2. Introduction to selected geological main units of Austria

2.1. The Bohemian Massif - a short introduction

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The Bohemian Massif is part of the Variscan orogenic belt of Europe which comprises different metamorphic units and granitic intrusions. The surface outcrops North of the river Danube belongs to the Bohemian Massif which extends as well to the South below the Rhenodanubian Flysch Zone and the Molasse Zone. It represents a former fragment of Northern Gondwana that split off during early Paleozoic time and collided with Avalonia and Baltica during middle Paleozoic time. This block is essentially composed of medium-grade metamorphic rocks derived from early to late Proterozoic and early Paleozoic precursory and extensive granites of Variscan age.
Structurally, the Bohemian Massif of Austria consists of two units, the Moldanubian Zone in the west and the Moravian Zone in the east. The former consists of paragneisses overlain by a complex of variegated crystalline rocks, granulites, and orthogneisses while the latter exhibits low- to medium-grade micaschists, metasedimentary rocks, orthogneisses and a cadomian granite (Thaya Batholith). During the Variscan Orogeny the Moldanubian Zone was thrust upon the Moravian Zone. Their complex lithologies and different evolutionary histories suggests, that originally the two zones may have represented two separate microplates.

The Moldanubian Zone

The Moldanubian part of the central European Variscan Belt shows characteristics of a collisional orogen. Nappe tectonics and high-P/high-T metamorphism have been identified. In the southeastern part of the Moldanubian zone, the development of the early Variscan metamorphism with subsequent nappe piling can be observed. The late orogenic development in the Moldanubian zone is dominated by high-T/low-P metamorphism within the lowermost structural units. The high temperatures led to regional migmatisation and the generation of granitoid magmas which formed the South Bohemian Batholith and other plutons.
The Moldanubian nappe pile consists, from top to bottom, of three major units: the

Gföhl nappe complex (or Gföhl unit), the
Drosendorf unit and the
Ostrong unit (= Monotonous Series).

The Gföhl nappe complex consists of an internal framework of different units (granulites, Raabs unit, Gföhl gneiss and Meisling unit), of generally high-grade (up to granulite-facies) metamorphism. The Meisling unit composed of amphibolites, orthogneisses and metasediments separates the Gföhl unit and the Drosendorf unit.

Fig. 2.: Geological Map of Austria and ----- FOREGS '99 Excursion route →

GEOLOGICAL MAP OF AUSTRIA

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BOHEMIAN MASSIF
- Granulite, Gföhl Gneiss
- Granite
- Orthogneiss, migmatite
- Paragneiss, micaschist, marble, amphibolite

TERTIARY BASINS
- Volcanite (Miocene, Pliocene)
- Clastic sediments (gravel, sand, clay) of the Molasse Zone and the intramontaneous basins
- Subalpine (deformed) Molasse Zone

HELVETIC UNIT
- Mesozoic to Early Tertiary sedimentary rocks

PENNINIC UNIT
- Flysch Zone (Cretaceous - Early Tertiary) inclusive Penninic Klippen
- Bündnerschiefer Group (Jurassic - Early Tertiary) with ophiolites
- Permo-Triassic metasedimentary rocks
- Central Gneiss
- Altkristallin Complex and metamorphic Paleozoic sedimentary rocks

AUSTROALPINE UNIT

Mesozoic of the Northern Calcareous Alps and equivalents
- Gosau Group
- Limestone, dolomite, marl and clastic sedimentary rocks

Paleozoic
- Sedimentary rocks and volcanics, partly metamorphic

Permo-Mesozoic, metamorphic
- Clastic/carbonatic sedimentary rocks

Austroalpine Crystalline Complexes
- Orthogneiss
- Paragneiss, micaschist
- Amphibolite
- Quartzphyllite, micaschist, paragneiss

PERIADRIATIC INTRUSIONS
- Magmatites (Oligocene)

SOUTHERN ALPINE
- Mesozoic and Paleozoic sedimentary rocks and volcanics

Thrust boundary 1st order / 2nd order

Fault

FOREGS '99 Excursion Route

Scale 1 : 2 100 000
(1cm = 21km)

0 10 20 30 40 50 60 70 80 90 100km

Topography based on the map ÖK 500 of the Bundesamt für Eich- und Vermessungswesen, Vienna.

