# Contribution to the Study of the Nöhagen Metadiorites

By Luiz Fernando Scheibe & Nizar Jaferali Maherali *)

## 1. Introduction

While mapping the area West of Hohenstein, the authors studied the northern part of a body of dioritic composition, described by F. Becke (1882, cit. Waldmann, 1963) as the "Körnigflaserig Dioritschiefer von Nöhagen". In this paper particular emphasis was put on the petrographic study of these rocks. This paper is a shortened text form of our final Unesco-course report which is equipped with figures and one geological map.

## 2. Location and Access

The Nöhagen Metadiorites occur near Nöhagen, in the Mautern Quadrangle, Lower Austria. The approximate geographical coordinates of the area are 15° 26′ E. W. and 48° 28′ N. The area is easily accessible by road and lies about 20 km NW of Krems.

## 3. General Geology

The area belongs to the Moldanubian Zone of the Bohemian Massive in Austria. The main geological units are coarse grained biotite-plagioclase-sillimanite gneisses; fine-grained biotite-plagioclase gneisses; amphibolites; calc-silicate rocks; pyroxene-plagioclase gneisses; marbles; and the metadiorites. These rocks are intensely folded, with dominance of NE directions. Ptygmatic folds as evidence of migmatization are common.

## 4. The Metadiorites

### 4.1. Occurrence

The part of the body which was studied occurs in Nöhagen and surroundings, and has an irregular shape which protrudes towards the NE, in the direction of the course of the River Krems. Best exposures are in the escarps of the valley of this river, but outcrops are common in top of the hills.

---

*) The authors participated from the 1969/70 Post Graduate Training Course for Geology, sponsored by the Republic of Austria, UNESCO and Organization of American States.

Present adresses: L. F. Scheibe, Rua Joaquim Costa 37, Florianopolis (SC), Brasil, N. J. Maherali, P. O. Box 903, Dodoma, Tanzania.

The body is included in the coarse-grained biotite-plagioclase-sillimanite gneisses, and, near the contact with this rock, it occurs an intercalation of cordierite-garnet-biotite-plagioclase gneisses ("Kinzigites" described by WALDMANN, 1963, 1967), whose characteristics are discussed below.

### 4.2. Structure

The metadiorites show variations in the structure, from massive (in the coarse grained parts) to gneissose (in the fine and medium grained parts, towards the contacts). This fine-grained rock shows good orientation of the biotites and it was possible to trace some folding in it. The intercalated layers of cordierite-garnet-biotite-plagioclase gneisses show complex folding, with s-planes and fold axis whose attitude do not conform with the general trend of the area.

### 4.3. Petrography

The meta-diorites are dark green, sometimes spotted, with medium to very coarse grained texture, pegmatitic in places, also fine grained in others. The massive character of the rock makes a contrast with the gneisses of the area.

In thin section, plagioclase, hornblende and biotite are the dominant minerals, as shown in the following table:

**Estimated modal composition of the Meta-diorites**

| | H-22 | H-24 | H-104 | H-125 | H-127 | H-128 | H-129 |
|---|---|---|---|---|---|---|---|
| Plagioclase | 40% | 40% | 50% | 60% | 20% | 35% | 55% |
| Hornblende | 18% | 40% | 25% | 10% | 50% | 50% | 20% |
| Biotite | 38% | 15% | alter. | 30% | 15% | 13% | 20% |
| Quartz | tr. | 3% | — | — | — | — | — |
| Sphene | tr. | tr. | 2% | tr. | 2% | tr. | tr. |
| Apatite | tr. | tr. | 2% | tr. | 3% | tr. | tr. |
| Zircon | tr. | tr. | tr. | tr. | tr. | tr. | tr. |
| Opaque | tr. | tr. | tr. | tr. | tr. | tr. | tr. |
| Microcline | — | — | — | — | 10% | — | — |
| Epidote | 2% | 2% | tr. | tr. | tr. | 2% | tr. |
| Chlorite | tr. | tr. | 20% | tr. | tr. | tr. | tr. |

Plagioclases were found (Universal Stage) to be of labradorite composition (55% An.), with normal zoning or with a "stained" feature, and complex twinning. In some samples, they are highly saussuritized.

Hornblende is pleochroic from light to dark green. Some samples contain relics of pyroxene, revealing that uralitization has taken place. The cleavage planes are sometimes accentuated by the deposition of opaque mineral, and sphene in rounded crystals is usually included.

