ADVISORY PANEL ON WEATHERING PHENOMENA AND NEOFORMATIONS

A PROGRESS REPORT

E. B. A. Bisdom, H.-J. Altemüller, J. Delvigne, J. Sleeman and G. Stoops

INTRODUCTION

Organisation of the Advisory Panel

The present 'Advisory Panel on Weathering Phenomena and Neoformations' (APWPN) started its work in 1973 (Stoops et al., 1978) as the 'Sub-group on Weathering Phenomena and Neoformations' The Sub-group was part of the 'Working Group on Soil Micromorphology' of the ISSS (International Society of Soil Science). During the 1978 ISSS Congress in Canada, the status of the 'Working Group on Soil Micromorphology changed into the Sub commission of Micromorphology', and our Sub-group became the present 'Advisory Panel on Weathering Phenomena and Neoformations'.

The members of APWPN are: H.-J. Altemüller (Federal Republic of Germany), E. B. A. Bisdom (Chairman/Secretary) (The Netherlands), J. Delvigne (Brazil), V. V. Dobrovolsky (U.S.S.R.), E. A. FitzPatrick (U.K.), G. Paneque (Spain), J. Sleeman (Australia) and G. Stoops (Belgium). P. Curmi (France) is a new member.

Meetings of APWPN

Meetings of the Advisory Panel were held in September 1978 (Ghent, Belgium), in September 1979 (Braunschweig, Federal Republic of Germany) and in March 1980 (Ghent, Belgium). No meeting was held in 1981 because Delvigne who is one of the key members of APWPN, departed for the ORSTOM in Brazil; and also because the International Working-Meeting on Soil Micromorphology takes place this year in London. The result of Delvigne's departure is that annual meetings will only be held when he is in Europe, viz. with the key members Altemüller, Bisdom and Stoops, and other members of the Advisory Panel.

The present work of the APWPN can now be done mainly by correspondence between key members because most of the details on the description of minerals and weathered rock fragments have already been worked out or are currently being tested before they are published. Papers which describe the alteration of individual minerals and their

weathering or new-formation products have been completed or started, and this type of work will take up most of the time of APWPN in the future.

Publications by APWPN

Two publications have been completed:

(1) Stoops, G., Altemüller, H.-J., Bisdom, E. B. A., Delvigne, J., Dobrovolsky, V. V., FitzPatrick, E. A., Paneque, G. and Sleeman, J. (1979). Guidelines for the description of mineral alterations in soil micromorphology. Pédologie, 29(1), 121-35.

(2) Delvigne, J., Bisdom, E. B. A., Sleeman, J. and Stoops, G. 1979. Olivines, their pseudomorphs and secondary products. Pédologie, 29(3), 247-309.

THE WORK OF THE ADVISORY PANEL

General

The work of APWPN can be subdivided into two units, viz. one to make a simple but valid classification scheme for altering minerals and weathering rocks, and a second which is less descriptive and allows some insight into what happens when individual minerals weather. The publication by Stoops et al. (1979) is an example of the first category, while the article by Delvigne et al. (1979) describes the alteration of a primary mineral and its weathering products. Our present work concerns the description of weathering rock fragments and the alteration of micas.

The Description of Weathering Minerals, Weathered Rock Fragments and Weathering Rock

Guidelines for the description of mineral alterations (Stoops et al., 1979) are the answer suggested by APWPN to an often intricate problem. The result is a simple and practical system which lacks detailed information but can be used in most cases when a mineral is studied in a thin section. Alteration sequences, which illustrate the different patterns and degrees of alteration, are given in drawings and a simple terminology introduced to describe each stage of the weathering of an individual mineral. Such a system proved to be practical, especially because no basic knowledge is necessary on the secondary products associated with the altering minerals. Nevertheless, various primary minerals show characteristic weathering patterns and a description of the alteration of individual

minerals will frequently give some information about the individual mineral or groups of primary minerals being studied.

At present, work is being done on the description of weathering rock fragments. This is more intricate than describing individual minerals, simply because various individual minerals may weather simultaneously and should be studied in connection with rock fabric and structure. APWPN has decided that it is not practical to take the approach of alteration sequences, patterns and degrees of alteration which are made visible in schematic drawings. Altemüller, Bisdom, Delvigne and Stoops have developed a checklist of weathering rock fragments and are currently in the process of applying this system in practice before publishing. Recognising and describing weathered rock fragments require at least some knowledge in this field and it is really work for a specialist. Finally, initial discussions took place on how to describe weathered rock itself. We decided that experience would be gained when using the checklist system.

