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Distribution of Heavy Metals and Trace Elements in Soils of Southwest Oregon

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THESIS APPROVAL

The abstract and thesis of Rafiqul Alam Khandoker for the Master of Science in Geology presented April 23, 1997, and accepted by the thesis committee and the department.

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Abstract

An abstract of the thesis of Rafiqul Alam Khandoker for the Master of Science in Geology presented April 23, 1997.

Title: Distribution of Heavy Metals and Trace Elements in Soils of Southwest Oregon

Soil samples from 118 sites on 71 geologic units in southwest Oregon were collected and analyzed to determine the background concentrations of metals in soils of the region. Sites were chosen in areas that were relatively undisturbed by human activities. The U. S. Environmental Protection Agency approved total-recoverable method was used to recover metals from samples for analysis. The twenty six metals analyzed were: Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, La, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Tl, V and Zn.

The Klamath Mountains followed by the Coast Range contain the highest soil concentrations of Al, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Ni, V and Zn. Soils of the Coastal Plain and High Lava Plains contain the lowest concentrations of these metals. Unusually high soil As concentrations are found at two sites in the Klamath Mountains. All Be and Cd values above laboratory's reporting limits are also from the Klamath Mountains and Coast Range. Concentrations of soil Ba and La are fairly uniform throughout the region. Soil Pb levels are generally low with a few exceptions in the Klamath Mountains, Coast and Cascade Ranges. The region west of the Cascade Range has higher soil Hg contents than in the east.

Soil metal concentrations are generally much higher in the region west of the Cascade Range, excluding the Coastal Plain, than in the east with the exception of Na, because of more ultramafic rocks and a wetter climate. Soil metal concentrations are directly related to soil development with the highest concentrations being found in well-developed Alfisols and Ultisols and the lowest concentrations in poorly developed Entisols. Most metals have similar averages and ranges of concentration compared to the rest of the United States (U.S.). Metals with high values compared to the rest of the U. S. are Cr, Co, Cu, Mn and Ni.

In general, Al, Co, Cr, Cu, Fe, La, Li, Mg, Na, Ni, and V are concentrated in the B horizon while Ba, Ca, Hg, K, Mn, Pb and Zn are concentrated in the A horizon.

DISTRIBUTION OF HEAVY METALS AND TRACE ELEMENTS IN SOILS OF
SOUTHWEST OREGON

by

RAFIQUL ALAM KHANDOKER

A thesis submitted in partial fulfillment of the
requirements for the degree of

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in
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CHAPTER I: INTRODUCTION

This study is an attempt to geologically and pedologically determine the background heavy metal and trace element concentrations in soils of southwest Oregon. The Oregon Department of Environmental Quality (DEQ) requires that all heavy-metal soil contaminations undergo remediation to reach background levels. Because of the lack of data, the DEQ has assigned arbitrary soil cleanup levels based on minimal research in the region (William Hartford, personal communication, 1993). There is a need for a heavy metal and trace element soil database so that cleanups are reasonable and equitable. This project was undertaken to help DEQ better define what the background heavy metal levels are in the soils of southwest Oregon.

The term 'heavy metal' is commonly adopted as a group name for the metals and metalloids which are associated with pollution and toxicity such as Pb, Cd, Hg, As, Tl and U (see Table 1), but it also includes some elements which are essential for living organisms at low concentrations, e.g. Co, Cu, Mn, Se and Zn (Alloway, 1993a). The classification is based on atomic density ($>6 \text{ g cm}^{-3}$) (Phipps, 1981). Heavy metals are also classed as 'trace elements' because, of the more than ninety elements which comprise the inorganic portion of soil, all but ten (i.e. O, Si, Al, Fe, Ca, Na, K, Mg, Ti and P) occur at concentrations of less than 0.1% (i.e. $<1,000 \text{ mg/kg}$ or $<1,000 \text{ ppm}$) (Jenkins and Jones, 1980). Most have average concentrations of less than 0.01% or 100 ppm (Mitchell, 1964). For convenience and consistency, all heavy metals and trace elements will hereafter be referred to as metals.

Table 1. Chemical symbols of elements (alphabetically) mentioned in the study (Sargent-Welch, 1979).

Chemical Symbols	Name	Chemical Symbols	Name
Ag	Silver	Mn	Manganese
Al	Aluminum	Mo	Molybdenum
As	Arsenic	N	Nitrogen
B	Boron	Na	Sodium
Ba	Barium	Ni	Nickel
Be	Beryllium	O	Oxygen
Ca	Calcium	P	Phosphorus
Cd	Cadmium	Pb	Lead
Co	Cobalt	Sb	Antimony
Cr	Chromium	Se	Selenium
Cu	Copper	Si	Silicon
Fe	Iron	Sr	Strontium
Hg	Mercury	Ti	Titanium
K	Potassium	Tl	Thallium
La	Lanthanum	U	Uranium
Li	Lithium	V	Vanadium
Mg	Magnesium	Zn	Zinc

Traditionally, research by soil chemists has been concerned primarily with plant macronutrients (N, P and K) and little work has been done on many of the metals until recently (Alloway, 1993a). This increasing attention in recent years is partly due to growing scientific and public awareness of environmental issues and partly because of recently available analytical techniques to measure heavy metal concentrations accurately. Various types of atomic spectroscopy, for example, allow large number of samples to be analyzed rapidly and accurately and thereby facilitate environmental monitoring.

Being at the interface between the atmosphere and the earth's crust as well as the

substrate for natural and agricultural ecosystems, the soil is open to inputs of metals from many sources. Metals occur naturally in soils, usually at relatively low concentrations, as a result of the weathering and other pedogenic processes acting on the rock fragments on which the soils develop (soil parent material). Considerable variations occur between the normal concentration ranges of different metals in soils. Rocks of different types vary considerably in their mineralogical and elemental composition giving rise to marked differences in concentrations between soils even in the absence of significant inputs from external sources. The metal concentrations inherited from soil parent material are modified by pedogenic and biochemical processes, by natural inputs such as dust particles derived from soil, rocks and volcanic ash and, most importantly, by anthropogenic inputs like pollution from agricultural fertilizers and pesticides and industrial wastes (Alloway, 1993a).

Soils containing anomalously high concentrations of metals can cause acute toxicity problems; increased concentrations (particularly metals like Cd and Pb) in the food chain may cause significant health effects in the long term (Alloway, 1993a). Metal polluted soils constitute a major environmental problem because many of the metals will persist in the soils for hundreds or even thousands of years (Kabata-Pendias and Pendias, 1984). Information on the background level concentrations of these metals in the soils is therefore essential for identification and subsequent careful management of polluted soils.

The study area is the southwest segment of Oregon (Figure 1), encompassing nine counties: Coos, Curry, Deschutes, Douglas, Jackson, Josephine, Klamath, Lake and Lane. The boundaries are the California border on the south, the city of Eugene on the north, the city of Bend on the east and the Pacific Coast on the west. The area contains most of the major geologic-physiographic provinces of the state, namely (from the west) the Coastal Plain, Coast Range, Klamath Mountains, Willamette Valley, Cascade Range, Basin and Range, and High Lava Plains (Zoback and others, 1994). The Willamette Valley, between the Coast and Cascade Ranges, is the most urbanized part of the area, whereas the rest of the region, apart from localized and recent settlements, is sparsely populated and rural.

The aim and objective of this study is to determine the background level concentrations of metals in the soils of southwest Oregon. Attempts have also been made to relate the significance of concentrations of these metals to soil-forming factors, particularly to the predominant factors, parent material and climatic conditions. Sampling sites were selected in remote areas to avoid contamination from any anthropogenic source. Samples were collected from soils developed on each geologic unit. Due to the reconnaissance nature of this study, it is assumed that soils developed on the same geologic unit have similar elemental compositions (Meriwether and others, 1988; Meriwether and others, 1992). The twenty six metals analyzed are: Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, La, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Tl, V and Zn. These metals were chosen because they are routinely analyzed at the Oregon

Figure 1. Location map of the study area

DEQ laboratory by atomic spectroscopy for environmental monitoring. The U.S. Environmental Protection Agency's priority pollutants included Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl and Zn (U.S. Environmental Protection Agency, 1988). The resulting database of data collected can be used as a tool by the DEQ and the environmental industry.

CHAPTER II: STUDY AREA

PHYSIOGRAPHY AND GEOLOGY

Southwest Oregon with its varied and spectacular physiography is picturesque. Scenic snow-covered high mountains, serene sites like Crater Lake and Newberry Crater, and numerous cinder cones and high-elevation lakes make this region attractive to all (Orr and others, 1992). This fascinating physiography comes from a turbulent past which includes tectonic deformation, volcanism, and Quaternary glaciation. The physiographic provinces of Oregon are shown in Figure 2.

Coastal Plain and Coast Range

A long, narrow belt of moderately high mountains and coastal headlands, the Coast Range extends from Washington state and the Columbia River in the north to the Klamath Mountains in the south. The Willamette Valley lies on its east side. The crest of the range averages 456 m in elevation with the highest point, Marys Peak near Philomath, reaching 1,245 m (Orr and others, 1992).

The line of abrupt coastal headlands along the ocean is fairly evenly interspersed with shallow bays, estuaries, pocket beaches, and sand dunes. Along the very southwestern edge of this province, wave-cut terraces have created a narrow coastal plain with remnants of older marine terraces rising up to 486 m (Kelsey and Bockheim, 1994).

Early Tertiary pillow basalts and breccias (e.g., the Siletz River Volcanics in the central part of the Coast Range, and the Roseburg Volcanics in the south) form the core of the Coast Range (Duncan, 1982; Wells and others, 1984). A thick sequence of

Figure 2. Physiographic provinces of Oregon (after Orr and others, 1992). The study area is shown in box.

Eocene to early Miocene marine clastic sedimentary rocks overlies these volcanics. The early Eocene sequence includes lithic sands, silts, and muds (derived from the Klamath Mountains) of the Roseburg, Lookingglass and Flourney Formations. The middle to late Eocene Tyee Formation consists of arkosic sands and silts derived from Idaho batholith. Provenance of the Oligocene and early Miocene pyroclastics and ash was the ancestral Cascade Mountains (Heller and others, 1987). Resistant Oligocene sills and dikes form the major peaks of the range today (Orr and others, 1992).

Willamette Valley

Enclosed between the Coast Range and Cascade Mountains, the Willamette Valley is the southern end of the Puget Sound-Willamette physiographic province which starts from Georgia Strait in Washington and pinches out near Cottage Grove, Oregon. A level and elongate alluvial plain of the Willamette River, the valley is the economic and cultural heart of Oregon. As the only natural lowland of any size in Oregon, its moderate climate supports 70% of Oregon's population as well as intense and varied agriculture (Orr and others, 1992).

The Willamette Valley, representing a north-plunging syncline, is filled with up to 600 m of late Pleistocene sediments. The sequence consists of about 30 m of Missoula Floods silts (e.g., Willamette Silts) underlain by up to 300 m of coarse gravels and sands of the Rowland Formation representing glacial outwash from the Cascade Mountains (Orr and others, 1992). The Rowland Formation is underlain by over 250 m of fluvial clays (Newton, 1969).

Cascade Mountains

With its high glaciated volcanic peaks, the Cascade Mountain physiographic province is undoubtedly the most dramatic and scenic in Oregon. Extending south into California and north into Washington and British Columbia, the Cascade Range is actually two parallel chains. The older, deeply eroded Western Cascades sharply contrast with the more recent snow-covered High Cascades that sit on the eastern flank of the older range. The Western Cascades, with elevations of 517 m at the western edge to 1,763 m on the eastern margin, are only half the elevation of the High Cascade peaks which reach elevations of more than 3,345 m (Orr and others, 1992). Dominated by large stratovolcanoes (e.g., Three Sisters, Mount McLoughlin), much of the High Cascades is a structural depression (Blackwell and others, 1990). The Cascade Mountains divide Oregon into western and eastern parts with contrasting climates and touch all of the physiographic regions in the state except the Coast Range, Blue Mountains and Owyhee Uplands (Figure 2).

The Western Cascades consist primarily of Eocene to late Miocene (40 to 10 my old) basalts with subordinate andesites and dacites (Priest, 1990). The Paleogene sedimentary sequence in the Western Cascades includes terrestrial pyroclastics of the Eocene Colestin Formation and marine sands and silts of the late Eocene-early Oligocene Eugene Formation (Orr and others, 1992).

The High Cascades consist of volcanic rocks ranging in age from 7.4 Ma to the present (Priest, 1990). Basalts make up as much as 85% of the Quaternary High

Cascades by volume (Orr and others, 1992). Locally basaltic andesite, dacite and rhyodacite occur. Virtually all of the High Cascade peaks (stratovolcanoes) are andesites and have an age of Pleistocene or younger (Orr and others, 1992).

Klamath Mountains

Lying south of the Coast Range, the Klamath Mountains form an elongate north-south trending belt, three-fifths of which is in northern California and the remainder in southwestern Oregon. The Western Cascades delineate the eastern margin of the Oregon Klamaths. Although the region boasts some deep, narrow canyons and mountain peaks reaching over 2,130 m, for the most part the province exhibits an even relief throughout (Orr and others, 1992).

The Oregon Klamath Mountain province consists of seven thrust-bounded accreted terranes of Devonian to late Jurassic age, with the oldest to the east and the youngest to the west (Wright and Wyld, 1994). Ophiolites make up much of the Klamath terranes (Moore, 1982). The Josephine ophiolite, situated in the central part of this province, is one of the largest and most complete ophiolite sequences in the world (Orr and others, 1992). Basalts, ultramafics (i.e. peridotite) and gabbros in the Klamath ophiolites have been metamorphosed to greenstone and serpentinite. Schists (e.g., Condrey Mountain Schist, Colebrook Schist, May Creek Schist, etc.), formed from shales and igneous rocks, constitute an appreciable portion of the Klamath metamorphic rocks (Orr and others, 1992). The basement terrane rocks are capped by Jurassic-Cretaceous turbidites with deep-sea cherts and volcanoclastics of the Galice, Dothan, Otter Point and other

formations (Orr and others, 1992). The Klamath Mountain province is characterized by numerous, large granitic intrusives of late Jurassic age (e.g., plutons of Mt. Ashland, Wooley Creek, Greyback, Grants Pass, etc.) (Orr and others, 1992). Only a thin veneer of Tertiary sediments (e.g., the late Eocene, nearshore conglomerates and sands overlain by pyroclastics of the Payne Cliffs Formation) are found in discrete areas of this province along the coastal margin (McKnight, 1984).

Basin and Range

The elongate Basin and Range physiographic province occupies a vast region of the southwestern United States. The northwest extension of it into southern Oregon is bordered on the west by the Cascades and on the north by the High Lava Plains. As the name implies, the Basin and Range is a series of long and narrow, north-south trending fault-block mountain ranges alternating with broad basins. Most of the province is more than 1,220 m in elevation, with the highest point 2,940 m in Steens Mountain (which is situated east of the study area) (Orr and others, 1992).

Late Cenozoic (Miocene through Pleistocene) volcanics constitute the Basin and Range province. Basalts make up the bulk of the rocks with subordinate silica-rich andesites and dacites. In discrete areas pluvial lake sediments, which include locally derived clastics and pyroclastics of Pleistocene age, overlie the volcanics (Orr and others, 1992).

High Lava Plains

The roughly rectangular High Lava Plains physiographic province is situated near the geographic center of Oregon. A high lava plateau averages just over 1.6 km above sea level. The overall topography, as the name implies, is smooth, with moderate relief. Elevation ranges from about 1,220 to 2,430 m (Orr and others, 1992). The low rainfall in this region has resulted in the lack of deep canyons and gullies as well as a poorly developed network of streams. The High Lava Plains in the study area consist entirely of volcanic rocks of possibly less than two million years in age. Volcanics are predominantly basaltic in composition with subordinate rhyolitic (Orr and others, 1992).

CLIMATE AND VEGETATION

General Climatology

Oregon's climate is controlled by topography and the maritime influence of the Pacific Ocean (Johnson and Dart, 1982). The Cascade Range divides Oregon into two climatic zones. The area west of those mountains has a maritime climate, whereas the east has a continental climate.

Oregon's precipitation generally originates from the Pacific Ocean. About 80% of the annual precipitation in western Oregon occurs between October and March; to a lesser degree the same is true for most of eastern Oregon (Hubbard, 1990). Most winter precipitation occurs as rain in western Oregon and snow in eastern Oregon.

The greatest annual precipitation in Oregon, as much as 365 cm, falls on the western slopes of the Coast Range; these are the first slopes to intercept the eastward-moving wind from the Pacific Ocean. From the crest of the Coast Range, annual

precipitation decreases to about 90 cm in the Willamette Valley, then increases to about 255 cm near the crest of the Cascade Range (Pacific Northwest River Basins Commission, 1969).

Precipitation decreases east of the Cascade Range. Some parts of eastern Oregon receive less than 25 cm annually; the higher mountain areas in eastern Oregon, however, receive annual precipitation of as much as 130 cm (Hubbard, 1990).

In the *General Soil Map - State of Oregon* (USDA, 1986), climate and vegetation have been broadly described for various landscapes. The following sections are mainly from that work. Information on vegetation has been further augmented by this author's field data.

Coast Range

With the close maritime influence, the coastal region has the highest average winter temperatures, the coolest summers and the greatest rainfall in Oregon (USDA, 1986). High rainfall and mild temperatures have contributed to a heavy forest with thick vegetation. Native vegetation in the coastal belt is Sitka spruce, western hemlock and shore pine, while that in the uplands is Douglas fir and western hemlock.

Willamette Valley and Foothills of the Coast and Cascade Ranges in Western Oregon

This region has a mild, subhumid climate with cool, moist winters and warm, dry summers. The mean annual precipitation is 65 to 150 cm (USDA, 1986). Native vegetation is Oregon white oak, Douglas fir, shrubs and grasses. Most of the areas are

cultivated to crops of grass seed, winter wheat, berries, orchards, grapes, Christmas trees, sweet corn and nursery crops.

Cascade Mountains

Western Cascades: Depending on the elevations, this area has a mild to cool humid climate with cool to cold wet winters and mild to cool moist summers. The annual precipitation is 150 to 280 cm (USDA, 1986). Native vegetation is Douglas fir, western hemlock and noble fir.

High Cascades: This region has a cold, humid climate with cold, wet winters and cool, moist summers. Areas at the highest elevations remain snow covered for most of the year. The mean annual precipitation is 75 to 305 cm (USDA, 1986). Native vegetation is noble fir, grand fir and lodgepole pine.

Klamath Mountains

Due to the close maritime influence, the western part of the Klamath Mountains has a similar climate and vegetation to that of the Coast Range. In the rest of this province, the area at lower elevations has a mild, subhumid climate with cool, moist winters and warm, dry summers. The mean annual precipitation is 65 to 150 cm (USDA, 1986). Native vegetation is Douglas fir, ponderosa pine, Pacific madrone, Oregon white oak, shrubs and grasses.

The area at comparatively higher elevations has a cool, subhumid climate with cold, moist winters and cool, dry summers. The mean annual precipitation is 100 to 180 cm (USDA, 1986). Native vegetation is white fir and Douglas fir.

Basin and Range Province

The fault-block mountain area has a cold, subhumid climate with cold, moist winters and cool, dry summers. The mean annual precipitation is 30 to 130 cm (USDA, 1986). Native vegetation is ponderosa pine and white fir or Idaho fescue and quaking aspen.

The basinal area has a mild, subhumid climate with cold, moist winters and warm, dry summers. The mean annual precipitation is 30 to 50 cm (USDA, 1986). Native vegetation is bluebunch wheatgrass and Idaho fescue. Some areas are cultivated to crops of winter wheat, green peas, alfalfa hay and pasture grasses.

High Lava Plains

This area has almost similar climate as that of mountainous area of the Basin and Range. The mean annual precipitation is 25 to 50 cm (USDA, 1986). Native vegetation is ponderosa pine, lodgepole pine and antelope bitterbrush.

SOILS

Introduction

Soils form as a result of the interaction of environmental conditions and biological activity on the surface of the weathering rock or transported sediment in the landscape.

Jenny (1941) expressed the factor of soil formation in an equation:

$$\text{Soil} = f(\text{Cl}, \text{O}, \text{R}, \text{P}, \text{T})$$

where $f()$ is a function, Cl is climate (temperature, precipitation), O is organisms (vegetation and other soil biota), R is topography (elevation, slope angle, and slope

orientation), P is parent material (the nature of minerals) and T is time. Of these factors, climatic conditions and parent material usually predominate.

Apart from the influence of parent material, soil formation in Oregon is controlled by topography, which in turn influences climate and vegetation. Division of Oregon into two contrasting climatic zones by the Cascade Ranges is also apparent in soil development in the region. In the wetter, maritime climate, mature soils (Alfisols and Ultisols) (see Table 2 for soil orders) have developed in parts of western Oregon, whereas the drier, continental climate of eastern Oregon has slowed soil development resulting in less developed, young soils (Entisols and Inceptisols).

Predominantly Inceptisols, with subordinate Entisols and Spodosols, have developed over the sandy materials of the coastal belt. High rainfall and mild temperatures have contributed to the formation of Alfisols and Ultisols over a large part of the heavily forested Coast Range and Klamath Mountains. Ultisols and Alfisols are also the predominant soil types carpeting the forested foothills of the Cascade Ranges in western Oregon. Parent material for these mature soils came mostly from basaltic rocks. Mollisols characterize the soils developed in the grass-shrub western Oregon interior valleys (USDA, 1986).

Cool to cold climate has influenced the development of predominantly Inceptisols in the forested high mountains which include the High Cascades and the higher elevations of the Western Cascades and Klamath Mountains. In eastern Oregon

Table 2. Soil Orders within the U. S. Soil Taxonomy (Soil Survey Staff, 1992). Description of the soil orders is after Birkeland (1984). For soil horizon nomenclature, see Figure 4.

Soil Order	Description
Entisols	Least developed soils, have A/C profile; have no distinct pedogenic horizons within one meter of the surface.
Inceptisols	Usually young soils having one or more pedogenic horizons (commonly indistinct); have A/Bw/C profile; some are composed of very stable minerals and may be old; many are formed in pyroclastic materials; found in most environments except those that are very dry.
Aridisols	Have an aridic moisture regime (dry >50% of the year) and no mollic epipedon; have a thin or light-colored surface horizon (ochric epipedon).
Mollisols	Have a mollic epipedon (dark-colored, friable surface horizon that is generally >18 cm thick and contains at least 1% organic matter; has a base saturation of >50%); mostly developed under grass vegetation.
Alfisols	Intermediate in many properties between Mollisols and Ultisols; have an argillic horizon (Bt) and commonly do not have dark surface horizons; have a base saturation of >35% which is less than that of Mollisols but more than that of Ultisols; developed soils.
Spodosols	Have a spodic horizon (a mineral soil horizon commonly below the surface); this horizon is either a Bs (illuvial accumulation of mainly sesquioxides*) or a Bh horizon (illuvial concentration of mainly organic matter) or a Bhs horizon (illuvial accumulation of both organic matter and sesquioxides as organic matter-sesquioxide complexes); mostly developed under forest vegetation and in sandy materials; may or may not have an overlying E horizon.
Ultisols	Have a Bt horizon with a base saturation of <35%; red; old, well-developed and leached soils.
Oxisols	Have an oxic horizon (Bo) and no Bt horizon; lateritic soils composed of mainly residual sesquioxides, formed under tropical climate; have few weatherable minerals, and a cation exchange capacity of <16 meq/100g; show the most advanced weathering and soil development of eleven soil orders. (not developed in the study area)
Vertisols	Clayey soils (with >30% clay in all horizons) and have deep, wide surface cracks when dry; appreciable horizon differentiation is not possible because the soils are thoroughly mixed up.
Andisols	Volcanic soils that are well drained; have >60% pyroclastics, <25% organic matter, and bulk density <0.85.
Histosols	Have a histic epipedon (an organic surface horizon underlain by mineral soil; saturated with water; generally 20-30 cm thick; contain >30% organic matter to a depth of 40 cm); Bog soils.
* Compounds of iron and aluminum	

semiarid and cool to cold climate has slowed soil development resulting in the formation of predominantly Inceptisols and Entisols on mountainous lava and pumice plateaus, while Mollisols are developed in the grass-shrub valleys and bedrock hills and plateaus (USDA, 1986). Soil survey reports (published by USDA, Soil Conservation Service) are

available from only three (Curry, Josephine and southern part of Klamath) of the nine counties covered in the present study (Buzzard and Bowsby, 1970; Borine, 1983; Cahoon, 1985). The *General Soil Map - State of Oregon* (USDA, 1986) provides an overall view of soil development in the region. In this map (Figure 3) soil groups are identified by the letters A, B, C, D, etc. and are based on a combination of soil forming factors. The soil map units (Table 3) are identified by a two-character symbol; the first character indicates the group it occurs in and the second character is an arabic number (examples, A1, M12). Each map unit represents a natural landscape. The map unit is identified by one, two and/or three of the major soil series on that landscape. Each soil series has unique characteristics that distinguish it from all other soil series. These characteristics, such as soil moisture and temperature regimes (Table 4), are used in classifying each soil within Soil Taxonomy (Soil Survey Staff, 1975). The following section has been extracted mainly from this map (USDA, 1986) and its accompanying information.

SOILS OF SOUTHWEST OREGON

Coastal Belt and Coast Range

In the coastal belt, udic isomesic soils (for soil moisture and temperature regimes see Table 4) are mainly Inceptisols. Entisols and Spodosols along with the dominant Inceptisols occur in A1 (see Table 3 for all the soil map units), while A2 consists entirely of Inceptisols. Of the udic mesic soils covering the heavily forested Coast Range, Inceptisols (C1) are again the dominant type, although Ultisols (C3) are developed over a large area.

Table 3. Soil Map Units in Figure 3 (USDA, 1986)

Soil Map Unit	Soil Order(s)	Physiographic Province(s)
A1	Inceptisols (dominant); Entisols; Inceptisols	Coastal Plain
A2	Inceptisols	Coastal Plain
B1	Alfisols; Inceptisols	Willamette Valley
C1	Inceptisols	Coast Range; Klamath Mountains
C3	Ultisols (dominant); Inceptisols	Coast Range; Klamath Mountains
C4	Inceptisols	Coast Range; Klamath Mountains
C5	Inceptisols; Alfisols	Coast Range; Klamath Mountains
C6	Ultisols	Coast Range; Klamath Mountains
C7	Inceptisols (dominant); Ultisols	Cascade Mountains
C9	Inceptisols	Cascade Mountains
D4	Inceptisols	Cascade Mountains
E1	Inceptisols (dominant); Spodosols	Cascade Mountains
E2	Entisols; Rock Outcrop	Cascade Mountains
F1	Inceptisols	Basin & Range
F2	Mollisols	Basin & Range
G1	Entisols	Basin & Range; High Lava Plains
G2	Entisols	Basin & Range; High Lava Plains
G3	Entisols (dominant); Spodosols	Basin & Range; High Lava Plains
H1	Inceptisols (dominant); Histosols	Basin & Range
I3	Mollisols (dominant); Vertisols	Willamette Valley
I4	Mollisols	Willamette Valley
I8	Mollisols	Willamette Valley
I9	Mollisols (dominant); Vertisols; Inceptisols	Willamette Valley
J2	Alfisols	Uplands of Western Oregon
J3	Ultisols	Uplands of Western Oregon
J4	Ultisols (dominant); Mollisols	Uplands of Western Oregon
K1	Mollisols (dominant); Vertisols	Klamath Mountains
K2	Alfisols	Klamath Mountains
K3	Inceptisols	Klamath Mountains
K4	Ultisols, Alfisols; Inceptisols	Klamath Mountains
K5	Alfisols (dominant), Inceptisols	Klamath Mountains
K7	Alfisols	Klamath Mountains
K8	Mollisols	Klamath Mountains
K9	Inceptisols (dominant); Alfisols	Klamath Mountains
L6	Mollisols (dominant); Inceptisols; Aridisols	Basin & Range
L7	Mollisols	Basin & Range
M12	Mollisols	Basin & Range
N1	Inceptisols	Klamath Mountains
N2	Mollisols (dominant); Inceptisols	Klamath Mountains
Q6	Mollisols (dominant); Inceptisols	Basin & Range
T1	Mollisols	High Lava Plains
T3	Mollisols	High Lava Plains
V2	Mollisols; Aridisols; Entisols	High Lava Plains
W2	Aridisols (dominant); Entisols	High Lava Plains

Table 4. Soil Moisture and Temperature Regimes of Southwest Oregon (USDA, 1986).

Soil Moisture Regimes	
Aquic Moisture Regime	Soils with aquic moisture regime are saturated with water during most of the year; are local, related to topographic low.
Aridic (or Torric) Moisture Regime	Soils with aridic moisture regime are dry for >50% of the year or are never moist for >90 days in a row; are found in the driest part of eastern Oregon.
Udic Moisture Regime	Soils with udic moisture regime are generally moist throughout the year; are found in the Coast and Cascade Ranges having the highest precipitation.
Xeric Moisture Regime	Soils with xeric moisture regime are in western and eastern Oregon having distinct dry summers and moist winters; this moisture regime has a shorter dry period during the summer (about 60 days) than does the aridic moisture regime.
Soil Temperature Regimes	
Cryic Soil Temperature Regime	has a mean annual soil temperature between 0 ^o C and 8 ^o C; has >5 ^o C difference between mean summer and mean winter soil temperature at 50 cm depth; has the mean summer soil temperature <8 ^o C.
Frigid Soil Temperature Regime	has a mean annual soil temperature between 0 ^o C and 8 ^o C; has >5 ^o C difference between mean summer and mean winter soil temperature at 50 cm depth; has the mean summer soil temperature >8 ^o C.
Mesic Soil Temperature Regime	has a mean annual soil temperature between 8 ^o C and 15 ^o C; has > 5 ^o C difference between mean summer and mean winter soil temperature at 50 cm depth.
Isomesic Soil Temperature Regime	is the same as mesic except that it has <5 ^o C difference between mean summer and mean winter soil temperature.

Terraces and Floodplains of the Willamette and Other Western Oregon Interior Valleys

The xeric mesic soils developed on the grass-shrub lands of the interior valleys of western Oregon are predominantly Mollisols. The units I4 and I8 consist entirely of Mollisols, while I3 and I9 are essentially Mollisols with subordinate Vertisols and Inceptisols.

Foothills of the Coast and Cascade Ranges in Western Oregon

The mature xeric mesic soils carpet the forested foothills of the Coast and Cascade Ranges in western Oregon. The units J2 and J3 consist entirely of Alfisols and Ultisols, respectively, while J4 is mainly Ultisols with subordinate Mollisols.

Cascade Mountains

The udic mesic soils developed in steep, heavily forested terrain of the Western Cascades are almost entirely Inceptisols (C7, C9). The unit C7 shows some Ultisol development along the western margin of this physiographic province. Inceptisols (D4) entirely make up the udic, frigid and cryic soils developed on the high mountains of the Western Cascades. In the High Cascades the udic, cryic soils consist mainly of Inceptisols with subordinate Spodosols (E1). Soils of the High Cascades and the high mountains of the Western Cascades have been reclassified as mainly Andisols with subordinate Inceptisols and Spodosols (Birkeland, 1984).

Klamath Mountains

In the western Klamath Mountains, including granitic and serpentine areas, udic mesic soils consist mainly of Ultisols (C3, C6) with sporadic developments of Inceptisols (C1, C4, C5). The xeric frigid soils of high mountainous areas of the Klamaths are dominantly Mollisols with subordinate Inceptisols (N2) in the east, while in the south and west they are entirely Inceptisols (N1). The rest of the Klamaths is covered by xeric mesic soils. These include Alfisols and Ultisols (K2, K4, K5) with subordinate Inceptisols (K3) in the forested areas, and Mollisols (K1, K8) and Inceptisols (K9) in the eastern grass-shrub land.

Basin and Range/High Lava Plains

Wide varieties of soils are observed in the different physiographic units of the Basin and Range province. The xeric, cryic soils of mountainous lava plateaus over bedrock and volcanic ash include Inceptisols (F1) and Mollisols (F2). The xeric, cryic soils on pumice plateaus almost entirely consist of Entisols (G1, G2, G3). These soils continue in the western part of the High Lava Plains which is included in the study area. Only unit G3 shows the incipient development of Spodosols in some places. The aquic, frigid and cryic soils of valleys formed in pumice or organic deposits consist mainly of Inceptisols with subordinate Histosols (H1). Inceptisols and Entisols of the Basin and Range province have been reclassified as mainly Andisols (Birkeland, 1984). In the southern part of the province exhibiting the characteristic fault-block mountain terrain, the xeric mesic soils on floodplains and terraces of valleys are predominantly Mollisols with subordinate Inceptisols and Aridisols (L6, L7). The xeric mesic and xeric frigid soils on grass-shrub bedrock hills and plateaus are entirely Mollisols (M12) and predominantly Mollisols with some Alfisols (Q6), respectively.

CHAPTER III: PREVIOUS WORK ON THE DISTRIBUTION OF HEAVY METALS AND TRACE ELEMENTS IN SOIL

Initially, the metal composition of a soil will be that of its geologic parent material.

With time composition will diverge progressively under the influence of pedogenic processes which in turn are determined by vegetation, topography and climate.

Divergence will be manifested initially by redistribution within fabric, then between profile horizons, and finally between soils in a landscape (Jenkins and Jones, 1980). The master soil profile horizons are shown in Figure 4.

Metals occur as trace constituents of primary minerals in igneous rocks. In general, Co, Mn, Zn, Cr, Ni, V and Cu are associated with relatively unstable ferromagnesian minerals concentrated in ultramafic and mafic igneous rocks. Felsic rocks, on the contrary, are poor in these metals and rich in Li, Be, Ba and Sr (Jenkins and Jones, 1980; Aubert and Pinta, 1980).

The metal concentrations in sedimentary rocks are dependent upon the mineralogy and adsorptive properties of the sedimentary material, the matrix and the concentrations of metals in the water in which the sediments were deposited. In general, clays and shales tend to have relatively high concentrations of many metals due to their ability to adsorb metal ions. Black (or bituminous) shales contain high concentrations of several metals and metalloids, including Ag, As, Cd, Cu, Pb, Mo, U, V and Zn (Rose and others, 1979). Sandstones usually contain only low concentrations of most elements because

US Soil Taxonomy
(post 1982)
(Guthrie and Witty, 1982)

US Soil Taxonomy
(pre 1982)

(Not all of these horizons are present in every profile)

Figure 4. A diagrammatic soil profile with US Soil Taxonomy Horizon nomenclature, modified after Alloway (1993b); description after Birkeland (1984).

The O and A horizons that are relatively high in organic matter occur at or near the surface. The only difference between the two is the amount of organic matter present. The O horizon consists of mainly undecomposed organic matter. The A horizon is dominated by mineral fraction but contains decomposed organics. In some environments, eluviation of coatings of clay and free Fe oxides at the base of an O or A horizon produces the light colored E horizon; common near the surface of Spodosols, or in upper Alfisol and Ultisol profiles. The B horizon underlies an O, A, or E horizon and overlies the parent material. Several kinds of B horizons are recognized, some based on the kinds of materials illuviated into them, others on residual concentrations of materials. For examples, Bw (development of color or structure with little or no apparent illuvial accumulation of material; common in Inceptisols); Bt (accumulation of silicate clay that has either formed *in situ* or is illuvial; hence it will have more clay than the assumed parent material and/or the overlying horizon). The C horizon represents parent material from which the soil formed or is presumed to have formed. It lacks properties of A and B horizons, but includes materials in various stages of weathering. The R horizon is consolidated bedrock underlying soil.

they consist mainly of quartz grains which have few trace constituents and little ability to adsorb metals.

The effects of metamorphism on metal distribution have not been studied.

Metamorphism in most instances appears to be isochemical (Jenkins and Jones, 1980) and so should involve no marked changes in total metal content from the rocks that were present before the metamorphism.

In soils, there is a positive relationship between metal content and that of argillaceous materials and humus. Even metals which are found in very low quantities, such as Mo and Se have their highest contents in very humiferous and heavy-textured soils (Aubert and Pinta, 1980). Within the soil profile, Ag, As, Cd, Cu, Hg, Pb, Sb and Zn are usually found concentrated in the surface horizons as a result of cycling through vegetation, atmospheric deposition and adsorption by the soil organic matter (Alloway, 1993b). The metals found concentrated in the lower horizons of the soil profile include Al, Fe, Mg, Ni and V, which tend to be associated with accumulations of translocated clays and hydrous oxides (Bowen, 1979). However, recently polluted soils often have higher contents of the pollutant metals in the topsoil because the pedogenic processes have not been operating long enough to effect a redistribution within the profile (Alloway, 1993b).

The solubility of metals in soil has great significance in their migration. Generally, in soils formed under a cool and humid climate, the leaching of metals downward through the profiles is greater than their accumulation, unless there is a high input of

these metals into the soils. Impoverishment of soils in metals is due mainly to their mobility downward with percolating waters through the profiles of freely drained acid soils and also to metal uptake by plants. In acid soils (with pH below 6), several metals, such as Zn, Mn, Ni, Cu, Fe, Co and B, are easily leached. These metals, however, are likely to form quite stable compounds if the pH of the soil rises above 7 (Kabata-Pendias and Pendias, 1984). Other metals, such as Mo and Se, are mobilized in alkaline soils, while in acid soils they become almost insoluble (Jones and others, 1993).

Apart from being influenced by parent material, metal concentrations are highest in fine-textured soils rich in humus and having a neutral or alkaline pH, for example, Mollisols and Vertisols of semiarid regions. Distribution of individual metals of interest in soils are briefly described alphabetically in Appendix 1.

CHAPTER IV: METHODOLOGY

This chapter presents the procedures used to collect and process soil samples and the laboratory methods used to determine metal concentrations and soil-solution pH. The analytical precision of laboratory determinations, metal variability in field duplicates (i.e. A1/A2 and B1/B2 sample pairs from the same pit) and statistical comparison between the A and B horizon values are also discussed.

FIELD METHODS

Soil sampling was based on geologic units. This is a reconnaissance study, so it is assumed that soils developed on the same geologic unit have similar metal chemistries. Samples were collected from two to five sites located on each major geologic unit in southwest Oregon of the geologic map of Oregon (1:500,000) (Walker and MacLeod, 1991). Rare, small units were sampled only once. If a site had abundant eolian sediment in the soil (i.e. ash) that was not related to the mapped bedrock unit, we changed the mapping unit name to reflect the eolian parent material. A total of 71 geologic units have been covered in this study (Appendix 2).

For the purpose of determining the background concentration of metals in soils, care was taken to sample soils in uncontaminated sites. Accordingly, sampling sites were selected in remote areas to avoid contamination from any possible anthropogenic source. Effort was also taken to excavate pits in undisturbed soils (as evidenced, for example, by nearby old trees) to get the natural distribution of metals in the soil profiles.

Samples from 118 sites have been used in this study. Samples from 103 sites were collected by Bill Douglas and Scott Burns in 1994-95 for a radionuclide investigation of soils of southwest Oregon (Scott Burns, personal communication, 1995). Samples from the other 15 sites (R1-R15) were collected by Scott Burns and the author in 1995. Figure 5 shows location of the sampling sites.

The method used at all sites was to first examine the area and then choose a suitable, undisturbed location. Detailed location and elevation of the site were noted from a topographic map. The estimated slope angle, vegetation and drainage of the site were also noted. Then a soil pit was dug by a non-rusty and non-colored carbon steel spade.

Once the pit was excavated, the soils underwent preliminary investigation. This involved the visual examination of the profile, checking for horizonation, depth of development and type of parent material. A description of the profile was made following standard procedure (Soil Survey Staff, 1993), noting soil color, texture and structure. Photographs were taken of the site and profile. The moist soil color was checked using the Munsell color charts (Munsell Color Company Inc., 1992). The field textural analysis using fingers was done to see how developed the soil was (Birkeland, 1984), and this also helped to estimate the percent of clay present in each horizon. Next, the horizons were named and their depth was measured.

The next step was to collect samples for laboratory analysis. Four homogeneous samples were collected from the walls of the soil pit: two from the A horizon and two

Figure 5. Location of sampling sites in Southwest Oregon (for detail of sampling site locations, see Appendix 3)

from the B horizon. The A1 sample was collected from the wall of the pit where the profile was described, while the A2 sample was taken from the opposite side. The B2 sample was taken from a lower part of the B horizon than that of B1, and both the depths were noted. The sample designation gives first site hyphenated by soil horizon and number of sample taken (for example, LM1-A1 denotes a sample collected at site LM1, from soil horizon A and # 1 sample). About 1000 grams of sample were collected each time in a polyethylene bag, zipped and labeled on the outside of the bag. The final step in the procedure was to note any special feature of the soils and/or of the site. Site characteristics and soil descriptions are given in Appendices 3 and 4.

LABORATORY METHODS

Determination of Soil-Solution pH

Soil pH was determined using a Chemtrix 41100 pH meter with a Whatman Ag/AgCl electrode following the U.S. Department of Agriculture method # 8C1a (USDA, 1972). A 1:1 solution by weight of soil to water (10 gm of dried soil to 10 ml of distilled water) was made and was allowed to equilibrate for 30 minutes, after which the solution was mixed and the pH measured. For each site, pH values were found for two samples from A horizon (A1 and A2) and for two samples from B horizon (B1 and B2). An average of two readings gave a more representative pH value for the horizon. Soil pH controls solubility and, in turn, migration of metals in soil.

Drying and Grinding Samples

Soil samples were spread on newspaper and dried at room temperature. The air-dried soil was passed through an aluminum sieve with a 2 mm mesh (USA standard sieve size #10). Particles larger than 2 mm were discarded at this stage. Next, about 30 gm of homogenized and less than 2 mm soil was taken in an acid-washed beaker and oven-dried at 60⁰ C for 24 hours, followed by cooling in a desiccator. Ten percent of samples were oven-dried in duplicate; the duplicates were selected at random. These duplicates were analyzed for quality assurance. A plastic spoon was used while handling the samples.

A ceramic sealed grinder was used for grinding samples. Between samples, the inside of the grinder was cleaned using the standard DEQ method of first grinding and discarding clean quartzitic sand, followed by grinding and discarding a little of the oven-dried sample (George Di Domenico, personal communication, 1995). Blowing air and clean tissue paper were used to wipe out discarded materials. In the case of hematitic samples, the sticky iron-stains were first removed by washing with warm water and/or wiping out with isopropyl alcohol before grinding sand. All these measures minimized carryover contamination between samples. Finally, an aliquot of the sample was ground, poured on a wax weighing paper and transferred into a clean snap vial. In most cases, two minutes of grinding was sufficient to completely homogenize the sample. The non-hematitic samples were ground first, followed by hematitic ones. Samples from Douglas

County were the last ones to be ground because of their potential to contaminate other samples with Hg (George Di Domenico, personal communication, 1995).

The total-recoverable method (SW-846, #3050A, U.S. Environmental Protection Agency, 1994) was used to digest samples. The procedure involves a mixture of concentrated nitric and hydrochloric acids that removes most material bound by surficial coatings on soil particles but removes less than 95% of the metals from the mineral matrix. This method is commonly used by regulatory agencies (like the DEQ) to determine the amount of material that ultimately may be bioavailable. Concentrations of Hg in the extracts were determined by cold-vapor atomic absorption spectroscopy (CVAAS). The remaining 25 metals were determined by inductively-coupled plasma atomic emission spectroscopy (ICPAES). All metal analyses were performed in accordance with a U.S. Environmental Protection Agency (EPA)/DEQ approved method (SW-846, #6010A, U.S. Environmental Protection Agency, 1994).

Acid Digestion of Samples for ICPAES Analysis

All glassware used was acid-washed (in 20% HNO_3), triple rinsed in de-ionized (DI) water and dried. Reagents were trace metals grade and concentrated (~70%) HNO_3 , HCl , and ultrapure 30% H_2O_2 . For all purposes, no water other than DI water supplied by the DEQ lab was used. To assess the quality of data, the following standard EPA/DEQ quality assurance procedures were used (Donna Larson, personal communication, 1996).

(1) Approximately 10% of samples were digested in duplicate. The percent differences between laboratory results for duplicate samples determine the precision of the analysis.

(2) Approximately 10% of samples were spiked with a specific amount of a solution containing known concentrations of those elements which were to be determined in the samples. Samples were spiked at random. One blank (reagents only) was also spiked per sample set. Spike solution was added before digestion. The spike recovery results indicate the accuracy of the analysis. Furthermore, the recovery results of a spiked blank show if any contaminants are present in any of the reagents or in the spike solution itself.

(3) Two reference materials (#2711 from the U.S. National Institute of Standards and Technology, and the EPA's reference control/reference assurance study 22), having known sets of values, were digested. The recovered amounts when compared to the known amounts provide checks of the accuracy of the analysis.

Exactly one gram of re-homogenized ground sample was placed in a labeled Phillips flask and approximately 5 ml DI water was added to it. One blank (approximately 6 ml DI water only) was digested per sample set. When spiking samples, the 5 ml DI water volume was reduced by the volume of the spiking solution. Usually a set of 20 samples was digested at a time.

The digestion procedure involved heating (refluxing and not boiling) a sample on a 150⁰ C hot plate three times (for a period of 10 minutes, 30 minutes and two hours), each

time adding 5 ml HNO_3 to it. Next, the sample was treated with 3 ml H_2O_2 (any further addition, up to a maximum of 10 ml, was always one ml at a time) for reacting mainly with organic content in the sample. The next step was adding 5 ml HCl to the sample and refluxing it on hot plate for 15 minutes. Each step in the digestion process was always preceded by cooling the sample to room temperature. Finally, the sample was filtered into a 100 ml volumetric flask and the final volume brought to exactly 100 ml with DI water.

Acid Digestion of Samples For CVAAS Analysis

Biochemical Oxygen Demand (BOD) bottles used were washed and kiln fired. All acids used (HNO_3 , HCl and H_2SO_4) were concentrated (~70%) and of trace metals grade. For all purposes, only DI water was used. For quality assurance, 20% of samples were digested in duplicate and with spike (spiking done with a two ppb Hg solution). For each set of samples, one blank (one ml DI water only), one spiked blank and the EPA/DEQ approved standard reference material # 2704 (available from the US National Institute of Standards and Technology) were digested.

Approximately two grams of ground and re-homogenized sample was weighed to two places past the decimal in a BOD bottle. Sample number, the corresponding bottle number and weight of the sample were noted. The amount of reference material taken was such that its Hg value was less than that of the highest calibration standard chosen (i.e. 10.0 ppb Hg) while analyzing samples. Usually Hg concentration in the reference

material was maintained between 3.5 and 4.5 ppb to keep its absorbance well within the calibration range of the analyzer.

The salient features of the procedure are as follows. To the sample were added 3.75 ml HCl and 1.25 ml HNO₃ and digested in water bath at 95⁰ C for 30 minutes. Next, after being cooled to room temperature, 150 ml DI water, 30 ml 50%-H₂SO₄ and 10 ml 4%-KMnO₄ were added to it. If permanganate color dissipated, a little of solid KMnO₄ was added to ensure excess. Finally, 3 ml 5%-K₂S₂O₈ was added to the sample and digested for two hours in water bath at 95⁰ C.

Sample Analysis

ICPAES Analysis

Twenty five elements were analyzed by the DEQ at their laboratory at Portland State University (PSU) campus using inductively-coupled plasma atomic emission spectroscopy (ICPAES). Each sample was analyzed in triplicate and the average of the three values was reported. The raw data were corrected for wave length interference in the ICPAES by a spreadsheet provided by the DEQ (Donna Larson, written communication, 1996). Since 1 gm of dry sample was taken for analysis, the corrected values multiplied by 100 gave the final concentrations of the metals in mg/kg or ppm dry. For samples run in duplicate, the final values were the average of the two.

CVAAS Analysis

Hg was analyzed at the DEQ laboratory using a Varian 400 atomic absorption spectroscopy and a Varian Group accessory 76 autosampler. The procedure involved reducing the Hg ions in the digestion solution to elemental Hg and vaporizing prior to

analysis. The QC (quality control), zero (with no Hg) and calibration standard solutions were prepared according to method # 3050A in SW-846 of EPA Manual (1994). The QC was a 2.5 ppb Hg solution. The Hg values in the standards were of 0.5, 1.0, 2.0, 5.0 and 10.0 ppb. A solution of 25% SnCl_2 in 20% HCl was prepared. This solution was run through the analyzer while analyzing samples to reduce Hg ions to elemental Hg. Shortly before analysis, 3 ml of 6% freshly prepared hydroxylamine hydrochloride was added to all standards, controls and samples, and shaken to dissolve MnO_2 . Samples were ready for analysis when solutions became clear. For each run, all the five standards were analyzed followed by zero and QC before analysis of samples. The absorbance values of standards are indicative of the calibration status of the analyzer and thereby the quality of data. The zero and standard 5.0 ppb Hg were run after every ten samples. The values of zero between -0.17 and +0.17 ppb (drift of one-third the reporting limit of 0.5 ppb) and those of the standard 5.0 from 4.5 to 5.5 were judged acceptable. If either of these were found to drift beyond the limits, analysis was restarted from the stage where data was anomalous.

The concentration values were given in ppb dry. Calculations were done as follows (SW- 846, #3050A, U.S. Environmental Protection Agency, 1994):

$$(i) \text{ ppm dry} = (\text{ppb} * 0.15)/\text{wt. of sample}$$

$$(ii) \% \text{spike recovery} = 100 * (X-Y)/S$$

where, X = measured concentration of Hg in spiked digest in ppb, Y = measured concentration of Hg in unspiked digest in ppb, and S = concentration of spike added (2 ppb).

QUALITY OF DATA

Analytical Precision

To determine the quality of data obtained from both the ICPAES and CVAAS analyses, percent difference of the laboratory duplicate results, and percent recovery of the spikes and standard reference materials (SRM) were calculated. For duplicates the difference of $\pm 10\%$ is considered good while the difference of $\pm 20\%$ is acceptable. For spikes and SRM 90-110% recovery is considered good while 80-120% recovery is acceptable (Donna Larson, written communication, 1996). The quality control/quality assurance data are presented in Appendix 5.

The duplicate results are within $\pm 10\%$ difference in 84% of the values from ICPAES and in 88% of the values from CVAAS. The rest of the duplicate values are almost entirely within $\pm 20\%$ difference range. The spike recoveries are within 90-110% range in 84% of the values from ICPAES and in 96% of the values from CVAAS. The rest of the spike recovery values are within 80-120% range. The recoveries of standard reference materials are within 90-110% in all cases.

Metal Variability for Samples A1 vs A2 and B1 vs B2

Samples from six sites (EO24, EO26, EO30, EO32, EO35, and KL7) were chosen to examine metal concentration variability between the A1/A2 and B1/B2 sample pairs from the same pit. This was done to see if just one A and one B sample from each pit

Table 5. Percent differences between metal concentrations determined for sample pairs (A1 and A2) from A horizon.

Site	EO24	EO26	EO30	EO32	EO35	KL7	
<i>Metal</i>							Average Percent Difference for Metal
<i>Ag</i>	--	--	--	--	--	--	--
<i>Mo</i>	--	--	--	--	--	--	--
<i>Cd</i>	--	--	--	--	--	--	--
<i>Ba</i>	9.9	0.8	17.4	20.4	12.2	19.0	13.3
<i>Be</i>	--	--	--	--	--	--	--
<i>Ni</i>	10.1	6.8	1.6	45.2	0.9	18.2	13.8
<i>Co</i>	17.4	21.1	--	--	7.9	--	--
<i>Cr</i>	11.4	16.7	1.8	31.7	3.0	11.1	12.6
<i>V</i>	2.2	3.1	10.9	16.0	7.1	4.5	7.3
<i>Cu</i>	9.5	5.0	9.4	1.9	2.1	34.9	10.5
<i>Zn</i>	3.5	11.0	3.1	10.6	16.4	6.1	8.0
<i>Fe</i>	10.4	11.8	1.6	1.8	3.4	7.2	6.0
<i>Mn</i>	12.5	3.1	11.1	20.8	23.5	39.7	18.0
<i>K</i>	16.0	18.5	5.7	9.0	19.2	18.2	14.0
<i>Al</i>	2.2	10.6	1.4	10.5	3.4	12.0	6.7
<i>Li</i>	--	--	--	4.4	8.4	--	--
<i>Ca</i>	9.2	6.2	12.5	11.6	9.3	30.9	13.3
<i>Na</i>	4.7	11.6	23.8	8.8	6.6	14.5	11.7
<i>Mg</i>	7.1	14.0	0.1	12.4	6.6	19.8	10.0
<i>La</i>	--	--	--	--	3.0	13.7	--
<i>Sb</i>	--	--	--	--	--	--	--
<i>Pb</i>	15.4	--	--	--	--	12.0	--
<i>Tl</i>	--	--	--	--	--	--	--
<i>As</i>	--	--	--	--	--	--	--
<i>Se</i>	--	--	--	--	--	--	--
<i>Hg</i>	22.2	--	--	46.2	--	--	--

-- Denotes that concentrations in one or both samples are less than laboratory's minimum reporting level and differences were not computed. The average percent difference of a metal was not calculated if its concentration difference was not computed for any site.

Table 6. Percent differences between metal concentrations determined for sample pairs (B1 and B2) from B horizon.

Site:		EO24	EO26	EO30	EO32	EO35	KL7	
<i>Metal</i>								Average Percent Difference for Metal
<i>Ag</i>		--	--	--	--	--	--	--
<i>Mo</i>		--	--	--	--	--	--	--
<i>Cd</i>		--	--	--	--	--	--	--
<i>Ba</i>		16.1	23.1	3.5	21.8	8.4	1.6	12.4
<i>Be</i>		--	--	--	--	--	--	--
<i>Ni</i>		2.7	5.1	3.5	13.5	3.2	2.7	5.1
<i>Co</i>		9.0	3.2	5.0	11.6	2.7	--	--
<i>Cr</i>		5.3	0.4	2.5	3.6	16.9	9.4	6.4
<i>V</i>		10.7	1.1	1.1	7.1	5.1	3.7	4.8
<i>Cu</i>		3.6	8.5	1.4	4.3	2.6	1.0	3.6
<i>Zn</i>		5.7	8.4	7.6	6.2	1.4	10.9	6.7
<i>Fe</i>		9.7	10.6	2.9	11.5	1.3	5.7	7.0
<i>Mn</i>		18.2	11.2	9.6	10.2	17.7	13.1	13.3
<i>K</i>		13.6	5.8	0.6	6.0	8.3	31.6	11.0
<i>Al</i>		2.3	4.1	1.1	11.6	2.1	10.5	5.3
<i>Li</i>		9.8	--	--	14.0	1.9	2.1	--
<i>Ca</i>		1.5	0.9	4.4	13.1	3.1	4.9	4.6
<i>Na</i>		10.8	5.4	3.9	17.1	13.0	12.9	10.5
<i>Mg</i>		1.6	14.8	10.4	3.2	2.2	5.3	6.3
<i>La</i>		1.8	--	--	17.1	0.4	14.3	--
<i>Sb</i>		--	--	--	--	--	--	--
<i>Pb</i>		--	--	--	--	--	--	--
<i>Tl</i>		--	--	--	--	--	--	--
<i>As</i>		--	--	--	--	--	--	--
<i>Se</i>		--	--	--	--	--	--	--
<i>Hg</i>		--	--	--	--	--	--	--

-- Denotes that concentrations in one or both samples are less than laboratory's minimum reporting level and differences were not computed. The average percent difference of a metal was not calculated if its concentration difference was not computed for any site.

could be used to save time and money. The percent difference between laboratory results for the sample pairs (Tables 5 and 6) was calculated by dividing the absolute difference between the two values (ppm) of each metal (see Appendix 6 for metal concentrations data of all sites) by the mean value for the pair and multiplying by 100 (Ames and Prych, 1995). The percent difference for a metal for a site was not calculated if the concentration in one or both samples was less than the laboratory's minimum reporting level.

