



Soil Classification

Newsletter No. 1

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Greetings from the New Chair

Commission 1.4 for Soil Classification is experiencing one of the most exciting times for this discipline. World travel, shared research, improved communications, technologies, growing populations and cooperation have increased dramatically in recent years, fostering an opportunity for world soil scientists to rethink their classification of soils. Discussions of a new Universal Soil Classification System at the IUSS meeting in Brisbane have brought excitement and resources to foster communication between soil scientists and users of their information. I am pleased to be involved and hope that the next years will be recorded as a rebirth of the role of soil survey and classification worldwide, especially in developing countries and in areas undergoing degradation from erosion, pollution, nutrient depletion and rapid changes such as warming temperatures, sea level rise, and melting permafrost. Please join me and our vice-chair Dr. Pavel Krasilnikov as we move toward unity and sharing. This newsletter was Pavel's idea and I applaud him for his efforts.

New Officers of the Commission and Soil Classification-related Working Groups

Soil Classification has never been more strongly represented in the structure of the IUSS. Apart from Commission 1.4 “Soil Classification,” we now have two approved Working Groups: the World Reference Base WG, and the Universal Soil Classification WG. New officers were elected at the 19th World Congress of Soil Science in Brisbane for the next four-year period.

IUSS Commission 1.4 “Soil Classification”



Chair – John Galbraith (USA)

John Galbraith is Associate Professor, Crop and Soil Environmental Sciences, Virginia Tech, Blacksburg, VA, having graduated with a PhD in 1997 in Soil Science, Agronomy, and Geomorphology from Cornell University. His research focuses on urban and mined-land classification; soil carbon; and wetland soil identification and genesis. His teaching includes wetland soils and mitigation, soil survey, soil genesis and classification, basic soils for majors and non-majors, soil description and interpretation in field settings, and GIS applications of soil information. John coaches the Virginia Tech Soil Judging Team. He has published 21 refereed journal articles; 7 refereed conference proceeding articles, six edited book chapters, 12 papers in editor-reviewed journals and conference proceedings and three USDA-NRCS soil surveys. John is chair of ICOMANTH, an international committee for study of human-altered and human-transported soils. He has been Associate Editor for Divisions S-10 and S-5. Soil Sci. Soc. Am. J. He is Affiliated Faculty of Conservation Management Institute, Center for Geospatial Information Technologies, and Center for Environmental Applications of Remote Sensing at Virginia Tech. John is a member of Soil Science Society of America and from 2007-8 elected Chair, Div. S-5 (Pedology) in SSSA.



Vice-Chair – Pavel Krasilnikov (Russia)

Pavel Krasilnikov is the head of the Soil Ecology and Soil Geography laboratory (Institute of Biology KarRC, Russian Academy of Sciences), and a half-time research officer at the Faculty of Soil Science, Moscow State University. Until 2010 he was also a Full Professor of the Faculty of Sciences of National Autonomous University of Mexico. He has more than 100 scientific publications, including the books (together with Prof. S. A. Shoba). “Soil Terminology and Correlation” (1999 – edition in Russian, 2002 – edition in English), “A Handbook of Soil Terminology, Correlation and Classification” (co-author), “Soil Geography and Geostatistics: Theory and Applications” (co-editor), and articles on the classification on tropical soil, acid sulphate soils, and vernacular soil classifications. He has organized the International Meetings on “Soil Classification 2004” (Petrozavodsk, Russia) and “Soil Geography: New Horizons” (2009, Huatulco, Mexico). He actively participates in the Commission on Russian soil classification and in the WRB Working Group.

IUSS Working Group WRB (World Reference Base for Soil Resources)



Chair – Peter Schad (Germany)

Master in biology, PhD in soil science, Lecturer at the Technische Universität München, Germany. He works in the IUSS Working Group WRB as a member since 1998, Vice-Chair 2002 – 2010, and Chair since 2010. He is also a member of the German Working Group Soil Systematics. His research experience covers the soils of Germany, Bolivia, Brasil and China.

Vice-Chair – Cornelius (Cornie) Van Huysteen



Cornie van Huyssteen is an associate professor in the Department of Soil, Crop and Climate Sciences at the University of the Free State since January 2000. He lectures Introductory Soil Science, Advanced Soil Chemistry, and Advanced Soil Geomorphology. His research focuses on the relationship between soil morphology and soil hydrology, especially as indicator for the delineation of wetlands. From 1991 to 1999 he was in the employment of the Institute for Soil Climate and Water of the Agricultural Research Council, where he aided in the land type survey and the spatial analysis of soil data. He received his B.Sc. Agric. (Soil Science and Agronomy) in 1991, M.Sc. (Soil Science) in 1995, both at the University of Stellenbosch and his Ph.D. in 2004 at the University of the Free State. His first contact with the WRB working group was in 2002, when the South African team presented the arid soils tour in South Africa and Namibia. Since then he attended the WRB congresses in Petrozavodsk and Santiago. he also attended the field workshops in Vorkuta, Santiago (North and Southern trip), Sydney to Brisbane, and Oslo to Trondheim (Norway). Currently he is working on the correlation between the South African Soil Classification and the WRB.

IUSS Working Group USC (Universal Soil Classification)



Chair – Jonathan W. (Jon) Hempel (USA)

Jon Hempel is the Director of the National Soil Survey Center – US Department of Agriculture – Natural Resources Conservation Service, Lincoln, Nebraska. Previously he worked as a Director of the National Geospatial Development Center – US Department of Agriculture – Natural Resources Conservation Service, Morgantown, West Virginia; State Soil Scientist in the US Department of Agriculture – Natural Resources Conservation Service – Madison, Wisconsin; Soil Data Quality Specialist – Soil Correlator – US Department of Agriculture – Natural Resources Conservation Service, St. Paul, Minnesota. Jon has over 30 years of applied soil survey work, studying how classification systems apply to real world mapping settings. He has extensive mapping and correlation experience in humid, glaciated and residual prairie and forested geomorphic settings. In addition, he has experience in mapping and correlation experience in tundra, arid and semi-arid geomorphic settings. He has been involved

in dozens of geomorphic studies to determine soil landscape correlations, and studied taxonomy and classification in many parts of the world.



Vice-Chair – Erika Michéli (Hungary)

Prof. Erika Michéli is a soil scientist and is Associate Professor and deputy head of the Department of Soil Science and Agricultural Chemistry of Szent István University. She has been on the faculty of SIU for 20 years. She is the major lecturer of Soil Science and the leader of soils related research in the department. She has coordinated several national and international projects in the area of soil degradation. In 2001 she has organized an International Conference on Soil Classification in Gödöllő (Hungary). In 2002-2006 she was the Chair, and in 2006-2010 – the Secretary of the Working Group of World Soil Reference Base for Soil Resources of the IUSS.

Universal Soil Classification

During the IUSS Inter-Congress Council Meeting in summer 2008, Paul Bertsch, on behalf of the US National Committee, raised that IUSS on behalf of Soil Science needs to address the problem of our lack of a common language within the Soil Science community, particularly in relation to the classification of soils. There followed some discussion of the background and structure of the Soil Taxonomy and the World Reference Base, in particular stressing that WRB was originally designed to act as an ‘umbrella’ for National Soil Classification Systems, rather than as a specific soil classification system. “Council recommends that IUSS through its WRB Working Group should make steps towards the establishment of uniform definitional observations and criteria and appropriate quantification within the various soil classification systems”. (Proposed by Winfried Blum, seconded by Rainer Horn).

In September 2009, in Hungary, several events were organized to celebrate the 100th anniversary of the 1st International Conference of Agrogeology. A symposium to overview the 100 years of advances in soil sciences and a seminar entitled “From the Dokuchaev School to Numerical Soil Classifications” were organized. As result of these discussions, a resolution (known as the “Godollo Resolution”) was prepared and forwarded to the IUSS Council for discussion at the 2010 World Congress of Soil Sciences in Brisbane, Australia. The resolution stated that there is a need to develop common standards, methods and terminology in soil observations and investigations and a universal soil classification system and for a new Working Group to coordinate the efforts of this global undertaking.

Many of the scientists who participated in the wording of the “Godollo Resolution” had a formal meeting in May 2010 in Rome, Italy during “Digital Soil Mapping 2010” workshop. There was a general agreement that there is a need for evaluation of current spatial soil definition and classification systems and new innovative approaches should be investigated to develop a common universally accepted system. It was also agreed that a new working group should be set up to coordinate the work and that the development of a Universal Soil Classification (USC) may need several years, hence national systems and the official correlation system of IUSS, the WRB (World Reference Base for soil Resources) should be maintained.

During the 2010 World Congress of Soil Sciences in Brisbane, Australia, the IUSS Council unanimously accepted the “Godollo Resolution” and formally accepted the proposal for a new Working Group to carry out

the proposed investigations and development of common standards, methods and terminology in soil observations and investigations and a universal soil classification system.

It was accepted that Jon Hempel, Director of the USDA National Soil Survey Center in Lincoln, Nebraska would chair the working group.

