Soil profiles: the more we see, the more we understand

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Abstract
The aesthetics of soils have fascinated soil scientists in all times. Since the late 1800s soil profile drawings, paintings and photographs have been depicted in hundreds of text books. The first soil profile depictions were simple diagrams illustrating different layers and soil processes. Photographs started to appear in textbooks at the end of the nineteenth century. In the 1950s, several books contained water paintings and from the 1970s onwards text books had colour photographs. Soil profile depictions were merely used to illustrate different orders in a classification system. Since the 1990s, efforts have been made to depict the soil profile in 3D. The depiction of soil profiles follows the understanding of the key properties and processes that have formed a soil.

Key Words
Soil profile, painting, soil science history, soil science literature.

Introduction

The first depictions of soil profiles were made long before soil science was established. In many national art galleries across the world, there are paintings of landscapes, usually from the seventeenth century onwards. They illustrate how artists viewed the landscape but also how the naturalists' view and the countryside has changed over time. Landscape painting was popular across Western Europe. Several authors have stated that the Dutch, for all intent and purposes, invented naturalistic landscape paintings in the seventeenth century. It was part of a comprehensive record in paint of their land, people and possessions.
Hans Jenny (1899-1992), best known for bringing together the factors of soil formation into an elegant formula (Jenny 1941), was a dedicated visitor of art galleries. To Jenny, soils were highly aesthetic; threatened soils deserved to be preserved for future generations – an idea that has spread to several countries including New Zealand and that was re-formulated by soil scientists in the USA in 2006 (Drohan and Farnham 2006). Some 40 years ago, Jenny (1968) wrote an article on the image of soil in landscape art from medieval times to the mid 1900s. In 19 paintings he discusses medieval rocks, Renaissance paintings, landscapes of the noble moods, trends towards naturalism, Mediterranean painters, red soils, and the abstract landscape. Jenny's article is a brief historic summary of the artists' views on soils and landscapes, and painters saw things that most other humans did not. In part, because they had never been there and thus it was new, and in part because the artist's ability to actually see and depict was better developed.
The main objective of this paper is to present a historic overview of soil profile depictions supplemented with some discussion on soil knowledge to put the depictions in context. Text books on soils, geology and natural resources from the late 1700s to the present were analysed. The depictions have been grouped chronologically and arbitrarily in periods based on the techniques by which the soil profiles are depicted.

Early depictions of the soil profile

One of the first clear depictions of a soil profile was made by the Dutch medical doctor, nature researcher, writer and poet J.F. le Francq van Berkhey (1729-1812) who wrote the *Natuurlijke historie van Holland* in 1771. Most things beneath the feet of the eighteenth century scientists were unknown, although there were various theories on stones in the soils (by chemical precipitation) or the formation of peat (by algae). Van Berkhey was one of the first to postulate that peat soils were formed from undecomposed plant material.
One of the first books in Britain that viewed soils from a geological point of view was written by J. Morton (1843). Morton wrote "The Nature and Property of Soils" in which discusses alluvial and diluvial soils – a distinction made between fine sediments deposited by water (alluvium), and coarse sediments deposited by floods (diluvium). To Morton soils and geology were one: "*The surface of the earth partakes of the nature and colour of the subsoil or rock on which it rests. The principal mineral of any district, is that of the geological formation under it.*" (Morton 1843). The book contains a detailed description of the Whitfield farm (near Bristol, UK), including a map with a cross-section in colour. No horizons were depicted by Morton and the soil pattern at the map is based on the geological formations.

An often neglected book in soil science history epistels was written by the German F.A. Fallou (1794-1877) who had studied jurisprudence at the University of Leipzig (Germany). He worked as a land tax assessor (Asio 2005) and was interested in mineralogy. Fallou was never married. His love of nature turned his attention to soils - he studied soils as a hobby and published *Pedologie oder allgemeine und besondere Bodenkunde* (Fallou 1862). Just like Senft (1857) he attempted to treat the study of soils as an independent science, and soil as a separate topic from geology – ideas that are mostly attributed to V.V. Dokuchaev. Fallou distinguished between soils formed in-situ and "washed-in" or alluvial soils. He discussed the effect of relief on soil depth, and introduced new terms like pedology and soil quality. Both are still widely used but with a different meaning to different people. Fallou's book contains two maps with soil and geological layers and diagrams of four soil profiles taken near Colditz, between Leipzig and Dresden in Germany.