For sample pairs from the A horizon the range of average differences between metal concentrations is 6 to 18 percent with the overall range of 0.1 to 46.2 percent (Table 5). For sample pairs from the B horizon the range of average differences between metal concentrations is 3.6 to 13.3 percent with the overall range of 0.4 to 31.6 percent (Table 6).

The DEQ accepts a variability of less than 20% in sampling (i.e. field duplicates) as well as in analytical results (i.e. laboratory duplicates) (SW-846, # 6010A, U.S. Environmental Protection Agency, 1994). The range of concentration variability between the A1/A2 and B1/B2 couples in Tables 5 and 6 was deemed acceptable within the DEQ's 20% variability envelope for heavy metals. Therefore, for the additional 112 sites only one sample from each of the A and B horizons was analyzed. Not enough samples were collected for each mapping unit to test variability between pits.

Comparison Between A and B Horizon Values

The t-test was done to determine if the concentrations of a metal in the A horizon were statistically different from the B horizon at a site. Each value measured has uncertainties associated with it. Different samples taken from the same site will have different values. The values are expected to fit a normal distribution. It is possible that the A and B horizons are statistically different. Each measurement for a metal has a standard deviation associated with it. The t-test is designed to test equalities of the means in two sets of data (Davis, 1986), e.g. measured metal concentrations in the A and B horizons in our case. The variance was calculated for the metal values in A1 and A2, B1 and B2 samples from six sites (EO24, EO28, EO30, EO32, EO35 and KL7).

The variance of concentration of a metal in the A1 versus A2 and in the B1 versus B2 samples for individual site was determined by the formula:

$$s^2 = (X_1 - \bar{X})^2 + (X_2 - \bar{X})^2$$

where s^2 is the variance, X_1 and X_2 are the two values, and $\bar{X}$ is the mean.

The pooled variance for the A and B horizons was computed by taking the sum of all variances and dividing it by the number of variance values minus 1. The pooled standard deviation for the A and B horizons is the square root of the pooled variance.

The t-test was performed by the formula:

$$t = (A_i - B_i)/S_p$$

where A_i and B_i are the concentration of a metal in the A and B horizons, respectively, and S_p is the pooled standard deviation.

The null hypothesis tested by the t-statistic was

$$H_0: A_i = B_i$$

A one-tailed level of significance (α) of 5% and 2-degrees of freedom was used in the t-test. If the null hypothesis was rejected then it was accepted that $A_i \neq B_i$. For convenience for each metal the critical value for rejecting $H_0: A_i = B_i$ was calculated by multiplying the t-critical value at 95% confidence level with the metal's pooled standard deviation for the A and B horizons. If $A_i - B_i$ was greater than the calculated critical value for that particular metal then $H_0: A_i = B_i$ was rejected. This critical value for a metal was used to determine if its concentrations in the A and B horizons were statistically different.

The F-test was done to examine the equality of variances of concentration of metals in the A and B horizons (Davis, 1986). The pooled variance for a horizon was computed by taking the sum of all variances and dividing it by the number of variance values minus 1. The F test ratio of variances between the two horizons was calculated by

$$F = s_1^2 / s_2^2$$

where s_1^2 is the larger variance and s_2^2 is the smaller. The null hypothesis tested was

$$H_0: s_1^2 = s_2^2$$

A one-tailed test with level of significance (α) of 5% and 4-degrees of freedom for both the variances was used in the testing. If the calculated value of F exceeded the critical value at the 95% confidence level (6.39 for our specific situation) then the null

hypothesis was rejected. If the null hypothesis is rejected, we can reject the equality of the variances between A and B.

The results of the F-tests are that Ca, Mn and Zn concentrations display a greater variance in the samples collected from the A horizon than from the B horizon. For the remaining metals we cannot reject the equality of variances of the values in the two horizons.

Minimum Reporting Levels

Table 7 lists the laboratory's minimum reporting levels (in ppm dry) for the metals studied. The values below the minimum reporting levels are listed as "less than the minimum reporting levels" in accordance with the practice of analytical laboratories. For example, all Ag values less than 1 ppm are listed as <1. Appendix 6 lists the acid-extractable metal concentrations data (in ppm of dry soil) of all sites. Concentration values of Hg have two decimal places because the minimum reporting level of the metal is 0.04 ppm. The rest of the metal values have been rounded to whole numbers in ppm. Appendix 7 lists the distribution statistics for concentrations (in ppm of dry soil) of metals in soils developed on each geologic unit.

Table 7. Minimum reporting levels for heavy metals and trace elements in soils in southwest Oregon analyzed by ICPAES¹ and CVAAS² (from DEQ laboratory, Portland State University campus, Oregon).

<i>Metal</i>	<i>Laboratory Reporting Limit (in ppm dry soil)</i>	<i>Metal</i>	<i>Laboratory Reporting Limit (in ppm dry soil)</i>
Ag	1	La	5
Al	10	Li	5
As	20	Mg	50
Ba	3	Mn	1
Be	1	Mo	5
Ca	10	Na	50
Cd	1	Ni	4
Co	6	Pb	10
Cr	3	Sb	20
Cu	2	Se	30
Fe	4	Tl	50
Hg	0.04	V	3
K	50	Zn	2

¹ inductively-coupled plasma atomic emission spectroscopy

² cold-vapor atomic absorption spectroscopy

CHAPTER V: RESULTS AND DISCUSSION

SOIL-SOLUTION PH

The t-test was done to determine if the mean soil-solution pH (1:1 water) values in the A (5.47 ± 0.68) and B (5.76 ± 0.54) horizons at 118 sites (pH values at individual sites are listed in Appendix 4) investigated were significantly different. The calculated t-value (3.60) exceeds the critical value (1.96) at 95% confidence level. Therefore, the A horizon soils are more acidic than the B horizon soils in the samples tested. The average soil-solution pH values for both the A and B soil horizons of the individual physiographic provinces are listed in Table 8. Again, the A horizon samples are generally more acidic than the B horizon samples. The two samples from the Willamette Valley are the exception. The Coast Range and Klamath Mountains samples have the same average soil pH values of 5.5 between them as well as between their soil horizons. Soils sampled from the semiarid eastern Klamath Mountains are less acidic than those of the humid western Klamath Mountains. The soil-solution pH, particularly in the B horizon, is more acidic in soils sampled west of the Cascade Range and more alkaline east of the Cascade Range. The same observation was made by Ames and Prych (1995) in their work in the state of Washington bordering Oregon on the north. The contrasting climates and their associated vegetation west and east of those mountains have probably caused the above soil pH difference.

Table 8. Average soil-solution pH (1:1 water) in Southwest Oregon.

Physiographic Province	Soil Horizon	Average pH (1:1 water)			
Coastal Plain ^a	A	4.4	+/-	0.4	(7)*
Coastal Plain ^a	B	5.2	+/-	0.2	(7)
Coast Range ^a	A	5.5	+/-	0.6	(16)
Coast Range ^a	B	5.5	+/-	0.4	(16)
Willamette Valley ^a	A	6.2	+/-	0.9	(2)
Willamette Valley ^a	B	5.6	+/-	1.0	(2)
Klamath Mountains ^a	A	5.5	+/-	0.6	(32)
Klamath Mountains ^a	B	5.6	+/-	0.5	(32)
Cascade Range	A	5.4	+/-	0.7	(39)
Cascade Range	B	5.7	+/-	0.5	(39)
Basin and Range ^b	A	5.6	+/-	0.6	(18)
Basin and Range ^b	B	6.3	+/-	0.3	(18)
High Lava Plains ^b	A	5.3	+/-	0.4	(4)
High Lava Plains ^b	B	6.2	+/-	0.1	(4)

* number in parentheses is the number of values averaged.

^a located west of the Cascade Range.

^b located east of the Cascade Range.

DISTRIBUTION OF SOIL METAL CONCENTRATIONS

A total of 248 samples from 118 sites were analyzed for 26 metals by both inductively-coupled plasma atomic emission spectroscopy (ICPAES), and cold-vapor atomic absorption spectroscopy (CVAAS). This number does not include duplicate and spiked samples analyzed.

Summary statistics of metal concentrations in soils measured in this study are listed in Tables 9 through 17. Summary statistics of the data illustrate the magnitude and variability of the concentrations of specific metals in the study area. Statistics have been computed for both the A and B soil horizons for the entire area (Tables 9 and 10) and for the individual physiographic provinces (Tables 11 to 17). Where the concentration of a metal in a sample is smaller than the laboratory's minimum reporting level, the

minimum reporting level is used for calculating statistics. Therefore, the statistics are qualified as less than or greater than the value given for sample sets that include values less than the reporting limit (Ames and Prych, 1995). Table 18 lists the average distribution of metals in soils developed on major igneous rocks of the study area. Table 19 lists the average concentration of metals in different soil orders of the region.

Ag, Mo, Sb, Se and Tl have no detect (i.e. sample with concentrations equal to or greater than the laboratory's minimum reporting level) in the study area, while Cd, Be and As have only a few detects. Study of the above eight metals has been severely limited due to their soil concentrations below the detection limits of the analyzer. The remainder 18 metals have detects from most or all sites. Distribution statistics for these 18 metals are listed in Tables 20-21 and 24-39. The magnitude and variability of the soil background concentrations of specific metals in the different physiographic provinces of the study area are discussed in relation to parent rocks and soil development. When comparing the metal values for physiographic provinces and soil orders, the arithmetic means (AM) for either the A or B horizons are compared. If a metal is normally concentrated in the A horizon, the A horizon AM values in the provinces or soil orders are compared; if a metal is normally concentrated in the B horizon, the B horizon AM values are compared. For a metal the horizon for the AM value is mentioned the first time and all the subsequent AM values are for the same horizon.

Table 9. Distribution statistics for concentrations (in ppm of dry soil) of metals in surface soils (A horizon) of all sites in Southwest Oregon.

Metal	Total Sample Number/ Detects¹	Arithmetic Mean	Arithmetic Standard Deviation	Median	Minimum	Maximum
Ag	118/0	<1	--	<1	<1	<1
Mo	118/0	<5	--	<5	<5	<5
Cd	118/8	<1	--	<1	<1	1.2
Ba	118/118	181	138	149	8	792
Be	118/3	<1	--	<1	<1	1
Ni	118/115	<52	>126	22	<4	1,132
Co	118/93	<18	>15	13	<6	95
Cr	118/118	56	135	23	3	1,302
V	118/118	69	56	55	6	374
Cu	118/117	<31	>29	22	<2	148
Zn	118/118	74	38	70	11	196
Fe	118/118	29,148	20,778	25,371	2,648	107,312
Mn	118/118	1,527	1,331	1,208	24	7,221
K	118/118	1,266	964	941	223	4,973
Al	118/118	30,125	18,253	24,721	2,541	93,717
Li	118/88	<11	>8.6	7.6	<5	48
Ca	118/118	5,741	3,970	4,793	638	18,682
Na	118/118	346	318	216	53	1,511
Mg	118/118	4,431	3,844	3,124	545	16,424
La	118/77	<8	>4.4	5.5	<5	26
Sb	118/0	<20	--	<20	<20	<20
Pb	118/45	<18	--	<10	<10	378
Tl	118/0	<50	--	<50	<50	<50
As	118/1	<20	--	<20	<20	36.4
Se	118/0	<30	--	<30	<30	<30
Hg	118/109	<0.1	>0.06	0.08	<0.04	0.37

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's minimum reporting level.

-- indicates statistics not computed because concentrations in most samples were less than the laboratory's minimum reporting level.

Note: Where the concentration of a metal in a sample is below the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics. Therefore, the statistics are qualified as less than or greater than the value given for sample sets that include values less than the laboratory's reporting limit.

Table 10. Distribution statistics for concentrations (in ppm of dry soil) of metals in subsoils (B horizon) of all sites in Southwest Oregon.

Metal	Total Sample Number/ Detects¹	Arithmetic Mean	Arithmetic Standard Deviation	Median	Minimum	Maximum
Ag	118/0	<1	--	<1	<1	<1
Mo	118/0	<5	--	<5	<5	<5
Cd	118/13	<1	--	<1	<1	1.5
Ba	118/118	141	107	123	7	525
Be	118/5	<1	--	<1	<1	1.3
Ni	118/115	<71	>201	25	<4	1,530
Co	118/102	<21	>23	16	<6	175
Cr	118/118	78	204	32	4	1,815
V	118/118	89	68	69	4	409
Cu	118/116	<42	>40	29	<2	193
Zn	118/118	69	37	67	9	183
Fe	118/118	37,300	26,338	30,240	3,066	137,939
Mn	118/118	848	811	597	21	4,951
K	118/118	1,083	941	780	73	5,535
Al	118/118	40,935	23,121	35,473	2,586	103,515
Li	118/107	<15	>11	11	<5	54
Ca	118/118	3,542	3,023	2,823	134	15,173
Na	118/118	419	426	200	47	2,341
Mg	118/118	5,325	4,752	3,914	591	23,606
La	118/95	<9.6	>5	8.4	<5	32.5
Sb	118/0	<20	--	<20	<20	<20
Pb	118/16	<10	--	<10	<10	40
Tl	118/0	<50	--	<50	<50	<50
As	118/2	<20	--	<20	<20	46.5
Se	118/0	<30	--	<30	<30	<30
Hg	118/72	<0.06	>0.04	0.04	<0.04	0.25

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's minimum reporting level.

-- indicates statistics not computed because concentrations in most samples were less than the laboratory's minimum reporting level.

Note: Where the concentration of a metal in a sample is below the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics. Therefore, the statistics are qualified as less than or greater than the value given for sample sets that include values less than the laboratory's reporting limit.

Table 11. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Coastal Plain of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	7/0	<1	<1	<1	Ag	7/0	<1	<1	<1
Mo	7/0	<5	<5	<5	Mo	7/0	<5	<5	<5
Cd	7/0	<1	<1	<1	Cd	7/0	<1	<1	<1
Ba	7/7	31	8	65	Ba	7/7	37	7	77
Be	7/0	<1	<1	<1	Be	7/0	<1	<1	<1
Ni	7/5	<9	<4	25	Ni	7/5	<13	<4	27
Co	7/1	<6	<6	6.2	Co	7/2	<6	<6	10.7
Cr	7/7	23	7	77	Cr	7/7	33	6	81
V	7/7	23	6	65	V	7/7	38	4	75
Cu	7/6	<8	<2	19	Cu	7/5	<11	<2	33
Zn	7/7	19	11	31	Zn	7/7	29	9	82
Fe	7/7	9,455	2,648	25,055	Fe	7/7	17,205	3,066	40,980
Mn	7/7	92	24	235	Mn	7/7	257	21	1,363
K	7/7	545	298	896	K	7/7	541	262	1,176
Al	7/7	9,806	2,541	29,237	Al	7/7	21,192	2,586	55,751
Li	7/3	<5	<5	23	Li	7/7	17	6	33
Ca	7/7	1,446	640	1,914	Ca	7/7	567	292	1,117
Na	7/7	215	129	362	Na	7/7	150	98	194
Mg	7/7	1,323	620	3,314	Mg	7/7	1,493	591	2,935
La	7/4	<5	<5	6.8	La	7/4	<8	<5	13.5
Sb	7/0	<20	<20	<20	Sb	7/0	<20	<20	<20
Pb	7/3	<10	<10	25	Pb	7/0	<10	<10	<10
Tl	7/0	<50	<50	<50	Tl	7/0	<50	<50	<50
As	7/0	<20	<20	<20	As	7/0	<20	<20	<20
Se	7/0	<30	<30	<30	Se	7/0	<30	<30	<30
Hg	7/6	<0.13	<0.04	0.19	Hg	7/4	<0.08	<0.04	0.14

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 12. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Coast Range of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	16/0	<1	<1	<1	Ag	16/0	<1	<1	<1
Mo	16/0	<5	<5	<5	Mo	16/0	<5	<5	<5
Cd	16/4	<1	<1	<1	Cd	16/4	<1	<1	1.1
Ba	16/16	175	22	287	Ba	16/16	131	23	196
Be	16/2	<1	<1	1	Be	16/2	<1	<1	1.3
Ni	16/16	59	5	170	Ni	16/16	73	5	163
Co	16/15	<23	<6	60	Co	16/15	<26	<6	56
Cr	16/16	59	15	120	Cr	16/16	77	30	161
V	16/16	82	27	219	V	16/16	100	43	248
Cu	16/16	42	5	148	Cu	16/16	52	7	193
Zn	16/16	83	18	131	Zn	16/16	81	23	136
Fe	16/16	39,369	15,727	78,302	Fe	16/16	48,819	23,048	98,169
Mn	16/16	1,501	31	5,279	Mn	16/16	1,100	49	4,951
K	16/16	1,938	861	4,666	K	16/16	1,838	518	5,022
Al	16/16	33,582	17,362	73,145	Al	16/16	45,461	19,743	100,324
Li	16/16	19	5	48	Li	16/16	24	5	54
Ca	16/16	5,536	638	15,137	Ca	16/16	3,014	376	14,619
Na	16/16	244	73	1,511	Na	16/16	287	59	2,341
Mg	16/16	6,548	1,328	11,425	Mg	16/16	7,394	1,655	13,848
La	16/16	11	5	26	La	16/16	13	5	33
Sb	16/0	<20	<20	<20	Sb	16/0	<20	<20	<20
Pb	16/8	<10	<10	51	Pb	16/6	<10	<10	39.6
Tl	16/0	<50	<50	<50	Tl	16/0	<50	<50	<50
As	16/0	<20	<20	<20	As	16/0	<20	<20	<20
Se	16/0	<30	<30	<30	Se	16/0	<30	<30	<30
Hg	16/16	0.12	0.06	0.37	Hg	16/14	<0.08	<0.04	0.25

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 13. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Willamette Valley of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	139	136	143	Ba	2/2	110	64	157
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	18	7	29	Ni	2/2	22	9	35
Co	2/2	13	7.7	18	Co	2/2	14	8	20
Cr	2/2	21	16	26	Cr	2/2	25	21	29
V	2/2	56	34	78	V	2/2	66	44	89
Cu	2/2	20	11	29	Cu	2/2	23	13	33
Zn	2/2	50	27	74	Zn	2/2	49	25	72
Fe	2/2	24,263	16,789	31,736	Fe	2/2	28,101	19,378	36,824
Mn	2/2	973	730	1,216	Mn	2/2	485	187	783
K	2/2	1,343	826	1,860	K	2/2	951	780	1,121
Al	2/2	22,631	14,574	30,688	Al	2/2	27,969	21,008	34,930
Li	2/2	6.1	5.4	6.7	Li	2/2	8.2	7.9	8.4
Ca	2/2	9,502	3,081	15,923	Ca	2/2	8,538	134	12,209
Na	2/2	738	60	1,416	Na	2/2	871	53	1,689
Mg	2/2	4,567	1,317	7,817	Mg	2/2	5,171	1,520	8,823
La	2/2	12	10.4	13	La	2/2	14	12	15
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<10	<10	40	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.085	0.08	0.09	Hg	2/1	<0.05	<0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 14. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Cascade Range of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arithmetic mean	Minimum	Maximum	Metal	Total sample number/ detects ¹	Arithmetic mean	Minimum	Maximum
Ag	39/0	<1	<1	<1	Ag	39/0	<1	<1	<1
Mo	39/0	<5	<5	<5	Mo	39/0	<5	<5	<5
Cd	39/0	<1	<1	<1	Cd	39/1	<1	<1	1
Ba	39/39	202	32	792	Ba	39/39	154	21	525
Be	39/0	<1	<1	<1	Be	39/0	<1	<1	<1
Ni	39/38	<18	<4	76	Ni	39/38	<21	<4	86
Co	39/31	<15	<6	52	Co	39/36	<16	<6	46
Cr	39/39	21	3	99	Cr	39/39	25	4	122
V	39/39	64	14	212	V	39/39	76	16	223
Cu	39/39	25	6	125	Cu	39/39	32	8	150
Zn	39/39	75	17	153	Zn	39/39	63	17	140
Fe	39/39	26,884	6,965	80,890	Fe	39/39	31,655	9,857	82,430
Mn	39/39	1,610	129	5,685	Mn	39/39	777	100	2,555
K	39/39	1,043	223	4,541	K	39/39	796	168	3,571
Al	39/39	31,382	4,634	85,913	Al	39/39	39,601	12,641	103,515
Li	39/28	<7	<5	15	Li	39/33	<9	<5	23
Ca	39/39	5,945	1,886	17,580	Ca	39/39	3,726	998	12,246
Na	39/39	425	61	1,353	Na	39/39	530	57	1,708
Mg	39/39	2,916	545	13,829	Mg	39/39	3,606	688	15,300
La	39/25	<9	<5	23	La	39/31	<10	<5	23
Sb	39/0	<20	<20	<20	Sb	39/0	<20	<20	<20
Pb	39/16	<10	<10	133	Pb	39/6	<10	<10	25
Tl	39/0	<50	<50	<50	Tl	39/0	<50	<50	<50
As	39/0	<20	<20	<20	As	39/0	<20	<20	<20
Se	39/0	<30	<30	<30	Se	39/0	<30	<30	<30
Hg	39/34	<0.09	<0.04	0.26	Hg	39/24	<0.05	<0.04	0.12

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 15. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Klamath Mountains of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	32/0	<1	<1	<1	Ag	32/0	<1	<1	<1
Mo	32/0	<5	<5	<5	Mo	32/0	<5	<5	<5
Cd	32/4	<1	<1	1	Cd	32/7	<1	<1	1.5
Ba	32/32	205	45	736	Ba	32/32	143	25	491
Be	32/1	<1	<1	1	Be	32/3	<1	<1	1.3
Ni	32/32	120	6	1,132	Ni	32/32	175	4	1,530
Co	32/31	<26	<6	95	Co	32/31	<35	<6	175
Cr	32/32	135	5	1,302	Cr	32/32	198	4	1,815
V	32/32	98	12	374	V	32/32	133	12	409
Cu	32/32	46	5	136	Cu	32/32	68	3	185
Zn	32/32	89	25	196	Zn	32/32	90	12	183
Fe	32/32	38,950	13,667	107,317	Fe	32/32	53,062	14,946	137,939
Mn	32/32	2,138	327	7,221	Mn	32/32	1,282	270	3,345
K	32/32	1,636	274	4,973	K	32/32	1,406	73	5,535
Al	32/32	34,706	17,715	57,938	Al	32/32	50,912	22,420	97,974
Li	32/27	<15	<5	48	Li	32/30	<22	<5	52
Ca	32/32	6,781	1,027	18,682	Ca	32/32	4,091	691	15,173
Na	32/32	148	53	494	Na	32/32	163	47	556
Mg	32/32	7,397	2,119	16,424	Mg	32/32	8,990	2,414	23,606
La	32/21	<7	<5	16	La	32/23	<9	<5	14
Sb	32/0	<20	<20	<20	Sb	32/0	<20	<20	<20
Pb	32/11	<27	<10	378	Pb	32/3	<10	<10	12.8
Tl	32/0	<50	<50	<50	Tl	32/0	<50	<50	<50
As	32/1	<20	<20	36.4	As	32/2	<20	<20	46.5
Se	32/0	<30	<30	<30	Se	32/0	<30	<30	<30
Hg	32/31	<0.12	<0.04	0.29	Hg	32/27	<0.07	<0.04	0.24

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 16. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the Basin and Range Province of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	18/0	<1	<1	<1	Ag	18/0	<1	<1	<1
Mo	18/0	<5	<5	<5	Mo	18/0	<5	<5	<5
Cd	18/0	<1	<1	<1	Cd	18/1	<1	<1	1
Ba	18/18	180	52	432	Ba	18/18	171	49	456
Be	18/0	<1	<1	<1	Be	18/0	<1	<1	<1
Ni	18/18	26	5	136	Ni	18/18	32	5	154
Co	18/11	<12	<6	41	Co	18/13	<15	<6	47
Cr	18/18	15	3	79	Cr	18/18	21	4	91
V	18/18	46	18	107	V	18/18	62	21	142
Cu	18/18	23	8	56	Cu	18/18	30	10	73
Zn	18/18	68	26	161	Zn	18/18	56	21	113
Fe	18/18	19,526	7,034	63,476	Fe	18/18	25,062	8,615	71,441
Mn	18/18	1,131	232	4,600	Mn	18/18	409	124	943
K	18/18	931	476	1,771	K	18/18	830	253	1,875
Al	18/18	27,964	12,544	93,717	Al	18/18	35,949	13,989	102,212
Li	18/11	<7	<5	12.4	Li	18/16	<8	<5	14
Ca	18/18	5,432	2,642	12,354	Ca	18/18	3,612	1,937	9,234
Na	18/18	565	200	1,491	Na	18/18	721	171	1,739
Mg	18/18	2,338	879	6,756	Mg	18/18	2,911	939	7,988
La	18/8	<5	<5	16	La	18/16	<9	<5	26
Sb	18/0	<20	<20	<20	Sb	18/0	<20	<20	<20
Pb	18/5	<10	<10	10.4	Pb	18/1	<10	<10	10
Tl	18/0	<50	<50	<50	Tl	18/0	<50	<50	<50
As	18/0	<20	<20	<20	As	18/0	<20	<20	<20
Se	18/0	<30	<30	<30	Se	18/0	<30	<30	<30
Hg	18/17	<0.06	<0.04	0.17	Hg	18/2	<0.04	<0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 17. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on the High Lava Plains of Southwest Oregon.

In A Horizon					In B Horizon				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	4/0	<1	<1	<1	Ag	4/0	<1	<1	<1
Mo	4/0	<5	<5	<5	Mo	4/0	<5	<5	<5
Cd	4/0	<1	<1	<1	Cd	4/0	<1	<1	<1
Ba	4/4	80	54	105	Ba	4/4	88	36	133
Be	4/0	<1	<1	<1	Be	4/0	<1	<1	<1
Ni	4/4	13	5	29	Ni	4/4	15	7	33
Co	4/2	<7	<6	11	Co	4/3	<8	<6	14
Cr	4/4	7	5	12	Cr	4/4	8	5	14
V	4/4	29	21	39	V	4/4	39	30	47
Cu	4/4	12	10	15	Cu	4/4	15	13	18
Zn	4/4	45	32	61	Zn	4/4	34	24	46
Fe	4/4	12,129	8,317	19,180	Fe	4/4	15,017	10,359	23,288
Mn	4/4	499	248	673	Mn	4/4	263	137	430
K	4/4	526	391	615	K	4/4	436	244	567
Al	4/4	16,426	13,597	21,690	Al	4/4	19,505	14,848	25,605
Li	4/1	<5	<5	6	Li	4/3	<6	<5	8
Ca	4/4	3,276	2,314	3,968	Ca	4/4	3,081	2,372	3,947
Na	4/4	614	470	767	Na	4/4	793	701	981
Mg	4/4	1,798	805	3,924	Mg	4/4	2,155	1,017	4,798
La	4/1	<5	<5	5.7	La	4/3	<6	<5	8
Sb	4/0	<20	<20	<20	Sb	4/0	<20	<20	<20
Pb	4/1	<10	<10	10	Pb	4/0	<10	<10	<10
Tl	4/0	<50	<50	<50	Tl	4/0	<50	<50	<50
As	4/0	<20	<20	<20	As	4/0	<20	<20	<20
Se	4/0	<30	<30	<30	Se	4/0	<30	<30	<30
Hg	4/3	<0.06	<0.04	0.09	Hg	4/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

Table 18. Average Distribution of Metals (in ppm dry) in Soils Developed on Major Igneous Rocks of Southwest Oregon.

<i>Metal</i>	<i>Ultramafic and Mafic Rocks^a</i> <i>(19)*</i>		<i>Intermediate and Felsic Rocks^b (7)*</i>		<i>Felsic Rocks^c (8)*</i>	
	<i>A Horizon</i>	<i>B Horizon</i>	<i>A Horizon</i>	<i>B Horizon</i>	<i>A Horizon</i>	<i>B Horizon</i>
Al**	3.7 (2.3) ***	4.8 (3.0)	2.9 (1.5)	4.1 (2.4)	1.7 (0.6)	2.5 (0.6)
Ba	189 (113)	160 (114)	138 (137)	126 (149)	156 (107)	96 (75)
Ca	6,755 (4,367)	3,810 (3,503)	4,094 (2,766)	3,226 (2,300)	3,417 (1,378)	2,297 (1,049)
Co	<27 (>26)	<33 (>33)	<12 (>9)	<15 (>10)	<7 (>1)	<8 (>2)
Cr	110 (298)	149 (412)	43 (82)	50 (90)	8 (7)	11 (9)
Cu	47 (46)	63 (62)	22 (9)	30 (15)	9 (4)	14 (8)
Fe**	4.0 (3.2)	5.0 (4.1)	2.3 (1.9)	2.9 (2.3)	1.2 (0.4)	1.6 (0.4)
Hg	<0.09 (>0.05)	<0.07 (>0.02)	0.09 (0.05)	<0.08 (>0.04)	0.06 (0.02)	<0.04 (>0.01)
K	1,052 (585)	806 (526)	767 (585)	686 (506)	836 (624)	767 (690)
La	<7 (>4)	<10 (>6)	<6 (>2)	<6 (>3)	<7 (>4)	<8 (>4)
Li	<8 (>4)	<10 (>5)	<14 (>16)	<16 (>17)	<8 (>6)	10 (8)
Mg	4,433 (4,046)	5,152 (4,692)	3,799 (4,788)	4,446 (5,327)	1,446 (588)	1,728 (538)
Mn	1,929 (1,472)	1,029 (955)	1,215 (1207)	386 (378)	984 (770)	487 (612)
Na	436 (341)	552 (511)	563 (514)	761 (668)	424 (243)	661 (440)
Ni	97 (254)	128 (344)	60 (116)	69 (125)	9 (5)	10 (4)
Pb	<10 (>0.13)	<10 (0)	<11 (>2)	<10 (0)	<11 (>3)	<10 (>0.6)
V	97 (91)	121 (103)	54 (27)	75 (47)	26 (7)	36 (14)
Zn	87 (42)	82 (40)	63 (32)	52 (27)	53 (26)	48 (33)

^a include geologic units bc, Ju, Qb, QTb, QTmv, QTvm, Tb, Tmv, Tob, Tpb, Tps, Trb, Tsr and Tub. Only Ju is ultramafic. The remainder are mafic.

^b include geologic units JTrgd, Qa, Qrd and Trh.

^c include geologic units KJg, Qma, Qmp, Tat and Tsv.

* number in parentheses is the number of values averaged.

** has concentration in percent.

*** value in parentheses is the arithmetic standard deviation.

Note: (1) Concentrations of Ag, As, Be, Cd, Mo, Sb, Se and Tl in most or all of the samples are below their laboratory's reporting limits. Therefore these metals are not included in the above comparative study.

(2) Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics. Accordingly the statistics of those metals are qualified as less than or greater than the value given.

Table 19. Average Distribution of Metals (in ppm dry) in Major Soil Orders of Southwest Oregon.

<i>Metal</i>	<i>Entisols</i> (27)*		<i>Inceptisols</i> (44)*		<i>Alfisols/Ultisols</i> (31)*		<i>Mollisols</i> (14)*	
	A Horizon	B Horizon	A Horizon	B Horizon	A Horizon	B Horizon	A Horizon	B Horizon
Al**	1.5	2.0	3.0	3.8	3.8	5.7	4.3	5.6
Ba	98	84	203	161	189	126	252	228
Ca	3,530	2,977	5,740	3,375	5,900	3,359	9,413	5,188
Co	<7	<8	<15	<18	<29	<36	22	28
Cr	6	9	46	58	125	188	32	41
Cu	<12	17	27	<34	49	72	44	57
Fe**	1.1	1.4	2.7	3.3	4.5	6.1	3.6	4.6
Hg	<0.06	<0.05	<0.11	<0.06	<0.12	<0.08	<0.10	<0.05
K	580	493	1,474	1,338	1,353	1,105	1,444	1,202
La	<5	<6	<9	<11	<8	<9	<11	<14
Li	<5	<6	<13	<17	<14	<20	<9	<11
Mg	1,311	1,701	5,081	5,990	6,267	7,737	4,294	4,994
Mn	833	216	1,541	961	2,125	1,229	1,757	998
Na	590	785	321	356	140	135	435	593
Ni	10	<13	<47	<60	107	160	32	39
Pb	<10	<10	<21	<11	<23	<10	<10	<10
V	29	38	57	71	114	152	88	113
Zn	49	38	78	76	85	82	86	78

* number in parentheses is the number of values averaged.

** has concentration in percent.

Note: (1) Concentrations of Ag, As, Be, Cd, Mo, Sb, Se and Tl in most or all of the samples are below their respective laboratory's minimum reporting levels. Therefore these metals are not included in the above comparative study.

(2) Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating average. Accordingly the average values of those metals are qualified as less than the value given.

In all cases the t-test at 95% confidence level was done to determine if a metal AM value for a horizon in the physiographic provinces or soil orders was statistically different between one another. The t-test at 95% confidence level was also done to determine if a metal AM value for a horizon was statistically different in soils derived from the major igneous rock units in the study area.

ALUMINUM (AL)

Distribution statistics for Al content in soils of the study area are listed in Table 20. At all 118 sites investigated, the Al concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of 10 ppm. The Al concentrations vary from 2,541 to 93,717 ppm with an average of 30,125 ppm in the A horizon and from 2,586 to 103,515 ppm with an average of 40,935 ppm in the B horizon.

The highest Al concentrations are in the analyzed samples from the Klamath Mountains (AM for the B horizon = 50,912 ppm) and Coast Range (AM = 45,461 ppm). The lowest analyzed soil Al levels are in the High Lava Plains (AM = 19,505 ppm) and Coastal Plain (AM = 21,192 ppm). The t-tests indicate that the first two values are different from the last two while the equality of values within the category cannot be rejected. Among soil orders, Alfisols/Ultisols (AM = 56,844 ppm) and Mollisols (AM = 56,089 ppm) are richest in analyzed Al. Entisols have the lowest analyzed Al concentrations (AM = 20,079 ppm). Al values in the analyzed samples from the

Table 20. Distribution statistics for Aluminum (Al) content (ppm dry) in soils of Southwest Oregon.

	Hori- zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	30,125	2,541	93,717	18,253	24,721
	B	118/118	40,935	2,586	103,515	23,121	35,473
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	9,806	2,541	29,237	9,804	6,246
	B	7/7	21,192	2,586	55,751	19,640	21,398
Coast Range	A	16/16	33,582	17,362	73,145	16,338	17,362
	B	16/16	45,461	19,743	100,324	21,709	38,323
Willamette Valley	A	2/2	22,631	14,574	30,688	11,395	22,631
	B	2/2	27,969	21,008	34,930	9,844	27,969
Cascade Range	A	39/39	31,382	4,634	85,913	21,265	20,868
	B	39/39	39,601	12,641	103,515	24,938	29,862
Klamath Mountains	A	32/32	34,706	17,715	57,938	11,854	32,306
	B	32/32	50,912	22,420	97,974	18,540	46,786
Basin and Range	A	18/18	27,964	12,544	93,717	21,596	16,987
	B	18/18	35,949	13,989	102,212	23,987	25,448
High Lava Plain	A	4/4	16,426	13,597	21,690	3,734	15,209
	B	4/4	19,505	14,848	25,605	4,581	18,783
<i>Soil Orders</i>							
Entisols	A	27/27	15,033	2,687	34,073	5,225	14,629
	B	27/27	20,079	2,752	38,105	6,856	18,549
Inceptisols	A	44/44	29,707	4,016	93,717	4,856	26,229
	B	44/44	38,452	2,586	102,212	19,168	35,235
Alfisols/ Ultisols	A	31/31	37,631	6,246	73,145	15,924	37,259
	B	31/31	56,844	29,679	100,324	20,008	57,490
Mollisols	A	14/14	42,945	14,574	85,913	22,412	35,145
	B	14/14	56,089	21,008	103,515	26,429	53,871
Spodosol	A	1/1	2,541 ^a	--	--	--	--
	B	1/1	5,001 ^a	--	--	--	--
Vertisol	A	1/1	51,739 ^a	--	--	--	--
	B	1/1	56,018 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Al concentrations vary widely.

The highest analyzed Al concentrations are in Mollisols and Alfisols/Ultisols formed on mafic and intermediate magmatic (geologic units cs, JTrgd, QTba, QTp, Trb, Tsr and Tub) and argillaceous sedimentary rocks (Kc, Tn and Ty). All the mentioned geologic units, except QTp, are in the Coast Range, Klamath Mountains and Cascade Range. These three physiographic provinces have comparable soil Al values. The lowest analyzed Al levels are in Entisols and Inceptisols derived from sandy and silty parent materials (Qd, Qt and Tt). Al is rather uniformly distributed in mafic, intermediate and felsic rocks (Kabata-Pendias and Pendias, 1984). Al is also concentrated in argillaceous sediments, while sandstones contain the lowest values of this metal (Aubert and Pinta, 1980). The Al content of soils is inherited from parent rocks (Peterson and Girling, 1981). In the study area, the average Al concentrations in soils on major types of igneous rocks are close, especially in mafic and intermediate rocks (Table 18).

In the cold and subhumid environments of the Basin and Range and High Lava Plains, Entisols formed on basaltic and andesitic rocks (QTps, QTvm, Tob and Tp) have low Al concentrations. This indicates that the soil Al content is also influenced by soil development, which in turn is greatly controlled by climatic conditions, in addition to parent rocks. In the samples from the study area, the average soil Al levels increase with soil development (Table 19), i.e. Entisols < Inceptisols < Alfisols/Ultisols. The t-test

indicates that the mean Al values in these soil orders are statistically different from one another.

Al is highly mobile in acid soil solutions (Peterson and Girling, 1981). Samples from acid leached sandy soils of the Coastal Plain (see Table 7 for average soil-solution pH in the different physiographic provinces covered in this study) are extremely poor in Al. Mollisols are developed in the Willamette Valley, eastern Klamath Mountains and Basin and Range province; all are characterized by a subhumid climate and slightly alkaline soil-solution. Mollisols are richest in analyzed Al, possibly because these soils have been able to hold the metal.

In the study area the analyzed Al concentrations in the A and B horizons have the pooled variance of 1,317,000 and the pooled standard deviation of 1147. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 3350 (2.92×1147 , i.e. the t-critical value at 95% confidence level multiplied by the pooled standard deviation). The results of the analysis for the Al concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 83.1% of the profiles and $A>B$ in 0.8% of the profiles. In the rest of the profiles (16.1%) we cannot reject the equality of the values in the two horizons. Bowen (1979) observed that Al is normally concentrated in the B horizon. The Al concentration difference between horizons is most pronounced in well-drained, humid Alfisols/Ultisols of the Coast Range and Klamath Mountains.

ANTIMONY (SB)

In the study area all the analyzed Sb values in both the A and B horizons are less than the laboratory's minimum reporting level of 20 ppm. This is expected as the total Sb content of soils is usually very low with an average of about 1 ppm (Bowen, 1979). Jones and others (1993) reported the total Sb concentrations of the U.S. soils vary from 2.3 to 9.5 ppm.

ARSENIC (AS)

In the analyzed samples from only two sites in the Klamath Mountains As has values at or above the laboratory's minimum reporting level of 20 ppm. Site KL21 contains 36.4 ppm in the A horizon and 46.5 ppm in the B horizon. Site R13 has 29.4 ppm in the B horizon. Both the sites occur in well-drained Alfisol (clay loam). The associated parent rocks are Condrey Mountain Schist (geologic unit cm) at site KL21 and basalt (Jub) at site R13.

The normal soil As range is 1-40 ppm (includes both the A and B horizons) with most soils being in the lower half of this range (O'Neill, 1993). In the U.S., the As values in the surface horizons of clay/clay loamy soils range from 1.7 to 27 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.1). Due to common As pollution, the levels of this metal are likely to be increased in topsoils (Kabata-Pendias and Pendias, 1984). The higher As values in the B horizon versus the A horizon at both the sites reduce the possibility of anthropogenic contamination. Boyle and Jonasson (1973) noted

elevated As levels with sulfide-mineralization which is common in the Klamath Mountains (Orr and others, 1992).

BARIUM (BA)

Distribution statistics for Ba content in soils of the study area are listed in Table 21. At all 118 sites investigated, the Ba concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of three ppm. The Ba levels range from 8 to 792 ppm with an average of 181 ppm in the A horizon and from 7 to 525 ppm with an average of 141 ppm in the B horizon. Kabata-Pendias and Pendias (1984) reported the U.S. surface soil Ba to range from 10 to 3,000 ppm, with an average of 265-835 ppm (Appendix 8.1). Soils of the study area have lower concentrations of Ba than soils of the rest of the U.S.

The highest Ba concentrations are in the analyzed samples from the Klamath Mountains (AM for the A horizon = 205 ppm) and Cascade Range (AM = 202 ppm). The Coastal Plain samples have the lowest Ba concentrations (AM = 31 ppm). The highest analyzed Ba concentrations are in Mollisols (AM = 252 ppm), Inceptisols (A = 203 ppm) and Alfisols/Ultisols (AM = 189 ppm). The mean Ba values in these three soil orders (Table 21) are statistically equal. Entisols have the lowest analyzed Ba concentrations (AM = 98 ppm). Ba values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Ba concentrations vary widely.

Table 21. Distribution statistics for Barium (Ba) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	181	8	792	138	149
	B	118/118	141	7	525	107	123
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	31	8	65	18	34
	B	7/7	37	7	77	24	36
Coast Range	A	16/16	175	22	287	77	173
	B	16/16	131	23	196	48	133
Willamette Valley	A	2/2	139	136	143	5	139
	B	2/2	110	64	157	66	110
Cascade Range	A	39/39	202	32	792	158	175
	B	39/39	154	21	525	128	124
Klamath Mountains	A	32/32	205	45	736	149	173
	B	32/32	143	25	491	99	131
Basin and Range	A	18/18	180	52	432	121	118
	B	18/18	171	49	456	119	117
High Lava Plain	A	4/4	80	54	105	21	80
	B	4/4	88	36	133	40	91
<i>Soil Orders</i>							
Entisols	A	27/27	98	8	204	49	86
	B	27/27	84	25	205	48	76
Inceptisols	A	44/44	203	14	792	158	161
	B	44/44	161	7	491	111	136
Alfisols/ Ultisols	A	31/31	189	22	523	124	178
	B	31/31	126	23	356	72	128
Mollisols	A	14/14	252	32	475	146	253
	B	14/14	228	31	525	167	185
Spodosol	A	1/1	34 ^a	--	--	--	--
	B	1/1	10 ^a	--	--	--	--
Vertisol	A	1/1	175 ^a	--	--	--	--
	B	1/1	170 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Inceptisols, Alfisols/Ultisols and Mollisols developed on argillaceous sedimentary rocks and volcanoclastics (geologic units Kc, TrPzs and Tus), basaltic andesite (Qtba and Trb), granite (KJg) and rhyolite and dacite (Trh) have the highest analyzed concentrations of Ba. The lowest analyzed Ba values are found in soils derived from clastic sedimentary rocks (silts, sands and gravels) (Qd, Qf, Qg, Qgf Qt and Tss) and ultramafics (Ju and Kjgu). The concentration of Ba in soils is reported to generally depend on parent rocks (Kabata-Pendias and Pendias, 1984). The above soil Ba concentrations are reasonable as Ba concentrates in intermediate and felsic magmatic rocks and argillaceous sediments (Kabata-Pendias and Pendias, 1984; Aubert and Pinta, 1980).

In the study area the analyzed Ba concentrations in the A and B horizons have the pooled variance of 281.8 and the pooled standard deviation of 16.8. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 49.0 (2.92×16.8). The results of the analysis for the Ba concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A > B$ in 32.2% of the profiles and $B > A$ in 5.9% of the profiles. In the rest of the profiles (61.9%) we cannot reject the equality of the values in the two horizons. The Ba concentrations in the B horizon are observed in podzols of the Coastal and High Lava Plains and in some well-drained, humid soils of the Coast and Cascade Ranges.

BERYLLIUM (BE)

Be has detects in the analyzed samples from only five sites situated in the Coast Range and Klamath Mountains. The analyzed Be values at or above the laboratory's reporting limit are listed in Table 22. The analyzed samples from both the sites LC9 and KL15 have Be levels of 1.0 ppm in the A horizon and 1.3 ppm in the B horizon. These are the highest Be values found in this study. The site LC9 occurs in well-drained Mollisol developed on mudstone of the Yamhill Formation (Ty) in the Coast Range. The site KL15 is in well-drained Inceptisol formed on shale and mudstone (Jss) in the Klamath Mountains. Be levels in surface soils of the U.S. range from <1 to 15 ppm with an average of 1.6 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.1). The surface-soil Be values (<1 to 1 ppm) found in this study are slightly lower than that of the U.S. in general. At all the five sites listed in Table 22, Be is rather uniformly distributed in the soil profiles.

Table 22. Beryllium (Be) values, at or above laboratory's reporting limit of 1 ppm, in Southwest Oregon.

Site	Physiographic Province	Geologic Unit	Conc (ppm) in A Horizon	Conc (ppm) in B Horizon	Soil Order
	Coast Range				
LC5	Coast Range	Tmsm	1.0	1.0	Inceptisol
LC9	Klamath Mtn	Ty	1.0	1.3	Mollisol
KL14	Klamath Mtn	Jss	<1.0	1.0	Alfi/Ultisol
KL15	Klamath Mtn	Jss	1.0	1.3	Inceptisol
R12	Klamath Mtn	Jub	<1.0	1.0	Inceptisol

CADMIUM (CD)

Cd has detects in the analyzed samples from 16 sites located mostly in the Coast Range and Klamath Mountains. The analyzed Cd values at or above the laboratory's reporting limit are listed in Table 23.

Almost all the Cd detects are in the samples from most developed soils, the Alfisols/Ultisols and Mollisols. The highest analyzed soil Cd concentration is at site KL16 (1.0 ppm in the A horizon and 1.5 ppm in the B horizon). The other notable Cd values are in the analyzed samples from site LC6 (1.2 ppm in the A horizon and 1.1 ppm in the B horizon) and site KL30 (1.0 ppm in the A horizon and 1.2 ppm in the B horizon). Clay-rich soils at all these sites are developed on ultramafic/mafic rocks (geologic units bc, Ju and Tsr). The soil Cd contents (<1-1.2 ppm in the A horizon and <1.0-1.5 ppm in the B horizon) found in this study are similar to Cd values (0.005 to 2.4 ppm) (includes both the A and B horizons) reported by Holmgren and others (1993) for uncontaminated soils from 36 states of the U.S.

In the study area the Cd concentrations in the A and B horizons have the pooled variance of 0.00. The Cd values in the A horizon versus the B horizon of the soil profiles at the 16 sites listed in Table 23 are as follows: B>A at ten sites (62.5%), A>B at four sites (25.0%) and at two sites (12.5%) we cannot reject the equality of the values in the two horizons. Usually Cd tends to accumulate in the surface horizons characterized by a relatively high humus content (Alloway, 1993b). The observed slightly higher Cd levels

in the B horizon than in the A horizon are possibly compatible with the slightly acidic soils of the Coast Range and Klamath Mountains (Alloway, 1993c).

Table 23. Cadmium (Cd) values, at or above laboratory's reporting limit of 1 ppm, in Southwest Oregon.

Site	Physiographic Province	Geologic Unit	Conc (ppm) in A Horizon	Conc (ppm) in B Horizon	Soil Order
LM1	Coast Range	Qls	1.0	<1.0	Inceptisol
LM14	Cascade Range	Trb	<1.0	1.0	Mollisol
LC6	Coast Range	Tsr	1.2	1.1	Mollisol
LC8	Coast Range	Tmss	1.0	<1.0	Inceptisol
LC10A	Coast Range	Tsr	1.0	1.1	Ultisol
LC19	Coast Range	Tsr	<1.0	1.1	Ultisol
LC23	Coast Range	Tpb	1.0	1.0	Inceptisol
EO7	Basin & Range	Tb	<1.0	1.0	Mollisol
KL1	Klamath Mtn	Js	<1.0	1.0	Ultisol
KL6	Klamath Mtn	cs	1.0	1.0	Alfisol
KL9	Klamath Mtn	JTrgd	<1.0	1.0	Ultisol
KL12	Klamath Mtn	cs	1.0	<1.0	Ultisol
KL16	Klamath Mtn	Ju	1.0	1.5	Alfi/Ultisol
KL17	Klamath Mtn	Jm	<1.0	1.1	Alfi/Ultisol
KL30	Klamath Mtn	bc	1.0	1.2	Alfisol
R13	Klamath Mtn	Jub	<1.0	1.0	Alfi/Ultisol

CALCIUM (CA)

Distribution statistics for Ca content in soils of the study area are listed in Table 24.

At all 118 sites investigated, the Ca concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of 10 ppm. The Ca concentrations vary from 638 to 18,682 ppm with an average of 5,741 ppm in the A horizon and from 134 to 15,173 ppm with an average of 3,542 ppm in the B horizon.

Table 24. Distribution statistics for Calcium (Ca) content (ppm dry) in soils of Southwest Oregon.

	Hori- zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	5,741	638	18,682	3,970	4,793
	B	118/118	3,542	134	15,173	3,023	2,823
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	1,446	640	1,914	503	1,553
	B	7/7	567	292	1,117	263	524
Coast Range	A	16/16	5,536	638	15,137	3,319	5,245
	B	16/16	3,014	376	14,619	3,626	1,465
Willamette Valley	A	2/2	9,502	3,081	15,923	9,081	9,502
	B	2/2	8,538	134	12,209	8,538	6,172
Cascade Range	A	39/39	5,945	1,886	17,580	4,411	4,370
	B	39/39	3,726	998	12,246	2,612	2,869
Klamath Mountains	A	32/32	6,781	1,027	18,682	4,109	6,159
	B	32/32	4,091	691	15,173	3,584	2,899
Basin and Range	A	18/18	5,432	2,642	12,354	2,543	4,550
	B	18/18	3,612	1,937	9,234	1,633	3,509
High Lava Plain	A	4/4	3,276	2,314	3,968	718	3,411
	B	4/4	3,081	2,372	3,947	659	3,002
<i>Soil Orders</i>							
Entisols	A	27/27	3,530	640	9,111	1,600	3,341
	B	27/27	2,977	576	9,234	1,624	2,735
Inceptisols	A	44/44	5,740	1,068	18,682	1,695	5,209
	B	44/44	3,375	411	9,980	2,476	2,825
Alfisols/ Ultisols	A	31/31	5,900	638	17,184	3,601	5,923
	B	31/31	3,359	292	15,173	3,467	1,777
Mollisols	A	14/14	9,413	3,042	17,580	5,469	7,957
	B	14/14	5,188	134	14,619	4,306	3,327
Spodosol	A	1/1	1,888 ^a	--	--	--	--
	B	1/1	465 ^a	--	--	--	--
Vertisol	A	1/1	13,409 ^a	--	--	--	--
	B	1/1	12,246 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

The highest analyzed soil Ca concentration is at site LM17 (15,923 ppm in the A horizon) in the Willamette Valley. Only two sites were sampled in this province (AM for the A horizon = 9,502 ppm). The sample from the other site (LC3) is not so rich in Ca (has only 3,081 ppm in the A horizon). Excluding the Willamette Valley, the highest analyzed Ca concentrations are in the Klamath Mountains (AM for the A horizon = 6,781 ppm), Cascade Range (AM = 5,945 ppm), Coast Range (AM = 5,536 ppm) and Basin and Range (AM = 5,432 ppm). The mean Ca values in these four provinces are statistically equal. The analyzed samples from the Coastal Plain have the lowest Ca values (AM = 1,446 ppm). Among soil orders, Mollisols have the highest analyzed Ca values (AM = 9,413 ppm). The analyzed Ca values in Alfisols/Ultisols (AM = 5,900 ppm) and Inceptisols (AM = 5,740 ppm) are similar. Entisols have the lowest analyzed Ca concentrations (AM = 3,530 ppm). Ca values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Ca concentrations vary widely.

The highest analyzed Ca values are found in Inceptisols, Alfisols/Ultisols and Mollisols formed on mafic igneous rocks (geologic units Jv, Tbaa, Tsr, TrPv and Tub), alluvial deposits (Qal), volcaniclastics (Tus) and shale (Tn and TrPzs). The lowest analyzed Ca levels are found in soils derived from felsic/intermediate rocks (JTrgd, KJg,) and silty, sandy and gravelly materials (Qd, Qg, Qt, Tmss, Tss, Tt and Ty). In the study area, the average Ca values increase in soils derived from felsic to mafic rocks

(Table 18). Soil Ca levels are controlled by parent rocks, and the Ca contents in igneous rocks decrease with increasing silica content (Fairbridge, 1972). Mollisols are richest in Ca because these subhumid and slightly alkaline soils have been able to hold Ca. The analyzed samples from the Klamath Mountains have the highest average soil Ca level due to Mollisols and Alfisols/Ultisols covering a large part of this physiographic province. The analyzed samples from acid-leached sandy soils of the Coastal Plain are Ca deficient. The highest analyzed Ca concentration at site LM17 in the Willamette Valley, mentioned earlier, is in Mollisol developed on alluvial deposits (geologic unit Qal). The analyzed samples from two other sites (LC11 and LM7, both in the Coast Range) on the same parent rock also have high Ca concentrations. The alluvial deposits (Qal) have possibly been derived from Ca-rich basaltic rocks.

In the study area the analyzed Ca concentrations in the A and B horizons have the pooled variance of 91,113 and the pooled standard deviation of 301.9. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 881.4 (2.92×301.9). The results of the analysis for the Ca concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A > B$ in 61.9% of the profiles and $A < B$ in 3.4% of the profiles. In the rest of the profiles (34.7%) we cannot reject the equality of the values in the two horizons. The Ca concentration in the A horizon is particularly evident in Mollisols developed in subhumid climate.

CHROMIUM (CR)

Distribution statistics for Cr content in soils of the study area are listed in Table 25.

