The Curious Origin of *podology*: The Story of a Milestone Paper

… It places soil study on a natural basis and in fact lays the foundation for a new science that we might call *podology*.

McCool, M. M.; J. O. Veatch and C. H. Spurway. 1923.
Soil Profile Studies in Michigan.

In 2006, the editorial staff of Soil Science reprinted the article, *Soil Profile Studies in Michigan* (McCool *et al.*, 1923) having selected it as one of the seminal papers in soil morphology and pedogenesis (Foss, 2006). Although Simonson had earlier recognized this paper as the first to describe soil characteristics by using horizons, he was also perplexed by the use of the term *podology* and, … *wondered if an error crept into the paper between time the manuscript was prepared and it finally appeared in print* (1999). The preface to the reprinted article makes no reference to nor attempts any explanation of podology (Foss, 2006).

Pedology, podology, Simonson's misprint explanation seems reasonable enough. However, an earlier version of the paper presented during the 1922 meeting of the American Association of Soil Survey Workers (AASSW) contains the term *podologist* (McCool and Veatch, 1923). *Podology* is more than just a misprint, it opens the door to a vibrant period which saw the reinvigoration of soil science due to the adoption of the profile method. It is also the story of the man who developed the foundational principles of pedology in the United States, and the efforts of two of his former students who pioneered its application.

Soil Profile Studies in Michigan was the first paper to demonstrate that horizons differentiated by the profile method had meaningful and consistent physical and chemical differences which the authors predicted, …*will revolutionize the methods of sampling soil* … (McCool *et al*., 1923). Today the use of soil horizons and profiles is so fundamental in soil investigations that it is almost impossible to imagine not using this approach. Yet from the creation of the Bureau of Soils[1] in 1894 until 1917 the definition of soil types was not based on individual soil characteristics but on an assumed relationship to the character of the rock material[2] (Marbut, 1935). From the first soil surveys in 1899 the work of the Bureau had been

[1] *Bureau of Soils* will be used to indicate activities of the Division of Agricultural Soils (1894-1895), the Division of Soils (1895-1901), and the Bureau of Soils (1901-1927).
[2] Putting a specific date on the paradigm shift is a challenge, since the change was a process rather than a specific event. 1917 has been used here in deference to Marbut's remark that the

done in great detail, describing soil types on a county wide or smaller basis. In 1909 a system for nesting the soil types into *great soil provinces* was introduced and was the link which allowed the classification of detailed soil types on a regional basis. This gave the soil survey, Bureau's flagship program, a truly national importance (Whitney, 1909). The province system is often described as a purely geological system (Brevik and Hartemink, 2012), but it had a mix of physiographic, climatic, and topographic components all of which classified soils on the basis of origin (Whitney, 1909; 1921b).

Classification was based on location within one of 13 mutually exclusive soil provinces. For example the Chester series is classified as follows:

Piedmont Plateau Province
Northern Piedmont
Igneous and Metamorphic rocks
Gneiss with some granite
Gray soil
Yellow subsoil
Chester

(Marbut *et al*., 1913; Figure 1.)

In the province system assumptions as to the origin of soils play a dominant role in classification and observable soil properties were not considered until near the end of the process. A second shortcoming is concealed and is observed only in the application of the system. The boundaries between provinces were absolute, a soil type could not belong to two different provinces. Two soils which when observed showed no difference in appearance would be classified as different types if they occurred in different provinces. This would lead to considerable confusion and ambiguity when mapping soils.

The approach of looking at observable **soil** properties, the profile method, was introduced and championed in the United States by Curtis Fletcher Marbut, who chanced upon it when a German translation of Konstantin Glinka's *Die typen der Bodenbildung – ihre Klassifikation und Geographische Verbreitung* made it to the USDA Library in early 1914 (Marbut, 1928). Marbut made a liberal translation of part of Glinka's book and immediately began to adopt and adapt the principles to soils in the United States (Fanning, D. S. Personal Communication; Glinka, 1927; Wilde, 1949). Glinka's book summarized over 30 years of Russian soil investigations and presented a paradigm which considered soils as natural bodies that could be understood by direct

profile method *… did not extend to the work of the Soil Survey to any great extent until after 1917* (Marbut, 1928).

observations of their properties. This change in point of view from province to profile is a classic example of a paradigm shift.