Members of the Working Group include:

- Alex McBratney, University of Sydney, Sydney, AU
- Alfred Hartemink, ISRIC, Wageningen, the Netherlands
- Ben Harms, Department of Natural Resources, Indooroopilly, QLD, AU
- Curtis Monger, New Mexico State University
- Erika Micheli, Head Department of Soil Science and Agricultural Chemistry Szent Istvan University Gödöllő, HUNGARY (Co-Chair)
- Ganlin Zhang, Chinese Academy of Sciences, Nanzing, China
- Humberto Santos, Embrapa Solos, Rio de Janeiro, Brazil
- John Galbraith, Virginia Tech University, Blacksburg, VA
- Jon Hempel, Director-National Soil Survey Center, Lincoln, NE (Chair)
- Luca Montanarella, Action Leader, Joint Research Center, Ispra, Italy
- Lucia Anjos, Federal Rural University of Rio de Janeiro (UFRRJ), Soils Department, Rio de Janeiro, Brazil
- Method Kilasara, Faculty of Agriculture, Department of Soil Science, Tanzania
- Micheal Golden, Director-Soil Survey Division, Washington, DC
- Peter Schad, Department of Ecology and Ecosystem Sciences, Technische Universität, München, Germany
- Pavel Krasilnikov, Institute of Biology, Karelia Research Center RAS, Petrozavodsk, Russia
- Phillip Owens, Assistant Professor, Department of Agronomy, Purdue University, West Lafayette, IN
- Sergey V. Goryachkin, Institute of Geography, Russian Academy of Sciences, Moscow, Russia

The USC Working Group is scheduled to meet in West Lafayette, Indiana at Purdue University May 6-10, 2011 to begin discussion of background information on proposal for the common standards and Universal Soil Classification System.

Guy Smith Medal

Guy Smith Medal Award Committee



Definition:

Guy Smith Medal Award Committee is a group of experts invited by the current officers of the 1.4. "Soil Classification" Commission of the IUSS in order to select outstanding individuals among the candidates proposed for investiture of the Guy Smith Medal.

The award honors Dr. Guy Smith, a university professor, a soil mapper, an internationally traveled taxonomist, and the principal author of the 7th Approximation of US Soil Taxonomy published in 1975. His body of work in developing a new classification system was exemplary, drawing on experiences of the worldwide community of pedologists and existing systems. The Guy Smith Medal is awarded for the person whose body of work has advanced soil classification.

Criteria for selection of awardees:

The awardee should have the following qualifications:

- 1) Be an active member or formerly active member of a national or international soil science professional society; and
- 2) Be a published author in the field of soil classification; and
- 3) Either have made a significant contribution that advanced the field of soil classification, or compiled a body of work that has advanced the science, success, methodology, or use of soil classification for the purpose of identifying the classification of soils and making soil maps.
- 4) The medal is not invested posthumously.
- 5) Actual officers of the Commission and related Working Groups cannot be nominated.

Periodicity of nomination

The Guy Smith Medal is awarded once in two years and dated to the World Soil Congresses and inter-congress Commission meetings. If the Commission conference data does not fall exactly between the World Congresses, the conference has a priority over the calendar midpoint.

Nomination procedure

The information about the nomination should be distributed by the Commission officers not later than six months before the suggested date of commitment of the Medal via the Commission Newsletter and IUSS Alerts.

The nominees may be proposed by institutions, societies, commissions and working groups of the IUSS, spearheads and individuals. Self-nomination is not encouraged.

The proposal for nomination should include a short justification, including the main steps of the scientific career of the nominee, his/her main scientific publications and the major contribution to the development of soil classification.

The receipt of nominations finishes at least three months before the suggested date of commitment of the Medal.

Award Committee Members

There are three Award Committee members, headed by the Chair. The members are invited by the officers of the IUSS Commission 1.4. Soil Classification. The service of the members of the Committee has no strict time limitation. The members of the Committee should inform the officers of the Commission, if they are planning to refuse their service to allow their timely replacement.

The responsibility of the Chair is to receive nominations and, after discussion and voting on the candidatures, announcing the decision to the Commission. The Chair has a priority to handle the Medal to the awardee; if he/she cannot do it personally, the responsibility may be passed to other members of the Committee or to the Commission officers.

Rudi Dudal Presented First Guy Smith Medal

Professor Emeritus Raoul (Rudi) Dudal, Geo-Institute, Katholieke Universiteit Leuven, Belgium has been awarded the Guy Smith award by the Commission on Soil Classification of the International Union of Soil Sciences, at the event of the 19th World Congress of Soil Science in Brisbane, Australia. It is the First presentation of the award. Foto's: Karen Vancampenhout.





Prof. Karl Star, Chair of IUSS Division of Soil in Space and Time, handing over the Guy Smith Medal, Brussels, Royal Academy for Science and Arts of Belgium, 22/02/2011

LAUDATIO FOR PROF RUDI DUDAL

By Prof. Jozef (Seppe) Deckers, Katholieke Universiteit Leuven
Secretary-General of the Soil Science Society of Belgium

Distinguished delegates, Mr. President of the Soil Science Society of Belgium, Mr. Chairman of the IUSS Division of Soil in Space and Time, it is a real honor for me to provide this laudatio for Professor Rudi Dudal at the occasion of the handing over of the first Guy Smith medal for soil classification.

Let me start by providing a brief overview of Rudi Dudal's professional career. After Rudi Dudal graduated as PhD in agricultural sciences from the Katholieke Universiteit Leuven (K.U.Leuven), Belgium he joined the Belgian Soil Survey Centre at Leuven as Party Chief. The soil survey was still in its early stage and aiming at inventorying our land resources for the purpose of sustained food production. Rudi contributed to setting up the morpho-genetic Belgian soil classification system. With his PhD in 1955 on the loess soils of Central Belgium, Rudi set a bench mark on soil genesis and classification.

He then joined FAO as technical assistant on Soil Resources Appraisal in Indonesia, where he also served as Professor in Soil Science at the University of Indonesia. At that time he travelled across Indochina by elephant to assess the soil resources of the area. As of 1960 he was posted at the FAO headquarters in Rome to become the correlator of the FAO/UNESCO Soil Map of the World of 1960. This was not an easy task in view of the cold war which was still causing big political tensions between the Western countries and the east-block countries. But Rudi managed to overcome these problems by developing friends all over the world

independent of political or religious conviction. This approach is clearly reflected in the soil names of the World soil map legend which find roots from all over the globe. From then onwards things moved very fast: in 1970 he was the Chief, Soil Resources Development and Conservation Service of FAO. At that time Rudi was elected as Secretary-General of the International Soil Science Society (IUSS). From 1976 till 1984 he was the Director of the Land and Water Development Division in FAO.

In 1984 he joined the K.U.Leuven University as full professor in Soil Geography, Soils of the Tropics and Land Evaluation at the Faculty of Agricultural and Applied Biological Sciences.

Let me now highlight Rudi's contributions to soil classification. By developing the Legend of the FAO/UNESCO Soil Map of the World, Rudi made a major contribution towards harmonizing existing national soil classification systems. Thanks to his good personal relations at the time with Guy Smith from USDA, Rudi took the fortunate decision to adopt the concept of diagnostic horizons, properties and materials and implemented it at World scale in the FAO Legend of the Soil Map of the World. This was so successful that afterwards many countries used the Legend of the Soil Map of the World for soil mapping and as a classification. When in 1980 FAO and UNEP took the initiative of the International Reference base for Soil Classification (IRB), Rudi was there to steer the initiative and became its secretary as of 1986 through to 1992. During the famous meeting of IRB at Montpellier in 1992, Rudi has played a key role in aligning the IRB with the revised legend of the FAO Soil map of the World. As such the World Reference Base for Soil Resources (WRB) was born and could count on the full support from FAO and other organizations of the United Nations. In 1998, during the World Congress of Soil Science at Montpellier, the IUSS adopted WRB as its system for soil correlation and classification. Presently Rudi continues to play an important role by supporting harmonization in soil classification, particularly in our recent project on the translation of the soil map of Belgium and Luxembourg to WRB. With his phenomenal background rooting back to his time as a Belgian soil surveyor and all what followed during his career as prominent soil scientist, we are very happy and proud to have Rudi on this team. We are very happy with Rudi's continued presence at the Geo-Institute at K.U.Leuven University where he is still keeping in close touch with the scholars in soil science, stirring up scientific debate on major world issues such as carbon cycles and soil evolution under the global change scenario.

We are very proud and happy that the selection committee of the Guy Smith Prize decided to award its first prize to Professor Rudi Dudal. May I now request Prof. Karl Star Chair of IUSS Division of Soil in Space and Time, to hand over the Guy Smith prize to Rudi Dudal.

Reports of Meetings

19th World Congress of Soil Science

There were three symposia on soil classification:

- 1) Soil classification and information demand (Conveners: Erika Michéli and Bernie Powell)

The symposium contained 16 papers that related soil classification systems with the information demanded by users in multiple countries. Also included were talks concerning conventional, numerical, and digital soil survey techniques for use in making interpretive maps. Other discussions concerned the adequacies or inadequacies of existing and proposed classification systems. A full review of the papers may be found at:

<http://www.iuss.org/19th%20WCSS/.%5Csymposium/pdf/1.4.1.pdf>

(Chair)

2) Soil classification - benefits and constraints to pedology (Conveners: [Bob Ahrens] and **Allan Hewitt**)



The symposium began the global scale and ended at the soil profile scale. Pavel Krasilnikov gave an excellent keynote presentation by surveying soil classification origins and the challenges it faces. He advocated development of a “long-term road map” towards development of a universal soil classification. The slides in this presentation were beautifully crafted on a backdrop of classical paintings. They suggested perhaps that soil classification is art as well as science. David Rees followed with a country perspective by comparing the World Reference Base classes to Australian Soil Classification classes for sodic soils. Modifications were suggested to both classifications to better accommodate Australian sodic soils. Catherine Fox presented the Canadian system for characterising and classifying topsoils, developed to track changes due to environmental and anthropogenic impacts. The focus of soil classification has been on relatively stable inherent soil properties. This paper however recognised that soil classification needs to consider how to better accommodate dynamic soil properties. The final paper by Rosa Poch focused on the relevance of soil morphology and related soil forming processes in the assessment of land for viticulture. It was a reminder that a goal of traditional soil classification has been to express the systematic relationships between soil forming factors, soil processes, soil morphology, life, and land use. New developments that will allow these relationships to be quantified must be embraced, but the need to be able to paint the big picture remains. This is the art of soil classification. A full review of the papers may be found at: <http://www.iuss.org/19th%20WCSS/.%5Csymposium/pdf/1.4.2.pdf>

3) The WRB[®] evolution (Conveners: **Peter Schad** and Andrew Biggs)



The second edition of the “World Reference Base for Soil Resources / WRB”, the official correlation scheme of the IUSS for soil classification, was published in 2006. After 4 years it seemed to be time to reflect the changes and to see which developments have been pushed on by the new edition.