At all 118 sites investigated, the Cr levels in both the A and B horizons exceed the laboratory's minimum reporting level of 3 ppm. The Cr concentrations range from 3 to 1,302 ppm with an average of 56 ppm in the A horizon and from 4 to 1,815 ppm with an average of 78 ppm in the B horizon. Kabata-Pendias and Pendias (1984) reported the Cr contents of surface soils of the U.S. to range from 3 to 1,500 ppm with an average of 54 ppm (Appendix 8.2). The Cr concentrations in surface soils of the study area are comparable to those of the rest of the U.S. However, the analyzed samples from the Klamath Mountains have Cr levels (average 135 ppm in the A horizon) much higher than that of the U.S. in general. The concentration of 3,117 ppm Cr (includes both the A and B horizons) at site KL16 in the Klamath Mountains could be one of the highest in the country.

The analyzed samples from the Klamath Mountains have the highest Cr levels (AM for the B horizon = 198 ppm). The High Lava Plains samples have the lowest analyzed soil Cr concentrations (AM = 7 ppm only). Among soil orders, Alfisols/Ultisols samples are richest in Cr (AM = 188 ppm). Entisols samples are poorest in Cr (AM = 9 ppm only). Figure 6 shows the graphic representations of soil Cr concentrations in physiographic provinces, soil orders and major igneous rocks of the study area.

The highest analyzed Cr values are in Alfisols/Ultisols derived from ultramafic

Table 25. Distribution statistics for Chromium (Cr) content (ppm dry) in soils of Southwest Oregon

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	56	3	1,302	135	23
	B	118/118	78	4	1,815	204	32
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	23	7	77	25	12
	B	7/7	33	6	81	28	33
Coast Range	A	16/16	59	15	120	32	49
	B	16/16	77	30	161	44	60
Willamette Valley	A	2/2	21	16	26	7	21
	B	2/2	25	21	29	6	25
Cascade Range	A	39/39	21	3	99	24	11
	B	39/39	25	4	122	29	13
Klamath Mountains	A	32/32	135	5	1,302	240	68
	B	32/32	198	4	1,815	365	95
Basin and Range	A	18/18	15	3	79	19	7
	B	18/18	21	4	91	23	10
High Lava Plains	A	4/4	7	5	12	4	5
	B	4/4	8	5	14	4	6
<i>Soil Orders</i>							
Entisols	A	27/27	6	3	28	5	5
	B	27/27	9	4	34	7	7
Inceptisols	A	44/44	46	4	273	14	28
	B	44/44	58	4	390	67	33
Alfisols/ Ultisols	A	31/31	125	8	1,302	245	46
	B	31/31	188	13	1,815	372	72
Mollisols	A	14/14	32	7	89	22	24
	B	14/14	41	40	101	27	35
Spodosol	A	1/1	9 ^a	--	--	--	--
	B	1/1	9 ^a	--	--	--	--
Vertisol	A	1/1	72 ^a	--	--	--	--
	B	1/1	81 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Figure 6. Soil Chromium (Cr) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

and mafic rocks (geologic units bc, cs, Jm, Ju, KJgu, Tpb and Tsr) in the Klamath Mountains and Coast Range. The lowest analyzed Cr levels are in Entisols and Inceptisols developed on felsic and intermediate igneous rocks (KJg, Qma, Qmp, Qrd, QTp and Tat) and silty, sandy and gravelly deposits (Qd, Qf, Qg, Qs, Qt, Ts and Tus). In the study area, although an apparent increase in average Cr contents is observed in soils derived from felsic, through intermediate, to mafic/ultramafic magmatic rocks (Figure 6), the equality of those values cannot be rejected at 95% confidence level. This is because the Cr concentrations in soils developed on ultramafic/mafic rocks in particular have an extremely large standard deviation (nearly three times the mean; Table 18). The soil Cr is inherited from parent rocks. Ultramafic and mafic rocks are richest in Cr, containing up to 3,400 ppm of this metal (McGrath and Smith, 1993; Kabata-Pendias and Pendias, 1984). The Cr content of felsic igneous and sedimentary rocks ranges from 2 to 590 ppm (Cannon, 1978). The analyzed Cr concentrations in soils of the study area display a great variability (have standard deviation more than twice the arithmetic mean) (Table 25). This is because soil sampled at site KL16 on geologic unit Ju (serpentinized ultramafic and related rocks of ophiolite sequences) contains an extremely high level of Cr (1,302 ppm in the A horizon and 1,815 ppm in the B horizon) compared to soils on other rocks. Soils on serpentines are known to contain as much as 2,000 to 4,000 ppm Cr (includes both the A and B horizons) (Kabata-Pendias and Pendias, 1984). Soils on serpentinized ultramafics in particular have contributed to the very high soil Cr level in the Klamath Mountains.

It is clear that soil Cr levels increase with soil development in the study area (Table 19). In favorable environments, Alfisols/Ultisols form on ultramafic/mafic rocks because they contain relatively unstable ferromagnesian minerals which weather fast, accelerating soil development. On the other hand, Entisols/Inceptisols form on the slowly weathered silica-rich felsic/intermediate rocks.

In the study area the analyzed Cr concentrations in the A and B horizons have the pooled variance of 1.50 and the pooled standard deviation of 1.22. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 3.6 (2.92×1.22). The results of the analysis for the Cr concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 60.2% of the profiles and $A>B$ in 3.4% of the profiles. In the rest of the profiles (36.4%) we cannot reject the equality of the values in the two horizons. The concentration of Cr in the B horizon is particularly evident in well-drained, humid Alfisols/Ultisols.

COBALT (CO)

Distribution statistics for Co content in soils of the study area are listed in Table 26. Out of a total of 118, Co has 93 values in the A horizon and 102 values in the B horizon above the laboratory's minimum reporting level of six ppm. The Co concentrations vary from <6 to 95 ppm with an average of <18 ppm in the A horizon and from <6 to 175 ppm with an average of <21 ppm in the B horizon. The Co content of surface soils of the U.S. ranges from <1 to 50 ppm, with the highest frequency in the range of 3 to 15 ppm and with an average of 8.2 ppm (Kabata-Pendias and Pendias,

Table 26. Distribution statistics for Cobalt (Co) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/93	<18	<6	95	>15	13
	B	118/102	<21	<6	175	>23	16
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/1	<6	<6	6.2	>0.07	<6
	B	7/2	<6	<6	10.7	>1.8	<6
Coast Range	A	16/15	<23	<6	60	>15	18
	B	16/15	<26	<6	56	>16	23
Willamette Valley	A	2/2	13	8	18	7	13
	B	2/2	14	8	20	9	14
Cascade Range	A	39/31	<15	<6	52	>12	9
	B	39/36	<16	<6	46	>12	10
Klamath Mountains	A	32/31	<26	<6	95	>19	23
	B	32/31	<35	<6	175	>35	25
Basin and Range	A	18/11	<12	<6	41	>10	7
	B	18/13	<15	<6	47	>12	9
High Lava Plain	A	4/2	<7	<6	11	>2	6
	B	4/3	<8	<6	14	>4	7
<i>Soil Orders</i>							
Entisols	A	27/13	<7	<6	15	>2	6
	B	27/18	<8	<6	18	>3	7
Inceptisols	A	44/36	<15	<6	45	>1	13
	B	44/39	<18	<6	56	>13	14
Alfisols/ Ultisols	A	31/29	<29	<6	95	>21	25
	B	31/30	<36	<6	175	>36	24
Mollisols	A	14/14	22	6	47	12	19
	B	14/14	28	7	50	13	28
Spodosol	A	1/0	<6 ^a	--	--	--	--
	B	1/0	<6 ^a	--	--	--	--
Vertisol	A	1/1	17 ^a	--	--	--	--
	B	1/1	19 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

1984) (Appendix 8.3). Soils in the study area are comparatively richer in Co than those in the rest of the U.S.

The analyzed samples from the Klamath Mountains and Coast Range have the highest Co concentrations (AM for the B horizon <35 ppm and <26 ppm, respectively). The Coastal Plain and High Lava Plains samples have the lowest Co values (AM <8 ppm and <6 ppm, respectively). Among soil orders, Alfisols/Ultisols and Mollisols have the highest analyzed Co contents (AM <36 ppm and 28 ppm, respectively). Entisols have the lowest analyzed Co values (AM <8 ppm). Co values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Co concentrations vary widely.

The highest analyzed Co values are in Alfisols/Ultisols and Mollisols derived from ultramafic and mafic rocks (geologic units bc, Jm, Ju, Qba, QTp, Tpb and Tsr) and argillaceous sediments (Tfee and TrPzs). The lowest analyzed Co levels are in Entisols and Inceptisols formed on felsic and intermediate magmatic rocks (KJg, Qma, Qmp, Qrd, QTp and Tat) and silty and sandy deposits (Qd, Qg, Qs, Qt, Ts, Tss and Tus).

The above soil Co concentrations are reasonable as the Co concentration in soils is inherited from parent materials, and mafic/ultramafic rocks and argillaceous sediments are very rich in Co compared to other rocks (Smith, 1993; Kabata-Pendias and Pendias, 1984). In the study area, the average Co levels increase in soils derived from felsic to mafic/ultramafic rocks (Table 18). The soil Co levels also increase with soil

development, i.e. Alfisols/Ultisols >Inceptisols >Entisols (Table 19). The average Co values in the soil orders are statistically different at 95% confidence level. Soils of the Klamath Mountains and Coast Range have high Co levels as Alfisols/Ultisols in particular are developed over large areas of these physiographic provinces.

In the study area the analyzed Co concentrations in the A and B horizons have the pooled variance of 0.36 and the pooled standard deviation of 0.60. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 1.8 (2.92×0.60). The results of the analysis for the Co concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 50.0% of the profiles and $A>B$ in 7.6% of the profiles. In the rest of the profiles (42.4%) we cannot reject the equality of the values in the two horizons. The concentration of Co in the B horizon is especially evident in clay-rich Alfisols/Ultisols. The Co distribution is uniform throughout the profile in young and less developed soils, i.e. Entisols and Inceptisols.

COPPER (CU)

Distribution statistics for Cu content in soils of the study area are listed in Table 27. Out of a total of 118, Cu has 117 values in the A horizon and 116 values in the B horizon at or above the laboratory's minimum reporting level of two ppm. The Cu concentrations vary from <2 to 148 ppm with an average of <31 ppm in the A horizon and from <2 to 193 ppm with an average of <42 ppm in the B horizon. For surface soils of the U.S., Kabata-Pendias and Pendias (1984) reported the mean 'background' Cu

Table 27. Distribution statistics for Copper (Cu) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/117	<31	<2	148	>29	22
	B	118/116	<42	<2	193	>40	29
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/6	<8	<2	19	>6	8
	B	7/5	<11	<2	33	>12	7
Coast Range	A	16/16	42	5	148	43	26
	B	16/16	52	7	193	59	31
Willamette Valley	A	2/2	20	11	29	12	20
	B	2/2	23	13	33	14	23
Cascade Range	A	39/39	25	6	25	24	16
	B	39/39	32	8	150	27	25
Klamath Mountains	A	32/32	46	5	136	30	37
	B	32/32	68	3	185	43	59
Basin and Range	A	18/18	23	8	56	15	17
	B	18/18	30	10	73	19	25
High Lava Plain	A	4/4	12	10	15	2	11
	B	4/4	15	13	18	2	14
<i>Soil Orders</i>							
Entisols	A	27/26	<12	<2	28	>6	10
	B	27/27	17	5	36	8	14
Inceptisols	A	44/44	27	2	71	4	21
	B	44/43	<34	<2	105	>25	28
Alfisols/ Ultisols	A	31/31	49	5	136	38	35
	B	31/31	72	7	188	52	61
Mollisols	A	14/14	44	11	148	34	30
	B	14/14	57	13	193	44	49
Spodosol	A	1/1	5 ^a	--	--	--	--
	B	1/0	<2 ^a	--	--	--	--
Vertisol	A	1/1	41 ^a	--	--	--	--
	B	1/1	42 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

concentrations to vary from 14 to 41 ppm (Appendix 8.2). The average Cu value of <31 ppm in surface soils of the study area falls within the U.S. values. The national soil Cu average for the A horizon is exceeded in the Klamath Mountains and Coast Range (see Table 27).

The analyzed samples from the Klamath Mountains and Coast Range have the highest soil Cu concentrations (AM for the B horizon = 68 ppm and 52 ppm, respectively). The lowest analyzed Cu values are in the High Lava Plains (AM = 15 ppm) and Coastal Plain (AM <11 ppm). Among soil orders, Alfisols/Ultisols and Mollisols have the highest analyzed Cu concentrations (AM = 72 ppm and 57 ppm, respectively). Entisols have the lowest analyzed Cu values (AM = 17 ppm). Figure 7 shows the graphic representations of soil Cu concentrations in physiographic provinces, soil orders and major igneous rocks of the study area. Cu values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Cu concentrations vary widely.

The highest analyzed Cu concentrations are in Alfisols/Ultisols and Mollisols formed on mafic igneous (geologic units bc, cs, Jv, TrPv, Tsr and Tub) and argillaceous rocks (cm and Tfee). The lowest analyzed Cu values are in Entisols and Inceptisols developed on silty, sandy and gravelly materials (Qd, Qt, Tss and Tt) and granitic rocks (KJg). The Cu content of soils is influenced by parent rocks. The above soil Cu levels associated with parent rocks seem compatible with Cu being most abundant in mafic

Figure 7. Soil Copper (Cu) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

rocks and argillaceous sediments (Baker, 1993; Kabata-Pendias and Pendias, 1984; Aubert and Pinta, 1980). In the study area there is a distinct increase in Cu content in soils derived from felsic to mafic rocks (Table 18). The soil Cu levels also increase distinctly with soil development (Table 19), i.e. Alfisols/Ultisols > Inceptisols > Entisols. The average Cu values in the soil orders are statistically different at 95% confidence level. High Cu levels in the Klamath Mountains and Coast Range are mainly due to Alfisols/Ultisols covering large areas of these provinces.

In the study area the analyzed Cu concentrations in the A and B horizons have the pooled variance of 1.00 and the pooled standard deviation of 1.00. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 2.9 (2.92×1.00). The results of the analysis of the Cu concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 72.9% of the profiles and $A>B$ in 4.2% of the profiles. In the rest of the profiles (22.9%) we cannot reject the equality of the values in the two horizons. The concentration of Cu in the B horizon is most apparent in well-drained, humid Alfisols/Ultisols.

IRON (FE)

Distribution statistics for Fe content in soils of the study area are listed in Table 28. At all 118 sites investigated, the Fe concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of four ppm. The Fe values vary from 2,648 to 107,317 ppm with an average 29,148 ppm in the A horizon and from 3,066 to 137,939 ppm with an average of 37,300 ppm in the B horizon.

Table 28. Distribution statistics for Iron (Fe) content (ppm dry) in soils of Southwest Oregon.

	Hori -zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	29,148	2,648	107,312	20,778	25,371
	B	118/118	37,300	3,066	137,939	26,338	30,240
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	9,455	2,648	25,055	8,482	5,600
	B	7/7	17,205	3,066	40,980	15,478	9,925
Coast Range	A	16/16	39,369	15,727	78,302	19,620	33,218
	B	16/16	48,819	23,048	98,169	24,160	41,781
Willamette Valley	A	2/2	24,263	16,789	31,736	10,570	24,263
	B	2/2	28,101	19,378	36,824	12,337	28,101
Cascade Range	A	39/39	26,884	6,965	80,890	19,954	20,052
	B	39/39	31,655	9,857	82,430	22,123	23,409
Klamath Mountains	A	32/32	38,950	13,667	107,317	21,503	32,426
	B	32/32	53,062	14,946	137,939	29,881	42,930
Basin and Range	A	18/18	19,526	7,034	63,476	15,566	12,224
	B	18/18	25,062	8,615	71,441	17,881	17,841
High Lava Plain	A	4/4	12,129	8,317	19,180	5,013	10,510
	B	4/4	15,017	10,359	23,288	5,978	13,210
<i>Soil Orders</i>							
Entisols	A	27/27	10,758	3,844	25,527	3,780	10,212
	B	27/27	13,878	3,846	29,284	5,232	13,010
Inceptisols	A	44/44	27,316	3,985	78,302	81	25,215
	B	44/44	32,953	3,066	98,169	18,041	29,347
Alfisols/ Ultisols	A	31/31	44,776	7,685	107,317	23,937	39,049
	B	31/31	61,308	25,361	137,939	28,922	55,190
Mollisols	A	14/14	35,972	10,930	74,040	18,312	30,664
	B	14/14	45,753	15,457	82,430	21,306	43,977
Spodosols	A	1/1	2,648 ^a	--	--	--	--
	B	1/1	4,538 ^a	--	--	--	--
Vertisols	A	1/1	37,541 ^a	--	--	--	--
	B	1/1	41,104 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

The analyzed samples from the Klamath Mountains and Coast Range have the highest soil Fe values (AM for the B horizon = 53,062 ppm and 48,819 ppm, respectively). The lowest analyzed soil Fe contents are in the Coastal Plain (AM = 17,205 ppm) and High Lava Plains (AM = 15,017 ppm). Among soil orders, Alfisols/Ultisols and Mollisols have the highest analyzed Fe values (AM = 61,308 ppm and 45,753 ppm, respectively). Entisols have the lowest analyzed Fe concentrations (AM = 13,878 ppm). Fe values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Fe concentrations vary widely.

The maximum Fe concentrations found in the B horizon samples from the Klamath Mountains, Coast Range, Cascade Range and Basin and Range provinces are 13.8%, 9.8%, 8.2% and 7.1%, respectively. All these values are higher than the upper range (5%) of Fe levels normally observed in soils (Kabata-Pendias and Pendias, 1984). The highest analyzed Fe values are in Alfisols/Ultisols developed on ultramafic and mafic rocks (geologic units bc, cs, Ju, Jub, QTp, Tpb, Trb and Tsr). The lowest analyzed Fe levels are in Entisols and Inceptisols formed on intermediate and felsic rocks (KJg, Qma, Qmp, Qrd, and Tat) and sedimentary clastics (Qd, Qf, Qg, Qs, Qt, Ts and Tus). The above soil Fe values are reasonable as the Fe content of soils is inherited from parent rocks, and Fe is concentrated mainly in the mafic rocks (Kabata-Pendias and Pendias, 1984). There is an increase in Fe content in soils derived from felsic to mafic rocks in

the study area (Table 18). The soil Fe levels also increase with soil development (Table 19), i.e. Alfisols/Ultisols > Inceptisols > Entisols. The average Fe values in the soil orders are statistically different at 95% confidence level. High Fe concentrations in the Klamath Mountains and Coast Range have been contributed especially by Alfisols/Ultisols covering large areas of these provinces.

In the study area the analyzed Fe concentrations in the A and B horizons have the pooled variance of 629,261 and the pooled standard deviation of 793.3. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 2316.3 (2.92×793.3). The results of the analysis for the Fe concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 77.1% of the profiles and $A>B$ in 0.8% of the profiles. In the rest of the profiles (22.1%) we cannot reject the equality of the values in the two horizons. The concentration of Fe in the B horizon is particularly evident in well-drained, humid and clayey Alfisols/Ultisols. This is compatible with the findings of Knezek and Ellis (1980).

LANTHANUM (La)

Distribution statistics for La content in soils of the study area are listed in Table 29. Out of a total of 118, La has 77 values in the A horizon and 95 values in the B horizon above the laboratory's minimum reporting level of five ppm. The La concentrations vary from <5 to 26 ppm with an average of <8 ppm in the A horizon and from <5 to 32.5 with an average of <9.6 in the B horizon.

The La concentrations in the analyzed samples from the different physiographic

Table 29. Distribution statistics for Lanthanum (La) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
For all sites							
	A	118/77	<8	<5	26	>4.4	5.5
	B	118/95	<9.6	<5	32.5	>5	8.4
Physiographic Provinces							
Coastal Plain	A	7/4	<6	<5	6.8	>0.7	5
	B	7/4	<8	<5	13.5	>3.6	8.5
Coast Range	A	16/16	11	5	26	6	9
	B	16/16	13	5	33	7	11
Willamette Valley	A	2/2	12	10.4	13	2	12
	B	2/2	14	12	15	2	14
Cascade Range	A	39/25	<9	<5	23	>5	5
	B	39/31	<10	<5	23	>5	8
Klamath Mountains	A	32/21	<7	<5	16	>3	5
	B	32/23	<9	<5	14	>3	8
Basin and Range	A	18/8	<5	<5	16	>3	<5
	B	18/16	<9	<5	26	>5	7
High Lava Plain	A	4/1	<5	<5	5.7	>0.4	<5
	B	4/3	<6	<5	8	>1	5
Soil Orders							
Entisols	A	27/4	<5	<5	5.9	>0.2	<5
	B	27/17	<6	<5	10	>1	5
Inceptisol	A	44/37	<9	<5	23	>6	8
	B	44/38	<11	<5	27	>5	11
Alfisols/ Ultisols	A	31/23	<8	<5	20	>4	7
	B	31/26	<9	<5	14	>3	8
Mollisols	A	14/12	<11	<5	26	>6	10
	B	14/13	<14	<5	33	>7	14
Spodosol	A	1/0	<5 ^a	--	--	--	--
	B	1/0	<5 ^a	--	--	--	--
Vertisol	A	1/1	14.7 ^a	--	--	--	--
	B	1/1	15.6 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

provinces of the study area are fairly uniform. The slightly higher values are in the samples from the Willamette Valley (AM for the B horizon = 14 ppm) and Coast Range (AM = 13 ppm). The lowest analyzed soil La levels are in the Coastal Plain (AM <8 ppm) and High Lava Plains (AM <6 ppm). The analyzed concentrations of La in major soil orders are also fairly uniform, with slightly higher values for Mollisols (AM <14 ppm) and slightly lower values for Entisols (AM <6 ppm). Mollisols are developed under grass vegetation mainly in the Willamette Valley, and in the valleys and bedrock hills and plateaus of south-central Oregon. Soil-solutions in these regions are slightly alkaline. Higher La concentrations in Mollisols may be related to soil alkalinity as indicated by Balashov and others (1964) in their study of rare earths in Russian platform soils. The highest analyzed La value (26 ppm in the A horizon and 32.5 ppm in the B horizon) at site LC9 is in Mollisol developed on sandstone of the Yamhill Formation (geologic unit Ty). The other analyzed high La values are found in soils formed on silts, sands and gravels (geologic units Tfee, Tmss and Tn) and felsic rocks (Tut and KJg). Fairbridge (1972) also indicated high La levels in soils developed on sandy deposits, particularly beach sands, and felsic rocks.

In the study area the analyzed La concentrations in the A and B horizons have the pooled variance of 1.26 and the pooled standard deviation of 1.12. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 3.3 (2.92×1.12). The results of the analysis for the La concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 24.6% of the profiles and $A>B$ in 1.7% of the

profiles. In the rest of the profiles (73.7%) we cannot reject the equality of the values in the two horizons.

LEAD (PB)

Distribution statistics for Pb content in soils of the study area are listed in Table 30. Out of a total of 118, Pb has 45 values in the A horizon and 16 values in the B horizon above the laboratory's minimum reporting level of 10 ppm. The Pb contents vary from <10 to 378 ppm with an average of <18 ppm in the A horizon and from <10 to 40 ppm with an average of <10 ppm in the B horizon. The Pb contents of surface soils of the U.S. range from <10 to 70 ppm, with an average of 20 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.2). Except for a few sporadic high values, Pb levels in the A horizon samples of the study area are similar to that of the U.S. in general.

The analyzed samples from the Klamath Mountains have the highest soil Pb concentrations (AM for the A horizon <27 ppm). At site KL14 the highest Pb concentration of 378 ppm (in the A horizon) is in Alfisol/Ultisol derived from a shale (geologic unit Jss). The site KL14 is located on a hill, 1.1 miles off Highway 199, about 3 miles southwest of Wonder, Oregon. At another site (R12) about 200 feet above Highway 199, west of Wonder, Oregon, 146 ppm Pb occurs in the A horizon of an Inceptisol developed on a sandstone (Jub). There are also a few sites with high analyzed soil Pb values in the Coast and Cascade Ranges. For example, at site R2 (for location see Appendix 3) in the Cascade Range, Inceptisol developed on basaltic and

Table 30. Distribution statistics for Lead (Pb) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
For all sites							
	A	118/45	<18	<10	378	>39	<10
	B	118/16	<11	<10	40	>3	<10
Physiographic Provinces							
Coastal Plain	A	7/3	<10	<10	25	>6	<10
	B	7/0	<10	<10	<10	0	<10
Coast Range	A	16/8	<15	<10	51	>10	10
	B	16/6	<10	<10	39.6	>7.4	10
Willamette Valley	A	2/1	<25	<10	40	>21	10
	B	2/0	<10	<10	<10	0	<10
Cascade Range	A	39/16	<17	<10	133	>24	<10
	B	39/6	<10	<10	25	>2.4	<10
Klamath Mountains	A	32/11	<27	<10	378	>68	<10
	B	32/3	<10	<10	12.8	>0.6	<10
Basin and Range	A	18/5	<10	<10	10.4	>0.1	<10
	B	18/1	<10	<10	10	0	<10
High Lava Plain	A	4/1	<10	<10	10	0	<10
	B	4/0	<10	<10	<10	0	<10
Soil Orders							
Entisols	A	27/8	<10	<10	14	>0.8	<10
	B	27/3	<10	<10	10	0	<10
Inceptisols	A	44/21	<21	<10	146	>89	10
	B	44/11	<11	<10	40	>5	<10
Alfisols/ Ultisols	A	31/10	<23	<10	378	>66	<10
	B	31/1	<10	<10	10	0	<10
Mollisols	A	14/5	<10	<10	40	>8	<10
	B	14/1	<10	<10	15.8	>1.5	<10
Spodosol	A	1/1	10 ^a	--	--	--	--
	B	1/0	<10 ^a	--	--	--	--
Vertisol	A	1/0	<10 ^a	--	--	--	--
	B	1/0	<10 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

andesitic rocks (Tbaa) has 133 ppm Pb in the A horizon. Also at site LM1 in the Coast Range, Inceptisol formed on landslide and debris flow deposits (Qls) contains 104 ppm Pb in the A horizon.

In the study area the analyzed Pb concentrations in the A and B horizons have the pooled variance of 1.73 and the pooled standard deviation of 1.31. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 3.8 (2.92×1.31). The results of the analysis for the Pb concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A>B$ in 17.8% of the profiles and $A<B$ in 0.8% of the profiles. In the rest of the profiles (81.4%) we cannot reject the equality of the values in the two horizons. All high Pb values are in the A horizon. This is consistent with the observations made by Wright and others (1955) in soils of eastern Canada. Figure 8 shows the graphic representations of soil Pb concentrations in physiographic provinces, soil orders and major igneous rocks of the study area. There is no relationship between Pb concentrations and soil orders/soil development since all the high values are in the A horizon.

LITHIUM (Li)

Distribution statistics for Li content in soils of the study area are listed in Table 31. Out of a total of 118, Li has 88 values in the A horizon and 107 values in the B horizon above the laboratory's minimum reporting level of five ppm. The Li contents vary from <5 to 48 ppm with an average of <11 ppm in the A horizon and from <5 to 54 ppm with an average of <15 ppm in the horizon. The average Li concentrations in

Figure 8. Soil Lead (Pb) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

Table 31. Distribution statistics for Lithium (Li) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
For all sites							
	A	118/88	<11	<5	48	>8.6	7.6
	B	118/107	<15	<5	54	>11	11
Physiographic Provinces							
Coastal Plain	A	7/3	<8	<5	23	>7	5
	B	7/7	17	6	33	11	15
Coast Range	A	16/16	19	5	48	11	20
	B	16/16	24	5	54	12	24
Willamette Valley	A	2/2	6.1	5.4	6.7	0.9	6.1
	B	2/2	8.2	7.9	8.4	0.4	8.2
Cascade Range	A	39/28	<7	<5	15	>3	6
	B	39/33	<9	<5	23	>4	7
Klamath Mountains	A	32/27	<15	<5	48	>11	13
	B	32/30	<22	<5	52	>14	20
Basin and Range	A	18/11	<7	<5	12.4	>2.7	5
	B	18/16	<8	<5	14	>3.4	8
High Lava Plain	A	4/1	<5	<5	6	>0.5	<5
	B	4/3	<6	<5	8	>1.3	5
Soil Orders							
Entisols	A	27/11	<5	<5	8.5	>1	<5
	B	27/22	<6	<5	10	>1.7	5.8
Inceptisol	A	44/37	<13	<5	48	>3	10
	B	44/40	<17	<5	54	>12	13
Alfisols/ Ultisols	A	31/26	<14	<5	48	>11	9
	B	31/30	<20	<5	52	>14	16
Mollisols	A	14/13	<9	<5	22	>5	7
	B	14/13	<11	<5	25	>6	10
Spodosol	A	1/0	<5 ^a	--	--	--	--
	B	1/1	9 ^a	--	--	--	--
Vertisol	A	1/1	15 ^a	--	--	--	--
	B	1/1	16 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

surface soils of the U.S. range from 13 to 34 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.5). Soils of the study area are less abundant in Li than that of the U.S. in general.

The analyzed samples from the Coast Range and Klamath Mountains contain the highest soil Li values (AM for the B horizon = 24 ppm and <22 ppm, respectively). The lowest analyzed Li concentrations are in the Cascade Range (AM <9 ppm), Basin and Range (AM <8 ppm) and High Lava Plains (AM <6 ppm). The analyzed Li value in Alfisols/Ultisols (AM <20 ppm) and Inceptisols (AM <17 ppm) are comparable. Entisols are poorest in Li (AM <6 ppm).

The highest analyzed Li contents are found in soils derived from granite and diorite (JTrgd) and siltstone and sandstone (Kc, Ks, KJds, Tmsm, Tmss, Tt and Ty). The lowest analyzed Li values are found in soils developed on sandy materials (Qd, Tn), glacial deposits (Qg) and mafic and ultramafic rocks (Jub, KJgu, QTb, QTmv, QTps, Tob, and Tsr). Kabata-Pendias and Pendias (1984) indicated Li contents in magmatic rocks increase with an increase in silica, being highest in felsic rocks. The lower Tertiary marine, arkosic sands and silts in the Coast Range (i.e. geologic units Tmsm, Tmss, Tt and Ty) were derived from the Idaho batholith (Heller and others, 1987). The high soil Li levels in the Coast Range seem to have been contributed by these feldspar-rich deposits.

In the study area the analyzed Li concentrations in the A and B horizons have the pooled variance of 0.56 and the pooled standard deviation of 0.75. The null hypothesis

Ho: $A=B$ can be rejected if $A-B$ is greater than 2.2 ($2.92 \cdot 0.75$). The results of the analysis for the Li concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 50.8% of the profiles and $A>B$ in 0.8% of the profiles. In the rest of the profiles (48.4%) we cannot reject the equality of the values in the two horizons. The concentration of Li in the B horizon is most apparent in well-drained, humid Alfisols/Ultisols.

MAGNESIUM (MG)

Distribution statistics for Mg content in soils of the study area are listed in Table 32. At all the 118 sites the Mg concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of 50 ppm. The Mg levels vary from 545 to 16,424 ppm with an average of 4,431 ppm in the A horizon and from 591 to 23,606 ppm with an average of 5,325 ppm in the B horizon.

The analyzed samples from the Klamath Mountains and Coast Range have the highest soil Mg levels (AM for the B horizon = 8,990 ppm and 7,394 ppm, respectively). The analyzed Mg concentrations in these two physiographic provinces are far higher than the 3,000 ppm average Mg values reported by Bowen (1966) for soils in general. The lowest analyzed soil Mg values are in the High Lava Plains (AM = 2,155 ppm) and Coastal Plain (AM = 1,493 ppm). Among soil orders, Alfisols/Ultisols have the highest analyzed Mg concentrations (AM = 7,737 ppm). The analyzed Mg levels in Inceptisols (AM = 5,990 ppm) and Mollisols (AM = 4,994 ppm) are comparable. Entisols have the lowest analyzed Mg values (AM = 1,701 ppm). Mg values in the

Table 32. Distribution statistics for Magnesium (Mg) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	4,431	545	16,424	3,844	3,124
	B	118/118	5,325	591	23,606	4,752	3,914
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	1,323	620	3,314	921	1,123
	B	7/7	1,493	591	2,935	932	951
Coast Range	A	16/16	6,548	1,328	11,425	3,396	6,739
	B	16/16	7,394	1,655	13,848	3,769	6,967
Willamette Valley	A	2/2	4,567	1,317	7,817	4,596	4,567
	B	2/2	5,171	1,520	8,823	5,164	5,171
Cascade Range	A	39/39	2,916	545	13,829	2,751	1,718
	B	39/39	3,606	688	15,300	3,345	2,216
Klamath Mountain	A	32/32	7,397	2,119	16,424	4,272	5,657
	B	32/32	8,990	2,414	23,606	5,743	6,522
Basin and Range	A	18/18	2,338	879	6,756	1,764	1,762
	B	18/18	2,911	939	7,988	2,149	2,066
High Lava Plain	A	4/4	1,798	805	3,924	1,433	1,231
	B	4/4	2,155	1,017	4,798	1,771	1,404
<i>Soil Orders</i>							
Entisols	A	27/27	1,311	689	4,927	827	1,120
	B	27/27	1,701	688	5,989	1,240	1,360
Inceptisols	A	44/44	5,081	545	16,424	703	3,944
	B	44/44	5,990	591	23,606	4,971	5,187
Alfisols/ Ultisols	A	31/31	6,267	1,328	14,470	4,024	4,750
	B	31/31	7,737	1,468	21,446	4,926	6,327
Mollisols	A	14/14	4,294	1,317	13,829	3,924	2,565
	B	14/14	4,994	1,520	15,300	4,411	3,011
Spodosol	A	1/1	704 ^a	--	--	--	--
	B	1/1	756 ^a	--	--	--	--
Vertisol	A	1/1	6,914 ^a	--	--	--	--
	B	1/1	7,317 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have large standard deviations because these soils have been derived from rocks in which the Mg concentrations vary widely.

The highest analyzed Mg values are in soils developed on mafic igneous (cs, TrPv, Tsr and Tub) and clastic sedimentary rocks (Jm, Js, Ks and TrPzs). Mg is concentrated mainly in mafic rocks, and Mg content of soils is influenced by parent materials (Fairbridge, 1972). In the study area, Mg levels increase in soils derived from felsic to mafic rocks (Table 18). Mg levels also increase with soil development (Table 19). Alfisols/Ultisols, derived from basaltic rocks, have contributed to the high Mg levels in the Klamath Mountains and Coast Range.

In the study area the analyzed Mg concentrations in the A and B horizons have the pooled variance of 25,271 and the pooled standard deviation of 159. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 464 (2.92×159). The results of the analysis for the Mg concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 53.4% of the profiles and $A>B$ in 3.4% of the profiles. In the rest of the profiles (43.2%) we cannot reject the equality of the values in the two horizons. The concentration of Mg predominantly in the B horizon is in accord with the observations made by Bowen (1979). The greatest leaching (i.e. where $B>A$) is most obvious in Alfisols/Ultisols.

MANGANESE (MN)

Distribution statistics for Mn content in soils of the study area are listed in Table 33. At all the 118 sites the Mn concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of one ppm. The Mn levels vary from 24 to 7,221 ppm with an average of 1,527 ppm in the A horizon and from 21 to 4,951 ppm with an average of 848 ppm in the B horizon. The Mn contents in surface soils of the U.S. range from 7 to 3,000 ppm with an average of 495 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.4). Soils of the study area are more abundant in Mn than that of the U.S. The highest analyzed soil Mn concentrations in the A horizon of the Klamath Mountains, Cascade Range, Coast Range and Basin and Range provinces are 7,221 ppm, 5,685 ppm, 5,279 ppm and 4,600 ppm, respectively (Table 33). All these values are higher than the highest Mn value (i.e. 3,000 ppm) reported for surface soils of the U.S.

The analyzed Mn concentrations in the Klamath Mountains (AM for the A horizon = 2,138 ppm), Cascade Range (AM = 1,610 ppm), Coast Range (AM = 1,501 ppm), Basin and Range (AM = 1,131 ppm) and Willamette Valley (AM = 973 ppm) are comparable. The equality of the soil Mn values in these physiographic provinces cannot be rejected. The lowest analyzed soil Mn values are in the Coastal Plain (AM = 92 ppm). Comparable Mn values are in the analyzed samples from Alfisols/Ultisols (AM = 2,125 ppm), Mollisols (AM = 1,757 ppm) and Inceptisols (AM = 1,541 ppm). Entisols have the lowest analyzed Mn values (AM = 833 ppm). Mn values in the analyzed

Table 33. Distribution statistics for Manganese (Mn) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	1,527	24	7,221	1,331	1,208
	B	118/118	848	21	4,951	811	597
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	92	24	235	86	52
	B	7/7	257	21	1,363	491	42
Coast Range	A	16/16	1,501	31	5,279	1,253	1,345
	B	16/16	1,100	49	4,951	1,159	827
Willamette Valley	A	2/2	973	730	1,216	344	973
	B	2/2	485	187	783	421	485
Cascade Range	A	39/39	1,610	129	5,685	1,285	1,209
	B	39/39	777	100	2,555	678	571
Klamath Mountains	A	32/32	2,138	327	7,221	1,440	1,717
	B	32/32	1,282	270	3,345	835	1,099
Basin and Range	A	18/18	1,131	232	4,600	1,146	704
	B	18/18	409	124	943	280	317
High Lava Plain	A	4/4	499	248	673	180	537
	B	4/4	263	137	430	122	243
<i>Soil Orders</i>							
Entisols	A	27/27	833	41	3,235	809	644
	B	27/27	216	30	473	114	178
Inceptisols	A	44/44	1,541	24	7,221	1,479	1,268
	B	44/44	961	21	4,951	890	729
Alfisols/Ultisols	A	31/31	2,125	31	5,685	1,407	1,825
	B	31/31	1,229	49	3,345	866	1,076
Mollisols	A	14/14	1,757	169	4,600	1,364	1,262
	B	14/14	998	164	2,077	530	1,041
Spodosol	A	1/1	52 ^a	--	--	--	--
	B	1/1	32 ^a	--	--	--	--
Vertisol	A	1/1	566 ^a	--	--	--	--
	B	1/1	571 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

samples from the different physiographic provinces as well as from the different soil orders in the study area have very high standard deviations because these soils have been derived from rocks in which the Mn concentrations vary widely.

The highest analyzed Mn values are in soils developed on ultramafic and mafic rocks (geologic units bc, cs, Ju, Jub, QTb, Trb and Tu) and clastic sedimentary and volcanoclastic rocks (Kc, Tfe, Tmsm, TrPzs, Tus). The lowest analyzed Mn values are from soils on felsic and intermediate rocks (JTrgd, KJg, Qa, Qma, Qmp, Qrd) and silty and sandy materials (Qd, Qf, Qt and Tss). Mn is most abundant in mafic igneous rocks, and soils derive virtually all their Mn content from parent materials (Smith, 1993; Kabata-Pendias and Pendias, 1984). In the study area, although an apparent increase in average Mn levels is observed in soils derived from felsic to mafic/ultramafic rocks (Table 18), the equality of these values cannot be rejected at 95% confidence level. This is because the Mn concentrations in soils derived from various rocks have very large standard deviations. Mn levels increase with soil development (Table 19). High soil Mn levels in the Klamath Mountains and Coast Range owe to Alfisols/Ultisols developed on ultramafic/mafic rocks.

In the study area the analyzed Mn concentrations in the A and B horizons have the pooled variance of 14,626 and the pooled standard deviation of 120.9. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 353 (2.92×120.9). The results of the analysis for the Mn concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A>B$ in 46.6% of the profiles and $B>A$ in 1.7% of the

profiles. In the rest of the profiles (51.7%) we cannot reject the equality of the values in the two horizons. Adriano (1986) and Aubert and Pinta (1980) suggest that Mn usually concentrates in the humiferous surface horizons. In the Coastal Plain, Mn has accumulated in the B horizon of well-drained sandy soils at a few sites (LC17, KL7 and KL8).

MERCURY (HG)

Distribution statistics for Hg content in soils of the study area are listed in Table 34. Out of a total of 118, Hg has 109 detects in the A horizon and 72 detects in the B horizon. For all sites Hg concentrations vary from <0.04 to 0.37 ppm with an average of <0.1 ppm in the A horizon and from <0.04 to 0.25 ppm with an average of <0.06 ppm in the B horizon. The soil Hg contents in the western U.S. vary from <0.01 to 4.6 ppm in both the A and B horizons, with an average of 0.08 ppm in the A horizon and 0.06 ppm in the B horizon (Steinnes, 1993). Hg levels in soils of the study area are within the range of that of the western U.S. The analyzed samples from all the physiographic provinces in western Oregon (i.e. west of the Cascade Range) have higher average Hg values (see Table 34) than those of the western U.S. Locally, Coos County (see Figure 5 for location) samples contain the highest concentrations of Hg from six sites (an average of 0.17 ppm in the A horizon and an average of <0.13 ppm in the B horizon). Site LC18, located in this county, has the maximum analyzed soil Hg value (0.37 ppm in the A horizon and 0.25 ppm in the B horizon) in the study area. Douglas County, anticipated to contain very high soil Hg levels (George Di Domenico, personal communication,

Table 34. Distribution statistics for Mercury (Hg) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
For all sites							
	A	118/109	<0.1	<0.04	0.37	>0.06	0.08
	B	118/72	<0.06	<0.04	0.25	>0.04	0.04
Physiographic Provinces							
Coastal Plain	A	7/6	<0.13	<0.04	0.19	>0.06	0.14
	B	7/4	<0.08	<0.04	0.14	>0.05	0.06
Coast Range	A	16/16	0.12	0.06	0.37	>0.08	0.09
	B	16/14	<0.08	<0.04	0.25	>0.05	0.06
Willamette Valley	A	2/2	0.09	0.08	0.09	0.01	0.09
	B	2/1	<0.05	<0.04	0.06	>0.01	0.05
Cascade Range	A	39/34	<0.09	<0.04	0.26	>0.05	0.08
	B	39/24	<0.05	<0.04	0.12	>0.02	0.04
Klamath Mountains	A	32/31	<0.12	<0.04	0.29	>0.06	0.11
	B	32/27	<0.07	<0.04	0.24	>0.04	0.06
Basin and Range	A	18/17	<0.06	<0.04	0.17	>0.03	0.06
	B	18/2	<0.04	<0.04	0.06	0	<0.04
High Lava Plain	A	4/3	<0.06	<0.04	0.09	>0.02	0.06
	B	4/0	<0.04	<0.04	<0.04	0	<0.04
Soil Orders							
Entisols	A	27/24	<0.06	<0.04	0.09	>0.02	0.06
	B	27/8	<0.05	<0.04	0.12	>0.02	<0.04
Inceptisols	A	44/41	<0.11	<0.04	0.29	>0.02	0.08
	B	44/30	<0.06	<0.04	0.18	>0.03	0.05
Alfisols/ Ultisols	A	31/30	<0.12	<0.04	0.37	>0.07	0.11
	B	31/28	<0.08	<0.04	0.25	>0.05	0.06
Mollisols	A	14/13	<0.1	<0.04	0.26	>0.06	0.08
	B	14/6	<0.05	<0.04	0.08	>0.01	<0.04
Spodosol	A	1/1	0.14 ^a	--	--	--	--
	B	1/0	<0.04 ^a	--	--	--	--
Vertisol	A	1/0	<0.04 ^a	--	--	--	--
	B	1/0	<0.04 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

1995), has an average of <0.09 ppm in the A horizon and an average of <0.06 ppm in the B horizon, from 21 sites.

Hg concentrations are highest in the analyzed samples from the Coastal Plain (AM for the A horizon <0.13 ppm), Coast Range (AM = 0.12 ppm) and Klamath Mountains (AM <0.12 ppm). Each of these provinces has a few sites with very high soil Hg levels. Hg values in the analyzed samples from the Basin and Range (AM <0.06 ppm) and High Lava Plains (AM < 0.06 ppm) are lowest. This shows that the soil Hg concentrations are higher in western Oregon than in eastern Oregon.

In their work in the state of Washington, Ames and Prych (1995) showed that organic matter concentrations in soils are generally greater in the regions west of the Cascade Range than in the east. The same is likely true for Oregon, as the physiographic setting, the climate, and the vegetation are similar in these two states. Thus, the higher soil Hg contents observed in western Oregon than in eastern Oregon might be related to differences in soil organic matter. Andersson (1979), in a study of Hg in profiles of virgin soils, demonstrated a very close correlation between Hg and organic matter content in acidic soils. Soils of western Oregon are also generally acidic (see Table 7 for average soil-solution pH in the study area). In the Coast Range at site LC18, Ultisol developed on tuffaceous siltstone and sandstone (Tss) has the highest analyzed Hg value of 0.62 ppm in the study area. The other high analyzed Hg values are in soils derived from sedimentary and volcanoclastic (Qt, TrPzs and Tus) and volcanic rocks (cs, Tbaa, Tpb and Jub). Steinnes (1993) reported that high concentrations of Hg occur in rocks

derived from volcanic debris or deposited in volcanic areas. Figure 9 shows the graphic representations of soil Hg concentrations in physiographic provinces, soil orders and major igneous rocks of the study area.

In the study area the analyzed Hg concentrations in the A and B horizons have the pooled variance of 0.00. The Hg values in the A horizon versus the B horizon at 118 sites investigated are as follows: A>B in 81.3% of the profiles and A<B in 6.8% of the profiles. In the rest of the profiles (11.9%) we cannot reject the equality of the values in the two horizons. The concentration of Hg in the A horizon of most profiles is consistent with an extensive survey of virgin soils from all the provinces of Canada by McKeague and Kloosterman (1974). Much higher concentration of Hg in the surface soil than in the subsoil has also been noted by Kabata-Pendias and Pendias (1984).

MOLYBDENUM (MO)

In the study area, the Mo concentrations in all the analyzed samples from both the A and B horizons are below the laboratory's minimum reporting level of five ppm. The total soil Mo contents are usually low, averaging 1-2 ppm (Massey and Lowe, 1961; Kabata-Pendias and Pendias, 1984).

NICKEL (NI)

Distribution statistics for Ni content in soils of the study area are listed in Table 35. Out of a total of 118, Ni has 115 detects from both the A and B horizons. The Ni concentrations vary from <4 to 1,132 ppm with an average of <52 ppm in the A horizon and from <4 to 1,530 ppm with an average of <71 ppm in the B horizon. In surface soils

Figure 9 Soil Mercury (Hg) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

Table 35. Distribution statistics for Nickel (Ni) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
For all sites							
	A	118/115	<52	<4	1,132	>126	22
	B	118/115	<71	<4	1,530	>201	25
Physiographic Provinces							
Coastal Plain	A	7/5	<9	<4	25	>8	4
	B	7/5	<13	<4	27	>10	10
Coast Range	A	16/16	59	5	170	46	55
	B	16/16	73	5	163	54	63
Willamett Valley	A	2/2	18	7	29	16	18
	B	2/2	22	9	35	18	22
Cascade Range	A	39/38	<18	<4	76	>16	12
	B	39/38	<21	<4	86	>19	13
Klamath Mountains	A	32/32	120	6	1,132	225	50
	B	32/32	175	4	1,530	364	59
Basin and Range	A	18/18	26	5	136	33	13
	B	18/18	32	5	154	38	18
High Lava Plain	A	4/4	13	5	29	11	9
	B	4/4	15	7	33	12	10
Soil Orders							
Entisols	A	27/27	10	4	43	7	8
	B	27/26	<13	<4	53	>11	10
Inceptisols	A	44/42	<47	<4	371	>22	27
	B	44/42	<60	<4	525	>85	30
Alfisols/ Ultisols	A	31/31	107	4	1,132	226	46
	B	31/31	160	5	1,530	366	56
Mollisols	A	14/14	32	7	76	20	28
	B	14/14	39	9	86	24	37
Spodosol	A	1/0	<4 ^a	--	--	--	--
	B	1/1	5 ^a	--	--	--	--
Vertisol	A	1/1	42 ^a	--	--	--	--
	B	1/1	48 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Note: Where the concentration of a metal in a sample is less than the laboratory's minimum reporting level, the minimum reporting level is used for calculating statistics, and the statistics are qualified as less than or greater than the value given.

of the U.S., Ni content ranges from <5 to 200 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.3). The surface soils of the study area are much richer in Ni than that of the U.S.

The analyzed samples from the Klamath Mountains have the highest soil Ni concentrations (AM for the B horizon = 175 ppm). Ni values in the analyzed samples from the Basin and Range (AM = 32 ppm), Willamette Valley (AM = 22 ppm) and Cascade Range (AM <21 ppm) are comparable. The lowest analyzed soil Ni values are in the High Lava Plains (AM = 15 ppm) and Coastal Plain (AM <13 ppm). Among soil orders, Alfisols/Ultisols have the highest analyzed Ni value (AM = 160 ppm). Entisols have the lowest analyzed Ni concentrations (AM <13 ppm). Figure 10 shows the graphic representations of soil Ni concentrations in physiographic provinces, soil orders and major igneous rocks of the study area. Ni values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have very high standard deviations because these soils have been derived from rocks in which the Ni concentrations vary widely.

The Klamath Mountains have very high soil Ni concentrations compared to the U.S. The analyzed surface-soil samples from the Klamath Mountains contain an average of 120 ppm Ni. This is more than four times the average Ni values (12-30 ppm; Appendix 8.3) reported by Kabata-Pendias and Pendias (1984) for surface soils of the U.S. The maximum analyzed Ni concentration of 1,132 ppm in the A horizon of the

Figure 10. Soil Nickel (Ni) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

Klamath Mountains is nearly six times the highest value (200 ppm) reported by them for surface soils of the U.S.

Unusually high Ni concentrations have been found in soils derived from serpentinized ultramafic rocks. For example, samples from soils developed on Ju (at site KL16) and Jm (at site KL17) in the Klamath Mountains have Ni values of 2,662 ppm and 2,122 ppm (includes both the A and B horizons), respectively. As noted by Brooks (1987), soils on serpentinized ultramafics (i.e. Jm and Ju) also contain exceptionally large concentrations of Cr, Fe and Mg (see Appendix 6 for soil metal values). The other high analyzed Ni levels are found in soils formed over mafic rocks (bc and QTp), partly metamorphosed argillaceous sedimentary rocks (TrPzs) and landslide and debris flow deposits (Qls). The lowest analyzed Ni contents are found in soils derived from granitic rocks (KJg), Mazama ash-flow and pumice deposits (Qma and Qmp) and sandy and silty rocks (Qd, Qt, Ts and Tss). Ni contents are highest in ultramafic rocks (1,400-2,000 ppm), and its concentrations decrease with increasing silica percentage in rocks down to 5 to 15 ppm in granites (McGrath and Smith, 1993; Aubert and Pinta, 1980). The soil Ni level is highly influenced by parent rocks (Kabata-Pendias and Pendias, 1984). In the study area, although there is an apparent increase in Ni concentrations in soils derived from felsic to mafic/ultramafic rocks (Figure 10), the equality of these values cannot be rejected at 95% confidence level. This is because the Ni concentrations in soils developed on ultramafic/mafic rocks in particular have an extremely large standard deviation (nearly three times the mean; Table 18). There is a

distinct increase in soil Ni level with soil development (Table 19). The Klamath Mountains have such a high soil Ni content due to Alfisols/Ultisols developed on mafics/ultramafics, particularly on ultramafics.

In the study area the analyzed Ni concentrations in the A and B horizons have the pooled variance of 1.55 and the pooled standard deviation of 1.24. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 3.6 (2.92×1.24). The results of the analysis for the Ni concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 48.3% of the profiles and $A>B$ in 7.6% of the profiles. In the rest of the profiles (44.1%) we cannot reject the equality of the values in the two horizons. The concentration of Ni in the B horizon is more evident in Alfisols/Ultisols than in other soil orders.

POTASSIUM (K)

Distribution statistics for K content in soils of the study area are listed in Table 36. At all 118 sites investigated, the K concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of 50 ppm. The K concentrations range from 223 to 4,973 ppm with an average of 1,266 ppm in the A horizon and from 73 to 5,535 ppm with an average of 1,083 ppm in the B horizon.

The analyzed samples from the Coast Range and Klamath Mountains have the highest soil K levels (AM for the A horizon = 1,938 ppm and 1,636 ppm, respectively). The lowest analyzed soil K levels are in the Coastal Plain (AM = 545 ppm) and High

Table 36. Distribution statistics for Potassium (K) content (ppm dry) in soils of Southwest Oregon.

	Horizon	Total Sample Number/ Detects ¹	Arithmetic Mean	Minimum	Maximum	Arithmetic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	1,266	223	4,973	964	941
	B	118/118	1,083	73	5,535	941	780
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	545	298	896	209	501
	B	7/7	541	262	1,176	321	558
Coast Range	A	16/16	1,938	861	4,666	1,029	1,594
	B	16/16	1,838	518	5,022	1,177	1,494
Willamette Valley	A	2/2	1,343	826	1,860	731	1,343
	B	2/2	951	780	1,121	242	951
Cascade Range	A	39/39	1,043	223	4,541	909	669
	B	39/39	796	168	3,571	718	456
Klamath Mountains	A	32/32	1,636	274	4,973	1,083	1,523
	B	32/32	1,406	73	5,535	1,111	1,115
Basin and Range	A	18/18	931	476	1,771	410	821
	B	18/18	830	253	1,875	466	642
High Lava Plain	A	4/4	526	391	615	106	549
	B	4/4	436	244	567	155	466
<i>Soil Orders</i>							
Entisols	A	27/27	580	275	1,546	267	513
	B	27/27	493	234	1,421	308	426
Inceptisols	A	44/44	1,474	223	4,973	465	1,198
	B	44/44	1,338	163	5,535	1,176	970
Alfisols/ Ultisols	A	31/31	1,353	286	3,881	801	1,065
	B	31/31	1,105	73	2,654	728	928
Mollisols	A	14/14	1,444	344	2,646	689	1,417
	B	14/14	1,202	248	2,948	738	1,096
Spodosol	A	1/1	530 ^a	--	--	--	--
	B	1/1	262 ^a	--	--	--	--
Vertisol	A	1/1	4,541 ^a	--	--	--	--
	B	1/1	3,571 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Lava Plains (AM = 526 ppm). The analyzed K levels in Inceptisols (AM = 1,474 ppm), Mollisols (AM = 1,444 ppm) and Alfisols/Ultisols (AM = 1,353 ppm) are comparable. Entisols have the lowest analyzed K values (AM = 580 ppm). K values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have standard deviations close to the means. This is because these soils have been derived from rocks in which the K concentrations vary widely.