As Thomas Kuhn has pointed out, a paradigm shift faces resistance from all levels within a scientific organization and quickly becomes more a human and often acrimonious process than one based on scientific merit (1970). Although Marbut was *In Charge* of the soil survey he was subordinate to the autocratic, long time, Chief of the Bureau of Soils, Milton Whitney who had a history of escalating conflicts with employees who did not agree with his point of view (Brevik, 1999; Brevik and Hartemink, 2012; Helms, 2002, Tanner and Simonson, 1993). Whitney's views became Bureau orthodoxy. In Whitney's mind the province system not only worked but it presented the soil survey as a meaningful national contribution of the Bureau. Marbut then faced two formidible challenges first, to overcome the inertia of a classification system which had developed over nearly two decades and second, to get a successful, long-term, autocratic Bureau Chief to set aside *his* system. Through a combination of evasion and command Whitney would make an art out of making any revision, or replacement, of the province system (Whitney; 1915, 1921b).

It would be too simple to ascribe Whitney's reluctance to abandon the province system as a knee-jerk defense of his point of view. From a practical (and bureaucratic) perspective, if the Bureau were to adopt the profile method the relevancy of decades of work would fall into question. Marbut realized that, *The complete disregard of the character of the soil . . . makes it extremely probable that a large part of these results will . . . be thrown on the scrap heap . . . of useless facts* and that it would necessitate remapping areas done previously (Marbut, 1921; Anonymous, 1922). For a career bureaucrat such as Whitney, this would be an almost impossible situation to sanction.

The atmosphere Marbut faced on his entry into the Bureau was insightfully described by his daughter Louise and corraborates Kuhn's insights:

> *… Having spent 15 years in a rather exceptionally congenial atmosphere of scholarly thinking at the University of Missouri … Professor Marbut was plunged into what was at first a hostile situation, and one which demanded all his resources of thought and patience and forbearance. It involved contacts with field men and others whose methods and point of view had been fixed by a number of years' practice of routine soil surveying or supervision of it* (Moomaw, 1942).

Soil provinces were first mentioned in Bulletin No. 55 which gives no reference to their origin but they bear a striking resemblence to maps of physiographic provinces being developed in the same era by geographers such as Isaiah Bowman and Nevin Fenneman (Bowman, 1911;

Fenneman, 1914; Whitney, 1909). By training a chemist, by inclination a geologist, Whitney no doubt thought that the soil provinces were a useful way to organize the 715 soil types delineated prior to January 1, 1908. However, not having the mindset of a geographer, Whitney appropriated their work without an appreciation of the limitations of a physiographic system. A major problem was that the scales of the detailed soil survey were not commensurate with those of the provinces. Fenneman was keenly aware of the difficulties this presented and in a remark that foresaw the difficulties faced by the soil survey stated, *. . . on small areas it becomes necessary to know where one province leaves off and another begins* (1914). Fuzzy boundaries becam major issues during detailed mapping. The province system was also developed with a very small database with only 3.4% of the country being represented by completed soil surveys (Brevik and Hartemink, 2012).

Marbut, however, by training and inclination was a geographer. Little has been written on the strong ties Marbut had with geographers despite several of his groundbreaking works on the soils of Africa, the Great Plains, and the Amazon Basin having been published in geographic journals (Marbut; 1923a, 1923b, 1926). Acknowledgement of his abilities as a geographer came from both teachers (Davis, 1897) and colleagues (Shantz, 1936). Marbut recognized that with respect to the classification methodology of the Bureau, *We did not in reality study the soil at all, we determined but little more than the nature of the parent material . . . and assumed that to be the end of the task assigned to us* (1922,).