Layout and realisation:
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The Drosendorf unit has a Proterozoic basement (Dobra gneiss) overlain by mainly metasedimentary units (Variegated unit) of probable Palaecozoic primary age. It consists f para- and orthogneisses, amphibolites, calcsilicates and marbles. The depositional environment was probably a passive continental margin. The mafic layers within the Dobra gneiss are interpreted as former basaltic dikes, while those in the Variegated unit are derived from synsedimentary volcanics.

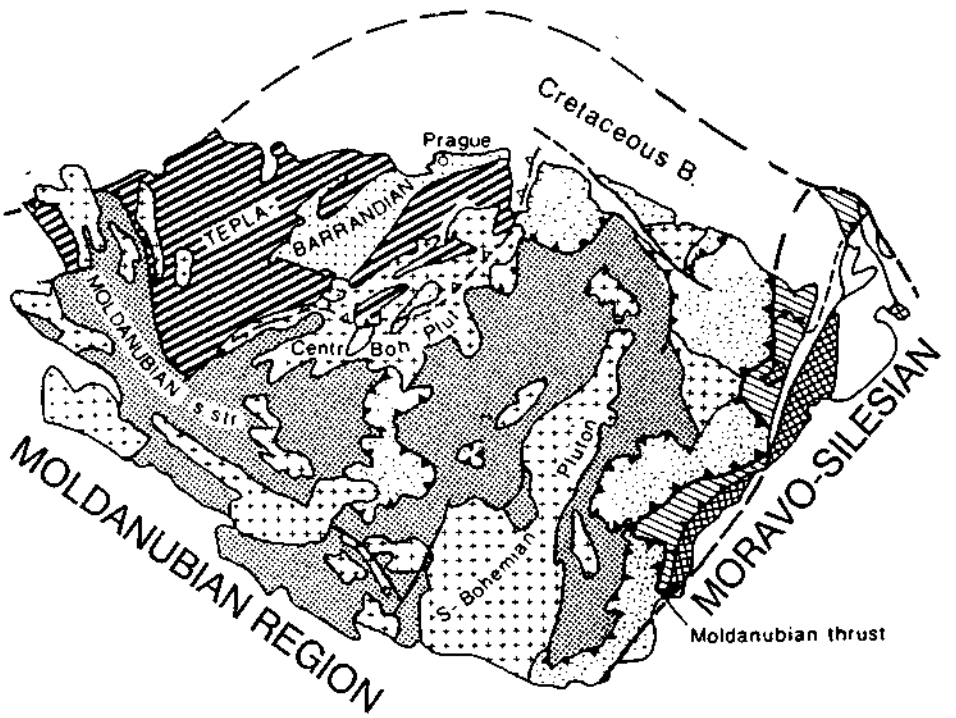

Fig. 2.1.: Tectonic map of the Bohemian Massif in Austria and adjacent areas (modified from FRANKE, 1989)

The lowest structural unit in the southeastern Moldanubian zone is the Ostrong unit, which is separated from the Drosendorf unit by a tectonic contact. Metapelitic rocks with cordierite and sillimanite dominate in the former called Monotonous Series. In addition, garnet-bearing ortho- and paragneisses and amphibolites occur. The protoliths of the metapelites and paragneisses were most probably pelites and greywackes.
The igneous rocks of the eastern part of the South Bohemian Batholith cut the Moldanubian nappe system. The South Bohemian Batholith extends for 160 km from Jihlava (Czech Republic) in the north to the Danube river in the south, and forms large areas in the Austrian part of the Bohemian Massif. The granitoids are late-orogenic plutonic complexes within the Variscan orogenic belt. The are emplaced at mid- to upper-crustal levels into hot country rocks shortly after the thermal peak of regional metamorphism. Clockwise P-T paths in the country rocks suggest that granite formation, low-P/high-T metamorphism and extensional thinning was preceded by a phase of intense crustal thickening which occurred within the framework of the late Palaeozoic continent-continent collision between Baltica and Gondwana. Apart from subordinate basic and intermediate rocks related to the granitoids the South Bohemian Batholith consists of different types of granites.