The highest analyzed K values are in soils developed over argillaceous rocks (geologic units cm, Tn, Jss and Ty), marine arkosic siltstone and sandstone (Tmsc, Tmsm, Tmss and Tt), granitic (KJg) and volcanic rocks (TrPv). The lowest analyzed K concentrations are in soils derived from ultramafic and mafic rocks (Jm, KJgu, mc, Qba, QTb and QTba) and sandy materials (Qd, Qt and Tss). K content in igneous rocks increases with increasing silica content, and the soil K levels are largely controlled by the associated parent rock materials (Fairbridge, 1972). In the study area, the equality of K concentrations in soils developed on major igneous rocks cannot be rejected. This is due to the large standard deviations of these values. The highest analyzed average soil K content in the Coast Range is due to Inceptisols formed on particularly feldspar-rich arkosic sandstones and siltstones. The humid, well-drained and developed Alfisols/Ultisols are expected to have low levels of K since the metal is highly mobile in soils (Birkeland, 1984). The comparable K values in Alfisols/Ultisols, Mollisols and Inceptisols indicate that K was not much leached out of the system, the reason of which cannot be found. The lowest analyzed average K content in Entisols could partly reflect

their associated parent rocks as these soils are derived from K-poor sandy materials at many sites.

In the study area the analyzed K concentrations in the A and B horizons have the pooled variance of 16,843 and the pooled standard deviation of 129.8. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 379.0 (2.92×129.8). The results of the analysis for the K concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A>B$ in 21.2% of the profiles and $B>A$ in 2.5% of the profiles. In the rest of the profiles (76.3%) we cannot reject the equality of the values in the two horizons. K is concentrated in the B horizon of well-drained, humid soils of the Coastal Plain, Coast Range and Klamath Mountains.

SELENIUM (SE)

In the study area Se values in all the analyzed samples from both the A and B horizons are below the laboratory's minimum reporting level of 30 ppm. This is expected as the Se levels in soils are normally very low. Kabata-Pendias and Pendias (1984) reported surface soil Se of the U.S. to range from <0.1 to 4 ppm with an average of 0.4 ppm (Appendix 8.4).

SILVER (AG)

In the study area none of the analyzed samples in either the A or B horizon has a Ag value at or above the laboratory's minimum reporting level of one ppm. Normal Ag contents in soils vary from <0.01 to 5 ppm with an average of about 0.1 ppm (Boyle, 1972).

SODIUM (NA)

Distribution statistics for Na content in soils of the study area are listed in Table 37. At all the 118 sites the Na concentrations in both the A and B horizons are greater than the laboratory's minimum reporting concentration of 50 ppm. The Na contents vary from 53 to 1,511 ppm with an average of 346 ppm in the A horizon and from 47 to 2,341 ppm with an average of 419 ppm in the B horizon.

The Na concentrations are generally greater in the soils sampled in semiarid eastern Oregon than in humid western Oregon. The analyzed soil Na values are high in the High Lava Plains (AM for the B horizon = 793 ppm) and Basin and Range (AM = 721 ppm). On the other hand, the Na levels are comparatively much lower in the analyzed samples from the Coast Range (AM = 287 ppm), Coastal Plain (AM = 150 ppm) and Klamath Mountains (AM = 163 ppm). The highest analyzed Na values (AM = 871 ppm from only two sites) in the Willamette Valley are the exception. The Na levels in the Cascade Range (AM = 530 ppm) samples are in between the above two categories. Among soil orders, Entisols and Mollisols have the highest analyzed Na concentrations (AM = 785 ppm and 593 ppm, respectively). The Alfisols/Ultisols have the lowest analyzed Na values (AM = 135 ppm). Na values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have very high standard deviations because these soils have been derived from rocks in which the Na concentrations vary widely. Climatic conditions have also greatly affected the soil Na concentrations in the region.

Table 37. Distribution statistics for Sodium (Na) content (ppm dry) in soils of Southwest Oregon.

	Hori- zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	346	53	1,511	318	216
	B	118/118	419	47	2,341	426	200
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	215	129	362	81	206
	B	7/7	150	98	194	42	140
Coast Range	A	16/16	244	73	1,511	352	122
	B	16/16	287	59	2,341	557	137
Willamette Valley	A	2/2	738	60	1,416	959	738
	B	2/2	871	53	1,689	1,157	871
Cascade Range	A	39/39	425	61	1,353	319	371
	B	39/39	530	57	1,708	427	502
Klamath Mountains	A	32/32	148	53	494	89	128
	B	32/32	163	47	556	108	128
Basin and Range	A	18/18	565	200	1,491	309	564
	B	18/18	721	171	1,739	339	661
High Lava Plain	A	4/4	614	470	767	146	611
	B	4/4	793	701	981	129	745
<i>Soil Orders</i>							
Entisols	A	27/27	590	129	1,491	227	576
	B	27/27	785	129	1,739	273	761
Inceptisols	A	44/44	321	53	1,353	118	206
	B	44/44	356	59	1,541	342	193
Alfisols/ Ultisols	A	31/31	140	57	405	88	106
	B	31/31	135	47	384	84	90
Mollisols	A	14/14	435	60	1,511	522	208
	B	14/14	593	53	2,341	746	216
Spodosol	A	1/1	241 ^a	--	--	--	--
	B	1/1	105 ^a	--	--	--	--
Vertisol	A	1/1	168 ^a	--	--	--	--
	B	1/1	163 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

The highest analyzed Na values are in soils derived from intermediate and felsic magmatic rocks (Qa, Qma, Qrd, QTps and Tat), alluvial deposits (Qal) and fanglomerate (Qf). The lowest analyzed Na concentrations are in soils on ultramafic and mafic rocks (bc, Ju, Jub, KJgu, QTb, QTvm). Na concentrations increase with increasing silica content of the magmatic rocks, and the soil Na content is inherited from parent rocks (Fairbridge, 1972). In the study area, the equality of the Na concentrations in soils developed on major igneous rocks cannot be rejected because these values have large standard deviations (Table 18). Surprisingly, at site LC6 in the Coast Range, the highest Na concentration of 3,852 ppm (1,511 ppm in the A horizon and 2,341 ppm in the B horizon) has been found in soil developed over the mafic Siletz River Volcanics (Tsr). The site LC6 is located east of Roseburg, Oregon, near a gravel pit. At two other sites (LC10A and LC19) in the Coast Range, soils on the same geologic unit contain Na concentrations of only 269 ppm and 576 ppm (includes both the A and B horizons), respectively. This shows that the unusually high soil Na content at site LC6 is likely due to anthropogenic contamination, and its value was not included in the averages. In the study area, the soil Na levels decrease with soil development (Table 19). Na is highly mobile in soil, being very soluble in water. Alfisols/Ultisols, formed on mafic/ultramafic rocks, are expected to be low in Na. These well developed soils in western Oregon have been extensively leached by groundwater resulting in further depletion of this metal. In general, leaching of Na downward through the profile has resulted in the low content of this metal in humid western Oregon. On the contrary,

semiaridic condition of eastern Oregon is responsible for high soil Na levels there. Exceptionally Na-rich soils in the Willamette Valley, developed on the Holocene Missoula Floods sediments, are much younger than those in the rest of the study area. Brief time coupled with subhumid environment were responsible for little loss of this metal by leaching.

In the study area the analyzed Na concentrations in the A and B horizons have the pooled variance of 5,087 and the pooled standard deviation of 71.3. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 208.3 (2.92×71.3). The results of the analysis for the Na concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 16.9% of the profiles and $A>B$ in 0.8% of the profiles. In the rest of the profiles (82.3%) we cannot reject the equality of the values in the two horizons. At a number of sites in the eastern Klamath Mountains, Basin and Range and High Lava Plains an accumulation of Na is found in the A horizon. These regions are characterized by a semiarid climate. Na has also accumulated in the A horizon at a few sites (LC14, LC16 and LC17) in the Coastal Plain. The latter is possibly due to an influence of the salt-rich air along the coast which overcomes the high rainfall that generally moves Na through the profile in this humid environment.

THALLIUM (TL)

In the study area none of the analyzed samples from either the A or B horizon contains Tl concentrations at or above the laboratory's minimum reporting level of 50

ppm. Previous work (Smith and Carson, 1977) indicates that Tl contents in surface soils of the U.S. range from 0.02 to 2.8 ppm.

VANADIUM (V)

Distribution statistics for V content in soils of the study area are listed in Table 38. At all the 118 sites the V concentrations in both the A and B horizons are greater than the laboratory's minimum reporting level of three ppm. The V concentrations range from 6 to 374 ppm with an average of 69 ppm in the A horizon and from 4 to 409 ppm with an average of 89 ppm in the B horizon. The V contents in surface soils of the U.S. range from <1 to 300 ppm with an average of 84 ppm (Kabata-Pendias and Pendias, 1984) (Appendix 8.4). Soil V levels in the study area are similar to that of the U.S.

The analyzed samples from the Klamath Mountains and Coast Range have the highest soil V contents (AM for the B horizon = 133 ppm and 100 ppm, respectively). The lowest analyzed soil V levels are in the High Lava Plains (AM = 39 ppm) and Coastal Plain (AM = 38 ppm). Among major soil orders, Alfisols/Ultisols and Mollisols have the highest analyzed V concentrations (AM = 152 ppm and 113 ppm, respectively). The lowest analyzed V values are in Entisols (AM = 38 ppm). V values in the analyzed samples from the different physiographic provinces as well as from the different soil orders in the study area have high standard deviations because these soils have been derived from rocks in which the V concentrations vary widely.

Table 38. Distribution statistics for Vanadium (V) content (ppm dry) in soils of Southwest Oregon.

	Hori- zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	69	6	374	56	55
	B	118/118	89	4	409	68	69
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	23	6	65	21	20
	B	7/7	38	4	75	32	43
Coast Range	A	16/16	82	27	219	57	62
	B	16/16	100	43	248	67	73
Willamette Valley	A	2/2	56	34	78	31	56
	B	2/2	66	44	89	31	66
Cascade Range	A	39/39	64	14	212	50	39
	B	39/39	76	16	223	55	52
Klamath Mountains	A	32/32	98	12	374	69	79
	B	32/32	133	12	409	84	114
Basin and Range	A	18/18	46	18	107	28	34
	B	18/18	62	21	142	37	49
High Lava Plain	A	4/4	29	21	39	9	28
	B	4/4	39	30	47	9	39
<i>Soil Orders</i>							
Entisols	A	27/27	29	6	49	9	29
	B	27/27	38	6	75	13	36
Inceptisols	A	44/44	57	8	182	19	54
	B	44/44	71	4	223	42	67
Alfisols/ Ultisols	A	31/31	114	20	374	71	102
	B	31/31	152	44	409	82	140
Mollisols	A	14/14	88	34	219	53	78
	B	14/14	113	44	238	58	109
Spodosol	A	1/1	7 ^a	--	--	--	--
	B	1/1	7 ^a	--	--	--	--
Vertisol	A	1/1	75 ^a	--	--	--	--
	B	1/1	88 ^a	--	--	--	----

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

The highest analyzed V levels are found in soils formed on ultramafic and mafic rocks (geologic units bc, cs, Ju, Jub, Jv, QTba and Tsr). The lowest analyzed V values are in soils derived from felsic rocks (KJg, Qrd and Tsv) and sandy materials (Qd, Qt, Tn and Tt). Earlier works (Jones and others, 1993; Kabata-Pendias and Pendias, 1984; Aubert and Pinta, 1980) indicate that the V concentrations increase with decreasing silica content in magmatic rocks, and the soil V contents are largely controlled by parent rock materials. In the study area, the average V contents increase in soils derived from felsic to mafic/ultramafic rocks (Table 18). Soil V contents also increase with soil development (Table 19), i.e. Alfisols/Ultisols > Inceptisols > Entisols. High V levels in the Klamath Mountains and Coast Range are mainly from Alfisols/Ultisols formed on mafic/ultramafic rocks.

In the study area the analyzed V concentrations in the A and B horizons have the pooled variance of 6.68 and the pooled standard deviation of 2.58. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 7.5 (2.92×2.58). The results of the analysis for the V concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $B>A$ in 75.4% of the profiles. In the rest of the profiles (24.6%) we cannot reject the equality of the values in the two horizons. The concentration of V in the B horizon is more apparent in well-drained, humid Alfisols/Ultisols than in others.

ZINC (ZN)

Distribution statistics for Zn content in soils of the study area are listed in Table 39.

Zn has detects in both the A and B horizons at all the 118 sites. The Zn concentrations range from 11 to 196 ppm with an average of 74 ppm in the A horizon and from 9 to 183 ppm with an average of 69 ppm in the B horizon. Kabata-Pendias and Pendias (1984) reported values of 34-84 ppm Zn as background average contents of surface soils of the U.S. (Appendix 8.3). Soil Zn concentrations in the study area are within the range of that of the U.S. with the averages slightly higher than the national average.

The Zn concentrations in the analyzed samples from the Klamath Mountains (AM for the A horizon = 89 ppm), Coast Range (AM = 83 ppm), Cascade Range (AM = 75 ppm), Basin and Range (AM = 68 ppm) and Willamette Valley (AM = 50 ppm) are comparable. The t-test indicates that the equality of the Zn values in these provinces cannot be rejected. The lowest analyzed soil Zn values are in the Coastal Plain (AM = 19 ppm). The analyzed Zn levels in Mollisols (AM = 86 ppm), Alfisols/Ultisols (AM = 85 ppm) and Inceptisols (AM = 78 ppm) are comparable. Entisols have the lowest analyzed Zn concentrations (AM = 49 ppm). Figure 11 shows the graphic representations of soil Zn concentrations in physiographic provinces, soil orders and major igneous rocks of the study area.

The highest analyzed Zn values are in soils developed on mafic rocks (bc, QTb, QTp, Tpb, Trb and Tu), argillaceous sediments (Jss, KJds and TrPzs) and landslide and debris flow deposits (Qls). The lowest analyzed Zn contents are in soils formed on

Table 39. Distribution statistics for Zinc (Zn) content (ppm dry) in soils of Southwest Oregon.

	Hori- zon	Total Sample Number/ Detects ¹	Arith- metic Mean	Mini- mum	Maxi- mum	Arith- metic Standard Deviation	Median
<i>For all sites</i>							
	A	118/118	74	11	196	38	70
	B	118/118	69	9	183	37	67
<i>Physiographic Provinces</i>							
Coastal Plain	A	7/7	19	11	31	8	16
	B	7/7	29	9	82	27	19
Coast Range	A	16/16	83	18	131	29	86
	B	16/16	81	23	136	29	85
Willamette Valley	A	2/2	50	27	74	34	50
	B	2/2	49	25	72	33	49
Cascade Range	A	39/39	75	17	153	34	68
	B	39/39	63	17	140	32	60
Klamath Mountains	A	32/32	89	25	196	39	81
	B	32/32	90	12	183	40	87
Basin and Range	A	18/18	68	26	161	38	56
	B	18/18	56	21	113	29	50
High Lava Plain	A	4/4	45	32	61	14	44
	B	4/4	34	24	46	10	32
<i>Soil Orders</i>							
Entisols	A	27/27	49	11	92	17	49
	B	27/27	38	19	91	14	35
Inceptisols	A	44/44	78	11	168	15	73
	B	44/44	76	9	183	40	71
Alfisols/ Ultisols	A	31/31	85	16	196	42	85
	B	31/31	82	12	171	35	85
Mollisol	A	14/14	86	23	161	39	88
	B	14/14	78	23	140	32	83
Spodosol	A	1/1	19 ^a	--	--	--	--
	B	1/1	11 ^a	--	--	--	--
Vertisol	A	1/1	80 ^a	--	--	--	--
	B	1/1	75 ^a	--	--	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory's reporting limit.

^a Only one concentration value is listed under arithmetic mean.

Figure 11. Soil Zinc (Zn) concentrations in physiographic provinces, soil orders and major igneous rocks of Southwest Oregon

sandy materials (KJm, Qd, Qt and Tss). The soil Zn content is mainly dependent on the composition of the parent rocks (Kabata-Pendias and Pendias, 1984). Previous works (Kabata-Pendias and Pendias, 1984; Aubert and Pinta, 1980; Krauskopf, 1972) indicate that Zn is rather uniformly distributed in magmatic rocks, with only slight increase in mafic rocks and slight decrease in felsic rocks. This is reflected in the similar average Zn contents in soils derived from felsic to mafic/ultramafic rocks in the study area (Table 18). The low arithmetic standard deviation (approximately half the arithmetic mean) (Table 39) is also indicative of less variability in soil Zn concentrations. Argillaceous sedimentary rocks have high Zn contents, while sandstones are very low in this metal (Aubert and Pinta, 1980). As expected, acid leached sandy soils of the Coastal Plain are Zn deficient. The young soils of the High Lava Plains are also Zn deficient. In the rest of the study area, the Zn concentrations are rather uniform, with a slight increase in the Klamath Mountains and Coast Range.

The highest analyzed Zn values are in soils developed on mafic rocks (bc, QTb, QTp, Tpb, Trb and Tu), argillaceous sediments (Jss, KJds and TrPzs) and landslide and debris flow deposits (Qls). The lowest analyzed Zn contents are in soils formed on sandy materials (KJm, Qd, Qt and Tss). The soil Zn content is mainly dependent on the composition of the parent rocks (Kabata-Pendias and Pendias, 1984). Previous works (Kabata-Pendias and Pendias, 1984; Aubert and Pinta, 1980; Krauskopf, 1972) indicate that Zn is rather uniformly distributed in magmatic rocks, with only slight increase in mafic rocks and slight decrease in felsic rocks. This is reflected in the similar average

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In the study area the analyzed Zn concentrations in the A and B horizons have the pooled variance of 12.14 and the pooled standard deviation of 3.48. The null hypothesis $H_0: A=B$ can be rejected if $A-B$ is greater than 10.2 (2.92×3.48). The Zn concentrations in the A horizon versus the B horizon at 118 sites investigated are as follows: $A > B$ in 32.2% of the profiles and $B > A$ in 11.9% of the profiles. In the rest of the profiles (55.9%) we cannot reject the equality of the values in the two horizons. The concentration of Zn in the B horizon is most evident in acid leached sandy soils of the Coastal Plain .

LIMITATIONS OF THE STUDY

In a study of soils in Washington, Ames and Prych (1995) noted that, "Metal concentrations determined by the total-recoverable method (used in this study) do not correlate with either organic carbon content or fraction of fines in the sample . . . the metal concentrations determined by the total-recoverable method are not simply dependent upon exchangeable metals concentrations, but also depend on the partial digestion of the various mineral phases present in the soils. Therefore, total-recoverable metals concentrations will vary between samples collected from soils that developed in different parent materials and in turn will depend on more subtle differences among different parent materials." The metal content of soil parent material corresponds closely to that of the different contributing rock types (Jenkins and Jones, 1980).

In this study soil sampling is based on geologic units. In most cases, individual geologic units are composed of various rock types. For example, the geologic unit Tn represents nonmarine sedimentary rocks consisting of sandstone, shale and conglomerate. Soils derived from different rock types of this geologic unit have different background metal distributions (see Appendix 5 for soil metal contents at sites R7, R8 and R9 over different rock types of geologic unit Tn). This can be of significance in determining if, and to what degree, soils were contaminated at a specific site where contamination is suspected. Soils developed on all rock types of a specific geologic unit have not been analyzed in this study. Also the site-specific petrographic details of the contributing rock types are not known in many cases. Local peculiarities

of parent rocks may have a considerable effect on metal distribution in the derived soils. Nevertheless, the database will help to predict the 'first order' distribution of metals in soils of southwest Oregon.

To use the database generated from this study, find on the Geologic Map of Oregon (Walker and MacLeod, 1991) your geologic unit of the site and turn to Appendix 7 for metal concentration ranges in soils formed on that geologic unit.

CHAPTER VI: CONCLUSIONS

A total of 248 samples from 118 sites on 71 geologic units in southwest Oregon were tested in this study. Eight of the 26 metals investigated have concentrations near or below the laboratory's reporting limits. The concentrations of Ag, Mo, Sb, Se and Tl are below the laboratory's reporting limits at all sites (Tables 9 and 10). As has values above the laboratory's reporting limit at only two sites (82.9 ppm at KL21 and 29.7 ppm at R13), both located in the Klamath Mountains. Higher than usual As concentrations at both the sites might be associated with sulfide-mineralization. Be has concentrations above laboratory's reporting limit at five sites located in the Klamath Mountains and Coast Range. The maximum concentration of 2.3 ppm Be is found at both sites LC9 and KL15 in the Coast Range and Klamath Mountains, respectively. Cd has concentrations above laboratory's reporting limit at 16 sites located mostly in the Klamath Mountains and Coast Range. The highest soil Cd content of 2.5 ppm occurs at site KL16 in the Klamath Mountains. The other notable Cd concentrations are 2.3 ppm at site LC6 (in the Coast Range) and 2.2 ppm at site KL30 (in the Klamath Mountains).

The Klamath Mountains, followed by the Coast Range, contain the highest soil concentrations of Al, Ca, Co, Cr, Cu, Fe, K, Mg, Mn, Ni, V and Zn (Tables 11 and 14). Soils of the Coastal Plain and High Lava Plains contain the lowest concentrations of these metals (Tables 10 and 16). Concentrations of these metals in the Willamette Valley, Cascade Range and Basin and Range (Tables 12, 13 and 15) fall generally between the above two categories.

Soils of the Klamath Mountains and Coast Range are also comparatively richer in Li than the rest of the study area. Concentrations of Ba and La are rather uniform throughout the region. Soil concentrations of Pb are generally low, with a few exceptions in the Klamath Mountains, Coast and Cascade Ranges. Very high Pb values have been found at two sites (388 ppm at KL14 and 159 ppm at R12) in the Klamath Mountains. The region west of the Cascade Range has higher soil Hg levels (average <0.14 to <0.21 ppm) than in the east (average <0.10 ppm). Semiaridic soils in the regions east of the Cascade Range generally contain higher Na concentrations than humid soils in the west.

In general, Al, As, Be, Cd, Co, Cr, Cu, Fe, La, Li, Mg, Na, Ni, and V are concentrated in the B horizon, while Ba, Ca, Hg, K, Mn, Pb and Zn are concentrated in the A horizon. This has implications for sampling. One must sample both the surface and the B horizons to find the maximum concentration of the metals.

Soil concentrations of the metals studied are generally much higher in western Oregon, excluding the Coastal Plain, than in eastern Oregon. A notable exception to this trend is Na which has higher concentrations in eastern Oregon than in western Oregon. Both parent rocks and climatic conditions have affected the soil metal concentrations in the regions. In humid and mild environments of western Oregon, Alfisols/Ultisols developed on mafic/ultramafic rocks are very rich in Co, Cr, Cu, Mn, Ni, Fe, Mg and V. This is particularly evident in the Klamath Mountains and Coast Range. Argillaceous sediments, containing high concentrations of As, Cd, Cu, K, Pb, V and Zn, are

developed only in western Oregon. The subhumid and cold climate of eastern Oregon has influenced the development of Entisols and Inceptisols on predominantly basaltic rocks. These less developed soils appear to contain low concentrations of most of the metals studied. Coarse-textured, low-organic and acid-leached soils of the Coastal Plain have the lowest concentrations of all metals except Li.

Metal concentration generally is related to soil development, i.e. highest in most developed and oldest soils (Alfisols and Ultisols) and lowest in the least developed soils (Entisols).

Table 40 shows the comparison of the concentration of metals in surface soils of the study area (from Table 9) with that of the rest of the U.S. (Kabata-Pendias and Pendias, 1984). The Oregon DEQ's soil cleanup level for various metals is also listed in Table 40. The comparison of the concentration of metals in subsoils (i.e. B horizon) of the study area (Table 10) with that of the rest of the U.S. is not possible because the latter is not available. The averages and ranges of soil Co, Mn and Ni values found in this study are higher than those of the U.S. in general. The maximum concentrations found for Pb and V in this study are also higher than the reported values in the U.S. The Klamath Mountains province has exceptionally high Cr and Cu values compared to the rest of the U.S. The remainder of the metals in the study area have similar average and range of concentrations to those of the rest of the country.

Table 40. Comparison of the concentration (in ppm dry; * in percent dry) of metals in surface soils of Southwest Oregon with that of the rest of the U.S. The DEQ's cleanup level for various metals is also listed.

Metal	Distribution statistics in the study area					Values in the US ^a		DEQ's Cleanup Level ^b
	Arithmetic Mean	Arithmetic St Dev	Median	Minimum	Maximum	Arithmetic Mean ^c	Range	
Ag	<1	--	<1	<1	<1	NA**	NA	1,500
Al*	3.0	1.8	2.5	0.3	9.4	NA	NA	na***
As	<20	--	<20	<20	36.4	5.0-8.8	<0.1-93.2	0.4
Ba	181	138	149	8	792	265-835	10-3,000	20,000
Be	<1	--	<1	<1	1	1.2-2.1	<1-15	0.1
Ca	5,741	3,970	4,793	638	18,68	NA	NA	na
Cd	<1	--	<1	<1	1.2	NA	NA	100
Co	<18	>15	13	<6	95	3.5-17	0.4-50	na
Cr	56	135	23	3	1,302	20-85	1-1,500	1,000
Cu	<31	>29	22	<2	148	14-41	1-300	10,000
Fe*	2.9	2.1	2.5	0.3	10.7	NA	NA	na
Hg	<0.1	>0.06	0.08	<0.04	0.37	0.11	<0.01-4.6	80
K	1,266	964	941	223	4,973	NA	NA	na
La	<8	>4.4	5.5	<5	26	NA	NA	na
Li	<11	>8.6	7.6	<5	48	13-34	<5-120	na
Mg	4,431	3,844	3,124	545	16,42	NA	NA	na
Mn	1,527	1,331	1,208	24	7,221	260-840	7-3,000	30,000
Mo	<5	--	<5	<5	<5	0.35-5.8	0.08-17.8	na
Na	346	318	216	53	1,511	NA	NA	na
Ni	<52	>126	22	<4	1,132	12-30	<5-200	5,000
Pb	<18	--	<10	<10	378	17-26	<10-70	200
Sb	<20	--	<20	<20	<20	NA	NA	na
Se	<30	--	<30	<30	<30	0.19-0.5	<0.1-4.0	na
Tl	<50	--	<50	<50	<50	NA	NA	na
V	69	56	55	6	374	38-136	0.7-300	na
Zn	74	38	70	11	196	34-83.5	<5-300	na

^a from Kabata-Pendias and Pendias (1984).

^b from Oregon DEQ (1994). The maximum allowable soil concentration given is for residential areas. For industrial sites the maximum allowable soil concentration is about an order of magnitude higher than that for residential area.

^c Kabata-Pendias and Pendias (1984) reported arithmetic mean values of metals in various types of soils of the U.S. (see Appendix 1). Mean values for all soils are not available. Therefore, the range of mean concentrations is given. Hg data of the U.S. are from Steinnes (1993).

not available; * not assigned

--arithmetic standard deviation is not computed since most or all values are below laboratory's minimum reporting level.

The Oregon DEQ (1994) has assigned soil cleanup level for only eleven of the 26 metals investigated in this study (Table 40). Except for As, Be, Cr and Pb, the cleanup level for metals in residential areas is far higher (about 5 times in Ni to more than 1,500 times in Ag) than their maximum background concentrations found in this study. Above the DEQ's maximum allowable soil concentration for residential areas, As has values from two sites (KL21 and R13) in the Klamath Mountains, Be has values from five sites (LC5, LC9, KL14, KL15 and R12) in the Klamath Mountains and Coast Range, Cr has values from two sites (KL16 and KL17) in the Klamath Mountains and Pb has a value from site KL14 in the Klamath Mountains. All soil metal concentrations found in this study are below the state cleanup levels for industrial sites which are about an order of magnitude higher than those for residential areas (Oregon DEQ, 1994).

FUTURE WORK

This reconnaissance study provides a foundation from which future studies may develop. Regionalized, detailed investigations should involve more sampling of soils to consider local peculiarities of the contributing rock types. DEQ's laboratory needs to lower the detection limit for environmentally significant trace elements like Ag, As, Be, Cd, Mo, Pb, Sb, Se and Tl to obtain values in their natural occurrence ranges. The relationship between soil drainage classes (well drained, moderately drained and poorly drained) and metal distribution in soil profile can also be investigated. Finally,

concentration maps for individual metals for the A and B horizons can be generated using GIS.

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Appendix 1. Previous Works on Metal Distributions in Rocks and Soils

Aluminum (Al)

Parent Rocks: As one of the main constituents of the earth's crust, Al in rocks commonly ranges from 0.45 to 10% with the lowest value for ultramafics and highest for argillaceous sediments. In other types of magmatic rocks, Al is rather uniformly distributed, ranging between 6.9 and 8.8%. In sandstones and carbonates, Al values are comparable to those in ultramafics (Kabata-Pendias and Pendias, 1984).

Aluminum Content of Soils: The total Al content of soils is inherited from parent rocks and ranges from 13.8% (for Aridisols) to 2.1% (for Spodosols) with an average of 7.1% (includes both surface and B horizons) (Peterson and Girling, 1981). Al concentrates in the B horizon along with translocated clays and hydrous oxides (Bowen, 1979). The metal is highly mobile in acid soil solutions (Peterson and Girling, 1981).

Antimony (Sb)

Parent Rocks: The crustal abundance of Sb is approximately 1 ppm. Argillaceous sediments contain up to 2 ppm Sb (Kabata-Pendias and Pendias, 1984). Overall igneous rocks average 0.2 ppm (Jones and others, 1993). Limestones and sandstones contain around 0.2 ppm (Fairbridge, 1972).

Antimony Content of Soils: Sb is usually concentrated in soil relative to parent materials (Jones and others, 1993). The average for soil Sb is around 1 ppm (Bowen, 1979), but wide ranges have been reported. Jones and others (1993) reported Sb contents of the U.S. soils to range from 2.3 to 9.5 ppm. Kabata-Pendias and Pendias

(1984) reported values of 0.05-4.0 ppm Sb for a large number of surface soils of different countries. The highest values were found in forest soils, while the lowest values were found in Histosols, Spodosols and sandy soils. Within the soil profile the highest Sb values are commonly found in the humiferous surface horizons (Alloway, 1993a; Crecelius and others, 1974).

Arsenic (As)

Parent Rocks: There is little difference in the concentrations of As in rocks unless the levels have been raised by associated mineralization (Boyle and Jonasson, 1973). Higher levels of As are often associated with the presence of sulfide minerals such as pyrites. Mean values of 2 ppm appear to be those most commonly found in igneous and sedimentary rocks, but finer-grained argillaceous rocks and phosphorites (sedimentary Ca sulfates) average 10-15 ppm As (O'Neill, 1993; Kabata-Pendias and Pendias, 1984).

Arsenic Content of Soils: In soils the natural As levels are dependent on the source rock type. The normal range is 1-40 ppm with most soils being in the lower half of this range (O'Neill, 1993). Due to As pollution, the levels of this metal are likely to be increased in topsoils (Kabata-Pendias and Pendias, 1984). The range in As in various types of surface soils in the U.S. is broad, from <0.1 to 93.2 ppm (Appendix 8.1) (Kabata-Pendias and Pendias, 1984) with a mean of 6.7 ppm. The lowest levels are found in sandy soils particularly derived from granites. Higher As concentrations are most often related to alluvial soils and soils rich in organic matter. Elevated levels of As are found in soils of sulfide-mineralized areas (Boyle and Jonasson, 1973).

Arsenic migration in soil is limited due to its strong adsorption by clays, hydroxides and organic matter (O'Neill, 1993). In heavy gley soil, As is accumulated only in the top horizon and is readily leached from the subsurface layer with a high reduction potential. In well-drained soils with low organic matter the metal is usually concentrated in the B horizon (Kabata-Pendias and Pendias, 1984).

Barium (Ba)

Parent Rocks: In the earth's crust, Ba is likely to be concentrated in intermediate and felsic magmatic rocks and commonly ranges in concentration from 400 to 1,200 ppm (Kabata-Pendias and Pendias, 1984). Ultramafic rocks contain very little Ba (0.5-25 ppm). Among sedimentary rocks, shales and clays are richest in Ba (500-800 ppm) (Aubert and Pinta, 1980).

Barium Content of Soils: The concentration of Ba in soils depends mainly on the associated parent rocks. Kabata-Pendias and Pendias (1984) reported the U.S. surface soil Ba ranges from 10 to 3,000 ppm, with an average of 265-835 ppm (Appendix 8.1). The highest concentrations were found in desert soils and in soils developed over felsic magmatic rocks. The lowest values were in the low-organic soils.

In Spodosols and well-drained soils in humid environments, Ba accumulates in the lower horizons. In arid and semiarid regions the Ba enrichment is most often observed on the surface. Varnishes formed at the surface of aridic soils always have an enrichment in Ba (Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984).

Beryllium (Be)

Parent Rocks: Kabata-Pendias and Pendias (1984) reported concentrations of this metal to regularly increase from ultramafic, through mafic and intermediate, to felsic rocks which contain 2-6.5 ppm Be. They also reported that concentration of Be in argillaceous rocks was enriched (2-6 ppm), while sandstones and carbonates contained 0.2-2 ppm.

Beryllium Content of Soils: Kabata-Pendias and Pendias (1984) reported concentration of Be in various surface soils of the U.S. to range from <1 to 15 ppm with an average of 1.6 ppm (Appendix 8.1). During rock weathering Be usually remains behind. Organic substances are known to bind Be, therefore, the metal is enriched in some coals and accumulates in organic soil horizons (Kabata-Pendias and Pendias, 1984). Most unleached soils usually have the highest Be levels in the surface horizons. In highly leached soils Be accumulates in the B horizon with organic matter (Adriano, 1986).

Cadmium (Cd)

Parent Rocks: Cd is mainly concentrated in argillaceous rocks, with phosphorites and marine black shales having the highest contents (0.3-980 ppm) (Alloway, 1993c). The abundance of this metal in other sedimentary and in magmatic rocks does not exceed 0.3 ppm (Kabata-Pendias and Pendias, 1984).

Cadmium Content of Soils: The main factor determining the Cd content of soil is the chemical composition of the parent rock. Most soils contain <1 ppm, except those

contaminated from discrete sources or developed on parent materials with high Cd, such as black shales (Alloway, 1993c). Cd concentrations of 22 ppm have been reported in uncontaminated soils developed on Monterey black shale at several locations in California (Page and others, 1987). Soils developed on Carboniferous black shales in Derbyshire, U.K. also have been found to contain 22 ppm Cd in the absence of anthropogenic contamination (Alloway, 1993c).

In the U.S., 3,305 samples collected from uncontaminated sites in 36 states revealed Cd from 0.005 to 2.4 ppm, with a mean of 0.27 ppm (Holmgren and others, 1993). In general, Histosols (peats) contained the most Cd (Page and others, 1987).

Within soil profiles, Cd tends to be higher in the surface horizon which is a reflection of the relatively high humus content, inputs from atmospheric deposition, fertilizers and cycling through plants (Alloway, 1993c). Page and others (1987) referred to studies on Mollisols and Alfisols where mean concentrations of 0.39 ppm Cd were found in the surface horizons and 0.23 ppm Cd in the subsurface horizons. This may be reversed in more acidic soils, though (Alloway, 1993c).

Cd is most mobile in acidic soils within the range of pH 4.5 to 5.5. In alkaline soil it is immobile (Kabata-Pendias and Pendias, 1984). Biddappa and others (1982) found that Cd, Ni and Zn were more readily leached down columns of two Japanese soils than Cu and Pb. In soils developed under the influence of humid climate, migration of Cd down the profile is more likely to occur than its accumulation in the surface horizon.

The enrichment in Cd content observed in topsoils should be related to contamination effects (Kabata-Pendias and Pendias, 1984).

Calcium (Ca)

Parent Rocks: Ca is one of the most abundant elements in the earth's crust. Ca content in igneous rocks decreases with increasing silica content: dunite, 0.7%; gabbros, 11%; diorites, 6.7%; granodiorites, 4.4%; and granites, 2.0% (Fairbridge, 1972). The average shale contains 3.1%, sandstone 5.5%, and limestone 42.6% Ca (Fairbridge, 1972).

Calcium Content of Soils: The soil Ca levels are controlled by parent rocks as well as by pedogenic processes. Ca is leached by the action of water or by reaction with dilute natural acids. Its concentration in soil as well as its distribution in the soil profile are controlled by its solubility and migration in aqueous solutions (Fairbridge, 1972). In arid and semiarid regions Ca concentrates in the A horizon, while in the humid areas leaching of Ca makes soils generally depleted of this metal (Fairbridge, 1972).

Chromium (Cr)

Parent Rocks: Ultramafic and mafic rocks are richest in Cr, containing up to 3,400 ppm of this metal (McGrath and Smith, 1993; Kabata-Pendias and Pendias, 1984). The Cr content of felsic igneous and sedimentary rocks ranges from 2 to 590 ppm, being highest in argillaceous sediments (Cannon, 1978).

Chromium Content of Soils: The soil Cr is inherited from parent rocks, and therefore its highest concentration is in soils derived from ultramafic and mafic rocks.

Soils on serpentines are known to contain as much as 2,000 to 4,000 ppm Cr (Kabata-Pendias and Pendias, 1984). Chromite is resistant to weathering and therefore accounts for most of the Cr in residual material. The Cr contents of surface soils of the U.S. range from 3 to 1,500 ppm (Appendix 8.2) (Kabata-Pendias and Pendias, 1984) with an average of 54 ppm.

An increase in Cr content in the upper horizons of soils which are particularly humified (Mollisols) can be noticed. In Spodosols and well-drained humid soils, the accumulation of Cr takes place in illuvial or gley horizons. Cr content also varies with soil texture. Concentrations are higher in clayey soils than in easily leached sandy soils (Aubert and Pinta, 1980).

Cobalt (Co)

Parent Rocks: The Co values in ultramafic rocks varies from 100 to 220 ppm and in felsic rocks from 1 to 15 ppm (Kabata-Pendias and Pendias, 1984). The Co abundance in sedimentary rocks ranges from <1 to 50 ppm with argillaceous sediments being the richest (Smith, 1993).

Cobalt Content of Soils: The Co concentration in soils is inherited from parent materials. Soils from mafic rocks and soils derived from clay deposits contain the highest amount of this metal (Smith, 1993). The normal Co content of surface soils of the U.S. ranges from <1 to 50 ppm (Appendix 8.3) (Kabata-Pendias and Pendias, 1984), with the highest frequency in the range of 3 to 15 ppm and with a mean of 8.2 ppm. In the U.S. higher Co contents are observed in soils of arid and semiarid regions. Low soil

Co has been reported for soils of the lower Atlantic Coastal Plain and for soils of the glaciated region in the northeast (Kubota and Allaway, 1972). Coarse-textured soil parent materials of low Co content and podzolization are features of soils associated with Co deficiency in the eastern U.S. (Kubota, 1980).

Within a given soil profile, Co is generally concentrated in those horizons rich in organic material, humus and clays (Smith, 1993). In Spodosols Co accumulates in the illuvial B horizon, whereas the eluvial E horizon is generally depleted. In contrast, in Mollisols and Vertisols the distribution of Co is relatively uniform throughout the profile (Aubert and Pinta, 1980). Generally greater concentrations of Co are observed in alkaline than in acidic soils (Smith, 1993).

Copper (Cu)

Parent Rocks: Cu is most abundant in mafic rocks (30-160 ppm, with an average of 90 ppm) (Baker, 1993). Its concentration in granitic rocks ranges between 4 and 30 ppm (average 15 ppm). In sedimentary rocks, the argillaceous sediments are the richest, while carbonates are the poorest (Baker, 1993; Kabata-Pendias and Pendias, 1984).

Copper Content of Soils: Average background concentrations of 20-30 ppm Cu have been reported for soils of the world (Baker, 1993). The total Cu content of soils is influenced by the parent rock. In Scotland Spodosols on granite and sandstones are poor in Cu (3-5 ppm) and those on mica-schists and olivine gabbro have 25-30 ppm Cu (Aubert and Pinta, 1980). For surface soils of the U.S., Kabata-Pendias and Pendias (1984) reported the background Cu concentrations from 1 to 300 ppm (Appendix 8.2),

highest for soils over volcanic rocks and lowest for sandy and organic soils. Soils of arid and semiarid regions are often richer in Cu than those of other climatic zones.

Cu contents of soils are related to that of humus and organic matter. An accumulation of Cu in the upper humiferous horizons can often be observed (Kabata-Pendias and Pendias, 1984). In Spodosols and well-drained humid soils the B horizons have been found to be richer in Cu than the E horizons, while in Mollisols Cu content variations between horizons are slight (Aubert and Pinta, 1980).

Iron (Fe)

Parent Rocks: Fe is one of the major constituents of the lithosphere (approximately 5%) and is concentrated mainly in the mafic rocks (Kabata-Pendias and Pendias, 1984).

Iron Content of Soils: The Fe content of soils is from parent rocks as well as the result of pedogenic processes. The most common range of Fe in soils is from 0.5 to 5% (Kabata-Pendias and Pendias, 1984). In Spodosols and well-drained humid soils Fe accumulates in the B horizon usually with organic matter (Knezek and Ellis, 1980).

Lanthanum (La)

Parent Rocks: The concentrations of La increase from mafic to felsic igneous rocks. The La concentration averages 17 ppm in basalts and 84 ppm in granites (Fairbridge, 1972). The major source of La is from monazite in beach sands. The accessory monazite originally present in granitic rocks resists weathering and is

concentrated by sedimentary processes. On average, sedimentary rocks have about 39 ppm La (Fairbridge, 1972).

Lanthanum Content of Soils: Data on La levels in soils are generally lacking. In a study of rare earths in Russian platform soils, Balashov and others (1964) found higher La concentrations in alkaline soils; lower concentrations were in acid soils, due to removal as soil organic complexes.

Lead (Pb)

Parent Rocks: There is a general increase in Pb concentrations from ultramafic to felsic igneous rocks. Nriagu (1978) calculated the mean Pb content of gabbro as 1.9 ppm, andesite as 8.3 ppm and granite as 22.7 ppm. Pb concentrations rise with increasing silica contents. Among sedimentary rocks, mudstones and shales have an average Pb content of 23 ppm; black shales are the richest. Sandstones contain an average of 10 ppm while carbonates contain about 7 ppm of Pb (Davies, 1993).

Lead Content of Soils: Soils are often richer in Pb than the rocks from which they are derived. Aubert and Pinta (1980) found that the average Pb concentration in soils was 15-25 ppm. Davies (1993) believed that in remote or recently settled areas soil Pb ranged between 10 and 30 ppm but elsewhere a general, low-level contamination has raised concentrations to 30-100 ppm. Davies (1977) stated that an upper limit for Pb content of a 'normal' soil could be established as 70 ppm. The Pb content of surface soils of the U.S. averages 20 ppm (Appendix 8.2) (Kabata-Pendias and Pendias, 1984).

Generally, soils of the temperate and boreal regions tend to have higher total Pb than those in other climatic areas (Aubert and Pinta, 1980).

Pb contents in soils vary in relation to humus and organic matter concentrations. Most of the time an accumulation of Pb is observed in surface horizons of soil. Wright and others (1955) noticed that Pb showed the greatest accumulation in surface horizons of soils in eastern Canada. Other authors have reported accumulations of Pb in surface horizons of uncontaminated soils (Merry and others, 1983). According to Aubert and Pinta (1980) this accumulation may be of biogenetic origin (accumulation by plants). There is little evidence that Pb is readily lost from soil profiles by leaching. Zimdahl and Skogerboe (1977) demonstrated that soils have rather large capacities for the immobilization of Pb, that the organic fraction is largely responsible for the observed fixation of the metal, and Pb from vehicle exhausts tends to remain near the soil surface. Scokart and others (1983) investigated the mobility of Pb and other metals near Belgian Zn smelters and found that Pb and Cu remained in the upper layers of soil without regard to the type of soil.

Lithium (Li)

Parent Rocks: Li contents in magmatic rocks increase with an increase in silica, being highest in felsic rocks (15-45 ppm). The richest Li accumulation (50-75 ppm) is observed in argillaceous sediments (Kabata-Pendias and Pendias, 1984).

Lithium Content of Soils: The Li content of soils is controlled mainly by pedogenic processes (Aubert and Pinta, 1980). The abundance of Li in surface soils of

the U.S. (Appendix 8.5) (Kabata-Pendias and Pendias, 1984) is fairly uniform. The highest (average 34 ppm) is in alluvial soils and the lowest (average 13 ppm) in low-organic soils. Lower contents of Li have been reported for sandy soils, especially those derived from glacial drift in a humid climate (Kabata-Pendias and Pendias, 1984). In the arid climatic zones Li accumulates in the surface horizons, while in the humid regions the metal is enriched in the lower horizons of the soil profile (Kabata-Pendias and Pendias, 1984).

Magnesium (Mg)

Mg is among the most prevalent elements in the earth's crust (2%) and is concentrated mainly in the mafic rocks (Wacker, 1977). Rocks usually contain a higher percentage of Mg than do soils, which reflects the loss of Mg during weathering. Bowen (1966) reports Mg concentrations for igneous rocks (2.33%), shales (1.5%), sandstones (1.1%), limestones (0.3%) and dolomites (20%).

Soils have an average of 0.3% Mg. The Mg content of soils is both inherited from parent rocks and the result of pedogenic processes (Fairbridge, 1972). It is concentrated in the B horizon of the soil profile, associated with accumulations of translocated clays and hydrous oxides (Bowen, 1979).

Manganese (Mn)

Parent Rocks: Mn is one of the most abundant trace elements in the lithosphere. The highest concentrations (up to several thousand ppm) are found in mafic igneous rocks (Kabata-Pendias and Pendias, 1984). Mn contents in felsic rocks vary between

200 and 1,000 ppm (Smith, 1993). The concentration range in argillaceous sediments and carbonates is about 400-600 ppm, but much lower concentrations are found in sandstones (20-500 ppm) (Mitchell, 1964; Aubert and Pinta, 1980).

Manganese Content of Soils: Soils derive virtually all their Mn content from parent materials. For example, in Scotland, total Mn content in Haplorthods developed on olivine gabbro till is 7,000 ppm, whereas that in Ferroids or Sideraquods on sandy materials is only 50 ppm (Smith, 1993). Most soils contain, on an average, from 500 to 1,000 ppm of total Mn (Aubert and Pinta, 1980). Kabata-Pendias and Pendias (1984) reported Mn contents of a large number of surface soils of the U.S. to range between 7 and 3,000 ppm (Appendix 8.4); the mean content of these soils was 495 ppm. The variation of Mn concentration rarely seems to be correlated with soil typology. Higher Mn levels are often reported for soils over mafic rocks, for soils rich in organic matter, and for soils from arid or semiarid regions (Aubert and Pinta, 1980). Sandy soils are generally less rich in Mn than clayey soils. Mn concentrations follow the distribution of humus in the profile. In all climatic regions, an accumulation of Mn is usually observed in the humiferous surface horizons (Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984; Adriano, 1986).

Mercury (Hg)

Parent Rocks: In all types of magmatic rocks the Hg content is approximately 0.01 ppm (Steinnes, 1993). In sedimentary rocks, sandstones and limestones have slightly higher concentrations than the magmatic rocks, whereas shales cover a very wide range

of Hg contents (0.006-0.51 ppm). Elevated concentrations of this metal occur in rocks derived from volcanic debris or deposited in volcanic areas (Steinnes, 1993).

Mercury Content of Soils: Background levels of Hg in soils are not easy to estimate due to widespread Hg pollution. Data reported for various soils on a world-wide basis show that mean concentrations of Hg in surface soils do not exceed 0.4 ppm (Kabata-Pendias and Pendias, 1984). Kabata-Pendias and Pendias (1984) reported Hg concentrations in surface soils of the U.S. to range from <0.01 to 4.6 ppm (Appendix 8.5). The highest average concentration of 0.28 ppm was found for Histosols followed by 0.13 ppm for loamy soils. This higher average Hg content in organic soils compared to mineral soils has been noted by many authors (John and others, 1975; Frank and others, 1976). Andersson (1979), in a study of Hg in profiles of virgin soils, demonstrated a very close correlation between Hg and organic matter content in acidic soils, whereas in neutral soils ($\text{pH} > 6$) the co-variation between Hg and Fe was stronger than that of Hg and organic matter. The distinctly higher Hg content observed in soils in the eastern compared to the western U.S. (see Appendix 8.5) could in part be explained by differences in soil organic matter (Steinnes, 1993).

Hg is found in the surface soil at several times the concentration as in the subsoil (Kabata-Pendias and Pendias, 1984). McKeague and Kloosterman (1974) in an extensive survey of virgin soils from all the provinces of Canada, observed that in more than half of the samples, particularly Spodosols and Entisols on sandy materials, the highest Hg concentrations were present in the surface layer. In some cases however the

Hg content in the surface horizon is similar to that of the subsoil (Mills and Zwarich, 1975). The removal of Hg from soils by leaching is in most cases insignificant (Steinnes, 1993).

Molybdenum (Mo)

Parent Rocks: Mo has its highest accumulation in organic-rich argillaceous sediments; black bituminous shales have concentrations up to 70 ppm or higher (Jones and others, 1993). In magmatic rocks, Mo is more associated with felsic rocks (1-2 ppm). Ultramafic rocks as well as sandstones and carbonates have Mo contents in the range of 0.2-0.4 ppm (Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984).

Molybdenum Content of Soils: Soil Mo contents average 1-2 ppm (Massey and Lowe, 1961; Kabata-Pendias and Pendias, 1984). The different types of soils in arid and semiarid regions generally have higher total Mo contents than those of other climatic zones (Aubert and Pinta, 1980).

Kabata-Pendias and Pendias (1984) reported the range of Mo in surface soils of the U.S. to be from 0.08 to 17.8 ppm (Appendix 8.6) with the median concentration being slightly more than 1 ppm. Soils formed in coarse-textured glacial till and outwash have less Mo than soils formed in lacustrine deposits. Endemic areas of Mo toxicity in the U.S. occur principally in the west. Granitic rocks commonly occur where Mo-toxic areas are recognized. Shales are important rock sources of soil Mo in parts of northwestern Oregon. Histosols are the dominant soils associated with Mo toxicity on

the broad basin-like lowlands in the Klamath area in southwestern Oregon (Kubota, 1980).

Generally, Mo accumulates in the upper soil horizons and, in particular, the humiferous horizons (Aubert and Pinta, 1980; Swaine and Mitchell, 1960). In Spodosols Mo accumulation occurs in the B illuvial horizon. Mo exists as an anion in soil and consequently shows increased solubility with increasing pH (Jones and others, 1993). Thus, the total Mo content is more in freely drained acidic soils than in poorly drained soils; in the latter case, the commonly high pH favors the mobilization of anions (Jones and others, 1993; Adriano, 1986).

Nickel (Ni)

Parent Rocks: Ni contents are highest in ultramafic rocks (1,400-2,000 ppm), and its concentrations decrease with increasing silica percentage in rocks down to 5 to 15 ppm in granites. Sedimentary rocks contain Ni in the range of 5 to 90 ppm, with the highest range being for argillaceous rocks and the lowest for sandstones (Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984; McGrath and Smith, 1993).

Nickel Content of Soils: The average concentrations of Ni in world soils is 40 ppm (McGrath and Smith, 1993). The Ni status in soils is highly dependent on that of the parent rocks. Soils formed on serpentine can contain 100-7,000 ppm of Ni along with unusually large concentrations of Cr, Mg and Fe (Brooks, 1987). Soils of arid and semiarid regions have Ni contents (5-300 ppm, with an average of about 50 ppm) which are generally higher than that of the temperate and boreal areas (Aubert and Pinta, 1980).

In the surface soils of the U.S., Ni contents range from <5 to 200 ppm (Appendix 8.3) (Kabata-Pendias and Pendias, 1984) with an average of 19 ppm. The higher Ni contents are in clay and loamy soils, in soils over mafic and volcanic rocks, in organic-rich soils, and in desert soils.

Depending on the origin of the soil and pedogenic processes, the surface or the subsoil may be relatively enriched in Ni concentrations. Generally, the distribution of Ni between the different horizons of soil profiles follows that of humus and organic matter. An accumulation of Ni is often observed in the humiferous surface horizons. Ni is uniformly distributed in Mollisols and Vertisols down the profiles, as is organic matter. In Spodosols and well-drained humid soils concentrations are higher in the B illuvial horizons. There also may be an accumulation of Ni in certain horizons very rich in Fe or Al sesquioxides (Aubert and Pinta, 1980; Adriano, 1986).

Potassium (K)

K is one of the major rock-forming elements of the earth's crust, and its concentration increases with increasing silica content of magmatic rocks. The terrestrial K abundance (in weight %) are as follows: granite, 3.4; syenite, 3.73; diorite, 1.75; gabbro, 0.74; dunite, 0.033; shale, 2.66; sandstone, 1.07; and limestone, 0.27 (Fairbridge, 1972). The soil K contents are largely controlled by the associated parent rock materials as well as pedogenic processes. K is highly mobile in the soil (Birkeland, 1984).

Selenium (Se)

Parent Rocks: In practice, Se tends to concentrate in sedimentary, rather than in magmatic rocks. Se contents in magmatic rocks rarely exceed 0.05 ppm (Neal, 1993; Kabata-Pendias and Pendias, 1984). Among the shales, those containing organic matter are generally richest in Se. In black shales, Se concentrations can range up to 675 ppm (Adriano, 1986). Se is mostly found as an impurity in sulfide rocks. Primary sources of Se in nature are volcanic emissions and metallic sulfides associated with igneous activity (Neal, 1993). Volcanic tuffs and shales of Wyoming contain anomalously high Se, averaging 9.15 ppm and 19.86 ppm, respectively (Rosenfeld and Beath, 1964). Elevated concentrations of Se are associated with some types of phosphatic rocks as well as with coal. Se can also occur in limestones and sandstones, but its content will likely be more related to the degree of carbonaceous debris present than to any other factor (Fleming, 1962).

Selenium Content of Soils: In the natural environment, elevated concentrations of Se in soils are associated primarily with volcanic materials, sulfide ore bodies, black shales and carbonaceous sandstones. The intensity of weathering and leaching processes on these parent materials will define the ultimate Se composition of associated soils (Neal, 1993).

The amount of Se present in most soils is detectable but highly variable. In the U.S., soil Se content ranges from trace amounts (<0.1 ppm) up to areas of acute toxicity (5,000 ppm) (Neal, 1993). In general, surface soils of the U.S. contain an average of 0.4

ppm Se (Appendix 8.4) (Kabata-Pendias and Pendias, 1984). Kubota (1980) described the geographic distribution of Se in soils of the U.S. In the central U.S., areas of Se toxicity are in calcareous soils formed on seleniferous Cretaceous shales. In the Pacific northwest, most of the soils in the intermountain valleys contain small amounts of Se, contributed by volcanic ash which mantles much of the eastern slopes of the Cascades. The low Se area on the lower Atlantic Coastal Plain is an area of extremely acid soils formed in highly weathered Coastal Plain deposits. The seleniferous soil of San Joaquin Valley of California is believed to be of natural origin. The finer-textured alluvial soil was derived from the Jurassic-Cretaceous sedimentary rocks of the Coast Range, thought to have contained seleno-sulfides of Fe (Neal, 1993).

