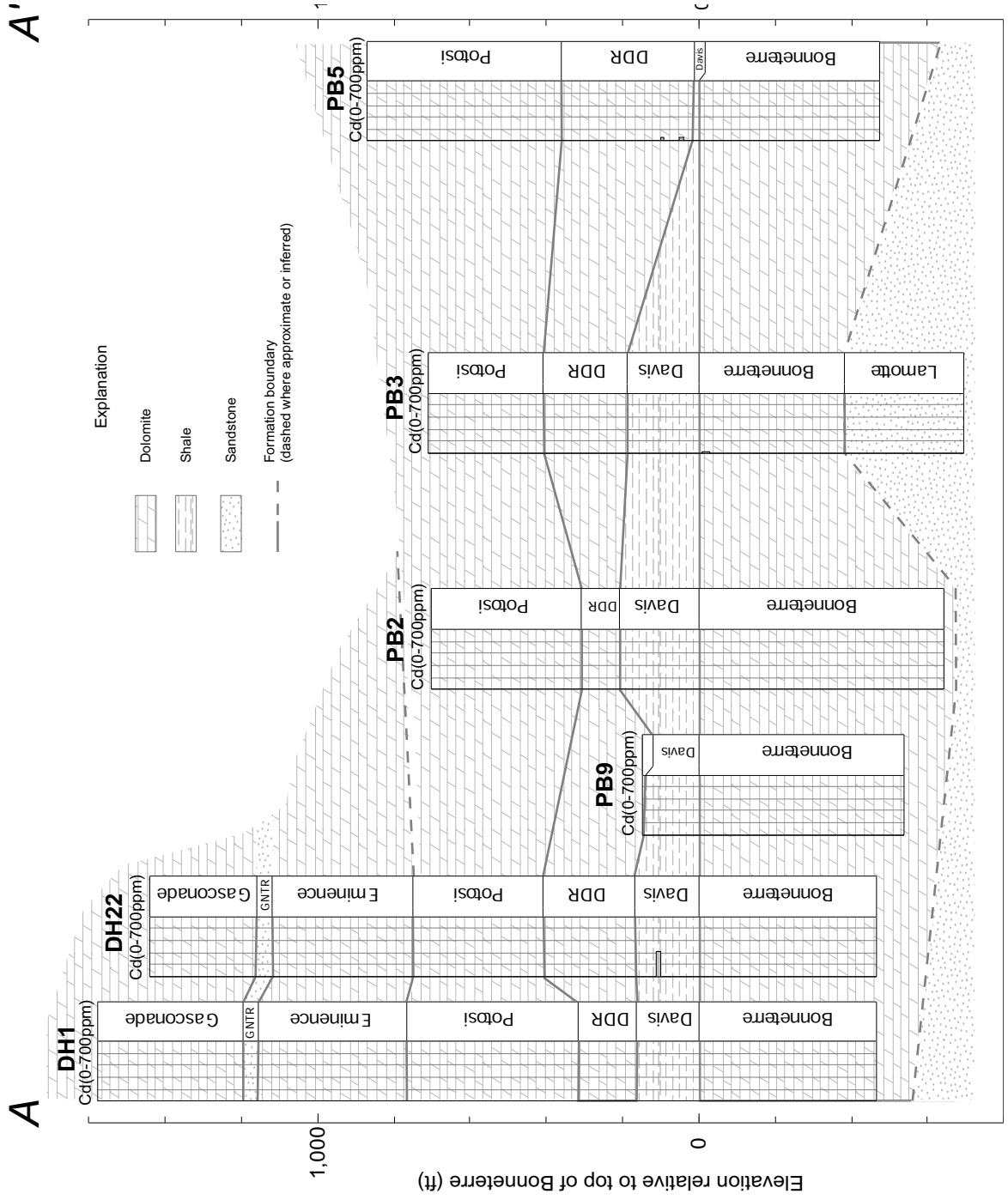

Figure 4. Cross section A-A' (see Figure 1) showing the down-hole distribution of cadmium in acid-insoluble residues of bore-hole rock samples.

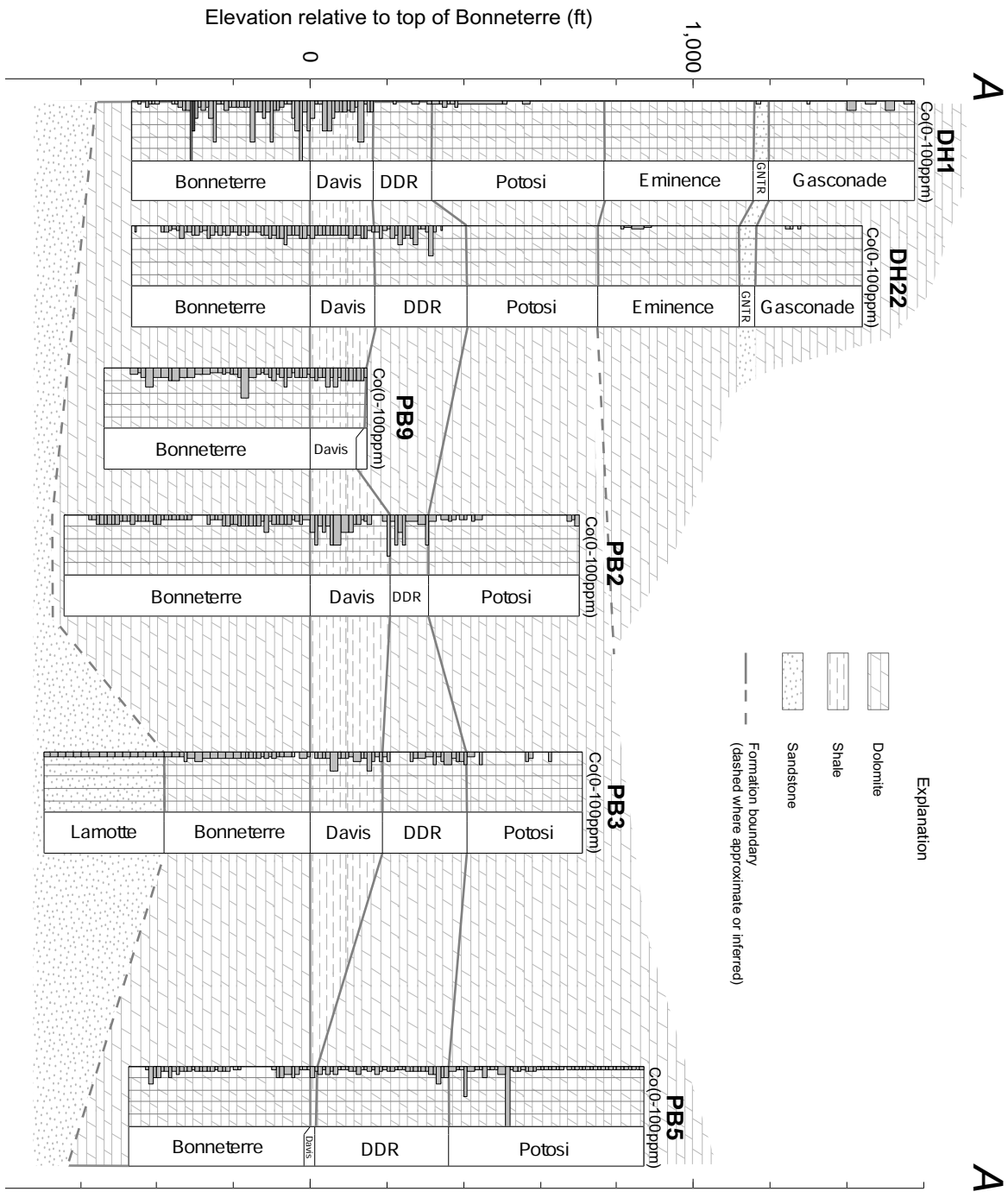

Figure 5. Cross section A-A' (see Figure 1) showing the down-hole distribution of cobalt in acid-insoluble residues of bore-hole rock samples.