The keynote speaker was Einar Eberhardt talking about “Finding a way through the maze – WBB classification with descriptive soil data”. Huge amounts of soil data are recorded in national databases using national nomenclatures. The author presented an approach to retrieve this information for classifying soils according to WRB using graphical algorithms. They can be automatised in the future and thus allow an automated classification. This approach also reveals ill-determined rules for soil description and illogical definitions in the classification system.

David Morand presented “The World Reference Base for Soils (WRB) and Soil Taxonomy: an initial appraisal of their application to the soils of the Northern Rivers of New South Wales”. Several correlation problems were discussed and fundamental reliance on laboratory data was found to be the most outstanding limitation. He came to the conclusion that WRB was easier to correlate with the Australian classification of the studied soils.

Eric Van Ranst gave a talk “On the origin of Planosols - the process of ferrolysis revisited”. Based on studies in Ethiopia he concluded that it is very unlikely that a process like ferrolysis could explain the genesis of Planosols. As Planosols are therefore not characterized by a unique process of soil formation and furthermore overlap with the recently introduced Stagnosols, it can be questioned that they remain to be a Reference Soil Group of their own.

Freddy Nachtergaele attracted the auditory's interest to mountain soils with "The classification of Leptosols in the WRB". He presented the history of definitions and subdivisions of Leptosols from the original FAO Legend to WRB 2006 and explained how complex these subdivisions had become during that time.

The last speaker was Vince Láng whose title was "Pedometrics application for correlation of Hungarian soil types with WRB". He presented an attempt to correlate different soil classification systems based on the taxonomic relationships of their classification units. This was tested by determining the taxonomic distances between the different types of the Brown forest soils of the Hungarian Soil Classification System and related WRB Reference Soil Groups using dominant identifiers. A full review of the papers may be found at: <http://www.iuss.org/19th%20WCSS/.%5Csymposium/WG1.1.html>

Regional Conferences

All-Russian Scientific Conference "Modern soil classifications and their regional adaptation", Vladivostok, Russia, 6-12 of September 2010.

The conference was held on the basis of the Far East Federal University (FEFU) and the Institute of Soil Science and Biology (ISSB) of the Far East branch of Russian Academy of Sciences with a backup of the Far East division of Dokuchaev Soil Science Society and financial support of Russian Foundation of Basic Research (project № 10-04-06098-g). The conference was attended by more than 80 specialists from all the regions of Russia: scientists working in the area of pedology, practical workers in regulatory actions and quality control of soils. Among the participants there were representatives of nine universities, seven research institutes, and of ecological centers and non-government environmental organizations. The proceedings of the conference have been published as a separate volume in Russian.

The scientific library of the FEFU prepared a thematic exhibition devoted to the history of soil science at the Russian Far East for the participants of the conference.

The conference was opened by the Deputy Director of the Academy of Ecology, Marine Biology and Biotechnology of the FEFU Yu. A. Galysheva, the Head of the department of Soil Science and Ecology of the ISSB N.M. Kostenkov and the Head of the Department of Soil Science and Soil Ecology of the FEFU O.V. Nesterova. The plenary lectures covered the topics of regional adaptation of Russian soil classification to the soils of the Far East (N.M. Kostenkov), genesis and classification of brown soils of the south of the Far East region and methods of their study (B.F. Pshenichnikov, the Department of Soil Science and Soil Ecology of the FEFU). The issues of mountainous soils classification were discussed by A.S. Vladychenski (Moscow State University) and V.S. Arzhanova (Pacific Institute of Geography).

The conference included three sections: 1) Russian classification of soils in plain areas, 2) Classification of mountainous soils and peculiarity of mountainous pedogenesis, 3) Classification of anthropogenically transformed soils.

The conference program included 53 oral and 15 poster presentations. Most of the presentations raised vivid discussions; the range of topics was very wide. The most attended section was that devoted to the classification of anthropogenic soils. The presence of the participants of various generations showed that pedology in Russia has a good potential for development. Most of the participants noted that the Russian soil classification should take into account the regional peculiarity of soils of Siberia and Russian Far East. The

guests of the conference noted high scientific level of the presentations and good organization of the conference.

The Conference program also included two field tours: “The soils of the catchment of Hanka Lake” and “The soils of coastal and island ecosystems”. The aim of the tours was to show particular soils with *argic* (*argillic*) and *cambic* horizons, which have morphology and properties different from that of soils in European part of Russia. The genesis, morphology and properties of these soils were vividly discussed by the participants; the conclusion was that actual Russian soil classification does not reflect the regional peculiarity of these soils.

(Alina Nazarkina, Olga Nesterova and Viktoria Semal)



The participants of the field tour “The soils of coastal and island ecosystems”.



The participants of the field tour “The soils of the catchment of Hanka Lake”: soils with *argic* horizon.

Soil Classification at the 2010 Annual SSSA Meeting

Convenor: **Anthony O'Geen**, Univ. California, Davis, CA USA

The symposium began with introductory remarks by Dr. O'Geen. **Samuel Indorante**, USDA-NRCS spoke on the "Relationship Between Sodium Affected Soil Distribution and Relict Patterned Ground On the Loess Covered Illinoian till Plain of South Central Illinois: I". The talk is summarized: The intricate pattern of SAS and non-SAS on level to nearly level uplands indicates differential redistribution of sodium derived from primary minerals in the loess. Previous research suggests that differential water movement and variations in evapotranspiration, both associated with current and historical soil landscape settings, were the mechanisms responsible for redistribution of sodium in solution. The recent updating and digitization of Illinois soil surveys revealed that patterns on aerial photos of SAS and non SAS soils on level to nearly level uplands are similar to patterns of ice-wedge polygons in areas of modern permafrost. A model is introduced that proposes that the microtopography responsible for driving the water system resulted, in part, from the formation and degradation of discontinuous permafrost during Wisconsinan glaciation.

The talk "Relationship Between Sodium Affected Soil Distribution and Relict Patterned Ground On the Loess Covered Illinoian till Plain of South Central Illinois: II" followed by co-author **Michael Konen**, Northern Illinois University. The talk explained the genesis of the sodium-affected soils and their distribution on relict ice-wedge polygon borders, as affected by microtopography.

Douglas Wysocki, USDA-NRCS, Lincoln, NE spoke next on "Looking for Loess in All the Wrong Places: Characteristics and Geomorphic Inferences of a Late Pleistocene (OIS 5a and 4) Paleosol in Silt-Rich Coastal Plain Deposits along the Potomac River in Southeastern Virginia." In summary: Most paleosols are found and studied in Pleistocene-age eolian deposits in the central United States. Paleosols in the Atlantic Coastal Plain region have had limited attention and until recently have not been considered stratigraphically or paleoclimatically important. A late Pleistocene paleosol from a shoreline outcrop at High Point on Mason Neck, on the east edge of Occoquan Bay in VA was sampled, and stratigraphically, the loess-derived paleosol marks a subaerial-exposure and soil-forming period sandwiched between two subaqueous units. More paleosol investigations are needed in the Atlantic Coastal Plain.

Patrick Drohan, Pennsylvania State University, University Park, PA spoke about the "Extent and Thickness of Last Glacial Aeolian Additions to Soils Across the Conterminous U.S." In summary: The authors sought to identify and potentially map aeolian soils in the conterminous United States, based on a model of the spatial extent and thickness of Last Glacial aeolian deposition of dissimilarities in particle size between upper 1.5 m soil profiles and parent materials underlying 900 soils from Pennsylvania. Results from this analysis were then used with a digital multilayer soil characteristics dataset for the conterminous United States (CONUS-SOIL) to derive the extent and thickness of aeolian additions across the conterminous U.S. Our results indicate aeolian additions are far more widespread than previously noted and its potential affect on soil genesis in the eastern U.S. is likely as significant as it is in western U.S. models of soil genesis, which are driven by profile aggradation. A rationale was also presented of some of the reasons that thin loess has not been reported in Pennsylvania.

Micheal Golden, USDA-NRCS, Director-Soil Survey Division, Washington, D.C. presented a talk called "Towards A Universal Soil Classification System." In summary: Soil Scientists from around the world have expressed the desire and need to develop a common USC System. The future USC should not be solely an academic exercise, but should be developed together with the major agencies supporting soil survey and mapping in the world. A global soil classification system that will be adopted by the major National soil survey and mapping agencies will ensure a continuity and consistency of information across political boundaries to assist with some of the more critical environmental issues facing the world today.