Biotite is pleochroic from light yellow to reddish brown, and sometimes intergrown with the hornblende. Shows alteration to chlorite (penninite) with exsolution of sphene, and, in H-104, is completely altered. Other alteration products are epidote (weakly pleochroic from colourless to pale green, with high birrefringence, low extinction angle, length fast or length slow, and angle 2 V around 90°) and muscovite. Zircon as inclusions produces pleochroic halos.

Quartz was detected in one of the samples only (H-24), as some large fractured crystals. Microcline in large crystals occurs in the coarse grained diorite (H-127). Apatite occurs as an exsolution product and the opaque minerals show rectangular shape and alteration to limonite, beeing possibly pyrite.

### 5. The Cordierite-garnet-biotite-plagioclase Gneisses

These gneisses occur as layers in which the alignement of the garnets accentuates the banding. They include layers of seemingly amphibolitic composition, deformed giving "boudinage" features, as well as some carbonated layers. The garnet crystals are large and sometimes reach 6 cm in diameter. These cordierite-garnet-biotite-plagioclase gneisses are dark coloured, with a bluish tint.

In thin section these rocks show a cordierite content which ranges from 20%—40%. This mineral occurs in xenomorphic masses which include quartz, plagioclase, sphene and relics of biotite, an indication that the mineral is formed later than the others. Cordierite in places shows pseudohexagonal twinning and is partially altered especially along the cleavages and fractures to a yellowish mineral (faintly pleochroic, parallel extinction and 1st order interference colours — blue). Garnet occurs up to 20% and forms large porphyroblasts with oriented inclusions.

The quartz content amounts to 40% of the rock in one sample. Biotite is strongly pleochroic and is extensively altered to chlorite. The amount of andesine is reduced to 5%. Sillimanite, kyanite, apatite, graphite and zircon (inclusions with pleochroic halos in both biotite and cordierite) occur as accessory minerals.

### 6. Conclusions

The rocks of the area belong to the high temperature field of the amphibolite facies (Scheibe & Maherali, 1970), probably attained during the Variscian Orogeny. Possibly during this Orogeny occured the emplacement of the diorites. The syntectonic character of these rocks is evidenced by the

orientation of the planar constituents in the contact zone of the body. The absence of orientation in its central parts, together with the lack of concordance of the structures indicate that the metadiorites did not suffer all the tectonic efforts which led to the formation of the gneisses of the area.

The formation of the cordierite-garnet-biotite-plagioclase gneisses, whose paragenesis is from the amphibolite-granulite transitional facies, could be related to a local temperature gradient due to the intrusion of the meta-diorites. However, a better study of these rocks is needed to make clear their origin and relationships.

The alteration of the biotites of the meta-diorites to chlorites, with exsolution of sphene, is one of the evidences of retrograde metamorphism which affected the crystalline rocks of the area, and which is possibly related to the Alpine Orogeny.

## 7. Acknowledgements

The authors gratefully acknowledge Prof. Dr. H. KÜPPER, Director of the Course, as well as Dr. A. MATURA and Dr. S. SCHARBERT for their help, orientation and criticism during the work.

### Selected Bibliography

MEHNERT, K. R.: Migmatites and the Origin of Granitic Rocks, 1968, Elsevier, Amsterdam.

SCHEIBE, L. F., & MAHERALI, N. J.: Geology of the Area West of Hohenstein, unpublished, Geol. Bundesanstalt Austria, Vienna.

TRÖGER, W. E.: Optische Bestimmung der gesteinsbildenden Minerale. Teil 1: Bestimmungstabellen, 3rd, ed., 1959, Schweizerbartsche Verlagsbuchhandlung, Stuttgart.

TURNER, F. J.: Metamorphic Petrology, 1968, McGraw Hill, New York.

WALDMANN, L.: Bericht über die Aufnahmen 1962 auf dem Blatt Spitz (37), Verh. Geol. BA., Wien 1963.

WALDMANN, L.: Bericht 1966 über Geologische Aufnahmen auf dem Blatt Spitz (37), Verh. Geol. BA., 1967 (A 54—A 55), 1967, Geol. BA., Austria, Vienna.

ZOUBEK, V., ed.,: Tectonic Development of Czechoslovakia, 1960, Ústredni Ústav Geologický, Praha.