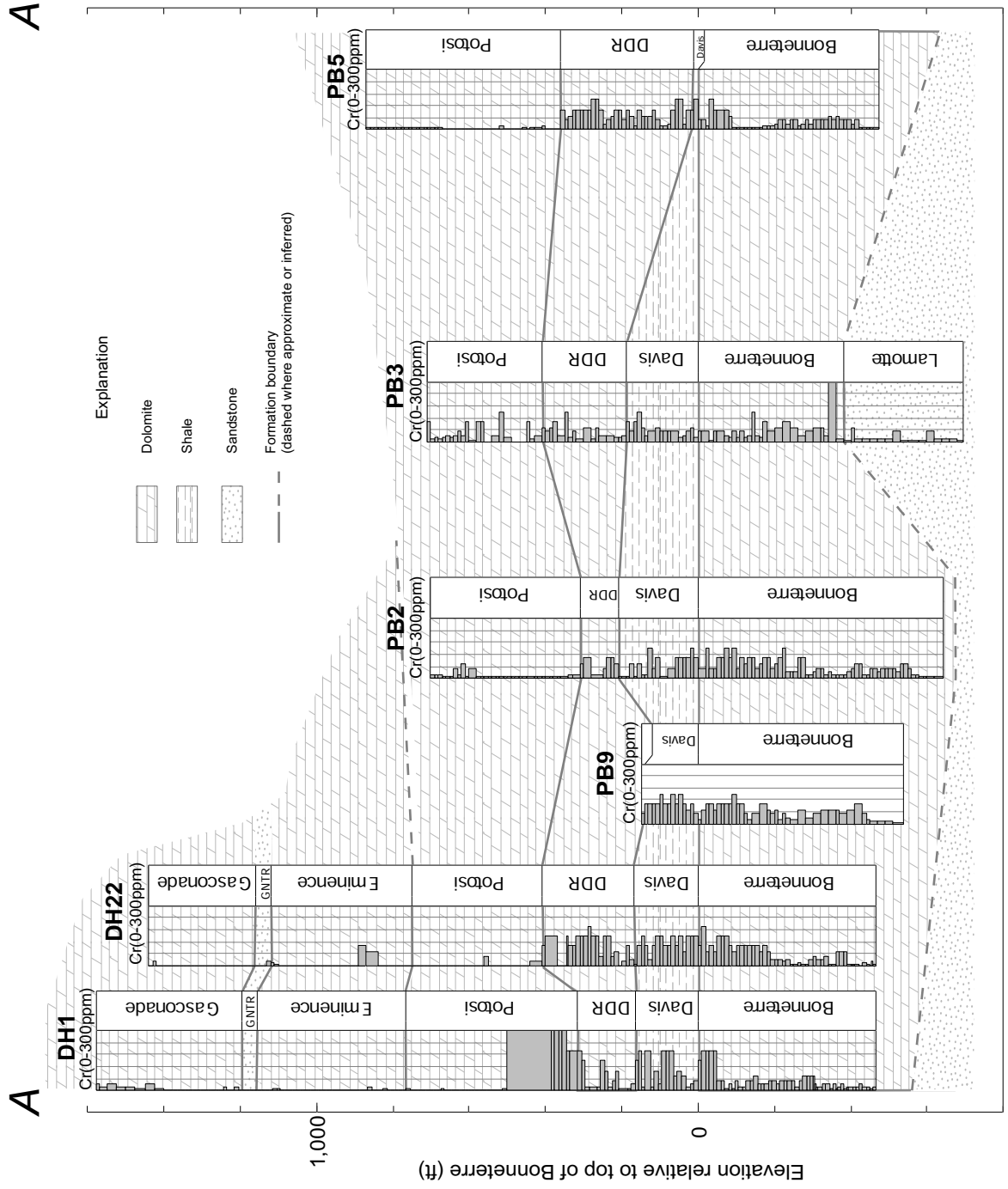

Figure 6. Cross section A-*A'* (see Figure 1) showing the down-hole distribution of chromium in acid-insoluble residues of bore-hole rock samples.

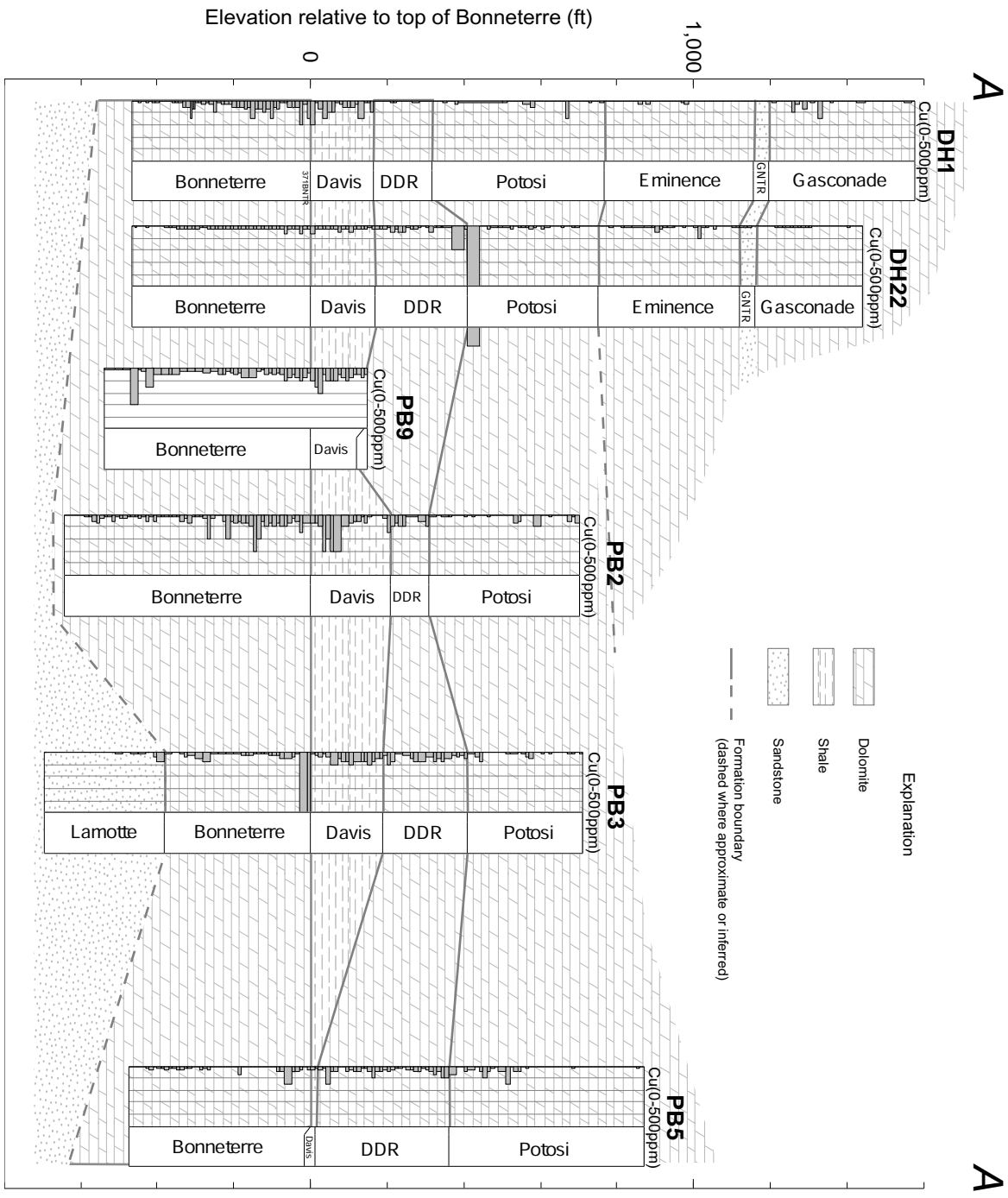

Figure 7. Cross section A-A' (see Figure 1) showing the down-hole distribution of copper in acid-insoluble residues of bore-hole rock samples.