Erika Michéli, Szent Istvan University, Godollo, Hungary spoke about “New Developments in WRB: From Pedon to Map and From Individual Classification to Automated Classification.” In summary: Originally designed for the classification of pedons, WRB can now also be used to construct legends for maps with a scale of 1 : 250 000 and smaller. For classification purposes, WRB has only two hierarchical levels, and on the lower level all qualifiers are equal. For mapping, the qualifiers were redistributed into main map unit qualifiers (ranked) and optional map unit qualifiers (non-hierarchical). This introduces on the one hand the hierarchy which is necessary for making maps at different scales and conserves on the other hand the big advantage of WRB as a flexible classification system with a loose hierarchy. The German Federal Institute for Geosciences and Natural Resources is developing a tool which gives a full WRB classification on the basis of field and laboratory data collected according to the German rules of soil survey. This tool can serve as a proxy for automated classification using other national soil databases, although major challenges have been encountered, requiring revisions in logical definitions that can be converted into algorithms.

Erika Michéli, Szent Istvan University, Godollo, Hungary spoke about “Problems with Global Inventory and Correlation of WRB Solonetz and Solonchak Soils with ST.” In summary: The paper presented the classification problems of salt affected soils, and possibilities of harmonization in ST (Soil Taxonomy) and WRB (World Reference Base for Soil Resources). Both systems are based on diagnostic approach, but differences in priority of soil properties in classification are causing spatial consequences in global inventory. There are implications for development of a universal soil classification.

Forthcoming Meetings

IUSS Soil Classification Conference

The Commission 1.4 Soil Classification Conference will be held in Lincoln, Nebraska hosted by the University of Nebraska-Lincoln and the USDA-NRCS National Soil Survey Center from June 9 to 16, 2012. The First Circular is coming soon.

WRB field workshop

The next WRB excursion will be in the region of Wroclaw, Poland. The organizer is Prof. Cezary Kabala from Wroclaw University of Environmental and Life Sciences: cezary.kabala@gmail.com. The dates will be:

Monday, August 29: arrival of participants

Tuesday, August 30, to Friday, September 2: field trip

Saturday, September 3: indoor meeting; farewell event

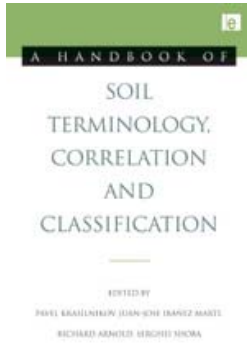
Sunday, September 4: departure of participants.

The details will be announced later.

Peter Schad

Chair of IUSS Working Group WRB

New Books



A Handbook of Soil Terminology, Correlation and Classification

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Soil classification and terminology are fundamental issues for the clear understanding and communication of the subject. However, while there are many national soil classification systems, these do not directly correlate with each other. This leads to confusion and great difficulty in undertaking comparative scientific research that draws on more than one system and in making sense of international scientific papers using a system that is unfamiliar to the reader. This book aims to clarify this position by describing and comparing different systems and evaluating them in the context of the World Reference Base (WRB) for Soil Resources. The latter was set up to resolve these problems by creating an international "umbrella" system for soil correlation. All soil scientists should then classify soils using the WRB as well as their national systems. The book is a definitive and essential reference work for all students studying soils as part of life, earth or environmental sciences, as well as professional soil scientists.

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'This is the most comprehensive and complete review of the state of the art of world-wide soil classification systems...A real desk reference book for soil scientists, especially pedologists.' (Prof. Winfried E.H. Blum, University of Natural Resources and Applied Life Sciences (BOKU), Vienna, Austria)

'Do you know what Spodosol or Rendzina are? This is an invaluable review of soil classification systems and terminology as used in a number of countries. It also reviews efforts for a correlative World Reference Base of Soil Resources (WRB) in addition to the more detailed USDA-sponsored Soil Taxonomy (ST).' (Prof. (emer.) Dan H. Yaalon, Hebrew University, Israel)

'Soil classification systems are more varied than those of other natural objects such as rocks and plants. This book unravels the diversity and idiosyncracies of the world's multitudinous soil classifications, both scientific and cultural. It reveals overt and cryptic commonalities and structures within them, and points the way towards a more united future.' (Prof. Alex. McBratney, The University of Sydney, Australia)

'The most comprehensive inventory of soil classification and correlation systems in the world, this book provides a full overview of the rich diversity of global soil resources and their naming and classification conventions; proving once again, that soil types are a strictly local reality deeply rooted in the cultural and historical context of their locations.' (Luca Montanarella, Land Management/ SOIL Action Unit, European Commission)

'The classification of soils . . . is nightmare stuff . . . so much jargon . . . and such complexity'; so wrote an eminent environmental scientist recently. The editors of this book dispel the mystery with charm and understanding while retaining the technical detail. They provide the keys to our Tower of Babel by matching the soil names in local schemes of classification to the World Reference Base for Soil Resources. The book will prove valuable to all pedologists and especially to those who have to communicate across national borders.' (R. Webster, Rothamsted Research, UK)

Historical Paper: Roy Simonson on the History of Soil Classification

Roy W. Simonson 1989. Historical Highlights of Soil Survey and Soil Classification with Emphasis on the United States, 1899-1970. Wageningen, ISRIC Technical Paper 18.

Chapter 5: SOIL CLASSIFICATION

Soils must be classified in some way before they can be mapped. Before kinds of soils can be shown on maps, kinds of some sort must be recognized. At the outset of the program to map the soils of Nizhni-Novgorod, Doukuchaiev listed the first step as classification of the soils (Yarilov, 1927). That requirement has not changed.

Early Efforts in Classification

Initial efforts in the American program to classify and name soils were made without looking beyond the boundaries of a survey area. Each survey area was a universe into itself. Even so, the possibility of correlating soils of one area with those of another was considered in 1900. The report of field operations for the first season includes a statement that no attempt will be made to correlate "a loam soil in the Connecticut Valley with a loam in the Susquehanna Valley of Pennsylvania unless the two are clearly identical in origin, in character, in relation to crops, and under essentially the same climatic condition" (Whitney, 1900). For a period of four years, the soil survey program was thus using an ad hoc system of soil classification consisting of a single category, the soil type. The possibility of relating soils of one survey area to those of another did not lie fallow long. What was done is brought out in successive books of instructions for soil surveys published in 1902, 1903, 1904, and 1906. The first of those books, published in the fourth year of the program (Bureau of Soils, 1902), includes a list of the 192 soil types recognized by that time. The book published in the fifth year (Bureau of Soils, 1903), however, introduced the soil series for the purpose of showing how soil types of one area were related to those of another. The concept of the series in the 1903 book (Simonson, 1952) is indirect but nonetheless clear:

When Norfolk sand is being deposited the conditions somewhere in the area will undoubtedly be favorable to the deposition of gravel, of fine sand, of silt, of loam, and of clay, and whenever material of these characters is encountered, presumably coming from the same source and being deposited essentially at the same time, they should be given this distinctive name so as to show their relation to one another. Knowing as we do the processes of soil formation, either from the disintegration of rock in place or of its transportation by wind or water, we should expect that materials from the same source would differ in their texture. The relationship of the derived soils should be shown by the use of a common name..." (Bureau of Soils, 1903).

Thus, by the fifth year of the survey program, the system of soil classification consisted of two categories – the *soil series* and the *soil type*. The system continued to be *ad hoc* rather than formal. Furthermore, efforts were made for a few years to "complete" soil series so that each would include the full range of textures from sand to clay, inclusive. The book of instructions issued in the sixth year (Bureau of Soils, 1904) reports much progress in "completing series" but admits that much remains to be done. The effort must have been dropped soon afterward, however, because no mention is made of completing series in the book of instructions published two years later (Bureau of Soils, 1906).

The philosophy underlying the USDA classification of soils in the American survey program as of 1904 is given in a statement by Whitney (1905) to introduce the report of field operations for the year. One section has the heading "Classification of soils," part of which follows:

"The classification of soils in the United States must take into account both the relationship between soils of limited areas and those which concern the entire country. Thus, while a classification founded chiefly upon texture and upon local conditions may be satisfactory over limited areas, the general classification must rely upon the basis of geological origin, the method of formation, and the topographic similarity.



Portrait of Milton Whitney. He was chief of the Bureau of Soils, U.S.D.A. In charge of a Division of Soils, Whitney initiated a soil survey program in 1899 intended to cover the entire country. USDA photograph.

In making the classification there are four main groups of factors which are found to occupy a position of special prominence. The first of these is soil texture.

The second point... is the structure of the soil – that is, the arrangement in space or the condition of aggregation of the soil particles...

The texture, structure, and organic matter content of the soil concern the characteristics of the soil body itself and are nearly as pronounced in the isolated sample as in the mass of the soil under field conditions. There are, however, soil characteristics which are dependent upon the location, the altitude, the surface configuration, and the relationship of the soil body to other surrounding materials. These peculiarities of the soil are grouped under the general term of the physiographic relationship."

Examples of such «peculiarities» are then listed as surface topography, depth to impervious clay or rock, stoniness, and landforms such as level, rolling, and hilly. All of these

groups of soil characteristics are taken into consideration in the classification and naming of the soil type. The place of the "physiographic relationship" mentioned by Whitney (1905) is brought out more clearly in the book of instructions published in the eighth year of the program (Bureau of Soils, 1906). Those instructions show that a third category had been added to the *ad hoc* system since 1904.