Levesque (1974) determined the distribution of Se in 54 soils (234 horizon samples) of northern Ontario, Canada. A general distribution pattern of Se decreasing with soil depth paralleled decreases in organic matter. Surface horizons of a wet soil had more Se (2.09 ppm) than surface horizons (0.41-0.64 ppm) of well-drained soils. In well-drained soils, the highest Mo levels were in the B horizon. In Ireland, the highest Se concentrations also have been found in surface horizons of poorly drained humic gley soils (Fleming, 1962).

Silver (Ag)

Parent Rocks: Igneous and sedimentary rocks contain, on an average, 0.1 ppm of Ag. In organic-rich shales Ag content can be up to 1 ppm (Aubert and Pinta, 1980; Jones and others, 1993).

Silver Content of Soils: The normal range of Ag in soils varies from <0.01 to 5 ppm with an average of about 0.1 ppm (Boyle, 1972). Data given by Shacklette and Boerngen (1984) for the U.S. show Ag in the plow zone of mineral soil to be 0.7 ppm and in soils rich in organic matter to be from 2 to 5 ppm. Values established by Bowen (1979) range from 0.01 to 8 ppm. All higher values for Ag in soils are found in mineralized areas. The Ag content in soils derived from sandstones or limestones is very low (0.05-0.07 ppm) (Jones and others, 1993).

Ag tends to accumulate in the surface, organic-rich horizons (Presant and Tupper, 1965). Due to the comparative insolubility of Ag, it is highly immobile in soils relative to other metals (Jones and others, 1993).

Sodium (Na)

Parent Rocks: Na is one of the most abundant of the elements in the earth's crust. In igneous rocks the Na concentrations increase with increasing silica content, resulting in Na enrichment especially in the feldspathoid-bearing rocks (e.g. nepheline syenite) and to a lesser extent in granites (Fairbridge, 1972). The average concentration of Na in magmatic rocks is 2.83% by weight, while that in sedimentary rocks is only about half as much (Fairbridge, 1972). The low content of Na in sedimentary rocks is probably because the continental sediments have been leached by groundwater.

Sodium Content of Soils: The Na content of soils is both inherited from parent rocks and the result of pedogenic processes. Na is highly mobile in the soil, being very soluble in water. The soil Na levels are high in the arid regions, and the metal

accumulates in the surface horizons. The leaching of Na downward through the profile results in the low content of this metal in well-drained humid soils (Fairbridge, 1972).

Thallium (Tl)

Parent Rocks: Tl is a rare and dispersed element in the earth's crust. Its concentration seems to increase with increasing silica content in magmatic rocks and with increasing clay content in sedimentary rocks. Common Tl contents of mafic rocks range from 0.05 to 0.4 ppm and in felsic rocks from 0.5 to 2.3 ppm. Tl content in argillaceous rocks ranges from 0.5 to 2.0 ppm and in carbonates as little as 0.01 to 0.14 ppm (Kabata-Pendias and Pendias, 1984). Tl is concentrated in certain sulfides, and deposits characteristically high in As are usually also high in Tl (Adriano, 1986).

Thallium Content of Soils: There is little information on the Tl status of soils. Smith and Carson (1977) widely reviewed environmental occurrences of Tl and cited its concentration to range from 0.02 to 2.8 ppm in surface soils of the U.S. and enriched contents of Tl (up to about 5 ppm) in soils over sphalerite veins. Jones and others (1993) reported the total Tl levels in a range of British soils to range from 0.03 to 0.99 ppm. Soils sampled from the vicinity of a cement plant near Leimen, southwestern Germany had an average Tl contents of 3.6, 0.7, and 0.1 ppm in the 0 to 10, 40 to 50, and 60 to 70 cm depths, respectively (Schoer, 1984). This indicates that although Tl is somewhat mobile in soil (Adriano, 1986), its mobility is limited. The above data also possibly indicate that Tl accumulates in the surface horizons.

Vanadium (V)

Parent Rocks: V is concentrated mainly in ultramafic and mafic rocks and in shales (within the common range of 100 to 250 ppm). Concentrations are much lower in felsic igneous rocks (30 -40 ppm). V contents are particularly low in sandstones and carbonates (about 20 ppm) (Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984; Jones and others, 1993).

Vanadium Content of Soils: Soils have V contents close to those of the rocks on which they were formed and sometimes even higher. The composition of parent material has less bearing on V content of mature, developed soils (Jones and others, 1993). Soils have a mean V concentration of 100 ppm (Hopkins and others, 1977). The average V content of surface soils of the U.S. (Appendix 8.4) (Kabata-Pendias and Pendias, 1984) is 84 ppm. As evident from the Appendix 8.4, the highest values are found for soils over volcanic rocks (30-300 ppm, with an average of 136 ppm), while the lowest are for organic, and sandy soils and lithosols on sandstones. Silty soils also contain large amounts of V (20-300 ppm, with an average of 102 ppm). In arid and semiarid regions, soil V contents (particularly in Vertisols, saline and Mediterranean red soils) are often very high (Aubert and Pinta, 1980). V contents in surface horizons of desert soils in the U.S. range between 30 and 150 ppm with an average of 93 ppm (Appendix 8.4).

In general, V is distributed in soil profiles rather uniformly (Kabata-Pendias and Pendias, 1984). However, this element prefers to concentrate in the humiferous

horizons. In temperate zones, the B horizon of leached soils and Spodosols is often richer in V than the surface horizon (Aubert and Pinta, 1980).

Zinc (Zn)

Parent Rocks: Zn seems to be distributed rather uniformly in magmatic rocks, and only its slight increase in mafic rocks (80-120 ppm) and its slight decrease in felsic rocks (40-60 ppm) is observed. The Zn concentrations in argillaceous sedimentary rocks is enhanced, ranging from 80 to 120 ppm, while in sandstones and carbonates concentrations of this metal range from 10 to 30 ppm (Krauskopf, 1972; Aubert and Pinta, 1980; Kabata-Pendias and Pendias, 1984).

Zinc Content of Soils: The total Zn content of soils is largely dependent on the composition of the parent rock material. The common total Zn contents of soils range from 10 to 300 ppm, with an average of 50 ppm (Lindsay, 1972). Kabata-Pendias and Pendias (1984) reported values of 34-83.5 ppm Zn as background average contents of surface soils of the U.S. (Appendix 8.3). The highest values are found in Mollisols and dark prairie soils and in soils over volcanic rocks, while the lowest values are in felsic mineral and low-organic soils. Aubert and Pinta (1980) also noted that Mollisols and saline alkali soils of the arid and semiarid regions generally contain high quantities of Zn.

In most soils, Zn accumulates in the humiferous surface horizon. Zn concentrations increase at the same time as those of humus and organic matter (John, 1974). In Mollisols the distribution of this metal is uniform between different horizons (Aubert

and Pinta, 1980). Zn is considered to be readily soluble relative to other heavy metals in soils. Acid leaching is very active in Zn mobilization; thus losses of this metal are observed in certain horizons, particularly in surface horizons of Spodosols and brown acid soils derived from sands (Kabata-Pendias and Pendias, 1984). The highly weathered, acid leached sandy soils of the lower Atlantic Coastal Plain appear to have uniformly low (20 to 30 ppm) Zn concentrations at the surface (Kubota, 1980).

Appendix 2: List of geologic units along with their associated soil sampling sites.
The geologic units and their description are from Walker and MacLeod (1991). For location of the sampling sites, see Figure 5.

Geologic Unit	Age	Description	Site #	Site ^a Location # in Fig.5	Physiographic Province
bc	Mesozoic or Paleozoic	Amphibolite of Briggs Creek	KL30	103	Klamath Mountains
cm	Triassic & Permian	Condrey Mountain Schist	KL21	95	Klamath Mountains
cs	Mesozoic or Paleozoic	Colebrook Schist	KL6, KL12	80, 86	Klamath Mountains
Jm	Jurassic	Melange	KL17	91	Klamath Mountains
Jop	Jurassic	Otter Point Formation & related rocks	KL13	87	Klamath Mountains
Js	Jurassic	Sedimentary rocks	KL1, KL11	75, 85	Klamath Mountains
Jss	Jurassic	Shale, mudstone & sandstone	KL14, KL15	88, 89	Klamath Mountains
JTrgd	Jurassic & Triassic	Granite & diorite	KL9, KL23	83, 97	Klamath Mountains
Ju	Jurassic	Ultramafic & related rocks of ophiolite sequences	KL16	90	Klamath Mountains
Jub	Jurassic	Basaltic, volcanic & sedimentary rocks	R12, R13	115, 116	Klamath Mountains
Jv	Jurassic	Volcanic rocks	KL3	77	Klamath Mountains
Kc	Cretaceous	Clastic sedimentary rocks	KL27	101	Klamath Mountains
KJds	Cretaceous & Jurassic	Sedimentary rocks of Dothan Formation	KL4	78	Klamath Mountains
KJg	Cretaceous & Jurassic	Granitic rocks	KL2, KL26	76, 100	Klamath Mountains
KJgu	Cretaceous & Jurassic	Gabbro and ultramafic rocks associated with granitic plutons	R10, R11	113, 114	Klamath Mountains
KJm	Cretaceous & Jurassic	Myrtle Group conglomerate, sandstone, siltstone & limestone	R14, R15	117, 118	Klamath Mountains

Appendix 2: List of geologic units along with their associated soil sampling sites. The geologic units and their description are from Walker and MacLeod (1991). For location of the sampling sites, see Figure 5 (continued).

Geologic Unit	Age	Description	Site # (s)	Site ^a Location # in Fig. 5	Physiographic Province
Ks	Cretaceous	Sedimentary rocks	KL10	84	Klamath Mountains
mc	Paleozoic	May Creek Schist	KL28	102	Klamath Mountains
Qa	Holocene & Pleistocene	Andesite	R3, R4	106, 107	Cascade Range
Qal	Holocene	Alluvial deposits	LC11, LM7, LM17 *	34, 8, 18	Coast Range Willamette V.*
Qb	Holocene & Pleistocene	Basalt & basaltic andesite	EO2	47	High Lava Plains
Qba	Holocene & Pleistocene	Basaltic andesite & basalt	LM9, LM16	10, 17	Cascade Range
Qd (young)	Holocene	Dune sand	LC13	36	Coastal Plain
Qd (old)	Holocene	Dune sand	LC14	37	Coastal Plain
Qf	Holocene & Pleistocene	Fanglomerate	EO26	66	Basin & Range
Qg	Pleistocene	Glacial deposits	LM4, LM10	5, 11	Cascade Range
Qgf	Pleistocene	Glaciofluvial deposits	LM21	21	Cascade Range
Qls	Holocene & Pleistocene	Landslide & debris flow deposits	LM1, LC20	1, 43	Coast Range
Qma	Holocene	Mazama ash-flow deposits	LM5, EO14	6, 55	Cascade Range
Qmp	Holocene	Mazama pumice deposits	LM6, EO23	7, 63	Cascade Range
Qrd	Holocene & Pleistocene	Rhyolite & dacite	EO24, EO25	64, 65	Cascade Range
Qs	Pleistocene	Lacustrine & fluvial sedimentary rocks	LC1, EO15*	23, 56	Cascade Range, Basin & Range*
Qt	Holocene & Pleistocene	Terrace pediment & lag gravels	LC3*, LC16, LC17, KL7, KL8	25, 39, 40, 81, 82	Willamette V.* Coastal Plain

Appendix 2: List of geologic units along with their associated soil sampling sites. The geologic units and their description are from Walker and MacLeod (1991). For location of the sampling sites, see Figure 5 (continued).

Geologic Unit	Age	Description	Site #	Site ^a Location # in Fig. 5	Physiographic Province
QTb	Pleistocene & Pliocene	Basalt	EO8, EO10	49, 51	Basin & Range
QTba	Pleistocene & Pliocene	Basalt & basaltic andesite	LM3B, LM15, EO18, EO21	4, 16, 59, 61	Cascade Range
QTmv	Pleistocene, Pliocene, & Miocene ?	Mafic vent complexes	LM11, EO20	12, 60	Cascade Range
QTp	Holocene to Miocene	Basaltic and andesitic ejecta	EO22, R5, R6	62, 108, 109	Basin & Range
QTps	Holocene to Miocene?	Subaqueous basaltic & andesitic ejecta	EO30	68	High Lava Plains
QTs	Pleistocene & Pliocene	Sedimentary rocks	EO13	54	Basin & Range
QTst	Pleistocene or Pliocene	Tuffaceous sedimentary rocks & tuffs	EO16, EO17	57, 58	High Lava Plains
QTvm	Pleistocene, Pliocene, & Miocene?	Mafic vent deposits	EO35	73	Basin & Range
Tat	Pliocene & Miocene	Silicic ash-flow tuff	EO31	69	Basin & Range
Tb	Miocene	Basalt	EO7	48	Basin & Range
Tbaa	Miocene	Basaltic & andesitic rocks	R1, R2	104, 105	Cascade Range
Tfc	Miocene	Flows & clastic rocks, undifferentiated	LM22	22	Cascade Range
Tfe	Oligocene & Eocene	Fisher & Eugene Fms. & correlative rocks	LC22	45	Cascade Range
Tfee	Oligocene & Eocene	Marine Eugene Fm.	LC2	24	Cascade Range
Tmsc	Eocene	Marine siltstone, sandstone & conglomerate	LC7	29	Coast Range

Appendix 2: List of geologic units along with their associated soil sampling sites. The geologic units and their description are from Walker and MacLeod (1991). For location of the sampling sites, see Figure 5 (continued).

Geologic Unit	Age	Description	Site #	Site ^a Location # in Fig. 5	Physiographic Province
Tmsm	Paleocene & Eocene	Marine siltstone, sandstone & conglomerate	LC5	27	Coast Range
Tmss	Eocene	Marine sandstone and siltstone	LC8, LC21, KL5	30, 44, 79	Coast Range
Tmv	Miocene	Mafic vent complexes	EO32	70	Cascade Range
Tn	Eocene	Nonmarine sedimentary rocks	R7, R8, R9	110, 111, 112	Cascade Range
Tob	Pliocene & Miocene	Olivine basalt	EO12, EO27	53, 67	Basin & Range
Tp	Pliocene & Miocene	Basaltic & andesitic ejecta	EO33	71	Basin & Range
Tpb	Eocene	Porphyritic basalt	LC23	46	Coast Range
Tps	Pliocene & Miocene	Subaqueous pyroclastic rocks of basaltic cinder cones	EO34	72	Basin & Range
Trb	Pliocene & Miocene	Ridge capping basalt & basaltic andesite	LM14	15	Cascade Range
Trh	Pliocene & Miocene	Rhyolite & dacite	EO36	74	Basin & Range
TrPv	Triassic & Permian	Volcanic rocks	KL19, KL22	93, 96	Klamath Mountains
TrPzm	Triassic or Paleozoic	Melange of Dutchmans Peak	KL24, KL25	98, 99	Klamath Mountains
TrPzs	Triassic & Paleozoic	Sedimentary rocks, partly metamorphosed	KL18, KL20	92, 94	Klamath Mountains
Ts	Pliocene & Miocene	Tuffaceous sedimentary rocks & tuff	EO9, EO11	50, 52	Basin & Range
Tsr	Eocene & Paleocene	Siletz River Volcanics & related rocks	LC6, LC10A, LC19	28, 32, 42	Coast Range
Tss	Eocene	Tuffaceous siltstone & sandstone	LC15, LC18	38, 41	Coast Range
Tsv	Pliocene, Miocene & Oligocene	Silica vent complexes	LM20	20	Cascade Range

Appendix 2: List of geologic units along with their associated soil sampling sites. The geologic units and their description are from Walker and MacLeod (1991). For location of the sampling sites, see Figure 5 (continued).

Geologic Unit	Age	Description	Site #	Site ^a Location # in Fig. 5	Physiographic Province
Tt	Eocene	Tyee Fm. (marine sandstone & siltstone)	LC4, LC12	26, 35	Coast Range
Tu	Miocene & Oligocene	Undifferentiated tuffaceous sedimentary rocks, tuffs, & basalt	LM8	9	Cascade Range
Tub	Oligocene	Basaltic lava flows	LM12	13	Cascade Range
Tus	Miocene & Oligocene	Sedimentary & volcanoclastic rocks	LM2, LM3A, LM13	2, 3, 14	Cascade Range
Tut	Miocene & Oligocene	Tuff	LM19	19	Cascade Range
Ty	Eocene	Yamhill Fm. & related rocks	LC9, LC10B	31, 33	Coast Range

^a Our site numbers were simplified into one set of numbers for Figure 5. These new numbers are given in this column and they appear in the same order as the site numbers.

* Site corresponds to physiographic province.

Appendix 3. Sampling Site Characteristics												
	Site	County	Quadrangle	UTM-E	UTM-N	LAT N	LONG W	Elev (m)	Veg. ^a	Drain ^b	Geol. Unit ^c	Soil Order ^d (**)
1*	LM1	Douglas	Mace Mtn 15	507100	4793700	43.30	122.91	268	df, m, a,	3	Qls	Incep (C9)
2	LM2	Douglas	Mace Mtn 15	513300	4795500	43.31	122.84	316	df	3	Tus	Incep (C9)
3	LM3A	Douglas	Mahee Rock 7.5	530900	4793200	43.30	122.62	438	df	4	Tus	Incep (C9)
4	LM3B	Douglas	Toketee Falls 15	549100	4788900	43.25	122.40	827	df	3	QTba	Incep (D4)
5	LM4	Douglas	Diamond Lake 15	570250	4780300	43.17	122.14	1301	p	3	Qg	Ent (G3)
6	LM5	Douglas	Diamond Lake 15	574250	4770990	43.10	122.10	1860	p, df	2	Qma	Ent (G3)
7	LM6	Klamath	Miller Lake 7.5	586550	4785375	43.22	121.93	1745	p, df	4	Qmp	Ent (G3)
8	LM7	Lane	Hardesty Mtn 15	535250	4850150	43.81	122.56	292	m,df, c, cw	2	Qal	Incep (C7)
9	LM8	Lane	Fairview Peak 15	536750	4842125	43.73	122.54	778	df	2	Tu	Ult (C7)
10	LM9	Lane	Waldo Lake 15	570700	4828700	43.61	122.12	1240	df	3	Qba)	Incep (E1)
11	LM10	Klamath	Odell Lake 7.5	585000	4821250	43.54	121.95	1453	p	4	Qg	Ent (G3)
12	LM11	Klamath	Odell Butte 7.5	591700	4813800	43.47	121.87	1873	df	3	QTmv	Ent (G3)
13	LM12	Jackson	Hyatt Reservoir 15	542700	4669900	42.18	122.48	1654	gf, df (old)	3	Tub	Moll (N2)
14	LM13	Jackson	Hyatt Reservoir 15	546000	4672350	42.20	122.44	1526	df	3	Tus	Moll (N2)
15	LM14	Klamath	Hyatt Reservoir 15	560200	4664900	42.14	122.27	1325	df	3	Trb	Moll (F2)
16	LM15	Klamath	Surveyor Mtn 15	569200	4663400	42.12	122.16	1350	df (old)	3	QTba	Moll (F2)
17	LM16	Klamath	Surveyor Mtn 15	580400	4664700	42.13	122.03	1289	p	3	Qba	Moll (F2)
18	LM17	Lane	Lowell 15	513925	4864000	43.93	122.83	182	df, m, p	3	Qal	Moll (J4)
19	LM19	Lane	Hardesty Mtn 15	535200	4855850	43.86	122.56	486	df	3	Tut	Incep (C9)
20	LM20	Lane	Hardesty Mtn 15	531400	4867600	43.96	122.61	292	df	3	Tsv	Incep (C7)
21	LM21	Lane	Chucksney Mtn 15	570400	4867900	43.96	122.12	730	df (old)	3	Qgf	Incep (D4)
22	LM22	Lane	McKenzie Bridge 15	561875	4885300	44.12	122.23	462	df, m	3	Tfc	Incep (D4)
23	LC1	Lane	Eugene West 7.5	486175	4877050	44.05	123.17	119	g	1	Qs	Moll (I4)
24	LC2	Lane	Eugene West 7.5	485300	4873900	44.02	123.18	249	df (young)	3	Tfee	Ult (J4)
25	LC3	Lane	Elmura 15	476600	4877900	44.06	123.30	106	df	2	Qt	Moll (J4)
26	LC4	Douglas	Drain 15	472650	4840000	43.71	123.34	219	df	3	Tt	Ult (J3)
27	LC5	Douglas	Sutherlin 15	474400	4813000	43.47	123.32	269	o, df	3	Tmsm	Incep (J2)
28	LC6	Douglas	Sutherlin 15	474400	4789550	43.26	123.32	213	o, lp	3	Tsr	Moll (J4)
29	LC7	Douglas	Camas Valley 15	549300	4765450	43.04	122.40	316	df, lp	3	Tmsc	Incep (D4)
30	LC8	Douglas	Camas Valley 15	440100	4762100	43.01	123.73	340	df	3	Tmss	Incep (J2)

Appendix 3. Sampling Site Characteristics (continued)												
	Site	County	Quadrangle	UTM-E	UTM-N	LAT N	LONG W	Elev (m)	Veg. ^a	Drain ^b	Geol. Unit ^c	Soil Order ^d (**)
31	LC9	Douglas	Devils Graveyard 7.5	448625	4831700	43.64	123.64	134	df, o	1	Ty	Moll (I4)
32	LC10A	Douglas	Sutherlin 15	482475	4795800	43.32	123.22	182	lp, f, g	3	Tsr	Ult (J4)
33	LC10B	Douglas	Scottsburg 15	436800	4835330	43.67	123.78	24	h, c	3	Ty	Ult (J3)
34	LC11	Douglas	Scottsburg 15	432600	4833000	43.65	123.84	0	w, m	3	Qal	Incep (C3)
35	LC12	Douglas	Scottsburg 15	432700	4832950	43.65	123.83	24	m, f	3	Tt	Incep (C3)
36	LC13	Douglas	Reedsport 15	403250	4834800	43.66	124.20	0	mb, sb,	3	Qd	Ent (A1)
37	LC14	Douglas	Reedsport 15	403675	4834500	43.66	124.19	0	df, cs, s	3	Qd	Spodo (A1)
38	LC15	Coos	Reedsport 15	405450	4827250	43.59	124.17	24	f, a	3	Tss	Incep (A2)
39	LC16	Coos	Reedsport 15	404800	4827000	43.59	124.18	0	f	3	Qt	Incep (?)
40	LC17	Coos	Cape Arago 7.5	388050	4797650	43.33	124.38	0	f (old)	3	Qt	Ult (C3)
41	LC18	Coos	Charleston 7.5	391150	4796850	43.32	124.34	109	f (old)	3	Tss	Ult (C3)
42	LC19	Coos	Coquille 7.5	406530	4778150	43.15	124.15	27	f, m, a	3	Tsr	Ult (C3)
43	LC20	Coos	Bone Mtn 7.5	433180	4757150	42.97	123.82	170	a, f	3	Qls	Incep (C1)
44	LC21	Douglas	Bone Mtn 7.5	441500	4760700	43.00	123.72	334	f, cs	3	Tmss	Alf (J2)
45	LC22	Lane	Fox Hollow 7.5	483970	4860480	43.90	123.20	489	f	3	Tfe	Ult (J4)
46	LC23	Lane	Heceta Head 15	414000	4891050	44.20	124.08	397	f	3	Tpb	Incep (C1)
47	EO2	Deschutes	Lava Butte 7.5	631800	4862450	43.91	121.40	1368	p	4	Qb	Incep (?)
48	EO7	Klamath	Swan Lake 15	619750	4694000	42.39	121.55	1398	p	3	Tb	Moll (F2)
49	EO8	Klamath	Swan Lake 15	610900	4696200	42.41	121.65	1885	f, p	3	QTb	Moll (F2)
50	EO9	Klamath	Chiloquin 15	600600	4717150	42.60	121.77	1286	p, br, g	3	Ts	Ent (G2)
51	EO10	Klamath	Culimus Butte 15	618400	4726600	42.68	121.55	1617	p, br	3	QTb	Ent (G2)
52	EO11	Klamath	Klamath Marsh 15	620900	4738400	42.79	121.52	1447	p	3	Ts	Ent (G2)
53	EO12	Klamath	Fuego Mtn 15	631900	4731150	42.72	121.39	1484	p	4	Tob	Ent (G2)
54	EO13	Klamath	Yamsay Mtn 15	625200	4759900	42.98	121.46	1423	p	3	QTs	Ent (G2)
55	EO14	Klamath	Lenz 15	597000	4746950	42.87	121.81	1377	p	3	Qma	Incep (H1)
56	EO15	Klamath	Odell Butte 7.5	599350	4812700	43.46	121.77	1392	p	3	Qs	Ent (G1)
57	EO16	Deschutes	Firley Butte 7.5	630750	4839575	43.70	121.38	1435	p	3	QTst	Ent (G1)
58	EO17	Deschutes	Paulina Peak 7.5	637000	4840100	43.70	121.30	1836	p	3	QTst	Ent (G3)
59	EO18	Deschutes	Davis Mtn 7.5	592350	4837800	43.69	121.85	1398	p	3	QTba	Incep (G1)
60	EO20	Deschutes	Davis Mtn 7.5	598850	4830850	43.63	121.77	1824	f, p	3	QTmv	Ent (G1)

Appendix 3. Sampling Site Characteristics (continued)												
	Site	County	Quadrangle	UTM-E	UTM-N	LAT N	LONG W	Elev. (m)	Veg. ^a	Drain ^b	Geol. Unit ^c	Soil Order ^d (**)
61	EO21	Klamath	Hamner Butte 7.5	595150	4828750	43.61	121.82	1338	f, p	3	QTba	Ent (G3)
62	EO22	Klamath	Muttonchop 15	593325	4802000	43.37	121.85	1514	p	3	QTp	Ent (G3)
63	EO23	Klamath	Burn Butte 7.5	590900	4802300	43.37	121.88	1471	p	3	Qmp	Ent (G3)
64	EO24	Klamath	Lenz 15	583450	4757150	42.96	121.98	1824	f, p	3	Qrd	Ent (G3)
65	EO25	Klamath	Lenz 15	586500	4749200	42.89	121.94	1569		3	QTba	Ent (G1)
66	EO26	Klamath	Lenz 15	590000	4745200	42.86	121.90	1386	p	3	Qf	Ent (G1)
67	EO27	Klamath	Lenz 15	583600	4734350	42.76	121.98	1435	f, p	3	Tob	Ent (G3)
68	EO30	Lake	Big Hole 7.5	637200	4808800	43.42	121.31	1404	p, g, br	3	QTps	Ent (G1)
69	EO31	Lake	McCarty 7.5	641175	4803190	43.37	121.26	1490	p, br	3	Tat	Ent (G1)
70	EO32	Klamath	Sugar Pine Mt 7.5	613275	4774300	43.11	121.61	1891	p, g, br	3	Tmv	Ent (G1)
71	EO33	Klamath	Bear Butte 7.5	627650	4767850	43.05	121.43	1526	p	3	Tp	Ent (G1)
72	EO34	Klamath	Chiloquin 15	597850	4718750	42.62	121.81	1325	p, br	3	Tps	Ent (G2)
73	EO35	Klamath	Calimus Butte 15	610350	4709150	42.53	121.66	1544	f, p	3	QTvm	Incep (H1)
74	EO36	Klamath	Beatty 7.5	627000	4696350	42.41	121.46	1569	f, p, g	3	Trh	Moll (Q6)
75	KL1	Josephine	Galice 15	455400	4712800	42.57	123.54	426	p, f (old)	3	Js	Ult (K4)
76	KL2	Josephine	Glendale 15	464650	4705300	42.50	123.43	316	m, f, p,	3	KJg	Incep (K3)
77	KL3	Josephine	Galice 15	451100	4714550	42.58	123.60	228	f	3	Jv	Alf (K4)
78	KL4	Curry	Marial 15	425100	4721200	42.64	123.91	1094	df (old),	3	KJds	Incep (N1)
79	KL5	Curry	Agness 15	414300	4714250	42.58	124.04	122	f, po, g	3	Tmss	Alfi (K4)
80	KL6	Curry	Agness 15	406300	4709200	42.53	124.14	195	p, f	3	cs	Alf (C4)
81	KL7	Curry	Langlois 15	378650	4740180	42.81	124.48	52	f	3	Qt	Incep (A1)
82	KL8	Curry	Cape Blanco 15	373450	4743100	42.83	124.55	61	p	3	Qt	Incep (A1)
83	KL9	Curry	Port Orford 15	386750	4728850	42.71	124.38	219	f, m, a	3	JTrgd	Ult (C3)
84	KL10	Curry	Port Orford 15	395050	4729550	42.71	124.28	170	f (old), m	3	Ks	Incep (C3)
85	KL11	Curry	Port Orford 15	394100	4729800	42.72	124.29	146	f	3	Js	Incep (C3)
86	KL12	Curry	Port Orford 15	389600	4713800	42.57	124.35	24	f	3	cs	Ult (C3)
87	KL13	Curry	Gold beach 15	384175	4705150	42.49	124.41	49	f	3	Jop	Incep (A2)
88	KL14	Josephine	Selma 15	452150	4687350	42.34	123.58	462	f	3	Jss	Alfi (K4)
89	KL15	Josephine	Cave Junction 15	447500	4675950	42.24	123.64	389	f	3	Jss	Incep (K4)
90	KL16	Josephine	Cave Junction 15	443300	4676800	42.24	123.69	365	f, p	3	Ju	Ult (K4)

Appendix 3. Sampling Site Characteristics (continued)												
	Site	County	Quadrangle	UTM-E	UTM-N	LAT N	LONG W	Elev. (m)	Veg ^a	Drain ^b	Geol Unit ^c	Soil Order ^d (**)
91	KL17	Josephine	Cave Junction 15	452000	4655350	42.05	123.58	584	f,	3	Jm	Alf/Ult (K4)
92	KL18	Josephine	Oregon Caves 15	465750	4661100	42.10	123.41	1021	f (old)	3	TrPzs	Alf (K4)
93	KL19	Jackson	Ruch 15	482400	4669600	42.18	123.21	657	f	3	TrPv	Alf/Ult (K4)
94	KL20	Josephine	Oregon Caves 15	475500	4653650	42.04	123.30	1386	f, p	3	TrPzs	Incep (N1)
95	KL21	Jackson	Ruch 15	489000	4652250	42.02	123.13	657	f, p	3	cm	Alf (K4)
96	KL22	Jackson	Ruch 15	495500	4662700	42.12	123.05	584	f, p	3	TrPv	Incep (K3)
97	KL23	Josephine	Chetco Peak 15	430600	4655600	42.05	123.84	1143	f, p	3	JTrgd	Alf (K5)
98	KL24	Jackson	Talent 15	514000	4655250	42.05	122.83	2019	f (old)	3	TrPzm	Alf (N1)
99	KL25	Jackson	Talent 15	507350	4654250	42.04	122.91	1946	f	3	TrPzm	Incep (N1)
100	KL26	Jackson	Ashland 15	523300	4658100	42.08	122.72	2043	f	3	KJg	Incep (N1)
101	KL27	Jackson	Wimer 15	484000	4724200	42.67	123.20	778	f	3	Kc	Alf/Ult (K4)
102	KL28	Jackson	Wimer 15	492200	4720500	42.64	123.10	754	f, p	3	mc	Incep (K4)
103	KL30	Josephine	Galice 15	445600	4709150	42.53	123.66	745	o, f, p	3	bc	Alf (K4)
104	R1	Lane	Waldo Lake 15	563400	4833650	43.66	122.21	803	df (old)	3	Tbaa	Incep (D4)
105	R2	Lane	Waldo Lake 15	568550	4832300	43.64	122.15	1094	df (old), vm	3	Tbaa	Incep (?)
106	R3	Klamath	Pumice Desert 7.5	570480	4761300	43.00	122.14	1933	lp, h (old)	3	Qa	Incep (E1)
107	R4	Klamath	Union Peak 7.5	570160	4746900	42.87	122.14	1885	h, lp	3	Qa	Moll (G3)
108	R5	Klamath	Lake O' Woods 15	572500	4698500	42.44	122.12	1277	pp, df (few)	3	QTP	Incep (F2)
109	R6	Klamath	Lake O' Woods 15	567500	4698800	42.44	122.18	1344	df	3	QTP	Incep (F1)
110	R7	Jackson	Trail 15	507250	4710500	42.55	122.91	456	md, pp, po	3	Tn	Incep (K1)
111	R8	Jackson	Medford 15	517000	4686400	42.33	122.79	608	o	2	Tn	Vert (K1)
112	R9	Jackson	Medford 15	518130	4679550	42.27	122.78	547	o	3	Tn	Incep (K1)
113	R10	Josephine	Grants Pass 15	471100	4688600	42.35	123.35	353	md, po, pp	3	KJgu	Alf/Ult (K4)
114	R11	Josephine	Grants Pass 15	470900	4688150	42.35	123.35	353	md, pp, o	3	KJgu	Alf/Ult (K4)
115	R12	Josephine	Selma 15	452350	4687450	42.34	123.58	486	df, md, pi	3	Jub	Incep (K4)
116	R13	Josephine	Wimer 15	480550	4721900	42.65	123.24	730	df, md (few)	3	Jub	Alf/Ult (K4)
117	R14	Douglas	Canyonville 15	473700	4751400	42.92	123.32	340	df, md, pp	3	KJm	Alf/Ult (K4)
118	R15	Douglas	Dixonville, 15	487100	4772500	43.11	123.16	271	df, pp, md	3	KJm	Alf/Ult (K4)

Appendix 3. Sampling Site Characteristics (continued)

- Sampling Site Location # in Figure 5.
- ** Soil Unit # (from USDA, 1986) in Figure 3.
- a Key to Vegetation: a = alder, br = brush, c = cedar, cs = citrus spruce, cw = cottonwood, df = Douglas fir, f = fir, fn = firn, g = grass, gf = ground foliage, h = hemlock, lp = lodgepole pine, m = maple, mb = myrtle bush, md = madrone, o = oak, p = pine, pi = poison ivy, po = poison oak, pp = ponderosa pine, s = salal, sb = scotch broom, vm = vine maple, w = willow.
- b Key to Drainage: 1 = poorly drained, 2 = moderately drained, 3 = well drained, 4 = very well drained.
- c For description of geologic units see Appendix 2.
- d Soil Orders from USDA (1986). These are in agreement with the respective soil characteristics listed in Appendix 4. Without data on base saturation (determination of which is beyond the scope of this study) distinction between Alfisols and Ultisols was not possible.

Note: Field inventory sheets of all sites except R1-R15 were from Bill Douglas (M.S. Geology student, Portland State University).

Appendix 4.1. Selected physical and morphological properties of the soils studied.								
Sample number	Horizon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
LM1	A	0-8	10 YR 4/3	10 YR 2/2	SCL	15	1m, f, sbk	5.9
LM1	Bw	8-30+	10 YR 5/4	10 YR 3/4	SCL	15	1m, f, sbk	5.9
LM2	A	0-10	10 YR 4/2	10 YR 2/2	SL	8	1m, f, sbk	6.1
LM2	Bw	10-25+	10 YR 5/3	10 YR 3/3	SL	8	1m, f, sbk	6.0
LM3A	A	0-15	10YR. 3/2	10 YR. 2/2	S	0	sg, f, gr	5.4
LM3A	Bw	15-40+	10 YR. 7/3	10 YR. 5/4	S	0	sg, f, gr	6.3
LM3B	A	0-3	10 YR. 5/4	10 YR. 3/3	S	<2	1m, f, gr	6.6
LM3B	Bw	3-25+	10 YR. 6/4	10 YR. 4/4	LS	<2	1m, f, gr	6.3
LM4	A	0-4	2.5 Y 4/3	2.5 Y 2.5/1	LS	<2	1m, f, gr	4.8
LM4	Bwj	4-25	2.5 Y 6/4	2.5 Y 3.5/2	LS	<2	1m,f-m, gr	5.6
LM5	A	0-3	10 YR 3/2	10 YR 2/2	LS	<2	1m, vf, gr	4.0
LM5	Bwj	3-20	10 YR 6/4	10 YR 4/4	LS	<2	1m, f, gr	5.7
LM6	A	0-2	2.5 Y 4/3	2.5 Y 3/2	LS	0	sg, f, gr	4.7
LM6	Bwj	2-20	2.5 Y 7/4	2.5 Y 5/6	S	0	sg, m, gr	5.8
LM7	A	0-8	2.5 Y 4/3	2.5 Y 3/3	SL	5	1m, f, sbk	6.1
LM7	C	8-30+	2.5 Y 5/3	2.5 Y 3/3	SL	5	1m, f, gr	6.0
LM8	A	0-6	10 YR 3/2	10 YR 2/2	SCL	20	2m, f, sbk	5.9
LM8	Bt	6-20+	10 YR 4/4	10 YR 3/4	SCL	30	2m, f, sbk	4.8
LM9	A	0-8	10 YR 3/2	10 YR 2/2	LS	<2	1m, f, gr	4.5
LM9	Bwj	8-25	10 YR 6/3	10 YR 4/3	LS	<2	1m, f, gr	5.3
LM10	A	0-1	10 YR 4/2	10 YR 2/2	S	<1	1m, f, gr	4.9
LM10	Bwj	1-20	10 YR 6/4	10 YR 4/4	S	<1	1m,m-c, gr	5.8
LM11	A	0-6	10 YR 3/2	10 YR 2/2	S	<1	sg, f-m, gr	4.8
LM11	Bwj	6-18	10 YR 6/4	10 YR 4/4	S	<1	sg, m-c, gr	5.6
LM12	A	0-10	10 YR 3/2	10 YR 2/1	LS	8	1m, f, sbk	5.9
LM12	Bw	10-40+	10 YR 3/3	10 YR 2/1	LS	8	1m, f, sbk	6.2
LM13	A	0-8	10 YR 3/2	10 YR 2/2	L	12	1m, f, sbk	6.2
LM13	Bw	8-35+	10 YR 4/4	10 YR 3/3	L	12	1m, f, sbk	5.6
LM14	A	0-8	7.5 YR 3/2	7.5 YR 2/1	L	10	1m, f, sbk	6.6
LM14	Bw	8-30+	7.5 YR 4/4	7.5 YR 3/3	L	10	1m, f, sbk	6.4
LM15	A	0-15	10 YR 4/4	10 YR 3/3	SL	8	1m, f, sbk	6.2
LM15	Bt	15-30+	7.5 YR 4/4	7.5 YR 3/3	SCL	30	2m, vf, sbk	6.6
LM16	A	0-8	10 YR. 4/3	10 YR. 3/3	L	8	1m, f, sbk	5.3
LM16	Bt	8-25+	10 YR. 4/3	10 YR. 3/3	L	15	1m, f, sbk	6.0
LM17	A	0-10	10 YR 4/3	10 YR 2/2	SiL	8	1m, f, sbk	6.8
LM17	Bw	10-35+	10 YR 5/4	10 YR 3/2	SiL	8	1m, f, sbk	6.4
LM19	A	0-5	2.5 Y 4/2	2.5 Y 2.5/1	L	8	1m, f, sbk	5.5
LM19	Bw	5-30+	2.5 Y 5/3	2.5 Y 3/2	L	8	1m, f, sbk	5.6
LM20	A	0-7	color not determined -		L	10	1m, f, sbk	5.3
LM20	Bw	7-30+	sample lost from lab		SiL	10	1m, f, sbk	5.6
LM21	A	0-4	10 YR 4/3	10 YR 3/2	SL	5	1m, f, sbk	5.4
LM21	Bw	4-30+	10 YR 5/4	10 YR 4/3	SL	5	1m, f, sbk	5.6
LM22	A	0-10	10 YR 3/2	10 YR 2/1	SL	5	1m, f, sbk	5.4
LM22	Bw	10-30+	10 YR 6/4	10 YR 3/3	SL	5	1m, f, sbk	5.6
LC1	A	0-6	2.5 Y 5/2	2.5 Y 3/2	C	>70	1m, vf, sbk	5.3

Appendix 4.2. Selected physical and morphological properties of the soils studied

Sample #	Horizon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
LC1	Bg	6-10+	2.5 Y 5/2	2.5 Y 3/2	C	70	1m, vf, sbk	5.1
LC2	A	0-7	7.5 YR 3/3	7.5 YR 3/2	SCL	30	1m, f, gr	5.5
LC2	Bt	7-28+	7.5 YR 5/8	7.5 YR 4/6	SCL	40	2m, f, sbk	4.6
LC3	A	0-16	2.5 Y 5/3	2.5 Y 2.5/2	SL	12	1m, f, sbk	5.5
LC3	Bw	16-22+	2.5 Y 6/4	2.5 Y 4.5/4	SL	12	1m, f, sbk	4.8
LC4	A	0-20	10 YR 5/4	10 YR 3/3	SL	8	1m, f, sbk	5.7
LC4	Bt	20-40+	10 YR 5/4	10 YR 3/4	SCL	15	1m, f, sbk	5.0
LC5	A	0-1	2.5 Y 4.5/4	2.5 Y 3/3	SiSL	5	1m, vf, sbk	6.2
LC5	Bw	1-28	2.5 Y 5/4	2.5 Y 3/3	SiSL	5	1m, vf, sbk	6.4
LC6	A	0-10	10 YR 4/4	10 YR 2/2	SL	8	1m, f, sbk	6.0
LC6	Bw	10-28	10 YR 4/4	10 YR 3/3	SL	8	1m, f, sbk	6.2
LC7	A	0-10	10 YR 4/4	10 YR 3/3	SiS	<2	1m, f, gr	5.7
LC7	Bw	10-25+	10 YR 6/4	10 YR 4/4	SiS	<2	1m, f, gr	5.1
LC8	A	0-5	10 YR 4/2	10 YR 3/2	SSiL	5	1m, f, sbk	5.7
LC8	Bw	5-30+	10 YR 6/4	10 YR 3/3	SSiL	5	1m, f, sbk	5.3
LC9	A	0-10	1.5 Y 5.5/4	1.5 Y 4/3	SCL	8	1m, f, sbk	5.3
LC9	Bw	10-25+	1.5 Y 6/6	1.5 Y 5/4	SCL	8	1m, f, sbk	5.0
LC10A	A	0-5	10 YR. 4/2	10 YR. 3/2	SCL	15	1m, m, sbk	5.4
LC10A	Bt	5-25	10 YR. 4/3	10 YR. 3/3	SCL	20	1m, c, sbk	5.8
LC10B	A	0-6	10 YR. 4/4	10 YR. 2/3	SiCL	30	1m, f, cpr	5.6
LC10B	Bt	6-14+	10 YR. 4/4	7.5YR. 3/3	SiCL	40	1m, f, sbk	5.4
LC11	A	0-4	10 YR 5/4	10 YR 4/3	SL	10	1m, m, sbk	5.9
LC11	Bw	4-12+	10 YR 4/3	10 YR 3/2	LS	1	1m, vc, gr	5.8
LC12	A	0-4	1.5 Y 4/3	1.5 Y 2.5/2	LS	1	1m, f, sbk	6.0
LC12	Bt	4-15+	10 YR 5/4	10 YR 3/3	SL	15	1m, f, sbk	5.7
LC13	A	0-2	2.5 Y 5/2	2.5 Y 4/2	S	0	sg, m, gr	5.1
LC13	C	2-20+	2.5 Y 7/4	2.5 Y 5.5/4	S	0	sg, m, gr	5.4
LC14	A	0-5	10 YR 4/1	10 YR 3/1	LS	7	1m, f, gr	4.0
LC14	E**	5-50			LS	<7	1m, f, gr	
LC14	Bw	50-80+	10 YR 6/7	10 YR 5/6	LS	7	1m, f, gr	5.5
LC15	A	0-10	10 YR 3/2	10 YR 4/4	SL	10	1m, f, sbk	4.1
LC15	Bw	10-80+	10 YR 4/4	10 YR 3/3	SL	10	1m, f, sbk	4.9
LC16	A*	0-5	color not determined -		S	<1	sg, f-m, gr	4.0
LC16	Bwj	5-40+	sample lost from lab		S	0	sg, f-m, gr	5.3
LC17	A*	0-8	10 YR 3/2	10 YR 2/2	SL	10	1m, f, sbk	4.1
LC17	Bt	8-30+	10 YR 5/4	10 YR 3/3	SCL	25	1m, m, sbk	4.9
LC18	A	0-30	10 YR 3/2	10 YR 2/2	SL	1	1m, f, sbk	4.0
LC18	Bt	30-50+	10 YR 4/4	10 YR 3/2	SCL	25	2m, f, sbk	4.8
LC19	A	0-15	10 YR 4/4	10 YR 3/3	SiCL	25	1m, f, sbk	5.7
LC19	Bt	15-95+	10 YR 4/4	10 YR 3/3	SiCL	35	2m, f, sbk	5.0
LC20	A	0-2	10 YR 4/2	10 YR 3/2	SL	18	1m, f, sbk	5.8
LC20	Bw	2-20+	10 YR 4/3	10 YR 3/2	SL	18	1m, f, sbk	5.8
LC21	A	0-3	7.5 YR 4/4	7.5 YR 2/2	SL	10	1m, f, sbk	5.8
LC21	Bt	3-50+	7.5 YR 5/8	7.5 YR 4/6	SCL	25	2m, f, sbk	5.1
LC22	A	0-5	6.5 YR 4/4	6.5 YR 3/3	CL	20	1m, vf, sbk	5.9

Appendix 4.3. Selected physical and morphological properties of the soils studied.								
Sample #	Horizon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
LC22	Bt	5-30+	4 YR 4/4	4 YR 3/3	CL	>20	2m, vf, sbk	5.3
LC 23	A	0-4	7.5 YR 4/4	7.5 YR 3/3	SiCL	15	1m, f, sbk	5.2
LC23	Bw	4-25+	6.5 YR 4/4	6.5 YR 3/4	SiCL	15	1m, f, sbk	5.5
EO2	A	0-8	color not determined -		LS	<2	1m, f, gr	5.1
EO2	Bw	8-35+	sample lost from lab		S	0	sg, f, gr	6.3
EO7	A	0-6	10 YR 4/3	10 YR 3/3	L	15	1m, f, sbk	5.7
EO7	Bw	6-30+	10 YR 4/4	10 YR 3/3	L	15	1m, f, sbk	6.3
EO8	A	0-10	10 YR 4/2	10 YR 2/2	LS	4	1m, f, gr	6.2
EO8	Bw	10-35+	10 YR 6/5	10 YR 3/4	LS	4	1m, f, gr	7.0
EO9	A	0-10	10 YR 5/2	10 YR 3/2	LS	5	1m, f, gr	5.0
EO9	C	10-40+	10 YR 5/2	10 YR 3/2	LS	5	1m, f, gr	6.3
EO10	A	0-10	2.5 Y 4/2	2.5 Y 2.5/1	LS	5	1m, f, gr	5.6
EO10	C	10-30+	2.5 Y 6/4	2.5 Y 4/3	S	<5	1m,m-c, gr	6.2
EO11	A	0-5	2.5 Y 5/2	2.5 Y 3/2	LS	5	1m, f, gr	5.2
EO11	C	5-25+	2.5 Y 6/3	2.5 Y 4/3	S	<5	1m, f, gr	6.2
EO12	A	0-8	2.5 Y 5/2	2.5 Y 3/2	LS	5	1m, f, gr	5.8
EO12	C	8-25+	2.5 Y 6/4	2.5 Y 4/3	S	<5	1m, f, gr	6.7
EO13	A*	0-12	2.5 Y 5/3	2.5 Y 3/2	LS	8	1m, vf, gr	5.2
EO13	C	12-30+	2.5 Y 6/3	2.5 Y 4/4	S	3	1m, f, gr	5.9
EO14	A	0-8	10 YR 3/2	10 YR 3/2	LS	3	1m, f, gr	4.9
EO14	Bw	8-30+	10 YR 6/4	10 YR 4/4	LS	3	1m, f, gr	6.2
EO15	A	0-10	2.5 Y 4/3	2.5 Y 3/1	LS	4	1m, f, gr	5.2
EO15	C	10-25+	2.5 Y 6/4	2.5 Y 4/3	LS	4	1m, f, gr	6.1
EO16	A*	0-8	2.5 Y 4/2	2.5 Y 3/2	LS	4	1m, f, gr	5.4
EO16	C	8-30+	2.5 Y 6/4	2.5 Y 4/4	S	<4	1m, f, gr	6.2
EO17	A	0-8	2.5 Y 4/3	2.5 Y 3/2	LS	5	1m, f, gr	4.9
EO17	C	8-30+	2.5 Y 6/4	2.5 Y 4/4	S	<5	1m, f, gr	6.1
EO18	A	0-10	2.5 Y 4/3	2.5 Y 3/2	LS	3	1m, vf, gr	5.2
EO18	Bwj	10-25+	2.5 Y 6/4	2.5 Y 5/6	LS	3	1m, f, gr	6.0
EO20	A	0-5	2.5 Y 4/3	2.5 Y 3/2	LS	2	1m, f, gr	5.5
EO20	C	5-30+	2.5 Y 6/6	2.5 Y 3/3	S	<2	1m, f, gr	6.3
EO21	A	0-5	2.5 Y 4/2	2.5 Y 3/2	LS	7	1m, f, sbk	4.8
EO21	C	5-30+	2.5 Y 6/4	2.5 Y 3/3	S	<5	1m, f, gr	5.7
EO22	A	0-8	2.5 Y 5/3	2.5 Y 3/2	LS	4	1m, f, sbk	5.1
EO22	C	8-30+	2.5 Y 7/3	2.5 Y 4/4	S	<2	1m, f, gr	6.2
EO23	A	0-5	2.5 Y 4/2	2.5 Y 3/2	LS	5	1m, f, sbk	4.8
EO23	C	5-30+	2.5 Y 6/4	2.5 Y 4/6	S	<2	1m, f, gr	6.3
EO24	A	0-6	2.5 Y 4/3	2.5 Y 2/2	SL	8	1m, f, sbk	5.4
EO24	C	6-30+	10 YR 6/4	10 YR 4/3	LS	<5	1m, f, gr	5.7
EO25	A	0-8	2.5 Y. 5/3	2.5 Y. 3/2	LS	4	1m, f, gr	5.5
EO25	C	8-30+	2.5 Y 7/3	2.5 Y 5/4	S	<4	1m, f, gr	5.6
EO26	A	0-10	2.5 Y 4/2	2.5 Y 3/2	SL	6	1m, f, sbk	4.7
EO26	C	10-30+	2.5 Y 5/6	2.5 Y 3/2	LS	<5	1m, f, gr	5.6
EO27	A*	0-7	2.5 Y 4/3	2.5 Y 3/2	LS	4	1m, vf, gr	5.7
EO27	C	7-30+	2.5 Y 7/4	2.5 Y 4/6	S	<2	sg, vf, gr	6.5

Appendix 4.4. Selected physical and morphological properties of the soils studied.