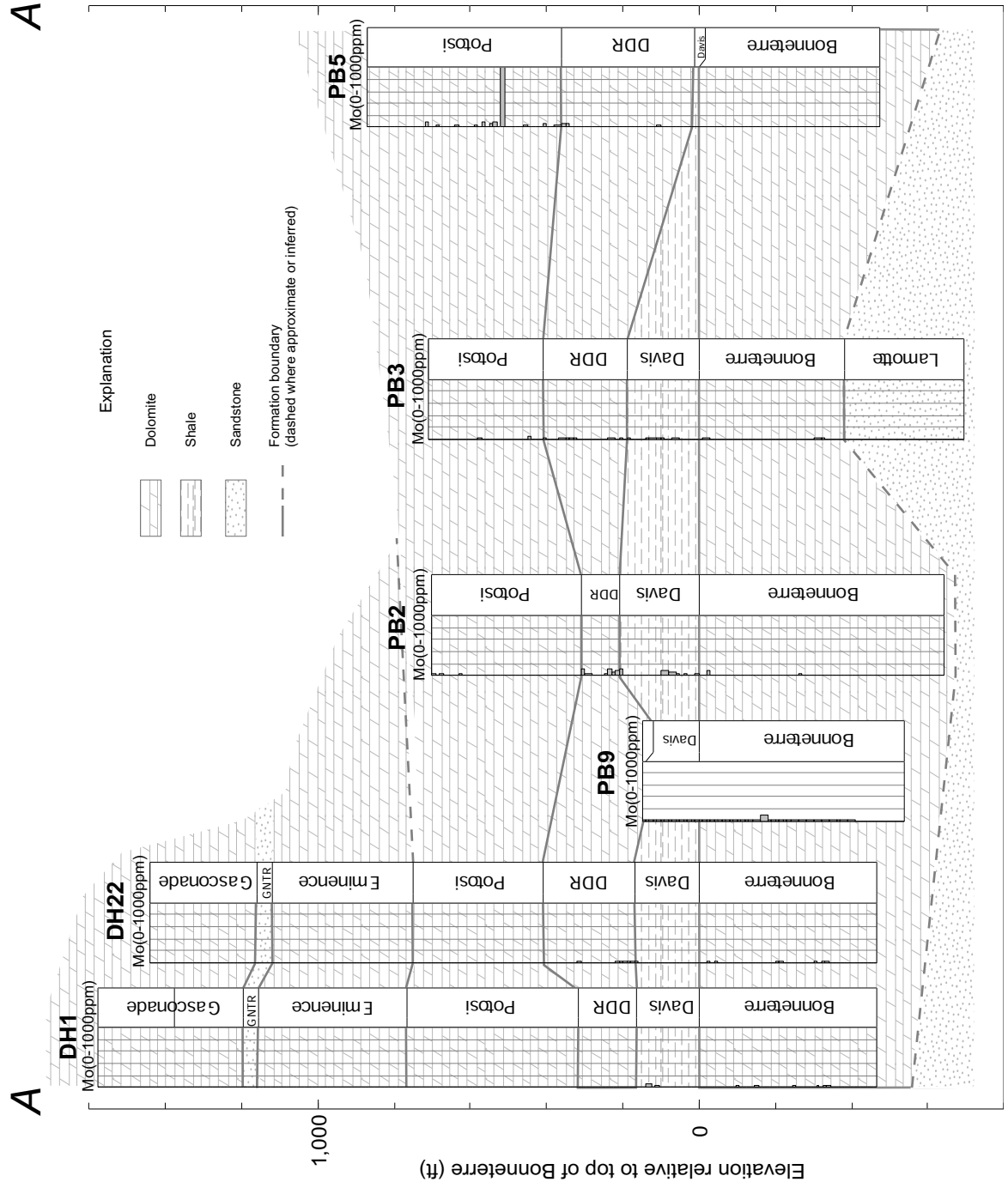

Figure 8. Cross section A-A' (see Figure 1) showing the down-hole distribution of molybdenum in acid-insoluble residues of bore-hole rock samples.

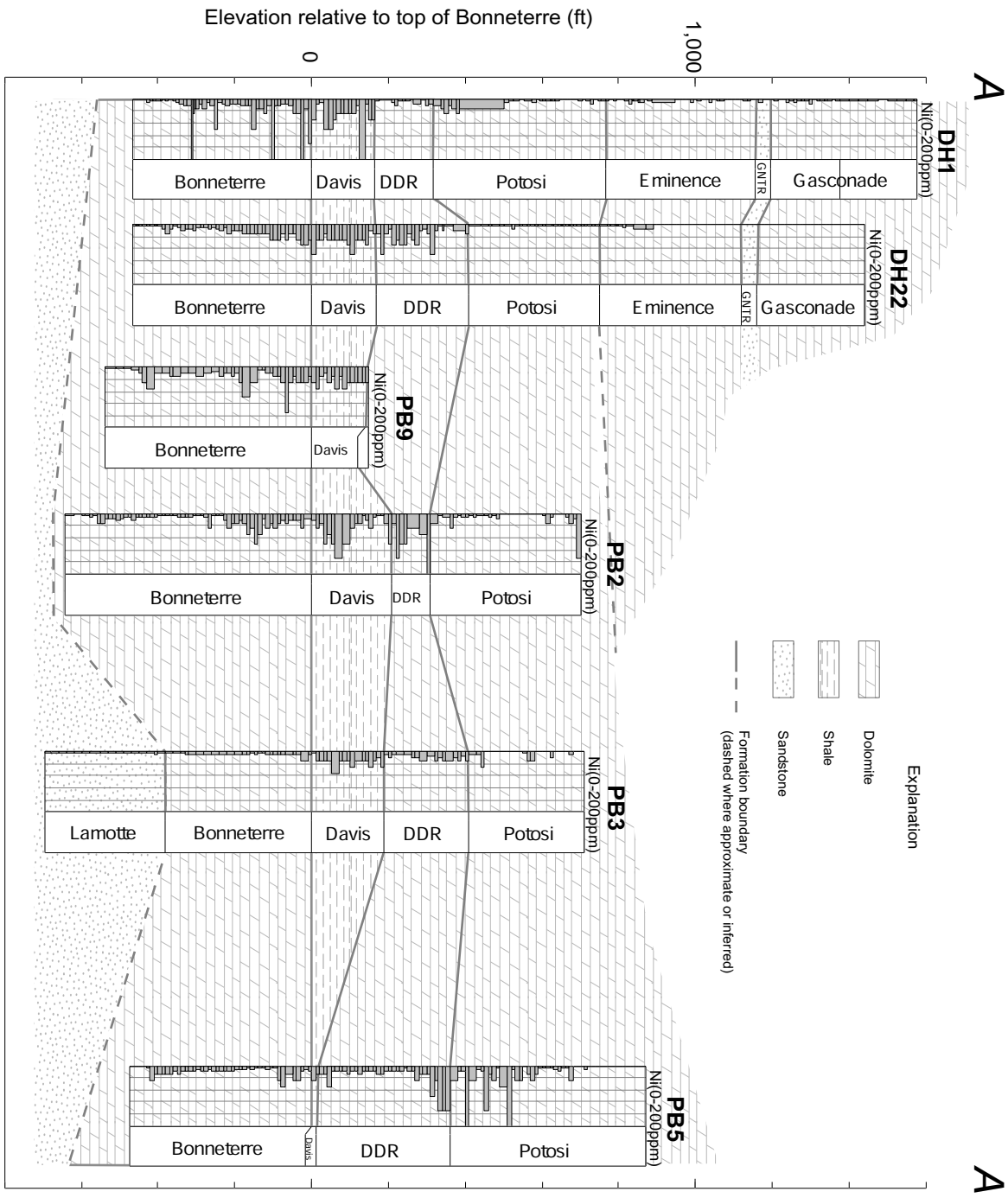

Figure 9. Cross section A-A' (see Figure 1) showing the down-hole distribution of nickel in acid-insoluble residues of bore-hole rock samples.

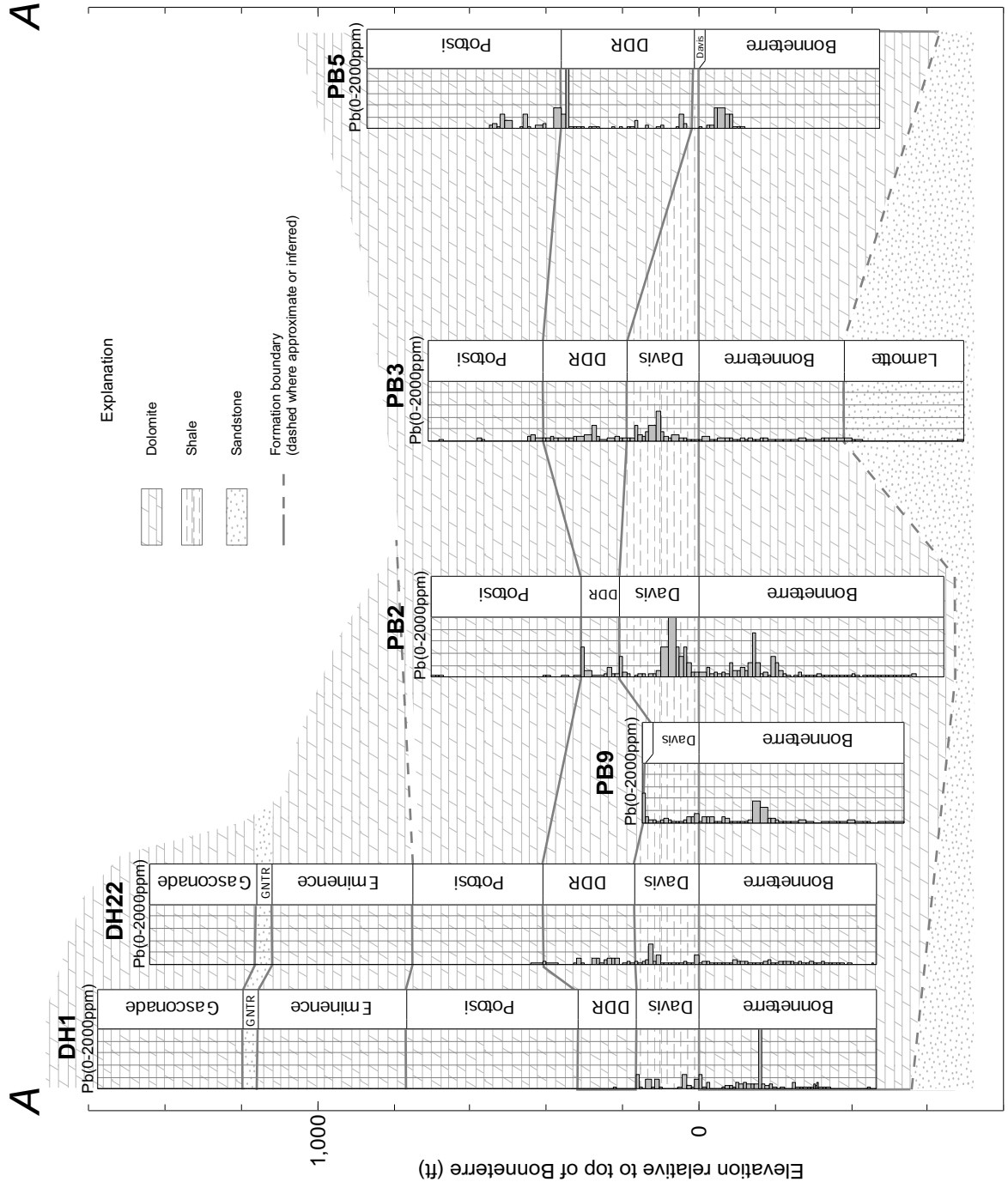

Figure 10. Cross section A-A' (see Figure 1) showing the down-hole distribution of lead in acid-insoluble residues of bore-hole rock samples.