No instructions were published in 1905 so far as I have been able to learn. The 1906 book listed soil types by series and soil series by physiographic provinces, 10 of which were recognized in the United States by that time. Three years later, the total was 14 and they were then called "great soil provinces" (Whitney, 1909). Examples of the names assigned to provinces are Atlantic and Gulf Coastal Plains, Piedmont Plateau, Limestone Valleys, and Glacial and Loessial Province. The three-category system continued to be *ad hoc* rather than formal and was never described in a publication as a system of soil classification. Yet it continued to be the primary frame of reference for construction of mapping legends and for the correlation of soils among survey areas for half a century. Furthermore, the system was a good reflection of the prevailing theory of soils genesis, namely, that rock weathering was also soil formation. That theory was well expressed

in the initial statement about the nature of the soil series (Bureau of Soils, 1903). Prevailing theories of soil genesis are strongly reflected in all systems of soil classification (Simonson, 1980).

Even though the main frame of reference for soil classification and correlation remained the same for many years, series criteria were gradually modified and expanded in number almost as soon as the category was first recognized. Summaries of such changes were not published. Changes can be found only if soil survey reports published in different years are compared. Thus, for example, thick and dark A horizons (not so designated) were added to the list of series criteria in the Glacial and Loessial Province by 1904. In that year, the Marshall and Miami series were both recognized in Tama County, Iowa (Ely et al., 1905). The soils are described as formed in identical loess but the Marshall soils had thick, dark surface layers and the Miami soils did not. Prior to 1904, the Miami series had been mapped throughout the region which extended from Maine to Mississippi to Montana. Thus, at the same time that Miami loam was mapped in New York and Ohio, Miami black loam was mapped in North Dakota. Even at that stage, however, a distinction was being made at the "soil type" level by insertion of "black" into the name in one instance. Beginning in 1904, the Miami series was restricted to soils with thin A horizons and evident E horizons (mostly Alfisols), whereas the soils with thick A horizons (mostly Mollisols) were set apart as the Marshall series. Many changes in series criteria were made over the years (Simonson, 1964). Approaches followed in the few efforts in soil survey and soil classification underway in other countries at the turn of the century were in part like those in the United States and in part different. Soils were classified on the basis of geology generally, as pointed out by Coffey (1912a). The one exception was the program in Russia, mentioned earlier. The concept of soil and the approach to classification developed in Russia during the last quarter of the 19th century remained largely unknown in other countries through all of the first and part of the second decades of the 20th century (Simonson, 1985). Few individuals heard of it prior to the second decade. Sibirtsev had presented the ideas of the Dokuchaiev school to the Seventh International Geological Congress in St. Petersburg, Russia, in 1897 (Coffey, 1912b). Although published in French (Boulaire, 1984), the paper largely escaped notice. A translation and condensation by Peter Fireman of the 1897 paper was published in the United States four years after it had been presented originally (Sibirtsev, 1901a, 1901 b) but that failed to register. Looking at the translation now, I think it was good. Yet it made little or no impression on American soil scientists. Even the identity of Peter Fireman is now a mystery. Americans missed a second chance to learn about the Russian work from a report published in Great Britain a bit later (Tulaikov, 1908). It had no more impact than did the earlier papers by Sibirtsev. The items were probably read by few American soil scientists. The prevailing American approach to soil classification during the first twenty years of the century and some indicators of coming changes are illustrated by three maps published by the Bureau of Soils within a 4-year span. These were the first efforts to present a general picture of soil resources of the United States. All of the maps were at a scale of 1:7,000,000. Published just prior to 1910 the first map had the title "United States Soil Provinces" (Whitney, 1909). Fourteen map units were used to show the soils of the country. Almost 20 years later Marbut (1928a) wrote of the map "...A so-called province map was constructed in 1907 or 1908 on the basis almost entirely of geological characteristics with practically no reference whatever to soil characteristics and for several years thereafter the soils were related to one another on the basis of geological features as outlined in that so-called province map".

The second map carried a 1911 date and the title "Preliminary Soil Map of the United States" (Coffey, 1912b). It had 22 map units, some with the same boundaries as those of the 1909 map but many with different boundaries and names. Two big differences between the maps prepared a few years apart and published by the same organization were (a) recognition by Coffey of a large region of "Arid soils, undifferentiated" in the western part of the country and (b) splitting the eastern part into 11 units of dark-

colored prairie soils and 10 units of light-colored timbered soils. The map was in a bulletin released in 1912 (Coffey, 1912b). In his letter of transmittal recommending publication of the manuscript by Coffey, Whitney wrote that the author had begun working for the Bureau of Soils in 1900 and had held all positions from the lowest to the highest. After a few more complimentary remarks, the letter repudiated the manuscript because it did not represent the view of the Bureau. When I first read that letter of transmittal a number of years ago, I thought it strange indeed for Whitney to recommend publication, on the one hand, and repudiate the manuscript, on the other. Later I learned that in 1903 Whitney had approved publication of three and rejected three manuscripts from the Division of Soil Management, of which F .H. King was Chief. Thereupon King resigned and went to the University of Wisconsin. Moreover, he published the second three papers privately (King, 1904) with the approval of the Secretary of Agriculture. The papers reported that yields of corn were increased continuously by progressively larger applications of manure on plots at Goldsboro, North Carolina; Upper Marlboro, Maryland; and Janesville, Wisconsin. Increases were marked on the poorer soils. Moreover, the amounts of nutrient elements soluble in water also increased as manure applications were increased. Such findings were in direct conflict with the thesis offered by Whitney and Cameron (1901), namely, that all soils contain enough nutrients for plant growth and that amendments of various kinds improve conditions of temperature and moisture rather than nutrient status. From this bit of history, I inferred that Whitney decided to recommend publication of the Coffey manuscript with a disclaimer rather than reject it and risk the possibility of later private publication. The first alternative must have seemed the lesser evil. By the time the manuscript was published, Coffey had left the Bureau, working later in both Ohio and Illinois.



Curtis F. Marbut at his office desk. He was in charge of soil surveys in the United States from 1910 until his retirement in 1934.

The third "soil map" of the United States, published in 1913, had the title "Soil Provinces and Soil Regions of the United States" (Marbut et al., 1913). That map had 13 units, one less than the 1909 map. Ironically, the one map unit in the 1909 legend that had included the word soils – "Residual soils of western prairies" – had been dropped by 1913. Many names in the 1913 legend are those used for physiographic provinces today, e.g., Great Plains, Piedmont Plateau, and Great Basin. Although the 1913 map is not mentioned in the criticisms by Marbut (1928a) of the 1909 map, those apply with equal force to both. Perhaps Marbut did not want to criticize his own efforts. Being senior author of the bulletin that carried the map, however, Marbut must have had major responsibility for it. Having been State Geologist in Missouri prior to joining the Bureau of Soils to take charge of soil surveys in 1910 (Kellogg, 1974), Marbut was apparently satisfied with the ad hoc three-category system through the early part of the decade. The combination of the text in Bulletin 96 and the general "soil map" provides good

evidence that changes in the viewpoint of Marbut had not yet occurred. Those changes might have followed his encounter with the book by Glinka (1914).

In addition to providing a general soil map of the country, Bulletin 96 seems to have been meant to serve as a Domesday Book for the American soil survey program up to that time. The volume is massive, with a total of 791 pages (Marbut et al., 1913). All soil series and types that had been recognized are listed in the volume by provinces or regions. Brief descriptions are given of the active series plus keys for their identification. Inactive series, those that were established but later dropped, are also listed together with current placements of such soils in active series. In other words, re-correlations of a number of soils are reported, which are indications of changes in progress. The text materials and their organization clearly show that the ad hoc system of classification consisting of three informal categories of physiographic provinces, soil series, and soil types – the frame of reference for the soil survey program.

Furthermore, the approach in Bulletin 96 also demonstrates that the concept of soil and the theory of soil genesis remained what they had been in the previous decade without showing any effect of the ideas presented by Coffey (1912b) the preceding year. Those ideas seem both eloquent and valid today, as for example:

...Although the soil consists largely of degenerated rock, not all unconsolidated rock can be considered as soil. This material must be acted upon by life in some form before it becomes a true soil. Until this action has taken place it is best to think of it as unconsolidated rock, although it may be readily converted into soil by the influence of organic agencies... The soil is an independent, natural body, a bio-geological formation, differing essentially from the rock which underlies it, although closely related to it. It is the one great formation in which the organic and inorganic kingdoms meet and derived its distinctive character from this union.

Supposedly, the bulletin by Coffey (1912b) was based on his Ph.D. thesis, submitted to George Washington University. The opening page carries a footnote of thanks to Dr. Merrill for “many helpful suggestions and kindly criticisms”, which is especially intriguing. Differences in concepts of soil and in theories of soil formation expressed by Coffey (1912b) and Merrill (1913) are striking. In all three editions of his book, Merrill clearly considers (a) soil to be the mantle of loose and weathered rock and (b) soil formation to be "rock weathering in its fullest sense." Coffey was obviously marching to his own drum despite those sounding all around him.

Although Coffey left the Bureau of Soils at the beginning of the second decade, he did not lose interest in soil classification for several years. He served as chairman of a "Committee on Soil Classification and Mapping" for the American Society of Agronomy (Coffey, 1914). The committee had two members from Canada, one from each of 10 states, two from the state of Ohio, and one from the Bureau of Soils. Among the group, three that were active in soil surveys for long periods were G.N. Coffey, C.F. Marbut, and A.R. Whitson. Checking the list as a matter of curiosity, I found that I had met five of the members, had heard of another five, and did not know of the remaining five.