Sample #	Horizon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
EO 30	A	0-2	2.5 Y 7/4	2.5 Y 4/4	S	<1	sg, f, gr	5.8
EO30	C	2-40+	2.5 Y 7/4	2.5 Y 4/4	S	<1	sg, f-m, gr	6.2
EO31	A	0-8	2.5 Y 4/3	2.5 Y 3/2	S	<2	sg, m-c, gr	5.1
EO31	C	8-25+	2.5 Y 7/3	2.5 Y 5/4	S	<2	sg, m-c, gr	6.3
EO32	A	0-5	2.5 Y 4/3	2.5 Y 3/2	S	<2	sg, m-c, gr	5.3
EO32	C	5-25+	2.5 Y 6/4	2.5 Y 4/4	S	<2	sg, m-c, gr	5.9
EO33	A	0-3	2.5 Y 4/3	2.5 Y 3/2	LS	5	1m,m, sbk	5.3
EO33	C	3-40+	2.5 Y 6/4	2.5 Y 3/3	S	<5	1m,m, sbk	6.4
EO34	A	0-3	2.5 Y 5/3	2.5 Y 3/2	LS	5	1m, f, sbk	6.0
EO34	C	3-30+	2.5 Y 6/4	2.5 Y 4/4	S	<5	1m, m, sbk	6.5
EO35	A	0-3	10 YR 5/4	10 YR 3/3	LS	8	1m,m-c, gr	6.8
EO35	Bw	3-10+	9 YR 5/4	9 YR 3/4	LS	8	1m, c, sbk	6.8
EO36	A	0-12	10 YR 3/3	10 YR 3/2	SL	7	1m, f, sbk	6.4
EO36	Bw	12-30+	10 YR 5/4	10 YR 3/3	SL	7	1m, f, sbk	6.4
KL1	A	0-1	10 YR 5/6	10 YR 4/4	L	5	1m, f, sbk	5.5
KL1	Bt	1-20+	7.5 YR 6/6	7.5 4/6	L	15	2m, f, sbk	5.7
KL2	A	0-10	2.5 Y 4/3	2.5 Y 3/2	LS	3	1m, f, sbk	6.2
KL2	Bw	10-45+	10 YR 5/6	10 YR 4/4	LS	3	1m, f, sbk	6.3
KL3	A	0-5	10 YR 6/6	10 YR 4/4	SL	10	1m, f, sbk	6.3
KL3	E**	5-50			SL	<10	1m, f, sbk	
KL3	Bt	50-200	10 YR 7/6	7.5 YR 5/8	SCL	30	2m, f, sbk	6.3
KL4	A	0-9	10 YR 4/4	10 YR 3/3	SL	5	1m, f, sbk	4.5
KL4	Bw	9-30+	2.5 YR 5/4	2.5 YR 3/3	SL	5	1m, f, sbk	4.9
KL5	A	0-3	10 YR 4/3	10 YR 2/2	LS	5	1m, f, sbk	5.3
KL5	Bt	3-25+	10 YR 6/5	10 YR 4/4	SL	8	1m, f, sbk	5.4
KL6	A	0-5	7.5 YR 5/6	7.5 YR 3/4	SL	15	1m, f, sbk	5.0
KL6	Bt	5-100+	5 YR 5/6	5 YR 4/6	CL	40	1m, f, sbk	5.6
KL7	A	0-12	2.5 Y 3/1	2.5 Y 2.5/1	SiL	5	1m, f, sbk	4.4
KL7	Bw	12-35+	2.5 Y 5/3	2.5 Y 3/2	SiL	5	1m, f, sbk	5.0
KL8	A	0-20	10 YR 3/3	10 YR 2/2	LS	8	1m, f, sbk	4.7
KL8	Bw	20-45+	10 YR 4/4	10 YR 3/4	LS	8	1m, f, sbk	5.2
KL9	A	0-5	7.5 YR 5/6	7.5 YR 3/3	SiCL	20	1m, f, sbk	4.5
KL9	Bt	5-15+	7.5 YR 5/6	7.5 YR 4/6	SiCL	30	2m, f, sbk	5.1
KL10	A	0-8	10 YR 4/3	10 YR 3/2	SL	10	1m, f, sbk	4.8
KL10	Bw	8-30+	10 YR 5/3	10 YR 3/3	SL	10	1m, f, sbk	5.4
KL11	A	0-5	10 YR 4/4	10 YR 3/2	LS	4	1m, f, gr	4.3
KL11	Bw	5-20+	10 YR 5/4	10 YR 3/4	LS	4	1m, f, sbk	4.9
KL12	A	0-10	10 YR 4/4	10 YR 3/2	SL	10	1m, f, sbk	5.8
KL12	Bt	10-40+	10 YR 6/6	10 YR 4/4	SL	15	1m, f, sbk	5.8
KL13	A	0-2	10 TR 3/3	10 YR 2/3	L	10	1m, f, sbk	5.3
KL13	Bw	2-25+	10 YR 4/4	10 YR 3/3	L	10	1m, f, sbk	5.5
KL14	A	0-3	10 YR 4/3	10 YR 3/2	L	10	1m, f, sbk	5.0
KL14	Bt	3-20+	10 YR 6/6	10 YR 5/6	L	15	1m, f, sbk	5.3
KL15	A	0-10	10 YR 4/3	10 YR 3/2	SL	8	1m, f, gr	5.2
KL15	Bw	10-30+	10 YR 5/4	10 YR 3/4	SL	8	1m, f, gr	5.2

Appendix 4.5. Selected physical and morphological properties of the soils studied.								
Sample #	Hori- zon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
KL16	A	0-3	5 YR 4/6	5 YR 3/3	L	20	1m, f, sbk	5.9
KL16	Bt	3-25+	2.5 YR 3/8	2.5 YR 3/4	CL	30	2m, f, sbk	5.9
KL17	A	0-5	10 YR 4/4	10 YR 3/3	LS	8	1m, f, sbk	4.8
KL17	Bt	5-20+	7.5 YR 4/4	7.5 YR 3/3	SCL	25	2m, f, sbk	5.2
KL18	A	0-7	2.5 Y 5/3	2.5 Y 3/2	L	25	1m, f, sbk	5.7
KL18	Bt	7-20+	10 YR 6/6	10 YR 5/6	CL	35	2m, f, sbk	5.7
KL19	A	0-10	10 YR 5/4	10 YR 3/4	L	10	1m, f, sbk	6.8
KL19	Bt	10-95+	10 YR 6/6	10 YR 4/6	CL	35	1m, f, sbk	6.1
KL20	A	0-10	10 YR 4/4	10 YR 3/3	L	15	1m, f, sbk	6.9
KL20	Bw	10-30+	7.5 YR 4/6	7.5 YR 3/3	L	15	1m, f, sbk	6.9
KL21	A	0-2	10 YR 4/4	10 YR 3/3	L	20	1m, f, sbk	5.5
KL21	Bt	2-40	7.5 YR 5/6	7.5 YR 4/6	CL	30	2m, f, sbk	6.7
KL22	A	0-10	10 YR 4/3	10 YR 3/2	SL	10	1m, f, sbk	5.4
KL22	Bw	10-40+	10 YR 6/6	10 YR 4/4	SL	10	1m, f, sbk	6.0
KL23	A	0-3	2.5 Y 5/3	2.5 Y 3/2	LS	3	1m, f, sbk	5.1
KL23	E**	3-15			SL	5	1m, f, sbk	
KL23	Bt	15-40+	2.5 Y 5/4	2.5 Y 4/4	SL	10	1m, f, sbk	5.2
KL24	A	0-3	10 YR 3/2	10 YR 2/2	SL	<5	1m, f, sbk	5.2
KL24	E**	3-8			SL	<5	1m, f, sbk	
KL24	Bt	8-30+	10 YR 4/4	10 YR 3/3	L	8	1m, f, sbk	4.9
KL25	A	0-6	10 YR 3/3	10 YR 2/2	SL	5	1m, f, sbk	5.2
KL25	Bw	6-30+	10 YR 4/4	10 YR 3/3	SL	5	1m, f, sbk	5.2
KL26	A	0-5	10 YR 4/3	10 YR 3/2	LS	4	1m, f, sbk	5.1
KL26	Bw	5-25+	10 YR 5/4	10 YR 3/3	LS	4	1m, f, sbk	5.0
KL27	A	0-4	7.5 YR 4/4	7.5 YR 3/3	L	10	1m, f, sbk	6.3
KL27	Bt	4-25+	7.5 YR 5/6	7.5 YR 4/4	L	25	1m, f, sbk	5.7
KL28	A	0-5	2.5 Y 4/3	2.5 Y 3/2	L	12	1m, f, sbk	5.9
KL28	Bw	5-30+	2.5 Y 5/3	2.5 Y 3/3	L	12	1m, f, sbk	5.7
KL30	A	0-5	5 YR 3/3	5 YR 2.5/2	L	18	1m, f, sbk	6.1
KL30	Bt	5-25	5 YR 4/6	5 YR 3/3	CL	30	2m, f, sbk	5.6
R1	A*	0-7	10 YR 5/2	10 YR 3/2	SL	10	1m, f, sbk	5.8
R1	Bw	7-35+	10 YR 6/2	10 YR 4/2	SL	10	1m, f, sbk	5.8
R2	A	0-7	2.5 YR 3/2	2.5 YR 3/1	SL	8	1m, f, gr	6.1
R2	Bw	7-35+	2.5 YR 7/2	2.5 YR 4/2	SL	8	1m, f, gr	5.6
R3	A	0-35	2.5 Y 4/3	2.5 Y 3/2	LS	5	1m, f, sbk	5.0
R3	Bw	35-50+	2.5 Y 6/4	10 YR 4/4	LS	5	1m, f, gr	5.7
R4	A*	0-4	10 YR 3/2	10 YR 2/1	LS	5	1m, f, gr	4.3
R4	Bw	4-65+	2.5 Y 5/4	10 YR 3/3	LS	5	1m, f, gr	4.9
R5	A	0-4	10 YR 4/4	7.5 YR 3/3	SL	12	1m, f, sbk	5.9
R5	Bw	4-35+	9 YR 5/6	7 YR 3.5/4	SL	12	1m, f, sbk	6.6
R6	A*	0-4	7.5 YR 4/4	7.5 YR 3/3	SL	15	1m, f, sbk	6.8
R6	Bw	4-35	7.5 YR 5/6	5 YR 3/4	SL	15	1m, f, sbk	6.2
R7	A	0-4	10 YR 5/2	10 YR 3/2	SL	10	1m, f, sbk	5.6
R7	Bw	4-40+	10 YR 6/4	10 YR 5/4	SL	10	1m, f, sbk	6.0
R8	A	0-8	N3	N3	C	>60	2m, f, sbk	6.8

Appendix 4.5. Selected physical and morphological properties of the soils studied.

Sample #	Horizon	Depth (cm)	Color (dry)	Color (wet)	Texture	Clay % (approx.)	Structure	pH
R8	B	8-47+	N3	N3	C	>60	2m, m, sbk	6.4
R9	A	0-6	10 YR 5/3	10 YR 4/3	SL	12	1m, f, gr	6.8
R9	Bw	6-40	10 YR 4/4	10 YR 3/3	SL	12	1m, f, sbk	6.5
R10	A	0-4	2.5 Y 6/3	2.5 Y 4/2	SL	15	1m, f, sbk	6.0
R10	Bt	5-50+	2.5 Y 5/4	2.5 Y 4/3	C	>50	2m, m, sbk	5.8
R11	A	0-10	10 YR 5/4	10 YR 3/2	SL	15	1m, f, sbk	6.1
R11	Bt	10-50+	10 YR 5/6	7.5 YR 4/6	SC	50	2m, m, sbk	6.1
R12	A*	0-5	10 YR 5/3	10 YR 3/2	SL	18	1m, f, sbk	5.6
R12	Bw	5-25	10 YR 6/4	10 YR 5/4	SL	18	1m, m, sbk	5.3
R13	A*	0-3	10 YR 3/3	10 YR 3/2	SCL	30	1m, f, sbk	5.0
R13	Bt	3-35+	5 YR 4/8	5 YR 4/6	SC	50	2m, f, sbk	5.7
R14	A	0-4	7.5 YR 6/5	7.5 YR 4/6	SCL	20	1m, f, sbk	5.8
R14	Bt	4-25	7.5 YR 6/6	7.5 YR 5/6	SCL	25	1m, f, sbk	5.6
R15	A	0-4	10 YR 5/5	7.5 YR 4/4	SCL	20	1m, f, sbk	6.3
R15	Bt	4-50+	9 YR 5/6	9 YR 4/6	SCL	30	1m, f, sbk	6.0

* Has 1-4 cm of the O horizon at the top. The O and A horizons were sampled together.

** The E horizon was identified and examined, but not sampled.

Key to soil texture determined in the field: C = clay, L = loam, S = sand, Si = silt.

Key to soil structure: sg = single grain, m = massive (modifiers 1, 2, 3 refer to weak, medium and strong, respectively); vf = very fine, f = fine, m = medium, c = coarse; gr = granular, sbk = subangular blocky (Soil Survey Staff, 1993).

APPENDIX 5. Quality Control/Quality Assurance data for Heavy Metals and Trace Elements in Soils of Southwest Oregon.

Appendix 5.1 Percent difference of concentration of metals in laboratory duplicate samples analyzed by inductively-coupled plasma atomic emission spectroscopy (ICPAES).

	Sample #	EO8-B1	EO13-B1	EO18A1	EO23-B1	EO31A1	EO34-B1	EO35-B1	KL2-A1	KL8-B1	KL12-B1
Metal											
Cd		13.7	--	--	21.7	--	3.0	1.4	--	21.4	11.1
Ba		2.6	0.71	0.4	0.2	6.6	0.9	15.7	0.8	3.4	0
Ni		0.4	13.2	0	13.1	3.3	3.6	8.2	4.4	8.4	1.7
Co		13.6	15.2	20.2	6.4	4.9	0.7	4.0	4.4	19.6	4.8
Cr		8.3	6.7	7.4	19.6	3.2	6.1	15.2	1.5	0.3	0.7
V		12.1	4.0	7.6	15.2	3.4	7.1	3.8	1.0	1.5	1.2
Cu		2.9	1.1	2.6	0.09	1.2	1.1	3.1	0.2	4.3	2.5
Zn		1.2	6.1	2.4	6.9	1.6	10.0	5.2	2.4	4.9	1.7
Fe		7.1	1.9	3.3	11.1	2.1	6.4	2.1	1.7	1.2	2.5
Mn		8.5	2.9	5.5	3.1	6.6	2.6	2.7	0.7	0.6	1.5
K		16.0	4.8	14.1	2.2	4.0	4.1	0.3	0.3	6.2	5.7
Al		0.3	1.4	0.4	0.8	1.5	4.7	5.2	0.3	0.7	2.4
Li		0	11.3	20.9	0	0	8.4	2.3	4.7	6.2	0.9
Ca		10.7	4.3	8.0	0.3	11.6	3.8	2.9	0.3	6.6	0.9
Na		37.9	4.3	9.4	4.8	4.9	2.4	2.2	7.2	5.8	0.1
Mg		6.7	14.0	1.9	15.4	1.4	2.1	4.8	0.8	1.3	1.6
La		14.6	2.1	0	11.5	6.1	0	4.1	3.8	2.4	7.0

Note: Percent difference of concentration of a metal in a duplicate pair is not calculated if the concentration in one or both the digests is below the laboratory's minimum reporting level.

Duplicate values are grouped as follows: 84% of the values fall within +/- 10% difference (considered good), 14% of the values fall within +/- 20% difference (acceptable) and only 2% of the values are above 20% limit. Calculation done as follows: % Difference = $[(A_1 - A_2) / (A_1 + A_2) / 2] * 100$, where A_1 and A_2 are concentrations in duplicate pair.

Appendix 5.2 Percent recovery in spiked samples analyzed by inductively-coupled plasma atomic emission spectroscopy (ICPAES).

	Sample #	EO8-B1	EO13-B1	EO18-A1	EO23-B1	EO31-A1	EO35-B1	KL2-A1	KL8-B1	KL12-B1	KL19-A1
<u>Metal</u>											
Ag		94.1	100	100.8	100.8	99.2	99.6	90	96.1	79.3	88.4
Mo		93.2	84.5	84.1	112.6	90.3	105.2	80.6	79.9	80.6	71.8
Cd		102.4	101.9	99.6	97.3	97	95.6	103.4	98.1	96	99.8
Ba		81.6	79.6	90.3	105.3	117.4	111.6	101.2	104.7	97.4	98.9
Be		106.4	113.7	106.7	96.7	97.2	96.3	101.7	104.1	104.5	106.7
Ni		97.5	97.1	97.7	103.3	100.3	103.7	98	100.6	94.3	104
Co		88.7	89.6	88.4	96.1	92.8	91.5	96.4	98.3	93.6	94.1
Cr		101.2	101.9	100	97.2	98.3	94.3	101.8	107.2	92.3	96.3
V		106.5	108.9	111.6	106.2	94.9	94.3	93.4	109.2	100.9	88.3
Cu		99.6	101.8	100.3	99.7	97.9	99.5	97.1	97.8	91.7	98.4
Zn		93.3	103.6	98	105.1	102	102.6	100.4	99.3	106.3	101.1

Note: Spike recovery values are grouped as follows: 84% of the values fall within 90-110% recovery range (considered good), 15% of the values fall within 80-120% recovery range (acceptable) and only 1% (just one value) below 80% recovery .

Calculation done as follows: % Spike Recovery = $\{[(A+S)-A]/S\} \times 100$, where (A+S) = concentration in spiked digest, A = concentration in unspiked digest, and S = concentration of spike added.

Appendix 5.3 Percent recovery of metal concentrations in RCRA Study 22 (an EPA-approved standard material) analyzed by inductively-coupled plasma atomic emission spectroscopy (ICPAES).

Al	Ba	Cd	Ca	Cr	Cu	Fe	Pb	Mg	Mn	Ni	K	Ag	Na	Zn
106.5	96.3	102.2	104.2	105.2	92.9	101.2	108.3	106.2	104	105.4	100.9	91.2	99.3	97.6

Note: Recovery for all metals are within 90-110% which is considered good.

Calculation done as follows: $(100/A) \times B$, where A = known concentration originally present and B = concentration recovered,

Appendix 5.4 Percent difference of Hg concentrations in duplicate samples analyzed by cold vapor atomic absorption spectroscopy (CVAAS).

Sample #	Percent Difference	Sample #	Percent Difference	Sample #	Percent Difference
EO1-A2	11.8	EO35-B1	9.1	LC18-B1	1.8
EO2-B1	3.2	KL1-A1	1.4	LC19-A1	1.3
EO7-A1	12.2	KL2-A1	8.4	LM6-B1	2.1
EO8-A1	2.2	KL3-B1	6.1	LM8-A1	0
EO9-B2	19.4	KL7-A1	0.4	LM10-B1	2.5
EO10-B1	10.2	KL8-B1	5.6	LM13-A1	2.1
EO11-A1	5.6	KL9-A2	0.9	LM14-B1	8
EO11-B2	9.1	KL10-B1	0	LM16-A1	1.1
EO12-A2	14	KL13-A1	2	LM19-B1	1.5
EO13-B1	11.1	KL18-A1	0.5	LM20-B1	2.2
EO14-B1	0	KL19-A1	2.1	LM22-A1	0
EO16-A1	3.7	KL20-B1	1.9	R3-B1	12
EO18-A1	0	KL23-A1	2.3	R6-A1	1
EO20-B1	9.3	KL26-B1	4.3	R2-A1	0.7
EO21-B1	6.3	KL28-A1	3.9	LC7-B1	2.9
EO23-B1	3.3	KL30-A1	1	LC10B-A1	2.4
EO24-A1	1.7	LC12-A1	0	LC23-B1	3.3
EO26-B1	15.4	LC12-B1	4.3	LM1-B1	1
EO31-A1	11.9	LC14-B1	8.7	LM3B-A1	0
EO32-A1	10.4	LC16-A1	2.6		

Note: Duplicate values are grouped as follows: 88% of the values fall within +/- 10% difference (considered good) and the remaining 12% of the values fall within +/- 20% difference (acceptable).

Appendix 5.5 Percent recovery of Hg in spiked samples analyzed by cold vapor atomic absorption spectroscopy (CVAAS).

Sample #	Percent Recover y	Sample #	Percent Recover y	Sample #	Percent Recover y	Sample #	Percent Recover y
EO2-A1	104	EO23-B1	103	KL23-B1	110	LM16-B1	103
EO2-B1	108	EO26-A1	106	KL27-A1	103	LM17-B1	105
EO7-B2	104	EO31-B1	98	KL30-B1	106	LM20-A1	103
EO8-A2	104	EO36-B1	100	LC3-A1	106	LM22-B1	100
EO9-B1	104	KL1-B1	90	LC12-B1	107	R3-A1	106
EO10-B2	107	KL3-A1	95	LC14-A1	102	R6-B1	104
EO11-B1	107	KL7-B1	87	LC16-B1	108	R12-B1	103
EO12-B1	107	KL11-A1	108	LC19-B1	103	LC4-B1	104
EO15-A1	97	KL13-B1	103	LM6-A1	99	LC8-A1	106
EO17-B1	99	KL16-A1	113	LM10-A1	102	LC10B-B1	107
EO18-B1	96	KL18-B1	108	LM13-B1	101	LC23-A1	103
EO22-B1	100	KL20-A1	104	LM14-A1	105	LM3B-B1	106

Note: Spiked recovery values are grouped as follows: 96% of the values fall within 90-110% recovery range (considered good) and the remaining 4% of the values fall within 80-120% recovery range (acceptable)

Appendix 5.6 Percent recovery of Hg in standard reference material (SRM) 2704 (from National Institute of Standards & Technology) and in standard Hg solution analyzed by cold vapor atomic absorption spectroscopy (CVAAS).

	Batch #	1	2	3	4	5	6	7	8	9	10	11
Hg Solution		98	98	98	98	99	98	101	100	98	101	98
SRM 2704		101	102	104	98	104	92	101	100	104	101	103

Note: Samples were analyzed for Hg in eleven batches. In each case the SRM 2704 and a standard Hg solution (with 2.5 ppb Hg) were run. Recovery are as follows: for Hg solution, 100% of the values are within 95-105% recovery range (considered good); for SRM 2704, 91% of the values are within 95-105% recovery range (considered good) and the remaining 9% of the values (just one value) are within 90-110% recovery range (acceptable).

Appendix 6.1 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
LM1	A	1.0	300	<1.0	25	35	99	182	46	152	57003	2540
LM1	B	<1.0	212	<1.0	27	42	122	223	48	140	68566	2055
LM2	A	<1.0	249	<1.0	17	19	28	129	21	102	43183	1913
LM2	B	<1.0	186	<1.0	17	20	30	145	25	93	44720	1215
LM3A	A	<1.0	792	<1.0	7	<6	4	14	11	131	11248	2924
LM3A	B	<1.0	446	<1.0	12	7	7	22	21	80	15469	450
LM3B	A	<1.0	309	<1.0	27	14	23	48	27	62	25215	1185
LM3B	B	<1.0	236	<1.0	23	14	21	49	31	60	25997	1047
LM4	A	<1.0	82	<1.0	8	6	6	27	16	56	13019	644
LM4	B	<1.0	51	<1.0	8	7	8	34	22	52	15918	443
LM5	A	<1.0	44	<1.0	6	<6	6	31	8	33	10250	315
LM5	B	<1.0	25	<1.0	11	9	10	49	29	37	17280	101
LM6	A	<1.0	107	<1.0	6	<6	5	29	7	44	10212	695
LM6	B	<1.0	40	<1.0	8	8	7	45	12	35	15880	195
LM7	A	<1.0	155	<1.0	35	17	30	83	30	71	34372	756
LM7	B	<1.0	170	<1.0	38	19	31	91	30	69	37932	789
LM8	A	<1.0	523	<1.0	10	35	8	96	13	148	38650	5685
LM8	B	<1.0	206	<1.0	6	15	13	138	31	108	63360	962
LM9	A	<1.0	39	<1.0	8	<6	4	28	7	27	8314	336
LM9	B	<1.0	21	<1.0	5	7	6	47	8	30	16001	246
LM10	A	<1.0	46	<1.0	8	6	5	39	11	38	14251	498
LM10	B	<1.0	32	<1.0	7	6	5	41	11	31	14274	279
LM11	A	<1.0	66	<1.0	5	6	3	31	8	52	13087	2625
LM11	B	<1.0	27	<1.0	4	<6	4	31	8	40	12642	176
LM12	A	<1.0	272	<1.0	28	23	21	95	70	94	41629	1596
LM12	B	<1.0	254	<1.0	30	27	25	110	81	94	49622	1525
LM13	A	<1.0	306	<1.0	27	19	23	67	28	85	27926	2774
LM13	B	<1.0	194	<1.0	41	32	41	118	48	75	48039	1465

Appendix 6.2 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
LM1	A	1039	56999	10	6830	178	6232	8	104	<20	0.15
LM1	B	924	71682	12	3322	136	7513	7	25	<20	0.08
LM2	A	1346	50985	11	7893	171	5308	9	22	<20	0.15
LM2	B	1170	54262	13	4202	170	5187	9	<10	<20	0.07
LM3A	A	888	18313	11	6773	338	1123	10	13	<20	0.14
LM3A	B	727	33387	23	2825	756	1448	15	<10	<20	0.05
LM3B	A	1031	43002	13	6645	617	2563	13	<10	<20	0.10
LM3B	B	664	49387	16	2350	694	1815	19	<10	<20	0.04
LM4	A	649	20954	5	1948	445	1520	<5	<10	<20	0.06
LM4	B	438	27380	9	1598	640	2038	9	10	<20	0.08
LM5	A	469	8580	<5	2101	679	689	<5	10	<20	0.06
LM5	B	430	27338	6	3021	1188	1498	<5	<10	<20	0.04
LM6	A	452	13442	<5	2254	478	841	<5	<10	<20	0.06
LM6	B	394	23427	7	1396	768	1035	<5	<10	<20	0.04
LM7	A	2285	32096	8	13066	1353	8385	11	<10	<20	0.08
LM7	B	1437	35235	8	9980	1357	9043	13	<10	<20	0.05
LM8	A	723	34515	6	9419	136	3419	5	20	<20	0.17
LM8	B	776	59463	8	5888	59	7446	<5	<10	<20	0.09
LM9	A	373	4634	<5	2194	357	545	<5	20	<20	0.14
LM9	B	214	12641	<5	998	557	791	<5	10	<20	0.06
LM10	A	310	20868	<5	2371	607	988	5	<10	<20	0.05
LM10	B	251	17406	<5	2139	722	960	6	<10	<20	<0.04
LM11	A	407	13415	<5	1886	471	784	<5	<10	<20	0.08
LM11	B	240	14925	<5	1067	502	688	<5	10	<20	0.04
LM12	A	2616	71482	11	14618	151	13829	7	<10	<20	0.14
LM12	B	1774	79896	13	10812	157	15300	8	<10	<20	0.08
LM13	A	857	47688	5	17580	123	2665	5	<10	<20	0.26
LM13	B	725	75682	9	3028	149	4499	11	<10	<20	<0.04

Appendix 6.3 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
LM14	A	<1.0	475	<1.0	63	31	63	116	52	151	55108	4571
LM14	B	1.0	484	<1.0	82	46	97	176	73	140	82430	2077
LM15	A	<1.0	472	<1.0	76	34	89	150	54	93	60452	2313
LM15	B	<1.0	525	<1.0	86	40	101	170	66	84	68459	1206
LM16	A	<1.0	284	<1.0	36	36	44	135	52	93	51558	1222
LM16	B	<1.0	356	<1.0	43	39	51	150	66	87	59114	1223
LM17	A	<1.0	136	<1.0	29	18	26	78	28	74	31736	730
LM17	B	<1.0	157	<1.0	35	20	29	88	33	72	36824	783
LM19	A	<1.0	246	<1.0	<4	6	4	14	7	68	20052	1209
LM19	B	<1.0	306	1.0	<4	7	4	16	9	103	21199	2147
LM20	A	<1.0	280	<1.0	8	9	11	27	12	113	21970	2000
LM20	B	<1.0	264	<1.0	12	9	12	30	12	127	23409	1913
LM21	A	<1.0	133	<1.0	25	14	17	46	21	83	25539	2399
LM21	B	<1.0	117	<1.0	35	17	22	62	31	80	31065	1134
LM22	A	<1.0	246	<1.0	19	13	17	64	24	106	26162	2800
LM22	B	<1.0	136	<1.0	24	14	20	78	37	64	28580	639
LC1	A	<1.0	98	<1.0	15	29	36	82	30	42	30541	1276
LC1	B	<1.0	75	<1.0	13	34	32	77	29	35	30496	1140
LC2	A	<1.0	252	<1.0	15	52	28	212	125	110	80890	2831
LC2	B	<1.0	162	<1.0	10	17	24	220	150	81	79319	470
LC3	A	<1.0	143	<1.0	7	8	16	34	11	26	16789	1216
LC3	B	<1.0	64	<1.0	9	8	21	44	13	25	19378	187
LC4	A	<1.0	209	<1.0	9	10	15	27	5	43	15727	730
LC4	B	<1.0	128	<1.0	12	7	30	44	12	42	25361	174
LC5	A	<1.0	206	1.0	100	30	61	85	71	123	53454	5279
LC5	B	<1.0	188	1.0	104	32	68	97	78	132	57709	4951
LC6	A	1.2	68	<1.0	56	47	37	218	148	101	74040	1248
LC6	B	1.1	59	<1.0	65	50	41	238	193	99	81995	1252

Appendix 6.4 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
LM14	A	1499	77558	9	15265	135	1612	11	<10	<20	0.17
LM14	B	1071	103515	12	2913	122	1683	17	<10	<20	0.05
LM15	A	1712	85913	13	5748	206	2181	13	<10	<20	0.07
LM15	B	1353	95618	16	3069	181	2396	16	<10	<20	0.04
LM16	A	1853	58412	11	3861	216	2893	17	<10	<20	0.07
LM16	B	1861	74450	14	3879	250	3129	21	<10	<20	<0.04
LM17	A	1860	30688	7	15923	1416	7817	10	<10	<20	0.08
LM17	B	1121	34930	8	12209	1689	8823	12	<10	<20	0.06
LM19	A	941	18506	<5	3552	117	1206	23	10	<20	0.09
LM19	B	1050	24374	7	2653	114	1319	18	<10	<20	0.05
LM20	A	669	25643	8	3996	181	1517	7	18	<20	0.10
LM20	B	515	31016	12	1261	185	1605	9	12	<20	0.07
LM21	A	520	31915	7	5110	409	4038	5	<10	<20	0.17
LM21	B	390	44482	8	2780	603	5277	13	<10	<20	0.06
LM22	A	470	31486	8	3389	371	2375	6	<10	<20	0.08
LM22	B	344	42274	9	2192	393	3456	5	<10	<20	0.06
LC1	A	766	32045	6	3042	141	2565	20	<10	<20	<0.04
LC1	B	446	29862	5	2575	127	2316	17	<10	<20	<0.04
LC2	A	963	56248	6	4589	92	6134	20	<10	<20	0.05
LC2	B	517	82482	5	4183	82	10958	8	<10	<20	<0.04
LC3	A	826	14574	5	3081	60	1317	13	40	<20	0.09
LC3	B	780	21008	8	134	53	1520	15	<10	<20	<0.04
LC4	A	890	18856	8	2906	73	1328	10	<10	<20	0.06
LC4	B	1105	41695	15	952	59	2088	10	10	<20	0.05
LC5	A	4666	35246	48	5209	88	10561	9	16	<20	0.07
LC5	B	5022	40154	54	4073	97	11308	10	14	<20	0.06
LC6	A	1335	38245	5	15137	1511	11419	5	<10	<20	0.06
LC6	B	518	48781	5	14619	2341	13405	6	<10	<20	<0.04

Appendix 6.5 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
LC7	A	<1.0	148	<1.0	91	22	74	59	28	63	32465	1522
LC7	B	<1.0	118	<1.0	121	30	99	69	35	71	42182	1228
LC8	A	1.0	281	<1.0	54	16	51	39	17	87	28374	1454
LC8	B	1.0	190	<1.0	61	19	62	48	20	82	32982	922
LC9	A	<1.0	232	1.0	22	19	30	33	27	85	30787	728
LC9	B	<1.0	176	1.3	25	22	39	44	35	95	38071	525
LC10A	A	1.0	193	<1.0	22	25	37	110	31	73	37471	1631
LC10A	B	1.1	196	<1.0	30	38	58	171	44	85	59116	1857
LC10B	A	<1.0	218	<1.0	23	7	46	65	17	76	35558	803
LC10B	B	<1.0	150	<1.0	27	8	54	78	19	78	41380	500
LC11	A	<1.0	119	<1.0	38	15	38	57	25	131	28956	941
LC11	B	<1.0	99	<1.0	32	13	33	54	20	86	26666	732
LC12	A	<1.0	125	<1.0	17	9	34	40	11	67	21565	353
LC12	B	<1.0	108	<1.0	17	10	37	43	9	60	23045	287
LC13	A	<1.0	8	<1.0	4	<6	8	6	<2	10	3844	41
LC13	B	<1.0	34	<1.0	<4	<6	9	6	4	19	3846	30
LC14	A	<1.0	34	<1.0	<4	<6	9	7	4	19	2648	52
LC14	B	<1.0	10	<1.0	5	<6	9	7	<2	11	4538	32
LC15	A	<1.0	36	<1.0	11	<6	28	34	19	31	17366	235
LC15	B	<1.0	73	<1.0	27	11	57	74	33	81	40980	1363
LC16	A	<1.0	14	<1.0	<4	<6	7	8	2	15	3985	24
LC16	B	<1.0	7	<1.0	<4	<6	6	4	<2	8	3066	21
LC17	A	<1.0	24	<1.0	4	<6	12	20	9	16	7685	62
LC17	B	<1.0	36	<1.0	13	8	39	55	21	48	29401	186
LC18	A	<1.0	22	<1.0	5	<6	28	57	12	18	20720	31
LC18	B	<1.0	23	<1.0	5	<6	53	72	7	23	35875	49

Appendix 6.6 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
LC7	A	2289	24623	23	6822	109	6508	8	<10	<20	0.08
LC7	B	2515	34060	31	877	94	6845	11	<10	<20	<0.04
LC8	A	2782	24526	27	6109	124	6850	13	<10	<20	0.06
LC8	B	2488	29474	34	2942	130	7881	15	10	<20	0.04
LC9	A	2646	26201	22	4148	96	4926	26	12	<20	0.09
LC9	B	2948	35519	25	1789	84	5632	33	16	<20	0.08
LC10A	A	1567	23752	5	8279	120	3186	8	<10	<20	0.16
LC10A	B	1704	35983	8	4369	149	4191	11	<10	<20	0.10
LC10B	A	1132	56172	28	1604	78	2284	16	<10	<20	0.06
LC10B	B	1025	67634	33	793	81	2457	13	<10	<20	0.05
LC11	A	1544	21845	16	6197	350	7059	13	16	<20	0.08
LC11	B	1137	19743	13	5933	444	6266	11	11	<20	0.04
LC12	A	2099	23010	19	4505	183	6629	14	25	<20	0.07
LC12	B	2016	26359	23	2384	156	7088	17	<10	<20	0.04
LC13	A	298	2689	6	640	129	895	<5	<10	<20	<0.04
LC13	B	315	2752	7	576	129	821	<5	<10	<20	<0.04
LC14	A	530	2541	<5	1888	241	704	<5	10	<20	0.14
LC14	B	262	5001	9	465	105	756	<5	<10	<20	<0.04
LC15	A	475	16442	5	1068	206	1187	5	10	<20	0.17
LC15	B	605	55751	26	587	194	2063	13	<10	<20	0.14
LC16	A	369	4016	<5.0	1151	138	620	<5	<10	<20	0.06
LC16	B	264	2586	6	411	98	591	<5	<10	<20	<0.04
LC17	A	896	6246	<5	1553	362	1419	7	<10	<20	0.19
LC17	B	1176	29679	33	292	190	2935	14	<10	<20	0.14
LC18	A	861	17362	7	638	405	1551	7	14	<20	0.37
LC18	B	818	41250	22	429	175	1655	9	<10	<20	0.25

Appendix 6.7 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
LC19	A	<1.0	138	<1.0	71	60	95	207	134	100	72999	1442
LC19	B	1.1	159	<1.0	122	51	159	248	188	86	97686	922
LC20	A	<1.0	152	<1.0	170	26	111	69	43	105	35746	598
LC20	B	<1.0	137	<1.0	154	27	107	69	37	85	32746	654
LC21	A	<1.0	285	<1.0	81	17	96	74	22	66	33971	2408
LC21	B	<1.0	124	<1.0	112	22	135	94	25	51	45439	413
LC22	A	<1.0	193	<1.0	9	22	21	133	51	62	78726	3495
LC22	B	<1.0	124	<1.0	9	23	22	142	61	60	82363	2555
LC23	A	<1.0	118	<1.0	117	45	120	117	65	105	78302	1988
LC23	B	1.0	91	<1.0	163	56	161	150	90	136	98169	1765
EO2	A	<1.0	105	<1.0	29	11	12	38	15	61	19180	559
EO2	B	<1.0	133	<1.0	33	13	14	47	18	46	23288	430
EO7	A	<1.0	234	<1.0	23	17	20	79	29	83	27200	779
EO7	B	1.0	256	<1.0	40	28	36	142	51	82	45716	943
EO8	A	<1.0	350	<1.0	19	8	7	40	16	161	15618	4600
EO8	B	<1.0	109	<1.0	24	12	11	56	24	104	22707	581
EO9	A	<1.0	92	<1.0	10	8	10	48	13	59	14220	699
EO9	B	<1.0	148	<1.0	15	11	16	75	24	45	21466	421
EO10	A	<1.0	100	<1.0	5	<6	3	18	8	36	7034	327
EO10	B	<1.0	73	<1.0	5	<6	4	31	11	30	10417	145
EO11	A	<1.0	70	<1.0	5	<6	4	23	10	38	8190	292
EO11	B	<1.0	76	<1.0	5	<6	4	27	12	29	9475	196
EO12	A	<1.0	67	<1.0	6	<6	4	24	9	32	8340	287
EO12	B	<1.0	71	<1.0	5	<6	4	25	10	91	8615	135
EO13	A	<1.0	85	<1.0	9	<6	5	31	11	52	9812	533
EO13	B	<1.0	112	<1.0	12	6	7	42	15	35	13010	214
EO14	A	<1.0	96	<1.0	7	<6	5	18	18	27	8402	232
EO14	B	<1.0	106	<1.0	8	<6	5	21	20	21	10204	210

Appendix 6.8 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
LC19	A	1622	73145	14	5534	265	11425	7	<10	<20	0.11
LC19	B	688	100324	18	1012	311	13848	5	<10	<20	0.06
LC20	A	3124	33024	21	8191	152	10809	10	51	<20	0.14
LC20	B	2666	32262	21	5931	145	10175	11	40	<20	0.13
LC21	A	1065	35732	20	4972	75	4714	8	10	<20	0.10
LC21	B	1284	52244	26	376	82	6420	13	<10	<20	0.08
LC22	A	631	53649	5	3884	61	1498	11	<10	<20	0.10
LC22	B	379	61317	6	2031	57	1468	12	<10	<20	0.07
LC23	A	947	61316	18	3051	198	7410	21	<10	<20	0.21
LC23	B	822	85402	25	608	163	8673	27	<10	<20	0.11
EO2	A	607	21690	6	3642	710	3924	6	10	<20	0.05
EO2	B	567	25605	8	3137	719	4798	8	<10	<20	<0.04
EO7	A	1317	31794	8	7077	328	2565	9	<10	<20	0.07
EO7	B	1875	58961	14	5061	560	3570	15	<10	<20	<0.04
EO8	A	807	24723	5	12354	268	2202	<5	10	<20	0.17
EO8	B	623	38927	8	2531	531	2531	6	<10	<20	<0.04
EO9	A	1042	14861	<5	3976	330	1282	<5	10	<20	0.09
EO9	B	1094	25721	7	3768	691	1567	7	<10	<20	<0.04
EO10	A	513	13198	<5	2787	446	879	<5	10	<20	0.04
EO10	B	336	18549	6	1937	601	972	5	<10	<20	<0.04
EO11	A	616	13820	<5	2642	519	1003	<5	<10	<20	0.04
EO11	B	449	17247	5	2292	627	1148	5	<10	<20	<0.04
EO12	A	541	13830	<5	3341	628	1164	<5	<10	<20	0.04
EO12	B	404	13989	<5	2523	600	967	<5	10	<20	<0.04
EO13	A	691	14823	<5	4001	625	1210	<5	10	<20	0.07
EO13	B	660	20113	5	3831	914	1595	5	<10	<20	<0.04
EO14	A	560	16879	6	3281	666	1564	5	<10	<20	0.04
EO14	B	513	20453	6	3168	1040	1846	6	<10	<20	<0.04

Appendix 6.9 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
EO15	A	<1.0	95	<1.0	8	<6	5	31	8	49	9874	709
EO15	B	<1.0	49	<1.0	8	<6	5	34	13	29	10583	182
EO16	A	<1.0	74	<1.0	6	6	5	35	10	53	12226	673
EO16	B	<1.0	85	<1.0	7	7	6	47	14	36	15507	251
EO17	A	<1.0	54	<1.0	5	<6	5	22	10	35	8317	514
EO17	B	<1.0	36	<1.0	7	<6	5	30	13	28	10359	236
EO18	A	<1.0	45	<1.0	7	<6	5	38	6	41	11326	383
EO18	B	<1.0	29	<1.0	7	6	5	38	13	30	11704	157
EO20	A	<1.0	183	<1.0	7	<6	3	20	7	48	6965	907
EO20	B	<1.0	68	<1.0	8	<6	5	31	12	30	9857	163
EO21	A	<1.0	58	<1.0	11	<6	4	20	9	46	9170	369
EO21	B	<1.0	143	<1.0	17	7	6	27	14	43	12944	352
EO22	A	<1.0	123	<1.0	8	6	4	26	8	64	9755	976
EO22	B	<1.0	97	<1.0	10	6	5	32	12	35	11430	137
EO23	A	<1.0	84	<1.0	9	6	5	35	9	43	11824	485
EO23	B	<1.0	46	<1.0	12	7	7	45	10	34	14524	178
EO24*	A1	<1.0	105	<1.0	12	6	5	31	19	92	11783	3235
EO24	A2	<1.0	116	<1.0	11	7	6	32	18	89	13079	2854
EO24	B1	<1.0	81	<1.0	19	9	10	46	36	42	16346	143
EO24	B2	<1.0	69	<1.0	20	10	10	51	38	39	18016	172
EO25	A	<1.0	148	<1.0	7	<6	4	23	10	66	9654	851
EO25	B	<1.0	95	<1.0	8	<6	5	24	13	45	10041	153
EO26*	A1	<1.0	52	<1.0	15	6	6	29	22	26	10219	451
EO26	A2	<1.0	52	<1.0	14	6	7	30	23	24	11505	465
EO26	B1	<1.0	61	<1.0	20	7	8	37	27	23	12490	165
EO26	B2	<1.0	49	<1.0	21	7	8	37	25	21	13894	184
EO27	A	<1.0	122	<1.0	13	7	4	36	27	49	12603	3049
EO27	B	<1.0	122	<1.0	13	7	7	35	27	49	14215	124
EO30*	A1	<1.0	86	<1.0	11	<6	5	21	11	32	8793	248

Appendix 6.10 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
EO15	A	476	14709	<5	3944	601	993	<5	10	<20	0.06
EO15	B	253	16323	5	2493	666	939	6	<10	<20	<0.04
EO16	A	615	13953	<5	3180	511	1148	<5	<10	<20	0.06
EO16	B	555	17556	5	2868	770	1360	6	<10	<20	<0.04
EO17	A	391	16465	<5	2314	470	805	<5	<10	<20	0.09
EO17	B	244	20011	5	2372	701	1017	5	<10	<20	<0.04
EO18	A	247	15862	<5	1997	475	867	<5	<10	<20	<0.04
EO18	B	178	17933	<5	1950	606	1030	6	<10	<20	<0.04
EO20	A	301	11973	<5	4500	643	776	<5	<10	<20	0.06
EO20	B	273	19287	5	3742	936	1026	<5	<10	<20	<0.04
EO21	A	513	11116	<5	3657	612	1108	<5	<10	<20	0.08
EO21	B	346	17218	7	2647	781	1867	6	<10	<20	<0.04
EO22	A	562	14818	5	3757	747	987	<5	<10	<20	0.04
EO22	B	397	16822	6	3261	864	1080	5	<10	<20	<0.04
EO23	A	275	15015	5	3108	576	1217	<5	10	<20	0.04
EO23	B	234	19087	6	2823	786	1544	5	<10	<20	<0.04
EO24*	A1	660	14629	<5	5630	638	1718	<5	14	<20	0.09
EO24	A2	775	14950	5	5136	609	1845	5	12	<20	0.09
EO24	B1	456	23871	6	4354	947	2513	6	<10	<20	0.12
EO24	B2	398	24430	6	4421	1055	2473	6	<10	<20	0.11
EO25	A	457	13875	7	2282	410	912	<5	10	<20	0.04
EO25	B	426	14857	7	1480	635	916	<5	<10	<20	0.04
EO26*	A1	513	20340	<5	9111	1491	2514	<5	<10	<20	0.07
EO26	A2	618	22611	<5	9696	1675	2892	5	<10	<20	0.08
EO26	B1	472	25175	<5	9234	1739	3173	<5	<10	<20	<0.04
EO26	B2	445	26237	<5	9542	1835	3681	5	<10	<20	<0.04
EO27	A	836	17095	8	4664	561	2055	5	<10	<20	0.06
EO27	B	506	18256	10	3432	655	1915	10	<10	<20	0.06
EO30*	A1	492	13597	<5	3968	767	1313	<5	<10	<20	<0.04

Appendix 6.11 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
EO30	A2	<1.0	102	<1.0	11	<6	5	19	12	30	8654	277
EO30	B1	<1.0	97	<1.0	13	6	7	31	15	24	10912	137
EO30	B2	<1.0	100	<1.0	12	6	6	30	15	26	11228	151
EO31	A	<1.0	203	<1.0	8	<6	4	25	9	51	8708	677
EO31	B	<1.0	77	<1.0	11	7	8	46	17	32	13675	164
EO32*	A1	<1.0	198	<1.0	10	6	5	29	11	63	10938	1010
EO32	A2	<1.0	162	<1.0	6	5	4	25	11	70	10744	1244
EO32	B1	<1.0	138	<1.0	13	7	7	37	20	41	13445	191
EO32	B2	<1.0	111	<1.0	11	8	7	40	20	38	15088	211
EO33	A	<1.0	113	<1.0	14	6	8	32	13	68	11845	757
EO33	B	<1.0	189	<1.0	44	15	30	51	30	50	26278	473
EO34	A	<1.0	182	<1.0	43	15	28	49	28	74	25527	635
EO34	B	<1.0	205	<1.0	52	18	34	62	30	52	29284	438
EO35*	A1	<1.0	388	<1.0	29	19	12	83	47	78	36177	1220
EO35	A2	<1.0	439	<1.0	28	21	12	77	48	91	34962	1544
EO35	B1	<1.0	358	<1.0	30	23	14	93	56	66	39721	774
EO35	B2	<1.0	331	<1.0	32	23	18	100	55	67	40669	657
EO36	A	<1.0	432	<1.0	31	18	22	69	37	92	29298	1380
EO36	B	1.0	456	<1.0	42	26	34	109	53	78	42238	894
KL1	A	<1.0	174	<1.0	28	25	24	136	35	95	46241	2096
KL1	B	1.0	172	<1.0	22	34	32	188	51	89	62989	1643
KL2	A	<1.0	343	<1.0	22	7	23	29	7	61	14538	2261
KL2	B	<1.0	115	<1.0	19	9	31	42	11	47	18333	741
KL3	A	<1.0	138	<1.0	8	25	12	169	111	87	48823	1825
KL3	B	<1.0	59	<1.0	7	25	17	202	136	72	57995	848
KL4	A	<1.0	185	<1.0	34	13	40	57	32	100	33887	2328
KL4	B	<1.0	172	<1.0	42	17	55	72	57	139	40417	1738
KL5	A	<1.0	287	<1.0	77	17	67	52	16	89	29774	2857

Appendix 6.12 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
EO30	A2	521	13791	<5	3502	604	1314	<5	<10	<20	<0.04
EO30	B1	378	14848	<5	3947	981	1447	<5	<10	<20	<0.04
EO30	B2	375	15009	<5	3777	944	1607	<5	<10	<20	<0.04
EO31	A	941	12544	5	5261	566	1223	<5	<10	<20	0.06
EO31	B	564	17901	6	3800	1039	1279	5	10	<20	<0.04
EO32*	A1	453	14686	7	3181	538	1120	<5	10	<20	0.07
EO32	A2	414	16309	7	2832	493	990	<5	<10	<20	0.06
EO32	B1	438	18999	9	2516	762	1507	8	<10	<20	<0.04
EO32	B2	465	21346	11	2867	904	1555	10	<10	<20	<0.04
EO33	A	634	16525	5	4436	655	1333	<5	<10	<20	0.06
EO33	B	1341	34967	9	3880	730	5079	7	<10	<20	0.04
EO34	A	1546	34073	9	4366	778	4927	6	<10	<20	<0.04
EO34	B	1421	38105	10	4136	830	5988	8	<10	<20	<0.04
EO35*	A1	1481	44100	12	6559	320	1960	10	<10	<20	0.04
EO35	A2	2009	42637	11	5977	299	2094	10	<10	<20	0.04
EO35	B1	970	49053	13	3118	397	2217	12	<10	<20	<0.04
EO35	B2	891	51378	13	3067	458	2321	12	<10	<20	<0.04
EO36	A	1771	42986	10	8838	210	2373	9	10	<20	0.06
EO36	B	1489	60563	13	3586	347	2893	13	<10	<20	<0.04
KL1	A	1775	46228	10	7698	100	4827	9	<10	<20	0.11
KL1	B	1706	64041	14	4418	123	6039	14	<10	<20	0.08
KL2	A	1085	26399	9	5430	106	2119	16	<10	<20	0.05
KL2	B	1141	35349	11	1997	124	2414	13	<10	<20	<0.04
KL3	A	1549	47179	8	17184	106	5536	<5	<10	<20	0.05
KL3	B	928	59727	11	12457	168	6327	<5	<10	<20	<0.04
KL4	A	1721	37090	28	1700	84	5305	5	14	<20	0.17
KL4	B	1534	54063	41	1116	96	6571	6	<10	<20	0.18
KL5	A	2445	24253	25	5281	81	8116	5	<10	<20	0.12

Appendix 6.13 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
KL5	B	<1.0	145	<1.0	112	24	96	73	26	88	42675	1368
KL6	A	1.0	163	<1.0	57	30	87	225	67	100	71957	3088
KL6	B	<1.0	165	<1.0	86	43	167	281	112	128	96329	1871
KL7*	A1	<1.0	65	<1.0	10	<6	19	23	8	11	5600	36
KL7	A2	<1.0	78	<1.0	12	<6	21	24	11	12	6019	54
KL7	B1	<1.0	63	<1.0	10	<6	33	43	7	11	9925	42
KL7	B2	<1.0	62	<1.0	10	<6	36	45	7	13	10511	48
KL8	A	<1.0	34	<1.0	25	6	77	65	13	29	25055	196
KL8	B	<1.0	36	<1.0	26	<6	81	74	9	24	28679	127
KL9	A	<1.0	87	<1.0	322	31	228	103	27	89	61486	327
KL9	B	1.0	80	<1.0	351	31	252	163	43	87	73605	270
KL10	A	<1.0	137	<1.0	94	22	104	76	45	78	30964	1036
KL10	B	<1.0	141	<1.0	116	22	124	78	53	99	39984	729
KL11	A	<1.0	174	<1.0	54	14	70	76	28	73	30281	1408
KL11	B	<1.0	160	<1.0	100	23	108	113	57	112	43822	1450
KL12	A	1.0	219	<1.0	51	26	52	157	59	91	49606	1226
KL12	B	<1.0	246	<1.0	56	26	61	173	61	97	56487	1122
KL13	A	<1.0	235	<1.0	47	8	117	74	8	48	27436	636
KL13	B	<1.0	181	<1.0	60	12	149	95	9	53	34681	454
KL14	A	<1.0	350	<1.0	46	12	44	32	18	106	19102	2872
KL14	B	<1.0	202	<1.0	35	6	54	47	22	62	25646	526
KL15	A	<1.0	436		1.0 48	11	35	39	31	131	24581	1609
KL15	B	<1.0	311		1.3 58	18	52	66	63	140	37107	601
KL16	A	1.0	187	<1.0	1132	95	1302	155	53	98	98652	3676
KL16	B	1.5	146	<1.0	1530	135	1814	215	81	119	137939	3345
KL17	A	<1.0	55	<1.0	641	66	562	78	28	75	46415	1144
KL17	B	1.1	32	<1.0	1481	175	1226	151	51	75	94215	1472
KL18	A	<1.0	404	<1.0	61	33	33	145	47	196	42255	4535

Appendix 6.14 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
KL5	B	2649	36493	35	1140	82	10379	9	<10	<20	0.04
KL6	A	698	57938	23	4024	83	4468	<5	<10	<20	0.19
KL6	B	584	97974	41	1740	83	4142	6	<10	<20	0.06
KL7*	A1	501	7474	<5	1906	260	1123	6	25	<20	0.17
KL7	A2	601	8430	<5	2603	301	1370	7	28	<20	0.16
KL7	B1	558	21398	15	524	140	951	9	<10	<20	0.06
KL7	B2	768	23764	14	550	159	1003	11	<10	<20	0.06
KL8	A	745	29237	23	1914	169	3314	5	<10	<20	0.14
KL8	B	604	31173	24	1117	193	2336	9	<10	<20	0.11
KL9	A	512	43065	48	1027	107	14470	5	<10	<20	0.17
KL9	B	779	69670	52	726	90	16352	6	<10	<20	0.10
KL10	A	1608	27195	22	6694	144	14216	9	<10	<20	0.11
KL10	B	2014	35663	35	3277	127	16633	13	<10	<20	0.07
KL11	A	1419	24499	18	4680	119	9937	6	<10	<20	0.14
KL11	B	1850	42084	34	4540	150	14555	9	<10	<20	0.10
KL12	A	1596	41497	19	5636	273	14187	15	<10	<20	0.23
KL12	B	1112	47073	23	3711	292	16076	13	<10	<20	0.24
KL13	A	811	26229	17	4356	242	3532	7	11	<20	0.14
KL13	B	788	35427	21	2722	218	3866	11	<10	<20	0.05
KL14	A	1834	18276	9	6466	96	3061	<5	378	<20	0.16
KL14	B	2070	29872	17	1045	61	2344	<5	10	<20	0.06
KL15	A	3902	26180	15	5699	95	3944	<5	35	<20	0.11
KL15	B	5535	45888	35	1235	118	5680	12	12	<20	0.09
KL16	A	783	54559	12	6174	57	6604	5	10	<20	0.11
KL16	B	731	75800	16	1777	47	7805	7	<10	<20	0.07
KL17	A	862	23249	<5	7117	146	11805	<5	10	<20	0.17
KL17	B	219	46498	6	6111	129	21446	<5	<10	<20	0.05
KL18	A	965	45086	22	5928	103	14242	<5	<10	<20	0.14

Appendix 6.15 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
KL18	B	<1.0	261	<1.0	64	35	34	191	68	164	50229	1358
KL19	A	<1.0	105	<1.0	22	24	36	106	100	77	37017	1046
KL19	B	<1.0	44	<1.0	22	19	53	136	165	55	40741	426
KL20	A	<1.0	736	<1.0	371	33	273	78	51	168	35594	7221
KL20	B	<1.0	491	<1.0	525	51	390	115	74	183	52646	3062
KL21	A	<1.0	178	<1.0	108	30	92	109	89	125	44399	1943
KL21	B	<1.0	125	<1.0	149	36	122	140	128	128	55190	1684
KL22	A	<1.0	147	<1.0	36	21	69	80	63	71	28428	917
KL22	B	<1.0	79	<1.0	48	29	109	128	105	68	40371	769
KL23	A	<1.0	128	<1.0	22	13	26	61	22	64	25616	2412
KL23	B	<1.0	110	<1.0	26	14	33	71	19	71	29983	971
KL24	A	<1.0	73	<1.0	54	15	84	88	49	85	22280	1535
KL24	B	<1.0	68	<1.0	62	19	115	114	62	88	28079	1076
KL25	A	<1.0	173	<1.0	37	15	67	58	50	70	25055	1855
KL25	B	<1.0	125	<1.0	35	17	71	67	54	64	28275	1278
KL26	A	<1.0	93	<1.0	6	<6	4	12	5	54	13667	1207
KL26	B	<1.0	92	<1.0	4	<6	4	12	3	49	14946	394
KL27	A	<1.0	503	<1.0	75	20	83	102	55	125	46659	3718
KL27	B	<1.0	356	<1.0	82	23	94	114	69	119	51633	2196
KL28	A	<1.0	64	<1.0	52	25	71	48	38	61	21477	1330
KL28	B	<1.0	33	<1.0	51	25	77	53	50	41	23727	554
KL30	A	1.0	149	<1.0	164	75	313	374	136	185	107317	4509
KL30	B	1.2	91	<1.0	178	84	341	409	185	171	120278	2718
R1	A	<1.0	214	<1.0	23	14	17	54	23	86	27635	1567
R1	B	<1.0	184	<1.0	26	18	24	74	28	71	34311	522
R2	A	<1.0	161	<1.0	15	11	12	38	19	74	18185	2404
R2	B	<1.0	76	<1.0	11	14	18	63	21	74	29347	699
R3	A	<1.0	34	<1.0	13	6	9	52	14	17	13492	129

Appendix 6.16 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
KL18	B	799	60659	27	3172	103	18551	<5	<10	<20	0.05
KL19	A	3881	45373	8	14223	156	10037	8	<10	<20	0.04
KL19	B	853	51007	10	15173	206	12919	5	<10	<20	0.04
KL20	A	1510	36989	21	18682	176	16424	9	<10	<20	0.29
KL20	B	1035	52737	31	8178	223	23606	12	<10	<20	0.12
KL21	A	3138	26607	16	8072	235	11541	8	<10	36	0.05
KL21	B	2654	33290	21	6527	189	13551	11	<10	47	0.06
KL22	A	4973	34601	10	11246	222	12975	6	<10	<20	0.04
KL22	B	3043	48844	15	9701	219	17873	9	<10	<20	<0.04
KL23	A	1398	49514	16	1404	60	3754	5	<10	<20	0.13
KL23	B	1234	66872	21	691	56	3949	<5	<10	<20	0.14
KL24	A	1535	22216	11	6700	139	8809	<5	<10	<20	0.18
KL24	B	1117	29711	14	2780	217	10850	<5	<10	<20	0.07
KL25	A	1463	26792	11	9675	264	7303	<5	<10	<20	0.17
KL25	B	937	30484	12	5778	306	7662	<5	<10	<20	0.07
KL26	A	2234	17715	23	1902	137	2398	10	<10	<20	0.06
KL26	B	2345	22420	29	913	162	2600	14	<10	<20	0.04
KL27	A	2165	50626	47	4907	84	4750	12	<10	<20	0.06
KL27	B	2170	58980	52	1407	84	5245	12	<10	<20	0.05
KL28	A	274	35554	<5	8943	494	5779	<5	<10	<20	0.06
KL28	B	163	39845	<5	7833	556	6473	<5	<10	<20	<0.04
KL30	A	806	55984	8	5923	149	6389	9	<10	<20	0.07
KL30	B	344	67663	9	3018	107	6801	13	<10	<20	0.07
R1	A	669	39053	7	5025	317	3903	5	<10	<20	0.08
R1	B	612	48870	7	3928	319	5266	7	<10	<20	0.06
R2	A	1733	19971	<5	17394	442	7569	6	133	<20	0.22
R2	B	1232	30418	9	6653	343	9982	5	<10	<20	<0.04
R3	A	223	19768	<5	4370	1294	1616	<5	<10	<20	0.07

Appendix 6.17 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>Cd</i>	<i>Ba</i>	<i>Be</i>	<i>Ni</i>	<i>Co</i>	<i>Cr</i>	<i>V</i>	<i>Cu</i>	<i>Zn</i>	<i>Fe</i>	<i>Mn</i>
R3	B	<1.0	28	<1.0	17	7	9	52	18	17	14589	106
R4	A	<1.0	32	<1.0	13	6	7	36	24	23	10930	169
R4	B	<1.0	31	<1.0	16	7	10	55	30	23	15457	164
R5	A	<1.0	238	<1.0	80	28	47	92	50	104	44916	1268
R5	B	<1.0	289	<1.0	91	32	52	105	51	85	49586	708
R6	A	<1.0	318	<1.0	136	40	79	107	55	140	63476	2457
R6	B	<1.0	326	<1.0	154	47	91	125	73	113	71441	592
R7	A	<1.0	89	<1.0	12	7	27	30	8	52	14403	561
R7	B	<1.0	83	<1.0	14	10	35	38	11	43	18012	589
R8	A	<1.0	175	<1.0	42	17	72	75	41	80	37541	566
R8	B	<1.0	170	<1.0	48	19	81	87	42	75	41104	571
R9	A	<1.0	89	<1.0	12	9	19	61	16	63	24504	625
R9	B	<1.0	99	<1.0	16	11	23	69	16	59	29298	737
R10	A	<1.0	54	<1.0	53	33	153	63	28	25	20230	1336
R10	B	<1.0	25	<1.0	97	23	187	59	86	12	27007	355
R11	A	<1.0	45	<1.0	58	33	160	96	34	36	28079	1155
R11	B	<1.0	27	<1.0	61	38	192	124	50	31	37969	993
R12	A	<1.0	312	<1.0	43	10	39	33	21	85	24618	2717
R12	B	<1.0	212	1.0	40	10	42	38	23	77	25109	607
R13	A	<1.0	179	<1.0	41	20	41	79	30	67	30659	3414
R13	B	<1.0	135	<1.0	45	50	70	238	71	126	91108	2809
R14	A	<1.0	158	<1.0	40	18	62	76	36	54	39049	586
R14	B	<1.0	147	<1.0	36	16	72	85	41	51	43186	368
R15	A	<1.0	178	<1.0	12	32	23	134	72	67	50041	1447
R15	B	<1.0	127	<1.0	11	33	26	153	81	61	54825	1235

Appendix 6.18 Database of Heavy Metals and Trace Elements (ppm) in Soils of Southwest Oregon.