Russian work brought the study of soils out of the chaos and confusion of the geologic, chemical, and agronomic points of view and established it as independent science (Marbut 1936). This thinking was more or less established with *Ruskii Chernozem* (Dokuchaev 1883). Dokuchaev was a keen observer, travelled widely across the Russian Empire, collected data, and combined existing knowledge into a definition of soil as a natural body with a science on its own. He has been as important for the development of soil science as C. Lyell for geology, C. Darwin for biology and C. Linnaeus for botany.

Many of the study and text books on soil science contain diagrams and pen drawings of soil profiles to illustrate processes or the horizonation of a particular soil. Some have argued that the distinction of different horizons and its relation to soil genesis was an important conceptual finding in soil science, and these discoveries can be largely attributed to the Russian school. Diagrams were very popular in soil science texts to explain the development of horizons, illuvial and eluvial processes, the formation of stone lines and many other soil processes and properties.

Paintings (1950s)
The technique of water and oil paintings for depicting soil profiles has been used in various books. W.L. Kubiëna (1950) wrote the first text book with a pan European view. For the soils of Europe, he introduced a key to classify the soils analogue to the existing keys for classifying flora and fauna. Firstly, the soils of Europe are grouped into 4 zones: Central and Northern Europe, Southern Europe, Alpine soils, and sub-aqueous or underwater soils. The colour of the topsoil is a diagnostic criterion, followed by free $CaCO_3$ content, and then parent material. Following this key, Kubiëna distinguished 173 soil formations (great soil groups) for the whole of Europe. The book contains water paintings of 47 of these soil formations. Although colour pictures were not uncommon in books in the 1950s (the first colour photographs were already made in the 1860s), Kubiëna preferred such paintings because "*..die Zeichnung das Wesentliche besser hervorheben kann*."

The German soil scientist E. Mückenhausen (1907-2005) published in 1957 *Die Wichtigsten Boden der Bundesrepublik Deutschland*. It contains water paintings of 60 soil profiles and although colour photography was reasonably well-developed in the 1950s, Mückenhausen just like Kubiëna, preferred painting. In his view photographs were often falsely coloured, particularly in dry soils and when a flash light was used (Mückenhausen 1957). Water paintings allowed for more freedom to depict the soil profile and details and specific attributes of an individual soil type could better highlighted. Mückenhausen admitted that the paintings were not always a true reflection of the soil, but merely a true representation of a particular type; in his view that was allowed: "*Das alles verstößt nicht gegen die Natur, hilfst aber, das Natürliche klarer verständlich zu machen*.".

Colour photographs (1960-present)
From the 1960s onwards soil science text books were published with colour photographs. Apparently, the technique of obtaining good pictures as well as reproducing them sharply, in true colour and at reasonable cost was overcome. An example from the Netherlands is shown in Fig. 18. De Bakker and Edelman-Vlam published in the mid-1960s soil profiles and their description in magazines for professional land developers. These profiles were compiled in the 1970s and published in a book (de Bakker and Edelman-Vlam 1976). It is a series of 32 common soils in the Netherlands including landscape pictures, laboratory data and razorblade sharp pictures of the soil profiles. The pictures have been taken in a studio from monoliths or lacquer profiles.

A number of books with colour pictures of the soils of the world have also been published. One of the first was a global atlas of soil profiles based on a French soil classification system (Duchaufour 1976). For each soil group (e.g. *Sols isohumiques et vertisols*) there are colour pictures of typical profiles with approximately equivalent classification in FAO-UNESCO and USDA Soil Taxonomy. The pictures are from all over the world.

The soil profile in 3D (1990s and the future)

The increased computer power and micro-computers that became available in the early 1990s made it possible to depict the soil profile in 3D. There were 3D drawings and diagrams from soil profiles made in the past in relation to the smallest unit that can be recognised on the land scale as a "soil", and it was used in the Australian land system mapping developed in the 1950s (Gibbons 1993). In the 1990s, it was possible to depict soils in three dimensions. This had direct applications for the prediction of soil compaction and shear strength or the movement of water and solutes but it also used to study horizons, pores, soil-landscape relations, modelling erosion and 3D GIS cartography-based on soil horizons.

Conclusions

The old landscape painters saw things that most other humans failed to see. They painted soil features that we now recognise as podzols (e.g. Jan van Goyen), paleosols (e.g. Jacob van Ruysdael), Oxisols (e.g. Paul Gauguin), or Vertisols (e.g. George Lambert). Many of these landscapes and soils have now disappeared under tarmac or through the expansion of agriculture and urbanisation. At the time they were painted these soils had no name, no description and soil science had yet to be invented. Yet we can now look at these early soil depictions and note that there is an element of great aesthetics. Perhaps, there was the hidden but apparent invitation to study what was seen. It is impossible to ascertain, but the arts may have opened the eyes for the science to follow – that link may have to be re-established.

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