As early July of 1915 Marbut had pointed out limitations of the province system in a 13 page memorandum to Whitney (Marbut, 1915). Whitney was not swayed then, and would resist abandoning the soil province system through the 1920s and perhaps until his death in 1927 (Whitney, 1921b). He generally gave no reason except for its success as a reason for keeping it. Fenneman offers one insight into this resistance, *There is something almost final and authoritative in the requirement that a province be a convienient unit for discussion* (Fenneman 1914). He then adds a caveat, *This demand is not met if areas are linked together which must be explained by totally different stories* (Fenneman 1914). In other words, the province system would have worked well if the provinces were homogeneous groupings of soil forming factors. Obviously with only 13 provinces for the entire United States *different stories* of soil formation would occur in nearly all of them. Whitney described the progress in developing the province system with the following language, *so far as perfected by the Bureau of Soils* (Whitney, 1909). The use of value-laden language with respect to the province systemmakes it even more difficult to change (why would anyone abandon a system that is being perfected). These considerations make it more understandable how Whitney may have painted himself into a corner having been captivated by, and unwilling to let go of his province system.

Marbut was an outsider in a very "clubby" organization with a reputation for fiercely opposing change. To successfully promote a paradigm change on the scale of moving from provinces to profiles, he would have to work with trusted associates. Two he turned to, Merris Mickey McCool and Jethro Otto Veatch were former students in Missouri who were now at Michigan Agricultural College (MAC). Given its lack of participation in cooperative soil survey work[3], Michigan may seem an unlikely location for groundbreaking work in pedology. However, this lack of involvement also meant that it didn't have a large investment in the soil province work and was able to embark on the new approach with little resistance.

While a student at the University of Missouri, McCool had worked under Marbut on cooperative soil surveys in Missouri from 1906 to 1908 and in 1914 assumed the position of the head of the Soils Department at MAC (University of Missouri; 1906, 1907, 1908; State Board of Agriculture, 1914). Shortly after his arrival McCool wrote to Marbut for advice on how to best prepare his students for work in the Bureau (McCool, 1914). Marbut replied that students should have knowledge of plane table work, geology, and physiography; but in an aside he shares his new insights into soils with his former student.

> … *As a matter of fact, soils are entirely different from geological formations since a soil may be the same extending over a great numer of geological formations… The best literature on that subject is some papers in the proceedings of the International Agro-Geological Congress and certain Russian works which have been translated into German. None of them have been translated into English. Prof. Hilgard has come nearer to the consideration of soils as distinct from geological formations than almost any other writer in this country … In the Bureau of Soils we have not considered that question at all; we are mapping soils as soils but that phase of the matter has never been discussed by us.* (Marbut, 1914a)

This correspondence reveals how quickly and radically Marbut's ideas changed. By his own timeline Marbut states that Glinka's book did not reach the USDA Library until the, . . . *latter part of 1914 and during the years 1914, 1915, and 1916 it was studied and translated* . . . (Marbut, 1928). Also, keep in mind that one of Marbut's first acccomplishments in the Bureau was overseeing the production of Bulletin No. 96, the most thorough application of the province othodoxy to date (Marbut *et al.* 1913). Less than 18 months after Bulletin 96 was issued, in Marbut's mind at least, it was obsolete.

[3] Full cooperators provided workers for the survey, split the livery costs, and sometimes even had a "State man" to coordinate survey activity and discuss matters of soil mapping, classification and correlation.

McCool's arrival was acccompanied by a flurry of activity in laboratory and field work and new positions were added to the faculty of the Soils Department and the staff of the Soils Section of the experiment station. McCool oversaw a series of soil investigations using an clever application of freezing point depressions on soil solutions (a greater freezing point depression indicating a greater concentration of soluble substances). These investigations provided independent refutation of another controversial Bureau orthodoxy, the inexhaustibility of 'plant food' in soils (Bouyoucos & McCool 1915; Bouyoucos & McCool 1916; Whitney, 1909). Thousands of samples were collected and rates of formation of soulble substances in these and samples from across the United States (some of which were provided by Marbut) were determined (McCool 1921, McCool & Millar 1920). McCool sent investigators through out the state of Michigan and a reconnaissance survey of the state and one of the Detroit area were started (McCool, 1915; 1916). His annual reports hint at a great deal of survey activity yet, in contrast to the stream of publications from the laboratory studies, the only soil survey published (as an Experiment Station Bulletin), was a rudimentary survey of the Detroit area (McCool & Grantham 1920). The State's reluctance to conribute to the cooperative soil survey seemingly made the task of completing and publishing a soil survey much more challenging.

