Amorphous character in twenty western Montana forest soils with apparent eolian influence
by Robert Joseph Ottersberg

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Soils
Montana State University

Abstract:
Volcanic ash is a significant component of eolian deposits of Recent age in Western Montana. A survey of soil scientists in this region indicated brown color, low bulk density and high silt content are used by many respondents to recognize volcanic ash influence. Twenty forest soils were sampled and characterized.

The soils represent Andept suborders, Andic and Andeptic subgroups and soils with apparent eolian influence indicated by their morphology. Strong amorphous character was associated with a combination of the following morphological properties: 1) high silt content, usually 60% or more; 2) high chroma, usually four or more for Andept suborders, and three or more for Andic and Andeptic subgroups; 3) weak consistence, usually soft, friable, nonsticky, nonplastic; 4) weak structural grade. Nutrient content, cation exchange capacity and water holding capacity appear to be much larger in andic soil with strong amorphous character than non-andic soil material when expressed on a weight basis. On a volume basis, analysis of andic layers was not very different from other soil material with similar textures.

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Date May 26, 1977

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by

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ABSTRACT

Volcanic ash is a significant component of eolian deposits of Recent age in Western Montana. A survey of soil scientists in this region indicated brown color, low bulk density and high silt content are used by many respondents to recognize volcanic ash influence. Twenty forest soils were sampled and characterized. The soils represent Andept suborders, Andic and Andeptic subgroups and soils with apparent eolian influence indicated by their morphology. Strong amorphous character was associated with a combination of the following morphological properties: 1) high silt content, usually 60% or more; 2) high chroma, usually four or more for Andept suborders, and three or more for Andic and Andeptic subgroups; 3) weak consistence, usually soft, friable, nonsticky, nonplastic; 4) weak structural grade. Nutrient content, cation exchange capacity and water holding capacity appear to be much larger in andic soil with strong amorphous character than non-andic soil material when expressed on a weight basis. On a volume basis, analysis of andic layers was not very different from other soil material with similar textures.

INTRODUCTION

Silt rich horizons cover many forest soils of Western Montana. Eolian deposits contributing to this layer include loess and volcanic ash. Volcanic ash influenced soils are considered important for plant growth by some whereas others say they are no more important than any other forest soil.

In a well drained site with a cool humid climate, volcanic ash can be expected to weather to form the amorphous clay mineral allophane. Distinctive properties of this clay mineral are used to determine its presence for classification purposes in Soil Taxonomy. Properties such as high water holding capacity, large pH dependent charge and the ability to complex organic matter may significantly affect fertility of soils containing amorphous clays.

The object of this study is to analyze Western Montana forest soils with apparent eolian deposits and probable amorphous character and to clarify the following questions:

1) Is amorphous character found in all forest soils with apparent eolian mantles? If so, is it strong enough for taxonomic recognition?

2) Can amorphous character be determined in the field by using morphological characteristics?

3) Does amorphous character relate to any physical or chemical properties of the soil?

LITERATURE REVIEW

Sources of Eolian Deposits in Western Montana

Two types of wind blown deposits were important in Western Montana in recent times; loess and volcanic ash. Loess is usually associated with glacial silt (11). Glacier-fed rivers like the Gallatin, Madison, and Bitterroot provided much of the silt deposited in areas they flowed through (4). Loess deposits were not limited to the valleys, but extended into nearby mountains such as the Sapphire Mountains east of the Bitterroot Valley (39). Silt rich surface mantles resulting from Bitterroot loess were found in soil series like Holloway and Trapper, both previously classified as Brown Podzolics. Mineralogy of the Holloway series from the Ninemile Canyon area north of Missoula showed that silt of the surface horizons was of a different origin than residual quartzite and argillite of lower horizons (44). Though early studies of Brown Podzolic soils in the Northern Rockies did not recognize the influence of loess, its presence is suggested by the large amounts of silt and very fine sand in upper horizons of some pedons (Table 1).

Other sources of loess are desert and aerosolic dust (16). Desert dust deposition was expected to have been high from 4,000 to 8,000 years ago during the altithermal or hypsithermal interval (15, 29). Volcanic ash deposited during this warm, dry period has been found sandwiched between layers of loess in Saskatchewan (9). Upper horizons of Palouse loess contain significant quantities of volcanic

Table 1. Three Brown Podzolic Soils with Apparent Eolian Deposition.*

Pend Orielle loam Bonner County, ID		Waits gravelly loam Flathead County, MT		Unnamed Glacier County, MT	
depth (cm)	si+vfs (%)	depth (cm)	si+vfs (%)	depth (cm)	si+vfs (%)
0 - 0.6	76	0 - 0.6	66	0 - 1.3	63
0.6- 1.9	80	0.6- 3.1	64	1.3- 8	58
1.9- 10	75	3.1- 13	66	8 - 23	56
10 - 25	76	13 - 28	65	23 - 43	55
25 - 38	70	28 - 75	58	43 - 68	46
38 - 50	57	75 -110	28	68 - 88	26
50 - 78	54			88 -118	47
78 -128	39			118 -150	53

*from Soil Survey Lab Memorandum #1 (38).

ash (30). During the altithermal, ash could have been deposited in the Rocky Mountains with desert dust, after initial deposition on the Palouse prairies.

Primary deposits of volcanic ash from at least three Cascade Range volcanoes are found in Western Montana (Fig. 1). Glacier Peak, Washington erupted near the end of the Wisconsin glacial period about 12,000 years ago (13). Mount Mazama (Crater Lake), Oregon ejected an