Underlying unit(s): Hochwipfel Formation (unconformable contact?).

Overlying unit(s): Hochwipfel Formation (unconformable contact?).

Lateral unit(s): Hochwipfel Formation.

Geographic distribution: Carnic Alps.

Remarks: -

Complementary references: KRAINER (1992), SCHÖNLAUB et al. (1992, 2004), SCHÖNLAUB (1997), SCHÖNLAUB & HISTON (1999, 2000), SCHÖNLAUB & FORKE (2007).

Post-Variscan Sequence

Waidegg-Formation / Waidegg Formation

HANS P. SCHÖNLAUB

Validity: Valid; first denomination and formalization by SCHÖNLAUB (1985a: p. 46). Note that SCHÖNLAUB & FORKE (2005: p. 17) renamed the formation in Collendiaul Formation.

Type area: ÖK50-UTM, map sheet 3110 Kötschach-Mauthen (ÖK50-BMN, map sheet 197 Kötschach), Carnic Alps, Carinthia.

Type section: Outflow of Lake Zollner to the west forming a waterfall and a cliff at approx. 1,760 m (N 46°36'13" / E 13°04'39").

Reference section(s): -

Derivation of name: After the ridge west of Lake Zollner (Italian: "Collen") in the Gail Valley between Hermagor and Kötschach-Mauthen.

Synonyms: Waidegger Gruppe (pars) (FENNINGER et al., 1971) exposed at the northern part of the "Waschbühel" ridge east of Waidegger Alm.

Remarks: In Austrian literature, the basal "Auernig beds" (Auernigschichten sensu HERITSCH et al., 1934) have long been described as "Waidegger Group" (FENNINGER et al., 1971). Consequently, SCHÖNLAUB (1985a: p. 46) has defined the Waidegg Formation with the type locality at the outflow of the Lake Zollner. However, the term Waidegger Group has always been intimately connected with the "Waidegger Fauna" (HERITSCH, 1934; HERITSCH et al., 1934; METZ, 1936; GAURI, 1965), which occurs in siltstones of the basal Auernig Formation and is therefore not part of the Waidegg Formation. To avoid further confusion about the lithologic subdivision and the fossil content, the new name "Collendiaul Formation" has been introduced by SCHÖNLAUB & FORKE (2005: p. 17). VENTURINI (1990a), when describing the basal conglomerates and breccias below the Auernig Formation (= Bombaso Formation), introduced the term "Pramollo Member" as part of the "Bombaso Formation". However, the type section of the "Pramollo Member" of the "Bombaso Formation" at the southern foothill of Auernig Mountain in fact represents sediments of the pre-Variscan Hochwipfel Formation. They are not equivalent to the basal conglomerates and breccias at Lake Zollner.

Lithology: Up to 20 m thick lydite breccias and conglomerates which are clast-supported in the lower and matrix-supported in the upper part.

Fossils: The coarse breccia and conglomerate contain no fossils except at the transition to the overlying pebble-bearing beds where some crinoids and gastropods occur.

Origin, facies: According to KRAINER (1992) and VENTURINI (1990a, b) these rocks are interpreted as alluvial fan deposits at the transition to an offshore beach environment.

Chronostratigraphic age: Since direct fossil evidence is missing, the age can only be inferred from conodonts and fusulinids occurring in the overlying beds. They indicate an equivalent of the lower Kasimovian Stage (FORKE & SAMANKASSOU, 2000; SCHÖNLAUB & FORKE, 2007). At locality Tomritsch in the basal deposits also plants of Cantabrian age occur suggesting an overall late Moscovian to early Kasimovian age for the formation of the Waidegg Formation (Collendiaul Formation).

Biostratigraphy: In the basal Auernig Fm. fusulinds (*Protriticites permirus, Beedeina asiatica*) and *conodonts* (*Idiognathodus* cf. *expansus, Swadelina ?* aff. *makhlinae*) indicate lower Kasimovian.

Thickness: Approximately 20 m.

Lithostratigraphically higher rank unit: -

Lithostratigraphic subdivision: -

Underlying unit(s): Bischofalm and Zollner Formations (Silurian to Devonian). An unconformity separates the post-Variscan Waidegg Formation from the underlying pre-Variscan basement (FENNINGER et al., 1976; SCHÖNLAUB, 1985a).

Overlying unit(s): Auernig Formation.

