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About the Origin of Aplitic Gneiss and Amphibolite Inclusions in Silicate Marble, Calc-silicate-gneiss and Spitz Gneiss near Spitz/Donau (Austria)

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Abstract

The different rock groups outcropping in Schlossberg area include Spitz gneiss, paragneiss, marbles, calc-silicate gneisses, amphibolites, aplitic gneisses and pegmatites. Particular attention has been given to the amphibolites and aplitic gneisses which occur as bands and boudinages concordant to the S-planes of the older rocks of the area.

Two main varieties of amphibolites are distinguished: spotted amphibolites and non-spotted amphibolites. Petrographic studies proved the igneous origin of the spotted amphibolites, whereas trace element studies confirmed this view and proved the same origin for the non-spotted variety.

The abnormal abundance of pyroxene (9%) and accessory sphene and apatite (14%) in the pyroxene bearing aplitic gneisses is due to the fact that the aplite could have been contaminated by assimilation of calcareous sediments.

The orthoamphibolites and aplitic gneisses have been originally intruded as doleritic? and aplitic sills respectively.

Introduction

The present work deals with geological problems of Schlossberg area which covers about 4 sq. km. and is located NW of Vienna around Spitz/Donau.

The area lies within the Bohemian Massif and is built up by rocks belonging to the Moldanubian Zone, which is the internal zone of the Middle-European branch of Hercynian system (Exner 1966).

The different rock groups outcropping in the area under consideration include Spitz gneiss, paragneiss, marble, calc-silicate gneiss, amphibolite, aplitic gneiss, and pegmatite. The general trend of the S-planes of all the rock groups of the area is almost NNE—SSW and the general dip is towards the east.

P r e v i o u s   w o r k

The fact that amphibolites are intercalated in Spitz gneiss and aplitic gneiss as well as amphibolite layers occur within the calc-silicate marbles near Spitz is well known since long time. L. WALDMANN mentioned this in his contribution to the „Geologie von Österreich" („Das außeralpine Grundgebirge Österreichs"). In later investigations SCHARBERT (1959) showed that the Fleckamphibolites near Spitz intercalated in a Spitz gneiss represent metamorphosed basaltic (doleritic) sills. JANDA, SCHROLL and SEDLAZEK (1965) analysed an amphibolite sample from Spitz quantitatively by spectrochemical methods among 43 samples of amphibolites, augite gneisses and related rocks from the Austrian Waldviertel and the Eastern Alps.

Method of Study

Mapping of the area under consideration was carried out on the scale 1 : 5.000. Different rock types were studied under the microscope.

Special attention was given to the origin of the amphibolites and accordingly quantitative determination of the trace elements was done by means of spectrochemical method.

X-ray diffraction pattern of representative samples of marbles and aplitic gneisses was carried out. Potash feldspar from an aplitic gneiss was seperated by heavy liquids (a mixture of tetrabromäthan and xylol, specific gravity 2.59) and was investigated by X-ray powder pattern method.

Field Observations

Detailed descriptions by L. WALDMANN about field relations in this area one can find in the field reports of Verh. Geol. B. A., 1956 and 1958. For the special aspect of this paper it is necessary to repeat the following features.

A m p h i b o l i t e s :

The amphibolites occur as band like bodies intercalating the Spitz gneiss and paragneisses and also as boudinage bodies within the marbles (pl. 1 A). The amphibolite bands vary in thickness from a few cms to 60 cm and rarely do they reach one meter thickness. The amphibolite bands and boudinages usually lie along the S-planes of the enclosing country rocks.

Two main varieties of amphibolites are distinguished in the field. A fine grained non-spotted variety which is dark greyish green in colour and which is rich in amphibole; and a spotted variety with leucocratic ovoids of plagioclase up to 7 mm across, set in a finer grained matrix identical to the non-spotted amphibolites. Some spotted amphibolites are rather rich in garnet, the latter seems to replace the feldspar spots as it forms rims around them. In some outcrops the amphibolites are seen to be crossed by gently folded leucocratic veins of gneissose character consisting of abundant plagioclase, orthoclase, biotite and hornblende.

Leucocratic aplitic gneisses like the amphibolites occur as boudinage bodies and bands concordant to the S-planes of the marbles and Spitz gneiss (pl. 1 B). Although most of the aplitic gneiss boudinages lie parallel to the S-planes of the marbles, yet irregular masses of aplitic gneisses showing no distinct orientation with the enclosing marbles are also recorded.

Xenoliths of Spitz gneiss (?) are found included in one of the aplitic gneiss boudinages. Also, pebble-like masses of quartz are found enclosed in the aplitic gneiss material.

The thin aplitic gneiss bands that intercalate the marbles commonly contain pyroxene and accessory sphene and apatite. Parts of the aplitic gneisses show coarse quartz and rare mica.