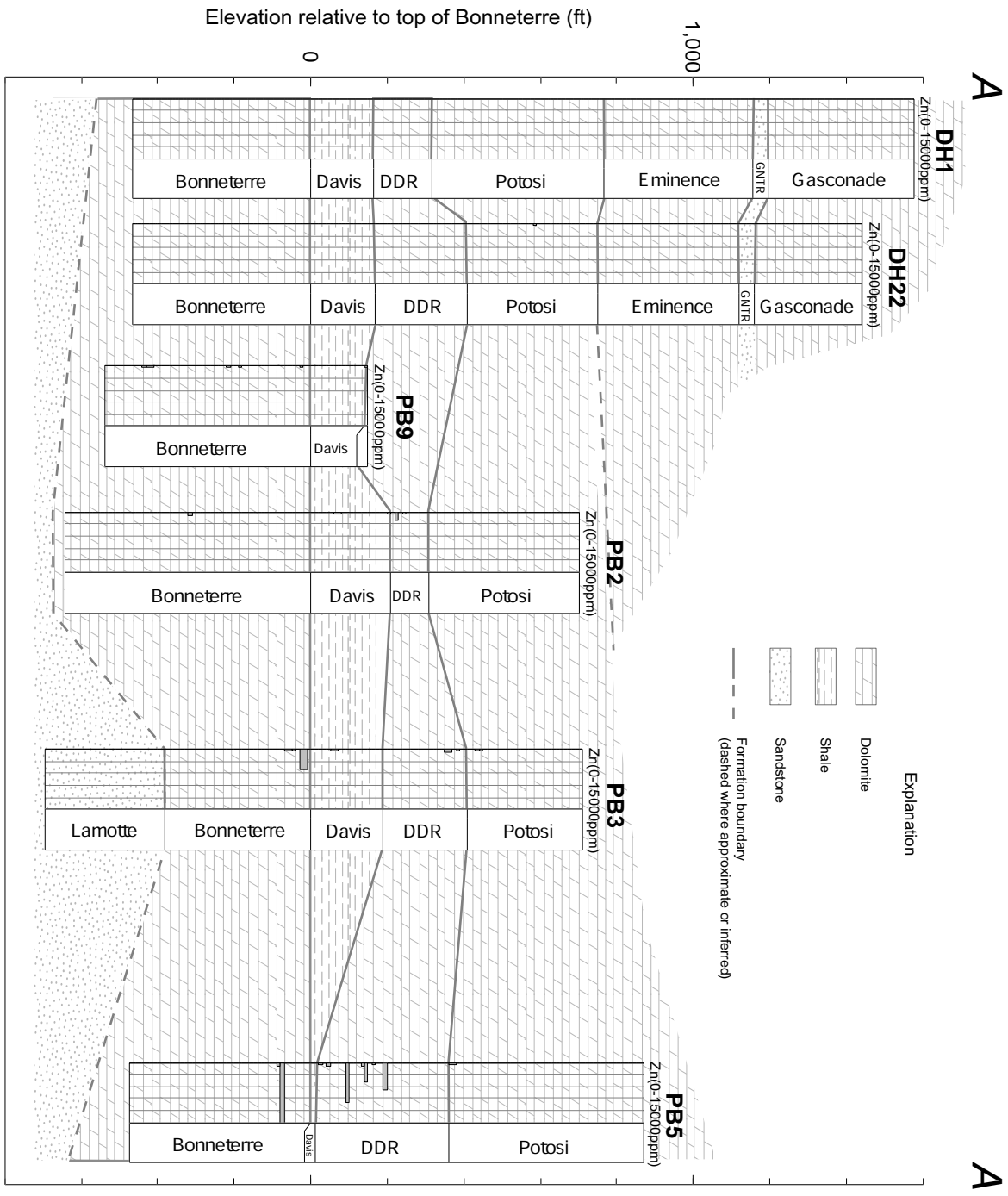

Figure 11. Cross section A-A' (see Figure 1) showing the down-hole distribution of zinc in acid-insoluble residues of bore-hole rock samples.

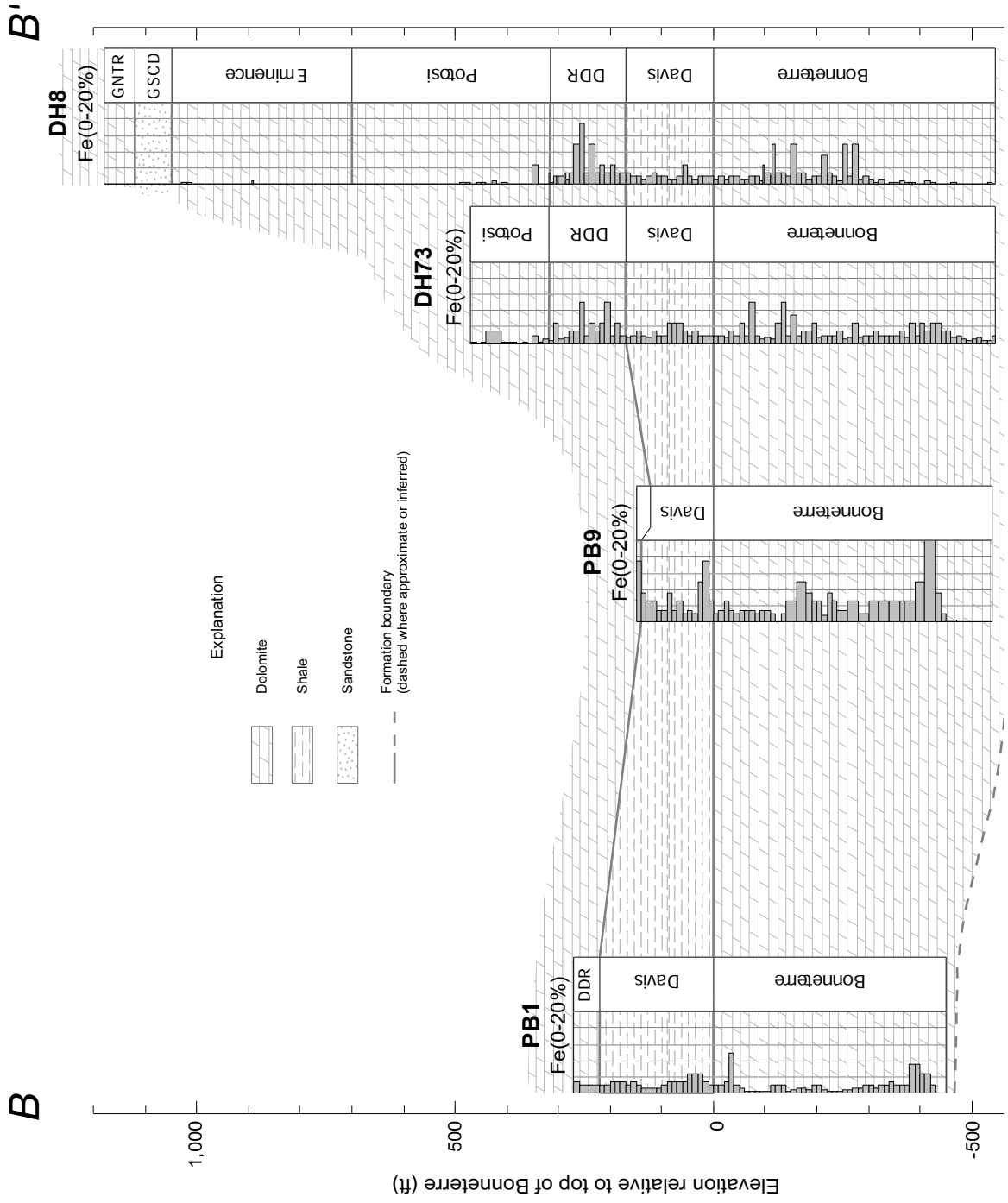

Figure 12. Cross section B-B′ (see Figure 1) showing the down-hole distribution of iron in acid-insoluble residues of bore-hole rock samples.