Lateral unit(s): Malinfier Formation (VENTURINI, 1982) and Auernigalm Limestone Breccia (VENTURINI 1990a, b; SCHÖNLAUB & FORKE, 2005) (both not indicated in the ASC 2004).

Geographic distribution: Carnic Alps, Naßfeld and Zollner region across the Austrian/Italian border.

Remarks: -

Complementary references: -

Auernig-Gruppe / Auernig Group

HANS P. SCHÖNLAUB

Validity: Invalid; the name "Auernigschichten" was introduced by FRECH (1894b).

Type area: ÖK50-UTM, map sheet 3116 Sonnenalpe Naßfeld and 3110 Kötschach-Mauthen (ÖK50-BMN, map sheets 197 Kötschach, 198 Weißbriach), central Carnic Alps extending on both sides of the state border between Garnitzen gorge, Naßfeld and Lake Zollner.

Type section: No continuous section is known through the whole succession. FORKE et al. (2006) proposed for the lower parts the "Waschbühel" ridge in the vicinity of the Waidegger Alm (N 46°35'39" / E 13°07'02"), for the middle parts the Naßfeld region above the Watschiger Alm, and for its upper parts the ridge from Gugga to Garnitzen south of Watschiger Alm (N 46°33'37" / E 13°17'53") as type sections.

Reference section(s): -

Derivation of name: Mountain Auernig (1,863 m) south of Naßfeld Pass, Carnic Alps. Auernig stems from the old slavic word "avornik" (German: Ahornberg; English: Acer Mountain).

Synonyms: Auernigschichten (FRECH, 1894b; HERITSCH et al., 1934); Gruppo dell' Auernig (SELLI, 1963).

Lithology: The clastic-carbonate succession is composed of quartz conglomerates, cross-bedded sandstones, bioturbated siltstones, and bedded, massive or nodular limestones.

The up to 20 m thick conglomerates have a grain- or matrix-supported fabric. Individual pebbles reach sizes of 10 cm and are composed predominantly of quartz and minor lydite embedded in a matrix of quartz and mica.

Sand-, siltstone and shale beds (6–50 m) show common cross-bedding and synsedimentary slumping structures. Intercalated shales and siltstones may yield abundant plant debris, large concretions, and are commonly bioturbated. Some of the siltstones are rich in fossils, especially brachiopods. Accessory minerals like tourmaline, zircon, brookite/leukoxen and chloritoid point to plutonic and weakly metamorphosed source rocks for the clastic sediments (FENNINGER & STATTEGGER, 1977; MADER & NEUBAUER, 2004; MADER et al., 2007).

Bedded limestones contain diverse fossil remains (foraminifers, brachiopods, calcareous algae), whereas the indistinctly bedded and massive limestones are composed mainly of calcareous algae in a micritic-peloidal matrix forming mounds. Nodular limestones may occur above the bedded and massive limestones, characterized by their black color, marly interlayers, and accumulation of bryozoans, brachiopods and a silicified microfauna.

Fossils: Fusulinids, smaller foraminifers, conodonts, calcareous algae, corals, coralline sponges (*Sphinctozoa*), ostracods, bryozoans, brachiopods, trilobites, echinoderms, radiolarians, megaplants and trace fossils.

Origin, facies: The existence of Late Paleozoic depositional cycles has already been recognized in the 19th century by repetitive alternations of marine carbonates and siliciclastics with rocks bearing fossil megaplants. The transgressive-regressive pattern has been termed "Auernig rhythm" by KAHLER (1955). More recently, several authors favored a cyclothem model and glacio-eustasy to explain this pattern (MASSARI & VENTURINI, 1990; MASSARI et al., 1991; VENTURINI, 1990a, b, 1991; KRAINER, 1991, 1992; SAMANKASSOU, 1997).

Cyclothems are 10–30 m thick. Different types occur. The lithologies show rapid changes and the sequences exhibit clear transgressive (fining-upward) and regressive (coarsening-upward) tendencies.

The duration of one cyclothem is estimated to be ca. 40 ky by MASSARI & VENTURINI (1990), whereas KRAINER (1992) proposed 100 ky per cyclothem. As no continuous section of the entire succession is exposed and the biostratigraphic resolution by fusulinids is well above the cyclothem duration, uncertainties remain as to the duration. However, the high number of cyclothems in a short period of time favors a glacio-eustatic origin, similar to those of the North American Midcontinent (SAMANKASSOU, 1997, 2002).

Chronostratigraphic age: Pennsylvanian (lower Kasimovian to Gzhelian).