The Committee prepared a progress report (Coffey, 1914) in which a system of classification was proposed. This had five categories, i.e., I. Precipitation and humidity – Soil regions; II. Dynamic agencies – Soil provinces; III. Lithology – Soil groups; IV. Specific characters and conditions – Soil series; and V. Texture – Soil class. Classes listed for Category I are humid, semi-arid, and arid soil regions. Classes are not listed for Category II but the "dynamic agencies" are given as weathering, biological, water, atmosphere, and glaciation. How

these might be used as class criteria for soil provinces is not explained or illustrated. Classes are not given for Category III, but four rock types are listed as criteria, namely, (a) Acid crystalline rocks; (b) Basic crystalline rocks; (c) Sandstones, quartzites, shales, and slates; and (d) "Lime rocks, including marl, limestone, and marble." A few remarks are made about Categories IV and V, the series and class, but full explanations are not given and may have been thought unnecessary. The scheme was a skeleton rather than complete system. Discussions recorded in the report show that agreement was not reached within the committee. Several members offered criticisms but few changes were actually suggested. Coffey offered a pair of criticisms plus a proposal for a change in Category I. He suggested that too much emphasis was being given to agencies of soil formation and not enough to properties of the soils themselves. Hence, he suggested that "dark-colored prairie soils (chernozems)" and "light-colored timbered soils" be set apart in the highest category. That step would bring the proposed system more into harmony with "work in other countries, especially Russia." That suggestion was rejected by the committee. Members seemingly shared the view expressed by Milton Whitney in his letter transmitting the manuscript for the bulletin by Coffey (1912b): "The primary grouping is based upon the origin and processes of formation rather than upon the characteristics of the soils themselves." The logic behind that statement is a far cry from current ideas in the United States. It resembles those in the Soviet Union where genesis of soils is considered the proper basis for their classification (Gerasimov and Ivanova, 1959). Current Russian understanding of soil genesis, however, differs greatly from that of Milton Whitney in 1912.

Coffey also objected to the list of "dynamic agencies" because they were not all of equal rank. Most could and should be included under the first one – weathering. That suggestion was also rejected by the committee. One item in the report, seemingly without a clear purpose, consists of remarks about the decision made by an International Commission for Mechanical and Physical Examination of Soil in 1913 (Lyon, 1914). The Commission had decided that size limits of soil separates should be those proposed by Atterberg (1908) in steps down from 2.0 mm, namely, 2.0-0.2, 0.2-0.02, 0.02-0.002, and less than 0.002 mm. Perhaps Lyon thought that those size limits could be adopted for use in defining soil classes (Category V).

I have never found a second report of the Committee on Soil Classification and Mapping. Consequently, I presume that the committee was unable to make further headway in its efforts. Moreover, the proposed system was not put into practice anywhere as far as I have been able to learn. Instead of adopting the proposal, the survey program continued to use the ad hoc system with three informal categories as the primary framework. Changes were being made in the concepts of soil series, as had been true from the beginning. In reporting on trends of the time Coffey (1916) wrote that the tendency was to classify on the basis of "actual differences in the character of the soil itself rather than upon a dissimilarity in the method of formation, the kind of rock from which it was derived, or some other basis".

Intermediate Efforts in Classification

Harbingers of coming change in the United States are provided by a pair of papers published by C.F. Marbut in the early twenties although the primary framework for correlation and naming of soils remained as it had been since the early part of the century. Soils were still classified into series and types within physiographic provinces with major emphasis on geology. For example, in a survey of the Panama Canal Zone and contiguous territory, Bennett (1929) set one soil type apart from two others because the underlying rocks were different, not that the soils themselves were known to be.

By 1920, Marbut had been in charge of soil surveys in the Bureau of Soils for about 10 years, with the opportunity to examine soils in all parts of the country. His universe had been greatly enlarged from that of

his native Missouri, where he first became interested in soils. Moreover, he had read "Die Typen der Bodenbildung: Ihre Klassifikation und geographische Verbreitung" by K.D. Glinka (1914). Acquaintance with a much larger universe of soils and with the Russian ideas must have changed his outlook. The change is strikingly illustrated by the contrast between ideas expressed in the two papers and his actions as a member of the Committee on Soil Classification and Mapping less than 10 years earlier (Coffey, 1914). At that earlier time, Marbut opposed a proposal by Coffey to set apart at a high level the dark-colored soils of the central prairies from the light-colored, leached soils of the eastern United States. Seven years later, Marbut (1921) distinguished these two broad groups in his top category (a category is a set of classes of the same rank).

In both papers Marbut (1921, 1922) outlines the beginnings of a classification system for soils east of the Rocky Mountains. That outline was a major part of the 1921 paper but only one of three in the 1922 paper. The system was a first approximation of the scheme presented in more complete form to the First International Congress of Soil Science in Washington, D.C. (Marbut, 1928b) and in the final form in the Atlas of American Agriculture (Marbut, 1935). Three elements of the final scheme were already embodied in the first two papers.

The three elements that persisted from the beginning are (a) splitting all soils into two classes in the top category, (b) geography as a class criterion, and (c) the concept of soil "maturity." Marbut (1921) first divided



Portrait of Curtis F. Marbut. In charge of soil surveys in the United States from 1910 until his retirement in 1934, Marbut had one career as a geologist prior to 1910 and another as a pedologist afterward.

the soils east of the Rockies into a pair of broad groups by a line running south and a little west from northwestern Minnesota to the Texas-Mexico border. West of the line the soils were said to be dark and east to be light in color. Six years later, Marbut (1928b) coined the terms Pedocals for soils west and Pedalfers for soils east of the line. From the evidence available then, he believed that calcium carbonate accumulated in soils west but not east of the line. Aluminum and iron were believed to accumulate in soils east of the line. Accumulations of carbonates, on the one hand, and of sesquioxides, on the other, were also thought to be mutually exclusive (Marbut, 1928b).

A second element of the 1921 paper that persisted through all of the draft schemes prepared by Marbut was the use of geography as a basis for differentiating classes of soils. The two broad groups east of the Rockies were set apart first on the basis of a geographic boundary rather than specified soil characteristics. The belief that geography and characteristics of soils coincided fully is implicit in the separation.

A third element in the 1921 paper that was carried through all later draft schemes consists of the concept of soil "maturity." Marbut (1921) proposed

that the broad groups of soils east of his north-south boundary be subdivided into east-west belts of gray, brown, and yellow soils from the Canadian border to the Gulf of Mexico. The southernmost belt is labeled "yellow soils" because Marbut considered them the "mature" specimens in the region. Soils with red colors in their deeper profiles were common, but those were not considered "mature." Marbut (1921) argued then and later that classification should be based on "mature" specimens of soils as was done for animals and plants.

Despite the emphasis on "mature" soils in 1921 and later (Marbut, 1926, 1928b, 1935), what he had in mind for them is not clear. The names of some groups of "mature" soils of dry regions are listed in a paper on the classification of "arid soils" (Marbut, 1926). First, soils of the word are subdivided into a pair of classes, viz.:

I. Soils developed or developing under the influence of normal good drainage.

II. Soils developed or developing under the influence of excessive moisture.

In the remainder of the paper, only those soils in the first group (1) which qualify as "arid soils" are considered. Such soils are said to be those that in a "mature" stage have a zone of salt accumulation, usually calcium carbonate, in some horizon of the profile. Four sets of soils are then listed in outline form, presumably with mature, immature, and post-mature specimens in each. In the first are black, grayish black, and very dark brown soils; in the second are chestnut or dark brown soils; in the third brown soils; and in the fourth gray desert soils. Post-mature soils are said to be rare and no indications are included as to how they can be recognized. Possible bases for recognition of immature soils are listed as thickness and color of the A and B horizons but no limits are specified.

From the various papers by Marbut, the best I can do is to guess what he might have had in mind for "mature" soils. My guess is that those were formed (a) in undulating uplands which had been stable for extended intervals, (b) in deep regoliths of intermediate physical constitution and chemical composition, and (c) with deep water tables. Because this is an interpretation, it may be in error.

The initial steps taken by Marbut (1921) in his first paper were repeated in part as the last three major sections of the paper published the next year (Marbut, 1922) and also in the paper given three years later (Marbut, 1926). These several efforts were partial approximations of the scheme of soil classification presented at the 1927 Congress in Washington, D.C. (Marbut, 1928b).

The first two major parts of the paper on soil classification (Marbut, 1922), however, break new ground of major importance, which is why I think of it as an American classic. The first major part includes a few remarks on the concept of soil and then spells out 10 principles for classification of soils as natural objects, with a strong flavor of the logic of John Stuart Mill (1874). The first of the principles begins "The soil is a natural body, developed by natural forces acting through natural processes on natural materials." That emphasis prevails throughout the paper.

The second major part consists of a list and discussion of 10 items that should be covered in the examination and description of a soil profile. The list is much more detailed and complete than any offered earlier in this country, as far as I know. Thirty years later, Whiteside (1954) found that the list largely remained valid although a few additions, deletions, and refinements had been made.

Although they cannot now be fully known, the circumstances of presentation and publication of the paper on soil classification (Marbut, 1922) are intriguing. The paper was published in the report of the second meeting

of a decidedly informal organization, the American Association of Soil Survey Workers. The program for the meeting lists a paper by Marbut comparing soils of southern Europe with those of the United States. No item on soil classification *per se* is in the program, and nothing on the soils of southern Europe appears in the published report. Marbut may have abandoned that topic for one he considered more important, program or no program. The report of the meeting consists of mimeographed pages stapled together without covers, a reasonable approach against annual dues of \$2. Those mimeographed sheets are becoming brittle after 60 years. Fortunately for future American pedologists who may be interested in ideas of their predecessors, the paper on soil classification as well as others by Marbut were reprinted later (Krusekopf, 1942).