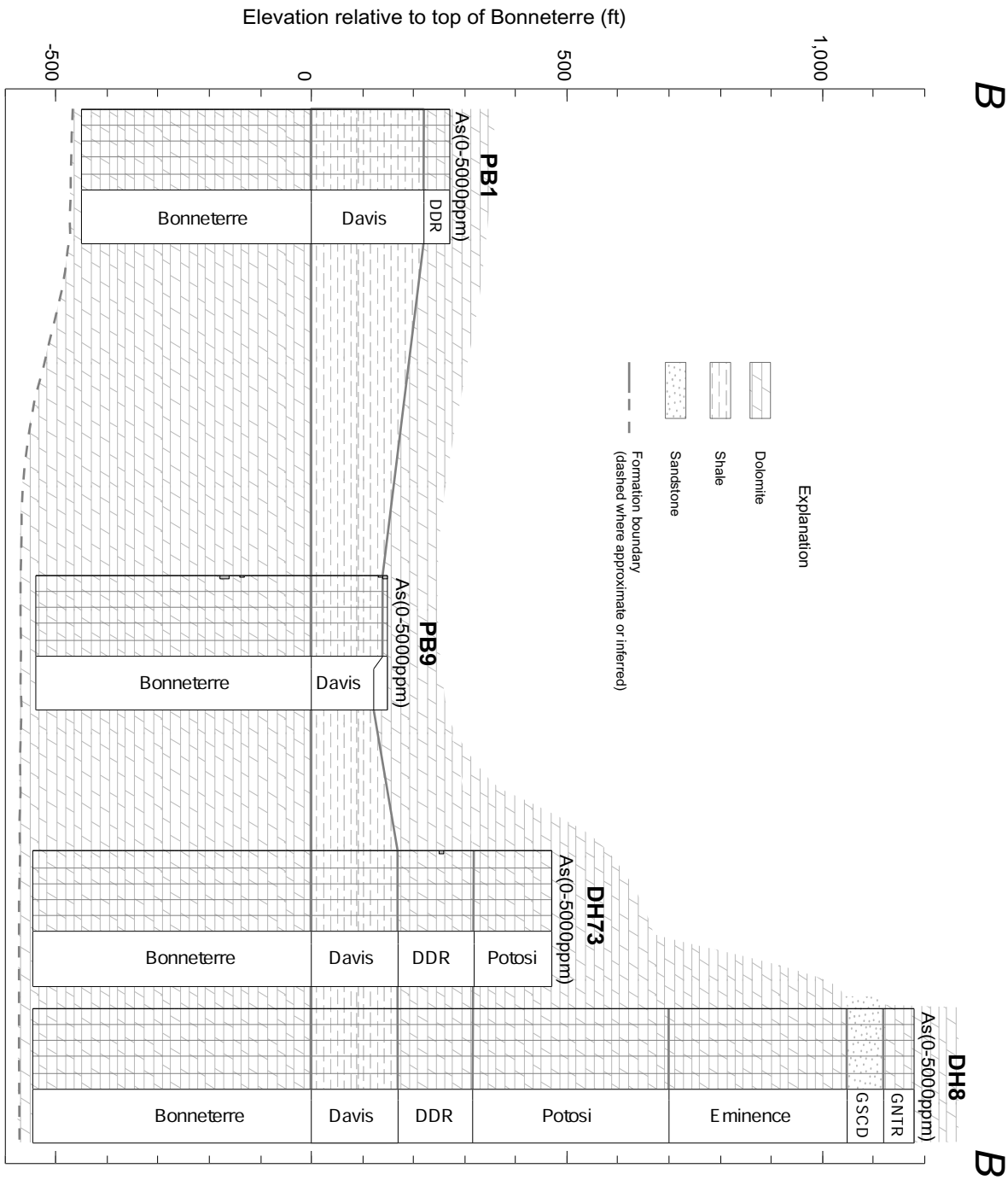

Figure 13. Cross section B-B' (see Figure 1) showing the down-hole distribution of arsenic in acid-insoluble residues of bore-hole rock samples.

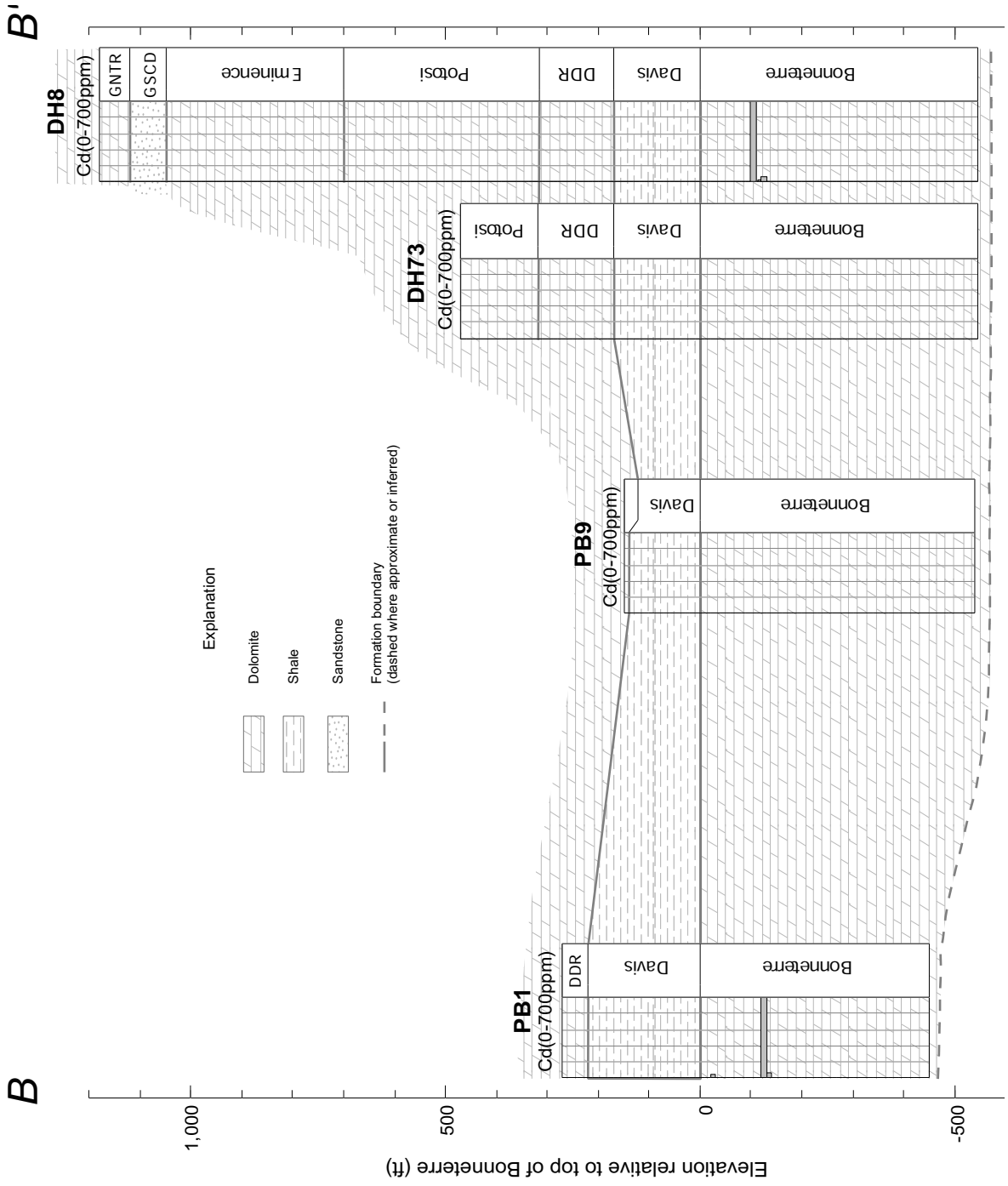

Figure 14. Cross section B-B′ (see Figure 1) showing the down-hole distribution of cadmium in acid-insoluble residues of bore-hole rock samples.