While McCool was building the soils program at MAC Marbut had been tirelessly testing the pedological ideas from Glinka's paradigm and adapting them to the soils of the United States. As the profile method was being tested and then gradually implemented by Marbut there was no mention of it in any Bureau bulletins, circulars, annual reports, etc. From the perspective of what the Bureau printed it was as though the profile method didn't exist. Two, very different, but equally probable explanations can be presented. One was that Marbut's work was not sanctioned or at the very least embraced by the Bureau, Whitney's previous behaviors would certainly make this a very real possibility. When L. N. Jensen wrote Marbut in 1917, *. . . to ask if you have on hand . . . your lecture on soil classification - the one you gave last winter . . . at the Cosmos club . . .*, the reply was that it, *. . . has never been published and probably never will be . . .* (Jensen, 1917; Marbut, 1917). This has the tone of someone resigned to a situation out of their control. The other explanation is that Marbut simply was not a prolific writer. R. S. Smith comments that Marbut's answer, *. . . to the pleas of his fellow workers . . .* that he publish more, *. . . was that he did not yet know enough* (Smith, 1942). This is in complete agreement with Marbut's character (Ekblaw, 1942; Russell, 1942). Both of these explanations are completely in character with the men in question.

Regardless of the underlying reason, Marbut was able to wedge his point of view into the soil survey reports through his editing. Subtly at first, but more boldly as he gathered more facts and gained more confidence in his new science. Marbut was always a thorough editor, but

starting in 1914 his editing would escalate into complete rewrites of the *Soils* chapters[4] of the reports which would use the profile method as a means of organizing soil facts (Marbut, 1914b).

Although McCool had marginal success in getting a vibrant soil survey program going it is clear that he had the *proper attitude* with respect to Marbut's pardigm. In his 1918-1919 annual report McCool states … *that the sooner we look upon the soil as being made up of many soil individuals each having to a greater or lesser extent an individuality of its own … the less short sighted we will be* (McCool, 1920a). In May of 1920 the Agricultural Experiment Station entered into a cooperative agreement with the Bureau and McCool remarked that Dr. Marbut assumed … *a very liberal and broad minded attitude* (McCool, 1921). After 20 years of development, the boiler plate language of cooperative agreements would be considered many things but hardly *liberal and broad minded*, unless Marbut and McCool had something new in mind. Almost immediately after the cooperative agreement was signed, soil surveys in 5 Michigan counties were approved (Whitney 1920a; Whitney 1920b). In December of 1920 McCool wrote Marbut … *If you have that carbon copy of Die Typfen (sic) Der Bodenbildung by Glinka which you promised to loan me I shall consider the perusal of the same a very agreeable and profitable indoor sport* (McCool, 1920b). It is apparent that McCool will be a willing partner in promoting the profile method.

Marbut's increasing influence in the Bureau can been seen in the 1920 *Report of the Chief of the Bureau of Soils*. Although it is issued under Whitney's signature, Marbut's point of view is apparent *It's* (the soil survey) *work is scientific in method and geographic in type, but its results . . . contributed . . . to the development of a new science of the soil* (Whitney, 1921c). The *General Review of the Work*, in the 1920 Field Operations of the Bureau of Soils, has a distinctly bipolar feel to it, the first page and a half is all Whitney, the last half page is Marbut who tells readers . . . *to all who have made themselves familiar with the progress of the work, it is evident that the experimental stage was passed years ago. The history of the soil survey is a study in evolution* (Whitney, 1925).

After six years of refining his new science, Marbut ended his period of public silence in October of 1920 when Jacob Lipman invited him to make a presentation at the annual meeting of

[4] The general format of the soil survey reports was to have chapters on the Description of the area, Climate, Agriculture, Soils, and, finally, one with detailed characterization of the soil types found. The party leader had great latitude in composing the Soil chapter which usually consisted of a discussion of the parent material of the county, usually a detailed description of the locations of specific geologic formations and general properties of the soil series. The Soil chapter is a good reflection of the paradigm the party leader employed with respect to pedological processes. In several instances Marbut's handwritten rewrite of a large portion of the Soil chapter was simply inserted into the draft of the report and was able to slip through the editing process. No evidence was found to indicate whether this was with or without Whitney's approval.