Criticisms by Marbut (1922) of past practice in the classification and naming of soils – criticisms which applied directly to what he himself had been doing – were repeated more completely later (Marbut, 1926). Those reflect the state of knowledge in the soil science of their day.

Soil science is probably the only one of the sciences which continues to use terms from some other science and which refers to the characteristics of bodies treated entirely in terms of those sciences with only an incidental relation to the soil. The science until recently has been encumbered with a great number of terms, and in common parlance and even in much literature that claims to be scientific many of those terms are still used. Some pedologists however have discarded many of those terms, such for example as those referring to geological features or agricultural crops, *granite soil* and *wheat soil* serving as illustrations of my meaning. Because, probably, of the close relation shown to exist, by the work of the last few years, between the soil and the climate under which it was developed there seems little tendency to discontinue the use of climatic terms in soil literature.

Those are, however, just as objectionable as those derived from geology or agriculture even though recent work has shown that the character of the soil is dependent at maturity to a much greater extent on the influence of climate than on that of the parent rock.

The two preceding paragraphs are from a paper entitled "The classification of arid soils". Thus, while he was criticizing others for using climatic terms in the names of soils, he did that himself for some reason. No explanation for that is available now.

The three papers on soil classification published by Marbut from 1921 through 1926 were preludes to the one presented to the First International Congress of Soil Science held in Washington, D.C., in 1927 (Marbut, 1928b). That scheme was subsequently revised for publication in the Atlas of American Agriculture (Marbut, 1935). The final version had six categories. Those had been numbered and given names from the bottom to the top as follows: I. Soil units (soils types); II. Soil series groups; III. Local environmental groups (family groups); IV. Broad environmental groups (great soil groups); V. Inorganic colloid composition groups; and VI. Solum composition groups.

The top category (VI) consisted of two classes, Pedalfers and Pedocals. The former was subdivided into three classes in Category V and these were called Soils from mechanically comminuted materials, Soils from siallitic decomposition products, and Soils from siallitic decomposition products. Only one class, Soils from mechanically comminuted materials, was recognized in Category V for the Pedocals.

In Category IV, eight great soil groups are listed for the Pedalfers and four plus "Pedocalcic soils of arctic and tropical regions" for the Pedocals. Those of Pedalfers are Tundra, Podzols, Gray-Brown Podzolic soils, Red

soils, Yellow soils, Prairie soils, Lateritic soils, and Laterites. Those named for the Pedocals are Chernozerns, Dark Brown soils, Brown soils, and Gray soils.

How the three classes of Pedalfers set apart in Category V were to be subdivided into the eight great soil groups in Category IV was not indicated. I presume that each of the three classes would not include all eight great soil groups. Some distribution of the eight among the three at the next higher level must have been intended though none is specified.

Recognition of Red soils and Yellow soils as separate great soil groups indicates a change from ideas held earlier by Marbut. He had previously considered the "yellow" soils but not the "red" ones to be "mature" (Marbut, 1921). If the principle that classification should be based exclusively on "mature" soils were to be followed, a great soil group of Red soils was not justified. Those might have been set apart from the yellow soils at the level of family groups (Category III).

In the final outline of his scheme, Marbut (1935) lists a number of kinds of soils that should be recognized as "family groups" in Category III. The lists of names are identical for the Pedalfers and Pedocals. viz.: Groups of mature but related soils, Swamp soils, Glei soils, Rendzinas, Alluvial soils, Immature soils on slopes, Salty soils, Alkali soils and Peat soils. The above list suggests that all kinds of soils associated with the "mature" soil or soils were to be part of a family group with the latter. Like his earlier publications, however, the monograph on soils of the United States (Marbut, 1935) is not explicit as to what "mature" does mean despite the importance given the term.

Previously, Marbut (1922) had pointed out that animals and plants were classified on the basis of mature specimens exclusively. Neither the old nor the young were part of the bases for scientific classifications of fauna and flora. Moreover, Marbut argued that the approach in soil classification should parallel those for animals and plants. Marbut must not have considered the large differences in the life spans of animals and plants, on the one hand, and the time-spans for the existence of kinds of soils, on the other, as important. Yet the greatly different time-scales certainly undercut the validity of the analogy.

Marbut was unable to complete his system. Even the final version remains unfinished. What he might have done had he had more time we cannot know. He had retired from the post of Chief, Division of Soil Survey, Bureau of Chemistry and Soils, USDA, in 1934 and been succeeded by Charles E. Kellogg. Marbut thus put the final touches on his scheme after he had retired. He then went to England in 1935 to attend the Third International Congress of Soil Science and left it bound for China, traveling part of the way on the Trans-Siberian Railroad. During the journey he contracted pneumonia and then died in Harbin, Manchuria, on August 23, 1935 (Krusekopf, 1942).

By that time, Marbut had been a major figure in soil survey and soil classification in the United States for 25 years. Special recognition was accorded him by the American Soil Survey Association at its annual meeting in Washington in the fall of 1934. On behalf of the Association, A.R. Whitson of Wisconsin presented a gold watch to Marbut at a banquet one evening. Much as he appreciated the gesture on the part of the Association, Marbut was about to attend the sessions the following day without wearing the watch until he was reminded of it. Then he did get the watch out of the desk and took it with him, although it seemed unimportant to him compared to the approval of his fellows.

Several gaps persisted in his system of soil classification. Marbut did not group classes in the lowest category into those in progressively higher categories. Soil types were being placed into series, but that was apart

from the proposed system. Some series were listed as examples of great soil groups (IV) and of solum composition groups (VI). Categories III and V, however, remained shadow rather than substance. Those categories were not used. Looking at the proposal by Marbut (1935) now, we can see that the system had serious flaws but was still a big step forward. The system was one of the first, if not the first, with a formal hierarchy of categories meant to have many classes at the bottom and few at the top, thus being adapted to universes differing greatly in size. The system was also an effort to define classes on the basis of soil characteristics.

The importance of basing their classification on characteristics of soils had been stressed by Marbut for some years, beginning in the early twenties (Marbut, 1922). One of his better statements was made, of all places, to a meeting of sugar technologists in Cuba (Marbut, 1932a). An excerpt follows:

The bases of classification selected in former years have been fundamentally inapplicable to soils mainly because of the lack of soil knowledge. Soils are natural bodies and their classification must recognize that fact. They must be classified as natural bodies. Until a knowledge of their characteristics as natural bodies had been accumulated, a classification as natural bodies was, of course, impossible. Although it is a fact that the soil is one of the great fundamental resources of the world which has been utilized by man as long as any other yet it has been almost the last one to receive any direct study. Until soils are studied as soils, knowledge of soils as soils, of course, cannot be obtained. The study of soils as soils can take place in one place only, and that is in the place where the soil lies. Soils lie in the open on the surface of the earth and must be studied in the place where they occur.

What then is a rational basis for soil classification? The answer is so simple that it seems almost childish to state it. The real basis consists of the characteristics of the soils themselves.

Prevailing viewpoints on soil classification in the early thirties are illustrated in the introductory remarks by Marbut (1932b) and subsequent comments by pedologists from Western Europe and the USSR during one session of the Second International Congress of Soil Science in Moscow in 1930. All remarks are centered on the relationships between broad soil groups and their environments. The remarks clearly indicate the extent to which theories of soil genesis shape efforts in soil classification. The remarks also demonstrate how much the ideas of a soil scientist are shaped by the universe within which he works.

Shortly after the final version of the classification system by Marbut (1935) was published, a new formal guide for making soil surveys was also issued (Kellogg, 1937). This manual included a major change in the definition of the soil series. The 1937 definition follows:

A series is a group of soils having genetic horizons similar as to differentiating characteristics and arrangement in the soil profile and developed from a particular parent material...

Approximately 1½ pages of text are then used to explain the definition. Emphasis on the profile, its horizons, and their characteristics is a marked departure from definitions of the soil series in the early field guides. In those, the series was to consist of a set of soils differing in texture but formed in regoliths deposited or otherwise accumulated at the same time and supposedly having the same composition.

The 1937 series definition reflected and summarized gradual changes that had been in progress from the early years of the soil survey program. Recognition of profiles as bases for the study of soils had been proposed almost 20 years earlier (Marbut, 1922). That profiles should get more attention had been gaining wider and wider acceptance. Several years earlier Rice (1929) had discussed the concept of the series and its

place in soil classification at a meeting of the American Soil Survey Association. He offered a series concept centered on the profile and its horizons their arrangement, morphology, and composition.

Publication of the modified series definition in the 1937 Manual was not followed by an immediate change in the framework for recognizing soil series. The old framework continued to be important. Patterns of thought once widely accepted and followed tend to persist for a long while; they have a momentum of their own (Simonson, 1980). Even so, those changes were underway and gaining strength is demonstrated by modifications in the classification of the soils originally included in the Sassafras series, recognized first in 1900 in the Coastal Plain of Maryland. Prior to 1931, two additional series had been split from the original Sassafras series. During the thirties, however, 10 more series were recognized among soils once included in the Sassafras series (Lyford and Quackenbush, 1956). The additional series were recognized because of two developments. First, the redefinition of the series category called for classes with narrower ranges than in the past. Second, much more mapping was being done than in the previous decade.