The Study of Mineral Alterations and Secondary Products

The first study of mineral alterations and secondary products by APWPN concerned the weathering of olivine (Delvigne et al., 1979). A second paper by Bisdom et al. on biotite is almost complete. The Advisory Panel had several technical problems to consider in these weathering studies and some are indicated below:

(1) Some minerals can give rise to a number of secondary minerals. Olivine and biotite are examples, whereas other primary minerals simply dissolve or form secondary minerals with the same composition, e.g. quartz and calcite. The result is that papers on the weathering of primary minerals may have a different layout for certain weathering minerals or mineral groups.

(2) Traditional approaches to the study of weathering minerals involve wet chemistry experiments, X-ray diffraction of loose weathered materials and the examination of weathering sequences of minerals in thin sections. Even in the earlier stages of thin section studies (Delvigne, 1965; Bisdom, 1967) it was realised that not only the clay but also coarser fractions contained newly-formed secondary minerals formed in various weathering environments. The study of the silt and finer fractions with XRD techniques

showed that various secondary minerals were present both in these fractions and in the clay fraction (Bisdom, 1967). This approach, however, did not allow in situ testing of chemical elements in the thin section and no information was obtained on the composition of amorphous materials.
(3) The in situ study of weathering minerals with submicroscopic techniques has become possible in recent years, e.g. Seddoh and Pedro (1975), Meunier (1977) and Curmi (1979). Using these techniques one can test for the presence of various chemical elements in micro-areas with a diameter of 1 µm (Bisdom et al., 1975, 1976) in both crystallised and amorphous materials in the thin section. Ion (Bisdom et al., 1977) and laser (Bisdom et al., 1981) techniques even allow the study of trace elements in thin sections. Recently, microchemical and quantitative analysis of all chemical elements in a thin section has become possible in an area of about 300µm diameter (Henstra et al., 1980) and in a micro-area with a diameter of 1.5µm (Bisdom et al., 1982). Electron microscopic, viz. EMA (electron microprobe analyser) (Delvigne) and SEM-EDXRA (scanning electron microscope - energy dispersive X-ray analyser) (Bisdom) techniques were applied to weathering olivine (Delvigne et al. 1979). These techniques also form part of the biotite-alteration study.

These submicroscopic techniques allow the collection of various data which are also important for the study of thin sections with weathering minerals. Apart from amorphous and microcrystalline materials one can obtain information of the so-called 'cloudy' accumulations in thin sections which are difficult or even impossible to examine with the light microscope alone; for example, an accumulation of iron hydroxide which coats other secondary minerals completely. The submicroscopic examination of such clouds usually allows the measurement of chemical elements other than iron in such clouds, if materials other than iron hydroxide are also present at such sites in the thin section.
(4) The idea of writing papers on the weathering of individual primary minerals is primarily to allow students and interested colleagues to enter this field of soil science and geology. The idea is to keep these papers predominantly micromorphological, viz. based on light microscopic observations. The material, however, also often requires the application of other techniques already

mentioned above. Only part of the latter information has been acquired to date, and the submicroscopic techniques in particular will give substantial new information because they can be applied in situ and can give data on micro-volumes of interest to the soil micromorphologist and mineralogist. It is also possible that the interpretation of XRD and wet chemical data, which are done on disturbed samples with a relatively large volume, will be easier when compared with light microscopic and submicroscopic data.

In conclusion we may say that a considerable number of relatively unconventional problems are related to the study of the weathering of individual minerals. Basically, light microscopic and several other techniques must be combined to obtain the necessary information. In practice, however, this is not usually done and one obtains rather fragmentary information which frequently leads to hypotheses that have not been tested as efficiently as they could have been. APWPN has tried to keep the information in its papers as factual as possible but, nevertheless, decided that some of the hypotheses should be mentioned.

One of the problems that is difficult to study is the origin of certain secondary minerals. Some authors regard these as marginal products of a weathering environment, whilst others disagree and consider them to have crystallised under other circumstances which cannot be regarded as belonging to a near surface weathering environment. The Advisory Panel spent considerable time in the beginning on this problem and finally agreed on the definition of weathering as given in the article by Stoops et al., (1979). We concluded that a number of processes (e.g. hydrothermal) had to be included in the studies of certain minerals because of a lack of specific diagnostic criteria to separate such minerals from those which had originated under accepted weathering conditons on or near the surface of the earth.

FUTURE WORK

The next publication of APWPN will be on biotite (Bisdom et al.). It forms part I of a series entitled: 'Micromorphology of Phyllosilicates and their Secondary Products'. Part II will be on muscovite (Bisdom et al.) and part III on chlorite (Stoops et al.).

Guidelines for the description of weathered rock fragments will be tested and published in the form of a checklist. This publication will be followed by one in which the approach to the description of weathered rocks is given.