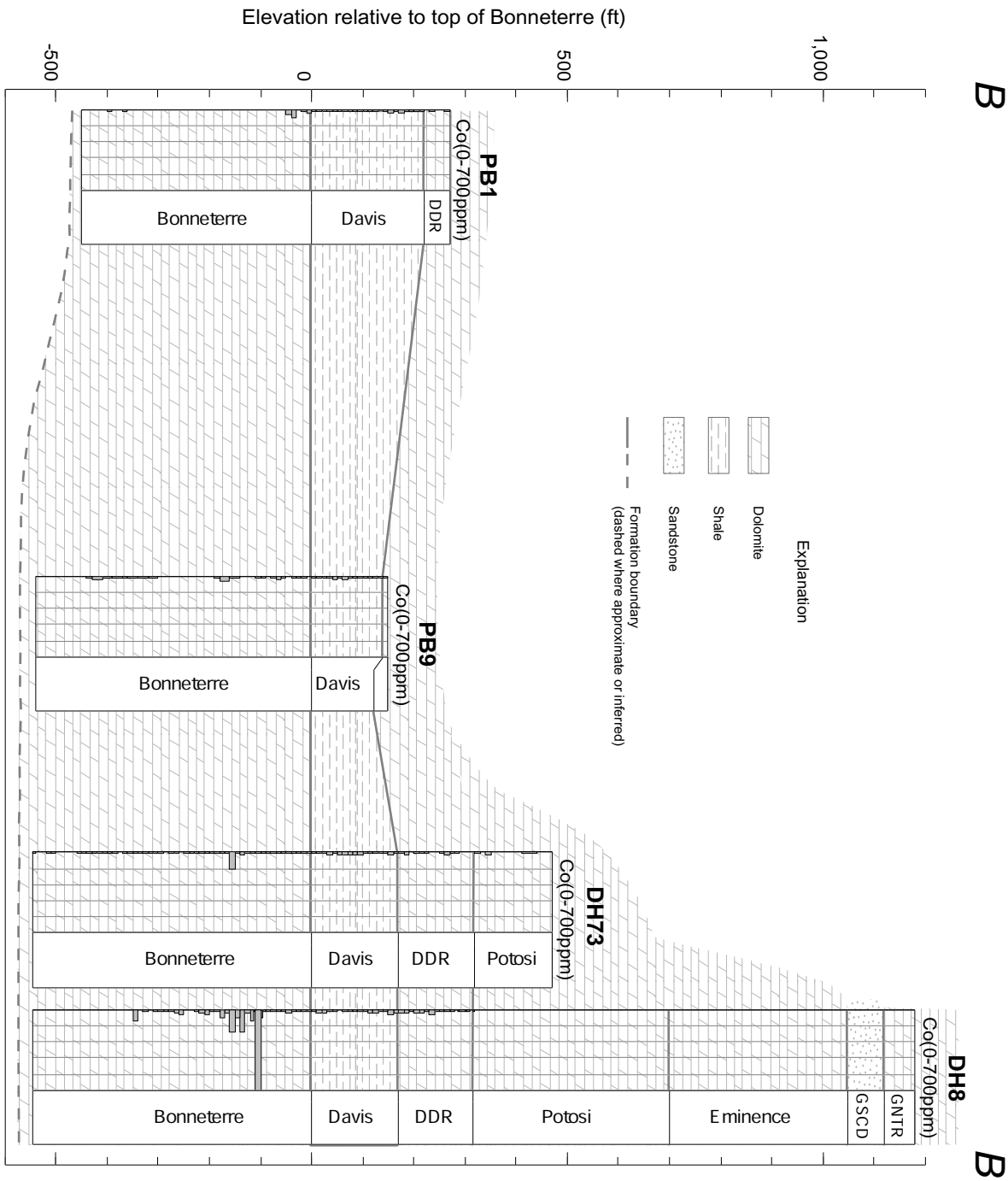

Figure 15. Cross section B-B' (see Figure 1) showing the down-hole distribution of cobalt in acid-insoluble residues of bore-hole rock samples.

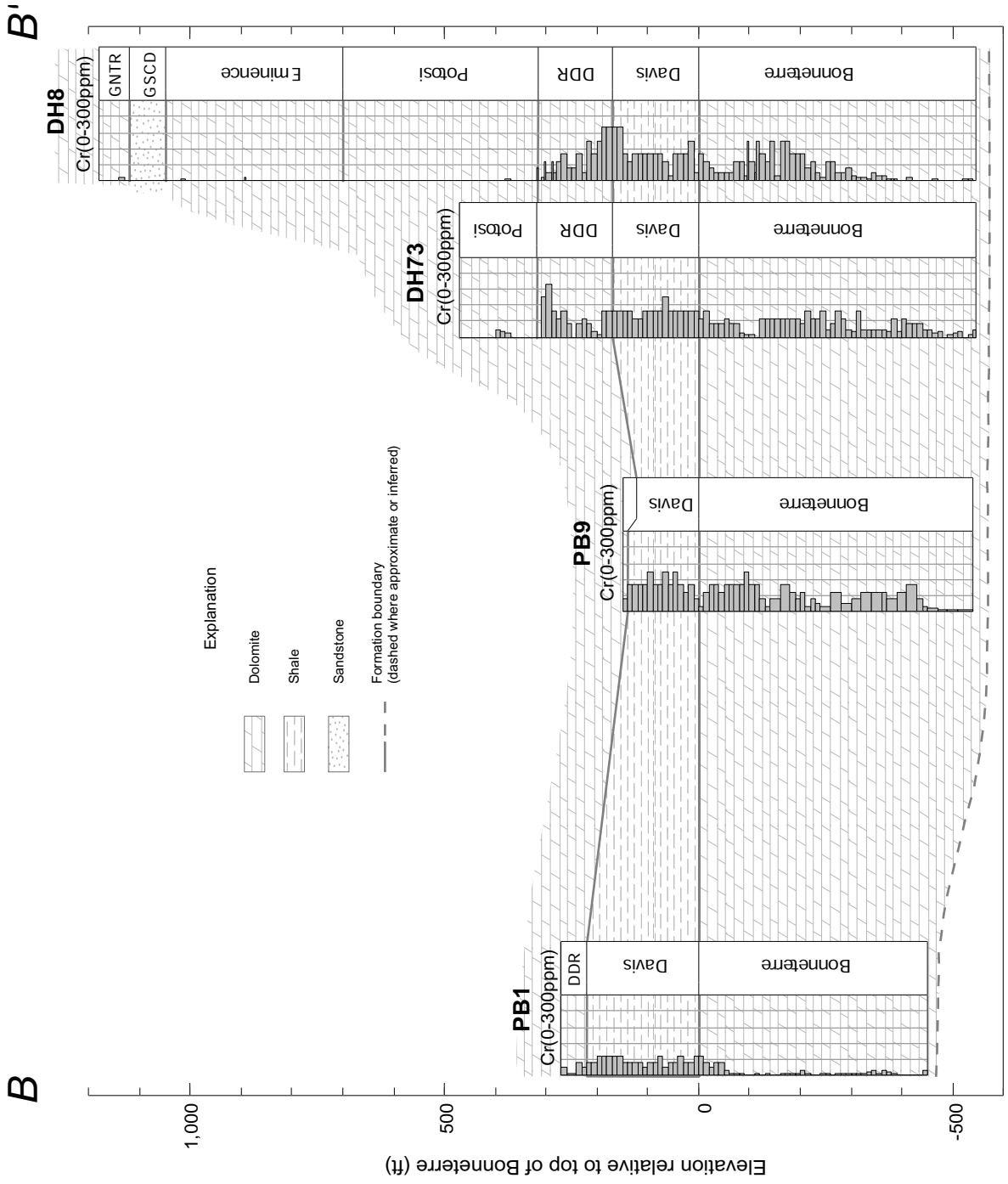

Figure 16. Cross section B-B′ (see Figure 1) showing the down-hole distribution of chromium in acid-insoluble residues of bore-hole rock samples.