Biostratigraphy: The biostratigraphy and correlation of the succession with other standard subdivisions is predominantly based on fusulinids (KAHLER & KAHLER, 1937, 1982; KAHLER, 1939, 1962, 1983a, b, 1985, 1986a, b, 1992; PASINI, 1963; FORKE et al., 1998; KRAINER & DAVYDOV, 1998; DAVYDOV & KRAINER, 1999), partly in combination with conodonts (FORKE, 1995a, 2002; FORKE & SAMANKASSOU, 2000). Brachiopods, trilobites and ostracods have further been used for biostratigraphic purposes (GAURI, 1965; HAHN & HAHN, 1987; FOHRER, 1991, 1997). Floral remains provide an important contribution for correlation with coeval West and East European deposits (FRITZ & BOERSMA, 1986a, b; FRITZ et al., 1990).

Based on the combined use of conodont and fusulinid faunas and the comparison with faunas from the Cantabrian Mts., Moscow and Donets Basins FORKE & SAMANKASSOU (2000) concluded that the oldest fossiliferous beds of the succession correlate biostratigraphically with the lower Kasimovian (Krevyakinian) although its base is apparently diachronous at different localities.

The upper part of the succession ["Watschiger" Mb., Krone (Corona) Mb., Gugga Mb., Garnitzen (Carnizza) Mb. in the sense of FORKE et al. (2006)] represents a continuous sequence of approximately 400 m thickness. It starts probably during the *Jigulites jigulensis* fusulinid zone (Pavlovoposadian) and ranges throughout the *Daixina sokensis* fusulinid zone (Noginskian) (KRAINER & DAVYDOV, 1998; FORKE, 2007).

Thickness: The composite section reaches a thickness of about 800 m.

Lithostratigraphically higher rank unit: -

Lithostratigraphic subdivision: In successive order the following formations were proposed by SELLI (1963) which, however, according to FORKE et al. (2006) and SCHÖNLAUB & FORKE (2007) must be regarded as Members: Meledis, Pizzul, Corona, Auernig and Carnizza. These members grossly correspond to the lithostratigraphic subdivision of HERITSCH et al. (1934).

Underlying unit(s): Waidegg Formation (now renamed in Collendiaul Formation).

Overlying unit(s): Lower Pseudoschwagerina Formation (recte: Schulterkofel Formation).

Lateral unit(s): No lateral transition into other units is known.

Geographic distribution: Carnic Alps of Austria and Italy, Karavanke Mountains of Austria and Slovenia.

Remarks: HERITSCH et al. (1934) lithologically defined and subdivided the "Auernigschichten" according to the predominance of limestone horizons into five units ("untere kalkarme, untere kalkreiche, mittlere kalkarme, obere kalkreiche, obere kalkarme Schichtgruppe"). A type section for the lower two units has been chosen along the "Waschbüchel" ridge in the vicinity of the Waidegger Alm. The upper part of the second unit ("untere kalkreiche Schichtgruppe") was defined as "Watschiger Schichten" with the type locality above the Watschiger Alm. The upper three units have their type section along the mountain ridge from Gugga to Garnitzen.

SELLI (1963) introduced in his description of the five formations of the Auernig Group the terms Meledis, Pizzul, Corona, Auernig and Carnizza, which are regarded as equivalents to those of HERITSCH et al. (1934). To avoid further

confusion between the terms “Auernig Formation” sensu SELLI (1963) and the term “Auernig Formation” used herein, the term “Gugga Member” was proposed by SCHÖNLAUB & FORKE (2007) as analogous replacement for the “obere kalkreiche Schichtgruppe” sensu HERITSCH et al. (1934). The Trögl-Creta di Rio Secco Member was introduced by FORKE et al. (2006) to describe a carbonate succession at Rosskofel (Monte Cavallo), directly overlying folded Devonian–lower Carboniferous limestones.

VENTURINI (1990) and VAI & VENTURINI (1997) proposed a revised stratigraphic subdivision of the upper Carboniferous clastic/carbonate succession of the Auernig Group, consisting of five formations and excluded the basal breccias and conglomerates as Bombaso Formation (Waidegg Formation in the ASC 2004 and Collendiaul Formation of SCHÖNLAUB & FORKE, 2005, respectively). This scheme was adopted by most following authors (KRAINER, 1990a, 1991, 1992, 1995; KRAINER & DAVYDOV, 1998; DAVYDOV & KRAINER, 1999).

