

Course: Soil Mineralogy

Identification

Code: SOL 853

Workload: 75 hours

Credits: 5 (2 hours theory - 3 hours practice)

Level: Master and Doctorate

Professor: Fabrício de Araújo Pedron

System: Biennial (II semester)

Discipline objectives

To know the structure, properties, and classification of geogenic and pedogenic minerals found in soils of tropical and subtropical environments, emphasizing the soils of Rio Grande do Sul State. To discuss the main methods used in studying soil mineralogy and to exercise the interpretation of mineralogical data. To know the primary and secondary minerals involved in pedogenesis and its mineralogical evolution and its implications in the morphological, chemical, and physical properties of soils. To study the application of soil mineralogical information in planning environmental and technological activities. To know the main analytical procedures used for the mineralogical characterization of soils.

Syllabus

The discipline Soil Mineralogy deals initially with the mineralogical composition of the Earth's crust, followed by crystallography elements and the characterization of the main primary and secondary minerals found in soils. The main methods of mineralogical analysis are also studied, in addition to sample preparation for X-ray diffractometry and exercises in interpreting diffractograms and other mineralogical data. The final part of the discipline presents the organo-mineral complexes and an analysis of the mineralogy of soils in Rio Grande do Sul State.

Methodology and/or teaching instruments

The discipline uses instruments such as theoretical lectures, seminars on scientific papers, and mineralogical analysis results; field trips to collect soil, saprolite, and rock samples for mineralogical analysis; field trips to visit laboratories related to soil mineralogy; laboratory practices related to soil, saprolite, and rock sample preparation for mineralogical analysis; activities involving the use of computer applications to treat mineralogical data; out-of-class exercises such as writing papers and reading texts on soil mineralogy; and projects on the applied use of soil mineralogy.

Forms of evaluation

Students will be evaluated through written evaluations (theoretical and practical); seminars; discussion of results from practical classes; reports from field and laboratory trips and classes; and the presentation of the final results from projects developed during the course.

Program: Title and breakdown of units

Unit 1

Composition of the Earth's crust (minerals and rocks)

1.1 - Fundamentals of geology and composition of the Earth's crust

1.2 - Main soil-forming rocks in Rio Grande do Sul State: mineralogical and chemical composition

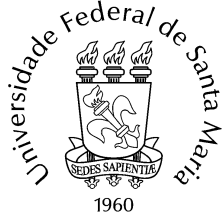
1.3 - Macroscopic identification of minerals and rocks

Unit 2

Elements of crystallography

2.1 - Basic concepts: unit cell, crystalline reticulum, etc.

2.2 - Bravais lattices



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- 2.3 - Crystallographic symmetry
- 2.4 - Crystallographic systems
- 2.5 - Miller indices
- 2.6 - Notions of crystallochemistry
- 2.7 - Physical properties of minerals

Unit 3

Main primary minerals found in soil

- 3.1 - Genesis of primary minerals
- 3.2 - Crystallographic and chemical characterization of the primary minerals
- 3.3 - Alteration conditions of primary minerals
- 3.4 - Identification of primary minerals in mineralogy studies
- 3.5 - Influence of primary minerals on soil behavior

Unit 4

Pedogenetic minerals: 2:1 and 2:1HI mineral groups

- 4.1 - Main 2:1 minerals
- 4.2 - Genesis of 2:1 minerals in the soil
- 4.3 - Physicochemical properties of 2:1 minerals
- 4.4 - Identification of 2:1 minerals
- 4.5 - Genesis and characteristics of 2:1HI minerals in the soil
- 4.6 - Identification of 2:1HI minerals in the soil
- 4.7 - Influence of 2:1 and 2:1HI minerals on soil behavior

Unit 5

Pedogenetic minerals: 1:1 mineral group

- 5.1 - Main 1:1 minerals
- 5.2 - Genesis of 1:1 minerals in the soil
- 5.3 - Physicochemical properties of 1:1 minerals
- 5.4 - 1:1 mineral identification
- 5.5 - Influence of 1:1 minerals on soil behavior

Unit 6

Pedogenetic minerals: oxides (oxides, hydroxides, and oxyhydroxides)

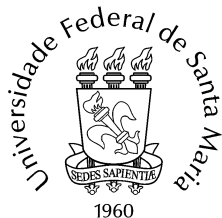
- 6.1 - Main soil oxides
- 6.2 - Genesis of oxides in the soil
- 6.3 - Physicochemical properties of oxides
- 6.4 - Identification of oxides
- 6.5 - Influence of oxides on soil behavior