Petrography

The description of the following rock types should be selected for the problem under discussion.

Amphibolites:

In thin sections, the amphibolites consist mainly of hornblende and plagioclase (0.4 mm average grain size) and subordinate biotite, quartz, garnet, and microcline. Sphene, iron oxide, and apatite are common abundant accessories, whereas zircon is rather rare. The hornblende crystals are preferrably oriented and pleochroic with X = yellow, Y = brown, Z = brownish green. Plagioclase is commonly normally zoned, and has an average composition of andesine (An 40%). Relic pyroxene with subophitic texture is occasionally met.

Spotted varieties of amphibolites show spots up to 5 mm across that lie in preferred orientation parallel to the hornblende prisms. The spots consist either of variably altered plagioclase porphyroblasts (2 mm across) of labradoritic composition (An 66%) and rimmed with finer grained mosaic plagioclase aggregate or consist totally of such a mosaic aggregate of strongly zoned plagioclase crystals.

Aplitic Gneisses:

Two main varieties are distinguished: pyroxene and amphibole bearing aplitic gneiss and biotite bearing aplitic gneiss.

Pyroxene and amphibole-bearing aplitic gneiss: this variety is confined to the thin leucocratic bands, that occur within the marble formation. The rock is composed of phenocrysts of potash feldspar (up to 5.2 mm across) embedded in a finer grained groundmass (grain size about 0.7 mm). The latter consists of quartz, potash feldspar, oligoclase, variable amounts of diopsidic augite, and actinolitic hornblende and rare biotite. Accessories include sphene, apatite, zircon, epidote, clinozoisite, and iron oxide. Relic porphyritic texture survive in complete preservation, whereas newly developed gneissose texture is less distinct.

Potash feldspar was investigated by X-ray diffraction pattern method, and was found to consist of orthoclase changing to microcline with a maximum angle of obliquity of 0.71 (determined by the position of 131 and $1\bar{3}1$ peaks in X-ray powder diagram). Potash feldspar and oligoclase are partly altered to sericite and kaolin. The former is sometimes microperthitic. Oligoclase (An 20%) tends to form idiomorphic tabular crystals. Quartz occurs in mosaic aggregate and shows undulose extinction. Diopsidic augite occurs as irregular grains and stout crystals and has $2V = 56°$. It is partly altered to amphibole especially along cleavage planes and around the peripheries of the crystals. Actinolitic hornblende forms stout prisms, and is pleochroic with X = pale yellows, Y = greenish yellow, Z = green. Biotite forms resorbed, partly chloritised flakes.

Biotite-bearing aplitic gneiss:

The rock is fine grained and equigranular and consists essentially of abundant quartz, feldspar, subordinate biotite and accessory zircon and epidote. Gneissose texture is marked by parallel alignment of biotite flakes. Relic micrographic texture is observed in some examples. Quartz and feldspar show strain extinction. Feldspars include orthoclase, microcline, and oligoclase (An 22%).

Modal composition of aplitic gneiss

costituent	biotite-aplitic gneiss S 7	pyrox.-amph. aplitic-gneiss S 50	pyrox.-amph. aplitic-gneiss S 52
	%	%	%
quartz	37.3	31.5	30.0
potash-fields	43.2	45.3	48.1
oligoclase	14.0	10.8	10.4
biotite	5.5	0.7	0.5
diopsidic augite	—	9.0	6.1
actinolitic hornblende	—	1.3	4.8
apatite	—	} 1.4	tr.
sphene	—		tr.
epidote	tr.	tr.	tr.
zircon	tr.	tr.	tr.
total	100%	100%	99.9%

Study of Distribution of Trace Elements in Amphibolites

To throw some light on the origin of spotted and non-spotted varieties of amphibolites, study of distribution of trace elements was carried out. Two average samples of spotted amphibolites and three average samples of non-spotted amphibolites have been analysed spectrochemically on their contents of Ni, V, Cu, Co, and Cr.

Jarrell U. Ash spectrograph was used for this purpose. The method adopted is given below:

Finely crushed material was mixed with a 0.01% pd-coal mixture in a proportion of 1 : 2. The conditions of exposure were as follows:

Spectrograph:	3.4 mm Ebert-Gitterspectrograph (Jarrell U. Ash) 30,000 lines/inch, 1 order, wave length range 4350—3175.
Optical conditions:	Filter 20/100%, slit 10
Electrical conditions:	220 V/10 A, Schaltung: Anodic
Photographical conditions:	Exposure time 180 Sec. Photoplate: Gevaert scientia 34B—50
Measurements of lines:	Quantitativ with background correction Microphotometer Jarrel U. Ash.

Calculating board was used to calculate the values obtained. The values were compared with standard samples, which were controlled by international standards form U. S. Geological Survey DTS-1.