the Society for the Promotion of Agricultural Science. Marbut's paper, *The Contribution of Soil Surveys to Soil Science* was a thorough treatment of the fundamental concepts of the profile method which Marbut would refer to as both a *point of view* and a *proper attitude* (Marbut, 1921). The evolution of the profile method was traced and the reader is told, in no uncertain terms, that this new point of view for defining the soil individual is the *right one*. Marbut has not only demoted the role of geology in soil classification, of the eight criteria Marbut presents for the differentiation of soil types, seven deal with the soil profile, with only the last being of a geological nature. An "old" geologic description and a "new" profile description are presented for comparison for two soil types. Marbut boldly announces that *we can now state that our soil survey is a soil survey and not a modified geological survey* and introduces this new branch of soil science as *soil anatomy* (1921). Other than soil anatomy, no new terminology is introduced to help characterize this new science. Pedology was not mentioned even though Marbut was absolutely aware of its use since it occurs in the title of the first chapter and the first sentence in his translation of *The Great Soil Groups of the World* (Glinka, 1927).

Just over a month later at the inaguaral meeting of the American Association of Soil Survey Workers (AASSW) Marbut would announce, as Bureau policy, that …*soils should be mapped regardless of geological origin on the basis of soil differences.*… (Stevenson and Brown, 1921). While the rest of the Association fretted about odometers, common problems in soil surveying, forms of soil maps and soil survey reports; Marbut was finalizing a new system of soil classification in the United States using the Russian paradigm.

By 1921 Marbut was thoroughly embedded in the Bureau and inexorably, through sheer force of will, transforming its culture. One of Marbut's most underrated contributions was instilling a scientific mindset into the soil survey which elevated the importance of the work of soil surveyors due to the emphasis on observation of soil properties. Under Marbut, field men were no longer just Whitney's *boys* relying on Bureau authority and tradition, but were now scientists, entrusted with evaluation of evidence and its interpretation (Bureau of Soils, 1914). Marbut had also organized the mountain of data which had been collected, standardizing and increasing the detail of soil descriptions, making it all available for more thorough review (Marbut *et al.*, 1913). Charles E. Kellogg would reminisce, *To appreciate the work of Dr. Marbut one must realize that although there was much information regarding soils … the data were isolated and scattered* (Kellogg, 1935). In addition, the operational resources of the divisions of chemical and physical investigaations at the Bureau were being increasingly diverted to the study of Marbut's new science (Davis, 1921; Gile, 1921). Much like a virus co-opts the systems of an organism, Marbut had insinuated himself so deeply into the culture of the Bureau that even though there were no public announcements of his new science, the Bureau symptoms attest to his increasing control.

1921 would be his most audacious year yet, Marbut planned to institutionalize the profile method from the very start of the survey. Of the 47 surveys completed that year 34 (70%) would use the profile method operationally to describe soils for an entire county from start to finish (Whitney, 1926).

With the cooperative agreement, a draft of a new classification system in place, and plans for the widespread employment of the profile method, the stage was set for the arrival a second student of Marbut's, Jethro Otto (J. O.) Veatch at MAC. Veatch preceeded McCool at the University of Missouri (1901-1904) and enjoyed a special relationship with Marbut. Next to his yearbook photo was printed, *A fossil. The butt of Marbut's jokes.* (Savitar 1904). Marbut favored a hands-on approach to teaching and in an article regarding teaching physiography would remark that … *a land area, in order to be studied thoroughly, must be mapped* (1905). 'Otto' Veatch took full advantage of this principle and carried out extensive plane table and geological mapping with Marbut during the Christmas vacation 1901-1902 and the summers of 1902 and 1903 (Marbut, 1902; Marbut, 1908; Whitney, 1913). After graduation Veatch worked a semester as Marbut's Assistant in Geology and spent a semester as a graduate student in geology at the University of Wisconsin. In June of 1905 he was hired as the Assistant State Geologist for Georgia. In short order Veatch contributed two substantial (400 p+) publications for the Georgia Geologic Survey and co-authored a USGS report of similar size (Veatch, 1909; Veatch & Stephenson, 1911; Stephenson & Veatch, 1915).