After the 1937 Soil Survey Manual was published, program was begun to prepare and distribute standard descriptions for all soil series in the country. The need for standards and their possible forms had been discussed by Baldwin (1934) several years earlier. Series descriptions, most of them very brief, were then on file at the headquarters of the Division of Soil Survey in Washington but were available to few people. The first standard descriptions for distribution were put out in mimeographed form in 1938. Even those were brief. Plans were to revise the descriptions and re-issue them periodically to keep them up-to-date.

Three years after the scheme developed by Marbut was published in final form, it was superseded (Baldwin et al., 1938). The new or modified system also had six categories called type, series, family, great soil group, suborder, and order from the bottom to the top. Changes were made to correct what were considered two major deficiencies in the earlier system and to drop the concept of soil maturity. The first purpose was to accumulate all of the geographic bias of the system in the top category, that of soil orders. That category was revised by replacing the two orders (Pedalfers and Pedocals) by three to be called zonal, intrazonal, and azonal. Those terms had been used by Sibirtsev (1901a, 1901b) prior to 1900. A second purpose was to recognize extensive and important soils lacking a clear place in the Marbut scheme. Such soils were set apart as great soil groups in the intrazonal and azonal orders.

The effort to correct deficiencies was partly successful. Like its predecessor, however, the system of Baldwin et al. (1938) was a skeleton with the same two shadow categories, the second and fourth from the top. Some geographic bias also persisted into the category of great soil groups. Moreover, the system was never completed by grouping soil series into the classes in progressively higher categories. Specimen series were listed for families and for great soil groups but more was not attempted generally (Simonson, 1980). Trial groupings of series into families were made prior to World War II in each of Iowa and New York but those were not published. Modification of the system of Marbut had to be hurried so that the results could be published in the 1938 Yearbook of the U.S. Department of Agriculture, "Soils and Men". The decision to cover soils in that yearbook was made in 1937, allowing a short lead time for preparation of materials to be published. I took part in the scramble for a while, working in Washington, D.C., during the summer of 1937 to edit and revise manuscripts for the next yearbook. My blue pencil marks were on several dozen of the manuscripts that were printed the next year.

Even after the classification system by Baldwin et al. (1938) was published for ostensible use in the American soil survey program, the old framework of physiographic provinces remained the primary one for recognition and naming of soil series (Simonson, 1980). Nonetheless, some changes were being made, e.g., ranges in

series were being narrowed. Thus, for example, a total of 20 series had been proposed by 1954 for soils that were all part of the Sassafras series in 1900 (Lyford and Quackenbush, 1956). Greater attention was also being given, though not wholeheartedly, to identification of soil profiles with the great soil groups of the 1938 system.

Later Efforts in Classification

A step toward placement of all series into the current classification system was taken at the soil survey conference in 1945 by adoption of a requirement that each standard description should identify the series with the appropriate great soil group unless that were clearly impossible. At least the order should be named: Some participants in the conference, as for example, James Thorp, objected to such a requirement because of probable difficulties. Nevertheless, the proposal was adopted, chiefly on the grounds that we should be using the system or quit saying that we were. The anticipated difficulties followed quickly. At the 1946 conference, Committees were set up to review and sharpen the concepts and definitions of a number of great soil groups. Summaries of the efforts over the next few years were published first by Thorp and Smith (1949) and later in more complete form by Simonson and Steele (1960).

Discussion and debate over the concepts and definitions of great soil groups and also of families continued at the annual conferences until 1950 without turning up satisfactory answers. By that time, conference participants had learned that changes in any category could affect others in the system. Additional difficulties had also been encountered. Consequently, the conference decided in 1950 that piecemeal modification of the 1938 system was unsatisfactory and that the whole system should be overhauled. That decision led eventually to the 7th Approximation and to "Soil Taxonomy".

With work started in 1950, much of the coming change in the American classification system had been accomplished by 1960 under the leadership of Guy D. Smith. Six proposals, identified as numbered approximations except for the first two, were developed by 1958. None of these was published for general criticism. The first to be issued for general review and criticism was the 7th Approximation put out in time for the Seventh International Congress of Soil Science (Soil Survey Staff, 1960). Summaries of the approximations and of some discussions have been assembled by Cline (1979).

Reactions to the approximations were mostly negative. Thus, the first one, which covered only the four top categories and had relatively few classes in each, drew heavy fire because of the coined names. Subsequently, names were omitted and classes were identified by a decimal numbering system until the 7th Approximation was issued. The hope was that attention and criticisms would be focused on the structure of the system and on the concepts and definitions of categories and classes. The 3rd and 5th approximations were circulated widely within the United States and to a limited extent outside the country. In contrast, copies of the 7th Approximation were given to all participants in the Seventh International Congress in 1960. Copies were also shipped to many individuals and organizations in other countries. I recall vividly how my friends from other countries recoiled in horror and shock at first sight of the names in the proposal. Still under development in 1960, the 7th Approximation was not adopted immediately in the American soil survey program. Consequently, during the fifties and first half of the sixties, three systems of soil classification were in existence in the United States. One system was being born so to speak; another was presumably being followed in the survey program (the 1938 system with some modifications); a third was still an important framework for recognition of new series, though not acknowledged (physiographic provinces, series, and types). Most of the soil series on the books had been recognized within the early system and a large residue remained in the collective minds of soil scientists.

The 7th Approximation with some modifications was adopted for general use in the American soil survey program at the beginning of 1965. By that time, several trial groupings of the soil series of the country had been completed and circulated widely for review and criticism. These provided guides for application of the system, the adoption of which did bring changes in its train. All series in a survey area had to be placed in the system when a report was prepared for publication. Moreover, all standard series descriptions had to be revised as well to show their placements. The revision of the standard descriptions of the 11,000 series on the books continued well beyond 1970.

Formal adoption of the 7th Approximation did not automatically eliminate use of previous systems. Some people reverted to one or the other of the previous systems from force of habit. Some preferred an earlier system. Supervising soil classification and correlation in the United States during the sixties, I frequently found that series were proposed or their validity defended within one of the other of the systems described by Whitney (1905) and Baldwin et al. (1938), more often the former than the latter. Thus, three systems were being used concurrently. That situation is not unique to soil classification. Ideas once widely accepted are not easily replaced but persist for a long time (Simonson, 1980). After recovering from their initial dismay over the 7th Approximation in 1960, soil scientists could consider it more thoughtfully. Furthermore, information was presented on the historical background and general structure (Simonson, 1962), the objectives and basic assumptions (Smith, 1963), and the logic (Cline, 1963). Evidence of growing interest was indicated by requests for a few thousand reprints of my 1962 paper. Further evidence came during the excursion prior to the Eighth International Congress of Soil Science in Romania in 1964. Asked to comment on the first profile, a Chernozem not far from Bucuresti, and recalling reactions of participants in the 1960 Congress, I confined my remarks to comparisons of the profile with soils in central Nebraska. When I stopped, a man in the pit asked, "Where would you put this in your 7th Approximation?" The people around the pit responded in lively fashion to my calling the profile a Vermustoll. At all subsequent stops during the excursion, Americans were asked for placements of profiles in the 7th Approximation unless those had already been volunteered.

Additional evidence of interest could be drawn from a number of sources but only one more will be cited. This comes from introductory remarks in a bulletin outlining a system of classification of South Africa:

This was an exciting time pervaded by an atmosphere of experimentation and improvisation. In the United States, the USDA Soil Survey Staff was developing an imaginative new system through concerted application of talent and experience that is unique in contemporary soil science. This was happening in full view of world attention. The logic of the approach was refreshing and it loosened the shackles of traditionalism and stimulated re-thinking on soil classification... (MacVicar et al., 1977).

Whatever the reasons, various national systems of soil classification were proposed during the sixties. Three examples will illustrate differing approaches. Bakker and Schelling (1966) described a system for the Netherlands which shares some criteria with the 7th Approximation but differs from it in many ways. The nomenclature is also different. Rather fine distinctions are recognized, consistent with the size of the universe. Northcote (1965) revised a bifurcating scheme for Australia in which a limited number of properties are considered with emphasis on morphology. Classes are rather broad and are identified by symbols rather than names. The Canada Soil Survey Committee (1978) developed a system over a period of years in parallel with efforts in the United States. The Canadian system thus shares a number of features with the 7th Approximation. Diagnostic criteria overlap in part but there are differences as well. Nomenclature is quite different.

Quite apart from any effects on soil classification generally, the 7th Approximation was the basis for a general soil map of the USA, published in the National Atlas (Douglass et al., 1969). The map was at a scale of 1:7,500,000, the same as the one in the 1938 Yearbook of Agriculture, "Soils and Men".

General soil maps were being published in other countries, of which three examples will be cited. The Stichting voor Bodemkartering (1961) put out a map of the Netherlands at a scale of 1:200,000. The map scale could be large because the universe covered was small. For the somewhat larger universe of Ireland, a scale of 1:575,000 was used (Gardiner and Ryan, 1969). For the much larger universe of Australia, a scale of 1:2,000,000 and 10 sheets were needed (Northcote et al., 1960-1967). The individual sheets together with explanatory notes were completed over a period of years with contributions from a number of individuals. Another general soil map of Australia was prepared for the Ninth International Congress of Soil Science held in Adelaide. It was on a single sheet at a scale of 1:10,000,000 (Stace et al., 1968). The intent of all of these maps was to present a general picture of the soils of a country.

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