However, due to the strong faulting and complex tectonics it is often difficult to find sections allowing a definition of the base and top of stratigraphic units. Up to now, a complete succession with composite sections has never been reconstructed, individual sections have neither lithologically, nor faunistically been successfully correlated, and a definition of stratigraphic units after the “Recommendations (guidelines) of the usage of stratigraphic nomenclature” (STEININGER & PILLER, 1999) has never been undertaken.

Furthermore, the proposed stratigraphic subdivision of the “Auernig Group” into formations would require distinguishing the formations as mappable units in the field. However, the formations are neither traceable for longer distances, nor presentable in geological maps.

There are several reasons to keep the upper Carboniferous succession as Auernig Formation and to give informal names for the different investigated sections:

1. The “untere kalkreiche Schichtgruppe” (or the equivalent “Pizzul Formation”) consists of two parts (Waschbühel Schichten and Watschiger Schichten), which have never been successfully correlated. Moreover, the base of the formation has never been defined after the revision of FENNINGER et al. (1971). The alternatively proposed type section (after the locality Monte Pizzul) is neither lithologically, nor biostratigraphically sufficiently investigated for correlation.

2. The “untere kalkarme Schichtgruppe” (or the equivalent “Meledis Formation”) in its original type section (Waschbühel ridge) is composed of two units bounded by tectonic contacts. Biostratigraphic data are available only from the northern (“lower”) part (so-called “Waidegger Fauna” of HERITSCH et al., 1934; METZ, 1936; GAURI, 1965). In the alternatively proposed type section (section Rio Cordin east of the Casera Meledis) the base of the formation is not exposed and the succession is overlain directly by the Middle Permian Gröden Formation. Moreover, KRAINER & DAVYDOV (1998) described an “early Gzhelian” (more probably late Kasimovian) fauna from this section, although the overlying (?) Pizzul Formation is partly older (middle-late Kasimovian fauna of the Waschbühel ridge).

Complementary references: -

Untere Pseudoschwagerinen-Formation / Lower Pseudoschwagerina Formation

[recte: Schulterkofel-Formation / Schulterkofel Formation (KRAINER, 1995)]

HANS P. SCHÖNLAUB

Validity: First denomination by KAHLER (1947) and later formalized by KRAINER (1995) who renamed the former Lower Pseudoschwagerina Limestone following international recommendations into Schulterkofel Formation (= valid).

Type area: ÖK50-UTM, map sheet 3116 Sonnenalpe Naßfeld (ÖK50-BMN, map sheet 198 Weißbriach), Carnic Alps, Carinthia.

Type section: The lower boundary and main part of the Schulterkofel Formation is exposed at the section along the northwestern edge of the cliff of the Mountain Schulterkofel (N 46°35’24” / E 13°10’09”).
Remarks: The upper boundary of the Schulterkofel Formation and transition to the basal Grenzland Formation is best exposed above the trail from Rattendorfer Schneid to Cordin Alm in a section forming peak 1,997 m ranging from the base of the cliff to south of peak 1,997 m.

Reference section(s): -

Derivation of name: After the genus *Pseudoschwagerina*, a fusulinid foraminifer.

Synonyms: Unterer Schwagerinenkalk (HERITSCH et al., 1934: p. 176); Unterer Pseudoschwagerinenkalk (KAHLER, 1947: p. 61); untere Pseudoschwagerinen Schichten (E. FLÜGEL, 1975); untere Pseudoschwagerinen-Formation (SCHÖNLAUB et al., 1988).
Remarks: Due to changes in the fusulinid systematics, KAHLER (1947) changed the original Lower Schwagerina Lst. of HERITSCH et al. (1934) to Lower Pseudoschwagerina Lst. However, since the genus *Pseudoschwagerina* is missing in this section, KRAINER (1995) recommended a change of the name according to the international usage of lithostratigraphic nomenclature.

Lithology: The Lower Pseudoschwagerina Formation (Schulterkofel Formation) is predominantly a carbonate succession with subordinate fine sand- and siltstones. Siliciclastic beds are often intercalated with fossiliferous horizons, grading from calcareous sandstones to sandy limestones with tempestitic beds, rich in smaller foraminifers, echinoderm fragments, brachiopods and gastropods.

Massive limestones form up to 20 m high, almost monospecific (*Anthracoporella spectabilis*) mounds with a sparse associated fauna of rare smaller foraminifers, ostracods and gastropods embedded in a micritic-peloidal matrix. Medium- to thick-bedded limestones occur at the base and in between individual mounds composed of a higher diverse fauna with foraminifers, phylloid algae and others.