1. The Rastenberg Granodiorite intruded along the tectonic contact between the Drosendorf and the Monotonous unit. The pluton is granodioritic to quartzmonzonitic in composition. A typical feature of this pluton is the occurrence of dioritic enclaves due to magma mingling. These mafic bodies are more frequent than in any other granitoids of the South Bohemian Batholith.
2. The coarse grained Weinsberg Granite is the most widespread. In general the Weinsberg granite shows a large geochemical variation partly as I-type and partly as S-type granite. Like the Rastenberg granodiorite, it is coarse grained and contains idioblastic K-feldspar of up to 12 cm in size. S-type material, such as amphibolite-facies metasediments, particularly metagreywackes, were the possible protoliths for the Weinsberg granite. Post-plutonic aplites, fine-grained granites and porphyrites cut the Rastenberg granodiorite and the Weinsberg granite. Both granitoids were classified as members of the "older plutons" in the succession of the South Bohemian Batholith.
3. The Eisgarn Granite, which is commonly a muscovite rich granite with clear S-type characteristics. Andalusite is a typical accessory mineral and indicates a crystallisation at a relative small P-T-field formed by the intersection of the andalusite stability field and the granite minimum melt curve. It is obviously contemporaneous with the Weinsberg Granite.
4. The Mauthausen Granite varies from granodioritic to granitic composition and most of the fine-grained biotite granites have been related to this group. They form dikes and irregularly stocks within or in the vicinity of the Weinsberg granite. They are characterized by a clear I-type geochemistry. Inclusions of xenoliths and K-feldspar xenocrysts derived from the Weinsberg type granite are a common phenomenon for Mauthausen granite. In some parts it is considerably younger than the above mentioned types.

The Moravian Zone

The Moravian Zone is regarded as former western marginal zone of the so called Bruno-Vistulian Block, which is an old, at the latest Cadomian consolidated continental micro plate in the eastern part of the Bohemian Massif. Today the Moravian Zone is dissected from the Bruno-Vistulian Block by post-Variscan sinistral strike slip movements along the Diendorf-Boskovice wrench-fault system, which amounted at least 25 km.
During Variscan orogeny the western marginal parts of the Bruno-Vistulian Block were overthrusted by a hot nappe pile of the Moldanubian mobile belt. Thrusting occurred in connection with a strong dextral transpression between the Moldanubicum and the western flank of the Bruno-Vistulian Block. This transpression is responsible for the very charakteristic North-South-trending elongation of the westernmost Moravian lithological units and demonstrates the strong indentation that occurred within the Variscan continent-collision zone of Central Europe. The transpressional movements are followed by local updoming. All these Variscan events together are responsible for the distinct metamorphic and structural style of the Moravian Zone: a high degree of deformation and medium grade metamorphism on top, continously decreasing towards the east and towards the northern and southern ends of the Thaya Dome.
The deepest structural unit of the Moravian Zone is the weakly metamorphosed and deformed granitoid complex of the Thaya Batholith of Cadomian Age. With regard to its petrographical and geochemical characteristics the granitiods of the Thaya Batholith broadly fit the definition of I-type granitoids.

Based on field mapping and chemical work four major lithologies could be distinguished within the Thaya Batholith: the "Hauptgranite"-type (=main granite type) comprises medium-grained light granites and granodiorites with low biotite, the "Gumping"-type defines a more or less gneissic biotite-rich granodiorites and quartz-monzodiorites with blocky K-feldspar phenocrysts and amphibole altered to biotite, the"Passendorf"-type comprises essentially fine- to medium-grained tonalites and meta-tonalites or their gneisses and the "Gauderndorf"-type is a fine grainde granitic to granodioritic rock with somewhat higher biotite contents than the "Hauptgranite" type.

Therasburg Formation

Toward the west the Thaya Batholith is overlain by the Therasburg Formation. It consists of micaschists partly with a considerable amount of albite and/or oligoclase leading to fine grained gneisses. The assumed stratigraphic position is inferred from some preserved intrusive contacts and migmatites of the Cadomian Thaya Batholith as Precadomian.

Stengelgneis of Weitersfeld

This distict gneisss body separates the Therasburg Formation from the tectonical higher sequence of the Pernegg formation. The Weitersfeld gneiss sensu stricto is restricted to the northern part of the Moravian Zone showing a granitic composition with a partly well developed Augen-structure, but seems to be in most parts derived from metaarkoses.

Pernegg-Formation

The Pernegg-Formation comprises micaschists, calcschists and pure marbles, which grade into each other. The marbles prevail in the upper part of the sequence as coherent layers, partly as elongated lenses. The uppermost part of the marbles is formed by a very distict horizon of calcsilicate schists, the so called "Fugnitzer Kalksilikatschiefer". It is an only several meters thick layer, sometimes also found as small layers and lenses in the above lying Bittesch Gneiss.

Bittesch Gneiss

The Bittesch Gneiss is the uppermost unit of the Moravian Zone. It is a highly deformed orthogneiss with well developed Augen structure. Dark ampibolite layers up to 50cm thick are restricted to the uppermost 20 to 30 meters.

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