Unit 7

Mineralogical analysis techniques

- 7.2 - Chemical dissolutions
- 7.3 - X-Ray fluorescence (XRF)
- 7.4 - Thermodifferential analysis (TDA)
- 7.5 - Thermogravimetric analysis (TGA)
- 7.6 - Petrographic microscopy
- 7.7 - Scanning electron microscopy (SEM)
- 7.8 - Transmission electron microscopy (TEM)
- 7.9 - Mossbauer spectroscopy
- 7.10 - Other techniques

Unit 8



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Fundamentals of X-ray diffractometry

- 8.1 - Electromagnetic spectrum
- 8.2 - History of X-ray use
- 8.3 - Precautions when using X-rays
- 8.4 - The production of X-rays
- 8.5 - Fundamentals of X-ray diffraction
- 8.6 - X-ray diffractometers

Unit 9

Sample preparation for X-ray diffractometry

- 9.1 - Sieve separation (sand, silt, and clay)
- 9.2 - Powdered and oriented samples
- 9.3 - Procedures to identify minerals

Unit 10

Processing and interpretation of X-ray diffractograms

- 10.1 - Setting up and interpreting X-ray diffractograms
- 10.2 - Use of computer applications in digital diffractogram analysis

Unit 11

Surface chemistry in soil minerals

- 11.1 - Active sites in mineral particles
- 11.2 - Reactivity at the solid-liquid interface

Unit 12

Organo-mineral complexes in soil

- 12.1 - Characteristics of the chemical structure of organic matter
- 12.2 - Binding of organic substances by colloidal soil particles
 - 11.2.1 - Interaction of non-humic substances with soil minerals
 - 11.2.2 - Interaction of synthetic polymers with soil minerals
 - 11.2.3 - Interaction of humic substances with soil minerals

Unit 13

Environmental and technological applications of soil mineralogy: case studies

- 13.1 - Agricultural applications
- 13.2 - Geotechnical applications
- 13.3 - Industrial applications
- 13.4 - Sanitary applications
- 13.5 - Paleoclimatic applications
- 13.6 - Other applications

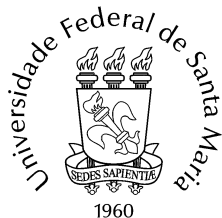
Unit 14

Mineralogy of soils in Rio Grande do Sul State

- 14.1 - Mineralogical alteration in Rio Grande do Sul State
- 14.2 - Main soils and their mineralogical composition

Basic literature

DIXON, J. B.; SCHULZE, D. G. **Soil mineralogy with environmental applications (Soil Science Society of America Book Series, No. 7)**. Madison: Soil Science Society of America, 2002.



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MELO, V. F.; ALLEONI, L. R. F. **Química e mineralogia do solo: conceitos básicos**. V.1, Viçosa: SBCS, 2009. 695p.

RESENDE, M. et al. **Mineralogia de solos brasileiros: interpretação e aplicação**. Lavras: ed. UFLA, 2005. 192p.

Complementary literature

AMONETTE, J. N.; ZELAZNY, L. W. **Quantitative methods in soil mineralogy**. Madison: SSSA, 1994. 462p.

BRINDLEY, G.W.; BROWN, G. **Cristal structures of clay minerals and their X ray identification**. London: Mineralogical Society, 1980. 495p.

DIXON, J. B.; WEED, S. B. **Minerals in soil environments**. 2 ed. Madison: Soil Science Society of America, 1989. 1244p.

KÄMPF, N.; CURI, N. Argilominerais em solos brasileiros. In: CURI, N. et al. (Eds.). **Tópicos em ciência do solo**. Viçosa: SBCS, 2003. v. 3, p.1-54.

KÄMPF, N.; CURI, N. Óxidos de ferro em solos brasileiros. In: NOVAIS, R. F. et al. (Eds.). **Tópicos em ciência do solo**. Viçosa: SBCS, 2000. v. 1, p.107-138.

KLUG, H. P.; ALEXANDER, L. E. **X-ray diffraction procedures for polycrystalline and amorphous materials**. New York: John Wiley & Sons, 1970. 716p.

KLUTE, A. **Methods of Soil Analysis - Part 1: Physical and mineralogical methods**. 2nd ed. Madison: American Society of Agronomy - Soil Science Society of America, 1986.

MOORE, D. M.; REYNOLDS Jr., R. C. **X-ray diffraction and the identification and analysis of clay minerals**. 2 ed., New York: Oxford University Press, 1997. 378p.

NESSE, W. D. **Introduction to mineralogy**. New York: Oxford University Press, 2000. 431p.

TEIXEIRA, W. et al. **Decifrando a terra**. São Paulo: Oficina de Textos, 2001. 568p