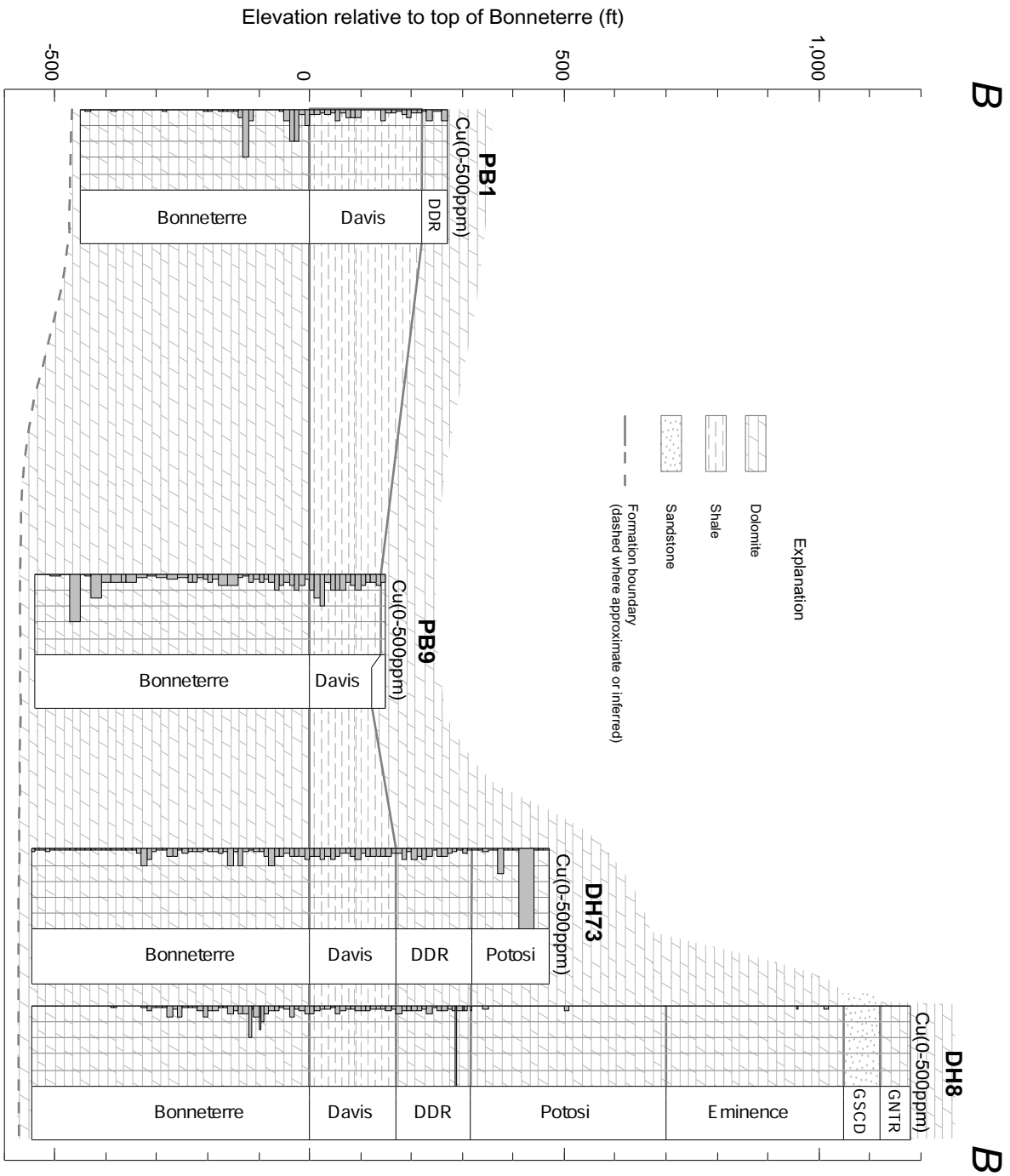

Figure 17. Cross section B-B' (see Figure 1) showing the down-hole distribution of copper in acid-insoluble residues of bore-hole rock samples.

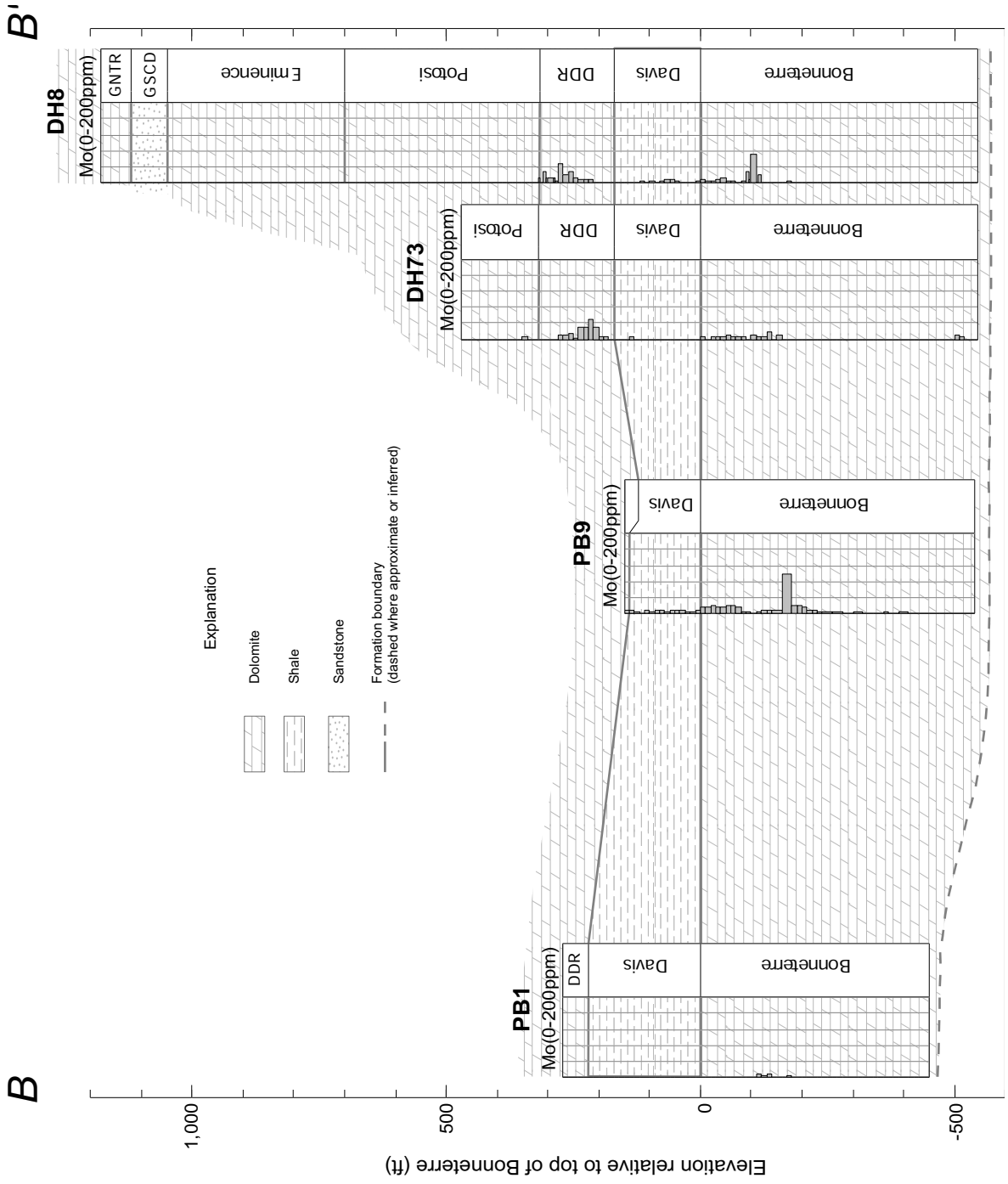

Figure 18. Cross section B-B' (see Figure 1) showing the down-hole distribution of molybdenum in acid-insoluble residues of bore-hole rock samples.

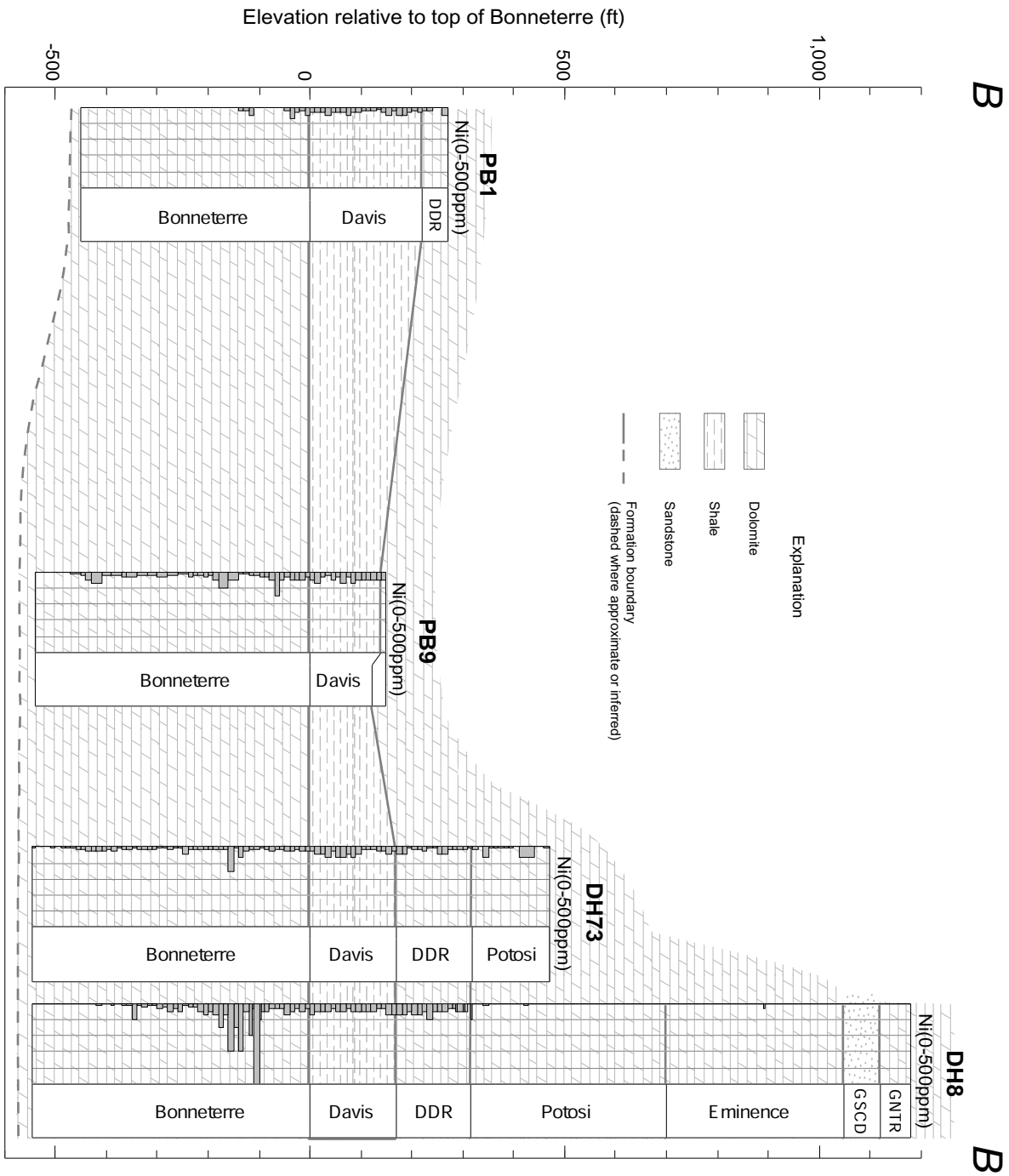

Figure 19. Cross section B-B' (see Figure 1) showing the down-hole distribution of nickel in acid-insoluble residues of bore-hole rock samples.