Mounds and bedded limestones are overlain by dark, nodular limestones (partly with shale interlayers) with chert nodules containing thick-shelled brachiopods, cephalopods and solitary corals.

Fossils: Fusulinids, smaller foraminifers, phylloid algae, dasycladacean algae (*Anthracoporella*), microproblematica (*Tubiphytes*).

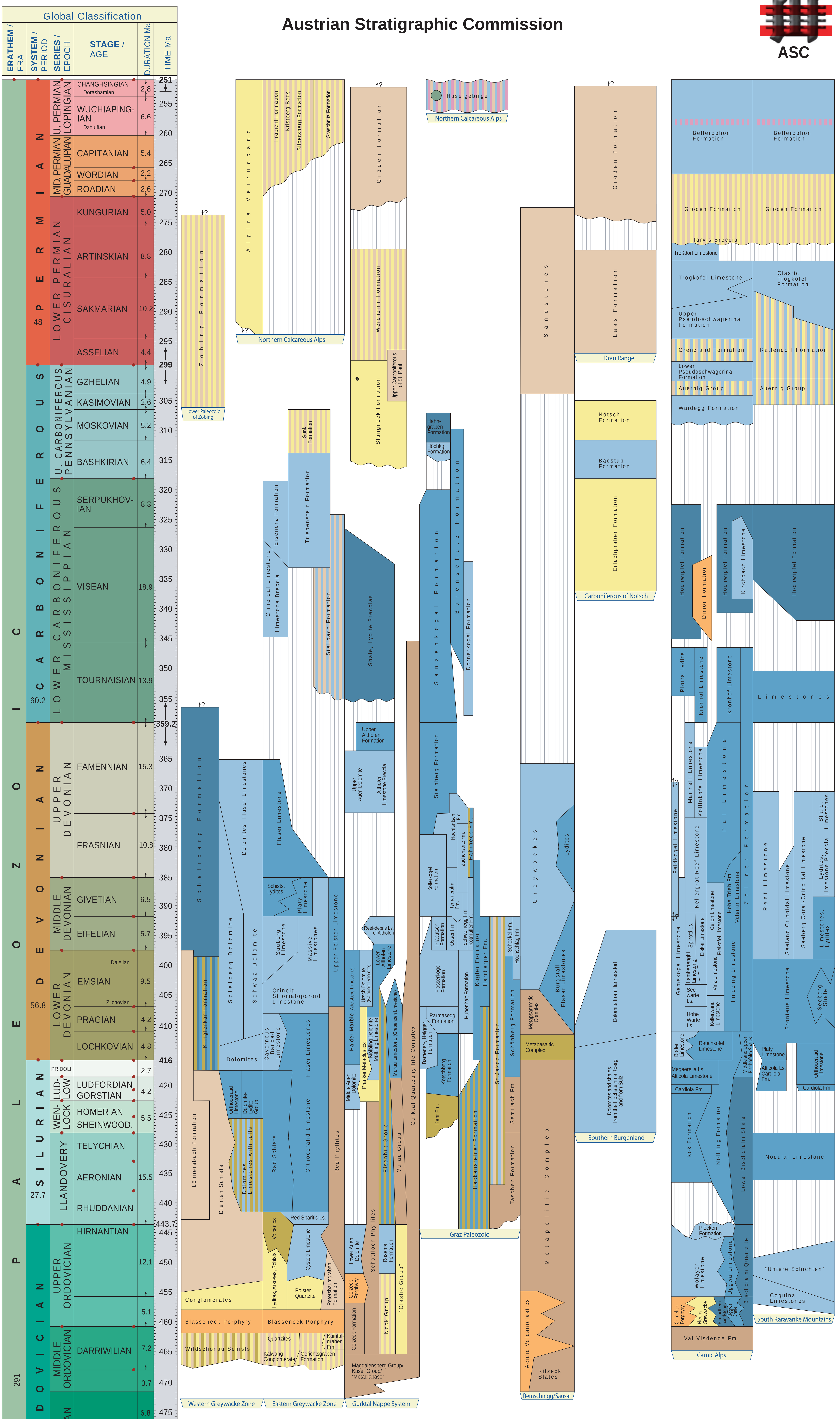
Origin, facies: Siliciclastics at the base represent shoreface deposits. Bedded and massive limestones occur below the storm wave base, but within the photic zone during