In 1912 Marbut hired Veatch at a generous salary, $280 more per year than men who had started in 1906, to be a "Special Agent" of the Bureau of Soils (Whitney, 1913). Veatch's first survey was Archer county, Texas and Marbut spent the month of April with the survey team, which was unprecedented (Marbut, 1912a; Marbut 1912b). The soil survey leader for the Archer county survey makes no mention in his weekly reports of any interactions with Marbut, in fact the only mentions of Marbut are in conjunction with Veatch … *Mr. Veatch and Prof. Marbut having left the area.*… and … *I am very much in need of the field notes, written by Prof. Marbut and Mr. Veatch*… (Taylor 1912a; Taylor 1912b). It seems as though this was an informal practicum for Veatch, giving Marbut the opportunity to share his knowledge, experience, and viewpoints with a favorite student.

From Texas Veatch proceeded to his second assignment, an unaccompanied survey of York county Pennsylvania. H. H. Bennett, never one for handing out compliments, describes Veatch's mapping of York County PA as … *an excellent piece of work* … and Marbut (under Whitney's signature) describes Veatch as … *one of the best trained men in the Soil Survey.*… (Bennett, 1912; Whitney, 1913). In his 9 years with the Bureau, Veatch was the survey leader of 12 of the 16 soil surveys he was cedited with working on.

From May of 1918 to May of 1919 Veatch was on a special assignment working on forest-soil relationships in cooperation with the US Forest Service and in June of 1921 received permission from Whitney to publish a paper related to that work. *Soils and Their Relation to Climatic and Vegetational Belts, San Franciscan Mountain Region, Arizona* was to have been in the inaugural volume of the journal Ecology (Whitney, 1921a). Lss than two months later Veatch sent a telegram to the Bureau … *Resign effective* (August) *25. Request immediate leave absence wire answer…* (Veatch, 1921b). What precipitated this sudden departure (he gave up 8 ½ days annual leave) is unknown (Veatch, 1921a). There are several possibilities, Veatch's wife had just had a servere illness and perhaps he, as many field men, wanted a change from the vagabond life of a soil surveyor. Second, his paper was never published in Ecology, did Whitney pull the plug?, or was Veatch offered an opportunity to have complete control over soil surveys in Michigan and apply the profile method for the entire survey, not just a few type descriptions? Unfortunately, the folder, *J. O. Veatch Resignation,* was not in the records of the National Archives (Anonymous, 1921). Regardless, MAC hired Veatch on August 21, 1921 as its state leader for soil survey work. (State Board of Agriculture, 1974).

Veatch's impact on the Michigan soil survey was immediate and substantial. During the period from 1899 to 1920 only 11 Soil Surveys had been carried out by the Bureau in the State, however from 1921-1935 under Veatch's leadership, while soil survey work in the rest of the country waned, 42 soil surveys were carried out in Michigan (Miller, 1950). In short order a reconnaissance survey of Ontonagon county was completed by mid November. Of the six soil series mapped during the survey, five were new soil series and all were described using the profile method (Veatch *et al.* 1923). Marbut (under Whitney's signature) singles out the Ontonagon County soil survey in the 1921 General Review of the Work commenting that . . . *it is the first survey yet published by any organization in thie country in which the profile of the predominant soils in Group I (spodosols) have been definitely described* . . . and that it . . . *marks a definite step forward in soil study* (Whitney, 1926).

The second AASSW meeting in November of 1921 was held in East Lansing, Michigan. Marbut's presentation, *Soil Classification*, was his next public step in his methodical creation and application of his new science. No mention is made of the unprecidented shift in point of view of the 1921 soil surveys. Clearly, Marbut's opportunities to report on his work can not keep pace with his on the ground activities. Marbut leads an audience of his soil survey field men through an overview of this new science and its merit, and does not hesitate to offer thoughtful but resolute critisism of the Bureau orthodoxy. Describing the geological (province) centered system he remarks . . . *Scientific history will probably record no greater mistake . . . than this one* . . . and . . . *in the first work of the soil survey practically nothing was learned of the soil* . . . (Marbut, 1922). Building on his 1920 classification Marbut described the profiles of ten soil

"families" (Groups I – X) in the United States based on color, texture, and calcium carbonate accumulations in the soil horizons (Marbut, 1922).

