Special Section

Time-scales and rates of pedogenic processes II.

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Preface

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Soils are natural bodies. Their characteristics result from the interaction of meteorological conditions (climate) on outcropping lithospheric materials over long periods of time. Plant cover produces organic residues which are incorporated into the soil by numerous and diverse soil organisms. Landscape position determines if the new formed mineral and organic (humic) materials stay in place, or if they are transported down slopes and eventually accumulate on foothills, valleys or plains, or end as sediments in rivers, lakes or oceans. On stable landscape positions, soil formation progresses and the soil differentiates into several horizons with distinct properties that reflect the dominant soil forming processes. Soil forming processes include weathering of primary minerals and the neoformation of clay minerals and oxides, humification of organic matter and aggregation of primary soil particles, along with translocation of clay (clay illuviation) or of metal-organic complexes (podsolization), dissolution and precipitation of secondary carbonates, among several other processes. The rates of all these processes vary widely in space according to the initial properties of the outcropping lithospheric materials and the prevailing climatic conditions over time. Lithospheric and climatic properties also help biomass production, turn over rates of organic residues and their mixing into the mineral soil body by soil organisms.

Soil scientists agree in very general terms that the formation of one centimeter of soil requires between 100 and 400 years in unconsolidated regolith such as alluvium, loess, tephra, or glacial sediment. Rates of bedrock disintegration to form regolith and soil are more poorly constrained. At these general rates, a one meter deep soil body would require 10,000 to 40,000 years to form, if soil formation is a linear process. However, not all processes progress at the same rates at any place, nor are these rates constant in time. Some processes proceed very fast at the beginning, and then slow down or reach a steady state (*e.g.*, the accumulation of humified organic matter). Other processes start slow and develop a maximum rate at an intermediate soil age, like clay illuviation, which requires specific chemical conditions throughout a soil profile.

As soil formation proceeds, landscape history is archived within the soil body in form of particular characteristic features. A fully developed soil that developed undisturbed on a stable

land surface is therefore a useful object to decipher how environmental conditions changed during the late Pleistocene and particularly during the Holocene.

Humans are interfering increasingly in soil forming processes. Deforestation, agricultural activities and urbanization are destabilizing the landscape, adding nutrients, compacting, polluting and sealing the soil surface and thus enhancing land degradation. The growing world population demands more and more agricultural land, so that less suitable land is increasingly incorporated into agriculture, and degraded soils need to be rehabilitated. For the latter, natural soil forming rates should be enhanced to achieve reasonable productivity in shorter time intervals.

Greater and more detailed knowledge of the rates of soil forming processes under a variety of natural conditions contributes not only to understanding past environmental conditions, but it also helps to design appropriate rehabilitation techniques for degraded areas. Information about characteristic rates of soil degradation processes will also help to decide on soil conservation and food security priorities.

With this in mind, the chairs of the International Union of Soil Science, Commission 1.3. Soil Genesis, and Commission 1.5. Paleopedology, Prof. Dr. Victor Targulian and Prof. Dr. Edoardo Costantini, proposed an international congress to gather soil scientists from different countries to talk about their experience in characteristic rates of either soil forming, or soil degradation processes as well as on monitoring results from soil rehabilitation experiments. The congress, called Global Soil Change, was organized by the Soil Science Department of the Instituto de Geología of the Universidad Nacional Autónoma de México, under the leadership of Dr. Segey Sedov in March, 2005. A total of 60 participants came from 13 different countries. Two field trips were offered before and after the congress. After the plenary talks, the participants decided to publish selected contributions in special sections of peer reviewed geoscience journals. One of these journals is the Revista Mexicana de Ciencias Geológicas. The selected contributions were organized in two sections: the first one, published in v. 24, no. 2 of this journal, included papers that report characteristic rates of natural soil forming processes. The papers by Schuelli *et al.* and Wagner *et al.* are on soil chronosequences on marine terraces from Norway (1 to 10 ka old) and Sicily (early to middle Pleistocene). They report on rates of podsolization, clay illuviation, clay neoformation and rubefication. Another contribution by Zhang *et al.* reports on weathering indices calculated on behalf of geochemical data from soils formed on basalts aged between 1 and 1000 ka at Hainan Island in China. The contribution by Olga Khokhlova deals with characteristic rates of Chernozems formed in the Ural steppe and buried under kurgans. In this paper soil property changes occurring in time intervals between decades, centuries and millennia are reported. Another contribution by A. L. Alexandrovkiy gives an overview of characteristic soil forming processes and their rates from the Russian plains. Here formation of Podsols, Chernozems and Luvisols in time intervals ranging form decades to several thousand years is discussed considering “normal” progress of soil development and also soil development influenced by bioturbation or by constant addition of allochthonous sediment to the soil surface.

The second section, published in this issue, concentrates contributions made in different soils and regions from Mexico. It starts with a paper by Krasilnikov *et al.* describing the effects of slope processes (mass movement) on the pedogenesis of mountain soils in Oaxaca. It emphasizes on how soil studies can be useful to evaluate rates (and recurrences) of geomorphic processes. Another paper by Haulon *et al.* deals with soil erosion and the main factors contributing to it in agricultural soils from Tlaxcala. One additional paper by Baez *et al.* reports rates of aggregate formation and humus accumulation in rehabilitated tepetates in the Texcoco region, Central Mexico. Also included is a paper by Bronger that summarizes extensive data on kaolinite formation in soils from different regions (Serbia, Morocco, Nepal, India, Tadjikistan and China) gathered during several decades of experience by the author.

We would like to thank all authors for their interesting contributions and to the editorial board of Revista Mexicana de Ciencias Geológicas for offering us a special section within this journal to share the experiences gained during the Global Soil Change Conference with the readership.