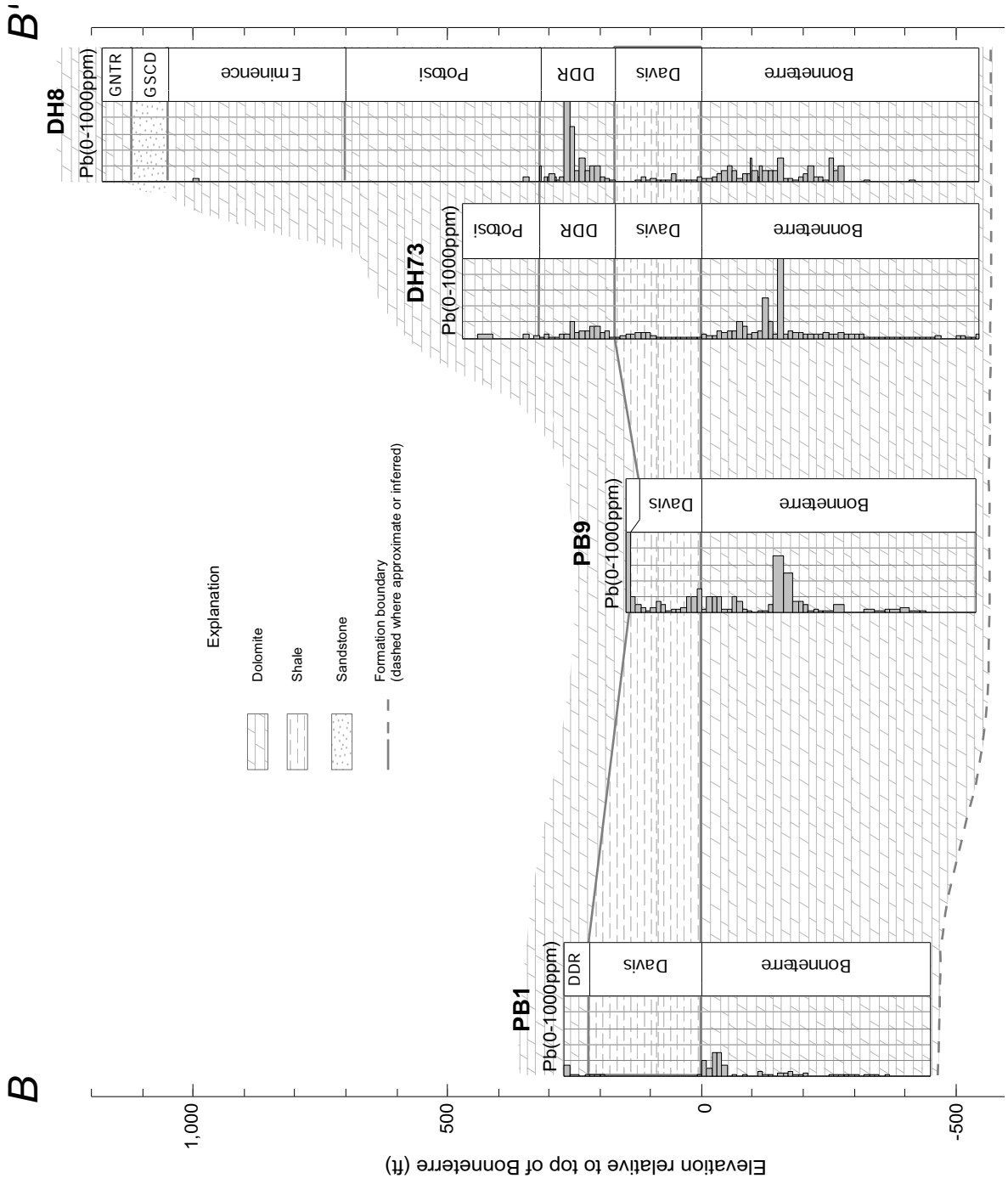

Figure 20. Cross section B-B′ (see Figure 1) showing the down-hole distribution of lead in acid-insoluble residues of bore-hole rock samples.

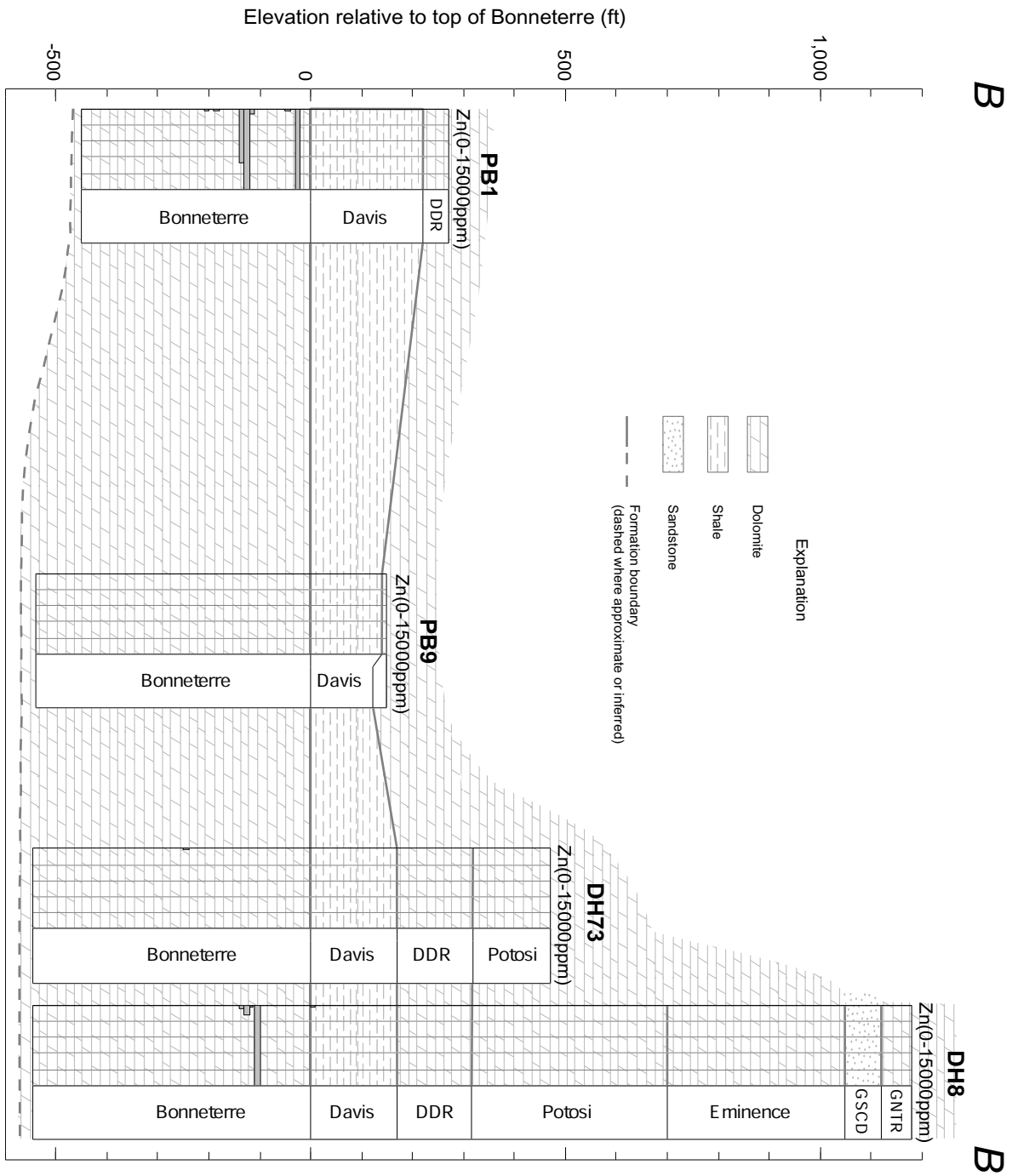

Figure 21. Cross section B-B' (see Figure 1) showing the down-hole distribution of zinc in acid-insoluble residues of bore-hole rock samples.