<i>Site</i>	<i>Horizon</i>	<i>K</i>	<i>Al</i>	<i>Li</i>	<i>Ca</i>	<i>Na</i>	<i>Mg</i>	<i>La</i>	<i>Pb</i>	<i>As</i>	<i>Hg</i>
R3	B	168	23013	<5	5323	1541	2284	<5	<10	<20	0.05
R4	A	344	18926	<5	5107	1224	1748	<5	11	<20	0.06
R4	B	248	27537	<5	6422	1708	2216	<5	<10	<20	0.04
R5	A	1198	63332	10	5533	968	6079	10	<10	<20	0.04
R5	B	1113	70569	11	4122	837	6727	11	<10	<20	<0.04
R6	A	1282	93717	12	5605	200	6756	16	<10	<20	0.08
R6	B	851	102212	14	2108	171	7988	26	<10	<20	<0.04
R7	A	2296	9909	5	3446	158	3463	11	11	<20	<0.04
R7	B	2360	13527	6	1900	161	4174	15	<10	<20	<0.04
R8	A	4541	51739	15	13409	168	6914	15	<10	<20	<0.04
R8	B	3571	56018	16	12246	163	7317	16	<10	<20	<0.04
R9	A	2864	17850	9	6150	220	4553	18	21	<20	<0.04
R9	B	2025	25484	11	5924	157	5028	23	12	<20	<0.04
R10	A	286	21990	<5	8850	185	4667	<5	13	<20	0.06
R10	B	73	72785	8	5092	384	6290	<5	<10	<20	0.08
R11	A	436	30010	<5	6143	206	2725	<5	<10	<20	0.07
R11	B	170	39467	5	4046	156	4418	5	<10	<20	0.04
R12	A	2206	24718	13	3753	53	3559	10	146	<20	0.07
R12	B	2445	32761	19	951	59	3742	12	13	<20	0.04
R13	A	885	20991	6	7517	76	4476	5	13	<20	0.19
R13	B	622	57490	13	1471	66	5401	11	<10	29	0.06
R14	A	1893	28984	17	1493	57	4080	10	12	<20	0.07
R14	B	2092	37561	22	1154	64	3878	8	<10	<20	0.09
R15	A	2158	37259	<5	7757	166	8778	5	<10	<20	<0.04
R15	B	1526	43532	<5	7486	216	9983	5	<10	<20	<0.04

Appendix 7. Distribution statistics for concentrations of metals in soils developed on individual geologic units in southwest Oregon.

Appendix 7.1. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "bc"** (Amphibolite of Briggs Creek; Mesozoic or Paleozoic). For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/1	1	--	--	Cd	1/1	1.2	--	--
Ba	1/1	149	--	--	Ba	1/1	91	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	164	--	--	Ni	1/1	178	--	--
Co	1/1	75	--	--	Co	1/1	84	--	--
Cr	1/1	313	--	--	Cr	1/1	341	--	--
V	1/1	374	--	--	V	1/1	409	--	--
Cu	1/1	136	--	--	Cu	1/1	185	--	--
Zn	1/1	185	--	--	Zn	1/1	171	--	--
Fe	1/1	107,317	--	--	Fe	1/1	120,278	--	--
Mn	1/1	4,509	--	--	Mn	1/1	2,718	--	--
K	1/1	809	--	--	K	1/1	344	--	--
Al	1/1	55,984	--	--	Al	1/1	67,663	--	--
Li	1/1	8	--	--	Li	1/1	9	--	--
Ca	1/1	5,923	--	--	Ca	1/1	3,018	--	--
Na	1/1	149	--	--	Na	1/1	107	--	--
Mg	1/1	6,389	--	--	Mg	1/1	6,801	--	--
La	1/1	9	--	--	La	1/1	13	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/1	0.07	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.2. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "cm"** (Condrey Mountain Schist, derived possibly from shales of the Galice Formation; Triassic and Permian). For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/ detects ¹	Arith-metic mean ²	Mini-mum	Maxi-mum	Metal	Total sample number/ detects ¹	Arith-metic mean ²	Mini-mum	Maxi-mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	178	--	--	Ba	1/1	125	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	108	--	--	Ni	1/1	149	--	--
Co	1/1	30	--	--	Co	1/1	36	--	--
Cr	1/1	92	--	--	Cr	1/1	122	--	--
V	1/1	109	--	--	V	1/1	140	--	--
Cu	1/1	89	--	--	Cu	1/1	128	--	--
Zn	1/1	125	--	--	Zn	1/1	128	--	--
Fe	1/1	44,399	--	--	Fe	1/1	55,190	--	--
Mn	1/1	1,943	--	--	Mn	1/1	1,684	--	--
K	1/1	3,138	--	--	K	1/1	2,654	--	--
Al	1/1	26,607	--	--	Al	1/1	33,290	--	--
Li	1/1	16	--	--	Li	1/1	21	--	--
Ca	1/1	8,072	--	--	Ca	1/1	6,527	--	--
Na	1/1	235	--	--	Na	1/1	189	--	--
Mg	1/1	11,541	--	--	Mg	1/1	13,551	--	--
La	1/1	8	--	--	La	1/1	11	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/1	36	--	--	As	1/1	47	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.05	--	--	Hg	1/1	0.06	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.3. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "cs"** (Colebrook Schist - originally tuffs, cherts and pillow lavas in deep sea; Mesozoic or Paleozoic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/2	1	1	1	Cd	2/1	<1	<1	1
Ba	2/2	191	163	219	Ba	2/2	205	165	246
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	54	51	57	Ni	2/2	71	56	86
Co	2/2	28	26	30	Co	2/2	34	26	43
Cr	2/2	70	52	87	Cr	2/2	114	61	167
V	2/2	191	157	225	V	2/2	227	173	281
Cu	2/2	63	59	67	Cu	2/2	87	61	112
Zn	2/2	96	91	100	Zn	2/2	112	97	128
Fe	2/2	60,782	49,606	71,957	Fe	2/2	76,408	56,487	96,329
Mn	2/2	2,157	1,226	3,088	Mn	2/2	1,497	1,123	1,871
K	2/2	1,147	698	1,596	K	2/2	848	584	1,112
Al	2/2	49,717	41,497	57,938	Al	2/2	72,524	47,073	97,974
Li	2/2	21	19	23	Li	2/2	32	23	41
Ca	2/2	4,830	4,024	5,636	Ca	2/2	2,725	1,740	3,711
Na	2/2	178	83	273	Na	2/2	188	83	292
Mg	2/2	9,327	4,468	14,187	Mg	2/2	10,109	4,142	16,076
La	2/1	<10*	<5	15	La	2/2	9	6	13
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.21	0.19	0.23	Hg	2/2	0.15	0.06	0.24

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.4. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Jm"** (Melange; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/1	1.1	--	--
Ba	1/1	55	--	--	Ba	1/1	32	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	641	--	--	Ni	1/1	1,481	--	--
Co	1/1	67	--	--	Co	1/1	175	--	--
Cr	1/1	562	--	--	Cr	1/1	1,226	--	--
V	1/1	78	--	--	V	1/1	151	--	--
Cu	1/1	28	--	--	Cu	1/1	51	--	--
Zn	1/1	75	--	--	Zn	1/1	75	--	--
Fe	1/1	46,415	--	--	Fe	1/1	94,215	--	--
Mn	1/1	1,144	--	--	Mn	1/1	1,472	--	--
K	1/1	862	--	--	K	1/1	219	--	--
Al	1/1	23,249	--	--	Al	1/1	46,498	--	--
Li	1/0	<5	--	--	Li	1/1	6	--	--
Ca	1/1	7,117	--	--	Ca	1/1	6,111	--	--
Na	1/1	146	--	--	Na	1/1	129	--	--
Mg	1/1	11,805	--	--	Mg	1/1	21,446	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.17	--	--	Hg	1/1	0.05	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.5. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Jop"** (Silt and sands of the Otter Point Formation & related rocks; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	235	--	--	Ba	1/1	181	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	47	--	--	Ni	1/1	60	--	--
Co	1/1	8	--	--	Co	1/1	12	--	--
Cr	1/1	117	--	--	Cr	1/1	149	--	--
V	1/1	74	--	--	V	1/1	95	--	--
Cu	1/1	8	--	--	Cu	1/1	9	--	--
Zn	1/1	48	--	--	Zn	1/1	53	--	--
Fe	1/1	27,436	--	--	Fe	1/1	34,681	--	--
Mn	1/1	636	--	--	Mn	1/1	454	--	--
K	1/1	811	--	--	K	1/1	788	--	--
Al	1/1	26,229	--	--	Al	1/1	35,427	--	--
Li	1/1	17	--	--	Li	1/1	21	--	--
Ca	1/1	4,356	--	--	Ca	1/1	2,722	--	--
Na	1/1	242	--	--	Na	1/1	218	--	--
Mg	1/1	3,532	--	--	Mg	1/1	3,866	--	--
La	1/1	7	--	--	La	1/1	11	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	11	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.14	--	--	Hg	1/1	0.05	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.6. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Js"** (Sedimentary rocks; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean	Minimum	Maximum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/1	<1*	<1	1
Ba	2/2	174	174	175	Ba	2/2	166	160	172
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	41	28	54	Ni	2/2	61	22	100
Co	2/2	19	14	25	Co	2/2	29	23	35
Cr	2/2	47	24	70	Cr	2/2	70	32	108
V	2/2	106	76	136	V	2/2	151	113	188
Cu	2/2	32	28	35	Cu	2/2	54	51	57
Zn	2/2	84	73	95	Zn	2/2	111	90	112
Fe	2/2	38,261	30,281	46,241	Fe	2/2	53,406	43,822	62,989
Mn	2/2	1,752	1,408	2,096	Mn	2/2	1,546	1,450	1,643
K	2/2	1,597	1,419	1,775	K	2/2	1,778	1,706	1,850
Al	2/2	35,363	24,499	46,228	Al	2/2	53,062	42,084	64,041
Li	2/2	14	10	18	Li	2/2	24	14	34
Ca	2/2	6,189	4,678	7,698	Ca	2/2	4,479	4,418	4,540
Na	2/2	109	100	119	Na	2/2	136	123	150
Mg	2/2	7,382	4,827	9,937	Mg	2/2	10,297	6,039	14,555
La	2/2	8	6	9	La	2/2	12	9	14
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.13	0.11	0.14	Hg	2/2	0.09	0.08	0.1

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.7. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Jss"** (Shale, mudstone & sandstone; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	393	350	436	Ba	2/2	257	202	311
Be	2/1	<1*	<1	1	Be	2/2	1.1	1	1.3
Ni	2/2	47	46	48	Ni	2/2	47	35	58
Co	2/2	12	11	12	Co	2/2	12	6	18
Cr	2/2	39	35	44	Cr	2/2	53	52	54
V	2/2	35	32	39	V	2/2	57	48	66
Cu	2/2	25	18	31	Cu	2/2	43	22	63
Zn	2/2	118	106	131	Zn	2/2	111	62	140
Fe	2/2	21,841	19,102	24,581	Fe	2/2	31,377	25,646	37,107
Mn	2/2	2,240	1,609	2,872	Mn	2/2	564	526	601
K	2/2	2,868	1,834	3,902	K	2/2	3,803	2,070	5,535
Al	2/2	22,228	18,276	26,180	Al	2/2	37,880	29,872	45,888
Li	2/2	12	9	15	Li	2/2	26	17	35
Ca	2/2	6,082	5,699	6,466	Ca	2/2	1,140	1,045	1,235
Na	2/2	96	95	96	Na	2/2	89	61	118
Mg	2/2	3,503	3,061	3,944	Mg	2/2	4,012	2,344	5,680
La	2/0	<5	<5	<5	La	2/1	<9*	<5	12
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/2	206	35	378	Pb	2/2	11	10	12
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.14	0.11	0.16	Hg	2/2	0.08	0.06	0.09

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.8. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "JTrgd"** (Granite & diorite; Jurassic and Triassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/1	<1*	<1	1
Ba	2/2	107	87	128	Ba	2/2	95	80	110
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	172	22	322	Ni	2/2	189	26	351
Co	2/2	22	13	31	Co	2/2	23	14	32
Cr	2/2	127	26	228	Cr	2/2	142	33	252
V	2/2	82	61	103	V	2/2	117	71	164
Cu	2/2	25	22	27	Cu	2/2	31	19	43
Zn	2/2	76	64	89	Zn	2/2	79	71	87
Fe	2/2	43,551	25,616	61,486	Fe	2/2	51,794	29,983	73,605
Mn	2/2	1,369	327	2,412	Mn	2/2	620	270	971
K	2/2	955	512	1,398	K	2/2	1,007	779	1,234
Al	2/2	46,289	43,065	49,514	Al	2/2	68,271	66,872	69,670
Li	2/2	32	16	48	Li	2/2	36	21	52
Ca	2/2	1,215	1,027	1,404	Ca	2/2	709	691	726
Na	2/2	84	60	107	Na	2/2	73	56	90
Mg	2/2	9,112	3,754	14,470	Mg	2/2	10,151	3,949	16,352
La	2/2	5	5	5	La	2/1	<5*	<5	6
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.15	0.13	0.17	Hg	2/2	0.12	0.10	0.14

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.9. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Ju"** (Ultramafic & related rocks of ophiolite sequences; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/1	1	--	--	Cd	1/1	1.5	--	--
Ba	1/1	187	--	--	Ba	1/1	146	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	1,132	--	--	Ni	1/1	1,530	--	--
Co	1/1	95	--	--	Co	1/1	135	--	--
Cr	1/1	1,302	--	--	Cr	1/1	1,815	--	--
V	1/1	155	--	--	V	1/1	215	--	--
Cu	1/1	53	--	--	Cu	1/1	81	--	--
Zn	1/1	98	--	--	Zn	1/1	119	--	--
Fe	1/1	98,652	--	--	Fe	1/1	137,939	--	--
Mn	1/1	3,676	--	--	Mn	1/1	3,345	--	--
K	1/1	783	--	--	K	1/1	731	--	--
Al	1/1	54,559	--	--	Al	1/1	75,800	--	--
Li	1/1	12	--	--	Li	1/1	16	--	--
Ca	1/1	6,174	--	--	Ca	1/1	1,777	--	--
Na	1/1	57	--	--	Na	1/1	47	--	--
Mg	1/1	6,604	--	--	Mg	1/1	7,805	--	--
La	1/1	5	--	--	La	1/1	7	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.11	--	--	Hg	1/1	0.07	--	--

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.10. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit “Jub”** (Basaltic, volcanic & sedimentary rocks; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/1	<1*	<1	1
Ba	2/2	246	179	312	Ba	2/2	174	135	212
Be	2/0	<1	<1	<1	Be	2/1	<1*	<1	1
Ni	2/2	42	41	43	Ni	2/2	43	40	45
Co	2/2	15	10	20	Co	2/2	30	10	50
Cr	2/2	40	39	41	Cr	2/2	56	42	70
V	2/2	56	33	79	V	2/2	138	38	239
Cu	2/2	25	21	30	Cu	2/2	47	23	71
Zn	2/2	76	67	85	Zn	2/2	102	78	126
Fe	2/2	27,639	24,618	30,659	Fe	2/2	58,108	25,110	91,108
Mn	2/2	3,066	2,717	3,414	Mn	2/2	1,708	607	2,809
K	2/2	1,546	885	2,206	K	2/2	1,533	622	2,445
Al	2/2	22,855	20,991	24,718	Al	2/2	45,126	32,761	57,490
Li	2/2	9	6	13	Li	2/2	16	13	19
Ca	2/2	5,635	3,753	7,517	Ca	2/2	1,211	951	1,471
Na	2/2	64	53	76	Na	2/2	63	59	66
Mg	2/2	4,018	3,559	4,476	Mg	2/2	4,571	3,742	5,401
La	2/2	7	5	10	La	2/2	12	11	12
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/2	79	13	146	Pb	2/1	<11*	<10	13
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/1	<25*	<20	29
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.13	0.07	0.19	Hg	2/2	0.05	0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.11. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Jv"** (Volcanic rocks; Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	138	--	--	Ba	1/1	59	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	8	--	--	Ni	1/1	7	--	--
Co	1/1	25	--	--	Co	1/1	25	--	--
Cr	1/1	12	--	--	Cr	1/1	17	--	--
V	1/1	169	--	--	V	1/1	202	--	--
Cu	1/1	111	--	--	Cu	1/1	136	--	--
Zn	1/1	87	--	--	Zn	1/1	72	--	--
Fe	1/1	48,823	--	--	Fe	1/1	57,995	--	--
Mn	1/1	1,825	--	--	Mn	1/1	848	--	--
K	1/1	1,549	--	--	K	1/1	928	--	--
Al	1/1	47,179	--	--	Al	1/1	59,727	--	--
Li	1/1	8	--	--	Li	1/1	11	--	--
Ca	1/1	17,184	--	--	Ca	1/1	12,457	--	--
Na	1/1	106	--	--	Na	1/1	168	--	--
Mg	1/1	5,536	--	--	Mg	1/1	6,327	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.05	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.12. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Kc"** (Clastic sedimentary rocks; Cretaceous). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	503	--	--	Ba	1/1	356	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	76	--	--	Ni	1/1	82	--	--
Co	1/1	20	--	--	Co	1/1	23	--	--
Cr	1/1	83	--	--	Cr	1/1	94	--	--
V	1/1	102	--	--	V	1/1	114	--	--
Cu	1/1	55	--	--	Cu	1/1	69	--	--
Zn	1/1	125	--	--	Zn	1/1	119	--	--
Fe	1/1	46,659	--	--	Fe	1/1	51,633	--	--
Mn	1/1	3,718	--	--	Mn	1/1	2,196	--	--
K	1/1	2,165	--	--	K	1/1	2,170	--	--
Al	1/1	50,626	--	--	Al	1/1	58,980	--	--
Li	1/1	47	--	--	Li	1/1	52	--	--
Ca	1/1	4,907	--	--	Ca	1/1	1,407	--	--
Na	1/1	84	--	--	Na	1/1	84	--	--
Mg	1/1	4,750	--	--	Mg	1/1	5,245	--	--
La	1/1	12	--	--	La	1/1	12	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.06	--	--	Hg	1/1	0.05	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.13. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "KJds"** (Turbidite sands and muds with some deep water cherts of Dothan Formation; Cretaceous & Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	186	--	--	Ba	1/0	172	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	34	--	--	Ni	1/1	42	--	--
Co	1/1	13	--	--	Co	1/1	17	--	--
Cr	1/1	40	--	--	Cr	1/1	55	--	--
V	1/1	57	--	--	V	1/1	72	--	--
Cu	1/1	32	--	--	Cu	1/1	57	--	--
Zn	1/1	100	--	--	Zn	1/1	140	--	--
Fe	1/1	33,887	--	--	Fe	1/1	40,417	--	--
Mn	1/1	2,328	--	--	Mn	1/1	1,738	--	--
K	1/1	1,721	--	--	K	1/1	1,534	--	--
Al	1/1	37,090	--	--	Al	1/1	54,063	--	--
Li	1/1	28	--	--	Li	1/1	41	--	--
Ca	1/1	1,700	--	--	Ca	1/1	1,116	--	--
Na	1/1	84	--	--	Na	1/1	96	--	--
Mg	1/1	5,305	--	--	Mg	1/1	6,571	--	--
La	1/1	5	--	--	La	1/1	6	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	14	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.17	--	--	Hg	1/1	0.18	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.14. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "KJg"** (Granitic rocks; Cretaceous & Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	218	93	343	Ba	2/2	103	92	115
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	14	6	22	Ni	2/2	11	4	19
Co	2/1	<7*	<6	7	Co	2/1	<8*	<6	9
Cr	2/2	14	5	23	Cr	2/2	17	4	31
V	2/2	21	12	29	V	2/2	27	12	42
Cu	2/2	6	5	7	Cu	2/2	7	3	11
Zn	2/2	58	55	61	Zn	2/2	48	47	49
Fe	2/2	14,103	13,667	14,538	Fe	2/2	16,640	14,946	18,333
Mn	2/2	1,734	1,207	2,261	Mn	2/2	568	394	741
K	2/2	1,659	1,085	2,234	K	2/2	1,743	1,141	2,345
Al	2/2	22,057	17,715	26,399	Al	2/2	28,885	22,420	35,349
Li	2/2	16	9	23	Li	2/2	20	11	29
Ca	2/2	3,666	1,902	5,430	Ca	2/2	1,455	913	1,997
Na	2/2	121	106	137	Na	2/2	143	124	162
Mg	2/2	2,259	2,119	2,398	Mg	2/2	2,507	2,414	2,600
La	2/2	13	10	16	La	2/2	14	13	14
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.06	0.05	0.06	Hg	2/1	<0.04	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.15. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit “KJgu”** (Gabbro & ultramafic rocks associated with granitic plutons; Cretaceous & Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	50	45	55	Ba	2/2	26	25	27
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	56	53	58	Ni	2/2	79	61	97
Co	2/2	33	33	34	Co	2/2	30	23	38
Cr	2/2	156	153	160	Cr	2/2	190	187	192
V	2/2	79	63	96	V	2/2	91	59	124
Cu	2/2	31	28	34	Cu	2/2	68	50	86
Zn	2/2	30	25	36	Zn	2/2	22	12	31
Fe	2/2	24,155	20,230	28,079	Fe	2/2	32,488	27,007	37,969
Mn	2/2	1,246	1,155	1,336	Mn	2/2	674	355	993
K	2/2	361	286	436	K	2/2	121	73	170
Al	2/2	26,000	21,990	30,010	Al	2/2	56,126	39,467	72,785
Li	2/0	<5	<5	<5	Li	2/2	7	5	8
Ca	2/2	7,497	6,143	8,850	Ca	2/2	4,569	4,046	5,092
Na	2/2	196	185	206	Na	2/2	270	156	384
Mg	2/2	3,696	2,725	4,667	Mg	2/2	5,354	4,418	6,290
La	2/0	<5	<5	<5	La	2/1	<5*	<5	5
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<11*	<10	13	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.07	0.06	0.07	Hg	2/2	0.06	0.04	0.08

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.16. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "KJm"** (Myrtle Group conglomerate, sandstone, siltstone & limestone; Cretaceous & Jurassic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	168	158	178	Ba	2/2	137	127	147
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	26	12	40	Ni	2/2	24	11	36
Co	2/2	25	18	32	Co	2/2	24	16	33
Cr	2/2	43	23	62	Cr	2/2	49	26	72
V	2/2	105	76	134	V	2/2	119	85	153
Cu	2/2	54	36	72	Cu	2/2	61	41	81
Zn	2/2	61	54	67	Zn	2/2	56	51	61
Fe	2/2	44,545	39,049	50,041	Fe	2/2	49,005	43,186	54,825
Mn	2/2	1,016	586	1,447	Mn	2/2	801	368	1,235
K	2/2	2,025	1,893	2,158	K	2/2	1,809	1,526	2,092
Al	2/2	33,121	28,984	37,259	Al	2/2	40,546	37,561	43,532
Li	2/1	<11*	<5	17	Li	2/1	<14*	<5	22
Ca	2/2	4,625	1,493	7,757	Ca	2/2	4,320	1,154	7,486
Na	2/2	112	57	166	Na	2/2	140	64	216
Mg	2/2	6,429	4,080	8,778	Mg	2/2	6,930	3,878	9,983
La	2/2	8	5	10	La	2/2	7	5	8
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<11*	<10	12	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/1	<0.06*	<0.04	0.07	Hg	2/1	<0.07*	<0.04	0.09

Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.17. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Ks"** (Sedimentary rocks; Cretaceous). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	137	--	--	Ba	1/1	141	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	94	--	--	Ni	1/1	116	--	--
Co	1/1	22	--	--	Co	1/1	22	--	--
Cr	1/1	104	--	--	Cr	1/1	124	--	--
V	1/1	76	--	--	V	1/1	78	--	--
Cu	1/1	45	--	--	Cu	1/1	53	--	--
Zn	1/1	78	--	--	Zn	1/1	99	--	--
Fe	1/1	30,964	--	--	Fe	1/1	39,984	--	--
Mn	1/1	1,036	--	--	Mn	1/1	729	--	--
K	1/1	1,608	--	--	K	1/1	2,014	--	--
Al	1/1	27,195	--	--	Al	1/1	35,663	--	--
Li	1/1	22	--	--	Li	1/1	35	--	--
Ca	1/1	6,694	--	--	Ca	1/1	3,277	--	--
Na	1/1	144	--	--	Na	1/1	127	--	--
Mg	1/1	14,216	--	--	Mg	1/1	16,633	--	--
La	1/1	9	--	--	La	1/1	13	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.11	--	--	Hg	1/1	0.07	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.18. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "mc"** (May Creek Schist; Paleozoic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	64	--	--	Ba	1/1	33	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	52	--	--	Ni	1/1	51	--	--
Co	1/1	25	--	--	Co	1/1	25	--	--
Cr	1/1	71	--	--	Cr	1/1	77	--	--
V	1/1	48	--	--	V	1/1	53	--	--
Cu	1/1	38	--	--	Cu	1/1	50	--	--
Zn	1/1	61	--	--	Zn	1/1	41	--	--
Fe	1/1	21,477	--	--	Fe	1/1	23,727	--	--
Mn	1/1	1,330	--	--	Mn	1/1	554	--	--
K	1/1	274	--	--	K	1/1	163	--	--
Al	1/1	35,554	--	--	Al	1/1	39,845	--	--
Li	1/0	<5	--	--	Li	1/0	<5	--	--
Ca	1/1	8,943	--	--	Ca	1/1	7,833	--	--
Na	1/1	494	--	--	Na	1/1	556	--	--
Mg	1/1	5,779	--	--	Mg	1/1	6,473	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.06	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.19. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qa"** (Andesite; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	33	32	34	Ba	2/2	29	28	312/0
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	13	13	13	Ni	2/2	17	16	17
Co	2/2	6	6	6	Co	2/2	7	7	7
Cr	2/2	8	7	9	Cr	2/2	10	9	10
V	2/2	44	36	52	V	2/2	54	52	55
Cu	2/2	19	14	24	Cu	2/2	24	18	30
Zn	2/2	20	17	23	Zn	2/2	20	17	23
Fe	2/2	12,211	10,930	13,492	Fe	2/2	15,023	14,589	15,457
Mn	2/2	149	129	169	Mn	2/2	135	106	164
K	2/2	284	223	344	K	2/2	208	168	248
Al	2/2	19,347	18,926	19,768	Al	2/2	25,275	23,013	27,537
Li	2/0	<5	<5	<5	Li	2/0	<5	<5	<5
Ca	2/2	4,739	4,370	5,107	Ca	2/2	5,873	5,323	6,422
Na	2/2	1,259	1,224	1,294	Na	2/2	1,625	1,541	1,708
Mg	2/2	1,682	1,616	1,748	Mg	2/2	2,250	2,216	2,284
La	2/0	<5	<5	<5	La	2/0	<5	<5	<5
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<11*	<10	12	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.07	0.06	0.07	Hg	2/2	0.05	0.04	0.05

Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.20. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qal"** (Alluvial deposits; Holocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/0	<5	<5	<5
Cd	3/0	<1	<10	<1	Cd	3/0	<1	<1	<1
Ba	3/3	137	119	155	Ba	3/3	142	99	170
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	34	29	38	Ni	3/3	35	32	38
Co	3/3	17	16	18	Co	3/3	18	13	20
Cr	3/3	31	26	38	Cr	3/3	31	29	33
V	3/3	73	57	83	V	3/3	77	54	91
Cu	3/3	28	25	30	Cu	3/3	27	20	33
Zn	3/3	92	71	131	Zn	3/3	76	69	86
Fe	3/3	31,688	28,956	34,372	Fe	3/3	33,808	26,666	37,932
Mn	3/3	809	730	941	Mn	3/3	768	732	789
K	3/3	1,897	1,544	2,285	K	3/3	1,232	1,121	1,437
Al	3/3	28,210	21,845	32,096	Al	3/3	29,969	19,743	35,235
Li	3/3	10	7	16	Li	3/3	10	8	13
Ca	3/3	11,729	6,197	15,923	Ca	3/3	9,374	5,933	12,209
Na	3/3	1,040	350	1,416	Na	3/3	1,163	444	1,689
Mg	3/3	7,754	7,059	8,385	Mg	3/3	8,044	6,266	9,043
La	3/3	12	10	13	La	3/3	12	11	13
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/1	<12*	<10	16	Pb	3/1	<10*	<10	11
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/3	0.08	0.08	0.08	Hg	3/3	0.05	0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.21. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qb"** (Basalt & basaltic andesite; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	105	--	--	Ba	1/1	133	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	29	--	--	Ni	1/1	33	--	--
Co	1/1	11	--	--	Co	1/1	14	--	--
Cr	1/1	12	--	--	Cr	1/1	14	--	--
V	1/1	39	--	--	V	1/1	47	--	--
Cu	1/1	15	--	--	Cu	1/1	18	--	--
Zn	1/1	61	--	--	Zn	1/1	46	--	--
Fe	1/1	19,180	--	--	Fe	1/1	23,288	--	--
Mn	1/1	559	--	--	Mn	1/1	430	--	--
K	1/1	607	--	--	K	1/1	567	--	--
Al	1/1	21,690	--	--	Al	1/1	25,605	--	--
Li	1/1	7	--	--	Li	1/1	8	--	--
Ca	1/1	3,642	--	--	Ca	1/1	3,137	--	--
Na	1/1	710	--	--	Na	1/1	719	--	--
Mg	1/1	3,924	--	--	Mg	1/1	4,798	--	--
La	1/1	6	--	--	La	1/1	8	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.05	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.22. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qba"** (Basaltic andesite & basalt; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	161	39	284	Ba	2/2	189	21	356
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	22	8	36	Ni	2/2	24	5	44
Co	2/1	<21*	<6	36	Co	2/2	23	7	39
Cr	2/2	24	4	45	Cr	2/2	29	6	52
V	2/2	81	28	135	V	2/2	99	47	150
Cu	2/2	30	7	52	Cu	2/2	37	8	66
Zn	2/2	60	27	93	Zn	2/2	59	30	87
Fe	2/2	29,936	8,314	51,558	Fe	2/2	37,558	16,001	59,114
Mn	2/2	779	336	1,222	Mn	2/2	734	246	1,223
K	2/2	1,113	373	1,853	K	2/2	1,038	214	1,861
Al	2/2	31,523	4,634	58,412	Al	2/2	43,545	12,641	74,450
Li	2/1	<8*	<5	11	Li	2/1	<10*	<5	14
Ca	2/2	3,028	2,194	3,861	Ca	2/2	2,439	998	3,879
Na	2/2	287	216	357	Na	2/2	404	250	557
Mg	2/2	1,719	545	2,893	Mg	2/2	1,960	791	3,129
La	2/1	<11	<5	17	La	2/1	<13*	<5	21
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<15*	<10	20	Pb	2/1	<10	<10	10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.11	0.07	0.14	Hg	2/1	<0.05	<0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.23. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qd" (young)** (Dune sand; Holocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/1	1	--	--
Mo	1/1	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	8	--	--	Ba	1/1	34	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	4	--	--	Ni	1/0	<4	--	--
Co	1/0	<6	--	--	Co	1/0	<6	--	--
Cr	1/1	9	--	--	Cr	1/1	9	--	--
V	1/1	6	--	--	V	1/1	6	--	--
Cu	1/0	<2	--	--	Cu	1/1	5	--	--
Zn	1/1	11	--	--	Zn	1/1	19	--	--
Fe	1/1	3,844	--	--	Fe	1/1	3,846	--	--
Mn	1/1	41	--	--	Mn	1/1	30	--	--
K	1/1	298	--	--	K	1/1	315	--	--
Al	1/1	2,689	--	--	Al	1/1	2,752	--	--
Li	1/1	6	--	--	Li	1/1	7	--	--
Ca	1/1	640	--	--	Ca	1/1	576	--	--
Na	1/1	129	--	--	Na	1/1	129	--	--
Mg	1/1	895	--	--	Mg	1/1	821	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/0	<0.04	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.24. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qd" (old)** (Dune sand; Holocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/1	1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	34	--	--	Ba	1/1	10	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/0	<4	--	--	Ni	1/1	5	--	--
Co	1/0	<6	--	--	Co	1/0	<6	--	--
Cr	1/1	9	--	--	Cr	1/1	9	--	--
V	1/1	7	--	--	V	1/1	7	--	--
Cu	1/1	5	--	--	Cu	1/0	<2	--	--
Zn	1/1	19	--	--	Zn	1/1	11	--	--
Fe	1/1	2,648	--	--	Fe	1/1	4,538	--	--
Mn	1/1	52	--	--	Mn	1/1	32	--	--
K	1/1	530	--	--	K	1/1	262	--	--
Al	1/1	2,541	--	--	Al	1/1	5,001	--	--
Li	1/0	<5	--	--	Li	1/1	9	--	--
Ca	1/1	1,888	--	--	Ca	1/1	465	--	--
Na	1/1	241	--	--	Na	1/1	105	--	--
Mg	1/1	704	--	--	Mg	1/1	756	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.14	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.25. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qf"** (Fanglomerate; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	52	--	--	Ba	1/1	61	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	15	--	--	Ni	1/1	20	--	--
Co	1/1	6	--	--	Co	1/1	7	--	--
Cr	1/1	6	--	--	Cr	1/1	8	--	--
V	1/1	29	--	--	V	1/1	37	--	--
Cu	1/1	22	--	--	Cu	1/1	27	--	--
Zn	1/1	26	--	--	Zn	1/1	23	--	--
Fe	1/1	10,219	--	--	Fe	1/1	12,490	--	--
Mn	1/1	451	--	--	Mn	1/1	165	--	--
K	1/1	513	--	--	K	1/1	472	--	--
Al	1/1	20,340	--	--	Al	1/1	25,175	--	--
Li	1/0	<5	--	--	Li	1/0	<5	--	--
Ca	1/1	9,111	--	--	Ca	1/1	9,234	--	--
Na	1/1	1,491	--	--	Na	1/1	1,739	--	--
Mg	1/1	2,514	--	--	Mg	1/1	3,173	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.26. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qg"** (Glacial deposits; Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	64	47	82	Ba	2/2	41	32	51
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	8	8	8	Ni	2/2	8	7	8
Co	2/2	6	6	6	Co	2/2	7	6	7
Cr	2/2	6	5	6	Cr	2/2	6	5	8
V	2/2	33	27	39	V	2/2	37	34	41
Cu	2/2	14	11	16	Cu	2/2	17	11	22
Zn	2/2	47	38	56	Zn	2/2	42	31	52
Fe	2/2	13,635	13,019	14,251	Fe	2/2	15,096	14,274	15,918
Mn	2/2	571	498	644	Mn	2/2	361	279	443
K	2/2	480	310	649	K	2/2	345	251	438
Al	2/2	20,911	20,868	20,954	Al	2/2	22,393	17,406	27,380
Li	2/1	<5*	<5	5	Li	2/1	<7*	<5	9
Ca	2/2	2,160	1,948	2,371	Ca	2/2	1,869	1,598	2,139
Na	2/2	526	445	607	Na	2/2	681	640	722
Mg	2/2	1,254	988	1,520	Mg	2/2	1,499	960	2,038
La	2/2	5	5	5	La	2/2	7	6	9
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/1	<10	<10	10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.06	0.05	0.06	Hg	2/1	<0.06*	<0.04	0.08

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.27. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qgf"** (Glaciofluvial deposits; Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	133	--	--	Ba	1/1	117	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	25	--	--	Ni	1/1	35	--	--
Co	1/1	14	--	--	Co	1/1	17	--	--
Cr	1/1	17	--	--	Cr	1/1	22	--	--
V	1/1	46	--	--	V	1/1	62	--	--
Cu	1/1	21	--	--	Cu	1/1	31	--	--
Zn	1/1	83	--	--	Zn	1/1	80	--	--
Fe	1/1	25,539	--	--	Fe	1/1	31,065	--	--
Mn	1/1	2,399	--	--	Mn	1/1	1,134	--	--
K	1/1	520	--	--	K	1/1	390	--	--
Al	1/1	31,915	--	--	Al	1/1	44,482	--	--
Li	1/1	7	--	--	Li	1/1	8	--	--
Ca	1/1	5,110	--	--	Ca	1/1	2,780	--	--
Na	1/1	409	--	--	Na	1/1	603	--	--
Mg	1/1	4,038	--	--	Mg	1/1	5,277	--	--
La	1/1	5	--	--	La	1/1	13	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.17	--	--	Hg	1/1	0.06	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.28. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qls"** (Landslide & debris flow deposits; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/1	<1	<1	1	Cd	2/0	<1	<1	<1
Ba	2/2	226	153	300	Ba	2/2	175	138	212
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	98	25	170	Ni	2/2	91	27	154
Co	2/2	30	26	35	Co	2/2	34	27	42
Cr	2/2	105	99	111	Cr	2/2	115	107	122
V	2/2	126	69	182	V	2/2	146	69	223
Cu	2/2	44	43	46	Cu	2/2	42	37	48
Zn	2/2	129	105	153	Zn	2/2	113	85	140
Fe	2/2	46,374	35,746	57,003	Fe	2/2	50,656	32,746	68,566
Mn	2/2	1,569	598	2,540	Mn	2/2	1,354	654	2,055
K	2/2	2,081	1,039	3,124	K	2/2	1,795	924	2,666
Al	2/2	45,012	33,024	56,999	Al	2/2	51,972	32,262	71,682
Li	2/2	16	10	21	Li	2/2	16	12	21
Ca	2/2	7,511	6,831	8,191	Ca	2/2	4,626	3,322	5,931
Na	2/2	165	152	178	Na	2/2	140	136	145
Mg	2/2	8,520	6,232	10,809	Mg	2/2	8,844	7,514	10,175
La	2/2	9	8	10	La	2/2	9	8	11
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/2	77	51	104	Pb	2/2	32	25	40
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.15	0.14	0.15	Hg	2/2	0.11	0.08	0.13

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.29. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qma"** (Mazama ash-flow deposits; Holocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	70	44	96	Ba	2/2	66	25	106
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	6	6	7	Ni	2/2	10	8	11
Co	2/0	<6	<6	<6	Co	2/1	<8*	<6	9
Cr	2/2	6	5	6	Cr	2/2	8	5	10
V	2/2	24	18	31	V	2/2	35	21	49
Cu	2/2	13	8	18	Cu	2/2	25	20	29
Zn	2/2	30	27	33	Zn	2/2	29	21	37
Fe	2/2	9,326	8,402	10,250	Fe	2/2	13,742	10,204	17,280
Mn	2/2	273	232	315	Mn	2/2	155	101	210
K	2/2	515	469	560	K	2/2	471	430	513
Al	2/2	12,729	8,580	16,879	Al	2/2	23,896	20,453	27,338
Li	2/1	<5	<5	6	Li	2/2	6	6	6
Ca	2/2	2,691	2,101	3,281	Ca	2/2	3,094	3,021	3,168
Na	2/2	673	666	679	Na	2/2	1,114	1,040	1,188
Mg	2/2	1,127	689	1,564	Mg	2/2	1,672	1,498	1,846
La	2/1	<5	<5	5	La	2/1	<5*	<5	6
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<10	<10	10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.05	0.04	0.06	Hg	2/1	<0.04	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.30. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qmp"** (Mazama pumice deposits; Holocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	96	84	107	Ba	2/2	43	40	47
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	8	6	9	Ni	2/2	10	8	12
Co	2/1	<6*	<6	6	Co	2/2	7	7	8
Cr	2/2	5	5	5	Cr	2/2	7	7	7
V	2/2	32	29	35	V	2/2	45	45	45
Cu	2/2	8	7	9	Cu	2/2	11	10	12
Zn	2/2	44	43	44	Zn	2/2	34	34	35
Fe	2/2	11,018	10,212	11,824	Fe	2/2	15,202	14,524	15,880
Mn	2/2	590	485	695	Mn	2/2	186	178	195
K	2/2	364	275	452	K	2/2	314	234	394
Al	2/2	14,229	13,442	15,015	Al	2/2	21,257	19,087	23,427
Li	2/1	<5*	<5	5	Li	2/2	7	6	7
Ca	2/2	2,681	2,254	3,108	Ca	2/2	2,109	1,396	2,823
Na	2/2	527	478	576	Na	2/2	777	768	786
Mg	2/2	1,029	841	1,217	Mg	2/2	1,290	1,035	1,544
La	2/0	<5	<5	<5	La	2/1	<5*	<5	5
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<10	<10	10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.05	0.04	0.06	Hg	2/1	<0.04*	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.31. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qrd"** (Rhyolite & dacite; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	105	--	--	Ba	1/1	81	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	13	--	--	Ni	1/1	19	--	--
Co	1/1	6	--	--	Co	1/1	9	--	--
Cr	1/1	5	--	--	Cr	1/1	10	--	--
V	1/1	32	--	--	V	1/1	46	--	--
Cu	1/1	19	--	--	Cu	1/1	36	--	--
Zn	1/1	92	--	--	Zn	1/1	42	--	--
Fe	1/1	11,783	--	--	Fe	1/1	16,346	--	--
Mn	1/1	3,235	--	--	Mn	1/1	143	--	--
K	1/1	660	--	--	K	1/1	456	--	--
Al	1/1	14,629	--	--	Al	1/1	23,871	--	--
Li	1/0	<5	--	--	Li	1/1	6	--	--
Ca	1/1	5,630	--	--	Ca	1/1	4,354	--	--
Na	1/1	638	--	--	Na	1/1	947	--	--
Mg	1/1	1,718	--	--	Mg	1/1	2,513	--	--
La	1/0	<5	--	--	La	1/1	6	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	14	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.09	--	--	Hg	1/1	0.12	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.32. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qs"** (Lacustrine & fluvial sedimentary rocks; Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	97	95	99	Ba	2/2	62	49	75
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	12	8	15	Ni	2/2	10	8	13
Co	2/1	<18*	<6	29	Co	2/1	<20*	<6	34
Cr	2/2	21	5	36	Cr	2/2	18	5	32
V	2/2	57	31	82	V	2/2	56	34	77
Cu	2/2	19	8	30	Cu	2/2	21	13	29
Zn	2/2	45	42	49	Zn	2/2	32	29	36
Fe	2/2	20,208	9,874	30,541	Fe	2/2	20,540	10,583	30,496
Mn	2/2	993	709	1,276	Mn	2/2	661	182	1,140
K	2/2	621	476	766	K	2/2	350	253	446
Al	2/2	23,377	14,709	32,045	Al	2/2	23,093	16,323	29,862
Li	2/1	<5*	<5	6	Li	2/2	5	5	5
Ca	2/2	3,493	3,042	3,944	Ca	2/2	2,534	2,493	2,575
Na	2/2	371	141	601	Na	2/2	396	127	666
Mg	2/2	1,779	993	2,565	Mg	2/2	1,627	939	2,316
La	2/1	<13*	<5	20	La	2/2	11	6	17
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<10*	<10	10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/0	<0.05*	<0.04	0.06	Hg	2/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.33. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Qt"** (Terrace pediment & lag gravels; Holocene & Pleistocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	5/0	<1	<1	<1	Ag	5/0	<1	<1	<1
Mo	5/0	<5	<5	<5	Mo	5/0	<5	<5	<5
Cd	5/0	<1	<1	<1	Cd	5/0	<1	<1	<1
Ba	5/5	56	14	143	Ba	5/5	41	7	64
Be	5/0	<1	<1	<1	Be	5/0	<1	<1	<1
Ni	5/4	<10*	<4	25	Ni	5/4	<12*	<4	26
Co	5/2	<6*	<6	8	Co	5/2	<7*	<6	8
Cr	5/5	26	7	77	Cr	5/5	36	6	81
V	5/5	30	8	65	V	5/5	44	4	74
Cu	5/5	9	2	13	Cu	5/4	<11*	<2	21
Zn	5/5	20	11	29	Zn	5/5	23	9	48
Fe	5/5	11,823	3,985	25,055	Fe	5/5	18,090	3,066	29,401
Mn	5/5	307	24	1,216	Mn	5/5	113	21	187
K	5/5	668	369	896	K	5/5	676	264	1,176
Al	5/5	12,309	4,016	29,237	Al	5/5	21,169	2,586	31,173
Li	5/2	<9*	<5	23	Li	5/5	17	6	33
Ca	5/5	1,921	1,151	3,081	Ca	5/5	496	134	1,117
Na	5/5	198	60	362	Na	5/5	135	53	193
Mg	5/5	1,559	620	3,314	Mg	5/5	1,666	591	2,935
La	5/4	<8*	<5	13	La	5/4	<11*	<5	15
Sb	5/0	<20	<20	<20	Sb	5/0	<20	<20	<20
Pb	5/2	<19*	<10	40	Pb	5/0	<10	<10	<10
Tl	5/0	<50	<50	<50	Tl	5/0	<50	<50	<50
As	5/0	<20	<20	<20	As	5/0	<20	<20	<20
Se	5/0	<30	<30	<30	Se	5/0	<30	<30	<30
Hg	5/5	0.13	0.06	0.19	Hg	5/3	<0.08*	<0.04	0.14

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.34. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTb"** (Basalt; Pleistocene & Pliocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	225	100	350	Ba	2/2	91	74	109
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	12	5	19	Ni	2/2	15	5	25
Co	2/1	<7*	<6	8	Co	2/1	<9*	<6	12
Cr	2/2	5	3	7	Cr	2/2	8	4	12
V	2/2	29	18	40	V	2/2	43	31	56
Cu	2/2	12	8	16	Cu	2/2	17	11	24
Zn	2/2	99	36	161	Zn	2/2	67	30	105
Fe	2/2	11,326	7,034	15,618	Fe	2/2	16,562	10,417	22,707
Mn	2/2	2,463	327	4,600	Mn	2/2	363	145	581
K	2/2	660	513	807	K	2/2	479	336	623
Al	2/2	18,961	13,198	24,723	Al	2/2	28,738	18,549	38,927
Li	2/1	<5*	<5	5	Li	2/2	7	6	8
Ca	2/2	7,571	2,787	12,354	Ca	2/2	2,234	1,937	2,531
Na	2/2	357	268	446	Na	2/2	566	531	601
Mg	2/2	1,540	879	2,202	Mg	2/2	1,752	972	2,531
La	2/0	<5	<5	<5	La	2/2	6	5	6
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/2	10	10	10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.11	0.04	0.17	Hg	2/0	<0.04	<0.04	<0.4