This application of the profile method was a groundbreaking accomplishment representing a tremendous amount of data collection and analysis. This was, perhaps, one of Marbut's best opportunities to name the new science, to distinguish this new point of view from the old. Terminology such as Groups I - X certainly does not capture the exciting conceptual aspects of this new science. Marbut demurs on the nomenclature leaving it . . . *open for future discussion* (Marbut, 1922). Why Marbut was so reticent about introducing new terminology? It seems odd for a man known for his firm convictions to balk at proposing terminology, after all he had just announced the creation of a new science and devoted the considerable resources of the Bureau to do so, why not give them some names? One reason is that it just might not have been very important to Marbut. For a man with his prodigious and near photographic memory for soils, Groups I – X may have been enough. *Forget about the names of the soil types:* Marbut gently reprimanded one colleague, *get the characteristics* (Johnston, 1942). In contrast with the staggering workload Marbut imposed on himself, he had a dislike for details, (Rice, 1942). Ternimology may have been a detail Marbut did not have time or inclination to address.

Thomas D. Rice, with the soil survey since 1901, recalled that Marbut's was more interested in the establishment of the Great Soil Groups than he was in pressing for laboratory studies of soil profiles (Rice, 1942). The question as to whether there were any meaningful differences in these profiles would fall to McCool and Veatch to answer. They were a productive team, with McCool organizing the administratie and laboratory work and Veatch supervising the field work, so that by the third AASSW meeting in November, 1922 they were able to present laboratory results to accompany their profile descriptions (McCool & Veatch, 1923). When compared to Marbut's more labored writing, *Soil Studies in Michigan* has a refreshingly concise style and use of terminology which seems more familiar to modern readers. The drawn out discussions of soil anatomy, profile evolution, and philosophy of differentiating objects of classification of Marbut become soil morphology, soil geography, and explicit discussions of the soil properties which differentiate horizons (McCool & Veatch, 1923). The stated purpose of the research was an … *attempt to apply the concepts and observations of the Russian podologist, Glinka… for the State of Michigan…* (McCool and Veatch, 1923). Podology clearly was an attempt to define the terminology of this new field of study and not a typographic error. Marbut, who was never a 'booster' or promoter had been reluctant to do so and McCool filled the void (Johnston, 1942).

During the 1922 meeting discussions were recorded after each presentation. There was only one comment after McCool and Veatch's paper, by Marbut (in fact Marbut seems to be

virtually the only commentator at this meeting!) *I think that (this) is the first work of the kind to be done in the United States. I am also very glad to get this division line between the northern and southern groups of soils in Michigan*[5]. Marbut has no comment the term podology, nor does anyone else. The absolute newness of this science is confirmed in that even its architect has not yet set his mind on what to call it. The lack of comment might also be interpreted to indicate that the assembled soil investigators and surveyors did not recognize the revolutionary implications of this work. Earlier in the program M. F. Miller had a brief presentation *Should We Have State Leaders of Soil Survey Work?* which generated three and a half pages of discussion (Miller, 1923). The AASSW at this time was known to be devoted issues involving the technic of mapping (Smith, 1942). Did this in depth pedological research catch them off guard?

The following year saw the publication of *Soil Profile Studies in Michigan*. The first sentence announces: *A new concept of soils . . . is gaining acceptance among American soil scientists (*McCool *et al.*, 1923*).* The paper is crisp and precise, what McCool *et al.* cover in one page, it took Marbut eighteen pages to cover. Their definition of the soil profile which, . . . *includes the whole thickness, upon which the soil-forming processes have operated . . .* is crystal clear and wastes no words. Likewise is the discussion of soil forming factors. Marbut's ideas have been distilled into the clean and compact style which would characterize 20th century sceince writing. Where Marbut focuses on descriptive profile descriptions with an ultimate aim of identifying great soil groups, McCool *et al.* have harnessed the considerable resources of the systematically assembled Soils Section at MAC to investigate the chemical characterization of soil profiles throughout the State. Physical and chemical analyses of each horizon are presented for northern (podzol, spodosol) transitional, and southern (alfisol) groups. The truly groundbreaking part of the paper is the discussion of the anaylitical results which are tied to explicit soil forming processes. Eluviation, illuviation, and podsolization are all linked to the chemical and physical characteristics of each horizon. In two short years McCool and Veatch had taken Marbut's 'point of view' and made it a science. No longer would soil investigators and surveyors rely on the untested assumptions of soil derivation from rocks, now there was a working system by which intrinsic soil characteristics could be analyzed.