The work of APWPN is mainly done by a few active members who wish their papers to be not only purely descriptive but to include information on weathering sequences and processes. Only the description of mineral alterations (Stoops et al., 1979) can be done with insufficient knowledge in the field of weathering. The checklist for weathering rock fragments will require more training. Papers on the alteration of individual minerals and their weathering products (Delvigne et al., 1979) include most of the knowledge gathered with the light microscope and other technical approaches.

Our aim is to gradually work with the active key members of the Advisory Panel towards the publication of a book. It will be some time, however, before we reach this goal, especially because a great deal of work still needs to be done before enough information has been obtained on little known areas in the field of weathering. We hope that several laboratories will take up the more advanced weathering studies to fill these gaps in our knowledge and, if possible, will cooperate with the Advisory Panel on Weathering Phenomena and Neoformations.

REFERENCES

Bisdom, E. B. A. 1967. Micromorphology of a weathered granite near the Ria de Arosa (NW Spain). Leidse Geol., 37, 33-67.

Bisdom, E. B. A., Henstra, S., Jongerius, A. and Thiel, F. 1975. Energy-dispersive X-ray analysis on thin sections and unimpregnated soil material. Neth. J. Agric. Sci., 23, 113-125.

Bisdom, E. B. A., Henstra, S., Hornsveld, M., Jongerius, A. and Letsch, A. C. 1976. Wavelength and energy dispersive X-ray microanalysis with EMA and SEM-EDXRA on thin sections of soils. Neth. J. Agric. Sci., 24, 209-222.

Bisdom, E. B. A., Henstra. S., Jongerius, A., Brown, J. D., Rosenstiel, A. P. von, and Gras, D. J. 1977. Light and heavy element detection in thin sections of soils with the ion microprobe mass analyzer (IMMA). Neth.

J. Agric. Sci., 25, 1-13.

Bisdom, E. B. A., Henstra, S., Jongerius, A., Heinen, H. J. and Meier, S. 1981. Chemical element detection in thin sections of soils with the laser microprobe mass analyser (LAMMA 500). Neth. J. Agric. Sci., 29, 23-36.

Bisdom, E. B. A., Henstra, S., Jongerius, A., Morgan, A. E. Werner, H. W., Grefte, H. A. M. de, Gourgout, J. M. and Migeon, H. N. 1982. Quantitative analysis of trace and other elements in thin sections of soils with the secondary ion microscope (Cameca). Neth. J. Agric. Sci., 30 (in press).

Curmi, P. 1979. Altération et différenciation pédologique sur granite en Bretagne. Etude d'une toposequence. Thèse, Lab. de Sci. du Sol, ENSA-INRA. Univ. de Rennes I, 176 pp.

Delvigne, J. 1965. Pédogenèse en zone tropicale. La formation des minéraux secondaires en milieu ferrallitique. ORSTOM, Dunod, Paris, 177 pp.

Delvigne, J. Bisdom, E. B. A., Sleeman, J. and Stoops, G. 1979. Olivines, their pseudomorphs and secondary products. Pédologie, 29, 247-309.

Henstra, S., Bisdom, E. B. A., Jongerius, A., Morgan, A. E. Werner, H. W. and Grefte, H. A. M. de, 1980. Quantitative analysis on thin sections of soils by secondary ion mass spectrometry. 7th Europ. Congr. Electron Microscopy, The Hague, The Netherlands. Electron Microscopy, 3, 224-225.

Meunier, A. 1977. Les mécanismes de l'altération des granites et le rôle des microsystèmes. Etude des arènes du massif granitique de Parthenay (Deux-Sèvres). Thèse, Univ. de Poitiers, 248 pp.

Seddoh, F. K and Pedro, G. 1975. Aspects microgéochimiques de l'altération superficielle. Application à l'étude de l'évolution des minéraux dans les arènes granitiques. Cahiers ORSTOM, série Pédologie, 13, 7-25.

Stoops, G., Bisdom, E. B. A., Delvigne, J., FitzPatrick, E. and Paneque, G. 1978. Sub-group on Weathering Phenomena and Neoformations. A progress report. In: M. Delgado (Ed), Micromorphologia de Suelos. Universidad de Granada, 1429-1441.

Stoops, G., Altemüller, H.-J., Bisdom, E. B. A., Delvigne, J. Dobrovolsky, V. V., FitzPatrick, E. A., Paneque, G. and Sleeman, J. 1979. Guidelines for the description

of mineral alterations in soil micromorphology. Pédologie, 29, 121-135.

Soil Micromorphology

VOLUME 1

Techniques and Applications

Edited by
P Bullock and C P Murphy
Rothamsted

A B ACADEMIC PUBLISHERS

10