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.35. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTba"** (Basalt & basaltic andesite; Pleistocene & Pliocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean	Minimum	Maximum
Ag	5/0	<1	<1	<1	Ag	5/0	<1	<1	<1
Mo	5/0	<5	<5	<5	Mo	5/0	<5	<5	<5
Cd	5/0	<1	<1	<1	Cd	5/0	<1	<1	<1
Ba	5/5	207	45	472	Ba	5/5	206	29	525
Be	5/0	<1	<1	<1	Be	5/0	<1	<1	<1
Ni	5/5	26	7	76	Ni	5/5	28	7	86
Co	2/5	<14*	<6	34	Co	5/4	<15*	<6	40
Cr	5/5	25	4	89	Cr	5/5	28	5	101
V	5/5	56	20	150	V	5/5	62	24	170
Cu	5/5	21	6	54	Cu	5/5	27	13	66
Zn	5/5	62	41	93	Zn	5/5	52	30	84
Fe	5/5	23,163	9,170	60,452	Fe	5/5	25,829	10,041	68,459
Mn	5/5	1,020	369	2,313	Mn	5/5	583	153	1,206
K	5/5	792	248	1,712	K	5/5	593	178	1,353
Al	5/5	33,954	11,116	85,913	Al	5/5	39,003	14,857	95,618
Li	5/3	<9*	<5	13	Li	5/4	<10*	<5	16
Ca	5/5	4,066	1,997	6,645	Ca	5/5	2,299	1,480	3,069
Na	5/5	464	206	617	Na	5/5	580	181	781
Mg	5/5	1,526	868	2,563	Mg	5/5	1,605	916	2,396
La	5/2	<8*	<5	13	La	5/4	<11*	<5	19
Sb	5/0	<20	<20	<20	Sb	5/0	<20	<20	<20
Pb	5/1	<10	<10	10	Pb	5/0	<10	<10	<10
Tl	5/0	<50	<50	<50	Tl	5/0	<50	<50	<50
As	5/0	<20	<20	<20	As	5/0	<20	<20	<20
Se	5/0	<30	<30	<30	Se	5/0	<30	<30	<30
Hg	5/4	<0.07	<0.04	0.10	Hg	5/3	<0.04	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.36. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTmv"** (Mafic vent complexes; Pleistocene, Pliocene & Miocene ?). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	124	66	183	Ba	2/2	48	28	68
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	6	5	7	Ni	2/2	6	4	8
Co	2/1	<6*	<6	6	Co	2/0	<6	<6	<6
Cr	2/2	3	3	3	Cr	2/2	5	4	5
V	2/2	26	20	31	V	2/2	31	31	31
Cu	2/2	8	7	8	Cu	2/2	10	8	12
Zn	2/2	50	48	52	Zn	2/2	35	30	40
Fe	2/2	10,026	6,965	13,087	Fe	2/2	11,250	9,857	12,642
Mn	2/2	1,766	907	2,625	Mn	2/2	169	163	176
K	2/2	354	301	407	K	2/2	257	240	273
Al	2/2	12,694	11,973	13,415	Al	2/2	17,106	14,925	19,287
Li	2/0	<5	<5	<5	Li	2/1	<5*	<5	5
Ca	2/2	3,193	1,886	4,500	Ca	2/2	2,405	1,067	3,742
Na	2/2	557	471	643	Na	2/2	719	502	936
Mg	2/2	780	776	784	Mg	2/2	857	688	1,026
La	2/0	<5	<5	<5	La	2/0	<5	<5	<5
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/1	<10*	<10	10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.07	0.06	0.08	Hg	2/1	<0.04*	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.37. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTp"** (Basaltic & andesitic ejecta; Holocene to Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/0	<5	<5	<5
Cd	3/0	<1	<1	<1	Cd	3/0	<1	<1	<1
Ba	3/3	226	123	318	Ba	3/3	238	97	326
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	75	8	136	Ni	3/3	85	10	154
Co	3/3	25	6	41	Co	3/3	28	6	47
Cr	3/3	43	4	79	Cr	3/3	49	5	91
V	3/3	75	26	107	V	3/3	87	32	125
Cu	3/3	38	8	56	Cu	3/3	45	12	73
Zn	3/3	103	64	140	Zn	3/3	78	35	113
Fe	3/3	39,382	9,755	63,476	Fe	3/3	44,152	11,430	71,441
Mn	3/3	1,567	976	2,457	Mn	3/3	479	137	708
K	3/3	1,014	562	1,282	K	3/3	787	397	1,113
Al	3/3	57,289	14,818	93,717	Al	3/3	63,201	16,822	102,212
Li	3/3	9	5	12	Li	3/3	10	6	14
Ca	3/3	4,965	3,757	5,605	Ca	3/3	3,164	2,108	4,122
Na	3/3	639	200	968	Na	3/3	624	171	864
Mg	3/3	4,607	987	6,756	Mg	3/3	5,265	1,080	7,988
La	3/2	<11*	<5	16	La	3/3	14	5	26
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/0	<10	<10	<10	Pb	3/0	<10	<10	<10
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/3	0.05	0.04	0.08	Hg	3/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.38. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit “QTps”** (Subaqueous basaltic & andesitic ejecta; Holocene to Miocene ?). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	86	--	--	Ba	1/1	97	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	11	--	--	Ni	1/1	13	--	--
Co	1/0	<6	--	--	Co	1/1	6	--	--
Cr	1/1	5	--	--	Cr	1/1	7	--	--
V	1/1	21	--	--	V	1/1	31	--	--
Cu	1/1	11	--	--	Cu	1/1	15	--	--
Zn	1/1	32	--	--	Zn	1/1	24	--	--
Fe	1/1	8,793	--	--	Fe	1/1	10,912	--	--
Mn	1/1	248	--	--	Mn	1/1	137	--	--
K	1/1	492	--	--	K	1/1	378	--	--
Al	1/1	13,597	--	--	Al	1/1	14,848	--	--
Li	1/0	<5	--	--	Li	1/0	<5	--	--
Ca	1/1	3,968	--	--	Ca	1/1	3,947	--	--
Na	1/1	767	--	--	Na	1/1	981	--	--
Mg	1/1	1,313	--	--	Mg	1/1	1,447	--	--
La	1/0	<5	--	--	La	1/0	<5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/0	<0.04	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.39. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTs"** (Sedimentary rocks; Pleistocene & Pliocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean ²	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean ²	Mini-mum	Maxi-mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	85	--	--	Ba	1/1	112	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	9	--	--	Ni	1/1	12	--	--
Co	1/0	<6	--	--	Co	1/1	6	--	--
Cr	1/1	5	--	--	Cr	1/1	8	--	--
V	1/1	31	--	--	V	1/1	42	--	--
Cu	1/1	11	--	--	Cu	1/1	15	--	--
Zn	1/1	52	--	--	Zn	1/1	35	--	--
Fe	1/1	9,812	--	--	Fe	1/1	13,010	--	--
Mn	1/1	533	--	--	Mn	1/1	214	--	--
K	1/1	691	--	--	K	1/1	660	--	--
Al	1/1	14,823	--	--	Al	1/1	20,113	--	--
Li	1/0	<5	--	--	Li	1/1	5	--	--
Ca	1/1	4,001	--	--	Ca	1/1	3,831	--	--
Na	1/1	625	--	--	Na	1/1	914	--	--
Mg	1/1	1,210	--	--	Mg	1/1	1,595	--	--
La	1/0	<5	--	--	La	1/1	5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.40. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on
geologic unit “QTst” (Tuffaceous sedimentary rocks & tuffs; Pleistocene or Pliocene).
 For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	64	54	74	Ba	2/2	61	36	85
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	6	5	6	Ni	2/2	7	7	7
Co	2/1	<6*	<6	6	Co	1/1	<7*	<6	7
Cr	2/2	5	5	5	Cr	2/2	6	5	6
V	2/2	28	22	35	V	2/2	39	30	47
Cu	2/2	10	10	11	Cu	2/2	14	13	14
Zn	2/2	44	35	53	Zn	2/2	32	28	36
Fe	2/2	10,272	8,317	12,226	Fe	2/2	12,933	10,359	15,507
Mn	2/2	593	514	673	Mn	2/2	243	236	251
K	2/2	503	391	615	K	2/2	399	244	555
Al	2/2	15,209	13,953	16,465	Al	2/2	18,783	17,556	20,011
Li	2/0	<5	<5	<5	Li	2/2	5	5	5
Ca	2/2	2,747	2,314	3,180	Ca	2/2	2,620	2,372	2,868
Na	2/2	490	470	511	Na	2/2	735	701	770
Mg	2/2	977	805	1,148	Mg	2/2	1,188	1,017	1,360
La	2/0	<5	<5	<5	La	2/2	5	5	6
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.08	0.06	0.09	Hg	2/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.41. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "QTvm"** (Mafic vent deposits; Pleistocene, Pliocene & Miocene ?). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	388	--	--	Ba	1/1	358	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	29	--	--	Ni	1/1	30	--	--
Co	1/1	19	--	--	Co	1/1	23	--	--
Cr	1/1	12	--	--	Cr	1/1	14	--	--
V	1/1	83	--	--	V	1/1	93	--	--
Cu	1/1	47	--	--	Cu	1/1	56	--	--
Zn	1/1	78	--	--	Zn	1/1	66	--	--
Fe	1/1	36,177	--	--	Fe	1/1	39,721	--	--
Mn	1/1	1,220	--	--	Mn	1/1	774	--	--
K	1/1	1,481	--	--	K	1/1	970	--	--
Al	1/1	44,100	--	--	Al	1/1	49,053	--	--
Li	1/1	12	--	--	Li	1/1	13	--	--
Ca	1/1	6,559	--	--	Ca	1/1	3,118	--	--
Na	1/1	320	--	--	Na	1/1	397	--	--
Mg	1/1	1,960	--	--	Mg	2,217	--	--	--
La	1/1	10	--	--	La	1/1	12	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.04	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.42. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tat"** (Silicic ash-flow tuff; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	204	--	--	Ba	1/1	77	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	8	--	--	Ni	1/1	11	--	--
Co	1/0	<6	--	--	Co	1/1	7	--	--
Cr	1/1	4	--	--	Cr	1/1	8	--	--
V	1/1	25	--	--	V	1/1	46	--	--
Cu	1/1	9	--	--	Cu	1/1	17	--	--
Zn	1/1	51	--	--	Zn	1/1	32	--	--
Fe	1/1	8,708	--	--	Fe	1/1	13,675	--	--
Mn	1/1	678	--	--	Mn	1/1	164	--	--
K	1/1	941	--	--	K	1/1	564	--	--
Al	1/1	12,544	--	--	Al	1/1	17,901	--	--
Li	1/1	5	--	--	Li	1/1	6	--	--
Ca	1/1	5,261	--	--	Ca	1/1	3,800	--	--
Na	1/1	566	--	--	Na	1/1	1,039	--	--
Mg	1/1	1,223	--	--	Mg	1/1	1,279	--	--
La	1/0	<5	--	--	La	1/1	5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.06	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.43. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tb"** (Basalt; Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/1	1	--	--
Ba	1/1	234	--	--	Ba	1/1	256	--	--
Be	1/1	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	23	--	--	Ni	1/1	40	--	--
Co	1/1	17	--	--	Co	1/1	28	--	--
Cr	1/1	20	--	--	Cr	1/1	36	--	--
V	1/1	79	--	--	V	1/1	142	--	--
Cu	1/1	30	--	--	Cu	1/1	51	--	--
Zn	1/1	83	--	--	Zn	1/1	82	--	--
Fe	1/1	27,200	--	--	Fe	1/1	45,716	--	--
Mn	1/1	779	--	--	Mn	1/1	943	--	--
K	1/1	1,317	--	--	K	1/1	1,875	--	--
Al	1/1	31,794	--	--	Al	1/1	58,961	--	--
Li	1/1	8	--	--	Li	1/1	14	--	--
Ca	1/1	7,077	--	--	Ca	1/1	5,061	--	--
Na	1/1	328	--	--	Na	1/1	560	--	--
Mg	1/1	2,565	--	--	Mg	1/1	3,570	--	--
La	1/1	9	--	--	La	1/1	15	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.44. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tbaa"** (Basaltic & andesitic rocks; Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	188	161	215	Ba	2/2	130	76	184
Be	2/0	<1	<1	<1	Be	2/2	<1	<1	<1
Ni	2/2	19	15	23	Ni	2/2	19	11	26
Co	2/2	12	11	14	Co	2/2	16	14	18
Cr	2/2	14	12	17	Cr	2/2	21	18	24
V	2/2	46	38	54	V	2/2	68	63	74
Cu	2/2	21	19	23	Cu	2/2	25	21	28
Zn	2/2	80	75	86	Zn	2/2	72	71	74
Fe	2/2	22,910	18,185	27,635	Fe	2/2	31,829	29,347	34,311
Mn	2/2	1,985	1,567	2,404	Mn	2/2	610	522	699
K	2/2	1,201	669	1,733	K	2/2	922	612	1,232
Al	2/2	29,512	19,971	39,053	Al	2/2	39,644	30,418	48,870
Li	2/1	<6*	<5	7	Li	2/2	8	7	9
Ca	2/2	11,210	5,025	17,394	Ca	2/2	5,291	3,928	6,653
Na	2/2	379	317	442	Na	2/2	331	319	343
Mg	2/2	5,736	3,903	7,569	Mg	2/2	7,624	5,266	9,982
La	2/2	5	5	6	La	2/2	6	5	7
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<72*	<10	133	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.15	0.08	0.22	Hg	2/1	0.05*	<0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.45. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tfc"** (Flows & clastic rocks, undifferentiated; Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	246	--	--	Ba	1/1	136	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	19	--	--	Ni	1/1	24	--	--
Co	1/1	13	--	--	Co	1/1	14	--	--
Cr	1/1	17	--	--	Cr	1/1	20	--	--
V	1/1	64	--	--	V	1/1	78	--	--
Cu	1/1	24	--	--	Cu	1/1	37	--	--
Zn	1/1	106	--	--	Zn	1/1	64	--	--
Fe	1/1	26,162	--	--	Fe	1/1	28,580	--	--
Mn	1/1	2,800	--	--	Mn	1/1	639	--	--
K	1/1	470	--	--	K	1/1	344	--	--
Al	1/1	31,486	--	--	Al	1/1	42,274	--	--
Li	1/1	8	--	--	Li	1/1	9	--	--
Ca	1/1	3,389	--	--	Ca	1/1	2,192	--	--
Na	1/1	371	--	--	Na	1/1	393	--	--
Mg	1/1	2,375	--	--	Mg	1/1	3,456	--	--
La	1/1	6	--	--	La	1/1	5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.08	--	--	Hg	1/1	0.06	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.46. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tfe"** (Tuffs, conglomerates, silts & sands of the Fisher & Eugene Formations & correlative rocks; Oligocene & Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	193	--	--	Ba	1/1	124	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	9	--	--	Ni	1/1	10	--	--
Co	1/1	22	--	--	Co	1/1	23	--	--
Cr	1/1	21	--	--	Cr	1/1	22	--	--
V	1/1	133	--	--	V	1/1	142	--	--
Cu	1/1	51	--	--	Cu	1/1	61	--	--
Zn	1/1	62	--	--	Zn	1/1	60	--	--
Fe	1/1	78,726	--	--	Fe	1/1	82,363	--	--
Mn	1/1	3,495	--	--	Mn	1/1	2,555	--	--
K	1/1	631	--	--	K	1/1	379	--	--
Al	1/1	53,649	--	--	Al	1/1	61,317	--	--
Li	1/1	5	--	--	Li	1/1	6	--	--
Ca	1/1	3,884	--	--	Ca	1/1	2,031	--	--
Na	1/1	61	--	--	Na	1/1	57	--	--
Mg	1/1	1,498	--	--	Mg	1/1	1,468	--	--
La	1/1	11	--	--	La	1/1	12	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	,10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.10	--	--	Hg	1/1	0.07	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.47. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tfee"** (Silt & sands of the marine Eugene Formation; Oligocene & Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	252	--	--	Ba	1/1	162	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	15	--	--	Ni	1/1	10	--	--
Co	1/1	52	--	--	Co	1/1	17	--	--
Cr	1/1	28	--	--	Cr	1/1	24	--	--
V	1/1	212	--	--	V	1/1	220	--	--
Cu	1/1	125	--	--	Cu	1/1	150	--	--
Zn	1/1	110	--	--	Zn	1/1	81	--	--
Fe	1/1	80,890	--	--	Fe	1/1	79,319	--	--
Mn	1/1	2,831	--	--	Mn	1/1	470	--	--
K	1/1	963	--	--	K	1/1	517	--	--
Al	1/1	56,248	--	--	Al	1/1	82,482	--	--
Li	1/1	6	--	--	Li	1/1	5	--	--
Ca	1/1	4,589	--	--	Ca	1/1	4,183	--	--
Na	1/1	92	--	--	Na	1/1	82	--	--
Mg	1/1	6,134	--	--	Mg	1/1	10,958	--	--
La	1/1	20	--	--	La	1/1	8	--	--
Sb	1/0	<20	--	--	Sb	1/0	,20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.05	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.48. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tmsc"** (Marine siltstone, sandstone & conglomerate; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	148	--	--	Ba	1/1	118	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	91	--	--	Ni	1/1	121	--	--
Co	1/1	22	--	--	Co	1/1	30	--	--
Cr	1/1	74	--	--	Cr	1/1	99	--	--
V	1/1	59	--	--	V	1/1	69	--	--
Cu	1/1	28	--	--	Cu	1/1	35	--	--
Zn	1/1	63	--	--	Zn	1/1	71	--	--
Fe	1/1	32,465	--	--	Fe	1/1	42,182	--	--
Mn	1/1	1,522	--	--	Mn	1/1	1,228	--	--
K	1/1	2,289	--	--	K	1/1	2,515	--	--
Al	1/1	24,623	--	--	Al	1/1	34,060	--	--
Li	1/1	23	--	--	Li	1/1	31	--	--
Ca	1/1	6,822	--	--	Ca	1/1	877	--	--
Na	1/1	109	--	--	Na	1/1	94	--	--
Mg	1/1	6,508	--	--	Mg	1/1	6,845	--	--
La	1/1	8	--	--	La	1/1	11	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.08	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.49. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tmsm"** (Marine siltstone, sandstone & conglomerate; Paleocene & Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	206	--	--	Ba	1/1	188	--	--
Be	1/1	1	--	--	Be	1/1	1	--	--
Ni	1/1	100	--	--	Ni	1/1	104	--	--
Co	1/1	30	--	--	Co	1/1	32	--	--
Cr	1/1	61	--	--	Cr	1/1	68	--	--
V	1/1	85	--	--	V	1/1	97	--	--
Cu	1/1	71	--	--	Cu	1/1	78	--	--
Zn	1/1	123	--	--	Zn	1/1	132	--	--
Fe	1/1	53,454	--	--	Fe	1/1	57,709	--	--
Mn	1/1	5,279	--	--	Mn	1/1	4,951	--	--
K	1/1	4,666	--	--	K	1/1	5,022	--	--
Al	1/1	35,246	--	--	Al	1/1	40,154	--	--
Li	1/1	48	--	--	Li	1/1	54	--	--
Ca	1/1	5,209	--	--	Ca	1/1	4,073	--	--
Na	1/1	88	--	--	Na	1/1	97	--	--
Mg	1/1	10,561	--	--	Mg	1/1	11,308	--	--
La	1/1	9	--	--	La	1/1	10	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	16	--	--	Pb	1/1	14	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/1	0.06	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.50. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tmss"** (Marine sandstone & siltstone; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/0	<5	<5	<5
Cd	3/1	<1*	<1	1	Cd	3/0	<1	<1	<1
Ba	3/3	284	281	287	Ba	3/3	153	124	190
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	70	54	81	Ni	3/0	95	61	112
Co	3/3	17	16	17	Co	3/3	22	19	24
Cr	3/3	72	51	96	Cr	3/3	98	62	135
V	3/3	55	39	74	V	3/3	71	48	94
Cu	3/3	18	16	22	Cu	3/3	24	20	26
Zn	3/3	81	66	89	Zn	3/3	74	51	88
Fe	3/3	30,706	28,374	33,971	Fe	3/3	40,365	32,982	45,439
Mn	3/3	2,240	1,454	2,857	Mn	3/3	901	413	1,368
K	3/3	2,097	1,065	2,782	K	3/3	2,140	1,284	2,649
Al	3/3	28,170	24,253	35,732	Al	3/3	39,404	29,474	52,244
Li	3/3	24	20	27	Li	3/3	32	26	35
Ca	3/3	5,454	4,972	6,109	Ca	3/3	1,486	376	2,942
Na	3/3	93	75	124	Na	3/3	98	82	130
Mg	3/3	6,560	4,714	8,116	Mg	3/3	8,227	6,420	10,379
La	3/3	9	5	13	La	3/3	12	9	15
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/1	<10*	<10	10	Pb	3/1	<10*	<10	10
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/3	0.09	0.06	0.12	Hg	3/3	0.05	0.04	0.08

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.51. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tmv"** (Mafic vent complexes; Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

<u>In A Horizon</u>					<u>In B Horizon</u>				
Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	199	--	--	Ba	1/1	138	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	10	--	--	Ni	1/1	13	--	--
Co	1/1	6	--	--	Co	1/1	7	--	--
Cr	1/1	5	--	--	Cr	1/1	7	--	--
V	1/1	29	--	--	V	1/1	37	--	--
Cu	1/1	11	--	--	Cu	1/1	20	--	--
Zn	1/1	63	--	--	Zn	1/1	41	--	--
Fe	1/1	10,938	--	--	Fe	1/1	13,445	--	--
Mn	1/1	1,010	--	--	Mn	1/1	191	--	--
K	1/1	453	--	--	K	1/1	438	--	--
Al	1/1	14,686	--	--	Al	1/1	18,999	--	--
Li	1/1	7	--	--	Li	1/1	9	--	--
Ca	1/1	3,181	--	--	Ca	1/1	2,516	--	--
Na	1/1	538	--	--	Na	1/1	762	--	--
Mg	1/1	1,120	--	--	Mg	1/1	1,507	--	--
La	1/0	<5	--	--	La	1/1	8	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.07	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.52. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tn"** (Non-marine sedimentary rocks; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/0	<5	<5	<5
Cd	3/0	<1	<1	<1	Cd	3/0	<1	<1	<1
Ba	3/3	118	89	175	Ba	3/3	117	83	170
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	22	12	42	Ni	3/3	26	14	48
Co	3/3	11	7	17	Co	3/3	13	10	19
Cr	3/3	39	19	72	Cr	3/3	46	23	81
V	3/3	55	30	75	V	3/3	65	38	88
Cu	3/3	22	8	41	Cu	3/3	23	11	42
Zn	3/3	65	52	80	Zn	3/3	59	43	75
Fe	3/3	25,483	14,403	37,541	Fe	3/3	29,472	18,012	41,104
Mn	3/3	584	561	625	Mn	3/3	633	571	737
K	3/3	3,234	2,296	4,541	K	3/3	2,652	2,025	3,571
Al	3/3	26,499	9,909	51,739	Al	3/3	31,676	13,527	56,018
Li	3/3	10	5	15	Li	3/3	11	6	16
Ca	3/3	7,668	3,446	13,409	Ca	3/3	6,690	1,900	12,246
Na	3/3	182	158	220	Na	3/3	160	157	163
Mg	3/3	4,977	3,463	6,914	Mg	3/3	5,507	4,174	7,317
La	3/3	15	11	18	La	3/3	18	15	23
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/2	<14*	<10	21	Pb	3/1	<11*	<10	12
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/0	<0.04	<0.04	<0.04	Hg	3/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.53. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tob"** (Olivine basalt; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	94	67	122	Ba	2/2	97	71	122
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	9	6	13	Ni	2/2	9	5	13
Co	2/1	<7*	<6	7	Co	2/1	<7*	<6	7
Cr	2/2	5	4	5	Cr	2/2	6	4	7
V	2/2	30	24	36	V	2/2	30	25	36
Cu	2/2	18	9	27	Cu	2/2	18	10	27
Zn	2/2	41	32	50	Zn	2/2	70	50	91
Fe	2/2	10,472	8,340	12,603	Fe	2/2	11,415	8,615	14,215
Mn	2/2	1,668	287	3,049	Mn	2/2	130	124	135
K	2/2	688	541	836	K	2/2	455	404	506
Al	2/2	15,462	13,830	17,095	Al	2/2	16,123	13,989	18,256
Li	2/1	<7*	<5	8	Li	2/1	<8*	5	10
Ca	2/2	4,003	3,341	4,664	Ca	2/2	2,978	2,523	3,432
Na	2/2	595	561	628	Na	628	600	655	
Mg	2/2	1,609	1,164	2,055	Mg	2/2	1,441	967	1,915
La	2/1	<5*	<5	5	La	2/1	<8*	5	10
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/1	<10*	<10	10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.05	0.04	0.06	Hg	2/1	<0.05*	<0.04	0.06

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.54. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tp"** (Basaltic & andesitic ejecta; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	113	--	--	Ba	1/1	189	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	14	--	--	Ni	1/1	44	--	--
Co	1/1	6	--	--	Co	1/1	15	--	--
Cr	1/1	8	--	--	Cr	1/1	30	--	--
V	1/1	32	--	--	V	1/1	51	--	--
Cu	1/1	13	--	--	Cu	1/1	30	--	--
Zn	68	--	--	--	Zn	1/1	50	--	--
Fe	1/1	11,845	--	--	Fe	1/1	26,278	--	--
Mn	1/1	757	--	--	Mn	1/1	473	--	--
K	1/1	634	--	--	K	1/1	1,341	--	--
Al	1/1	16,529	--	--	Al	1/1	34,967	--	--
Li	1/1	5	--	--	Li	1/1	9	--	--
Ca	1/1	4,436	--	--	Ca	1/1	3,880	--	--
Na	1/1	655	--	--	Na	1/1	730	--	--
Mg	1/1	1,333	--	--	Mg	1/1	5,079	--	--
La	1/0	<5	--	--	La	1/1	7	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.06	--	--	Hg	1/1	0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.55. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tpb"** (Porphyritic basalt; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/1	1	--	--	Cd	1/1	1	--	--
Ba	1/1	118	--	--	Ba	1/1	91	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	117	--	--	Ni	1/1	163	--	--
Co	1/1	45	--	--	Co	1/1	56	--	--
Cr	1/1	120	--	--	Cr	1/1	161	--	--
V	1/1	117	--	--	V	1/1	150	--	--
Cu	1/1	65	--	--	Cu	1/1	90	--	--
Zn	1/1	105	--	--	Zn	1/1	136	--	--
Fe	1/1	78,302	--	--	Fe	1/1	98,169	--	--
Mn	1/1	1,988	--	--	Mn	1/1	1,765	--	--
K	1/1	947	--	--	K	1/1	822	--	--
Al	1/1	61,316	--	--	Al	1/1	85,402	--	--
Li	1/1	18	--	--	Li	1/1	25	--	--
Ca	1/1	3,051	--	--	Ca	1/1	608	--	--
Na	1/1	198	--	--	Na	1/1	163	--	--
Mg	1/1	7,410	--	--	Mg	1/1	8,673	--	--
La	1/1	21	--	--	La	1/1	27	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.21	--	--	Hg	1/1	0.11	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.56. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tps"** (Subaqueous pyroclastic rocks of basaltic cinder cones; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum	Metal	Total sample number/detects ¹	Arithmetic mean ²	Minimum	Maximum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	182	--	--	Ba	1/1	205	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	43	--	--	Ni	1/1	53	--	--
Co	1/1	15	--	--	Co	1/1	18	--	--
Cr	1/1	28--	--	--	Cr	1/1	34	--	--
V	1/1	49	--	--	V	1/1	63	--	--
Cu	1/1	28	--	--	Cu	1/1	30	--	--
Zn	1/1	74	--	--	Zn	1/1	52	--	--
Fe	1/1	25,527	--	--	Fe	1/1	29,284	--	--
Mn	1/1	635	--	--	Mn	1/1	438	--	--
K	1/1	1,546	--	--	K	1/1	1,421	--	--
Al	1/1	34,073	--	--	Al	1/1	38,105	--	--
Li	1/1	9	--	--	Li	1/1	10	--	--
Ca	1/1	4,366	--	--	Ca	1/1	4,137	--	--
Na	1/1	778	--	--	Na	1/1	830	--	--
Mg	1/1	4,927	--	--	Mg	1/1	5,989	--	--
La	1/1	6	--	--	La	1/1	8	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/1	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/0	<0.04	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.57. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Trb"** (Ridge capping basalt & basaltic andesite; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/1	1	--	--
Ba	1/1	475	--	--	Ba	1/1	484	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	63	--	--	Ni	1/1	82	--	--
Co	1/1	31	--	--	Co	1/1	46	--	--
Cr	1/1	63	--	--	Cr	1/1	97	--	--
V	1/1	116	--	--	V	1/1	176	--	--
Cu	1/1	52	--	--	Cu	1/1	73	--	--
Zn	1/1	151	--	--	Zn	1/1	140	--	--
Fe	1/1	55,108	--	--	Fe	1/1	82,430	--	--
Mn	1/1	4,571	--	--	Mn	1/1	2,077	--	--
K	1/1	1,499	--	--	K	1/1	1,072	--	--
Al	1/1	77,558	--	--	Al	1/1	103,515	--	--
Li	1/1	9	--	--	Li	1/1	12	--	--
Ca	1/1	15,265	--	--	Ca	1/1	2,913	--	--
Na	1/1	135	--	--	Na	1/1	122	--	--
Mg	1/1	1,612	--	--	Mg	1/1	1,683	--	--
La	1/1	11	--	--	La	1/1	17	--	--
Sb	1/0	<20	--	--	Sb	1/1	20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.17	--	--	Hg	1/1	0.05	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.58. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Trh"** (Rhyolite & dacite; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	432	--	--	Ba	1/1	456	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	31	--	--	Ni	1/1	42	--	--
Co	1/1	18	--	--	Co	1/1	27	--	--
Cr	1/1	22	--	--	Cr	1/1	34	--	--
V	1/1	69	--	--	V	1/1	109	--	--
Cu	1/1	37	--	--	Cu	1/1	53	--	--
Zn	1/1	92	--	--	Zn	1/1	78	--	--
Fe	1/1	29,298	--	--	Fe	1/1	42,238	--	--
Mn	1/1	1,380	--	--	Mn	1/1	894	--	--
K	1/1	1,771	--	--	K	1/1	1,489	--	--
Al	1/1	42,986	--	--	Al	1/1	60,563	--	--
Li	1/1	10	--	--	Li	1/1	13	--	--
Ca	1/1	8,838	--	--	Ca	1/1	3,586	--	--
Na	1/1	210	--	--	Na	1/1	347	--	--
Mg	1/1	2,373	--	--	Mg	1/1	2,893	--	--
La	1/1	9	--	--	La	1/1	13	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.06	--	--	Hg	1/0	<0.04	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.59. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "TrPv"** (Volcanic rocks; Triassic & Permian). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	126	105	148	Ba	2/2	61	44	79
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	29	22	36	Ni	2/2	35	22	48
Co	2/2	23	21	24	Co	2/2	24	19	29
Cr	2/2	52	36	69	Cr	2/2	81	53	109
V	2/2	93	80	106	V	2/2	132	128	136
Cu	2/2	82	63	100	Cu	2/2	135	105	165
Zn	2/2	74	71	77	Zn	2/2	62	55	68
Fe	2/2	32,723	28,428	37,017	Fe	2/2	40,556	40,371	40,741
Mn	2/2	981	917	1,046	Mn	2/2	598	426	769
K	2/2	4,427	3,881	4,973	K	2/2	1,948	853	3,043
Al	2/2	39,987	34,601	45,373	Al	2/2	49,925	48,844	51,007
Li	2/2	9	8	10	Li	2/2	13	10	15
Ca	2/2	12,734	11,246	14,223	Ca	2/2	12,437	9,701	15,173
Na	2/2	189	157	222	Na	2/2	213	206	219
Mg	2/2	11,506	10,037	12,975	Mg	2/2	15,396	12,919	17,873
La	2/2	7	6	8	La	2/2	7	5	9
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.04	0.04	0.04	Hg	2/1	<0.04*	<0.04	0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.60. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "TrPzm"** (Melange of Dutchmans Peak; Triassic or Paleozoic). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	123	73	173	Ba	2/2	96	68	125
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	46	37	54	Ni	2/2	49	35	63
Co	2/2	15	15	15	Co	2/2	18	17	19
Cr	2/2	76	67	84	Cr	2/2	93	71	115
V	2/2	73	58	88	V	2/2	91	67	114
Cu	2/2	49	49	50	Cu	2/2	58	54	62
Zn	2/2	78	70	85	Zn	2/2	76	64	88
Fe	2/2	23,668	22,280	25,055	Fe	2/2	28,177	28,079	28,275
Mn	2/2	1,695	1,535	1,855	Mn	2/2	1,177	1,076	1,278
K	2/2	1,499	1,463	1,535	K	2/2	1,027	937	1,117
Al	2/2	24,509	22,216	26,792	Al	2/2	30,097	29,711	30,484
Li	2/2	11	11	11	Li	2/2	13	12	14
Ca	2/2	8,188	6,700	9,675	Ca	2/2	4,279	2,780	5,778
Na	2/2	202	139	264	Na	2/2	262	217	306
Mg	2/2	8,056	7,303	8,809	Mg	2/2	9,256	7,662	10,850
La	2/0	<5	<5	<5	La	2/0	<5	<5	<5
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.18	0.17	0.18	Hg	2/2	0.07	0.07	0.07

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.61. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on
geologic unit "TrPzs" (Sedimentary rocks, partly metamorphosed; Triassic & Paleozoic).
 For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	,5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	570	404	736	Ba	2/2	376	261	491
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	217	62	372	Ni	2/2	295	64	525
Co	2/2	33	33	33	Co	2/2	43	35	51
Cr	2/2	153	33	273	Cr	2/2	212	35	390
V	2/2	112	78	145	V	2/2	153	115	191
Cu	2/2	49	47	51	Cu	2/2	71	68	74
Zn	2/2	182	168	196	Zn	2/2	173	164	183
Fe	2/2	38,924	35,594	42,255	Fe	2/2	51,437	50,229	52,646
Mn	2/2	5,878	4,535	7,221	Mn	2/2	2,210	1,358	3,062
K	2/2	1,238	9,65	1,510	K	2/2	917	799	1,035
Al	2/2	41,037	36,989	45,086	Al	2/2	56,698	52,737	60,659
Li	2/2	22	21	22	Li	2/2	29	27	31
Ca	2/2	12,305	5,928	18,682	Ca	2/2	5,675	3,172	8,178
Na	2/2	140	103	176	Na	2/2	163	103	223
Mg	2/2	15,333	14,242	16,424	Mg	2/2	21,078	18,551	23,606
La	2/1	<7*	<5	9	La	2/1	<9*	<5	12
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/0	<10	<10	<10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.22	0.14	0.29	Hg	2/2	0.09	0.05	0.12

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.62. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Ts"** (Tuffaceous sedimentary rocks & tuff; Pliocene & Miocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum	Metal	Total sample number/detects ¹	Arith-metic mean	Mini-mum	Maxi-mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	81	70	92	Ba	2/2	112	76	148
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	7	5	10	Ni	2/2	10	5	15
Co	2/1	<7*	<6	8	Co	2/1	<9*	<6	12
Cr	2/2	7	4	10	Cr	2/2	10	4	16
V	2/2	36	23	48	V	2/2	51	27	75
Cu	2/2	12	10	13	Cu	2/2	18	12	24
Zn	2/2	48	38	59	Zn	2/2	37	29	45
Fe	2/2	11,205	8,190	14,220	Fe	2/2	15,471	9,475	21,466
Mn	2/2	496	292	699	Mn	2/2	308	196	421
K	2/2	829	616	1,042	K	2/2	772	449	1,094
Al	2/2	14,340	13,820	14,861	Al	2/2	21,484	17,247	25,721
Li	2/0	<5	<5	<5	Li	2/2	6	5	7
Ca	2/2	3,309	2,642	3,976	Ca	2/2	3,030	2,292	3,768
Na	2/2	425	330	519	Na	2/2	659	627	691
Mg	2/2	1,142	1,003	1,282	Mg	2/2	1,357	1,148	1,567
La	2/0	<5	<5	<5	La	2/2	6	5	7
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<10*	<10	10	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.07	0.04	0.09	Hg	2/0	<0.04	<0.04	<0.04

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.63. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tsr"** (Siletz River Volcanics & related rocks; Eocene & Paleocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/0	<5	<5	<5
Cd	3/2	<1.1*	<1	1.2	Cd	3/3	1.1	1.1	1.1
Ba	3/3	133	68	193	Ba	3/3	138	59	196
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	50	22	72	Ni	3/3	72	30	122
Co	3/3	44	25	60	Co	3/3	46	38	51
Cr	3/3	57	37	95	Cr	3/3	86	41	159
V	3/3	179	111	219	V	3/3	219	172	248
Cu	3/3	104	31	148	Cu	3/3	142	44	193
Zn	3/3	91	73	101	Zn	3/3	90	85	99
Fe	3/3	61,503	37,471	74,040	Fe	3/3	79,599	59,116	97,686
Mn	3/3	1,440	1,248	1,631	Mn	3/3	1,344	922	1,857
K	3/3	1,508	1,335	1,622	K	3/3	970	518	1,704
Al	3/3	45,047	23,752	73,145	Al	3/3	61,696	35,983	100,324
Li	3/3	8	5	14	Li	3/3	10	5	18
Ca	3/3	9,650	5,534	15,137	Ca	3/3	6,667	1,012	14,619
Na	3/3	632	120	1,511	Na	3/3	934	149	2,341
Mg	3/3	8,677	3,186	11,425	Mg	3/3	10,481	4,191	13,848
La	3/3	6	5	8	La	3/3	7	5	11
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/0	<10	<10	<10	Pb	3/0	<10	<10	<10
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/3	0.11	0.06	0.16	Hg	3/2	<0.07*	<0.04	0.10

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.64. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tss"** (Tuffaceous siltstone & sandstone; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	29	22	36	Ba	2/2	48	23	73
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	8	5	11	Ni	2/2	16	5	27
Co	2/0	<6	<6	<6	Co	2/1	<9*	<6	11
Cr	2/2	28	28	28	Cr	2/2	55	53	57
V	2/2	46	34	57	V	2/2	73	72	75
Cu	2/2	15	12	19	Cu	2/2	20	7	33
Zn	2/2	25	18	31	Zn	2/2	52	23	82
Fe	2/2	19,043	17,366	20,720	Fe	2/2	38,428	35,875	40,980
Mn	2/2	133	31	235	Mn	2/2	706	49	1,363
K	2/2	668	475	861	K	2/2	712	605	818
Al	2/2	16,902	16,442	17,362	Al	2/2	48,501	41,250	55,751
Li	2/2	6	5	7	Li	2/2	24	22	26
Ca	2/2	853	638	1,068	Ca	2/2	508	429	587
Na	2/2	306	206	405	Na	2/2	184	175	194
Mg	2/2	1,369	1,187	1,551	Mg	2/2	1,859	1,655	2,063
La	2/2	6	5	7	La	2/2	11	9	13
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/2	12	10	14	Pb	2/0	<10	<10	<10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.27	0.17	0.37	Hg	2/2	0.20	0.14	0.25

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.65. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tsv"** (Silica vent complexes; Pliocene, Miocene & Oligocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	280	--	--	Ba	1/1	264	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	8	--	--	Ni	1/1	12	--	--
Co	1/1	9	--	--	Co	1/1	10	--	--
Cr	1/1	11	--	--	Cr	1/1	12	--	--
V	1/1	27	--	--	V	1/1	30	--	--
Cu	1/1	12	--	--	Cu	1/1	12	--	--
Zn	1/1	113	--	--	Zn	1/1	127	--	--
Fe	1/1	21,970	--	--	Fe	1/1	23,409	--	--
Mn	1/1	2,000	--	--	Mn	1/1	1,913	--	--
K	1/1	669	--	--	K	1/1	515	--	--
Al	25,643	--	--	--	Al	1/1	31,016	--	--
Li	1/1	8	--	--	Li	1/1	12	--	--
Ca	1/1	3,996	--	--	Ca	1/1	1,261	--	--
Na	1/1	181	--	--	Na	1/1	185	--	--
Mg	1/1	1,517	--	--	Mg	1/1	1,605	--	--
La	1/1	7	--	--	La	1/1	9	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	18	--	--	Pb	1/1	12	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.10	--	--	Hg	1/1	0.07	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.66. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tt"** (Marine sandstone & siltstone of the Tyee Formation; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	167	125	210	Ba	2/2	118	108	128
Be	2/0	<1	<1	<1	Be	2/0	<1	<1	<1
Ni	2/2	13	9	17	Ni	2/2	15	12	18
Co	2/2	10	9	10	Co	2/2	9	8	10
Cr	2/2	24	15	34	Cr	2/2	33	30	37
V	2/2	34	27	40	V	2/2	44	43	44
Cu	2/2	8	5	11	Cu	2/2	10	9	12
Zn	2/2	55	43	67	Zn	2/2	51	42	61
Fe	2/2	18,646	15,727	21,565	Fe	2/2	24,203	23,045	25,361
Mn	2/2	542	353	730	Mn	2/2	231	174	287
K	2/2	1,495	890	2,099	K	2/2	1,561	1,105	2,016
Al	2/2	20,933	18,856	23,010	Al	2/2	34,027	26,359	41,695
Li	2/2	14	8	19	Li	2/2	19	15	23
Ca	2/2	3,705	2,906	4,505	Ca	2/2	1,668	952	2,384
Na	2/2	128	73	183	Na	2/2	108	59	156
Mg	2/2	3,978	1,328	6,629	Mg	2/2	4,588	2,088	7,088
La	2/2	12	10	14	La	2/2	13	10	17
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<18*	<10	25	Pb	2/1	<10*	<10	10
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.07	0.06	0.07	Hg	2/2	0.05	0.04	0.05

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.67. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tu"** (Undifferentiated tuffaceous sedimentary rocks, tuffs & basalt; Miocene & Oligocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	523	--	--	Ba	1/1	206	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	10	--	--	Ni	1/1	6	--	--
Co	1/1	35	--	--	Co	1/1	15	--	--
Cr	1/1	8	--	--	Cr	1/1	13	--	--
V	1/1	97	--	--	V	1/1	138	--	--
Cu	1/1	13	--	--	Cu	1/1	31	--	--
Zn	1/1	148	--	--	Zn	1/1	108	--	--
Fe	1/1	38,650	--	--	Fe	1/1	63,360	--	--
Mn	1/1	5,685	--	--	Mn	1/1	962	--	--
K	1/1	723	--	--	K	1/1	776	--	--
Al	1/1	34,515	--	--	Al	1/1	59,463	--	--
Li	1/1	6	--	--	Li	1/1	8	--	--
Ca	1/1	9,419	--	--	Ca	1/1	5,888	--	--
Na	1/1	136	--	--	Na	1/1	59	--	--
Mg	1/1	3,419	--	--	Mg	1/1	7,446	--	--
La	1/1	5	--	--	La	1/1	5	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	20	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.17	--	--	Hg	1/1	0.09	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.68. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tub"** (Basaltic lava flows; Oligocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	272	--	--	Ba	1/1	254	--	--
Be	10	<1	--	--	Be	1/0	<1	--	--
Ni	1/1	28	--	--	Ni	1/1	30	--	--
Co	1/1	23	--	--	Co	1/1	27	--	--
Cr	1/1	21	--	--	Cr	1/1	25	--	--
V	1/1	95	--	--	V	1/1	110	--	--
Cu	1/1	70	--	--	Cu	1/1	81	--	--
Zn	1/1	94	--	--	Zn	1/1	94	--	--
Fe	1/1	41,629	--	--	Fe	1/1	49,622	--	--
Mn	1/1	1,596	--	--	Mn	1/1	1,525	--	--
K	1/1	2,616	--	--	K	1/1	1,774	--	--
Al	1/1	71,482	--	--	Al	1/1	79,896	--	--
Li	1/1	11	--	--	Li	1/1	13	--	--
Ca	1/1	14,618	--	--	Ca	1/1	10,812	--	--
Na	1/1	151	--	--	Na	1/1	157	--	--
Mg	1/1	13,829	--	--	Mg	1/1	15,300	--	--
La	1/1	7	--	--	La	1/1	8	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/0	<10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.14	--	--	Hg	1/1	0.08	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.69. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tus"** (Sedimentary & volcanoclastic rocks; Miocene & Oligocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	3/0	<1	<1	<1	Ag	3/0	<1	<1	<1
Mo	3/0	<5	<5	<5	Mo	3/1	<5*	<5	5
Cd	3/0	<1	<1	<1	Cd	3/0	<1	<1	<1
Ba	3/3	449	249	792	Ba	3/3	275	186	446
Be	3/0	<1	<1	<1	Be	3/0	<1	<1	<1
Ni	3/3	17	7	27	Ni	3/3	23	12	41
Co	3/2	<15*	<6	19	Co	3/3	20	7	32
Cr	3/3	18	4	28	Cr	3/3	26	7	41
V	3/3	70	14	129	V	3/3	95	22	145
Cu	3/3	20	11	28	Cu	3/3	31	21	48
Zn	3/3	106	85	131	Zn	3/3	83	75	93
Fe	3/3	27,452	11,248	43,183	Fe	3/3	36,076	15,469	48,039
Mn	3/3	2,537	1,913	2,924	Mn	3/3	1,043	450	1,465
K	3/3	1,030	857	1,346	K	3/3	874	725	1,170
Al	3/3	38,995	18,313	50,985	Al	3/3	54,444	33,387	75,682
Li	3/3	9	5	11	Li	3/3	15	9	23
Ca	3/3	10,749	6,773	17,580	Ca	3/3	3,352	2,825	4,202
Na	3/3	211	123	338	Na	3/3	359	149	756
Mg	3/3	3,032	1,123	5,308	Mg	3/3	3,712	1,448	5,187
La	3/3	8	5	10	La	3/3	12	9	15
Sb	3/0	<20	<20	<20	Sb	3/0	<20	<20	<20
Pb	3/2	<15*	<10	22	Pb	3/0	<10	<10	<10
Tl	3/0	<50	<50	<50	Tl	3/0	<50	<50	<50
As	3/0	<20	<20	<20	As	3/0	<20	<20	<20
Se	3/0	<30	<30	<30	Se	3/0	<30	<30	<30
Hg	3/3	0.18	0.14	0.26	Hg	3/2	<0.05*	<0.04	0.07

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

Appendix 7.70. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Tut"** (Tuff; Miocene & Oligocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean ²	Mini- mum	Maxi- mum
Ag	1/0	<1	--	--	Ag	1/0	<1	--	--
Mo	1/0	<5	--	--	Mo	1/0	<5	--	--
Cd	1/0	<1	--	--	Cd	1/0	<1	--	--
Ba	1/1	246	--	--	Ba	1/1	306	--	--
Be	1/0	<1	--	--	Be	1/0	<1	--	--
Ni	1/0	<4	--	--	Ni	1/0	<4	--	--
Co	1/1	6	--	--	Co	1/1	7	--	--
Cr	1/1	4	--	--	Cr	1/1	4	--	--
V	1/1	14	--	--	V	1/1	16	--	--
Cu	1/1	7	--	--	Cu	1/1	9	--	--
Zn	1/1	68	--	--	Zn	1/1	103	--	--
Fe	1/1	20,052	--	--	Fe	1/1	21,199	--	--
Mn	1/1	1,209	--	--	Mn	1/1	2,147	--	--
K	1/1	941	--	--	K	1/1	1,050	--	--
Al	1/1	18,506	--	--	Al	1/1	24,374	--	--
Li	1/1	5	--	--	Li	1/1	7	--	--
Ca	1/1	3,552	--	--	Ca	1/1	2,653	--	--
Na	1/1	117	--	--	Na	1/1	--	--	--
Mg	1/1	1,206	--	--	Mg	1/1	1,319	--	--
La	1/1	23	--	--	La	1/1	18	--	--
Sb	1/0	<20	--	--	Sb	1/0	<20	--	--
Pb	1/1	10	--	--	Pb	1/0	<10	--	--
Tl	1/0	<50	--	--	Tl	1/0	<50	--	--
As	1/0	<20	--	--	As	1/0	<20	--	--
Se	1/0	<30	--	--	Se	1/0	<30	--	--
Hg	1/1	0.09	--	--	Hg	1/1	0.05	--	--

¹Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

² Only one concentration value for the soils is listed under arithmetic mean.

Appendix 7.71. Distribution statistics for concentrations (in ppm of dry soil) of metals in soils on **geologic unit "Ty"** (Mudstone & siltstone, with interbedded arkosic, glauconitic and basaltic sandstone of the Yamhill Formation & related rocks; Eocene). For sampling site #(s) and physiographic province(s) see Appendix 2.

In A HorizonIn B Horizon

Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum	Metal	Total sample number/ detects ¹	Arith- metic mean	Mini- mum	Maxi- mum
Ag	2/0	<1	<1	<1	Ag	2/0	<1	<1	<1
Mo	2/0	<5	<5	<5	Mo	2/0	<5	<5	<5
Cd	2/0	<1	<1	<1	Cd	2/0	<1	<1	<1
Ba	2/2	225	218	232	Ba	2/2	163	163	176
Be	2/1	<1*	<1	1	Be	2/1	<1.2*	<1	1.3
Ni	2/2	23	22	23	Ni	2/2	26	25	27
Co	2/2	13	7	19	Co	2/2	15	8	22
Cr	2/2	38	30	46	Cr	2/2	46	39	54
V	2/2	49	34	65	V	2/2	61	44	79
Cu	2/2	22	17	27	Cu	2/2	27	19	35
Zn	2/2	80	76	85	Zn	2/2	86	78	95
Fe	2/2	33,172	30,787	35,558	Fe	2/2	39,726	38,071	41,380
Mn	2/2	765	728	803	Mn	2/2	513	500	525
K	2/2	1,889	1,132	2,646	K	2/2	1,987	1,025	2,948
Al	2/2	41,186	26,201	56,172	Al	2/2	51,576	35,519	67,634
Li	2/2	25	22	28	Li	2/2	29	25	33
Ca	2/2	2,876	1,604	4,148	Ca	2/2	1,291	793	1,789
Na	2/2	87	78	96	Na	2/2	82	81	84
Mg	2/2	3,605	2,284	4,926	Mg	2/2	4,045	2,457	5,632
La	2/2	21	16	26	La	2/2	23	13	33
Sb	2/0	<20	<20	<20	Sb	2/0	<20	<20	<20
Pb	2/1	<11*	<10	12	Pb	2/1	<13*	<10	16
Tl	2/0	<50	<50	<50	Tl	2/0	<50	<50	<50
As	2/0	<20	<20	<20	As	2/0	<20	<20	<20
Se	2/0	<30	<30	<30	Se	2/0	<30	<30	<30
Hg	2/2	0.08	0.06	0.09	Hg	2/2	0.07	0.05	0.08

¹ Detects are the number of samples with concentrations equal to or greater than the laboratory reporting limit.

* Where the concentration of a metal in a sample is less than the laboratory minimum reporting level, the minimum reporting level is used for calculating arithmetic mean, and the arithmetic mean is qualified as less than the value given.

APPENDIX 8. Heavy Metal and Trace Element Contents of Surface Soils of the United States. (Compiled)

Appendix 8.1 Arsenic, Barium and Beryllium Contents of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984)

Soil	Arsenic (As)		Barium (Ba)		Beryllium (Be)	
	Range	Mean	Range	Mean	Range	Mean
Sandy soils and lithosols on sandstones	<0.1-30.0	5.1	20-1,500	400	<1-3	1.9
Light loamy soils	0.4-31.0	7.3	70-1,000	555	1-3	1.7
Loess and soils on silt deposits	1.9-16.0	6.6	200-1,500	675	1-3	1.7
Clay and clay loamy soils	1.7-27.0	7.7	150-1,500	535	<1-15	1.9
Alluvial soils	2.1-22.0	8.2	200-1,500	660	1-3	1.6
Soils over granites and gneisses	0.7-15.0	3.6	300-1,500	785	1-2	1.6
Soils over volcanic rocks	2.1-11.0	5.9	500-1,500	770	<1-3	1.7
Soils over limestones and calcareous rocks	1.5-21.0	7.8	150-1,500	520	1-2	1.6
Soils on glacial till and drift	2.1-12.0	6.7	300-1,500	765	<1-2	1.6
Light desert soils	1.2-18.0	6.4	300-2,000	835	<1-7	2.1
Silty prairie soils	2.0-12.0	5.6	200-1,500	765	1-1.5	1.4
Mollisols and dark prairie soils	1.9-23.0	8.8	100-1,000	595	<1-3	1.5
Organic light soils	<0.1-48.0	5.0	10-700	265	<1-1.5	1.2
Forest soils	1.5-16.0	6.5	150-2,000	505	1-3	1.9
Various soils*	<1.0-93.2	7.0	70-3,000	560	<1-5	1.6

* All other soils which cannot be encompassed by the groups above.

Appendix 8.2 Chromium, Copper and Lead Contents of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984)

Soil	Chromium (Cr)		Copper (Cu)		Lead (Pb)	
	Range	Mean	Range	Mean	Range	Mean
Sandy soils and lithosols on sandstones	3-200	40	1-70	14	<10-70	17
Light loamy soils	10-100	55	3-70	25	<10-50	20
Loess and soils on silt deposits	10-100	55	7-100	25	10-30	19
Clay and clay loamy soils	20-100	55	7-70	29	10-70	22
Alluvial soils	15-100	55	5-50	27	10-30	18
Soils over granites and gneisses	10-100	45	7-70	24	10-50	21
Soils over volcanic rocks	20-700	85	10-150	41	10-70	20
Soils over limestones and calcareous rocks	5-150	50	7-70	21	10-50	22
Soils on glacial till and drift	30-150	80	15-50	21	10-30	17
Light desert soils	10-200	60	5-100	24	10-70	23
Silty prairie soils	20-100	50	10-50	20	10-30	21
Mollisols and dark prairie soils	15-150	55	10-70	27	10-70	19
Organic light soils	1-100	20	1-100	15	10-50	24
Forest soils	15-150	55	7-150	17	10-50	20
Various soils*	7-1,500	50	3-300	26	<10-70	26

* All other soils which cannot be encompassed by the groups above.

Appendix 8.3 Cobalt, Nickel and Zinc Contents of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984)

Soil	Cobalt (Co)		Nickel (Ni)		Zinc (Zn)	
	Range	Mean	Range	Mean	Range	Mean
Spodosols and Sandy soils	0.4-20	3.5	<5-70	13.0	<5-164	40.0
Light loamy soils	3-30	7.5	5-200	22.0	20-118	55.0
Loess and soils on silt deposits	3-30	11.0	5-30	17.0	20-109	58.5
Clay and clay loamy soils	3-30	8.0	5-50	20.5	20-220	67.0
Alluvial soils	3-20	9.0	7-50	19.0	20-108	58.5
Soils over granites and gneisses	3-15	6.0	<5-50	18.5	30-125	73.5
Soils over volcanic rocks	5-50	17.0	7-150	30.0	30-116	78.5
Soils over limestones and calcareous rocks	3-20	9.5	<5-70	18.0	10-106	50.0
Soils on glacial till and drift	5-15	7.5	10-30	18.0	47-131	64.0
Light desert soils	3-20	10.0	7-150	22.0	25-150	52.5
Silty prairie soils	3-15	7.5	<5-50	16.0	30-88	54.3
Mollisols and dark prairie soils	3-15	7.5	7-70	19.5	20-246	83.5
Organic light soils	3-10	6.0	5-50	12.0	<5-108	34.0
Forest soils	5-20	10.0	7-100	22.0	25-155	45.7
Various soils*	3-50	10.5	<5-150	18.5	13-300	73.5

* All other soils which cannot be encompassed by the groups above.

Appendix 8.4 Manganese, Selenium and Vanadium Contents of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984)

Soil	Manganese (Mn)		Selenium (Se)		Vanadium (V)	
	Range	Mean	Range	Mean	Range	Mean
Sandy soils and lithosols on sandstones	7-2,000	345	<0.1-3.5	0.50	7-150	47
Light loamy soils	50-1,000	480	<0.1-1.2	0.33	20-150	77
Loess and soils on silt deposits	50-1,500	525	<0.1-0.7	0.26	20-300	102
Clay and clay loamy soils	50-2,000	580	<0.1-1.9	0.50	20-150	87
Alluvial soils	150-1,500	405	<0.1-2.0	0.50	30-150	79
Soils over granites and gneisses	150-1,000	540	<0.1-1.2	0.40	50-200	100
Soils over volcanic rocks	300-3,000	840	0.1-0.5	0.20	30-300	136
Soils over limestones and calcareous rocks	70-2,000	470	0.1-1.4	0.19	10-150	72
Soils on glacial till and drift	200-700	475	0.2-0.8	0.40	30-200	95
Light desert soils	150-1,000	360	<0.1-1.1	0.50	30-150	93
Silty prairie soils	200-1,000	430	<0.1-1.0	0.30	50-150	87
Mollisols and dark prairie soils	100-2,000	600	<0.1-1.2	0.40	30-150	92
Organic light soils	7-1,500	260	<0.1-1.5	0.30	<7-150	38
Forest soils	150-1,500	645	<0.1-1.6	0.40	15-200	85
Various soils*	20-3,000	490	<0.1-4.0	0.31	0.7-98	--

* All other soils which cannot be encompassed by the groups above.

Appendix 8.5 Mercury and Lithium Contents of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984; ^a from Steinnes, 1993)

Soil	Mercury (Hg)		Lithium (Li)	
	Range	Mean	Range	Mean
Sandy soils and lithosols on sandstones	<0.01-0.54	0.08	<5-50	16.5
Light loamy soils	0.01-0.60	0.07	9-46	24.5
Loess and soils on silt deposits	0.01-0.38	0.08	9-30	20.5
Clay and clay loamy soils	0.01-0.90	0.13	10-64	23.5
Alluvial soils	0.02-0.15	0.05	10-120	34.0
Soils over granites and gneisses	0.01-0.14	0.06	10-45	23.5
Soils over volcanic rocks	0.01-0.18	0.05	15-41	25.5
Soils over limestones and calcareous rocks	0.01-0.50	0.08	6-88	26.5
Soils on glacial till and drift	0.02-0.36	0.07	10-30	18.0
Light desert soils	0.02-0.32	0.06	9-69	25.0
Silty prairie soils	0.02-0.06	0.04	10-34	20.5
Mollisols and dark prairie soils	0.02-0.53	0.10	8-40	22.5
Organic light soils	0.01-4.60	0.28	<5-71	13.0
Forest soils	0.02-0.14	0.06	10-57	24.0
Various soils*	0.02-1.50	0.17	<5-100	28.0
Surface soils (entire U.S.) ^a	<0.01-4.6	0.11	--	--
Surface soils (western states) ^a	<0.01-4.6	0.08	--	--
B horizon (western states) ^a	<0.01-4.6	0.06	--	--
Surface soils (eastern states) ^a	0.01-3.4	0.15	--	--
B horizon (eastern states) ^a	0.01-3.4	0.10	--	--

* All other soils which cannot be encompassed by the groups above.

Appendix 8.6 Molybdenum (Mo) Content of Surface Soils of the U.S. (in ppm dry) (from Kabata-Pendias and Pendias, 1984)

Soil	Range	Mean
Soils over shales	0.30-3.30	2.13
Soils over volcanic ash	0.40-1.80	1.08
Soils over loess	0.75-6.40	2.53
Soils on lacustrine deposits	1.20-7.15	4.14
Alluvial deposits	0.40-2.80	0.88
Alluvial deposits ^a	1.50-17.80	5.80
Soils on glacial deposits	0.08-4.68	1.22
Soils on granitic alluvium	0.13-0.50	0.35
Soils on calcareous alluvium	0.30-2.00	1.25
Various soils*	0.80-3.30	2.00

^a Soils from areas of the western states of Mo toxicity to grazing animals.

* All other soils which cannot be encompassed by the groups above.