There is a sense of purpose to the paper, a palpable excitement and confidence, soils were beginning to make sense. The paper reinforces the sense that the profile method has merit, *In scientific investigations pertaining to soils, it is also evident that soils should be sampled with respect to soil profiles and their horizons and not on the basis of linear depths alone.* A

[5] In 1920 Marbut had a somewhat peevish series of correspondences with Michiganders P. S. Lovejoy and J. A. Doelle on the effect of wild fires on soils, where the location of this division line had been one (of many) points of contention. Both Lovejoy and Doelle loved a good scrap which makes Marbut's happiness genuine.

paradigm is useful when it can be used to explain. For many years the province system had not been a useful explanatory tool. This paper is the first to demonstrate the ability of the profile method to explain soils, to have them make sense. McCool *et al.* clearly understand that their paper is ground breaking and podology is their attempt to place their claim its terminiology.

But why podology? Because of its newness there was no scientific body to propose new nomenclature for soil science. Soil biology, soil chemistry, and soil physics were reported as the fields covered by the journal Soil Science in its inaugural issue (Lipman, 1916). The subject area covered by pedology was not even considered even though seven years later this journal would publish *Soil Profile Studies in Michigan*. Charles Shaw prepared a thorough survey of the term pedology covering the Greek roots of the word and the erroneous adoption of pedology by child (or foot) specialists in medicine (1930). Although, as Shaw points out *Paedology* is the correct term for child specialists (and in fact was used by the University of Minnesota Medical School in 1887 (Wilson, 1989)), the debate over the confusion that adopting an already appropriated terminology must have been going on long before that. Marbut's disinclination to develop a detailed terminology left the matter to be decided by the American Soil Survey Association (formerly the AASSW) which finally, in 1929, adopted a resolution that … *Soil Science may properly be termed Pedology…* (O'Neal , 1930). The debate over what to call soil science … *If soil science, why not "rock science," and "plant science," and "stuff science" ?* … would continue, with Gilbert Wooding Robinson contending that "soil science" was a barbaric term (1937).

It seems that podology was widely used at MAC, but it never caught on outside the College. This is borne out by an examination of the College catalogs. In 1924 a graduate track, *Soils 103 Origin of Soils and Principles of Soil Classification: Podology* was introduced and remained on the books (with a change to *Soils 503* in 1926) until 1930 when Soils 503 becomes Pedology and Soils 504 Pedologic Ecology is added as a second graduate track (Michigan Agricultural College 1924; Michigan State College , 1925, 1926, 1927, 1928, 1929, 1930). Glacial geologist, early soil surveyor, and head of the Department of Geology and Geography, Stanard G Bergquist continued to use the term into the mid-1930's, unaware, no doubt, that new terminology had been adopted. (Bergquist 1933; Bergquist, 1935). Bergquist having worked on Michigan soil surveys in 1921, 1922, and 1923 was exposed to the term and it seems to have stuck with him.

Podology was a term intended to give a new name to a new science, but its use was provincial and the historical precedence of pedology led to its recognition (Simonson, 1999). As McCool *et al.* had predicted the profile method did revolutionize sampling for soil investigations. Researchers across the country began work and soon a flood of soil profile articles would appear.

Marbut would continue his development and mapping of the Great Soil Groups and in 1927 preside over his greatest achievement, the International Congress of Soil Science. When Marbut began his development of the profile method the province system had reached a crisis point and some soil surveyors were even ashamed to admit they were part of the soil survey (Rice, 1942). The ascention of the profile method revived the flagging morale of the soil survey field men. *We needed a leader, one able to recreate our science and to convince the world of its merit* (Rice, 1942). Marbut was that leader and his students capably supported him.

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