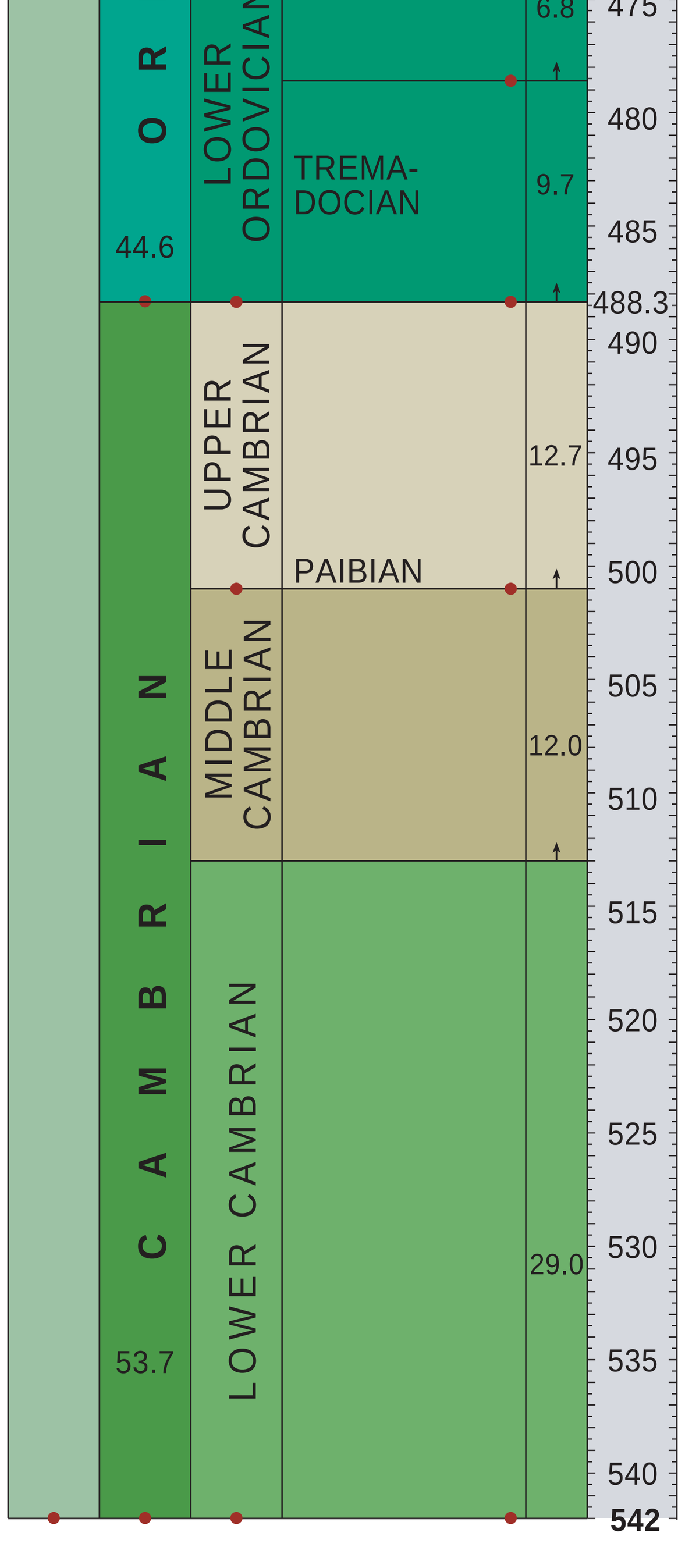
Austrian Stratigraphic Chart 2004 - Paleozoic

(sedimentary successions)

Austrian Stratigraphic Commission

ASC





Legend

- pelagic, offshore, siliciclastic
- pelagic, nearshore, calcareous
- shallow marin, neritic
- terrestrial-continental, coarse clastic
- terrestrial-continental, fine clastic
- evaporite (chloride, sulphate)
- rhyolite, dacite
- (basaltic) andesite, trachyandesite
- basalt
- phyllite
- mixed-facies (in corresponding colors)
- ● coal (may include several seams)
- ? position/age doubtful/controversial
- | equal units
- \ older unit left \ younger unit right
- hiatus
- unconformity
- ● GSSP
- Fm. Formation
- Ls. Limestone

Cutout and English adaptation of the "Die Stratigraphische Tabelle von Österreich 2004": Geological Survey of Austria

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