The results of the trace element studies are tabulated below:

Sample No.	name of rock	Ni ppm.	V ppm.	Cu ppm.	Co ppm.	Cr ppm.
S 14	spotted amph.	58	380	100	43	62
S 33	spotted amph.	42	360	87	42	43
S 6	non-spotted amph.	44	430	70	50	88
S 26	non-spotted amph.	49	480	39	46	115
S 18	non-spotted amph.	42	355	115	43	49

Discussion and Concluding Remarks

Origin of the Amphibolites:

1) The preservation of basic plagioclase (labradorite An 66%) porphyroblasts in the spotted amphibolites reflects their igneous origin.

2) Mineralogically, both spotted and non-spotted amphibolites are identical. Moreover, they almost show the same distribution of trace elements. This indicates that spotted amphibolites and non-spotted amphibolites have the same origin.

3) The high contents of the elements Ni, V, Co, Cr, and Cu in both varieties of amphibolites reflect their igneous origin.

As all the amphibolite bands and boudinages lie along the S-planes of the country rock, it is apparent therefore that the *ortho*-amphibolites have been intruded originally as sills.

Origin of the Aplitic Gneisses:

1) The mineralogical and modal composition of the biotite bearing aplitic gneisses together with the preservation of relic igneous textures in

the aplitic gneisses, in general, indicate the original aplitic or microgranitic nature of the rock.

2) As the pyroxene and amphibole bearing aplitic gneisses are only confined to those thin bands which intercalate the marbles, it is believed accordingly that the original granitic magma could have been contaminated by assimilation of calcareous sediments.

3) The aplitic gneisses usually occur as thin layers intercalated with the marble bands, as well as boudinages lying along the S-planes of the country rock. This indicates that these gneisses have been intruded originally as aplitic or microgranitic sills.

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PLATE 1

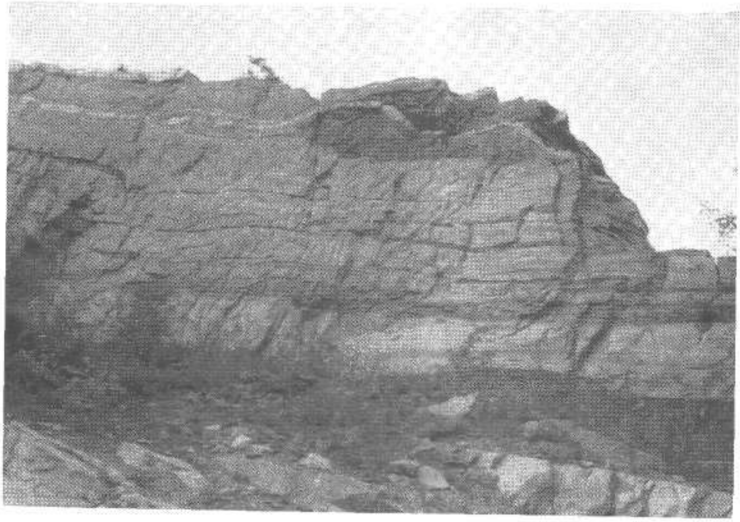

Fig. A. Amphibolite boudinages and bands (dark) running parallel to the S-planes of marbles near the Devil's wall.

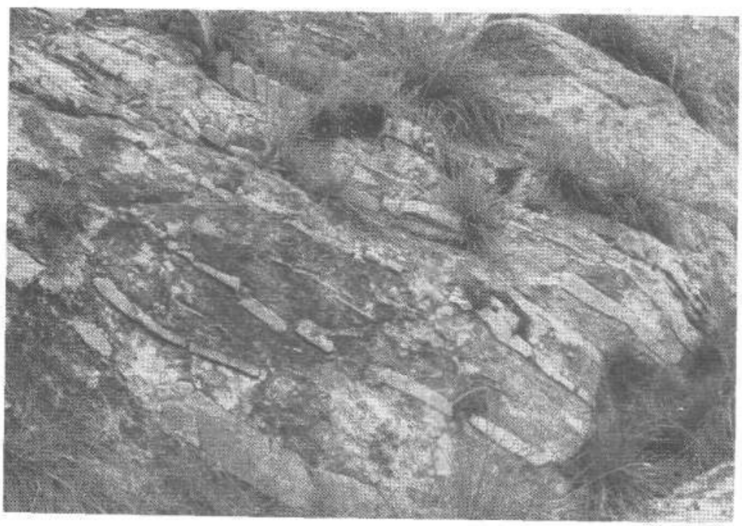

Fig. B. Thin pyroxene and amphibol-bearing aplitic gneiss bands in a marble country rock.

GEOLOGICAL MAP OF THE MIDDLE PART OF THE KAMP VALLEY BETWEEN WALDREICHS AND WEGSCHEID BY MAHMOUD KHAFFAGY 1967

USING THE SKETCH MAP OF CH. EXNER (1957)